Application: 21-06-021
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Exhibit No.: (PG&E-4)
Date: November 5, 2021
Witness(es): Various

PACIFIC GAS AND ELECTRIC COMPANY

2023 GENERAL RATE CASE

EXHIBIT (PG&E-4)

ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING CHAPTERS 14-23

VOLUME 2 OF 2

[INCLUDES NOVEMBER 5, 2021 ERRATA]



PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4)
ELECTRIC DISTRIBUTION

TABLE OF CONTENTS

Chapter	Title	Witness
2	ELECTRIC DISTRIBUTION FORECAST AND INVESTMENT PLANNING [INCLUDES NOVEMBER 5, 2021 ERRATA]	Tatjana Rmus
3	ELECTRIC DISTRIBUTION RISK MANAGEMENT [INCLUDES NOVEMBER 5, 2021 ERRATA]	Paul McGregor
4	WILDFIRE RISK MITIGATIONS [INCLUDES NOVEMBER 5, 2021 ERRATA]	Ben Almario Mark Esguerra Shawn Holder Tahir Paroo Matthew T. Pender
5	EMERGENCY PREPAREDNESS AND RESPONSE [INCLUDES NOVEMBER 5, 2021 ERRATA]	Angelina M. Gibson
6	ELECTRIC EMERGENCY RECOVERY	Angelina M. Gibson Marcus Wendler
7	DISTRIBUTION SYSTEM OPERATIONS	Kari Chester
8	FIELD METERING [INCLUDES NOVEMBER 5, 2021 ERRATA]	Craig W. Kurtz
9	VEGETATION MANAGEMENT	Kamran Rasheed
10	OVERHEAD AND UNDERGROUND ELECTRIC ASSET INSPECTIONS	Mark Esguerra
11	OVERHEAD AND UNDERGROUND ELECTRIC DISTRIBUTION MAINTENANCE [INCLUDES NOVEMBER 5, 2021 ERRATA]	Mark Esguerra[1]
12	POLE ASSET MANAGEMENT	Mark Esguerra[1]

1 New witness from the June 30, 2021 submission.

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4)
ELECTRIC DISTRIBUTION

TABLE OF CONTENTS
(CONTINUED)

Chapter	Title	Witness
13	OVERHEAD AND UNDERGROUND ASSET MANAGEMENT AND RELIABILITY [INCLUDES NOVEMBER 5, 2021 ERRATA]	Mark Esguerra[1]
14	NETWORK ASSET MANAGEMENT	Mark Esguerra[1]
15	SUBSTATION ASSET MANAGEMENT [INCLUDES NOVEMBER 5, 2021 ERRATA]	Maria P. Ly
16	DISTRIBUTION SYSTEM AUTOMATION AND PROTECTION [INCLUDES NOVEMBER 5, 2021 ERRATA]	David Carroll
17	ELECTRIC DISTRIBUTION CAPACITY, ENGINEERING, AND PLANNING	Satvir Nagra
18	NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS [INCLUDES NOVEMBER 5, 2021 ERRATA]	Josh Jones
19	RULE 20A	Tamon Norimoto
20	ELECTRIC DISTRIBUTION DATA MANAGEMENT AND TECHNOLOGY	Jadwindar Singh
21	INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN [INCLUDES NOVEMBER 5, 2021 ERRATA]	Quinn Nakayama Elaine Reusing
22	ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES	Tatjana Rmus
23	COMMUNITY REBUILD PROGRAM [INCLUDES NOVEMBER 5, 2021 ERRATA]	Marcela Fox

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 14, NETWORK ASSET MANAGEMENT

TABLE OF CONTENTS

Subject	Page No.
Expense Workpapers	
Workpaper Table 14-1: Expenses by Major Work Category - Nominal Dollars	WP 14-1
Workpaper Table 14-2: Expenses by Major Work Category - Base Year Dollars	WP 14-2
Workpaper Table 14-3: Major Work Category KC - Recorded Walk	WP 14-3
Workpaper Table 14-4: Major Work Category KC - Forecast Walk	WP 14-4
Workpaper Table 14-5: MWC KC Forecast Details	WP 14-5
Workpaper Table 14-6: Unit Cost and Forecast Details: MAT KCA	WP 14-6
Workpaper Table 14-7: Unit Cost and Forecast Details: MAT KCB	WP 14-7
Workpaper Table 14-8: Unit Cost and Forecast Details: MAT KCD	WP 14-8
Workpaper Table 14-9: Unit Cost and Forecast Details: MAT KCE	WP 14-9

PACIFIC GAS AND ELECTRIC COMPANY
2020 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 14, NETWORK ASSET MANAGEMENT
TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Capital Workpapers	
Workpaper Table 14-10: Capital Expenditures by Major Work Category	WP 14-10
Workpaper Table 14-11: Forecast Capital Expenditures Summary	WP 14-11
Workpaper Table 14-12: Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million	WP 14-12
Workpaper Table 14-13: Recorded and Forecast Capital Expenditures Details - Other Work	WP 14-13
Workpaper Table 14-14: Major Work Category 2C - Recorded Walk	WP 14-14
Workpaper Table 14-15: Major Work Category 2C - Forecast Walk	WP 14-15
Workpaper Table 14-16: Major Work Category 2C - Forecast Details	WP 14-16
Workpaper Table 14-17: Unit Cost and Forecast Details: MAT 2CA	WP 14-17
Workpaper Table 14-18: Unit Cost and Forecast Details: MAT 2CC	WP 14-18
Workpaper Table 14-19: Unit Cost and Forecast Details: MAT 2CD	WP 14-19
Workpaper Table 14-20: MAT 56N - Recorded Walk	WP 14-20
Workpaper Table 14-21: MAT 56N - Forecast Walk	WP 14-21
Workpaper Table 14-22: MAT 56N Network Systems Forecast Details	WP 14-22
Workpaper Table 14-23: Unit Cost and Forecast Details: MAT 56N	WP 14-23
Project Summary - Network SCADA Safety Monitoring	WP 14-24
Project Summary - Venting Manhole Cover Program	WP 14-26
Project Summary – Cable Replacements in San Francisco and East Bay Network Systems	WP 14-28
Project Summary - Network Transformer Protector Replacements	WP 14-31

Workpaper Table 14-1
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 14
Network Asset Management
Expenses by Major Work Category
(Thousands of Nominal Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference (A)
1	KC	Network Preventive Maintenance and Repair	4,196	3,693	4,007	4,514	4,891	4,198	4,204	5,021	WP 14-3, WP 14-4
2	**Total**		**4,196**	**3,693**	**4,007**	**4,514**	**4,891**	**4,198**	**4,204**	**5,021**	

Workpaper Table 14-2
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 14
Network Asset Management
Expenses by Major Work Category
(Thousands of Base Year Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast
1	KC	Network Preventive Maintenance and Repair	4,643	3,992	4,213	4,600	4,891	4,107	3,985	4,609
2	**Total**		**4,643**	**3,992**	**4,213**	**4,600**	**4,891**	**4,107**	**3,985**	**4,609**

Workpaper Table 14-3
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #14, Network Asset Management
Major Work Category KC – Recorded Walk
MWC KC - Network Preventive Maintenance and Repair
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$ 4,196**			
2		Network Related EC Notifications (MAT KCA)	$ (47)		Minor variations in work cost.	WP 14-5 Line 2
3		Network Transformer Oil Replacement (MAT KCB)	$ (27)		Minor variations in work cost.	WP 14-5 Line 3
4		Network Vault Cleanup (MAT KCC)	$ (45)		Minor variations in work cost.	WP 14-5 Line 8
5		Network Transformer Oil Sampling (MAT KCD)	$ (131)		Minor variations in work cost.	WP 14-5 Line 4
6		Network Protector Maintenance (MAT KCE)	$ (143)		PG&E maintains 4 of the 12 network groups per year (3-year cycle). The variation in cost is due to the number of network protectors per network group and the timing of the cycles.	WP 14-5 Line 5
7		Fiber Optic/SCADA Communication Repair (MAT KCF)	$ (110)		Minor variations in work cost.	WP 14-5 Line 9
8	**2017**	**Recorded Adjusted**	**$ 3,693**			
9		Network Related EC Notifications (MAT KCA)	$ 175		EC Notification spend fluctuates year over year because there is a wide range of repairs covered in this MAT code and a varying number of repairs per year.	WP 14-5 Line 2
10		Network Transformer Oil Replacement (MAT KCB)	$ 2		Minor variations in work cost.	WP 14-5 Line 3
11		Network Vault Cleanup (MAT KCC)	$ 80		Minor variations in work cost.	WP 14-5 Line 8
12		Network Transformer Oil Sampling (MAT KCD)	$ (386)		Temporary reduction in work	WP 14-5 Line 4
13		Network Protector Maintenance (MAT KCE)	$ 89		Minor variations in work cost.	WP 14-5 Line 5
14		Fiber Optic/SCADA Communication Repair (MAT KCF)	$ 354		Increase in contract labor cost.	WP 14-5 Line 9
15	**2018**	**Recorded Adjusted**	**$ 4,007**			
16		Network Related EC Notifications (MAT KCA)	$ (216)		EC Notification spend fluctuates year over year because there is a wide range of repairs covered in this MAT code and a varying number of repairs per year.	WP 14-5 Line 2
17		Network Transformer Oil Replacement (MAT KCB)	$ 27		Minor variations in work cost.	WP 14-5 Line 3
18		Network Vault Cleanup (MAT KCC)	$ (72)		Minor variations in work cost.	WP 14-5 Line 8
19		Network Transformer Oil Sampling (MAT KCD)	$ 439		Work returned to planned levels	WP 14-5 Line 4
20		Network Protector Maintenance (MAT KCE)	$ 187		PG&E maintains 4 of the 12 network groups per year (3-year cycle). The variation in cost is due to the number of network protectors per network group and the timing of the cycles.	WP 14-5 Line 5
21		Fiber Optic/SCADA Communication Repair (MAT KCF)	$ 70		Minor variations in work cost.	WP 14-5 Line 9
22		Standard Cost Variance (MAT KC#)	$ 73		Minor variations in work cost.	WP 14-5 Line 10
23	**2019**	**Recorded Adjusted**	**$ 4,514**			
24		Network Related EC Notifications (MAT KCA)	$ (114)		EC Notification spend fluctuates year over year because there is a wide range of repairs covered in this MAT code and a varying number of repairs per year.	WP 14-5 Line 2
25		Network Transformer Oil Replacement (MAT KCB)	$ 85		Minor variations in work cost.	WP 14-5 Line 3
26		Network Vault Cleanup (MAT KCC)	$ 23		Minor variations in work cost.	WP 14-5 Line 8
27		Network Transformer Oil Sampling (MAT KCD)	$ 590		Increase due to alternative work schedule as a result of COVID-19.	WP 14-5 Line 4
28		Network Protector Maintenance (MAT KCE)	$ 102		PG&E maintains 4 of the 12 network groups per year (3-year cycle). The variation in cost is due to the number of network protectors per network group and the timing of the cycles.	WP 14-5 Line 5
29		Fiber Optic/SCADA Communication Repair (MAT KCF)	$ (237)		Reduced contractor labor costs as a result of COVID-19.	WP 14-5 Line 9
30		Standard Cost Variance (MAT KC#)	$ (73)		Minor variations in work cost.	WP 14-5 Line 10
31	**2020**	**Recorded Adjusted**	**$ 4,891**			

Workpaper Table 14-4
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #14, Network Asset Management
Expenses by Major Work Category KC – Forecast Walk
MWC KC - Network Preventive Maintenance and Repair
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$ 4,891**			
2		Network Related EC Notifications (MAT KCA)	$ 102		Minor forecast variations consistent with recorded data.	WP 14-5 Line 2
3		Network Transformer Oil Replacement (MAT KCB)	$ (93)		Minor forecast variations consistent with recorded data.	WP 14-5 Line 3
4		Network Vault Cleanup (MAT KCC)	$ 30		No significant change.	WP 14-5 Line 8
5		Network Transformer Oil Sampling (MAT KCD)	$ (94)		Minor forecast variations consistent with recorded data.	WP 14-5 Line 4
6		Network Protector Maintenance (MAT KCE)	$ (176)		2020 spend was higher than average due to alternative work schedule as a result of COVID-19. Forecasted work is consistent with historical averages.	WP 14-5 Line 5
7		Fiber Optic/SCADA Communication Repair (MAT KCF)	$ 177		Forecasted work consistent with historical averages. Less work was performed in 2020 due to COVID-19 pandemic.	WP 14-5 Line 9
8		Forecast Adjustment (MAT KC#)	$ (638)		Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.	WP 14-5 Line 11
9	**2021**	**Forecast**	**$ 4,198**			
10		Network Related EC Notifications (MAT KCA)	$ 0		No significant change.	WP 14-5 Line 2
11		Network Transformer Oil Replacement (MAT KCB)	$ 0		No significant change.	WP 14-5 Line 3
12		Network Vault Cleanup (MAT KCC)	$ 0		No significant change.	WP 14-5 Line 8
13		Network Transformer Oil Sampling (MAT KCD)	$ 4		No significant change.	WP 14-5 Line 4
14		Network Protector Maintenance (MAT KCE)	$ 1		No significant change.	WP 14-5 Line 5
15		Fiber Optic/SCADA Communication Repair (MAT KCF)	$ 1		No significant change.	WP 14-5 Line 9
16		Forecast Adjustment (MAT KC#)	$ (1)		No significant change.	WP 14-5 Line 11
17	**2022**	**Forecast**	**$ 4,204**			
18		Network Related EC Notifications (MAT KCA)	$ 237		EC Notification spend fluctuates year over year because there is a wide range of repairs covered in this MAT code and a varying number of repairs per year.	WP 14-5 Line 2
19		Network Transformer Oil Replacement (MAT KCB)	$ (7)		No significant change.	WP 14-5 Line 3
20		Network Vault Cleanup (MAT KCC)	$ 31		Increase for additional costs related to environmental cleanup work that is anticipated to increase as more focus is placed on biohazard waste cleanup in San Francisco.	WP 14-5 Line 8
21		Network Transformer Oil Sampling (MAT KCD)	$ (161)		No significant change.	WP 14-5 Line 4
22		Network Protector Maintenance (MAT KCE)	$ (6)		No significant change.	WP 14-5 Line 5
23		Fiber Optic/SCADA Communication Repair (MAT KCF)	$ 83		No significant change.	WP 14-5 Line 9
24		Forecast Adjustment (MAT KC#)	$ 639		No forecast adjustment in 2023.	WP 14-5 Line 11
25	**2023**	**Forecast**	**$ 5,021**			

Workpaper Table 14-5
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 14, Network Asset Management
Expenses by Major Work Category KC – Forecast Details
(Thousands of Nominal Dollars)

Line No.		MAT CODE	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	Assumptions	Reference
1	**Total Cost by Activity Type**											
2	Total Cost of Network Related EC Notifications	KCA	$ 299	$ 252	$ 428	$ 212	$ 98	$ 200	$ 200	$ 438		WP 14-6
3	Total Cost of Network Transformer Oil Replacemer	KCB	$ 47	$ 20	$ 21	$ 48	$ 133	$ 40	$ 40	$ 33		WP 14-7
4	Total Cost of Network Transformer Oil Sampling	KCD	$ 2,474	$ 2,343	$ 1,956	$ 2,395	$ 2,986	$ 2,891	$ 2,896	$ 2,735		WP 14-8
5	Total Cost of Network Protector Maintenance	KCE	$ 645	$ 502	$ 592	$ 779	$ 881	$ 705	$ 706	$ 700		WP 14-9
6	**Subtotal Cost by Activity Type**		$ 3,464	$ 3,117	$ 2,997	$ 3,434	$ 4,097	$ 3,836	$ 3,842	$ 3,905		
7	**Additional Project Cost**											
8	Total Cost of Network Vault Cleanup	KCC	$ 85	$ 39	$ 119	$ 47	$ 70	$ 100	$ 100	$ 131	(1)	
9	Fiber Optic/SCADA Communication Repair	KCF	$ 647	$ 537	$ 891	$ 960	$ 723	$ 900	$ 901	$ 985	(2)	
10	Standard Cost Variance	KC#	$ -	$ -	$ -	$ 73	$ 0	$ -	$ -	$ -	(3)	
11	Forecast Adjustment	KC#	$ -	$ -	$ -	$ -	$ -	$ (638)	$ (639)	$ -	(4)	Chapter 2 Section D
12	**Subtotal Additional Project Costs**		$ 732	$ 576	$ 1,009	$ 1,080	$ 794	$ 362	$ 362	$ 1,116		
13	**Total MWC KC**		**$ 4,196**	**$ 3,693**	**$ 4,007**	**$ 4,514**	**$ 4,891**	**$ 4,198**	**$ 4,204**	**$ 5,021**		

Forecast Assumptions and Details

(1) Network vault cleanup involves basic repairs and environmental cleanup. The 2023 forecast is based on recorded costs plus an increase for additional costs related to environmental cleanup work that is anticipated to increase as more focus is placed on biohazard waste cleanup in San Francisco.
(2) The forecasted unit/unit costs are based on historical recorded amounts, taking into account the most recent trends for the program. These costs are expected to remain fairly consistent through the forecast years.
(3) These recorded costs include the standard cost variance and small miscellaneous projects.
(4) Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.

Workpaper Table 14-6
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 14 - Network Asset Management
Unit Cost and Forecast Details: MAT KCA

Line No.		
1	**MAT Code**	KCA
2	**GRC Ch.**	14 - Network Asset Management
3	**MAT Code Definition**	Network Equipment CM Notifications – Repairs related to network transformers and NPs. Does not include oil replacement work. Units measured: Number of notifications. This program relates to safety, reliability, or maintenance because it addresses troubles found on the network equipment and repairs made to correct the problems to maintain a safe and reliable distribution network system.

	Risk ID	Type	Name
4	DNTWK-C002	Control	Maintenance and Corrective Work

5	**Program Area**	Maintenance and Compliance
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Locations
8	**Unit Cost (2023)**	$ 5,469
9	**Unit Cost Forecast Basis**	Historic costs for similar types of work over past five years and adjustments for escalated labor costs and varying work environment.
10	**Unit Forecast Basis**	Based on number of units averaged from 2016 through 2020.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 299,354	$ 252,321	$ 427,641	$ 211,578	$ 97,557	Calculated - Line 12 * Line 13
12	**No. of Units**	116	76	104	63	41	
13	**Unit Cost**	$ 2,581	$ 3,320	$ 4,112	$ 3,358	$ 2,379	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 199,980	$ 200,272	$ 437,557	Calculated - Line 15 * Line 16
15	**No. of Units**	40	40	80	
16	**Unit Cost**	$ 5,000	$ 5,007	$ 5,469	

17	**Notes (A)**	Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper Table 14-7
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 14 - Network Asset Management
Unit Cost and Forecast Details: MAT KCB

Line No.		
1	**MAT Code**	KCB
2	**GRC Ch.**	14 - Network Asset Management
3	**MAT Code Definition**	Network Transformer Oil Replacement & 60-Day Follow Up Notifications – Replacement of oil in network primary termination chambers or network ground switches. Includes resample of network transformer oil. Units measured: Number of oil replacements. This program relates to safety, reliability, or maintenance because it addresses the issues identified on the sample oil from laboratory testing. The replacement of the oil at the network transformer chamber is needed to maintain safe operation.

	Risk ID	**Type**	**Name**
4	DNTWK-C002	Control	Maintenance and Corrective Work

5	**Program Area**	Maintenance and Compliance
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Locations
8	**Unit Cost (2023)**	$ 1,313
9	**Unit Cost Forecast Basis**	Historic costs for similar types of work from 2016-2019. Elevated units and cost in 2020 are due to preparation work for SCADA project. 2021 and 2022 are expected to be elevated due to carryover work from 2020 and 2021, respectively.
10	**Unit Forecast Basis**	Based on number of units averaged from 2016 through 2019. (Units completed in 2020 are elevated due to preparation work for SCADA project. 2021 and 2022 units are expected to be elevated as well due to carryover work from 2020 and 2021, respectively.)

		Recorded Costs & Units (A)					**Reference**
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 46,774	$ 19,719	$ 21,438	$ 47,988	$ 132,958	Calculated - Line 12 * Line 13
12	**No. of Units**	136	123	49	26	197	
13	**Unit Cost**	$ 344	$ 160	$ 438	$ 1,846	$ 675	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 39,996	$ 40,055	$ 32,817	Calculated - Line 15 * Line 16
15	**No. of Units**	125	100	25	
16	**Unit Cost**	$ 320	$ 401	$ 1,313	

17	**Notes (A)**	Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper Table 14-8
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 14 - Network Asset Management
Unit Cost and Forecast Details: MAT KCD

Line No.		
1	**MAT Code**	KCD
2	**GRC Ch.**	14 - Network Asset Management
3	**MAT Code Definition**	Network Transformer Preventive Maintenance/Restore Notifications – Annual maintenance on network transformers and associated oil filled chambers. Includes oil sampling on all chambers and pressure testing of units. Units measured: Number of oil samplings. This program relates to safety, reliability, or maintenance because it addresses the maintenance of network transformers for safe and reliable operation.

	Risk ID	Type	Name
4	DNTWK-C002	Control	Maintenance and Corrective Work

5	**Program Area**	Maintenance and Compliance
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Transformer Oil Tests
8	**Unit Cost (2023)**	$ 760
9	**Unit Cost Forecast Basis**	Historic costs for similar types of work over past two years.
10	**Unit Forecast Basis**	Units are fixed and work is performed on an annual basis.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 2,473,501	$ 2,342,538	$ 1,956,481	$ 2,395,372	$ 2,985,679	Calculated - Line 12 * Line 13
12	**No. of Units**	3,479	3,473	3,477	3,490	3,542	
13	**Unit Cost**	$ 711	$ 674	$ 563	$ 686	$ 843	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 2,891,303	$ 2,895,517	$ 2,734,733	Calculated - Line 15 * Line 16
15	**No. of Units**	3,600	3,600	3,600	
16	**Unit Cost**	$ 803	$ 804	$ 760	

17	**Notes (A)**	Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper Table 14-9
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 14 - Network Asset Management
Unit Cost and Forecast Details: MAT KCE

Line No.		
1	**MAT Code**	KCE
2	**GRC Ch.**	14 - Network Asset Management
3	**MAT Code Definition**	NP Preventive Maintenance Notifications – Routine maintenance of NPs conducted once every three years (triennial). Excludes repairs in excess of $500 or requiring greater than one hour which are covered by MAT category KCA. Units measured: Number of protector maintenance tags. This program relates to safety, reliability, or maintenance because it addresses the maintenance of NPs for safe and reliable operation.

	Risk ID	Type	Name
4	DNTWK-C002	Control	Maintenance and Corrective Work

5	**Program Area**	Maintenance and Compliance
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Network Protectors
8	**Unit Cost (2023)**	$ 1,742
9	**Unit Cost Forecast Basis**	Historic costs for similar types of work over past several years for each cycle.
10	**Unit Forecast Basis**	Units are fixed on a 3-year cycle.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 644,805	$ 502,225	$ 591,615	$ 778,800	$ 880,903	Calculated - Line 12 * Line 13
12	**No. of Units**	478	388	472	505	402	
13	**Unit Cost**	$ 1,349	$ 1,294	$ 1,253	$ 1,542	$ 2,191	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 704,927	$ 705,955	$ 700,092	Calculated - Line 15 * Line 16
15	**No. of Units**	468	537	402	
16	**Unit Cost**	$ 1,506	$ 1,315	$ 1,742	

17	**Notes (A)**	Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper Table 14-10
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 14
Network Asset Management
Capital Expenditures by Major Work Category
(Thousands of Nominal Dollars)

			Capital Expenditures											
No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	2C	Inst/Repl Network Assets	14,532	17,490	20,847	18,470	22,566	15,868	18,739	13,552	13,605	13,704	13,828	WP 14-14, WP 14-15
2	56	E Dist Replace UG Asset-Gen	11,000	19,893	24,548	20,746	21,929	25,199	25,199	30,871	31,706	32,562	33,441	WP 14-20, WP 14-21
3		**Grand Total**	**25,532**	**37,383**	**45,395**	**39,216**	**44,495**	**41,067**	**43,938**	**44,423**	**45,312**	**46,265**	**47,269**	

Workpaper Table 14-11
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 14
Network Asset Management
Forecast Capital Expenditures Summary
(Thousands of Nominal Dollars)

		Capital Expenditures							
Line No.	Description	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	Projects > $3 Million*	17,614	25,269	42,542	43,879	44,753	45,691	46,680	WP 14-12
2	Other Work	1,234	15,798	1,396	544	559	574	589	WP 14-13
3	**Total**	**18,848**	**41,067**	**43,938**	**44,423**	**45,312**	**46,265**	**47,269**	

4 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 14-12
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 14
Network Asset Management
Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million*
(Thousands of Nominal Dollars)

					CWIP	Capital Expenditures							
Line No.	Planning Order	Description	MWC	Operative Date	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Subtotal	Reference
	MWC - 2C	**Inst/Repl Network Assets**											
1	5543515	SYSPLAN ED 2CC DNTWK-C003	2C		-	-	2,855	987	2,462	2,279	2,115	10,698	
2	5544394	SYSPLAN ED 2CC DNTWK-M001	2C		-	3,122	-	-	-	-	-	3,122	
3	5544395	SYSPLAN ED 2CC DNTWK-M005	2C		-	-	5,378	2,684	1,013	1,041	1,069	11,185	
4	5544397	SYSPLAN ED 2CE DNTWK-M003	2C		-	8,926	9,110	9,337	9,571	9,810	10,055	56,809	
5	5778512	Network SCADA Loop Replac and Safety Ins	2C	Jun-2021	10,861	-	-	-	-	-	-	10,861	
6	**Total**				**10,861**	**12,048**	**17,343**	**13,008**	**13,046**	**13,130**	**13,239**	**92,675**	WP 14-16
	MWC - 56	**E Dist Replace UG Asset-Gen**											
7	5780541	C1106 Primary Cable Repl-OaK Netwrk	56	Jul-2021	4,314	1,809	-	-	-	-	-	6,123	
8	5780546	X1123 Primary Cable Repl-SF Ntwrk	56	Mar-2021	2,084	1,113	-	-	-	-	-	3,197	
9	5780551	Z1106 Primary Cable Repl-SF Ntwrk	56	Dec-2021	294	3,001	-	-	-	-	-	3,295	
10	5787758	Y1Phase 2 Secondary Cable Replacement SF	56	Aug-2021	45	4,299	-	-	-	-	-	4,344	
11	5791729	Y1132 Pri Cable Replaement-SF Network	56	Dec-2022	16	3,000	-	-	-	-	-	3,016	
12	5795604	SYSPLAN ED 56N DNTWK-C001	56	Dec-2020	-	-	25,199	24,361	25,033	25,722	26,430	126,745	
13	5795605	SYSPLAN ED 56N DNTWK-M004	56	Dec-2020	-	-	-	6,510	6,673	6,840	7,011	27,034	
14	**Total**				**6,753**	**13,221**	**25,199**	**30,871**	**31,706**	**32,562**	**33,441**	**173,753**	WP 14-22
15		**Grand Total**			**17,614**	**25,269**	**42,542**	**43,879**	**44,753**	**45,691**	**46,680**	**266,428**	

16 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 14-13
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 14
Network Asset Management
Recorded and Forecast Capital Expenditures Details - Other Work*
(Thousands of Nominal Dollars)

			Capital Expenditures											
Line No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	2C	Inst/Repl Network Assets	14,532	17,488	15,183	12,140	14,755	3,820	1,396	544	559	574	589	WP 14-16
2	56	E Dist Replace UG Asset-Gen	11,000	19,893	24,548	16,976	18,153	11,978	-	-	-	-	-	WP 14-22
3	**Grand Total**		**25,532**	**37,381**	**39,731**	**29,116**	**32,908**	**15,798**	**1,396**	**544**	**559**	**574**	**589**	

4 * Excludes projects greater than $3M

Workpaper Table 14-14
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #14, Network Asset Management
Major Work Category 2C – Recorded Walk
MWC 2C - Install/Replace Network Assets
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$ 14,532**			
2		Network Protector Relay Replacement (MAT 2CA)	$ 23		Minor variations in work cost.	WP 14-16 Line 2
3		Fiber/SCADA Communication Replacement (MAT 2CB)	$ 106		Minor variations in work cost.	WP 14-16 Line 7
4		Network Transformer and Protector Replacement (MAT 2CC)	$ 961		Cost increase due to variation in cost based on location, construction complexity of equipment, and number of units identified for replacement.	WP 14-16 Line 3
5		Network Venting Manhole Cover Program (MAT 2CD)	$ (1,564)		Cost decrease due to beginning the process of addressing non-standard covers. There was less production during this year as the program was evaluating technical solutions and conducting system surveys.	WP 14-16 Line 4
6		Network SCADA Safety Monitoring Project (MAT 2CE)	$ 3,575		Program targets approximately one network group per year; variations in cost are based on the number of units in the different network groups.	WP 14-16 Line 8
7		Network Projects (MAT 2CP)	$ (0)		No significant change.	WP 14-16 Line 9
8		Standard Cost Variance (MAT 2C#)	$ (143)		Reduction in Standard Cost Variance.	WP 14-16 Line 11
9	**2017**	**Recorded Adjusted**	**$ 17,490**			
10		Network Protector Relay Replacement (MAT 2CA)	$ 1		No significant change.	WP 14-16 Line 2
11		Fiber/SCADA Communication Replacement (MAT 2CB)	$ 8		No significant change.	WP 14-16 Line 7
12		Network Transformer and Protector Replacement (MAT 2CC)	$ 1,122		Cost increase due to variation in cost based on location, construction complexity of equipment, and number of units identified for replacement.	WP 14-16 Line 3
13		Network Venting Manhole Cover Program (MAT 2CD)	$ 1,438		Increase to restore work volume to normal levels as system surveys and evaluations occuring during 2017 were resolved.	WP 14-16 Line 4
14		Network SCADA Safety Monitoring Project (MAT 2CE)	$ 1,073		Program targets approximately one network group per year; variations in cost are based on the number of units in the different network groups.	WP 14-16 Line 8
15		Network Projects (MAT 2CP)	$ -		No significant change.	WP 14-16 Line 9
16		Standard Cost Variance (MAT 2C#)	$ (286)		Reduction in Standard Cost Variance.	WP 14-16 Line 11
17	**2018**	**Recorded Adjusted**	**$ 20,847**			
18		Network Protector Relay Replacement (MAT 2CA)	$ (119)		Decrease due to fewer defective units replaced in 2019.	WP 14-16 Line 2
19		Fiber/SCADA Communication Replacement (MAT 2CB)	$ (65)		No significant change.	WP 14-16 Line 7
20		Network Transformer and Protector Replacement (MAT 2CC)	$ 858		Cost increase due to variation in cost based on location, construction complexity of equipment, and number of units identified for replacement.	WP 14-16 Line 3
21		Network Venting Manhole Cover Program (MAT 2CD)	$ 1,178		Work in 2018 was standard work that did not require excavations. Increase is due to the excavations required for work in 2019.	WP 14-16 Line 4
22		Network SCADA Safety Monitoring Project (MAT 2CE)	$ (3,560)		Program targets approximately one network group per year; variations in cost are based on the number of units in the different network groups.	WP 14-16 Line 8
23		Standard Cost Variance (MAT 2C#)	$ (670)		Reduction in Standard Cost Variance.	WP 14-16 Line 11
24	**2019**	**Recorded Adjusted**	**$ 18,470**			
25		Network Protector Relay Replacement (MAT 2CA)	$ 216		Increase in number of units replaced in 2020.	WP 14-16 Line 2
26		Fiber/SCADA Communication Replacement (MAT 2CB)	$ (65)		No significant change.	WP 14-16 Line 7
27		Network Transformer and Protector Replacement (MAT 2CC)	$ (434)		Cost increase due to variation in cost based on location, construction complexity of equipment, and number of units identified for replacement.	WP 14-16 Line 3
28		Network Venting Manhole Cover Program (MAT 2CD)	$ (1,555)		Decrease due to permitting delays and complications in Oakland and San Francisco as well as COVID delays.	WP 14-16 Line 4
29		Network SCADA Safety Monitoring Project (MAT 2CE)	$ 4,986		Program targets approximately one network group per year; variations in cost are based on the number of units in the different network groups.	WP 14-16 Line 8
30		Standard Cost Variance (MAT 2C#)	$ 948		Reduction in Standard Cost Variance.	WP 14-16 Line 11
31	**2020**	**Recorded Adjusted**	**$ 22,566**			

Workpaper Table 14-15
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #14, Network Asset Management
Major Work Category 2C – Forecast Walk
MWC 2C - Install/Replace Network Assets
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$ 22,566**			
2		Network Protector Relay Replacement (MAT 2CA)	$ (66)		No significant change.	WP 14-16 Line 2
3		Fiber/SCADA Communication Replacement (MAT 2CB)	$ (25)		No significant change.	WP 14-16 Line 7
4		Network Transformer and Protector Replacement (MAT 2CC)	$ (3,103)		Work is forecasted to remain similar to 2020 levels, however due to the authorized targets, unidentified efficiencies are needed to offset these costs.	WP 14-16 Line 3
5		Network Venting Manhole Cover Program (MAT 2CD)	$ (546)		MAT 2CD previously covered network and non-network locations, however, in 2020, non-network locations were moved to MAT 2BP	WP 14-16 Line 4
6		Network SCADA Safety Monitoring Project (MAT 2CE)	$ (3,148)		Funding was based on the size of the network group involved. The network group involved in the work forecasted in 2021 is much smaller than the group worked with in 2020.	WP 14-16 Line 8
7		Standard Cost Variance (MAT 2C#)	$ 191		No standard cost variance in 2021.	WP 14-16 Line 11
8	**2021**	**Forecast**	**$ 15,868**			
9		Network Protector Relay Replacement (MAT 2CA)	$ 16		No significant change.	WP 14-16 Line 2
10		Fiber/SCADA Communication Replacement (MAT 2CB)	$ -		No significant change.	WP 14-16 Line 7
11		Network Transformer and Protector Replacement (MAT 2CC)	$ 5,641		Increase is due to the start of work to replace dry-type transformers in high-rise buildings and CMD-type network protectors.	WP 14-16 Line 3
12		Network Venting Manhole Cover Program (MAT 2CD)	$ (2,970)		Program is ramping down and expected to complete in 2022. Non-network manhole cover replacement will continue in MAT 2BP.	WP 14-16 Line 4
13		Network SCADA Safety Monitoring Project (MAT 2CE)	$ 184		No significant change.	WP 14-16 Line 8
14	**2022**	**Forecast**	**$ 18,739**			
15		Network Protector Relay Replacement (MAT 2CA)	$ 9		No significant change.	WP 14-16 Line 2
16		Network Transformer and Protector Replacement (MAT 2CC)	$ (4,873)		Decrease due to the completion of replacement of oil-filled transformers in high-rise buildings and fewer units of dry-type transformers forecasted to replaced.	WP 14-16 Line 3
17		Network Venting Manhole Cover Program (MAT 2CD)	$ (550)		Program is expected to complete.	WP 14-16 Line 4
18		Network SCADA Safety Monitoring Project (MAT 2CE)	$ 227		No significant change.	WP 14-16 Line 8
19	**2023**	**Forecast**	**$ 13,552**			
20		Network Protector Relay Replacement (MAT 2CA)	$ 9		No significant change.	WP 14-16 Line 2
21		Network Transformer and Protector Replacement (MAT 2CC)	$ (189)		No significant change.	WP 14-16 Line 3
22		Network SCADA Safety Monitoring Project (MAT 2CE)	$ 234		No significant change.	WP 14-16 Line 8
23	**2024**	**Forecast**	**$ 13,605**			
24		Network Protector Relay Replacement (MAT 2CA)	$ 9		No significant change.	WP 14-16 Line 2
25		Network Transformer and Protector Replacement (MAT 2CC)	$ (150)		No significant change.	WP 14-16 Line 3
26		Network SCADA Safety Monitoring Project (MAT 2CE)	$ 239		No significant change.	WP 14-16 Line 8
27	**2025**	**Forecast**	**$ 13,704**			
28		Network Protector Relay Replacement (MAT 2CA)	$ 9		No significant change.	WP 14-16 Line 2
29		Network Transformer and Protector Replacement (MAT 2CC)	$ (129)		No significant change.	WP 14-16 Line 3
30		Network SCADA Safety Monitoring Project (MAT 2CE)	$ 245		No significant change.	WP 14-16 Line 8
31	**2026**	**Forecast**	**$ 13,828**			

Workpaper Table 14-16
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 14, Network Asset Management
Major Work Category 2C – Forecast Details
(Thousands of Nominal Dollars)

Line No.		MAT CODE	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Assumptions	Reference
1	**Total Cost by Activity Type (Unitized Work)**														
2	Total Cost of Network Protector Relay Replacement	2CA	$ 245	$ 268	$ 269	$ 151	$ 366	$ 300	$ 316	$ 325	$ 334	$ 343	$ 352		WP 14-17
3	Total Cost of Network Transformer and Protector Replacemer	2CC	$ 3,717	$ 4,678	$ 5,801	$ 6,659	$ 6,225	$ 3,122	$ 8,763	$ 3,890	$ 3,701	$ 3,551	$ 3,421		WP 14-18
4	Total Cost of Network Venting Manhole Cover Program	2CD	$ 4,568	$ 3,004	$ 4,442	$ 5,620	$ 4,065	$ 3,520	$ 550	$ -	$ -	$ -	$ -		WP 14-19
5	**Subtotal Cost by Activity Type**		$ 8,530	$ 7,950	$ 10,512	$ 12,430	$ 10,657	$ 6,942	$ 9,629	$ 4,215	$ 4,034	$ 3,894	$ 3,773		
6	**Additional Project Cost**														
7	Fiber/SCADA Communication Replacement	2CB	$ 41	$ 147	$ 155	$ 90	$ 25	$ -	$ -	$ -	$ -	$ -	$ -	(1)	
8	Network SCADA Safety Monitoring Project	2CE	$ 6,000	$ 9,575	$ 10,648	$ 7,088	$ 12,075	$ 8,926	$ 9,110	$ 9,337	$ 9,571	$ 9,810	$ 10,055		WP 14-24
9	Network Projects	2CP	$ 0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
10	**Subtotal Cost by Activity Type**		$ 6,041	$ 9,722	$ 10,803	$ 7,179	$ 12,100	$ 8,926	$ 9,110	$ 9,337	$ 9,571	$ 9,810	$ 10,055		
11	**Standard Cost Variance**		$ (39)	$ (182)	$ (469)	$ (1,138)	$ (191)	$ -	$ -	$ -	$ -	$ -	$ -	(2)	
12	**Total MWC 2C**		**$ 14,532**	**$ 17,490**	**$ 20,847**	**$ 18,470**	**$ 22,566**	**$ 15,868**	**$ 18,739**	**$ 13,552**	**$ 13,605**	**$ 13,704**	**$ 13,828**		Line 5 + Line 10 + Line 11

Forecast Assumptions and Details
(1) MAT 2CB work is incorporated into MAT 2CE for the forecast years.
(2) These recorded costs include the standard cost variance and small miscellaneous projects. Standard cost variance is not forecasted.

Workpaper Table 14-17
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 14 - Network Asset Management
Unit Cost and Forecast Details: MAT 2CA

Line No.		
1	**MAT Code**	2CA
2	**GRC Ch.**	14 - Network Asset Management
3	**MAT Code Definition**	NP Relay Replacement – Replacement of individual NP or replacement of NPs as part of planned replacement program. Units measured: Number of replacements. This program relates to safety, reliability, or maintenance because it addresses the replacement of any inoperable NP relays to maintain a safe and reliable distribution network system.

	Risk ID	Type	Name
4	DNTWK-C003	Control	Network Component (Transformer, Protector) Replacements - Condition Based

5	**Program Area**	Asset Management and Reliability
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Relays replaced
8	**Unit Cost (2023)**	$ 12,998
9	**Unit Cost Forecast Basis**	Based on number of planned units for each year.
10	**Unit Forecast Basis**	Based on historic target for units.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 245,191	$ 268,421	$ 269,492	$ 150,685	$ 366,490	Calculated - Line 12 * Line 13
12	**No. of Units**	22	33	34	6	57	
13	**Unit Cost**	$ 11,145	$ 8,134	$ 7,926	$ 25,114	$ 6,430	

		Forecast Costs & Units (Escalated) (A)						
	Year	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
14	**Forecast Costs**	$ 299,992	$ 316,418	$ 324,961	$ 333,750	$ 342,756	$ 352,008	Calculated - Line 15 * Line 16
15	**No. of Units**	27	25	25	25	25	25	
16	**Unit Cost**	$ 11,111	$ 12,657	$ 12,998	$ 13,350	$ 13,710	$ 14,080	

17 **Notes (A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper Table 14-18
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 14 - Network Asset Management
Unit Cost and Forecast Details: MAT 2CC

Line No.		
1	**MAT Code**	2CC
2	**GRC Ch.**	14 - Network Asset Management
3	**MAT Code Definition**	Network Transformer & Protector Replace – Planned replacement of electric distribution network transformers including deteriorated, oil related or high rise. Units measured: Number of replacements. This program relates to safety, reliability, or maintenance because it addresses the replacement of both network transformer and NP including high rise location to maintain a safe and reliable distribution network system.

	Risk ID	Type	Name
4	DNTWK-M001	Mitigation	Network Component Replacements - Targeted Replacement of Oil Filled Transformers in High-Rise Buildings
5	DNTWK-C003	Control	Network Component (Transformer, Protector) Replacements - Condition Based
6	DNTWK-M005	Mitigation	Network Component Replacements - High-Rise Dry-Type Transformers
7	DNTWK-M006	Mitigation	Network Component Replacements - Targeted Network Protector Replacement

8	**Program Area**	Risk Reduction
9	**Forecast Method**	Unit cost
10	**Unit of Measure**	Transformers/network protector replaced
11	**Unit Cost (2023)**	$ 155,602
12	**Unit Cost Forecast Basis**	Based on number of planned units for each year.
13	**Unit Forecast Basis**	Based on historic target for units. Expect increase in number of units for 2022 due to the start of 2 new programs: dry-type transformer replacements in high-rise buildings, replacement of CMD protectors.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
14	**Recorded Costs**	$ 3,716,909	$ 4,678,286	$ 5,800,610	$ 6,658,945	$ 6,225,050	Calculated - Line 14 * Line 15
15	**No. of Units**	30	27	28	32	31	
16	**Unit Cost**	$ 123,897	$ 173,270	$ 207,165	$ 208,092	$ 200,808	

		Forecast Costs & Units (Escalated) (A)						
	Year	**2021**	**2022 (B)**	**2023**	**2024**	**2025**	**2026**	
17	**Forecast Costs**	$ 3,122,145	$ 8,762,710	$ 3,890,055	$ 3,700,649	$ 3,550,750	$ 3,421,447	Calculated - Line 17 * Line 18
18	**No. of Units**	25	30	25	25	25	25	
19	**Unit Cost**	$ 124,886	$ 292,090	$ 155,602	$ 148,026	$ 142,030	$ 136,858	

	Notes	
20	**(A)**	Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.
21	**(B)**	A greater proportion of high-rise dry-type transformer replacements are planned for 2022, resulting in higher unit cost.

Workpaper Table 14-19
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 14 - Network Asset Management
Unit Cost and Forecast Details: MAT 2CD

Line No.		
1	**MAT Code**	2CD
2	**GRC Ch.**	14 - Network Asset Management
3	**MAT Code Definition**	Venting Manhole Covers Replacement – Replacement of existing manhole covers on the electric distribution network and distribution radial systems with venting manhole covers. Units measured: Number of replacements. This program relates to safety, reliability, or maintenance because it addresses public safety in the event of an electrical failure in an underground vault and the possible ejection of the manhole cover.

	Risk ID	**Type**	**Name**
4	DNTWK-M002	Mitigation	Venting Manhole Cover Replacements

5	**Program Area**	Risk Reduction
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Manhole covers replaced
8	**Unit Cost (2023)**	$ -
9	**Unit Cost Forecast Basis**	Based on number of planned units for each year.
10	**Unit Forecast Basis**	Based on historic target for units.

		Recorded Costs & Units (A)					**Reference**
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 4,567,719	$ 3,003,741	$ 4,442,098	$ 5,620,102	$ 4,065,348	Calculated - Line 13 * Line 14
12	**No. of Units**	1,500	137	1,042	521	541	
13	**Unit Cost**	$ 3,045	$ 21,925	$ 4,263	$ 10,787	$ 7,515	

		Forecast Costs & Units (Escalated) (A)						
	Year	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
14	**Forecast Costs**	$ 3,519,601	$ 550,000	$ -	$ -	$ -	$ -	Calculated - Line 16 * Line 17
15	**No. of Units**	300	45	-	-	-	-	
16	**Unit Cost**	$ 11,734	$ 12,182	$ -	$ -	$ -	$ -	

17 **Notes (A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper Table 14-20
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #14, Network Asset Management
MAT 56N - Recorded Walk
MAT 56N - Primary Network Cable Replacement Program
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount	Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$ 11,000**		
2		**Net Change**	$ 8,893	Ramp up to include replacement of primary cable in Oakland and secondary cable in San Francisco.	WP 14-22 Line 58
3	**2017**	**Recorded Adjusted**	**$ 19,893**		
4		**Net Change**	$ 4,656	Ramp up to include replacement of primary cable in Oakland and secondary cable in San Francisco.	WP 14-22 Line 58
5	**2018**	**Recorded Adjusted**	**$ 24,548**		
6		**Net Change**	$ (3,803)	Rescheduled work to support higher priority work	WP 14-22 Line 58
7	**2019**	**Recorded Adjusted**	**$ 20,746**		
8		**Net Change**	$ 1,183	Ramp up to include replacement of primary cable in Oakland and secondary cable in San Francisco.	WP 14-22 Line 58
9	**2020**	**Recorded Adjusted**	**$ 21,929**		

Workpaper Table 14-21
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #14, Network Asset Management
MAT 56N - Forecast Walk
MAT 56N - Primary Network Cable Replacement Program
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount	Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$ 21,929**		
2		**Net Change**	$ 3,270	Increase to complete replacement of secondary cable in San Francisco.	WP 14-22 Line 58
3	**2021**	**Forecast**	**$ 25,199**		
4		**Net Change**	$ -	No change	WP 14-22 Line 58
5	**2022**	**Forecast**	**$ 25,199**		
6		**Net Change**	$ 5,672	Increase in funding due to proposed RAMP mitigation 4 (Incremental Primary Network Cable Replacements)	WP 14-22 Line 58
7	**2023**	**Forecast**	**$ 30,871**		
8		**Net Change**	$ 835	Minor increase from prior year	WP 14-22 Line 58
9	**2024**	**Forecast**	**$ 31,706**		
10		**Net Change**	$ 856	Minor increase from prior year	WP 14-22 Line 58
11	**2025**	**Forecast**	**$ 32,562**		
12		**Net Change**	$ 879	Minor increase from prior year	WP 14-22 Line 58
13	**2026**	**Forecast**	**$ 33,441**		

Workpaper Table 14-22
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 14, Network Asset Management
MAT 56N Primary Network Cable Replacement Forecast Details
(Nominal Dollars)

Network Cable Replacement Forecast

Planning Order	Planning Order Description	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Notes	Reference
5514123	56N - Network Cable Replacement-SF	57,180		2,064	(1,071)	146,836	2,399,129						(1), (2)	
5524379	ED Rpl UG Cable-74007542-Y2 SF-PH1		2,842,720	5,084									(1), (2)	
5524380	ED Rpl UG Cable-74007810-Y2 SF-PH2	752	2,451,829	426,210									(1), (2)	
5524381	ED Rpl UG Cable-74007811-Y2 SF-PH3	751	487,551	1,926,998									(1), (2)	
5526100	Y3 Phase 4 - Network Secondary Cable Rep		23,999	6,569,545	1,608,873	1,621,260							(3)	
5530302	Y1 Phase 1 Secondary Cable Repl-SF Ntwrk				5,127,319	3,219,133							(3)	
5530303	Y1 Phase 3 Secondary Cable Repl-SF Ntwrk			14,614	(14,562)								(3)	
5530365	Y1 Phase 2 Secondary Cable Repl-SF Ntwrk			2,135	(347)								(3)	
5533406	56N 2021 Planning Wedge						(3,637,142)						(1), (2)	
5536499	Y1 Phase 1 Secondary Cable Repl-SF Ntwrk			9,527	(9,527)								(3)	
5743284	Econ Stim:2011 Network Cable Replacement	970	1,047	2,107	865	1,393							(1), (2)	
5747660	56 SF - Network Feeder - X1153	522,911	4,945,201	3,050,493	128,274	(102,740)							(1), (2)	
5747729	56 SF - Network Feeder - Y1101	83		994									(1), (2)	
5747738	56 SF - Network Feeder - Y1116	3,868,119	11,640										(1), (2)	
5747994	56-SF-NetworkFeeder-X1117	17,224											(1), (2)	
5764347	56N EB-Network Feeder-L1113	84,138	5,057										(1), (2)	
5764348	56N EB-Network Feeder-L1114	3,617,006	101,763										(1), (2)	
5764349	56N EB-Network Feeder-C1101	159,983	4,540,796	24,339									(1), (2)	
5764353	56N SF-Network Secondary-Y3	2,627,981	3,256,553	4,200									(3)	
5775166	Z1103 - Network Cable Replace - Folsom			68,360	815,634	825,183							(1), (2)	
5775219	Y1101 - Network Cable replacement - Prim		318,860	5,527,924	102,270								(1), (2)	
5775220	C1103 - Oakland Network Cable Replacemen		107,272	5,594,094	20,072								(1), (2)	
5780539	X1162 Primary Cable Repl-SF Ntwrk			394,669	(369,200)	(25,469)							(1), (2)	
5780541	C1106 Primary Cable Repl-OaK Netwrk				3,729,940	1,295,622	1,808,879						(1), (2)	
5780542	L1111 Primary Cable Repl-OaK Netwrk				212,960	622,196							(1), (2)	
5780546	X1123 Primary Cable Repl-SF Ntwrk				13,985	2,123,166	1,112,675						(1), (2)	
5780547	C1104 Primary Cable Repl-OaK Netwrk					291,152							(1), (2)	
5780551	Z1106 Primary Cable Repl-SF Ntwrk					314,990	3,000,508						(1), (2)	
5786180	Y1112-13-14-15 Primary Cable Replacement				15,721	1,765,602							(1), (2)	
5786189	Y1114-Y1115 Primary Cable Replac-SF Netw				22,508	2,886,385							(1), (2)	
5786321	X1162 Primary Cable Repl-SF Ntwrk				7,690,703	501,061							(1), (2)	
5786323	C1106 Primary Cable Repl-OaK Netwrk			108,772	(108,772)								(1), (2)	
5787429	J1103 Primary Cable Replac-SF Network				185,487	2,055,971							(1), (2)	
5787758	Y1Phase 2 Secondary Cable Replacement SF				25,554	24,591	4,298,981						(3)	
5787759	Y1Phase 3 Secondary Cable Replacement-SF				21,351	8,270	971						(3)	
5787764	J1106 Primary Cable Replacement-SF Netwo				159,134	2,699,604							(1), (2)	
5788322	X1112 Primary Cable Replac-SF Network					15,463	2,700,502						(1), (2)	
5788323	Y1134 Primary Cable Replac-SF Network					243,867	2,334,239						(1), (2)	
5791728	Y1113 Pri Cable Replac-Ph 2-SF Network					91,584	1,601,833						(1), (2)	
5791729	Y1132 Pri Cable Replaement-SF Network					17,502	3,000,006						(1), (2)	
5791761	Z1102 Primary Cable Replacement-SF Netwo					122,029	2,802,059						(1), (2)	
5791762	Y1112 (Y2) Pri Cable Replacement-SF Netw					111,116	1,600,022						(1), (2)	
5795604	SYSPLAN ED 56N DNTWK-C001							25,198,998	28,268,382	28,324,852	28,379,624	28,434,805	Unidentified future work	
5795605	SYSPLAN ED 56N DNTWK-M004								2,602,920	3,381,444	4,182,173	5,005,932		WP 14-28
Subtotal Cable Replacement		**10,957,098**	**19,094,288**	**23,732,130**	**19,377,171**	**20,875,769**	**23,022,662**	**25,198,998**	**30,871,302**	**31,706,296**	**32,561,797**	**33,440,737**		

Network Switch Installation Forecast

Planning Order	Planning Order Description	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast		Reference
5772038	SF Network Switch Project Group 1	28,061	719,807	168,392									(4)	
5772039	SF Network Switch Project Group 2	4,956	8,399	126,300	10,912	5,790	1,131,270						(4)	
5772040	SF Network Switch Project Group 3	9,876	55,448	490,992	1,340,007	854,498							(4)	
5775221	Network Switch Replacement - Group 4		14,744	30,676	17,635	192,908	1,045,066						(4)	
Subtotal Switch Installation		**42,894**	**798,398**	**816,360**	**1,368,554**	**1,053,195**	**2,176,336**	**0**	**0**	**0**	**0**	**0**		

Network System Total Forecast

Year	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast
Cable Replacements	10,957,098	19,094,288	23,732,130	19,377,171	20,875,769	23,022,662	25,198,998	30,871,302	31,706,296	32,561,797	33,440,737
Switch Installations	$ 42,894	$ 798,398	$ 816,360	$ 1,368,554	$ 1,053,195	$ 2,176,336	$ -	$ -	$ -	$ -	$ -
Total	**10,999,992**	**19,892,686**	**24,548,490**	**20,745,725**	**21,928,964**	**25,198,998**	**25,198,998**	**30,871,302**	**31,706,296**	**32,561,797**	**33,440,737**

Assumptions and Details

(1) There are a total of 60 12KV, and nine 34-35KV network circuits in San Francisco and Oakland divisions.
(2) Costs based on actual expenditures.
(3) Secondary grid replacement is necessary for the replacement of aging cables on the 120/208 grids. Off gassing of the secondary cables during short circuits can create a significant explosion risk.
(4) Switches will be installed on feeders immediately outside of substations in an effort to reduce wear and tear on critical substation breakers. Many of network switches that were initially planned to be replaced on this program are being installed on substation projects or as part of Network Cable Replacement projects.

Workpaper Table 14-23
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 14 - Network Asset Management
Unit Cost and Forecast Details: MAT 56N

Line No.		
1	**MAT Code**	56N
2	**GRC Ch.**	14 - Network Asset Management
3	**MAT Code Definition**	Network Cable Replacement – Systematic replacement of network cable assets in San Francisco and Oakland. The work involves replacing primary and secondary cables and installing new equipment. This program relates to safety, reliability, or maintenance because the network cable system is in an urban where the public is in close proximity to energized equipment. This necessitates a safety driver to minimize in-service failure; a reliability driver to minimize service outages disrupting customer business and life; and a maintenance driver to execute a consistent asset management strategy for the safety and operating performance of the system to balance risk, performance, and cost.

	Risk ID	Type	Name
4	DNTWK-C001	Control	Network Cable Replacement
5	DNTWK-M004	Mitigation	Incremental Primary Network Cable Replacements

6	**Program Area**	Asset Management and Reliability / Risk Reduction
7	**Forecast Method**	Unit cost
8	**Unit of Measure**	Total Circuit Feet
9	**Unit Cost (2023)**	$ 543
10	**Unit Cost Forecast Basis**	Historic costs for 2020 work subtracting out switch projects which do not contribute to units.
11	**Unit Forecast Basis**	Project plan that will reduce failures and improve safety for the greatest number of customers.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
12	**Recorded Costs**	$ 10,999,992	$ 19,892,686	$ 24,548,490	$ 20,745,725	$ 21,928,964	Calculated - Line 13 * Line 14
13	**No. of Units**	35,829	48,824	73,171	57,415	40,967	
14	**Unit Cost**	$ 307	$ 407	$ 335	$ 361	$ 535	

		Forecast Costs & Units (Escalated) (A)						
	Year	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
15	**Forecast Costs**	$ 25,198,998	$ 25,198,998	$ 30,871,302	$ 31,706,296	$ 32,561,797	$ 33,440,737	Calculated - Line 16 * Line 17
16	**No. of Units**	48,930	47,690	56,889	56,889	56,889	56,889	
17	**Unit Cost**	$ 515	$ 528	$ 543	$ 557	$ 572	$ 588	

18	**Notes (A)**	Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4) Chapter 14, Network Asset Management
Project Summary – Network SCADA Safety Monitoring

Project Title: Network SCADA Safety Monitoring
Major Work Categories: 2CE
Planning Order Numbers: 5544397
Project Start Date: 2011
Project Completion Date: 2028
Operative Date (only applies to Capital): Operative as installed

Project Description

PG&E is upgrading its SCADA systems for its distribution network systems in downtown San Francisco and downtown Oakland. The new SCADA systems are a part of the condition-based maintenance program implemented for the networks and is designed to improve system safety.

The work in MAT 2CE is a mitigation for the Failure of Network Assets risk (DNTWK-M003) referred to as Network Component Replacements – Targeted Network Protector Replacement.

Justification

PG&E's existing network SCADA systems were installed in the 1980s and have long since passed the projected life expectancy for this type of communications system. The costs to maintain the legacy SCADA systems are expected to continue to increase as the systems continue to age. This increase will be offset by the replacement of the existing systems with new systems over the project period and the overall expense is forecasted to remain constant until the replacement project is complete.

In addition, the existing systems, although useful, are significantly limited and based on obsolete technology. These systems only measure load and open/close status of the network protectors. The new upgraded SCADA system are designed to significantly improve safety on the distribution networks in these dense urban areas. These new systems monitor additional conditions including oil temperature, oil level and tank pressure to identify issues in a specific transformer. In addition, the new systems have control capabilities allowing Distribution Operators to quickly remove a unit from service if a system identifies a problem on the transformer or protector. Information from the systems are used for real time safety assessment and is part of the condition-based maintenance and replacement process now used for the distribution network systems.

Through 2021, 6 of the 12 network groups are using the new SCADA systems. 3 other network groups are in progress of construction, with 2 expected to be on line by the end of 2021 and 1 in 2022. This project was previously forecasted to be complete in 2024. Based on recent experience of completing one network group per year, with larger network groups being completed in two years, the program is now forecasted to be complete by 2028.

Network Safety SCADA Monitoring is a mitigation for the Failure of Distribution Underground Network Assets risk.

Cost

The 2021-2026 forecast was derived using a 5-year historical average with escalation. A 5-year historical average was used because the work remains relatively consistent year over year with minor fluctuations due to the size of the network groups identified for work during a given year.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4) Chapter 14, Network Asset Management
Project Summary – Network SCADA Safety Monitoring

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
Various	6,000	9,575	10,648	7,008	12,075							45,306	
PO 5544397						8,926	9,110	9,337	9,571	9,810	10,055	56,809	
Capital Total	**6,000**	**9,575**	**10,648**	**7,008**	**12,075**	**8,926**	**9,110**	**9,337**	**9,571**	**9,810**	**10,055**	**102,115**	WP 14-16 Line 8
TOTAL PROJECT COST	**6,000**	**9,575**	**10,648**	**7,008**	**12,075**	**8,926**	**9,110**	**9,337**	**9,571**	**9,810**	**10,055**	**102,115**	

Benefits

- The Network SCADA Safety Monitoring is the key system to monitor the equipment health of the distribution networks. Network equipment is located underground in a dense urban environment where the public is in close proximity. This system is critical to reduce risks of in-service failures for safe and reliable operations.

Alternatives Considered

The status quo alternative is to leave the existing 1980s-era SCADA systems in place and continue to maintain them. The existing systems do not provide the information necessary for condition-based maintenance and replacement, so this alternative has not been selected as it does not address the risks to public and employee safety.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4) Chapter 14, Network Asset Management
Project Summary – Venting Manhole Cover Program

Project Title: Venting Manhole Cover Program
Major Work Categories: 2CD
Planning Order Numbers: 5536485, 5540259, 5544484
Project Start Date: 2010
Project Completion Date: 2022
Operative Date (only applies to Capital): Operative as installed

Project Description

Beginning in 2010, PG&E began replacing existing round, solid and grated manhole covers with venting covers throughout the system starting in areas with significant pedestrian traffic. The venting manhole cover design allows the cover to remain in place in the event of a failure in the vault. The new covers release energy in a direction that decreases risk of injury to pedestrians. During an event such as a splice or cable failure, the venting cover will stay in place up to the point where the vault itself is at risk of failing. At that point the cover will release in an effort to reduce the possibility of the vault collapsing and failing catastrophically.

Since this program started in 2010, it has focused on replacing covers located on streets in San Francisco and Oakland with high pedestrian traffic. So far, PG&E has replaced over 7,500 covers, over 90 percent of the necessary replacements in HPZs in San Francisco. Most of the remaining HPZ locations have non-standard vaults/covers, which have a higher cost and tend to require more permitting. In 2020, PG&E replaced 774 manhole covers as part of this program. This includes locations both within and outside of the Network. PG&E expects to complete replacement of manhole covers on network vaults by 2022 but will continue to replace covers on vaults that are not part of the network system after that.

Historically, all venting manhole cover replacements were recorded in MAT 2CD, regardless of whether the covers being replaced were on network vaults or non-network vaults. Beginning in 2020, PG&E created separate planning orders for network and non-network work. Replacement of manhole covers on network vaults is still being recorded in MAT 2CD, and the forecast for MAT 2CD work is discussed in Chapter 14 of this exhibit. Replacement of manhole covers on non-network vaults is now being recorded is MAT 2BP. The forecast for MAT 2BP is discussed in Chapter 11.

The Venting Manhole Cover Replacement program is a mitigation for the Failure of Electric Distribution Network Assets risk (DNTWK-M002).

Justification

Underground vault explosions, although not a common occurrence, can result in significant property damage and injuries to the public and PG&E personnel, in part due to the possibility that the manhole cover over the

vault will become airborne in the event of an explosion. Although the frequency of these explosions can be reduced through appropriate monitoring, maintenance and replacement activities, the risk cannot be eliminated. The venting cover is an additional level of risk mitigation in the event of catastrophic equipment failure/explosion in the manhole, as it would prevent the cover from becoming dislodged.

Cost

Work in MAT 2CD is unitized. To develop the forecast for this MAT, PG&E identified the number of units for each year and multiplied by a unit cost, based on historical costs.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4) Chapter 14, Network Asset Management
Project Summary – Venting Manhole Cover Program

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
PO 5508439, 5528539, 5536484	4,568	3,004	4,442	5,620	4,065							**21,699**	
PO 5536485, 5540259, 5544484						3,520	550	-	-	-	-	4,070	
Capital Total	**4,568**	**3,004**	**4,442**	**5,620**	**4,065**	**3,520**	**550**	**-**	**-**	**-**	**-**	**25,769**	**WP 14-16 Line 4**
TOTAL PROJECT COST	**4,568**	**3,004**	**4,442**	**5,620**	**4,065**	**3,520**	**550**	**-**	**-**	**-**	**-**	**25,769**	

Benefits

- This program replaces existing solid and grated manhole covers on vaults with hinged venting manhole covers designed to stay in place in the event of a vault explosion. A venting cover that stays in place during a vault explosion reduces the potential for exposure to hot gasses from the vault, eliminates the risk of a projectile manhole cover, and reduces the force of the explosion.
- Venting covers improve public safety and reduce the risk of collateral component and infrastructure damage.

Alternatives Considered

The status quo alternative is to leave the existing manhole covers in place and replace and repair failed portions of existing system. This alternative was not chosen as it does not address the risk to public and employee safety.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4) Chapter 14, Network Asset Management
Project Summary – Cable Replacements in San Francisco and East Bay Network Systems

Project Title: Cable Replacements in San Francisco and East Bay Network Systems
Major Work Categories: MWC 56, MAT 56N
Planning Order Numbers: See Cost Section
Project Start Date: 2012
Project Completion Date: To be determined
Operative Date (only applies to Capital): Operative as installed

Project Description

This project covers replacement of all primary and secondary network cables in the cities of San Francisco and Oakland (East Bay Division).

The Network Systems work PG&E forecasts for this GRC is to continue the replacements of primary and secondary network cables, which began 2012 in San Francisco and 2015 in Oakland.

Primary network cable replacement is a mitigation for the Failure of Distribution Network Assets risk (DNTWK-M004) referred to as Incremental Primary Network Cable Replacements.

Justification

This project is a continuation of the SF Network Cable Replacement project which began in 2012. Since its inception, the scope of the project has been expanded to include network cable replacements in Oakland.

Primary and secondary network cable failures can result in electrical outages, equipment damage, explosions, smoke and fires; some of which may cause personal injury and property damage to the public and employees. These risks are higher with network cables, which are located in dense urban environments with significant pedestrian traffic. Some of these failures result in blown manhole covers which present further safety risk to the public. Since 2008, there have been a total of 145 network cable and splice failures in San Francisco and Oakland. It is anticipated that as these facilities age, the network system will continue to experience cable and splice failures.

In order to expedite the completion of primary cable replacements on the network system, PG&E will increase the miles of primary cable replacement starting in 2023 as part of its Incremental Primary Network Cable Replacements mitigation (DNTWK-M004).

Risk – The project helps mitigate the following risks:

a) Safety risk to public and employees from explosions and fires. These risks are higher with network cables due the location of these facilities in dense urban environments with significant pedestrian traffic.
b) Property damage to the public from explosions and fires, as well as from potential displacement of manhole covers.
c) Electrical outages to the community, which may have negative economic effects.
d) Prolonged outages due to the need to deploy both substation and M&C crews to respond for faults or work outside substation.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4) Chapter 14, Network Asset Management
Project Summary – San Francisco and East Bay Network Systems

Safety and Reliability – This project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. This program is necessary for reducing safety issues and for reliability, as it has a major impact to a large number of customers.

Cost

The unit costs used to forecast the network feeder replacement is shown below. Unit costs are forecast to be significantly higher than those forecast in the 2020 GRC. The forecast is an average unit cost; individual project costs may vary significantly depending on the need for duct/conduit installation or repairs.

a) Primary cable and Secondary cable: $510 per primary circuit foot

See Workpaper 14-15 "Network Systems Forecast Details," for more details on costs derivations.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
Various	11,000	19,893	24,548	20,746	21,929	25,199						123,315	
PO 5795604							25,199	28,268	28,325	28,380	28,435	138,607	WP 14-22 Line 44
PO 5795605								2,603	3,381	4,182	5,006	15,172	WP 14-22 Line 45
Capital Total	**11,000**	**19,893**	**24,548**	**20,746**	**21,929**	**25,199**	**25,199**	**30,871**	**31,706**	**32,562**	**33,441**	**277,094**	WP 14-22, Line 58
TOTAL PROJECT COST	**11,000**	**19,893**	**24,548**	**20,746**	**21,929**	**25,199**	**25,199**	**30,871**	**31,706**	**32,562**	**33,441**	**277,094**	

Benefits

- The primary purpose of this project is to improve public and employee safety, service reliability, customer satisfaction, and reduce the possibility of equipment damage.
- As indicated above, this work supports the proactive replacement of aging infrastructure on a planned basis.

Alternatives Considered

1 – Discontinue Future Cable Replacements

- This option does not take a proactive approach to mitigate the safety and reliability risks associated with the aging network cable infrastructure. This option is not recommended.

2 – Lower Rate of Future Installations

Reduce the forecasted expenditure by 50 percent to approximately $15 million per year for years 2023 to 2026. This would translate into slower replacement of both primary and secondary cable in San Francisco and Oakland.

- While this alternative provides more benefits than discontinuing replacements entirely, the slower rate of work still poses a significant risk to public and employee safety, as well as risk to service reliability.

3 – Increase Rate of Future Installations
Escalate forecasted expenditure by 100 percent to $60 million per year for 2023 to 2026. This would translate into faster replacement of both primary and secondary cable in San Francisco and Oakland.

- This option would mitigate the safety and reliability risks at a faster rate. However, the increased cost and construction logistics and resource implications involved in completing the projects at an accelerated rate while performing other planned work, would present significant execution challenges and is not preferred by PG&E at this time.

PG&E believes that its current forecast for 2023 to 2026 is the best option in terms of addressing both safety and reliability risks while factoring in resource and execution constraints and affordability. At the current expenditure forecast, the project would replace primary on 5 network feeders per year and complete Y1 secondary network by 2024.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4) Chapter 14, Network Asset Management
Project Summary – Network Transformer and Protector Replacement

Project Title: Network Transformer and Protector Replacement
Major Work Categories: 2CC
Planning Order Numbers: 5543515, 5544394, 5544395, 5544396
Project Start Date: 2008
Project Completion Date: Condition-based Network Component Replacement (Ongoing); Oil-Filled in High-Rise Replacement (2021), Vintage Dry-Type in High-Rise Replacement (2024), CMD-Type Network Protectors (Ongoing)
Operative Date (only applies to Capital): Operative as installed

Project Description

This project focuses on the replacement of transformers and network protectors on secondary networks located in San Francisco and Oakland. There are currently two key drivers for this project:

- Replace high-rise building oil-filled transformers with dry-type transformers
- Replace deteriorated transformer and network protectors identified through PG&E's network maintenance and monitoring programs

PG&E's program to replace vintage dry-type transformers in high-rise buildings is scheduled to begin in 2022, after completion of the Oil-Filled in High-Rise Replacement program. PG&E has identified 22 of these older dry type transformers and estimates three years to replace all 22 units.

The work in MAT 2CC incorporates three mitigations for the Failure of Network Assets risk:

- DNTWK-M001: Network Component Replacements – Targeted Replacement of Oil Filled Transformers in High-Rise Buildings;
- DNTWK-M005: Network Component Replacements – High-Rise Dry Type Transformers; and
- DNTWK-M006: Network Component Replacements – Targeted Network Protector Replacement.

Justification

In 2008, PG&E instituted a comprehensive network program which included sampling, inspection and replacement of deteriorated equipment on the San Francisco and Oakland Electric Distribution Networks. The following table provides a summary of work on this program since inception:

Year	Transformers Replaced	High Rise Replacement / Retrofit	Network Protectors Replaced
2008	16	0	21
2009	0	0	18
2010	28	1	29
2011	23	14	35
2012	2	16	21

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4) Chapter 14, Network Asset Management
Project Summary – Network Transformer and Protector Replacement

2013	24	0	14
2014	27	7	11
2015	0	11	19
2016	0	7	23
2017	0	5	22
2018	7	1	20
2019	10	3	19
2020	8	4	19

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4) Chapter 14, Network Asset Management
Project Summary – Network Transformer and Protector Replacement

High-rise Replacements

The high-rise replacement initiative started in 2010 with the objective of replacing all oil-filled transformers with dry-type transformers to minimize fire risks and increase safety. Dry type units are typically larger in dimension and weigh significantly more than oil-filled transformers creating challenging and building-specific engineering problems. Structural evaluation and reinforcement is done as necessary as part of the project. PG&E works closely with building owners to address construction challenges and reliability concerns.

The program was temporarily suspended in 2013 to address a non-related manufacturing issue with General Electric transformers. In 2015, there was a delay due to change of ownership of two buildings targeted for replacements. Some key high-rise replacements completed since inception included the Montgomery and Powell Street BART stations, the Van Ness Muni Station, the McKesson Building at 600 Market, the Chevron Building located at 525 Market Street, the Stanford Court Hotel located at 905 California Street, an apartment building located at northeast corner of Post and Hyde, and PG&E's headquarters located at 77 Beale Street. In the 2017 GRC, the high-rise replacement work was forecast to be completed by 2018. Due to the delays mentioned above, it is expected that the high-rise replacements will be completed by 2021.

After completion of the Oil-Filled in High-Rise Replacement program, PG&E is planning to replace some older dry type transformers also located in high rise buildings. PG&E has identified 22 of these older dry type transformers, mostly installed in the 1980s, located in four high rise buildings (three in San Francisco and one in Oakland). These units are at the end of their useful lives and some of them have rust and other corrosion. PG&E estimates that replacing these 22 transformers will take three years and cost approximately $10 million, with nine replacements per year planned for 2022 and 2023 and four replacements planned for 2024.

Condition-Based Replacements

Most of PG&E’s network transformers were installed in the 1980s as part of a PCB replacement program. The network protectors were not replaced as part of this program. Therefore, there are network protectors still in service dating back to the 1940s through the 1970s. The manufacturer rated service life of the network protectors are the same as the transformers (approximately 35 years or 10,000 operations).

Problems occurring in the network protectors include wand contacts, motor- and bearing-related problems, relays that are not working properly, aging seals and gaskets, corrosion on the cabinet and internal components. Since the network protectors are exposed to the same general environmental conditions as the transformers, and as a result can suffer from the same component degradation, the network protectors are replaced at the same time as the network transformers. Based on service records, PG&E has concluded that CMD network protectors are more difficult to repair and replace as they are of an older style and have obsolete components. As part of the mitigation DNTWK M006, PG&E plans to start replacing CMD type network protectors in 2022. PG&E estimates there are 229 CMD network protectors on its EDN system.

Finally, deteriorated transformers and network protectors may be identified through the maintenance and oil sampling programs. As a result, the actual number of transformers and network protectors replaced as part of this project may be higher than the number already identified. Costs to replace deteriorated units are included in the project forecast.

Risk

These programs address the Failure of Electric Distribution Network Assets risk.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4) Chapter 14, Network Asset Management
Project Summary – Network Transformer and Protector Replacement

Cost

Work in MAT 2CC is unitized. To develop the forecast, PG&E identified the number of units for each program and multiplied by a unit cost based on historical costs.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
5509539, 5509859	3,717	4,678	5,801	6,659	6,225							**27,080**	
5543515, 5544394, 5544395, 5544396						3122	8763	3890	3701	3551	3421	**26,448**	
Capital Total	**3,717**	**4,678**	**5,801**	**6,659**	**6,225**	**3,122**	**8,763**	**3,890**	**3,701**	**3,551**	**3,421**	**53,528**	WP 14-16, Line 3
TOTAL PROJECT COST	**3,717**	**4,678**	**5,801**	**6,659**	**6,225**	**3,122**	**8,763**	**3,890**	**3,701**	**3,551**	**3,421**	**53,528**	

Benefits

- The replacement of oil-filled to dry-type transformer will improve the overall fire safety in high rise buildings in the event of a catastrophic failure.
- The replacement of deteriorated three chamber style with GE OMEGA or single chamber style transformers will improve safety by replacing 3-tank oil filled transformers with GE OMEGA transformers or single-tank transformers. GE OMEGA transformers have a special design to improve safety by redirecting any explosion away from the vault opening. In addition, moving to a single-tank design will reduce the number of oil-filled chambers associated with the networks.
- The replacement of the CMD network protectors, which are more difficult to repair and replace due to their older style and obsolete components, will minimize the impact in the event of a failure.

Alternatives Considered

The status quo alternative is to leave the existing equipment in place and replace and repair failed portions of existing system. This alternative was not chosen as it does not address the risk to public and employee safety.

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 15, SUBSTATION ASSET MANAGEMENT

TABLE OF CONTENTS

Subject	Page No.
Expense Workpapers	
Workpaper Table 15-1: Expenses by Major Work Category - Nominal Dollars	WP 15-1
Workpaper Table 15-2: Expenses by Major Work Category - Base Year Dollars	WP 15-2
Workpaper Table 15-3: Major Work Category GC - Recorded Walk	WP 15-3
Workpaper Table 15-4: Major Work Category GC - Forecast Walk	WP 15-4
Workpaper Table 15-5: Summary by Activity - MWC GC	WP 15-5
Workpaper Table 15-6: MWC GC – Preventative Maintenance Forecast Details	WP 15-6
Workpaper Table 15-7: MWC GC - Corrective Maintenance Forecast Details	WP 15-7
Workpaper Table 15-8: MWC GC - Support Activities Forecast Details	WP 15-8
Workpaper Table 15-9: Unit Cost and Forecast Details: MAT GCA	WP 15-9
Workpaper Table 15-10: Unit Cost and Forecast Details: MAT GCB	WP 15-10
Workpaper Table 15-11: Unit Cost and Forecast Details: MAT GCC	WP 15-11
Workpaper Table 15-12: Unit Cost and Forecast Details: MAT GCD	WP 15-12
Workpaper Table 15-13: Unit Cost and Forecast Details: MAT GCE	WP 15-13
Workpaper Table 15-14: Unit Cost and Forecast Details: MAT GCF	WP 15-14
Workpaper Table 15-15: Unit Cost and Forecast Details: MAT GCI	WP 15-15
Workpaper Table 15-16: Unit Cost and Forecast Details: MAT GCJ	WP 15-16
Workpaper Table 15-17: Unit Cost and Forecast Details: MAT GCM	WP 15-17
Workpaper Table 15-18: Unit Cost and Forecast Details: MAT GCO	WP 15-18
Workpaper Table 15-19: Unit Cost and Forecast Details: MAT GCS	WP 15-19
Workpaper Table 15-20: Unit Cost and Forecast Details: MAT GCV	WP 15-20
Workpaper Table 15-21: Unit Cost and Forecast Details: MAT GCW	WP 15-21

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 15, SUBSTATION ASSET MANAGEMENT

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Capital Workpapers	
Workpaper Table 15-22: Capital Expenditures by Major Work Category	WP 15-22
Workpaper Table 15-23: Forecast Capital Expenditures Summary	WP 15-23
Workpaper Table 15-24: Recorded CWIP and Forecast Capital Expenditures Details - Planning Orders Over $3 Million	WP 15-24
Workpaper Table 15-25: Recorded and Forecast Capital Expenditures Details - Other Work	WP 15-25
Workpaper Table 15-26: Major Work Category 48 - Recorded Walk	WP 15-26
Workpaper Table 15-27: Major Work Category 48 - Forecast Walk	WP 15-27
Workpaper Table 15-28: Major Work Category 54 - Recorded Walk	WP 15-29
Workpaper Table 15-29: Major Work Category 54 - Forecast Walk	WP 15-30
Workpaper Table 15-30: Major Work Category 58 - Recorded Walk	WP 15-31
Workpaper Table 15-31: Major Work Category 58 - Forecast Walk	WP 15-32
Workpaper Table 15-32: Major Work Category 59 - Recorded Walk	WP 15-33
Workpaper Table 15-33: Major Work Category 59 - Forecast Walk	WP 15-34
Workpaper Table 15-34: Capital Summary	WP 15-35
Workpaper Table 15-35: Unit Cost and Forecast Details Workpaper: MAT 48C	WP 15-36
Workpaper Table 15-36: Unit Cost and Forecast Details Workpaper: MAT 48D	WP 15-37
Workpaper Table 15-37: Unit Cost and Forecast Details Workpaper: MAT 48X	WP 15-38
Workpaper Table 15-38: MAT 48F Switchgear Forecast Basis	WP 15-39

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 15, SUBSTATION ASSET MANAGEMENT

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Project Summary	
Project Summary – Animal Abatement, MAT 48X	WP 15-40
Project Summary – Battery Replacement, MAT 48C	WP 15-42
Project Summary – Circuit Breaker Replacement, MAT 48D	WP 15-44
Project Summary – Civil Structure, MAT 48H	WP 15-46
Project Summary – Emergency Replacement, MWC 59	WP 15-49
Project Summary – Insulator Replacement, MAT 48N	WP 15-51
Project Summary – Line Work Support, MAT 48L	WP 15-53
Project Summary – Other Equipment Replacement, MAT 48A	WP 15-55
Project Summary – Distribution Substation Safety and Security, MWC 58	WP 15-57
Project Summary – Switch Replacement. MAT 48E	WP 15-59
Project Summary – Switchgear Replacement, MAT 48F	WP 15-61
Project Summary – Transformer Replacement, MWC 54	WP 15-64
Index Template	WP 15-67

Workpaper Table 15-1
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15
Substation Asset Management
Expenses by Major Work Category
(Thousands of Nominal Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference
1	GC	E Dist Subst O&M	24,607	26,569	26,958	49,089	51,181	38,767	39,731	50,940	WP 15-3, WP 15-4
2	**Total**		**24,607**	**26,569**	**26,958**	**49,089**	**51,181**	**38,767**	**39,731**	**50,940**	

Workpaper Table 15-2
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15
Substation Asset Management
Expenses by Major Work Category
(Thousands of Base Year Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast
1	GC	E Dist Subst O&M	27,391	28,722	28,250	49,438	51,181	38,256	38,117	47,467
2	**Total**		**27,391**	**28,722**	**28,250**	**49,438**	**51,181**	**38,256**	**38,117**	**47,467**

Workpaper Table 15-3
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category GC - Recorded Walk
MWC GC - Electric Distribution Substation Operations & Maintenance
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**24,607**			
2		Preventive Maintenance	70		Increase driven by a higher expenditures for substation relay tests.	WP 15-5 Line 1
3		Corrective Maintenance	220		Increase due to a higher than anticipated corrective actions required.	WP 15-5 Line 2
4		Substation Support Activities	1,672		Increase driven by emergent work and building maintenance	WP 15-5 Line 3
5		Standard Cost Variance/Recorded Expenditures Not Assigned a MAT code	-		No significant change	WP 15-5 Line 4, Line 6
6		**Net Change**	**1,962**			
7	**2017**	**Recorded Adjusted**	**26,569**			
8		Preventive Maintenance	(940)		Decreases attributed to equal reductions across Load tap Changers (LTCs) inspected and breakers maintained and serviced	WP 15-5 Line 1
9		Corrective Maintenance	1,117		Increase due to a higher than anticipated volume of issues identified in the field	WP 15-5 Line 2
10		Substation Support Activities	212		Increase primarily due to Vegetation Management	WP 15-5 Line 3
11		Standard Cost Variance/Recorded Expenditures Not Assigned a MAT code	0		No significant change	WP 15-5 Line 4, Line 6
12		**Net Change**	**389**			
13	**2018**	**Recorded Adjusted**	**26,958**			
14		Preventive Maintenance	416		Increase due to higher expenditures related to statiion reads and circuit switcher and motor operator mechanisms serviced	WP 15-5 Line 1
15		Corrective Maintenance	(554)		Net decrease driven by lower than anticipated volume of issues identified in the field	WP 15-5 Line 2
16		Substation Support Activities	22,268		Increase due to Vegetation Management and WSIP repair activities	WP 15-5 Line 3
17		Standard Cost Variance/Recorded Expenditures Not Assigned a MAT code	1		No significant change	WP 15-5 Line 4, Line 6
18		**Net Change**	**22,131**			
19	**2019**	**Recorded Adjusted**	**49,089**			
20		Preventive Maintenance	3,764		Increase driven by station inspections	WP 15-5 Line 1
21		Corrective Maintenance	3,990		Net increase driven by higher than anticipated volume of issues identified in the field	WP 15-5 Line 2
22		Substation Support Activities	(5,660)		Decrease driven by Vegetation Management	WP 15-5 Line 3
23		Standard Cost Variance/Recorded Expenditures Not Assigned a MAT code	(1)		No significant change	WP 15-5 Line 4, Line 6
24		**Net Change**	**2,092**			
25	**2020**	**Recorded Adjusted**	**51,181**			

Workpaper Table 15-4
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category GC - Forecast Walk
MWC GC - Electric Distribution Substation Operations & Maintenance
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$ 51,181**			
2		Preventive Maintenance	(1,688)		Decrease due to fewer than anticipated station inspections.	WP 15-5 Line 1
3		Corrective Maintenance	(2,356)		Decrease due to reduction in WSIP enhanced inspections	WP 15-5 Line 2
4		Substation Support Activities	(3,344)		Net decrease is due to building and major emergency corrective maintenance	WP 15-5 Line 3
5		Forecast Adjustment	(5,027)		Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast	WP 15-5 Line 5
6		**Net Change**	**(12,414)**			
7	**2021**	**Forecast**	**38,767**			
8		Preventive Maintenance	15		No significant change	WP 15-5 Line 1
9		Corrective Maintenance	13		No significant change	WP 15-5 Line 2
10		Substation Support Activities	944		Increase due to major emergency corrective maintenance	WP 15-5 Line 3
11		Forecast Adjustment	(7)		Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast	WP 15-5 Line 5
12		**Net Change**	**965**			
13	**2022**	**Forecast**	**39,731**			
14		Preventive Maintenance	636		Minor increases across all preventive maintenance activities, primarily escalation.	WP 15-5 Line 1
15		Corrective Maintenance	550		Minor increase, primarily escalation	WP 15-5 Line 2
16		Substation Support Activities	4,989		Increase driven by major emergency corrective maintenance	WP 15-5 Line 3
17		Forecast Adjustment	5,034		No forecast adjustment in 2023	WP 15-5 Line 5
18		**Net Change**	**11,209**			
19	**2023**	**Forecast**	**50,940**			

Workpaper Table 15-5
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Expense Summary
(Thousands of Nominal Dollars)

Line No.	MWC GC - Expense	MAT	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	Notes	Reference
1	Preventive Maintenance	GCA, GCB, GCC, GCD, GCE, GCF, GCI, GCM, GCO, GCS, GCV, GCW	$ 8,734	$ 8,805	$ 7,864	$ 8,280	$ 12,044	$ 10,356	$ 10,371	$ 11,007	(1)	WP 15-6
2	Corrective Maintenance	GCJ	$ 6,550	$ 6,769	$ 7,886	$ 7,333	$ 11,322	$ 8,967	$ 8,980	$ 9,530	(2)	WP 15-7
3	Substation Support Activities	GC1, GCH, GCG, GC5, GC2	$ 9,323	$ 10,995	$ 11,207	$ 33,475	$ 27,815	$ 24,471	$ 25,415	$ 30,404	(3), (7)	WP 15-8
4	Standard Cost Variance	#	$ -	$ -	$ -	$ 1	$ -	$ -	$ -	$ -	(4)	
5	Forecast Adjustment	#	$ -	$ -	$ -	$ -	$ -	$ (5,027)	$ (5,034)	$ -	(5)	Chapter 2, Section D
6	Recorded Expenditures Not Assigned a MAT code	#	$ -	$ -	$ 0	$ 0	$ -	$ -	$ -	$ -	(6)	
7	**Total**		**$ 24,607**	**$ 26,569**	**$ 26,958**	**$ 49,089**	**$ 51,181**	**$ 38,767**	**$ 39,731**	**$ 50,940**		

Assumptions and Notes

(1) Preventive Maintenance are maintenance tasks that must be completed to conform with substation maintenance requirements for various systems and equipment. Substation maintenance requirements use a combined time-based and condition-based maintenance (CBM) approach; CBM combines and uses all available inspection information, diagnostic testing data, and new technologies, in conjuction with maintenance practices, histories, and design data to determine the operating condition of equipment.

(2) Corrective Maintenance is repair work initiated from corrective notifications for issues identified by field personnel.

(3) Substation Support Activities encompass a variety of work not included in the preventive and corrective maintenance categories: engineering and maintenance support (e.g., miscellaneous materials and contracts), major emergencies and emergent work, enhanced Inspections are supplemental inspections to post-2019 WSIP inspections, vegetation management, and building maintenance.

(4) Standard Cost Variance is not forecasted.

(5) Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.

(6) Minor recorded expenditures were not assigned a MAT code.

(7) The 2020 recorded value varies from the values listed in the Results of Operations (RO) Model due to errata. These amounts do not align to the RO Model provided to the Public Advocates Office at the time of filing. The RO will be updated to incorporate these errata with the Joint Comparison Exhibit submittal.

Workpaper Table 15-6
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Expenses for MWC GC - Preventive Maintenance Forecast Details
(Thousands of Nominal Dollars)

Line No.		MAT Code	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	Assumptions	Reference
1	Transformer Preventive Maintenance	GCA	$743	$706	$797	$771	$930	$1,020	$1,021	$1,084	1	WP 15-9
2	Circuit Breaker Preventive Maintenance	GCB	$1,048	$718	$449	$457	$559	$741	$742	$788	2	WP 15-10
3	Substation Relay Preventive Maintenance	GCC	$1,537	$1,888	$1,978	$1,631	$2,294	$1,422	$1,424	$1,512	3	WP 15-11
4	Substation Inspections	GCD	$2,328	$2,212	$2,141	$2,526	$4,645	$2,945	$2,949	$3,130	4	WP 15-12
5	General Station Preventive Maintenance	GCE	$358	$362	$312	$405	$403	$480	$480	$510	5	WP 15-13
6	Battery Preventive Maintenance	GCF	$288	$255	$265	$392	$423	$470	$471	$500	6	WP 15-14
7	Switch Preventive Maintenance	GCI	$78	$66	$62	$67	$68	$95	$95	$101	7	WP 15-15
8	Circuit Breaker Mechanism Service Preventive Maintenance	GCM	$899	$988	$678	$728	$1,544	$1,413	$1,415	$1,502	8	WP 15-17
9	Transformer LTC Overhaul Inspections	GCO	$892	$1,123	$749	$741	$541	$1,149	$1,150	$1,221	9	WP 15-18
10	Circuit Switcher & Motor-Operated Air Switch Preventive	GCS	$203	$120	$89	$260	$193	$191	$192	$203	10	WP 15-19
11	Circuit Breaker Overhauls	GCV	$55	$25	$20	$66	$72	$19	$19	$20	11	WP 15-20
12	Station Washes	GCW	$304	$341	$323	$237	$371	$412	$412	$438	12	WP 15-21
13	**Total Cost by Activity Type**		**$8,734**	**$8,805**	**$7,864**	**$8,280**	**$12,044**	**$10,356**	**$10,371**	**$11,007**		

Workpaper Table 15-7
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Expenses for MWC GC - Corrective Maintenance Forecast Details
(Thousands of Nominal Dollars)

Line No.	Corrective Maintenance	MAT Code	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	Assumptions	Reference
1	Notifications	GCJ	6,550	6,769	7,886	7,333	11,322	8,967	8,980	9,530	(1), (2)	WP 15-16
2	**Total**		**6,550**	**6,769**	**7,886**	**7,333**	**11,322**	**8,967**	**8,980**	**9,530**		

Forecast Assumptions and Details

(1) Corrective notifications are tags created in SAP by electricians who have identified issues in substations that need to be fixed. This corrective work is assigned a priority ranging from immediately correctable to monitoring status depending on the severity of the issue; meaning, impact to operations, safety and reliability. For example, electrician's time when responding to station alarms, facility repairs, and emergency overhauls all constitute corrective work and widely vary in cost. Corrective notifications are ready to be worked once a financial order number is released in SAP for charging.

The forecast is based on a 3 year average (2018-2020) of work notifications performed multiplied by an average estimated cost per notification (4,600 tags * $1,880 = $8.6 million).

(2) In 2020 PG&E incurred uniquely high cost work for the following: Equipment oil leak repairs, PSPS related activities, as well as 500 additional notifications over 2019.

Workpaper Table 15-8
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Expenses for MWC GC - Support Activities Forecast Details
(Thousands of Nominal Dollars)

Line No.	Substation Support Activities	MAT Code	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	Assumptions
1	Engineering Maintenance Support	GC1	**$ 4,865**	**$ 4,744**	**$ 4,611**	**$ 5,547**	**$ 4,996**	**$ 5,066**	**$ 5,080**	**$ 5,389**	(1)
2	Major Emergency Corrective Maintenance	GC2	$ 2,475	$ 3,816	$ 3,617	$ 3,773	$ 4,238	$ 6,475	$ 5,017	$ 14,069	(2)
3	WSIP & Supplemental Inspection Repair Tier 2,3,2/3A	GC2	$ -	$ -	$ -	$ 5,247	$ 2,468	$ 1,111	$ 6,484	$ -	(3), (13)
4	**GC2 Total**		**$ 2,475**	**$ 3,816**	**$ 3,617**	**$ 9,020**	**$ 6,707**	**$ 7,586**	**$ 11,501**	**$ 14,069**	(4)
5	WSIP & Supplemental Inspections Tier 2,3,2/3A	GC5	$ -	$ -	$ 7	$ 8,148	$ 5,067	$ 3,036	$ -	$ -	(5)
6	Supplemental Inspections Non-HFTD	GC5	$ -	$ -	$ -	$ -	$ 533	$ -	$ -	$ -	(6)
7	**GC5 Total**		**$ -**	**$ -**	**$ 7**	**$ 8,148**	**$ 5,600**	**$ 3,036**	**$ -**	**$ -**	
8	Vegetation & Facility Property Management	GCG	$ 1,379	$ 1,499	$ 1,889	$ 2,113	$ 3,290	$ 6,538	$ 6,548	$ 9,904	(7)
9	Def Sp Fac. Prop. Mgmt. Non-HFTD	GCG	$ -	$ -	$ -	$ -	$ 1,022	$ -	$ -	$ -	(8)
10	Def Sp Fac. Prop. Mgmt. Tier 2, 3, 2/3A	GCG	$ -	$ -	$ -	$ -	$ 3,119	$ 1,265	$ 1,304	$ -	(9), (13)
11	CWSP Fac. Prop. Mgmt.	GCG	$ -	$ -	$ 25	$ 7,278	$ 1,424	$ -	$ -	$ -	(10)
12	**GCG Total**		**$ 1,379**	**$ 1,499**	**$ 1,914**	**$ 9,391**	**$ 8,855**	**$ 7,803**	**$ 7,852**	**$ 9,904**	(11)
13	Building Maintenance	GCH	**$ 603**	**$ 937**	**$ 1,058**	**$ 1,369**	**$ 1,657**	**$ 980**	**$ 981**	**$ 1,041**	(12)
	Substation Support Total		**$ 9,323**	**$ 10,995**	**$ 11,207**	**$ 33,475**	**$ 27,815**	**$ 24,471**	**$ 25,415**	**$ 30,404**	

Forecast Assumptions and Details

(1) **GC1 - Engineering and Maintenance Support** - This work encompasses (A) engineering support, (B) system-level work, and (C) miscellaneous materials and contracts. (A) Engineering staff provides support activities on distribution substation standards, guidelines & work procedures, maintenance-related studies, and field support requests. (B) system-level work supports land leasing/fees, licensing for software used by maintenance, surveys, root cause analysis, service advisory, transformer relocations, maintenance of energy storage systems (at Vaca Dixon, Yerba Buena, Browns Valley Energy), and many other miscellaneous activities to support substation maintenance and operations. (C) Miscellaneous materials and contracts program supports the procurement of testing equipment and contracts with third-party groups to perform any work such as repairs, inspections and/or testing; and various materials to maintain and operate distribution substation equipment.

The 2021-2023 forecast is based on historical three year average actual charges from 2018 - 2020.

(2) **GC2 Major Emergency Corrective Maintenance -** Major emergency and emergent work supports unforeseen emergencies/major repairs and emergent work with high reliability impact or system-wide risk, such as: anticipated major substation emergencies, mobile equipment maintenance & spare transformers testing for emergency readiness, large transformer oil leak repairs, animal abatement repairs, deteriorated foundation repairs, corrosion repairs, and mark & locate distribution line assets in electric facilities.

(See assumption 4 for forecast)

(3) GC2 Supplemental Inspection Repair Tier 2,3,2/3A - This work is identified through supplemental inspections completed at substations in Non-High Fire Threat Districts. Corrective notifications (tags created in SAP) identify issues in these substations that need to be fixed. This corrective work is assigned a priority ranging from 'immediately correctable' to 'monitoring status' depending on the severity of the issue; meaning, impact to operations, safety and reliability. Corrective notifications require budget approval, and are ready to be worked once an order number is released in SAP for charging.

(See assumption 4 for forecast)

(4) GC2 Major Emergency Corrective Maintenance - (subtotal)

The 2021 -2023 forecast is a future projection that combines carry-over repair costs as well as consideration for the anticipated upward stemming from Supplemental inspections.

(5) GC5 WSIP & Supplemental Inspections Tier 2,3,2/3A - This work is for supplemental inspections to the 2019 WSIP inspections, including inspection types: CIRT, DIRT and GROUND. The subsequent corrective work derived from these supplemental inspections is assigned a priority ranging from 'immediately correctable' to 'monitoring status' depending on the severity of the issue; meaning, impact to operations, safety and reliability.

The 2021 forecast is based on the total estimated equipment counts across identified electric facilities requiring inspection, multiplied by derived inspection rate.

(6) GC5 Supplemental Inspections Non-HFTD - This work is for supplemental inspections to the 2019 WSIP inspections, in non high fire threat districts, including inspection types: CIRT, DIRT and GROUND. The subsequent corrective work derived from these supplemental inspections is assigned a priority ranging from 'immediately correctable' to 'monitoring status' depending on the severity of the issue; meaning, impact to operations, safety and reliability.

Only recorded actuals show for this work because all the work has been completed.

(7) **GCG Vegetation Facility Management** - This work supports the trimming, mowing, and when required, chemical treating of vegetation on substation property to mitigate potential fire hazards, blight, and remain in compliance with regulatory ordinances. These costs differ from PG&E's Corporate Vegetation Management program costs because these activities occur within the substation property perimeter which is not part of the overall Vegetation Management Program. The work is contract driven based on the total number of distribution substations mitigated annually in the operating system.

(See assumption (11) for forecast)

(8) **GCG Def Sp Fac. Prop. Mgmt. Non-HFTD** - This work supports Facility Property Management for Defensible Space in non-HFTD areas which has been incorporated into base forecast.

(See assumption (11) for forecast)

(9) **GCG Def Sp Fac. Prop. Mgmt. in Tiers 2,3 and 2/3A -** This work supports facility property management to achieve defensible space and is based on planned annual vegetation inspections performed at tier 2,3, 2/3A substations (eg: fuel reduction, maintenance, to prevent wildfire ignition in areas external to the substation).

The 2021 - 2023 forecast is based on similar contracts for this type of work and will vary according to site acreage.

(10) **GCG CWSP Fac. Prop. Mgmt.-** This work represents completed 2019 WSIP Inspection assessments and vegetation clearance activities to achieve defensible space in Tier 2 and 3 areas (HFTD).

Only recorded actuals show for this work because all the work has been completed.

(11) **GCG Vegetation Facility Management** - This work supports both Defensible Space and routine vegetation facility management activity outlined in (7). The work is contract driven based on the total number of distribution substations mitigated annually in the operating system.

The 2021 - 2023 forecast basis starts with the number of distribution substations scheduled for facility management in a given year. The acreage at each site is multiplied by average cost rates, and then again by the number of days the work is estimated to take.

(12) **GCH Building Maintenance -** Building maintenance generally includes typical commercial facilities-type repair and maintenance work such as janitorial, landscaping, HVAC maintenance, fencing repair, broken windows repair, graffiti removal, and similar work.

(13) The 2020 recorded value varies from the values listed in the Results of Operations (RO) Model due to errata. These amounts do not align to the RO Model provided to the Public Advocates Office at the time of filing. The RO will be updated to incorporate these errata with the Joint Comparison Exhibit submittal.

Workpaper 15-9
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCA

Line No.		
1	**MAT Code**	GCA
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Transformer Preventive Maintenance – Distribution substation costs for transformers, regulators, and Load Tap Changer (LTC) Oil Tests. Units measured: Number of transformers. This program relates to safety, reliability, or maintenance because it monitors transformer condition and identifies any abnormalities that may lead to a potential mis-operation of the transformer.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Risk Reduction
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Transformers Maintained
8	**Unit Cost (2023)**	$ 237
9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 742,869	$ 706,058	$ 797,154	$ 770,541	$ 930,069	Calculated - Line 12 * Line 13
12	**No. of Units**	4,308	4,268	4,768	4,650	4,557	
13	**Unit Cost**	$ 172	$ 165	$ 167	$ 166	$ 204	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 1,019,954	$ 1,021,441	$ 1,084,048	Calculated - Line 15 * Line 16
15	**No. of Units**	4,574	4,445	4,574	
16	**Unit Cost**	$ 223	$ 230	$ 237	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-10
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCB

Line No.		
1	**MAT Code**	GCB
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Circuit Breaker Preventive Maintenance – Distribution substation costs for breaker exercises. Units measured: Number of circuit breakers. This program relates to safety, reliability, or maintenance because it analyzes the condition of the circuit breaker.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance

6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Breakers Maintained
8	**Unit Cost (2023)**	$ 419

9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 1,047,956	$ 718,270	$ 448,673	$ 457,147	$ 558,913	Calculated - Line 12 * Line 13
12	**No. of Units**	2,557	2,113	1,196	1,446	1,365	
13	**Unit Cost**	$ 410	$ 340	$ 375	$ 316	$ 409	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 741,045	$ 742,125	$ 787,603	Calculated - Line 15 * Line 16
15	**No. of Units**	1,882	1,829	1,882	
16	**Unit Cost**	$ 394	$ 406	$ 419	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-11
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCC

Line No.		
1	**MAT Code**	GCC
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Relay Preventive Maintenance – Distribution substation costs for relay functional tests. Units measured: Number of substation tests. This program relates to safety, reliability, or maintenance because it inspects the relay schemes and tests the condition of the relay to prevent mis-operation.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance

6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Relays Maintained
8	**Unit Cost (2023)**	$ 1,062

9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 1,537,208	$ 1,887,727	$ 1,978,343	$ 1,630,829	$ 2,294,039	Calculated - Line 12 * Line 13
12	**No. of Units**	1,152	1,564	1,127	1,257	1,408	
13	**Unit Cost**	$ 1,334	$ 1,207	$ 1,755	$ 1,297	$ 1,629	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 1,422,402	$ 1,424,475	$ 1,511,760	Calculated - Line 15 * Line 16
15	**No. of Units**	1,423	1,383	1,423	
16	**Unit Cost**	$ 1,000	$ 1,030	$ 1,062	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-12
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCD

Line No.		
1	**MAT Code**	GCD
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Inspections – Distribution substation costs for recurring station inspection of equipment. Units measured: Number of substation inspections. This program relates to safety, reliability, or maintenance because inspections such as EI, Security Check, Environmental Check, and Load Data Collection are performed within the substation.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance

6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Substation Inspections
8	**Unit Cost (2023)**	$ 457

9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 2,328,328	$ 2,212,198	$ 2,140,713	$ 2,525,764	$ 4,645,189	Calculated - Line 12 * Line 13
12	**No. of Units**	7,652	7,555	7,167	6,868	6,996	
13	**Unit Cost**	$ 304	$ 293	$ 299	$ 368	$ 664	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 2,944,623	$ 2,948,915	$ 3,129,629	Calculated - Line 15 * Line 16
15	**No. of Units**	6,850	6,656	6,850	
16	**Unit Cost**	$ 430	$ 443	$ 457	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-13
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCE

Line No.		
1	**MAT Code**	GCE
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: General Station Preventive Maintenance – Distribution substation costs for preventive maintenance tasks on variety of other types of substation equipment. Units measured: Number of tasks. This program relates to safety, reliability, or maintenance because tests are performed on minor substation equipment (e.g., spare transformers, fire system tests, etc.) not specifically captured under other specified maintenance programs to inspect and identify any abnormalities.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Substation Preventative
8	**Unit Cost (2023)**	$ 433
9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 358,045	$ 362,055	$ 312,336	$ 405,321	$ 402,989	Calculated - Line 12 * Line 13
12	**No. of Units**	902	972	1,137	1,376	1,187	
13	**Unit Cost**	$ 397	$ 372	$ 275	$ 295	$ 340	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 479,618	$ 480,317	$ 509,754	Calculated - Line 15 * Line 16
15	**No. of Units**	1,177	1,144	1,177	
16	**Unit Cost**	$ 407	$ 420	$ 433	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-14
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCF

Line No.		
1	**MAT Code**	GCF
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Battery Preventive Maintenance – Distribution substation costs for battery tests. Units measured: Number of batteries. This program relates to safety, reliability, or maintenance because inspections, tests (e.g., resistance and discharge tests) are performed on batteries to identify any abnormalities and determine the batteries can perform as designed.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Batteries Maintained
8	**Unit Cost (2023)**	$ 403
9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 288,485	$ 254,948	$ 265,092	$ 391,973	$ 423,368	Calculated - Line 12 * Line 13
12	**No. of Units**	610	638	653	1,212	1,171	
13	**Unit Cost**	$ 473	$ 400	$ 406	$ 323	$ 362	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 470,352	$ 471,038	$ 499,909	Calculated - Line 15 * Line 16
15	**No. of Units**	1,239	1,204	1,239	
16	**Unit Cost**	$ 380	$ 391	$ 403	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-15
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCI

Line No.		
1	**MAT Code**	GCI
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Switch Preventive Maintenance – Distribution substation costs for switch diagnostic/performance tests. Units measured: Number of switches. This program relates to safety, reliability, or maintenance because diagnostic testing and infrared inspections are performed on switches to identify any abnormal conditions.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance

6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Switches Maintained
8	**Unit Cost (2023)**	$ 899

9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 77,843	$ 66,255	$ 62,268	$ 66,596	$ 68,048	Calculated - Line 12 * Line 13
12	**No. of Units**	94	114	91	104	104	
13	**Unit Cost**	$ 828	$ 581	$ 684	$ 640	$ 654	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 94,686	$ 94,824	$ 100,638	Calculated - Line 15 * Line 16
15	**No. of Units**	112	109	112	
16	**Unit Cost**	$ 845	$ 871	$ 899	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-16
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCJ

Line No.		
1	**MAT Code**	GCJ
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Corrective (T80) – Distribution substation costs for various substation equipment corrective repair work. This program relates to safety, reliability, or maintenance because it involves the corrective repairs of substation equipment that are identified during inspections or test of substation equipment.

	Risk ID	Type	Name
4	None	N/A	N/A

5	**Program Area**	Maintenance and Compliance

6	**Forecast Method**	Unit Cost
7	**Unit of Measure**	Substation Corrective
8	**Unit Cost (2023)**	$ 2,016

9	**Unit Cost Forecast Basis**	The 2021 through 2026 cost forecast is based on number of average hours completed per corrective tag in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 6,549,507	$ 6,769,211	$ 7,886,179	$ 7,332,602	$ 11,322,310	Calculated - Line 12 * Line 13
12	**No. of Units**	4,470	4,585	4,692	4,025	4,461	
13	**Unit Cost**	$ 1,465	$ 1,476	$ 1,681	$ 1,822	$ 2,538	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 8,966,683	$ 8,979,753	$ 9,529,998	Calculated - Line 15 * Line 16
15	**No. of Units**	4,727	4,593	4,727	
16	**Unit Cost**	$ 1,897	$ 1,955	$ 2,016	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-17
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCM

Line No.		
1	**MAT Code**	GCM
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Circuit Breaker Mechanism Services – Distribution substation costs for breaker mechanism services, including required breaker oil analysis. Units measured: Number of breakers. This program relates to safety, reliability, or maintenance because it involves the mechanism service of the circuit breaker to determine whether it is operating as needed.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance

6	**Forecast Method**	Unit cost
7	**Unit of Measure**	# Mech Services
8	**Unit Cost (2023)**	$ 2,115

9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 898,922	$ 988,014	$ 678,088	$ 727,953	$ 1,543,787	Calculated - Line 12 * Line 13
12	**No. of Units**	598	711	434	424	753	
13	**Unit Cost**	$ 1,503	$ 1,390	$ 1,562	$ 1,717	$ 2,050	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 1,413,136	$ 1,415,196	$ 1,501,915	Calculated - Line 15 * Line 16
15	**No. of Units**	710	690	710	
16	**Unit Cost**	$ 1,990	$ 2,051	$ 2,115	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-18
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCO

Line No.		
1	**MAT Code**	GCO
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Transformer Overhaul Inspections – Distribution substation costs for transformer/regulator LTC overhaul inspections. Units measured: Number of transformer overhaul inspections. This program relates to safety, reliability, or maintenance because it involves the overhaul inspection of transformer and regulator LTC to detect deterioration or abnormal conditions.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	# Mech Services
8	**Unit Cost (2023)**	$ 8,085
9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 892,321	$ 1,122,728	$ 749,112	$ 740,716	$ 540,612	Calculated - Line 12 * Line 13
12	**No. of Units**	119	133	59	72	49	
13	**Unit Cost**	$ 7,498	$ 8,442	$ 12,697	$ 10,288	$ 11,033	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 1,148,605	$ 1,150,279	$ 1,220,785	Calculated - Line 15 * Line 16
15	**No. of Units**	151	147	151	
16	**Unit Cost**	$ 7,608	$ 7,839	$ 8,085	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-19
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCS

Line No.		
1	**MAT Code**	GCS
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Circuit Switcher & Motor-Operated Air Switch (MOAS) Mechanism Services – Distribution substation costs for circuit switcher and MOAS mechanism services. Units measured: Number of services. This program relates to safety, reliability, or maintenance because it involves mechanism service related specifically to the performance of circuit switches and MOAS (e.g., performing open and closing operations manually and/or under remote test conditions).

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance

6	**Forecast Method**	Unit cost
7	**Unit of Measure**	# Overhauls
8	**Unit Cost (2023)**	$ 2,481

9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 202,737	$ 120,450	$ 88,943	$ 259,768	$ 192,971	Calculated - Line 12 * Line 13
12	**No. of Units**	90	74	52	95	90	
13	**Unit Cost**	$ 2,253	$ 1,628	$ 1,710	$ 2,734	$ 2,144	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 191,426	$ 191,705	$ 203,464	Calculated - Line 15 * Line 16
15	**No. of Units**	82	80	82	
16	**Unit Cost**	$ 2,335	$ 2,406	$ 2,481	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-20
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCV

Line No.		
1	**MAT Code**	GCV
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Circuit Breaker Overhauls – Distribution substation costs for circuit breaker overhauls. Units measured: Number of circuit breaker overhauls. This program relates to safety, reliability, or maintenance because it involves the circuit breaker overhaul which includes a detailed list of maintenance tasks to determine the circuit breaker is operating as intended.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	# Overhauls
8	**Unit Cost (2023)**	$ 3,937
9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 55,391	$ 25,036	$ 20,369	$ 66,474	$ 72,350	Calculated - Line 12 * Line 13
12	**No. of Units**	15	12	5	14	15	
13	**Unit Cost**	$ 3,693	$ 2,086	$ 4,074	$ 4,748	$ 4,823	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 18,521	$ 18,548	$ 19,690	Calculated - Line 15 * Line 16
15	**No. of Units**	5	5	5	
16	**Unit Cost**	$ 3,704	$ 3,818	$ 3,937	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-21
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT GCW

Line No.		
1	**MAT Code**	GCW
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation: Station Washes – Distribution substation costs for station insulator washing. This program relates to safety, reliability, or maintenance because it involves washing insulators to prevent contamination accumulation that may result in a flashover.

	Risk ID	Type	Name
4	SBSTN-C017	Control	Proactive Maintenance

5	**Program Area**	Maintenance and Compliance
6	**Forecast Method**	Unit cost
7	**Unit of Measure**	Substation Preventative
8	**Unit Cost (2023)**	$ 1,018
9	**Unit Cost Forecast Basis**	The unit cost is based on mid-2020 analysis that reviewed average of hours spent per maintenance tasks in this MAT, multiplied by the personnel hourly rate.
10	**Unit Forecast Basis**	2020 volume of units extracted from SAP for assets that meet time or condition based triggers from the date of install.

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 304,161	$ 340,811	$ 323,161	$ 236,753	$ 371,478	Calculated - Line 12 * Line 13
12	**No. of Units**	389	496	412	251	422	
13	**Unit Cost**	$ 782	$ 687	$ 784	$ 943	$ 880	

		Forecast Costs & Units (Escalated) (A)			
	Year	**2021**	**2022**	**2023**	
14	**Forecast Costs**	$ 411,690	$ 412,290	$ 437,557	Calculated - Line 15 * Line 16
15	**No. of Units**	430	418	430	
16	**Unit Cost**	$ 957	$ 987	$ 1,018	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper Table 15-22
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 15
Substation Asset Management
Capital Expenditures by Major Work Category
(Thousands of Nominal Dollars)

			Capital Expenditures											
No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	48	E Dist Subst Repl Other Equip	44,837	96,896	106,901	79,977	77,377	76,601	96,588	96,331	87,218	84,078	77,723	WP 15-26, WP 15-27
2	54	E Dist Subst Repl Transformer	54,495	22,641	31,413	39,288	31,907	40,766	27,970	21,243	30,294	35,418	38,721	WP 15-29, WP 15-30
3	58	E Dist Repl Substation Safety	602	3,177	2,290	9,054	3,369	5,980	1,738	8,232	12,882	15,743	22,218	WP 15-31, WP 15-32
4	59	E Dist Subst Emergency Repl	58,816	82,607	63,711	82,180	119,133	101,935	77,872	82,323	84,550	86,831	89,175	WP 15-33, WP 15-34
5		**Grand Total**	**158,750**	**205,320**	**204,313**	**210,499**	**231,786**	225,282	204,167	208,129	214,944	222,071	227,837	

Table 15-23
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 15
Substation Asset Management
Forecast Capital Expenditures Summary
(Thousands of Nominal Dollars)

		Capital Expenditures							
Line No.	Description	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	Projects > $3 Million*	116,806	151,820	201,014	206,474	214,742	221,871	227,632	WP 15-24
2	Other Work	41,878	73,463	3,153	1,655	202	200	205	WP 15-25
3	**Total**	**158,684**	**225,282**	**204,167**	**208,129**	**214,944**	**222,071**	**227,837**	

4 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 15-24
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 15
Substation Asset Management
Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million*
(Thousands of Nominal Dollars)

Line	Planning				CWIP	Capital Expenditures							
				Operative	2020 Recorded	2021	2022	2023	2024	2025	2026		
No.	Order	Description	MWC	Date	Adjusted	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Subtotal	Reference
	MWC - 48	**E Dist Subst Repl Other Equip**											
1	5543522	SYSPLAN ED 48A SBSTN-C16A WLDFR-C10A	48		-	3,425	4,197	3,782	2,678	2,656	2,728	19,467	
2	5543533	SYSPLAN ED 48H SBSTN-M006/SBSTN-C005	48		-	-	3,326	4,056	9,456	6,284	6,453	29,576	
3	5543539	SYSPLAN ED 48X SBSTN-C002	48		-	-	5,404	5,760	4,963	4,466	4,576	25,168	
4	5544459	SYSPLAN ED 48C SBSTN-C16C WLDFR-C10C	48		-	-	3,025	3,250	3,338	3,428	3,520	16,560	
5	5544460	SYSPLAN ED 48N SBSTN-C16H WLDFR-C10I	48		-	-	527	5,416	5,563	5,713	5,867	23,085	
6	5544486	SYSPLAN FRMMA 48E SBSTN-C16E WLDFR-C	48		-	-	3,457	2,166	4,450	4,570	3,520	18,164	
7	5732860	OAKLAND K:Rpl 12KV Swgr SBSTN-C16FWFC1(	48	Nov-2022	1,135	1,218	7,231	1,057	-	-	-	10,642	
8	5746778	LARKIN: Repl 12 KV SWGR SBC16F WFC10F	48	Sep-2021	85,421	11,843	1,778	1,611	287	-	-	100,940	
9	5756850	MOUNT EDEN: Repl 12 KV CB 1106- 1107	48	Aug-2021	-	829	2,191	-	-	-	-	3,019	
10	5761700	ASHLAN:1103-8,13-14;2105,10;SBC16DWFC10I	48	Nov-2024	4	-	828	195	2,092	86	-	3,204	
11	5763198	POTRERO:Rpl12KV DBDB SWGR SBSC16FWFI	48	Jul-2027	584	365	6,118	14,804	13,236	16,126	15,652	66,886	
12	5768782	HUNTERS PT:Rpl12KVBusW/SWGR SBC16FWF	48	Dec-2023	1,451	6,599	14,462	13,746	1,076	-	-	37,334	
13	5774718	HARTLEY: Repl SWGR SBSTN-C16F WLDFR-C'	48	Oct-2024	18	2	426	1,215	2,092	461	-	4,214	
14	5775005	Berkeley T: CKTs 12kV 3/3 SBC16GWFC10H	48	Dec-2023	41	-	31	5,287	2,329	-	-	7,688	
15	5775006	Berkeley T: CKTs 12kV 2/3 SBC16GWFC10H	48	Dec-2022	101	-	3,318	3,818	-	-	-	7,237	
16	5785561	Larkin (SF Y) Reconfigure Feeders	48	Jul-2021	1,183	4,066	-	-	-	-	-	5,249	
17	5787180	Summit: Rebld Sub SBSTN-C16A WLDFR-C10A	48	Jan-2023	176	664	6,507	142	-	-	-	7,490	
18	5795584	SYSPLAN ED 48D SBSTN-C16D WLDFR-C10D	48	Dec-2020	-	13,461	28,237	28,370	29,896	34,376	29,334	163,673	
19	5795587	SYSPLAN ED 48F SBSTN-C16F WLDFR-C10F	48	Dec-2020	-	6,780	1,255	-	-	-	-	8,034	
20	5795588	SYSPLAN ED 48L SBSTN-C16G	48	Dec-2020	-	20,865	2,677	-	5,563	5,713	5,867	40,684	
21	**Total**				**90,114**	**70,118**	**94,994**	**94,675**	**87,016**	**83,878**	**77,517**	**598,313**	WP 15-35
	MWC - 54	**E Dist Subst Repl Transformer**											
22	5543550	SYSPLAN ED 54A SBSTN-M002 WLDFR-C10K	54		-	-	2,729	1,979	2,965	3,519	3,872	15,064	
23	5543552	SYSPLAN ED 54L SBSTN-M001	54		-	-	3,164	3,250	3,338	3,428	3,520	16,699	
24	5746763	EMBARCADERO: Repl BK 1	54	Dec-2021	1,414	6,705	-	-	-	-	-	8,119	
25	5747138	PENNGROVE: Repl 115/12 KV BK 1	54	Sep-2021	2,205	2,847	-	-	-	-	-	5,051	
26	5757708	ASHLAN AVENUE: Repl 230/12 KV BK 2	54	Mar-2022	899	6,458	-	-	-	-	-	7,356	
27	5783018	Valley Springs: Install 60/12kV Bank	54	Dec-2021	1,818	4,896	-	-	-	-	-	6,715	
28	5795598	SYSPLAN ED 54A SBSTN-C16J WLDFR-C10K	54	Dec-2020	-	-	22,077	16,014	23,991	28,472	31,329	121,882	
29	**Total**				**6,336**	**20,906**	**27,970**	**21,243**	**30,294**	**35,418**	**38,721**	**180,886**	WP 15-35
	MWC - 58	**E Dist Repl Substation Safety**											
30	5506602	Fire Prtctn-Suprsn:SBSTN-C009 WLDFR-C018	58		-	-	-	3,250	3,338	1,143	1,173	8,903	
31	5543563	SYSPLAN ED 58S SBSTN-C001 WLDFR-C10M	58		-	678	1,688	4,983	5,563	4,570	-	17,480	
32	5747133	Distribution Seismic Program SBSTN-C007	58	Dec-2020	-	-	-	-	3,338	3,428	-	6,765	
33	5764278	EMBARCADERO:Retrofit Building SBSTN-C007	58	Nov-2027	213	-	-	-	645	6,603	21,045	28,506	
34	**Total**				**213**	**678**	**1,688**	**8,232**	**12,882**	**15,743**	**22,218**	**61,654**	
	MWC - 59	**E Dist Subst Emergency Repl**											
35	5506239	Emergency Replacement , Overall Budget	59		-	35,000	-	-	-	-	-	35,000	
36	5540599	CALAVERAS CEMENT: REPL BK 1 EMERG	59		-	4,326	-	-	-	-	-	4,326	
37	5544465	SYSPLAN ED 59A	59		-	-	76,362	82,323	84,550	86,831	89,175	419,243	
38	5782760	Placer: Replace BK 3 Wood Poles	59	Feb-2021	2,936	255	-	-	-	-	-	3,191	
39	5783959	Livermore: Replace Bank 1	59	Feb-2021	4,434	902	-	-	-	-	-	5,337	
40	5785338	DUNLAP SUB: EM REP BK 1	59	May-2021	7,133	173	-	-	-	-	-	7,306	
41	5788918	Salmon Creek: Repl Bk 1 fuse; PSPS Relay	59	Apr-2021	769	2,745	-	-	-	-	-	3,514	
42	5789152	Colusa Substation: Replace Bank 2	59	May-2021	2,277	1,449	-	-	-	-	-	3,725	
43	5789679	Colusa Substation: Replace Bank 1	59	May-2022	1,057	2,757	-	-	-	-	-	3,814	
44	5789684	SF A Potrero: Repalce 115/12kV Bank 2	59	Sep-2021	279	5,077	-	-	-	-	-	5,356	
45	5789685	Oakland C: Repalce 115/12kV Bank 2	59	Sep-2021	1,205	4,452	-	-	-	-	-	5,658	
46	5791006	Sneath Lane: Replace Banks 1 & 2	59	Apr-2025	52	2,982	-	-	-	-	-	3,034	
47	**Total**				**20,143**	**60,119**	**76,362**	**82,323**	**84,550**	**86,831**	**89,175**	**499,504**	
48		**Grand Total**			**116,806**	**151,820**	**201,014**	**206,474**	**214,742**	**221,871**	**227,632**	**1,340,358**	

49 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 15-25
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 15
Substation Asset Management
Recorded and Forecast Capital Expenditures Details - Other Work*
(Thousands of Nominal Dollars)

			Capital Expenditures											
Line No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	48	E Dist Subst Repl Other Equip	38,589	73,843	85,410	64,438	49,585	6,484	1,593	1,655	202	200	205	WP 15-35
2	54	E Dist Subst Repl Transformer	54,436	22,474	30,684	36,821	28,957	19,861	-	-	-	-	-	WP 15-35
3	58	E Dist Repl Substation Safety	604	3,179	2,290	9,025	3,172	5,302	50	-	-	-	-	WP 15-35
4	59	E Dist Subst Emergency Repl	58,745	82,607	63,687	79,703	99,034	41,816	1,510	-	-	-	-	WP 15-35
5	**Grand Total**		**152,374**	**182,103**	**182,071**	**189,987**	**180,748**	**73,463**	**3,153**	**1,655**	**202**	**200**	**205**	

6 * Excludes projects greater than $3M

Workpaper Table 15-26
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category 48 - Recorded Walk
MWC 48 - Replace Substation Equipment
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$44,837**			
2		Net Change	$52,059		Increase due to rise in switchgear replacement (at Larkin, El Cerrito, Martin), circuit breaker replacement (at Rewood City, Stockton A, Spring Gap), line work support, and animal abatement work	WP 15-35 Line 14
3	**2017**	**Recorded Adjusted**	**$96,896**			
4		Net Change	$10,005		Increase due to the completion of in-flight projects and PG&E's decision to limit proactive substation asset replacement projects	WP 15-35 Line 14
5	**2018**	**Recorded Adjusted**	**$106,901**			
6		Net Change	-$26,924		Decrease due to the transition of multiple switchgear and breaker replacement projects progressing to their next phase in the project cycle	WP 15-35 Line 14
7	**2019**	**Recorded Adjusted**	**$79,977**			
8		Net Change	-$2,600		Decrease due to variability in project work towards closing-out several in-flight projects.	WP 15-35 Line 14
9	**2020**	**Recorded Adjusted**	**$77,377**			

Workpaper Table 15-27
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category 48 - Forecast Walk
MWC 48 - Replace Substation Equipment
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$77,377**			
2		Switchgear Replacement (MAT 48F)	-$18,552		Decrease due to the closing-out of the Larkin 12kV switchgear project.	WP 15-35 Line 1
3		Circuit Breaker Replacement (MAT 48D)	$9,777		Increase due to the reinitiation of breaker replacements.	WP 15-35 Line 2
4		Animal Abatement (MAT 48X)	-$428		Decrease due to the variability of animal abatement project moving to the next phase of their respective project life cycles.	WP 15-35 Line 3
5		Battery Replacement (MAT 48C)	-$101		Minor decrease due to the completion of two battery replacement projects at Mira Vista and Jarvis substations.	WP 15-35 Line 4
6		Line Work Support (MAT 48L)	$9,004		Increase due to the distribution line work associated with switchgear and cutover projects such as Larkin and El Cerrito switchgear repalcement as well as the Sausalito cutover project.	WP 15-35 Line 5
7		Subtotal of all Other Equipment Replacement Work (MAT 48A, 48E, 48H, 48G, 48B, 48N, 48R)	-$476		No signficant change	WP 15-35 Line 6
8		**Net Change**	**-$776**			
9	**2021**	**Forecast**	**$76,601**			
10		Switchgear Replacement (MAT 48F)	$4,462		Increase is due to an increase in the Hunter's Point switchgear replacement project	WP 15-35 Line 1
11		Circuit Breaker Replacement (MAT 48D)	$16,965		Increase due to the continuation of deferred breaker replacements.	WP 15-35 Line 2
12		Animal Abatement (MAT 48X)	$870		Increase is due to reinitiated animal abatement projects.	WP 15-35 Line 3
13		Battery Replacement (MAT 48C)	$2,843		Increase is attributed battery projects initiated in 2021.	WP 15-35 Line 4
14		Line Work Support (MAT 48L)	-$18,904		Decrease is due to the completion of distribution line work associated with switchgear and cutover projects such as Larkin and El Cerrito switchgear repalcement as well as the Sausalito cutover project.	WP 15-35 Line 5
15		Subtotal of all Other Equipment Replacement Work (MAT 48A, 48E, 48H, 48G, 48B, 48N, 48R)	$13,749		Increase is driven by the Summit substation rebuild and various ground grid replacement projects.	WP 15-35 Line 6
16		**Net Change**	**$19,986**			
17	**2022**	**Forecast**	**$96,588**			
18		Switchgear Replacement (MAT 48F)	$1,164		Increase is due to an increase in the Potrero switchgear replacement project	WP 15-35 Line 1
19		Circuit Breaker Replacement (MAT 48D)	-$2,691		Decrease primarily due to the completion of the Mt. Eden breaker repalcement project.	WP 15-35 Line 2
20		Animal Abatement (MAT 48X)	$357		Increase is attributed to the continuation of animal abatement projects.	WP 15-35 Line 3
21		Battery Replacement (MAT 48C)	$225		Minor increase due to escalation	WP 15-35 Line 4
22		Line Work Support (MAT 48L)	$3,078		Increase is due to the distribution line work associated with Berkeley T cutover project.	WP 15-35 Line 5
23		Subtotal of all Other Equipment Replacement Work (MAT 48A, 48E, 48H, 48G, 48B, 48N, 48R)	-$2,389		Decrease is due to the closing-out of the Summit substation rebuild project	WP 15-35 Line 6
24		**Net Change**	**-$257**			
25	**2023**	**Forecast**	**$96,331**			
26		Switchgear Replacement (MAT 48F)	-$15,743		Decrease is due lower expenditures for the Hunters Point switchgear project that is slated for completion	WP 15-35 Line 1
27		Circuit Breaker Replacement (MAT 48D)	$3,423		Increase is primarily driven to initiate new breakers	WP 15-35 Line 2
28		Animal Abatement (MAT 48X)	-$798		Decrease due to completed animal abatement projects.	WP 15-35 Line 3
29		Battery Replacement (MAT 48C)	$88		Minor increase to continue battery projects.	WP 15-35 Line 4
30		Line Work Support (MAT 48L)	-$1,213		Decrease is due to the completion of distribution line work associated with Vierra distribution line relocation project.	WP 15-35 Line 5
31		Subtotal of all Other Equipment Replacement Work (MAT 48A, 48E, 48H, 48G, 48B, 48N, 48R)	$5,130		Increase is primarily driven by civil structure and insulator replacement projects.	WP 15-35 Line 6
32		**Net Change**	**-$9,113**			
33	**2024**	**Forecast**	**$87,218**			

Workpaper Table 15-27
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category 48 - Forecast Walk
MWC 48 - Replace Substation Equipment
(Thousands of Nominal Dollars)

34		Switchgear Replacement (MAT 48F)	-$102		Decrease is due to the close-out of the Hartley switchgear replacement project.	WP 15-35 Line 1
35		Circuit Breaker Replacement (MAT 48D)	$2,474		Increase due to the continuation of new breaker replacements	WP 15-35 Line 2
36		Animal Abatement (MAT 48X)	-$497		Decrease is due to the scheduled completion of animal abatement projects.	WP 15-35 Line 3
37		Battery Replacement (MAT 48C)	$90		No significant change	WP 15-35 Line 4
38		Line Work Support (MAT 48L)	-$2,179		Decrease is due to the completion of the distribution line work associated with Berkeley T cutover project.	WP 15-35 Line 5
39		Subtotal of all Other Equipment Replacement Work (MAT 48A, 48E, 48H, 48G, 48B, 48N, 48R)	-$2,926		Decrease is primarily driven by the scheduled completion of the Old Kearney 12kV structure replacement project.	WP 15-35 Line 6
40		**Net Change**	**-$3,140**			
41	**2025**	**Forecast**	**$84,078**			
42		Switchgear Replacement (MAT 48F)	-$936		Decrease is attributed to the scheduled completion of Gualala and Hartley switchgear replacement projects.	WP 15-35 Line 1
43		Circuit Breaker Replacement (MAT 48D)	-$5,128		Decrease is due to the completion of circuit breaker replacements.	WP 15-35 Line 2
44		Animal Abatement (MAT 48X)	$110		Minor increase due to escalation	WP 15-35 Line 3
45		Battery Replacement (MAT 48C)	$93		Minor increase due to escalation	WP 15-35 Line 4
46		Line Work Support (MAT 48L)	$154		Minor increase due to escalation	WP 15-35 Line 5
47		Subtotal of all Other Equipment Replacement Work (MAT 48A, 48E, 48H, 48G, 48B, 48N, 48R)	-$649		Decrease in planned switch work	WP 15-35 Line 6
48		**Net Change**	**-$6,356**			
49	**2026**	**Forecast**	**$77,723**			

Workpaper Table 15-28
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category 54 - Recorded Walk
MWC 54 - Transformer Replacements

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$54,495**			
2		Net Change	-$31,854		Decrease driven by the completion of various transformer replacement projects	WP 15-35 Line 19
3	**2017**	**Recorded Adjusted**	**$22,641**			
4		Net Change	$8,772		Increase due to the reinitiation of various deferred or previously reprioritized transformer replacement projects.	WP 15-35 Line 19
5	**2018**	**Recorded Adjusted**	**$31,413**			
6		Net Change	$7,876		Increase due to the reinitiation of various deferred or previously reprioritized transformer replacement projects.	WP 15-35 Line 19
7	**2019**	**Recorded Adjusted**	**$39,288**			
8		Net Change	-$7,382		Decrease due to the completion of the Embarcadero (San Francisco Z) decoupling project and the receipt of a mobile transformer.	WP 15-35 Line 19
9	**2020**	**Recorded Adjusted**	**$31,907**			

Workpaper Table 15-29
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category 54 - Forecast Walk
MWC 54 - Transformer Replacements
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$31,907**			
2		Transformer Replacement (MAT 54A)	-$466		Minor variation due to the completion of transformer projects.	WP 15-35 Line 15
3		Mobile Equipment and Capitalized Emergency Material (54A)	$9,439		Increase is driven by the procurement of four (4) CEM transformers and funding to procure a mobile transformer.	WP 15-35 Line 16
4		MAT 54#	-$113		Minor variance	WP 15-35 Line 18
5		**Net Change**	**$8,860**			
6	**2021**	**Forecast**	**$40,766**			
7		Transformer Replacement (MAT 54A)	-$10,143		Decrease is driven by the completion of various transformer replacement projects.	WP 15-35 Line 15
8		Mobile Equipment and Capitalized Emergency Material (54A)	-$5,931		Decrease is driven by the reciept of CEM equipment.	WP 15-35 Line 16
9		Transformer Life Extension (MAT 54L)	$3,164		Increase due to the re-initiation of the Transformer Life Extension program.	WP 15-35 Line 17
10		MAT 54#	$113		Minor variance	WP 15-35 Line 18
11		**Net Change**	**-$12,797**			
12	**2022**	**Forecast**	**$27,970**			
13		Transformer Replacement (MAT 54A)	-$6,063		Decrease is due to the scheduled completion of the Cambria Bank 1 replacement project.	WP 15-35 Line 15
14		Mobile Equipment and Capitalized Emergency Material (54A)	-$749		Decrease is due to the scheduled receipt of CEM transformers.	WP 15-35 Line 16
15		Transformer Life Extension (MAT 54L)	$85		Minor variance due to escalation.	WP 15-35 Line 17
16		**Net Change**	**-$6,727**			
17	**2023**	**Forecast**	**$21,243**			
18		Transformer Replacement (MAT 54A)	$7,977		Increase is driven by the initiation new transformer replacement projects.	WP 15-35 Line 15
19		Mobile Equipment and Capitalized Emergency Material (54A)	$986		Increase due to the scheduled procurement of CEM equipment.	WP 15-35 Line 16
20		Transformer Life Extension (MAT 54L)	$88		Minor variance due to escalation.	WP 15-35 Line 17
21		**Net Change**	**$9,051**			
22	**2024**	**Forecast**	**$30,294**			
23		Transformer Replacement (MAT 54A)	$4,481		Increase is driven continued transformer replacement projects.	WP 15-35 Line 15
24		Mobile Equipment and Capitalized Emergency Material (54A)	$554		Minor variance due to escalation.	WP 15-35 Line 16
25		Transformer Life Extension (MAT 54L)	$90		Minor variance due to escalation.	WP 15-35 Line 17
26		**Net Change**	**$5,125**			
27	**2025**	**Forecast**	**$35,418**			
28		Transformer Replacement (MAT 54A)	$2,857		Increase is driven by continued transformer replacement projects.	WP 15-35 Line 15
29		Mobile Equipment and Capitalized Emergency Material (54A)	$353		Minor variance due to escalation.	WP 15-35 Line 16
30		Transformer Life Extension (MAT 54L)	$93		Minor variance due to escalation.	WP 15-35 Line 17
31		**Net Change**	**$3,303**			
32	**2026**	**Forecast**	**$38,721**			

Workpaper Table 15-30
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category 58 - Recorded Walk
MWC 58 - Distribution Substation Safety and Security
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$602**			
2		Net Change	$2,575		Increase driven by the implementation of the various seismic upgrade projects (at Stockton and Vallejo B Substations)	WP 15-35 Line 25
3	**2017**	**Recorded Adjusted**	**$3,177**			
4		Net Change	-$887		Decrease is due to a reduction in expenditures for the Stockton A control building replacement.	WP 15-35 Line 25
5	**2018**	**Recorded Adjusted**	**$2,290**			
6		Net Change	$6,765		Increase due to an increase in expenditures related to the Stockton A control building replacement as well as the demolition of the Vallejo B control building and the Edenvale physical security project.	WP 15-35 Line 25
7	**2019**	**Recorded Adjusted**	**$9,054**			
8		Net Change	-$5,685		Decrease the closing out of the Stockton A control building replacement as well as the demolition of the Vallejo B control building and the Edenvale physical security project.	WP 15-35 Line 25
9	**2020**	**Recorded Adjusted**	**$3,369**			

Workpaper Table 15-31
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category 58 - Forecast Walk
MWC 58 - Distribution Substation Safety and Security
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$3,369**			
2		Safety, Seismic, Fire Protection Suppression, Security	$2,610		Increase driven by the Manchester physical security project.	WP 15-35 Line 25
3		**Net Change**	**$2,610**			
4	**2021**	**Forecast**	**$5,980**			
5		Safety, Seismic, Fire Protection Suppression, Security	-$4,242		Decrease due to the completion of fire protection and suppression projects and the completion of the Manchester physical security project.	WP 15-35 Line 25
6		**Net Change**	**-$4,242**			
7	**2022**	**Forecast**	**$1,738**			
8		Safety, Seismic, Fire Protection Suppression, Security	$6,495		Increase due planned work related to fire protection and suppression as well as and increase in physical security projects at various substations to meet CPUC decision requirements.	WP 15-35 Line 25
9		**Net Change**	**$6,495**			
10	**2023**	**Forecast**	**$8,232**			
11		Safety, Seismic, Fire Protection Suppression, Security	$4,650		Increase is due to the Embarcadero substation building seismic retrofit project.	WP 15-35 Line 25
12		**Net Change**	**$4,650**			
13	**2024**	**Forecast**	**$12,882**			
14		Safety, Seismic, Fire Protection Suppression, Security	$2,861		Increase is due to the continuation of the Embarcadero substation building seismic retrofit project.	WP 15-35 Line 25
15		**Net Change**	**$2,861**			
16	**2025**	**Forecast**	**$15,743**			
17		Safety, Seismic, Fire Protection Suppression, Security	$6,475		Increase is due to the continuation of the Embarcadero substation building seismic retrofit project.	WP 15-35 Line 25
18		**Net Change**	**$6,475**			
19	**2026**	**Forecast**	**$22,218**			

Workpaper Table 15-32
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category 59 - Recorded Walk
MWC 59 - Distribution Substation Emergency Equipment Replacement
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$58,816**			
2		Net Change	$23,791		Increase is primarily driven by the rise of emergency transformer replacement work needed in 2017.	WP 15-35 Line 29
3	**2017**	**Recorded Adjusted**	**$82,607**			
4		Net Change	-$18,896		Decrease is driven by they high number and scope of emergency work in 2017 that was not forecasted to continue in 2018.	WP 15-35 Line 29
5	**2018**	**Recorded Adjusted**	**$63,711**			
6		Net Change	$18,469		Increase driven by the multiple miscellaneous minor equipment replacements including the initiation of the 2019 Substation WSIP efforts.	WP 15-35 Line 29
7	**2019**	**Recorded Adjusted**	**$82,180**			
8		Net Change	$36,953		Increase across all major and minor emergency replacement activities.	WP 15-35 Line 29
9	**2020**	**Recorded Adjusted**	**$119,133**			

Workpaper Table 15-33
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Major Work Category 59 - Forecast Walk
MWC 59 - Distribution Substation Emergency Equipment Replacement
(Thousands of Nominal Dollars)

mn. No.	Year	Program/Activity	Amount		Detained Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$119,133**			
2		Emergency Replacement	-$17,199		Decrease due to WSIP identified capital projects completed as well as various miscellaneous emergency replacements.	WP 15-35 Line 29
3		**Net Change**	**-$17,199**			
4	**2021**	**Forecast**	**$101,935**			
5		Emergency Replacement	-$24,063		Decrease due to the completion of multiple bank emergency replacement projects.	WP 15-35 Line 29
6		**Net Change**	**-$24,063**			
7	**2022**	**Forecast**	**$77,872**			
8		Emergency Replacement	$4,451		Increase driven by a lower forecast for emergency work and escalation.	WP 15-35 Line 29
9		**Net Change**	**$4,451**			
10	**2023**	**Forecast**	**$82,323**			
11		Emergency Replacement	$2,227		Minor variation in forecasted work, primarily escalation	WP 15-35 Line 29
12		**Net Change**	**$2,227**			
13	**2024**	**Forecast**	**$84,550**			
14		Emergency Replacement	$2,281		Minor variation in forecasted work, primarily escalation	WP 15-35 Line 29
15		**Net Change**	**$2,281**			
16	**2025**	**Forecast**	**$86,831**			
17		Emergency Replacement	$2,344		Minor variation in forecasted work, primarily escalation	WP 15-35 Line 29
18		**Net Change**	**$2,344**			
19	**2026**	**Forecast**	**$89,175**			

Workpaper Table 15-34
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
Capital Summary

Line No.	MWC 48 - Replace Substation Equipment	MAT	2016 Actual	2017 Actual	2018 Actual	2019 Actual	2020 Actual	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Notes	Reference
1	**Switchgear Replacement**	**48F**	$ 29,725	$ 60,058	$ 64,547	$ 41,310	$ 45,360	$ 26,808	$ 31,269	$ 32,433	$ 16,690	$ 16,588	$ 15,652		WP 15-39
2	**Circuit Breaker Replacement**	**48D**	$ 2,991	$ 9,901	$ 11,096	$ 14,176	$ 4,513	$ 14,290	$ 31,255	$ 28,564	$ 31,987	$ 34,462	$ 29,334		WP 15-37
3	**Animal Abatement**	**48X**	$ 2,176	$ 6,318	$ 4,178	$ 1,303	$ 4,961	$ 4,533	$ 5,404	$ 5,760	$ 4,963	$ 4,466	$ 4,576		WP 15-38
4	**Battery Replacement**	**48C**	$ 1,131	$ 142	$ 734	$ 49	$ 282	$ 181	$ 3,025	$ 3,250	$ 3,338	$ 3,428	$ 3,520		WP 15-36
5	**Line Work Support**	**48L**	$ 883	$ 6,988	$ 17,740	$ 15,030	$ 15,926	$ 24,931	$ 6,027	$ 9,105	$ 7,892	$ 5,713	$ 5,867		WP 15-53
6	**Subtotal of all Other Equipment Replacement Work**		$ 7,931	$ 13,489	$ 8,605	$ 8,108	$ 6,335	$ 5,858	$ 19,608	$ 17,218	$ 22,349	$ 19,423	$ 18,774		
7	Other Equipment - Other Equipment Replacement	**48A**	$ 2,042	$ 4,393	$ 3,669	$ 4,762	$ 2,983	$ 4,397	$ 11,510	$ 4,220	$ 2,880	$ 2,856	$ 2,933	(4)	WP 15-55
8	Other Equipment - Civil Structure	**48H**	$ 4,721	$ 4,101	$ 721	$ 48	$ 191	$ 514	$ 4,113	$ 5,416	$ 9,456	$ 6,284	$ 6,453		WP 15-46
9	Other Equipment - Insulator Replacement	**48N**	$ (28)	$ 2,634	$ 2,400	$ 1,650	$ 623	$ -	$ 527	$ 5,416	$ 5,563	$ 5,713	$ 5,867		WP 15-51
10	Other Equipment - Switch Replacement	**48E**	$ 937	$ 1,844	$ 1,163	$ 1,734	$ 2,538	$ 945	$ 3,457	$ 2,166	$ 4,450	$ 4,570	$ 3,520		WP 15-59
11	Other Equipment - Regulator Replacement	**48B**	$ 192	$ 646	$ 651	$ (86)	$ 1	$ 1	$ -	$ -	$ -	$ -	$ -	(1)	
12	Other Equipment - Arc Flash Reduction	**48R**	$ 68	$ (130)	$ 0	$ 0	$ (1)	$ -	$ -	$ -	$ -	$ -	$ -	(2)	
13	**MWC 48 Total**		**$ 44,837**	**$ 96,896**	**$ 106,901**	**$ 79,977**	**$ 77,377**	$ 76,601	$ 96,588	$ 96,331	$ 87,218	$ 84,078	$ 77,723		

Line No.	MWC 54 - Transformer Replacements	MAT	2016 Actual	2017 Actual	2018 Actual	2019 Actual	2020 Actual	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Notes	Reference
14															
15	**Transformer Replacement**	**54A**	$ 51,831	$ 21,776	$ 30,731	$ 37,616	$ 32,686	$ 32,220	$ 22,077	$ 16,014	$ 23,991	$ 28,472	$ 31,329		WP 15-64
16	**Mobile Equipment and Capitalized Emergency Material**	**54A**	$ 2,665	$ 865	$ 682	$ 1,673	$ (779)	$ 8,660	$ 2,729	$ 1,979	$ 2,965	$ 3,519	$ 3,872		WP 15-64
17	**Transformer Life Extension**	**54L**	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,164	$ 3,250	$ 3,338	$ 3,428	$ 3,520		WP 15-64
18	**Forecast Adjustment**	**54#**	$ -	$ -	$ -	$ -	$ -	$ (113)	$ -	$ -	$ -	$ -	$ -	(3)	Chapter 2, Section D
19	**MWC 54 Total**		**$ 54,495**	**$ 22,641**	**$ 31,413**	**$ 39,288**	**$ 31,907**	**$ 40,766**	**$ 27,970**	**$ 21,243**	**$ 30,294**	**$ 35,418**	**$ 38,721**		

Line No.	MWC 58 - Distribution Substation Safety and Security	MAT	2016 Actual	2017 Actual	2018 Actual	2019 Actual	2020 Actual	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Notes	Reference
20															
21	**Fire Protection and Suppression**	**58A**	$ 290	$ 2,919	$ 2,116	$ 7,245	$ 2,583	$ 1,681	$ 4	$ 3,250	$ 3,338	$ 1,143	$ 1,173		WP 15-58
22	**Seismic Program**	**58B**	$ -	$ -	$ 0	$ 29	$ 198	$ 1,126	$ -	$ -	$ 3,982	$ 10,030	$ 21,045		WP 15-58
23	**Dist Sub Misc Equip (MAT discontinued)**	**58C**	$ -	$ -	$ -	$ -	$ 16	$ 21	$ -	$ -	$ -	$ -	$ -		WP 15-58
24	**Distribution Substation Security**	**58S**	$ 312	$ 258	$ 173	$ 1,780	$ 573	$ 3,152	$ 1,734	$ 4,983	$ 5,563	$ 4,570	$ -		WP 15-58
25	**MWC 58 Total**		**$ 602**	**$ 3,177**	**$ 2,290**	**$ 9,054**	**$ 3,369**	**$ 5,980**	**$ 1,738**	**$ 8,232**	**$ 12,882**	**$ 15,743**	**$ 22,218**		

Line No.	MWC 59 - Distribution Substation Emergency Equipment Replacement	MAT	2016 Actual	2017 Actual	2018 Actual	2019 Actual	2020 Actual	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Notes	Reference
26															
27	**Emergency Replacement**	**59A, 59C, 59D, 59E,**	$ 58,816	$ 82,607	$ 63,711	$ 82,180	$ 119,133	$ 103,644	$ 77,872	$ 82,323	$ 84,550	$ 86,831	$ 89,175		WP 15-49
28	**Forecast Adjustment**	**59#**	$ -	$ -	$ -	$ -	$ -	$ (1,709)	$ -	$ -	$ -	$ -	$ -	(3)	Chapter 2, Section D
29	**MWC 59 Total**		**$ 58,816**	**$ 82,607**	**$ 63,711**	**$ 82,180**	**$ 119,133**	**$ 101,935**	**$ 77,872**	**$ 82,323**	**$ 84,550**	**$ 86,831**	**$ 89,175**		
30															
31	**Total Capital**		**$ 158,750**	**$ 205,320**	**$ 204,313**	**$ 210,499**	**$ 231,786**	$ 225,282	$ 204,167	$ 208,129	$ 214,944	$ 222,071	$ 227,837		

Assumptions and Notes

(1) MAT Code 48B was used to account for substation Regulator replacement work in the past. The work is now forecasted in MAT Code 54A - Transformer Replacement Program.
(2) MAT Code 48R was used to account for substation Arc Flash Reduction work in the past. The work is now forecasted in MAT Code 48A - Other Equipment Replacement Program.
(3) Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR
(4) The 2020 recorded value varies from the values listed in the Results of Operations (RO) Model due to errata. These amounts do not align to the RO Model provided to the Public Advocates Office at the time of filing. The RO will be updated to incorporate these errata with the Joint Comparison Exhibit submittal.

Workpaper 15-35
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT 48C

Line No.		
1	**MAT Code**	48C
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Replace Electric Distribution Substation Batteries – Replace battery system at electric distribution substation. Units measured: Number of batteries. This program relates to reliability because it targets the replacement of substation batteries to minimize reliability risk due to battery failures.

	Risk ID	Type	Name
4	SBSTN-C16C	Control	Proactive Asset Replacement - Batteries
5	WLDFR-C10C	Control	Substation Proactive Asset Replacement - Batteries

5	**Program Area**	Asset Management and Reliability
6	**Forecast Method**	Unit Cost
7	**Unit of Measure**	Batteries replaced
8	**Unit Cost (2023)**	$ 324,961
9	**Unit Cost Forecast Basis**	The unit cost to replace a battery is estimated at approximately $300,000 per battery based on similarly completed projects. The forecast includes escalation.
10	**Unit Forecast Basis**	The 2021 forecast completes in-flight battery replacements. The 2022-2026 forecast seeks to proactively 10 batteries per year over a one to two year execution periord. Years with units listed as zero indicate that no units are expected to be operative in that year. Costs are incurred as a result of projects in a engineering, construction or close-out phase. Please reference the *Project Summary – Battery Replacement, MAT 48C.*

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 1,130,622	$ 141,689	$ 734,128	$ 48,677	$ 282,048	Calculated - Line 12 * Line 13
12	**No. of Units**	2	-	4	-	2	
13	**Unit Cost**	$ 565,311	$ -	$ 183,532	$ -	$ 141,024	

		Forecast Costs & Units (Escalated) (A)						
	Year	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
14	**Forecast Costs**	$ 181,361	$ 3,024,758	$ 3,249,611	$ 3,337,505	$ 3,427,558	$ 3,520,078	Calculated - Line 15 * Line 16
15	**No. of Units**	1	10	10	10	10	10	
16	**Unit Cost**	$ 181,361	$ 302,476	$ 324,961	$ 333,751	$ 342,756	$ 352,008	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-36
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT 48D

Line No.		
1	**MAT Code**	48D
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Replace Electric Distribution Substation Breakers – Replace electric distribution substation circuit breakers. This program relates to reliability because it involves the proactive planned replacement of circuit breakers aimed to prevent failures and maintain reliability.

	Risk ID	Type	Name
4	SBSTN-C16D	Control	Proactive Asset Replacement - Circuit Breakers
	WLDFR-C10D	Control	Substation Proactive Asset Replacement - Breakers

5	**Program Area**	Asset Management and Reliability
6	**Forecast Method**	Unit Cost
7	**Unit of Measure**	Circuit breakers replaced
8	**Unit Cost (2023)**	$ 714,111
9	**Unit Cost Forecast Basis**	The estimated cost to replace a circuit breaker is based on recorded costs for similarly completed projects from 2010 to 2019 is approximately $700,000 per single circuit breaker replacement. Each individual project will vary depending on the scope, size and complexity of the work required. The forecast unit cost includes escalation.
10	**Unit Forecast Basis**	The number of units planned for replacement is based on a renewed effort to increase circuit breaker repalcements. The number of breakers is based on a ramp-up rate to reduce the overall age of the fleet while targeting the highest-risk breakers. Years with units listed as zero indicate that no units are expected to be operative in that year. Costs are incurred as a result of projects in a engineering, construction or close-out phase. Please reference the *Project Summary – Circuit Breaker Replacement, MAT 48D*

		Recorded Costs & Units (A)					Reference
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 2,990,790	$ 9,901,062	$ 11,095,802	$ 14,176,229	$ 4,513,366	Calculated - Line 12 * Line 13
12	**No. of Units**	4	1	5	6	-	
13	**Unit Cost**	$ 747,697	$ 9,901,062	$ 2,219,160	$ 2,362,705	$ -	

		Forecast Costs & Units (Escalated) (A)						
	Year	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
14	**Forecast Costs**	$ 14,290,160	$ 31,255,215	$ 28,564,458	$ 31,987,261	$ 34,461,619	$ 29,333,980	Calculated - Line 15 * Line 16
15	**No. of Units**	16	37	40	42	50	50	
16	**Unit Cost**	$ 893,135	$ 844,736	$ 714,111	$ 761,601	$ 689,232	$ 586,680	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper 15-37
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 15 - Substation Asset Management
Unit Cost and Forecast Details: MAT 48X

Line No.		
1	**MAT Code**	48X
2	**GRC Ch.**	15 - Substation Asset Management
3	**MAT Code Definition**	Electric Distribution Substation Animal Abatement – Animal abatement program retroactively mitigates substations to prevent animal contacts. Units measured: Number of locations. This program relates to reliability because it involves the abatement of substation assets to prevent equipment damage and customer outages due to animal contacts.

	Risk ID	**Type**	**Name**
4	SBSTN-C002	Control	Animal Abatement Substation

5	**Program Area**	Asset Management and Reliability
6	**Forecast Method**	Unit Cost
7	**Unit of Measure**	Number of locations
8	**Unit Cost (2023)**	$ 443,094
9	**Unit Cost Forecast Basis**	Animal abatement projects are typically completed on a two-year cycle for engineering and construction and are based on historical recorded costs from 2016-2019 at approximately $300,000 per substation. The forecast unit costs includes escalation. Please reference the Project
10	**Unit Forecast Basis**	The number of units is based on a count of in-flight projects and new planned targets. In 2019, PG&E pursued fewer planned animal abatement projects to accelerate those identified through Substation WSIP efforts under emergency. PG&E has re-initiated animal abatement projects and continues to implement this program in the 2023 through 2026 timeframe. Please reference the *Project Summary – Animal Abatement, MAT 48X.*

		Recorded Costs & Units (A)					**Reference**
	Year	**2016**	**2017**	**2018**	**2019**	**2020**	
11	**Recorded Costs**	$ 2,175,929	$ 6,318,178	$ 4,178,426	$ 1,303,404	$ 4,960,889	Calculated - Line 12 * Line 13
12	**No. of Units**	12	14	16	5	2	
13	**Unit Cost**	$ 181,327	$ 451,298	$ 261,152	$ 260,681	$ 2,480,444	

		Forecast Costs & Units (Escalated) (A)						**Reference**
	Year	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
14	**Forecast Costs**	$ 4,533,184	$ 5,403,529	$ 5,760,222	$ 4,962,690	$ 4,465,842	$ 4,576,101	Calculated - Line 15 * Line 16
15	**No. of Units**	18	16	17	18	15	15	
16	**Unit Cost**	$ 251,844	$ 337,721	$ 338,837	$ 275,705	$ 297,723	$ 305,073	

Notes

17 **(A)** Cost calculations of units and unit costs displayed in workpapers may differ from recorded and forecasted amounts due to rounding.

Workpaper Table 15-38
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 15, Substation Asset Management
MAT 48F Switchgear Forecast Basis

Line No.

1 **Description of Switchgear Replacement**

Substation switchgear equipment replacement is the replacement of a deteriorated set of breakers or existing switchgear with new switchgear. Switchgear refers to the electrical disconnect switches, bus conductor and circuit breakers used to control power flow, isolate problems and protect electrical equipment. Switchgear is compact and contained in a metal enclosure. The physical size of switchgear varies depending on the number of cells or compartments of circuit breakers required for the particular substation application.

2 **Number of Forecast Switchgear Replacements**

The number of forecast switchgear projects per year are prioritized based on factors such as condition, age, impact, and overstress loading.

3 **Forecast Cost Basis**

4 **Switchgear Procurement Strategy**

Before switchgear specifications are finalized, the project team works closely with Distribution Planning to specify how many switchgear cells are required for future load growth and coordinates with Distribution Operations to understand operational needs and determine the required switchgear configuration. The resulting specifications directly impact the overall cost of switchgear. Other cost drivers include: complexity of implementation (space availability), circuit density, and the number of circuits.

5 **Cost Drivers**

Switchgear Configuration
PG&E procures two types of switchgear configurations: double bus double breaker (DBDB) and single bus normal maintenance (SBNM). Although there are pros and cons of each configuration, in densely populated areas DBDB is a more reliable configuration in that there are two (protective) circuit breakers per bus element. This configuration significantly increases operational flexibility, and hence, reduces restoration time in the event of an outage. The additional cost of the second breaker in a DBDB configuration increases the overall switchgear cost. The main compartments of switchgear contain circuit breakers, additional compartments (or cells) are required to fit other components. Additional cells for automation equipment, spare cells, bank breakers, bus sectionalizing breakers, as well as miscellaneous control devices. A switchgear building is manufactured to contain the switchgear and all associated ancillary equipment.

Space Availability
Many PG&E substations that contain 4kV and 12kV switchgear are located in buildings in urban areas. Switchgear is delivered in sections and, in most cases, requires almost all sections be connected to energize. Required building dimensions vary depending on number of circuits that need to be connected. Each circuit is transferred, tested and energized one at a time. For densely populated areas, additional land may be required to be procured or a phased approach to transfer circuits and energize the equipment within the existing substation building is employed.

Number of Circuits
The number of circuits is directly proportional to the number of cells required in the replacement switchgear.

Circuit Density
Circuit density is an indicator of the level of customer impact in the event of a sustained outage as well as the clearance availability. The indicators are high, medium, or low (H,M,L). A high circuit density may require higher interrupting capability be specified in the new switchgear.

PG&E has increased the number of completed projects for use in forecasting future switchgear replacements. PG&E forecasts are based on engineering estimates which leverages experiences from completed and in-progress projects. Forecast costs are based on Subject Matter Expertise, Engineering Judgment, and similarly completed projects. No two projects are the same. The logistics behind replacement can be very challenging.

Forecast - Switchgear Cost Summary By Project

	MWC	MAT	Planning Order	Description	Number of Circuits/Ties	Circuit Density	Operative Date	2020 CWIP	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Subtotal	Notes
7	**MWC 48 - E Dist Subst Repl Other Equip**																
8	48	48F	5795587	SYSPLAN ED 48F SBSTN-C16F				-	-	6,779,708	1,254,508	0	0	0	0	$ 8,034,216	(1)
9	48	48F	5763198	POTRERO: Repl 12 KV DBDB SWGR	28	H	Jul-27	584,440	66,681	365,433	6,118,058	14,803,664	13,235,776	16,126,411	15,651,896	$ 66,952,359	
10	48	48F	5774718	HARTLEY: Repl SWGR	2	L	Oct-24	18,233	1,459	1,537	425,801	1,215,210	2,091,649	461,259	-	$ 4,215,148	
11	48	48F	5746773	GUALALA: Repl 12 KV Switchgear	1	L	May-25	-	(8,619)	-	0	0	0	0	-	$ (8,619)	
12	48	48F	5768782	HUNTERS POINT: Repl 12 KV Bus with SWGR	10	M	Dec-23	1,451,030	388,621	6,599,450	14,461,883	13,745,876	1,075,697	-	-	$ 37,722,557	
13	48	48F	5746778	SAN FRAN Y: Replace 12 KV SWGR	49	H	Sep-21	85,421,426	26,337,981	11,843,082	1,778,180	1,611,113	286,675	-	-	$ 127,278,458	
15	48	48F	5773499	SAN FRAN Y-LARKIN: Repl 12 KV SWGR	12	M	Nov-21	439,907	39,876	-	-	-	-	-	-	$ 479,782	
14	48	48F	5732860	OAKLAND K: Repl 12 KV SW	7	M	Nov-22	1,134,880	502,721	1,218,360	7,230,942	1,057,375		-	-	$ 11,144,278	
16	48	48F	5721326	SAN FRAN E: Repl 4 KV E SWGR	8	M	Jul-29	211,461	16,947	-	-	-	-	-	-	$ 228,408	
18	48	48F	5773405	S FRANCISCO M: Repl BK 1 12 KV & 4 SWGR	6	M	Jun-18	-	4,741,528	-	-	-	-	-	-	$ 4,741,528	
19	49	48F	5767961	SAN FRANCISCO F (Marina): Replace 4 KV Sv	8	M	Feb-19	-	4,580,624	-	-	-	-	-	-	$ 4,580,624	
20	48	48F	5770161	OAKLAND D: Repl 4 KV SWGR	4	L	Jun-20	-	3,299,436	-	-	-	-	-	-	$ 3,299,436	
17	48	48F	5792683	Oakland D: Replace Relay for Oakland K	n/a		Mar-23	12,544	13,391	-	-	-	-	-	-	$ 25,936	
21	48	48F	5767956	EL CERRITO G: Repl 12 KV CBS with SWGR	17	H	Jan-20	-	1,690,366	-	-	-	-	-	-	$ 1,690,366	
22	48	48F		Other Switchgear Projects				-	3,688,731							$ 3,688,731	
23				**Total**				**89,273,921**	**45,359,745**	26,807,570	31,269,372	32,433,238	16,689,797	16,587,670	15,651,896		

Notes:
(1) Reflects the close-out of multiple switchgear projects including: Oakland L, Castro Valley, Martin, and others

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – ANIMAL ABATEMENT

Project Title: Animal Abatement
Major Work Categories: 48X
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

The Animal Abatement subprogram implements mitigation measures at distribution substations to prevent animal contacts. Mitigation measures can include the new installation and or upgrade of animal abatement material.

There are various types of animal abatement material implemented at PG&E. Animal abatement material has evolved over time from tapes, to custom molded products. PG&E currently implements animal abatement with primarily molded products to achieve longevity.

SYSPLAN ED 48X SBSTN-C002 (PO Number: 5543539)
A future project planning order is used as a placeholder for installation and or to upgrade animal abatement at unidentified sites at the time of filing.

Justification

Animal abatement ranks notifications based on prior history of animal contacts and the number of customers. Animal abatement projects are typically completed on a two-year cycle for engineering and construction.

Animal-related outages are one of the leading causes of substation outages and equipment damage. Analysis of animal contacts shows that most contacts occur on equipment rated 21 kV or lower. Lower voltage equipment is more vulnerable to animal contact due to smaller physical distances between phase-to-phase and phase-to-ground voltages. A substation animal contact may result in a sustained customer outage and cause substation equipment damage.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – ANIMAL ABATEMENT

Cost

Animal abatement projects are typically completed on a two-year cycle for engineering and construction and are based on historical recorded costs from 2016-2019 at $300,000 per substation. Once a project is initiated the individual scope and specific conditions of the project refines the estimates. In 2019, PG&E pursued fewer planned animal abatement projects to accelerate projects identified through Substation WSIP efforts, which were replaced under emergency (MAT 59F). Beginning in 2020, PG&E re-initiated planned animal abatement projects and will continue to implement this program in the 2023 through 2026 timeframe. Estimates for the forecasted costs for 2021 to 2026 are based on a blend of new projects spread over two years at $150,000 per year as well as forecast estimates for in-flight work. PG&E estimates completing approximately seventeen (17) projects annually in the 2021 to 2026 timeframe.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
MAT 48X, PO 5543539							5,404	5,760	4,963	4,466	4,576	25,168	
MWC 48X < $3M	2,176	6,318	4,178	1,303	4,961	4,533						23,470	
Capital Total	**2,176**	**6,318**	**4,178**	**1,303**	**4,961**	**4,533**	**5,404**	**5,760**	**4,963**	**4,466**	**4,576**	**48,638**	
TOTAL COST	**2,176**	**6,318**	**4,178**	**1,303**	**4,961**	**4,533**	**5,404**	**5,760**	**4,963**	**4,466**	**4,576**	**48,638**	**WP 15-35 Line 3**

Benefits

The primary purpose of animal abatement projects is to reduce the number of sustained outages experienced due to animal contacts on exposed conductive elements.

Animal abatement projects mitigate the potential number of outages, and maintain existing reliability:

- Reduce SAIDI, SAIFI, and CAIFI.
- Maintain existing reliability

This project has no direct cost savings anticipated.

Alternatives Considered

1. Proactively install Animal Abatement measures– This strategy would mitigate safety/reliability concerns but would increase costs to customers. - **Recommended**

2. Long term deferral of Animal Abatement measure (i.e. run to failure) – Existing animal abatement measures would degrade over time until gaps in the installed product result in critical failures. Long-term deferral of sites with no animal abatement are subject to exposure that impact on safety/reliability this approach were instituted for a prolonged period.–- **Not recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – BATTERY REPLACEMENT

Project Title: Battery Replacement
Major Work Categories: 48C
Planning Order Numbers: 5544459
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This subprogram maintains or improves the reliability of targeted substations through the planned replacement of substation batteries.

Future Projects (PO Number: 5544459)
This Planning Order number is comprised of several projects to proactively replace batteries. A future project planning order is used as a placeholder for battery replacement and or upgrade projects at unidentified locations at the time of filing.

Justification

Batteries are an important component in a substation. Protection, automation, and remote station control all run and depend on substation batteries. Typical substation batteries are used to reliably supply internal substation loads such as emergency control house lighting, circuit breaker trip and close functions, relay and control equipment, and supervisory and alarm circuits.

The prioritization criteria for the battery replacement program are primarily based on age, condition, and customer impact. PG&E's substation batteries have an average life expectancy of 20 years. Condition assessments include reviews of maintenance data diagnostic results.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – BATTERY REPLACEMENT

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
MAT 48C, PO 5544459							3,025	3,250	3,338	3,428	3,520	16,560	
MWC 48C < $3M	1,131	142	734	49	282	181						2,519	
Capital Total	**1,131**	**142**	**734**	**49**	**282**	**181**	**3,025**	**3,250**	**3,338**	**3,428**	**3,520**	**19,078**	
TOTAL COST	**1,131**	**142**	**734**	**49**	**282**	**181**	**3,025**	**3,250**	**3,338**	**3,428**	**3,520**	**19,078**	**WP 15-35 Line 4**

The 2021 forecast completes in-flight battery replacements. The 2022-2026 forecast is for proactively replacing 10 batteries per year at an estimated unit cost of approximately $300,000 per battery. The cost per battery includes the battery itself and associated battery monitoring system that aligns with PG&E's procedures for battery replacements.

Benefits

The primary purpose of battery replacement projects is to ensure all the station lighting, protective relays, and other Direct Current (DC) equipment have a reliable source of power.

These projects have no direct cost savings anticipated.

Alternatives Considered

1. Proactively replace equipment —– Equipment will be replaced on a proactive basis prior to the end of its useful life, or when repairs could not be made. This strategy would mitigate safety/reliability concerns but would increase costs to customers. - **Recommended**

2. Long term deferral of replacement until failure (i.e. run to failure) – Assets would not be replaced until critical failures occur, often times beyond the end of the equipment's useful life. Although this may reduce the immediate need for replacements, the impact on safety/reliability could be significant and costs required to remediate failures and outages could be higher if this approach were instituted for a prolonged period.–- **Not recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – CIRCUIT BREAKER REPLACEMENT

Project Title: Circuit Breaker Replacement
Major Work Categories: 48D
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This subprogram replaces existing distribution circuit breakers with new ones or installs new circuit breakers in place of other equipment (e.g. fuses).

SYSPLAN ED 48D SBSTN-C16D (PO Number: 5795584)
This planning order is a placeholder for circuit breaker replacement projects across the system that have not yet been identified.

Ashlan Ave: Replace CB1103-08 1113-14 2105 2110 (PO Number: 5761700)
This planned project replaces six (6) circuit breakers at the Ashlan Ave substation.

Mount Eden: Replace 12 KV CB 1106- 1107 (PO Number: 5756850)
This planned project replaces two (2) circuit breakers at the Mount Eden substation.

Justification

The circuit breaker replacements planned in the 2021 to 2026 timeframe are a combination of completing in-flight and new work geared toward replacing the breakers with the highest risk of failure.

Since the last GRC cycle, PG&E has revamped its approach to circuit breaker prioritization for new work. Instead of a single list with weighted criteria, PG&E now prioritizes four lists to highlight overstress, age, and interrupting mediums for oil and vacuum circuit breakers. The following assessment criteria are applied to the lists for oil and vacuum:

Accumulative Circuit Current
Accumulated Critical Current (ACC) is the total fault current accrued by a circuit breaker since the last overhaul and is a calculation intended to track circuit breaker interrupter wear.

Breaker Oil Analysis
Breaker Oil Analysis diagnostic testing is performed on oil breakers to verify if the breaker oil is filled.

High Failure Rate Models
Select breakers with make and models that have historically high failure rates.

There are an additional nine projects identified in the 2021 through 2022 forecast to replace high-side fused transformers with circuit breakers or circuit switchers to support PG&E's PSPS impact mitigation efforts.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – CIRCUIT BREAKER REPLACEMENT

Cost

PG&E's 2021 through 2023 forecast for this program is primarily driven by multiple in-flight breaker replacement projects under $3 million that have associated authorizations, scopes, and/or detailed job estimates. The forecasted costs include funds to initiate 22 new breaker replacement projects in 2023, 50 projects in both 2023 and 2025, and 30 projects in 2026.

The estimated cost to replace a circuit breaker is based on recorded costs for similarly completed projects from 2010 to 2019 is approximately $700,000 per single circuit breaker replacement. Each individual project will vary depending on the scope, size and complexity of the work required.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
MAT 48D, PO 5795584						13,461	28,237	28,370	29,896	34,376	29,334	163,673	
MAT 48D, PO 5761700		1	0	0	3		828	195	2,092	86		3,204	
MAT 48D, PO 5756850						829	2,191					3,019	
MWC 48D < $3M	3,005	9,900	11,096	14,176	4,510							42,688	
Capital Total	**3,005**	**9,901**	**11,096**	**14,176**	**4,513**	**14,290**	**31,255**	**28,564**	**31,987**	**34,462**	**29,334**	**212,584**	
TOTAL COST	**3,005**	**9,901**	**11,096**	**14,176**	**4,513**	**14,290**	**31,255**	**28,564**	**31,987**	**34,462**	**29,334**	**212,584**	**WP 15-35 Line 2**

Benefits

The primary purpose of the circuit breaker replacement subprogram is to ensure all deteriorated circuit breakers are replaced to maintain substation infrastructure. Benefits of having functional circuit breakers:

- Reduce SAIDI, SAIFI, and CAIFI.
- Maintain existing reliability
- Increase operational flexibility and system resiliency.
- Enhance ability to perform planned clearances or assist with PSPS activities.

These projects have no direct cost savings anticipated.

Alternatives Considered

1) Proactively replace equipment —— Equipment will be replaced on a proactive basis prior to the end of its useful life, or when repairs could not be made. This strategy would mitigate safety/reliability concerns but would increase costs to customers. - **Recommended**

2) Long term deferral of replacement until failure (i.e. run to failure) – Assets would not be replaced until critical failures occur, often times beyond the end of the equipment's useful life. Although this may reduce the immediate need for replacements, the impact on safety/reliability could be significant and costs required to remediate failures and outages could be higher if this approach were instituted for a prolonged period. - **Not recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – CIVIL STRUCTURES

Project Title: Civil Structures
Major Work Categories: 48H
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This Civil Structures subprogram replaces both steel and wood structures supporting electrical buses, switches, and other auxiliary equipment that connects to major assets. This subprogram also replaces distribution civil structures within substations such as control buildings and foundations.

SYSPLN-48H-Civil Structures SBSTN-C005 (PO Number: 5543533)
Projects for this subprogram are identified through annual feedback from maintenance personnel regarding distribution substation structures within their respective areas, engineering assessments, as well as projects driven by other programs. A future project planning order is used as a placeholder for replacement or improvement projects. The following planned work is included in the forecast:

Maintenance Feedback

- Old Kearney-Replace 12kV Structure
  - This project will replace the deteriorated bus structure at Old Kearney substation.
- Carbona: Replace Bk 1 sinking foundation
  - This project will replace the sinking foundation on Bank 1 at Carbona substation requiring excavation and pier installation.
- Oakland J: Replace substation roof
  - This project will replace the substation roof at Oakland J substation

Civil Engineering Assessment

- Tejon: Replace 70kV SW 75 structure
  - This project will replace a stand-alone deteriorated structure and foundation at Tejon substation

Projects driven by other Programs

- Famoso: Replace control building
  - This project will replace the main control building at Famoso substation in construction coordination with a System Automation project.
- Placer Sub: Replace Bk3 12kV Westinghouse structure
  - This project will be sequenced with transmission work at Placer substation to replace and relocate the existing antiquated 12kV structure.

SYSPLAN ED 48H SBSTN-M006 Minimize Wood in Substations (PO Number: 5543534)
This mitigation is a subpart of the control to replace civil structures. Projects for this subprogram are identified through annual feedback from maintenance personnel regarding distribution substation structures within their

respective areas. A future project planning order is used as a placeholder to capture projects that minimize wood in substations.

Maintenance Feedback

- Dobbins: Replace SW 15 wood structure
  - This project will replace the wooden switch structure at Dobbins substation.
- Wood pole replacements
  - This project will replace 10 wooden substation poles at various substation locations to be identified.

Justification

The Civil Structure Replacement Program identifies substation support structures at risk of failure, and prioritizes them based on safety hazard to personnel, substation criticality, customer and system impact, facility condition, and environmental issues. This subprogram also supports deteriorated structure replacements in coordination driven by other substation programs. A failure of civil structures can result in sustained outages for PG&E customers.

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
MAT 48H, PO 5543533							3,326	4,056	9,456	6,284	6,453	29,576	
MAT 48H, PO 5543534							787	1,360	0	0	0	2,147	
MAT 48H < $3M	4,721	4,101	721	48	192	514						10,297	
Capital Total	**4,721**	**4,101**	**721**	**48**	**192**	**514**	**4,113**	**5,416**	**9,456**	**6,284**	**6,453**	**42,020**	
TOTAL COST	**4,721**	**4,101**	**721**	**48**	**192**	**514**	**4,113**	**5,416**	**9,456**	**6,284**	**6,453**	**42,020**	**WP 15-35 Line 8**

The 2021-2026 forecast is based on specific project estimates for in-flight work and estimates based on similarly completed projects. Variability in estimates is due to the size and condition of the civil structure.

Benefits

The primary purpose of the civil structure replacement subprogram is to replace or remove structures that support and/or enclose equipment in distribution substations to ensure public and employee safety, and reliability.

This project has no direct cost savings anticipated.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – CIVIL STRUCTURES

Alternatives Considered

1. Proactively replace equipment – Equipment will be replaced on a proactive basis prior to the end of its useful life, or when repairs could not be made. This strategy would mitigate safety/reliability concerns but would increase costs to customers. - **Recommended**

2. Long term deferral of replacement until failure (i.e. run to failure) – Assets would not be replaced until critical failures occur, often times beyond the end of the equipment's useful life. Although this may reduce the immediate need for replacements, the impact on safety/reliability could be significant and costs required to remediate failures and outages could be higher if this approach were instituted for a prolonged period. – **Not recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – EMERGENCY REPLACEMENT

Project Title: Emergency Replacement
Major Work Categories: 59
Planning Order Numbers: 5544465
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This program replaces substation equipment that fails or is forced out of service.

SYSPLAN ED 59A SBSTN-C011 (PO Number: 5544465)
Substation emergency replacement projects are identified through maintenance data examination or unanticipated events that warrant equipment replacement. A future project planning order is used as a placeholder for potential replacement or improvement projects that do not have a defined work scope at the time of filing.

Justification

The substation Emergency subprogram funds projects to replace equipment that has failed in-service or is likely to fail imminently. Safe and timely replacement of substation equipment is necessary for public safety and to avoid any potential collateral damage of nearby equipment. If not replaced, failed equipment can result in sustained outages for PG&E customers.

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
MAT 59, PO 5544465							76,362	82,323	84,550	86,831	89,175	419,243	
MWC 59, Other Work	58,816	82,607	63,711	82,180	119,133	101,935	1,510					509,891	
Capital Total	**58,816**	**82,607**	**63,711**	**82,180**	**119,133**	**101,935**	**77,872**	**82,323**	**84,550**	**86,831**	**89,175**	**929,134**	
TOTAL COST	**58,816**	**82,607**	**63,711**	**82,180**	**119,133**	**101,935**	**77,872**	**82,323**	**84,550**	**86,831**	**89,175**	**929,134**	**WP 15-35 Line 29**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – EMERGENCY REPLACEMENT

Historical expenditures for this program averaged approximately $76 million from 2017 to 2019. In 2020, PG&E experienced an exceptionally high cost for emergency replacement expenditures ($119 million) due to unexpected equipment failures and Substation WSIP capital activities. PG&E anticipates that it will continue to spend more than 2017-2019 levels in 2021 due to carry over work from 2020. For 2022 and 2023, PG&E forecasts that emergency replacement work will return to close to 2017-2019 levels.

Given the average of the historical expenditures from 2017 to 2019, PG&E estimates a forecast of roughly $76 million per year for 2023 through 2026, plus escalation.

Benefits

The primary purpose of the Emergency subprogram is to ensure that failed or likely to fail equipment is replaced in a timely manner to ensure public and employee safety, and reliability.

This project has no direct cost savings anticipated.

Alternatives Considered

1) Defer all replacements until failure (i.e. run to failure) – Assets would not be replaced until critical failures occur, often times beyond the end of the equipment useful life, requiring PG&E to fully rely on its emergency program for its assets. Although this may reduce the immediate need for replacements, the impact on safety/reliability could be severe and costs required to remediate failures and outages could be high. - **Not recommended**
2) Limited proactive equipment replacement strategy – A smaller focus to replace equipment on a proactive basis prior to the end of its useful life, or when repairs cannot be made. This strategy would have modest mitigation of safety/reliability concerns but would likely require more replacements on an emergency basis which could result in potential outage impacts to customers and safety concerns. – **Not recommended for a prolonged period**
3) Combined proactive and emergency equipment replacement strategy – Emergency replacements are a required component of PG&E's asset strategy as incidents that cause asset failures are not able to be prevented in all scenarios. Thus, a combined strategy of proactive replacements to mitigate safety/reliability concerns with emergency replacements to address unforeseen incidents is required. - **Recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – INSULATOR REPLACEMENT

Project Title: Insulator Replacement
Major Work Categories: 48N
Planning Order Numbers: 5544460
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This program replaces defective insulators located in distribution substations.

Future Projects (PO Number: 5544460)
Insulator replacements are identified through maintenance assessment and inventory. A future project planning order is used as a placeholder for insulator replacement work that do not have a defined work scope at the time of filing.

Justification

The Insulator Replacement Program identifies insulators at risk of failure, and prioritizes them based on safety hazard to personnel, substation criticality, customer and system impact, facility condition, and environmental issues. Failures of the insulators can result in electrical equipment damages leading to sustained outages for PG&E customers.

PG&E initially focused on the replacement of Ohio Brass (OB) insulators that were found to be defective and deemed unsafe from an industry perspective. PG&E performed an internal inventory identifying these models in the system and initiated a targeted replacement program. Most of the insulators replaced were distribution owned, but transmission voltage class insulators were also replaced starting in 2017. A separate inventory was subsequently performed for distribution owned distribution voltage class insulators that expanded to include antiquated cement and glass insulators also requiring replacement. The 2023-2026 forecast targets these replacements. The 2022 forecast completes one deferred in-flight project.

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
MAT 48N, PO 5544460							527	5,416	5,563	5,713	5,867	23,085	
MWC 48N < $3M	-28	2,634	2,400	1,650	623	0						7,279	
Capital Total	**-28**	**2,634**	**2,400**	**1,650**	**623**	**0**	**527**	**5,416**	**5,563**	**5,713**	**5,867**	**30,364**	
TOTAL COST	**-28**	**2,634**	**2,400**	**1,650**	**623**	**0**	**527**	**5,416**	**5,563**	**5,713**	**5,867**	**30,364**	**WP 15-35 Line 9**

Costs estimates can vary depending due to the complexity that can arise from the site count and position of the identified insulators. A higher site count may warrant a bus reconfiguration and or structure replacement. The position of the targeted insulators may require a replacement that increases the height and affects associated

components the insulator supports. PG&E's forecast for this program should allow PG&E to undertake 2-3 sites annually in this GRC cycle.

Benefits

The primary purpose of an insulator is to prevent unwanted flow of current from energized electrical equipment to earth through supporting structures or facilities. Insulators are installed for public and employee safety, and reliability purposes. Replacing defective or failed insulators allows them to serve their designated purpose.

This project has no direct cost savings anticipated.

Alternatives Considered

1. Proactively replace equipment – Equipment will be replaced on a proactive basis prior to the end of its useful life, or when repairs could not be made. This strategy would mitigate safety/reliability concerns but would increase costs to customers. - **Recommended**

2. Long term deferral of replacement until failure (i.e. run to failure) – Assets would not be replaced until critical failures occur, often times beyond the end of the equipment's useful life. Although this may reduce the immediate need for replacements, the impact on safety/reliability could be significant and costs required to remediate failures and outages could be higher if this approach were instituted for a prolonged period.–- **Not recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – LINE WORK SUPPORT

Project Title: Line Work Support
Major Work Categories: 48L
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This program relocates existing distribution lines and associated equipment when necessary to support distribution substation projects.

SYSPLAN ED 48L SBSTN-C16G (PO Numbers: 5795588)
Line projects are identified through the parent substation project that triggers the work. A future project planning order is used as a placeholder for a projected forecast for line work that does not have a defined work scope at the time of filing.

Berkeley T CONV. CK's to 12kV 2of3 (PO Number: 5775005, 5775006)
This project plans to cutover Berkeley T Substation's 4 kV feeders to 12 kV in a phased approach. This is part of a larger project to decommission Berkeley T Substation.

Larkin (SF Y) Reconfigure Feeders (PO Number: 5785561)
This project replaces and relocates the feeders from the replaced switchgear to the new switchgear at Larkin substation.

Justification

The Line Work Support Substation Program is a new sub-program created to add transparency in identifying distribution line work needed to support proposed distribution substation projects. Previously these costs were recorded in the individual substation projects that the line work was associated with. Failure to do the line work will prevent the substation project from meeting designed work scope and safety requirements.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – LINE WORK SUPPORT

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
MAT 48L, PO 5795588						20,865	2,677		5,563	5,713	5,867	40,684	
MAT 48L, PO 5775005				16	28		31	5,287	2,329			7,691	
MAT 48L, PO 5775006		2	1	40	64		3,318	3,818				7,244	
MAT 48L, PO 5785561				971	211	4,066						5,248	
MWC 48L < $3M	883	6,986	17,739	14,003	15,623							55,235	
Capital Total	**883**	**6,988**	**17,740**	**15,030**	**15,926**	**24,931**	**6,027**	**9,105**	**7,892**	**5,713**	**5,867**	**116,102**	
TOTAL COST	**883**	**6,988**	**17,740**	**15,030**	**15,926**	**24,931**	**6,027**	**9,105**	**7,892**	**5,713**	**5,867**	**116,102**	**WP 15-35 Line 5**

SYSPLAN ED 48L SBSTN-C16G (PO Numbers: 5795588)
The 2021-2022 forecast is based on in-flight work across several substations. The 2023 forecast is zero because costs are accounted for under the Berkeley T project. The 2024-2026 forecast is estimated at $5 million per year to support switchgear and transformer replacement forecast work in the same timeframe.

Berkeley T CONV. CK's to 12kV 2of3 (PO Number: 5775005, 5775006)
Costs estimates for this phased project are based on job estimates.

Larkin (SF Y) Reconfigure Feeders (PO Number: 5785561)
The 2021 forecast is based on job estimates for the completion of line work associated with Larkin switchgear replacement project.

Benefits

The primary purpose of the line work support substation subprogram is to ensure distribution lines at substations are installed properly to ensure public and employee safety, and reliability. These projects have no direct cost savings anticipated.

Alternatives Considered

No Alternatives - Line work to relocate existing distribution lines and associated equipment is a necessary component of distribution substation projects. Each project in this sub-program is part of a larger project that supports safe and reliable services to our customers. No alternative is feasible since the projects in this sub-program are essential to the completion of the larger projects.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – OTHER EQUIPMENT REPLACEMENT

Project Title: Other Equipment Replacement
Major Work Categories: 48A
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This subprogram captures a variety of work to upgrade ancillary equipment and ground grids, as well as the removal of idle facilities at distribution substations. The forecast for this subprogram is primarily dedicated to ground grid replacements in this GRC cycle.

Ground Grid Subprogram & Other Equipment Replacement (PO Numbers: 5543522 & 5795582)
The projects identified in this subprogram are primarily for ground grid upgrades and a smaller volume of ancillary equipment replacements.

Summit Substation: Rebuild Substation (PO Number: 5787180)
This planned project rebuilds Summit substation. Summit Substation is a unique distribution substation where the equipment is installed on a platform. In addition, lack of space in control room eliminates possible substation expansion and does not meet the latest design clearance requirements.

Justification

The equipment covered in this subprogram (ancillary equipment, ground grids, and idle facilities, etc.) is required to be in working order to ensure safety and reliability. If the equipment reaches the end of its useful life, has degraded, or has experienced a failure where a repair is not possible, it needs to be replaced.

Ground Grid Subprogram & Other Equipment Replacement (PO Numbers: 5543522 & 5795582)
The projects identified for ground grid upgrades are based on studies performed to evaluate the adequacy of the grounding system. Capital project replacements in the forecast initiate the need for the studies to be completed, evaluated, and prioritized. Other equipment replacement is identified as equipment issues arise from maintenance or manufacturers and require capitalization.

Summit Substation: Rebuild Substation (PO Number: 5787180)
Summit Substation is a unique distribution substation where the equipment is installed on a platform. In addition, lack of space in control room eliminates possible substation expansion.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – OTHER EQUIPMENT REPLACEMENT

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper
CAPITAL													
MAT 48A, PO 5543522						3,425	4,197	3,782	2,678	2,656	2,728	19,467	
MAT 48A, PO 5787180					188	664	6,507	142				7,502	
MAT 48A < $3M	2,042	4,393	3,669	4,762	2,795	308	806	295	202	200	205	19,676	
Capital Total	**2,042**	**4,393**	**3,669**	**4,762**	**2,983**	**4,397**	**11,510**	**4,220**	**2,880**	**2,856**	**2,933**	**46,645**	
TOTAL COST	**2,042**	**4,393**	**3,669**	**4,762**	**2,983**	**4,397**	**11,510**	**4,220**	**2,880**	**2,856**	**2,933**	**46,645**	**WP 15-35 Line 7**

Ground Grid Subprogram & Other Equipment Replacement (PO Numbers: 5543522 & 5795582)
Costs estimates ground grid projects are based on historically completed projects. Costs for other equipment replacement are based on SME estimates for similar work in this category.

Summit Substation: Rebuild Substation (PO Number: 5787180)
The costs estimate for the rebuild of Summit substation is based on the specific project estimates.

Benefits

The Other Equipment Replacement Program has the following benefits:

- SAIDI/SAIFI -
  - Ancillary equipment identified as requiring replacement may contribute to the failure of equipment resulting in a sustained outage.
- Safety -
  - Ground Grids - Reducing touch and step potential safety issues associated with missing or deficient grounding at substation.
  - Summit Rebuild – Rebuilding Summit will ensure the substation meets PG&E's latest design standards.

Alternatives Considered

1. Proactively replace equipment – Equipment will be replaced on a proactive basis prior to the end of its useful life, or when repairs could not be made. This strategy would mitigate safety/reliability concerns but would increase costs to customers. - **Recommended**

2. Long term deferral of replacement until failure (i.e. run to failure) – Assets would not be replaced until critical failures occur, often times beyond the end of the equipment's useful life. Although this may reduce the immediate need for replacements, the impact on safety/reliability could be significant and costs required to remediate failures and outages could be higher if this approach were instituted for a prolonged period.–- **Not recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – DISTRIBUTION SUBSTATION SAFETY AND SECURITY

Project Title: Distribution Substation Safety and Security
Major Work Categories: 58
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This subprogram includes work for substation security, fire protection and seismic upgrades.

SYSPLAN ED 58S SBSTN-C001 (PO Number: 5543563)
The Distribution Substation Security subprogram installs, upgrades, or replaces physical security measures within substations. This future planning order is a placeholder for physical security projects.

Fire Protection-Suppression (PO Numbers: 5506602)
The Fire Protection and Suppression subprogram installs, replaces, or upgrades fire mitigations as required by local Fire Marshalls and state regulations. The forecast includes a ramping up the number of fire measures third party reviews to meet insurance obligations.

Distribution Seismic Program (PO Numbers: 5747133)
The seismic program addresses seismic reinforcements/upgrades for distribution substation buildings not identified at the time of forecast.

EMBARCADERO: Retrofit Building (PO Numbers: 5764278)
This project seismically retrofits the Embarcadero substation building and is likely to require authorization in the next GRC cycle.

Justification

The program covers work associated with security enhancements within substation perimeters, fire installation or suppression mitigations, and seismic resiliency efforts. Failure to address these issues could impact personnel, customers, substation reliability, and facility conditions.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – DISTRIBUTION SUBSTATION SAFETY AND SECURITY

Cost

The costs for substation security and fire protection are based on SME estimates to complete the work over a two-year period. Seismic costs are based on specific projects estimates for the Embarcadero seismic work as well as a placeholder to complete additional seismic work to be identified in 2024-2025 timeframe at an estimate of $6 million over two years.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
MAT 58B, PO 5764278			0	29	198				645	6,603	21,045	28,520	
MAT 58S, PO 5543563						678	1,688	4,983	5,563	4,570		17,480	
MAT 58A, PO 5506602	-2	-3						3,250	3,338	1,143	1,173	8,898	
MAT 58B, PO 5747133									3,338	3,428		6,765	
MWC 58 < $3M	604	3,179	2,290	9,025	3,172	5,302	50					23,622	
Capital Total	**602**	**3,177**	**2,290**	**9,054**	**3,369**	**5,980**	**1,738**	**8,232**	**12,882**	**15,743**	**22,218**	**85,285**	
TOTAL COST	**602**	**3,177**	**2,290**	**9,054**	**3,369**	**5,980**	**1,738**	**8,232**	**12,882**	**15,743**	**22,218**	**85,285**	**WP 15-35 Line 25**

Benefits

The primary purpose of the subprogram is to perform work for security enhancements, fire protection, and seismic upgrades.

Projects in the Distribution Substation Safety and Security have no direct cost savings anticipated.

- Earthquake resiliency
- Fire suppression
- Substation security against vandalism, theft, and/or sabotage

Alternatives Considered

1. Proactively replacement/upgrade– Addressing substation security, fire protection and seismic upgrades is a vital component to provide safe and reliable service to customers, it should be included in PG&E's overall substation strategy. Work under this subprogram is prioritized based on the criticality of the need. - **Recommended**

2. Long term deferral of replacement – This is not a viable alternative since addressing substation security, fire protection and seismic upgrades is a vital component to provide safe and reliable service to customers – **Not recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – SWITCH REPLACEMENT

Project Title: Switch Replacement
Major Work Categories: 48E
Planning Order Numbers: 5544486
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): OAI

Project Description

This subprogram replaces distribution substation switch types such as disconnect switches, motor operated air switches, and circuit switchers.

SYSPLAN FRMMA 48E SBSTN-C16E: (PO Number: 5544486)
This planning order is a placeholder for switch replacement projects across the system that have not yet been identified.

Justification

PG&E's approach to switch replacements will be more proactive in this GRC cycle because it will include targeted switch replacements in addition to work identified through other substation replacements. For example, PG&E replaces switches associated with circuit breakers when the circuit breaker is being replaced and occasionally fund the work under MAT code 48E. Most of the historical work undertaken in this subprogram has been driven by other substation project work where switch upgrades or replacements were identified through maintenance examination at the time of project scoping. Switch upgrade costs are tracked separately under this subprogram.

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper
CAPITAL													
MAT 48E, PO 5544486			0	29	198		3,457	2,166	4,450	4,570	3,520	18,391	
MWC 48E < $3M	937	1,844	1,165	1,734	2,538	945	50					9,213	
Capital Total	**937**	**1,844**	**1,165**	**1,763**	**2,736**	**945**	**3,507**	**2,166**	**4,450**	**4,570**	**3,520**	**27,604**	
TOTAL COST	**937**	**1,844**	**1,165**	**1,763**	**2,736**	**945**	**3,507**	**2,166**	**4,450**	**4,570**	**3,520**	**27,604**	**WP 15-35 Line 10**

Additional Cost Information:
The 2021 forecast is based on project estimates for in-flight smaller switch replacement projects. The 2022-2024 forecast is an estimate to replace field verified legacy disconnect switches at an estimated $300,000 each over a 2-year execution period. The 2025 and 2026 forecast are estimated at $4.6 and $3.5 million, respectively to replace select switches with missing attachments.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – SWITCH REPLACEMENT

Benefits

The primary purpose of the switch replacement subprogram is to ensure all deteriorated switches are replaced to maintain substation infrastructure. Benefits of having functional switches include:

- Reduce safety issues from injury when manually operating switches.
- Increase operational flexibility and system resiliency.

Alternatives Considered

1) Proactively replace equipment – Equipment will be replaced on a proactive basis prior to the end of its useful life, or when repairs could not be made. This strategy would mitigate safety/reliability concerns but would increase costs to customers. - **Recommended**

2) Long term deferral of replacement until failure (i.e. run to failure) – Assets would not be replaced until critical failures occur, often times beyond the end of the equipment's useful life. Although this may reduce the immediate need for replacements, the impact on safety/reliability could be significant and costs required to remediate failures and outages could be higher if this approach were instituted for a prolonged period. – **Not recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – SWITCHGEAR REPLACEMENT

Project Title: Switchgear Replacement
Major Work Categories: 48F
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This subprogram replaces deteriorated distribution switchgear before equipment failure results in customer service interruption. The identified substation switchgear projects were originally identified and prioritized through a third-party study and modified if new maintenance data was provided. Whether it is an outdoor or indoor project, large scale switchgear replacement work can be very complex, and take multiple years from start to finish. Projects at Hunters Point, Potrero, and Larkin are good examples. In addition to requiring careful engineering design and implementation, these replacement projects are often dependent on the success of material procurement, community outreach, acquiring the necessary regulatory permits, and construction clearances. Delay in any one of these segments can adversely impact the overall project schedule.

Project: SAN FRANCISCO "Y" (LARKIN) SUB: REPL 12 KV SWGR. (PO Number: 5746778)
This project replaces the 12kV switchgear and associated equipment at Larkin substation. The current planned operative date is September 2021.

- The Larkin switchgear project was authorized in the 2017 and 2020 rate cases. PG&E is also seeking authorization in this 2023 GRC cycle to complete and close-out this project. This project has experienced multiple delays caused by weather-related issues at the manufacturing facilities, permit acquisition challenges, mitigations that took place as a result of the fire in April 2017, and vendor challenges due to bankruptcy.

Project: POTRERO: REPL 12 KV DBDB SWGR. (PO Number: 5763198)
This project replaces the existing 12 kV switchgear. This is part of a larger effort to rebuild the substation.

- This project was authorized in the 2017 and 2020 rate cases. The current planned operative date is July 2027.

  This 12kV switchgear replacement project is not a stand-alone switchgear replacement project with predictable schedule. It is part of the Potrero Substation rebuild which includes coordination with transmission and gas line relocations not included in this forecast. The rebuild effort also requires that PG&E to coordinate with various external agencies (such as the City of San Francisco, California Public Utilities Commission, environmental agencies, toxic waste department, third party development) and neighboring land owners, as well as perform community outreach. Interdependencies and interactions with other agencies and neighboring landowners are the main reasons why the project is taking longer than was originally planned.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – SWITCHGEAR REPLACEMENT

Project: HUNTERS POINT: REPL 12 KV BUS WITH SWGR. (PO Number: 5768782)
This project replaces existing Hunter Point 12 kV bus with a double-bus-double-breaker (DBDB) switchgear. It is part of a larger effort to rebuild the substation

- This project was authorized in the 2017 and 2020 rate cases. PG&E seeks additional authorization in this 2023 GRC with a planned operative date in December 2023.

  This 12kV switchgear replacement project is not a small-scale switchgear replacement project with predictable schedule. It is part of a complete relocation and rebuild of Hunters Point Substation that requires PG&E to coordinate with various external agencies (such as the City of San Francisco, California Public Utilities Commission, environmental agencies, toxic waste department), and perform community outreach. Coordination and permitting issues have caused significant delays to the original project plan.

SYSPLAN ED 48F SBSTN-C16F (PO Number: 5795587)
This planning order is used as a placeholder for the completion and close-out costs for several in-flight switchgear projects.

Project: OAKLAND “K” SUB: REPL 12 KV SWGR. (PO Number: 5732860)
This project replaces the existing 12kV switchgear at Oakland K Substation with an operative date of November 2022.

Project: HARTLEY: Replace SWGR . (PO Number: 5774718)
This project replaces the 12kV switchgear at Hartley substation with an operative date of October 2024.

Justification

The switchgear in this replacement subprogram was assessed using criteria such as location of the switchgear, age, condition, criticality, overstress, and high failure rate models. Condition assessments include the maintenance examination of:

- External Contamination (i.e., rust or moisture/water entering the switchgear enclosure)
- Damaged components such as closing coil
- Deteriorated unit cells or switchgear enclosure

The primary justification to replace switchgear is for safety and reliability because switchgear failure is a low frequency but high customer impact event. Older switchgear designs are more susceptible to larger-scale outages that have the potential to cascade due to the proximity of the components and collateral damage.

Cost

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – SWITCHGEAR REPLACEMENT

The cost to replace a switchgear is based on engineering design and estimates specific to the individual substation and equipment condition.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**Total**	**Workpaper Reference**
CAPITAL													
MAT 48F, PO 5746778	6,080	22,622	20,937	13,939	26,338	11,843	1,778	1,611	287			105,435	WP 15-39 line 13,14
MAT 48F, PO 5763198	43	274	156	79	67	365	6,118	14,804	13,236	16,126	15,652	66,921	WP 15-39 line 9
MAT 48F, PO 5768782	106	145	172	137	389	6,599	14,462	13,746	1,076			36,832	WP 15-39 line 12
MAT 48F, PO 5732860	6	4	223	355	503	1,218	7,231	1,057				10,598	WP 15-39 line 15
MAT 48F, PO 5795587						6,780	1,255	0	0	0	0	8,035	WP 15-39 line 8
MAT 48F, PO 5746773	7	-6	1	0	-9		0	0	0	0		-7	WP 15-39 line 11
MAT 48F, PO 5774718	11	5	1	1	1	2	426	1,215	2,092	461		4,215	WP 15-39 line 10
MAT 48F < $3M	23,470	37,013	43,057	26,799	18,071							148,410	
Capital Total	**29,725**	**60,058**	**64,547**	**41,310**	**45,360**	**26,808**	**31,270**	**32,433**	**16,691**	**16,587**	**15,652**	**380,440**	
TOTAL COST	**29,725**	**60,058**	**64,547**	**41,310**	**45,360**	**26,808**	**31,270**	**32,433**	**16,691**	**16,587**	**15,652**	**380,440**	**WP 15-35 Line 1**

Benefits

The primary purpose of the switchgear replacement subprogram is to ensure all deteriorated switchgears are replaced to maintain substation infrastructure. These projects have no direct cost savings anticipated. Benefits of having functional switchgears:

- Reduce SAIDI, SAIFI, and CAIFI.
- Maintain existing reliability.
- Increase operational flexibility and system resiliency.
- Enhance ability to perform planned clearances.

Alternatives Considered

1) Proactively replace equipment – Equipment will be replaced on a proactive basis prior to the end of its useful life, or when repairs could not be made. This strategy would mitigate safety/reliability concerns but would increase costs to customers. - **Recommended**

2) Long term deferral of replacement until failure (i.e. run to failure) – Assets would not be replaced until critical failures occur, often times beyond the end of the equipment's useful life. Although this may reduce the immediate need for replacements, the impact on safety/reliability could be significant and costs required to remediate failures and outages could be higher if this approach were instituted for a prolonged period.–- **Not recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – TRANSFORMER REPLACEMENT

Project Title: Transformer Replacement
Major Work Categories: 54
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This program performs the following activities: (1) proactive distribution transformer replacement; (2) emergency transformer inventory of mobile transformers and CEM transformers and; (3) transformer life extension.

1. Proactive replacement of distribution transformers

   SYSPLAN ED 54A SBSTN-C16J (PO Number: 5795598)
   This planning order is a placeholder to proactively replace transformers at unidentified locations at the time of filing.

   Embarcadero Bank 1 Replacement (PO Number: 5746763)
   This in-flight project replaces a transformer at the Embarcadero substation and is expected to be completed in 2021.

   Ashlan Avenue Bank 2 Replacement (PO Number: 5757708)
   This in-flight project replaces a transformer at the Ashlan Avenue substation and is expected to be completed in 2022.

   Valley Springs (PO Number: 5783018)
   This in-flight project replaces transformers at the Valley Springs substation and is expected to be completed in 2021.

   Penngrove Bank 1 Replacement (PO Number: 5747138)
   This in-flight project replaces a transformer at Penngrove substation and is expected to be completed in 2021.

2. Emergency Transformer Inventory (PO Number: 5543550)
   Projects in this planning order increase and or replace mobile transformers to minimize outage duration as well as increase the Capitalized Emergency Material (CEM) transformer inventory to expedite the replacement of failed transformers.

3. Transformer Life Extension Program (PO Number: 5543552)
   The life extension program reconditions select transformers to extend their life-expectancy.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – TRANSFORMER REPLACEMENT

Justification

PG&E forecasts the initiation of new transformer projects beginning in 2023 based on targeting the highest risk equipment using criteria such as age, condition, criticality, and high failure rate models. Projects recorded in the 2017-2020 timeframe did not initiate new work and projects in the 2021 – 2022 address in-flight work that was previously deferred.

Costs

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
1. MAT 54A, PO 5795598							22,077	16,014	23,991	28,472	31,329	121,882	WP 15-35 Line 15
1. MAT 54A, PO 5746763	36	52	114	515	667	6,705						8,088	WP 15-35 Line 15
1. MAT 54A, PO 5757708			33	121	805	6,458						7,417	WP 15-35 Line 15
1. MAT 54A, PO 5783018			131	512	1,175	4,896						6,714	WP 15-35 Line 15
1. MAT 54A, PO 5747138	23	115	450	1,320	303	2,847						5,058	WP 15-35 Line 15
2. MAT 54A, PO 5543550							2,729	1,979	2,965	3,519	3,872	15,064	WP 15-35 Line 16
3. MAT 54L, PO 5543552							3,164	3,250	3,338	3,428	3,520	16,699	WP 15-35 Line 17
Other Projects <$3M	54,436	22,474	30,684	36,821	28,957	19,861	0	0	0	0	0	193,233	
Capital Total	**54,495**	**22,641**	**31,413**	**39,288**	**31,907**	**40,766**	**27,970**	**21,243**	**30,294**	**35,418**	**38,721**	**193,233**	
TOTAL COST	**54,495**	**22,641**	**31,413**	**39,288**	**31,907**	**40,766**	**27,970**	**21,243**	**30,294**	**35,418**	**38,721**	**193,233**	**WP 15-35 Line 19**

1. SYSPLAN ED 54A SBSTN-C16J (PO Number: 5795598) &
   In-Flight Projects: Embarcadero Bank 1 Replacement (PO Number: 5746763); Ashlan Avenue Bank 2 (PO Number: 5757708); Valley Springs (PO Number: 5783018); Penngrove Bank 1 (PO Number: 5747138)

Cost estimates for these projects are based on engineering estimates.

2. Emergency Transformer Inventory (PO Number: 5543550)

Cost estimates for emergency transformer, mobile and spare transformer inventory for 2023 to 2026 are based on historical costs of equipment.

3. Transformer Life Extension Program (PO Number: 5543552)

Costs for the transformer life extension program are based on contracts for similarly completed reconditioning work estimated at $500,000 per transformer. PG&E plans to recondition six transformers annually.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 15, SUBSTATION ASSET MANAGEMENT
PROJECT SUMMARY – TRANSFORMER REPLACEMENT

Benefits

The primary purpose of the transformer replacement subprogram is to ensure that transformers, including mobiles, are adequate for normal and emergency operations to ensure public and employee safety, and reliability.

This project has no direct cost savings anticipated.

Alternatives Considered

1. Proactively replace equipment – Equipment will be replaced on a proactive basis prior to the end of its useful life, or when repairs could not be made. This strategy would mitigate safety/reliability concerns but would increase costs to customers. - **Recommended**

2. Long term deferral of replacement until failure (i.e. run to failure) – Assets would not be replaced until critical failures occur, often times beyond the end of the equipment's useful life. Although this may reduce the immediate need for replacements, the impact on safety/reliability could be significant and costs required to remediate failures and outages could be higher if this approach were instituted for a prolonged period.–- **Not recommended**

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE

Testimony ____ _____ Workpapers ____X_____ SOQ _____

Exhibit Number: ___PG&E-4_____ Chapter Number: ___15____

Chapter Title: ___Substation Asset Management_____

Witness Name: _____Maria P. Ly_____

Page No.	Line No.	Item	As Filed	As Corrected
Errata as of November 5, 2021				
WP 15-22 Capital Expenditures by Major Work Category	Line 1	E Dist Susbt Repl Other Equip	2021 $ 76,619 2022 $ 96,925 2023 $ 98,614 2024 $ 88,875 2025 $ 84,644 2026 $ 77,795	2021 $ 76,601 2022 $ 96,588 2023 $ 96,331 2024 $ 87,218 2025 $ 84,078 2026 $ 77,723
WP 15-24 Capital Expenditures Details - Projects Over $3 Million	Line 8	GUALALA: Replace 12 KV Switchgear SAN FRANCISCO “F” (PO Number: 5746773) removed	2022 $ 318 2023 $ 2,252 2024 $ 1,458 2025 $ 500	2022 $ 0 2023 $ 0 2024 $ 0 2025 $ 0
WP 15-24 Capital Expenditures Details - Projects Over $3 Million	Line 20		2021 $ 6,797 2022 $ 1,274 2023 $ 31 2024 $ 199 2025 $ 66 2026 $ 72	2021 $ 6,780 2022 $ 1,255 2023 $ 0 2024 $ 0 2025 $ 0 2026 $ 0
WP 15-35	Line 1	48F Switchgear Replacement Forecast Costs	2021 $26,825 2022 $31,607 2023 $34,716 2024 $18,347 2025 $17,154 2026 $15,724	2021 $26,808 2022 $31,269 2023 $32,433 2024 $16,690 2025 $16,588 2026 $15,652
WP 15-38	Line 10	Unit Forecast Basis	The number of units is based on a 3-year historical of units completed in the	The number of units is based on a count of in-flight projects and new planned targets.

			2016 -2019 timeframe.	
WP 15-38	Line 15	Forecast Units	2021 11 2022 13 2023 13 2024 13 2025 13 2026 13	2021 18 2022 16 2023 17 2024 18 2025 15 2026 15
WP 15-38	Line 16	Forecast Costs	2021 $ 412,108 2022 $ 415,656 2023 $ 443,094 2024 $ 381,745 2025 $ 343,526 2026 $ 352,008	2021 $ 251,844 2022 $ 337,721 2023 $ 338,837 2024 $ 275,705 2025 $ 297,723 2026 $ 305,073
WP 15-39	Line 8	Forecast Capital costs	2021 $ 6,797,285 2022 $ 1,274,145 2023 $ 31,186 2024 $ 199,398 2025 $ 65,974 2026 $ 72,128	2021 $ 6,779,708 2022 $ 1,254,508 2023 $ 0 2024 $ 0 2025 $ 0 2026 $ 0
WP 15-39	Line 11	Forecast Capital costs	2022 $ 318,063 2023 $ 2,251,883 2024 $ 1,458,232 2025 $ 499,911	2022 $ 0 2023 $ 0 2024 $ 0 2025 $ 0
WP-15-41	Project Summary - Animal Abatement	Cost paragraph	Estimates for the forecasted costs for 2023-2026 are based on a blend of new projects spread over two years at $150,000 per year as well as forecast estimates for in-flight work. PG&E estimates completing thirteen (13) projects annually.	Estimates for the forecasted costs for 2021-2026 are based on a blend of new projects spread over two years at $150,000 per year as well as forecast estimates for in-flight work. PG&E estimates completing approximately seventeen (17) projects annually in the 2021 to 2026 timeframe.
WP 15-62	Project Summary-Switchgear Replacement Subprogram	Removing project	<u>Project: GUALALA: Replace 12 KV Switchgear SAN FRANCISCO “F” (PO Number: 5746773)</u> This project replaces the 12kV switchgear at Gualala substation	Removed

			with an operative date of May 2025.	
WP 15-63	Project Summary-Switchgear Replacement Subprogram	Forecast Costs, Major Project Spending Estimates	PO 5795587 2021 $ 6,797 2022 $ 1,274 2023 $ 31 2024 $ 199 2025 $ 66 2026 $ 72 PO 5746773 2022 $ 318 2023 $ 2,252 2024 $ 1,458 2025 $ 500 Total $ -6	PO 5795587 2021 $ 6,780 2022 $ 1,255 2023 $ 0 2024 $ 0 2025 $ 0 2026 $ 0 PO 5746773 2022 $ 0 2023 $ 0 2024 $ 0 2025 $ 0 Total $ -7

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 16, DISTRIBUTION SYSTEM AUTOMATION AND PROTECTION

TABLE OF CONTENTS

Subject	Page No.
Expense Workpapers	
Workpaper Table 16-1: Expenses by Major Work Category - Nominal Dollars	WP 16-1
Workpaper Table 16-2: Expenses by Major Work Category - Base Year Dollars	WP 16-2
Workpaper Table 16-3: Major Work Category HX - Recorded Walk	WP 16-3
Workpaper Table 16-4: Major Work Category HX - Forecast Walk	WP 16-4
Workpaper Table 16-5: Expenses for MWC HX Forecast Details	WP 16-5

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 16, DISTRIBUTION SYSTEM AUTOMATION AND PROTECTION

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Capital Workpapers	
Workpaper Table 16-6: Capital Expenditures by Major Work Category	WP 16-6
Workpaper Table 16-7: Forecast Capital Expenditures Summary	WP 16-7
Workpaper Table 16-8: Recorded CWIP and Forecast Capital Expenditures Details - Planning Orders Over $3 Million	WP 16-8
Workpaper Table 16-9: Recorded and Forecast Capital Expenditures Details - Other Work	WP 16-9
Workpaper Table 16-10: Major Work Category 09 - Recorded Walk	WP 16-10
Workpaper Table 16-11: Major Work Category 09 - Forecast Walk	WP 16-11
Workpaper Table 16-12: Major Work Category 09 - Capital Expenditure Summary	WP 16-12
Workpaper Table 16-13: MAT 09B - Replace Substation SCADA Forecast Detail	WP 16-13
Workpaper Table 16-14: MAT 09D - Install Substation SCADA Forecast Detail	WP 16-14
Workpaper Table 16-15: MAT 09B - Replace Substation SCADA Unit Cost Forecast Basis	WP 16-15
Workpaper Table 16-16: MAT 09D - Install Substation SCADA Unit Cost Forecast Basis	WP 16-16
Workpaper Table 16-17: MAT 09E - Replace Substation Protective Relays Forecast Detail	WP 16-17
Workpaper Table 16-18: MAT 09E - Replace Substation Protective Relays Unit Cost Forecast Basis	WP 16-18
Project Summary: Install Substation SCADA	WP 16-19
Project Summary: Replace Substation SCADA	WP 16-21
Index Template	WP 16-23

Workpaper Table 16-1
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 16
Distribution System Automation and Protection
Expenses by Major Work Category
(Thousands of Nominal Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference
1	HX	E T&D Automation & Protection	1,400	1,592	1,447	1,971	2,344	2,412	2,416	3,008	WP 16-3, WP 16-4
2	**Total**		**1,400**	**1,592**	**1,447**	**1,971**	**2,344**	**2,412**	**2,416**	**3,008**	

Workpaper Table 16-2
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 16
Distribution System Automation and Protection
Expenses by Major Work Category
(Thousands of Base Year Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast
1	HX	E T&D Automation & Protection	1,563	1,716	1,512	2,009	2,344	2,366	2,298	2,774
2	**Total**		**1,563**	**1,716**	**1,512**	**2,009**	**2,344**	**2,366**	**2,298**	**2,774**

Workpaper Table 16-3
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
Major Work Category HX - Recorded Walk
(Thousands of Nominal Dollars)

Line No.	Year	Program/Activity	Amount	Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$1,400**		
2		Automation Engineering Support	$87	Increase remains relatively consistent with recorded level with minor variations.	WP 16-5, Line 1
3		Protection Engineering Support	$268	Increase due to additional support and training required due to the new PG&E Protection SMP Design standard.	WP 16-5, Line 2
4		Automation Specialist Support	-$163	Decrease due to support directed towards capital projects	WP 16-5, Line 3
5		**Net Change**	**$192**		
6	**2017**	**Recorded Adjusted**	**$1,592**		
7		Automation Engineering Support	-$55	Decrease remains relatively consistent with recorded level with minor variations.	WP 16-5, Line 1
8		Protection Engineering Support	-$19	Decrease remains relatively consistent with recorded level with minor variations.	WP 16-5, Line 2
9		Automation Specialist Support	-$71	Decrease remains relatively consistent with recorded level with minor variations.	WP 16-5, Line 3
10		**Net Change**	**-$145**		
11	**2018**	**Recorded Adjusted**	**$1,447**		
12		Automation Engineering Support	$204	Increase remains relatively consistent with recorded level with minor increase associated with headcount increase.	WP 16-5, Line 1
13		Protection Engineering Support	$47	Increase remains relatively consistent with recorded level with minor variations.	WP 16-5, Line 2
14		Automation Specialist Support	$272	Increase remains relatively consistent with recorded level with minor increase associated with headcount increase.	WP 16-5, Line 3
15		**Net Change**	**$524**		
16	**2019**	**Recorded Adjusted**	**$1,971**		
17		Automation Engineering Support	$104	Increase remains relatively consistent with recorded level with minor increase due to support of PSPS.	WP 16-5, Line 1
18		Protection Engineering Support	$368	Increase due to support of PSPS, DG support, mobile generators and islanding initiative.	WP 16-5, Line 2
19		Automation Specialist Support	-$98	Decrease remains relatively consistent with recorded level with minor variations due to headcount reduction.	WP 16-5, Line 3
20		**Net Change**	**$373**		
21	**2020**	**Recorded Adjusted**	**$2,344**		

Workpaper Table 16-4
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
Major Work Category HX - Forecast Walk
(Thousands of Nominal Dollars)

Line No.	Year	Program/Activity	Amount	Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$2,344**		
2		Automation Engineering Support	$170	Work is forecast to remain relatively consistent with recorded levels with only minor variations.	WP 16-5, Line 1
3		Protection Engineering Support	$239	Increase due to review protective relay settings for distribution feeder circuits in support of PSPS activities.	WP 16-5, Line 2
4		Automation Specialist Support	$26	Work is forecast to remain relatively consistent with recorded levels with only minor variations.	WP 16-5, Line 3
5		Forecast Adjustment	-$367	Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.	WP 16-5, Line 4
6		**Net Change**	**$68**		
7	**2021**	**Forecast**	**$2,412**		
8		Automation Engineering Support	$0	Work is forecast to remain relatively consistent with recorded levels.	WP 16-5, Line 1
9		Protection Engineering Support	$5	Work is forecast to remain relatively consistent with recorded levels with only minor variations.	WP 16-5, Line 2
10		Automation Specialist Support	$0	Work is forecast to remain relatively consistent with recorded levels.	WP 16-5, Line 3
11		Forecast Adjustment	-$1	Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.	WP 16-5, Line 4
12		**Net Change**	**$4**		
13	**2022**	**Forecast**	**$2,416**		
14		Automation Engineering Support	$0	Forecast will remain relatively consistent with record level with minor increase associated to headcount increase.	WP 16-5, Line 1
15		Protection Engineering Support	$94	Increase to review protective relay settings for distribution feeder circuits in support of PSPS, mobile generators and islanding initiative.	WP 16-5, Line 2
16		Automation Specialist Support	$131	Forecast will remain relatively consistent with record level with minor increase associated to headcount increase.	WP 16-5, Line 3
17		Forecast Adjustment	$367	No forecast adjustment in 2023	WP 16-5, Line 4
18		**Net Change**	**$592**		
19	**2023**	**Forecast**	**$3,008**		

Workpaper Table 16-5
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
Expenses for MWC HX Forecast Details
(Thousands of Nominal Dollars)

Line No.		2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	Assumptions	Reference
1	Automation Engineering Support	$269	$357	$302	$506	$611	$780	$780	$780	(1)	
2	Protection Engineering Support	$567	$835	$816	$864	$1,231	$1,470	$1,475	$1,569	(2)	
3	Automation Specialist Support	$563	$400	$329	$601	$502	$528	$528	$659	(3)	
4	Forecast Adjustment	$0	$0	$0	$0	$0	($367)	($367)	$0	(4)	Chapter 2 Section D
5	**Total**	**$1,400**	**$1,592**	**$1,447**	**$1,971**	**$2,344**	**$2,412**	**$2,416**	**$3,008**		

Forecast Assumptions and Details

(1) Automation Engineering Support provides engineering support for existing substation and line automation equipment. These costs are for labor and are based on the Last Recorded Year (2020) as the program is expected to maintain its current levels with a minor increase related to attrition.

(2) Protection Engineering Support provides engineering support for existing substation protection equipment. These costs are for labor and are based on the Last Recorded Year (2020), with an increase to review protective relay settings for distribution feeder circuits in support of PSPS, and provide support to perform annual audit on distribution feeders in order to capture efficiency and improve system reliability, annual training for distribution planners/operations, outage reviews, standards development, Rule 21 compliance, DG support, mobile generators and islanding initiative.

(3) The Automation Specialist Support group supports the deployment, operation and maintenance of those systems associated with the implementation of substation automation equipment such as but not limited to Human Machine Interface (HMI) devices.

(4) Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.

Workpaper Table 16-6
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 16
Distribution System Automation and Protection
Capital Expenditures by Major Work Category
(Thousands of Nominal Dollars)

			Capital Expenditures											
No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	9	E Dist Automation & Protection	56,243	52,745	64,365	56,508	37,437	25,483	26,371	27,003	27,745	28,540	29,281	WP 16-10, 16-11
2		**Grand Total**	**56,243**	**52,745**	**64,365**	**56,508**	**37,437**	**25,483**	**26,371**	**27,003**	**27,745**	**28,540**	**29,281**	

Workpaper Table 16-7
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 16
Distribution System Automation and Protection
Forecast Capital Expenditures Summary
(Thousands of Nominal Dollars)

		Capital Expenditures							
Line No.	Description	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	Projects > $3 Million*	2,405	21,133	26,371	27,003	27,745	28,540	29,281	WP 16-8
2	Other Work	16,911	4,350	-	-	-	-	-	WP 16-9
3	**Total**	**19,316**	**25,483**	**26,371**	**27,003**	**27,745**	**28,540**	**29,281**	

4 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 16-8
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 16
Distribution System Automation and Protection
Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million*
(Thousands of Nominal Dollars)

					CWIP	Capital Expenditures							
Line No.	Planning Order	Description	MWC	Operative Date	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Subtotal	Reference
	MWC - 09	**E Dist Automation & Protection**											
1	5534919	Dist SCADA Emergency Replacement Bucket	9		-	4,000	-	-	-	-	-	4,000	
2	5543445	SYSPLAN ED 09B DOVHD-C007	9		-	10,284	10,565	10,468	16,703	16,410	16,944	81,374	
3	5543446	SYSPLAN ED 09D DOVHD-C007	9		-	6,599	6,329	470	3	78	239	13,718	
4	5543447	SYSPLAN ED 09E DOVHD-C007	9		-	-	2,540	2,908	3,714	3,100	3,430	15,692	
5	5543448	SYSPLAN ED 09F DOVHD-C007	9		-	-	5,274	5,416	5,563	5,713	5,867	27,832	
6	5764465	San Rafael:Rpl DSCADA 10 IPAC DOVHD-C007	9	Jun-2023	45	2	616	3,184	0	-	-	3,847	
7	5765181	Edenvale:Rpl DSCADA w/16 IPAC DOVHD-C007	9	Nov-2023	86	6	903	3,200	10	-	-	4,205	
8	5768863	OAKLAD L: Install SCADA DOVHD-C007	9	Mar-2021	2,274	242	-	-	-	3,223	2,801	8,540	
9	5781439	Trimble Sub:Rpl DSCADA 19IPAC DOVHD-C007	9	Apr-2025	-	-	145	1,359	1,750	16	-	3,270	
10	**Total**				**2,405**	**21,133**	**26,371**	**27,003**	**27,745**	**28,540**	**29,281**	**162,477**	WP 16-12
11		**Grand Total**			**2,405**	**21,133**	**26,371**	**27,003**	**27,745**	**28,540**	**29,281**	**162,477**	

12 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 16-9
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 16
Distribution System Automation and Protection
Recorded and Forecast Capital Expenditures Details - Other Work*
(Thousands of Nominal Dollars)

			Capital Expenditures											
Line No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	9	E Dist Automation & Protection	56,243	52,576	63,665	55,676	36,545	4,350	-	-	-	-	-	WP 16-12
2	**Grand Total**		**56,243**	**52,576**	**63,665**	**55,676**	**36,545**	**4,350**	**-**	**-**	**-**	**-**	**-**	

3 * Excludes projects greater than $3M

Workpaper Table 16-10
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
Major Work Category 09 - Recorded Walk
MWC 09 - Distribution Automation and System Protection
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$56,243**			
2		Replace Substation SCADA (MAT 09B)	$2,538		Increase in replacement of substation RTUs to proactively address aging assets prone to failure.	WP 16-12, Line 1
3		Install Substation SCADA (MAT 09D)	-$6,780		Ramping down the program as it approaches nearly 100% SCADA penetration in 2019	WP 16-12, Line 2
4		Replace Substation Protective Relays (MAT 09E)	$190		Work is consistent with recorded levels with only minor variations.	WP 16-12, Line 3
5		Miscellaneous/Emergency SCADA Equipment Replacement (MAT 09F)	$557		Work is consistent with recorded levels with only minor variations.	WP 16-12, Line 4
6		Not Assigned (MAT 09#)	-$2		Minor variations	WP 16-12, Line 5
7		**Net Change**	**-$3,498**			
8	**2017**	**Recorded Adjusted**	**$52,745**			
9		Replace Substation SCADA (MAT 09B)	$6,502		Increase in replacement of substation RTUs to proactively address aging assets prone to failure.	WP 16-12, Line 1
10		Install Substation SCADA (MAT 09D)	-$1,342		Ramping down the program as it approaches nearly 100% SCADA penetration in 2019	WP 16-12, Line 2
11		Replace Substation Protective Relays (MAT 09E)	$2,750		Completed projects of high complexity increasing project costs.	WP 16-12, Line 3
12		Miscellaneous/Emergency SCADA Equipment Replacement (MAT 09F)	$3,711		Increase in unplanned replacement due to equipment failure.	WP 16-12, Line 4
13		Not Assigned (MAT 09#)	-$1		Minor variations	WP 16-12, Line 5
14		**Net Change**	**$11,620**			
15	**2018**	**Recorded Adjusted**	**$64,365**			
16		Replace Substation SCADA (MAT 09B)	$2,947		Increase in replacement of substation RTUs to proactively address aging assets prone to failure.	WP 16-12, Line 1
17		Install Substation SCADA (MAT 09D)	-$8,655		Ramping down the program as it approaches nearly 100% SCADA penetration in 2019	WP 16-12, Line 2
18		Replace Substation Protective Relays (MAT 09E)	-$2,621		Decrease to nominal annual costs.	WP 16-12, Line 3
19		Miscellaneous/Emergency SCADA Equipment Replacement (MAT 09F)	$471		Work is consistent with recorded levels with only minor variations.	WP 16-12, Line 4
20		Not Assigned (MAT 09#)	$0		No change	WP 16-12, Line 5
21		**Net Change**	**-$7,857**			
22	**2019**	**Recorded Adjusted**	**$56,508**			
23		Replace Substation SCADA (MAT 09B)	-$2,778		Decrease associated with COVID-19 related project delays.	WP 16-12, Line 1
24		Install Substation SCADA (MAT 09D)	-$20,108		Ramping down the program as it approaches nearly 100% SCADA penetration in 2019	WP 16-12, Line 2
25		Replace Substation Protective Relays (MAT 09E)	$1,306		Completed projects of high complexity increasing project costs.	WP 16-12, Line 3
26		Miscellaneous/Emergency SCADA Equipment Replacement (MAT 09F)	$2,509		Increase in unplanned replacement due to equipment failure.	WP 16-12, Line 4
27		Not Assigned (MAT 09#)	$0		Minor variations	WP 16-12, Line 5
28		**Net Change**	**-$19,071**			
29	**2020**	**Recorded Adjusted**	**$37,437**			

Workpaper Table 16-11
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
Major Work Category 09 - Forecast Walk
MWC 09 - Distribution Automation and System Protection
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$37,437**			
2		Replace Substation SCADA (MAT 09B)	-$1,125		Reduction to support authorized targets and higher priority work	WP 16-12, Line 1
3		Install Substation SCADA (MAT 09D)	-$7,466		Reduction to support authorized targets and higher priority work	WP 16-12, Line 2
4		Replace Substation Protective Relays (MAT 09E)	-$819		Reduction to support authorized targets and higher priority work	WP 16-12, Line 3
5		Miscellaneous/Emergency SCADA Equipment Replacement (MAT 09F)	-$2,545		Reduction due to a decrease in failed equipment	WP 16-12, Line 4
6		Not Assigned (MAT 09#)	$0		Minor variations	
7		**Net Change**	**-$11,954**			
8	**2021**	**Forecast**	**$25,483**			
9		Replace Substation SCADA (MAT 09B)	$1,936		Gradually ramping up SCADA replacement to proactively address aging assets	WP 16-12, Line 1
10		Install Substation SCADA (MAT 09D)	-$511		Minor variations in forecast	WP 16-12, Line 2
11		Replace Substation Protective Relays (MAT 09E)	-$41		Minor variations in forecast	WP 16-12, Line 3
12		Miscellaneous/Emergency SCADA Equipment Replacement (MAT 09F)	-$496		Minor variations in forecast for failed equipment	WP 16-12, Line 4
13		**Net Change**	**$888**			
14	**2022**	**Forecast**	**$26,371**			
15		Replace Substation SCADA (MAT 09B)	$5,982		Gradually ramping up SCADA replacement to proactively address aging assets	WP 16-12, Line 1
16		Install Substation SCADA (MAT 09D)	-$5,860		Ramping down the program as it approaches nearly 100% SCADA penetration in 2019	WP 16-12, Line 2
17		Replace Substation Protective Relays (MAT 09E)	$368		Minor variations in forecast	WP 16-12, Line 3
18		Miscellaneous/Emergency SCADA Equipment Replacement (MAT 09F)	$142		Minor variations in forecast for failed equipment	WP 16-12, Line 4
19		**Net Change**	**$632**			
20	**2023**	**Forecast**	**$27,003**			
21		Replace Substation SCADA (MAT 09B)	$255		Gradually ramping up SCADA replacement to proactively address aging assets	WP 16-12, Line 1
22		Install Substation SCADA (MAT 09D)	-$466		Minor variations in forecast	WP 16-12, Line 2
23		Replace Substation Protective Relays (MAT 09E)	$807		Minor variations in forecast - Allow completion of more complex project (specific projects related to Bahia and El Dorado). The portfolio has an estimated 7 projects in various stages in 2024.	WP 16-12, Line 3
24		Miscellaneous/Emergency SCADA Equipment Replacement (MAT 09F)	$146		Minor variations in forecast for failed equipment	WP 16-12, Line 4
25		**Net Change**	**$742**			
26	**2024**	**Forecast**	**$27,745**			
27		Replace Substation SCADA (MAT 09B)	-$2,039		Ramping down work to normal levels after previous year's focus	WP 16-12, Line 1
28		Install Substation SCADA (MAT 09D)	$3,298		Increase is to align with the switchgear replacement project at Oakland L Substation.	WP 16-12, Line 2
29		Replace Substation Protective Relays (MAT 09E)	-$614		Minor variations in forecast - ramping work to normal levels after previous year's focus- The portfolio has an estimated 6 projects in various stages in 2025 and all the projects are expected to be medium complexity.	WP 16-12, Line 3
30		Miscellaneous/Emergency SCADA Equipment Replacement (MAT 09F)	$150		Minor variations in forecast for failed equipment	WP 16-12, Line 4
31		**Net Change**	**$795**			
32	**2025**	**Forecast**	**$28,540**			
33		Replace Substation SCADA (MAT 09B)	$518		Gradually ramping up SCADA replacement to proactively address aging assets	WP 16-12, Line 1
34		Install Substation SCADA (MAT 09D)	-$262		Minor variations in forecast	WP 16-12, Line 2
35		Replace Substation Protective Relays (MAT 09E)	$330		Minor variations in forecast	WP 16-12, Line 3
36		Miscellaneous/Emergency SCADA Equipment Replacement (MAT 09F)	$154		Minor variations in forecast for failed equipment	WP 16-12, Line 4
37		**Net Change**	**$741**			
38	**2026**	**Forecast**	**$29,281**			

Workpaper Table 16-12
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
Major Work Category 09 - Capital Expenditure Summary
(Thousands of Nominal Dollars)

Line No.		MAT Code	Subprogram/Title	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Assumptions	Reference
1		**09B**	Replace Substation SCADA	$2,207	$4,745	$11,247	$14,194	$11,417	$10,292	$12,228	$18,210	$18,465	$16,426	$16,944		WP 16-13, WP 16-15
2		**09D**	Install Substation SCADA	$51,192	$44,412	$43,070	$34,415	$14,307	$6,841	$6,329	$470	$3	$3,301	$3,040		WP 16-14, WP 16-16
3		**09E**	Replace Substation Protective Relays	$1,774	$1,964	$4,714	$2,093	$3,399	$2,580	$2,540	$2,908	$3,714	$3,100	$3,430		WP 16-17, WP 16-18
4		**09F**	Miscellaneous/Emergency SCADA Equipment Replacement	$1,067	$1,624	$5,335	$5,805	$8,314	$5,769	$5,274	$5,416	$5,563	$5,713	$5,867	(1)	
5		**09#**	Not Assigned	$2	$1	$0	$0	$0	$0	$0	$0	$0	$0	$0	(2)	
6			**E Dist Automation & Protection**	**$ 56,243**	**$ 52,745**	**$ 64,365**	**$ 56,508**	**$ 37,437**	**$ 25,483**	**$ 26,371**	**$ 27,003**	**$ 27,745**	**$ 28,540**	**$ 29,281**		

Forecast Assumptions and Details

(1) Forecast is based on 3-year average (2018-2020) of recorded costs since this is the best representation of expected future costs.

(2) These recorded costs include the standard cost variance and small miscellaneous projects.

Workpaper Table 16-13
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
MAT 09B - Replace Substation SCADA Forecast Detail
(Thousands of Nominal Dollars)

Replacement Projects Greater than $3M (A)

Line No.	Proposed Work	MAT	Total # of Unit	Operational Date	YR2021	YR2022	YR2023	YR2024	YR2025	YR2026	Project Total	Assumptions
1	Edenvale: Replace D-SCADA with 16 IPAC	09B	17	2023	$6	$905	$2,676	$0	$0	$0	$3,587	
2	Trimble Sub: Replace Dist SCADA 19 IPAC	09B	20	2024	$0	$145	$1,765	$2,310	$0	$0	$4,220	
3	Dist SCADA Replacement Bucket	09B	Various	Operative as Installed	$0	$0	$911	$1,946	$1,984	$8,271	$13,112	(1)
4	**Sub Total Replacement SCADA - Substation - > $3M**	**09B**	**37**		**$6**	**$1,050**	**$5,352**	**$4,256**	**$1,984**	**$8,271**	**$20,919**	

Replacement Projects Less than $3M (A)

	Proposed Work	MAT	Total # of Unit	Operational Date	YR2021	YR2022	YR2023	YR2024	YR2025	YR2026	Project Total
5	BAHIA: Repl and Consolidate 2 RTU	09B	2	2020	$137						$137
6	DIXON LANDING: REPLACE D-RTU	09B	2	2020	$22						$22
7	IGNACIO: Repl D-RTU	09B	2	2020	$12						$12
8	RADUM: Repl CB 1105 W/IPAC	09B	1	2020	$8						$8
9	Davis Sub-D-SCADA Replace 7 IPAC	09B	7	2021	$1,621	$146					$1,767
10	Millbrae: Replace D-RTU & 4 IPAC	09B	5	2021	$1,329	$94					$1,423
11	ELK: Replace D-RTU & 1 IPAC	09B	2	2021	$452	$28					$480
12	Monticello: Repl ALS RTU & CB1101 IPAC	09B	2	2021	$596	$14					$610
13	BELLEVUE: Replace D-RTU & 7 IPAC	09B	8	2021	$514	$7					$521
14	BAY MEADOWS: Replace D-RTU & 10 IPAC	09B	11	2021	$1,350	$7					$1,357
15	Stockdale Sub: Replace D-SCADA 3 IPAC	09B	3	2021	$579						$579
16	KINGSBURG: Replace D-RTU & 4 IPAC	09B	5	2021	$497						$497
17	Cotati: Replace D-RTU & 4 IPAC	09B	5	2021	$475						$475
18	OLEMA: Repl D-SCADA CB 1101	09B	2	2021	$184						$184
19	Vaca Dixon_ Develop/Repl Feeder Rly Std	09B	1	2021	$179						$179
20	ORICK: Repl ALS RTU	09B	2	2021	$67						$67
21	Salmon Creek Sub: Replace CB1101 w IPAC	09B	2	2021	$29						$29
22	Pueblo Sub SCADA Replacement & 5 IPAC	09B	6	2022	$235	$1,031					$1,266
23	Evergreen Sub: Replace D_SCADA & 4 IPAC	09B	5	2022	$182	$873					$1,055
24	LLagas: Replace D-RTU & 3 IPAC	09B	4	2022	$11	$833					$844
25	BARTON: Repl/Add IPAC D-SCADA 12 KV FDRs & 3 IPAC	09B	4	2022	$463	$381					$844
26	Fort Bragg A: Replace RTU & 3 IPAC	09B	4	2022	$309	$535					$844
27	BIG BASIN: Replace D-RTU & 2 IPAC	09B	3	2022	$1	$632					$633
28	EIGHT MILE: Replace D-RTU & 2 IPAC	09B	3	2022	$0	$633					$633
29	Philo Sub Replace RTU & 2 IPAC, MOAS & Reg	09B	3	2022	$50	$583					$633
30	Buellton: Replace RTU D20M+, CB1101 & 1102 with IPAC	09B	3	2022	$253	$380					$633
31	Low Gap Sub Replace RTU	09B	2	2022	$236	$186					$422
32	Point Arena Sub Replace RTU & 1 IPAC	09B	2	2022	$290	$132					$422
33	CAL WATER: Replace D-RTU & 1 IPAC	09B	2	2022	$205	$217					$422
34	San Rafael: Replace Dist SCADA 10 IPAC	09B	11	2023		$620	$1,701				$2,321
35	SF J: Replace D-RTU & 8 Breakers	09B	9	2023		$760	$1,139				$1,899
36	Monroe: Replace D-SCADA with 7 IPAC	09B	8	2023		$675	$1,013				$1,688
37	Stockdale: Rep D-SCADA_21KV 7 IPAC	09B	7	2023		$591	$886				$1,477
38	HOLLISTER: Replace D-RTU & 5 IPAC	09B	6	2023		$489	$777				$1,266
39	Livermore: Replace D-RTU & 4 IPAC	09B	5	2023		$306	$749				$1,055
40	Sobrante: Repl DSCADA CB1101/1102/1103 IPAC	09B	3	2023		$251	$382				$633
41	Balfour Sub Replace RTU	09B	2	2023		$168	$254				$422
42	Burlingame: Repl D20M Consolidate D20ME	09B	2	2023		$168	$254				$422
43	El Patio Sub: Replace Dist SCADA 13 IPAC	09B	14	2024		$203	$1,085	$1,666			$2,954
44	Saratoga Sub SCADA Replacement 10 IPAC	09B	11	2024		$145	$915	$1,260			$2,321
45	BIG RIVER: Replace D-RTU & CB1101	09B	2	2024		$92	$72	$258			$422
46	Newark Dist Sub: Replace RTU & 9 IPAC	09B	10	2024			$844	$1,266			$2,110
47	Oakland J: Replace ALS RTU & D20M++ RTU & 10 IPAC	09B	11	2024			$928	$1,393			$2,321
48	Paul Sweet: Replace RTU & 7 IPAC	09B	8	2024			$675	$1,013			$1,688
49	JANES CREEK: Replace D-RTU & 4 IPAC	09B	5	2024			$423	$632			$1,055
50	Summit: D-RTU Replace D20ME & 2 IPAC	09B	3	2024			$253	$380			$633
51	Daly City Sub: Replace 5 IPAC	09B	6	2024			$506	$760			$1,266
52	Las Positas Sub: Replace RTU & 7 IPAC	09B	8	2025				$675	$1,013		$1,688
53	Tidewater: Replace RTU & 6 IPAC	09B	7	2025				$591	$886		$1,477
54	Silverado: Replace Dist SCADA 5 IPAC	09B	6	2025				$433	$833		$1,266
55	Redwood City: Replace RTU & 4 IPAC	09B	5	2025				$422	$633		$1,055
56	Swift: Replace RTU & 4 IPAC	09B	5	2025				$422	$633		$1,055
57	Vasco: Replace RTU & 3 IPAC	09B	4	2025				$338	$506		$844
58	West Lane: Replace RTU & 3 IPAC	09B	4	2025				$338	$506		$844
59	Purisima: Replace RTU & CB1101 IPAC	09B	2	2025				$169	$253		$422
60	Berkeley F: Replace RTU & HMI with EATON	09B	1	2025				$84	$127		$211
61	Manteca Sub: Replace RTU and Reconfigure Wiring	09B	1	2025				$84	$127		$211
62	San Fran Airport: Replace RTU	09B	1	2025				$84	$127		$211
63	Jamerson Sub: Replace RTU & 4 IPAC	09B	5	2025				$422	$633		$1,055
64	Parkway Sub: Replace RTU & 4 IPAC	09B	5	2025				$422	$633		$1,055
65	Carbona Sub: Replace Relays CB1101, 1103 & 1104	09B	4	2025				$338	$506		$844
66	Mormon Sub: Replace RTU & 2 IPAC	09B	3	2025				$253	$380		$633
67	Dunlap Sub: Replace with IPAC CB1102	09B	2	2025				$169	$253		$422
68	Perry Sub: Replace RTU & CB1101	09B	2	2025				$169	$253		$422
69	Caruthers Sub: Replace RTU	09B	1	2025				$84	$127		$211
70	Cassidy Sub: Replace RTU	09B	1	2025				$84	$127		$211
71	California Ave Sub: Replace D-RTU & 10 IPAC	09B	11	2026					$960	$1,361	$2,321
72	Whisman Sub: Replace D-RTU & 10 IPAC	09B	11	2026					$959	$1,362	$2,321
73	Oceano Sub: Replace D-RTU & 5 IPAC	09B	6	2026					$506	$760	$1,266
74	San Luis Obispo Sub: Replace D-RTU & 5 IPAC	09B	6	2026					$506	$760	$1,266
75	Pacifica Sub: Replace D-RTU & 4 IPAC	09B	5	2026					$422	$633	$1,055
76	Copus Sub: Replace D-RTU & 3 IPAC	09B	4	2026					$338	$506	$844
77	Morgan Sub: Replace D-RTU & 3 IPAC	09B	4	2026					$338	$506	$844
78	Cottonwood Sub: Replace 12kV RTU & 2 IPAC	09B	3	2026					$253	$380	$633
79	Los Altos Sub: Replace D-RTU & 2 IPAC	09B	3	2026					$253	$380	$633
80	Santa Maria Sub: Replace D-RTU & 2 IPAC	09B	3	2026					$253	$380	$633
81	Sneath Sub: Replace D-RTU & 2 IPAC	09B	3	2026					$253	$380	$633
82	Carquinez Sub: Replace D-RTU & 1 IPAC	09B	2	2026					$169	$253	$422
83	Divide Sub: Replace D-RTU & 1 IPAC	09B	2	2026					$169	$253	$422
84	Richmond R Sub: Replace D-RTU & 1 IPAC	09B	2	2026					$169	$253	$422
85	Serramonte Sub: Replace D-RTU & 1 IPAC	09B	2	2026					$169	$253	$422
86	Willow Creek Sub: Replace D-RTU & 1 IPAC	09B	2	2026					$169	$253	$422
87	**Sub Total Replacement SCADA - Substation - < $3M**	**09B**	**362**		**$10,286**	**$11,178**	**$12,858**	**$14,208**	**$14,441**	**$8,673**	**$71,645**

88	**Total Replace SCADA Substation**	**09B**	**399**		**$10,292**	**$12,228**	**$18,210**	**$18,464**	**$16,425**	**$16,944**	**$92,564**
89	**Annual Total, Replacement Projects Under Construction**										

Forecast Assumptions and Details

(1) This planning order reflects unidentified work and is based on an estimated unit cost of $211,000 and completing approximately 62 units.

Workpaper Table 16-14
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
MAT 09D - Install Substation SCADA Forecast Detail
(Thousands of Nominal Dollars)

Installation Projects Greater than $3M

Line No.	Proposed Work	MAT	Total # of Unit	Operational Date	YR2021	YR2022	YR2023	YR2024	YR2025	YR2026	Project Total	Assumptions
1	OAKLAND L: Install SCADA	09D	27	2026	$243	$0	$0	$0	$3,216	$2,900	$6,359	
2	Dist SCADA Installation Bucket	09D	Various	Operative as Installed	$1,422	$2,045	$0	$0	$0	$0	$3,467	(1)
3	**Sub Total Install SCADA - Substation - > $3M**	**09D**	**27**		**$1,665**	**$2,045**	**$0**	**$0**	**$3,216**	**$2,900**	**$9,826**	

Installation Projects Less than $3M

	Proposed Work	MAT	Total # of Unit	Operational Date	YR2021	YR2022	YR2023	YR2024	YR2025	YR2026	Project Total
4	SPANISH CREEK: Install D-SCADA	09D	4	2018	$72						$72
5	GANSNER: Install D-SCADA CB 1101	09D	3	2018	$74						$74
6	MIRABEL: Inst D-SCADA on CB 1101- 1102	09D	3	2018	$24						$24
7	COLUMBIA HILL: Inst D-SCADA on CB 1101	09D	3	2018	$36						$36
8	UPPER LAKE: Install D-SCADA CB 1101	09D	4	2018	$1						$1
9	FRENCH GULCH: Install D-SCADA	09D	3	2019	$51						$51
10	CRESCENT MILLS: Inst D-SCADA on CB 210	09D	3	2019	$241						$241
11	ANNAPOLIS: Install D-SCADA	09D	4	2019	$49						$49
12	ELK CREEK: Install D-SCADA CB 1101	09D	2	2019	$3						$3
13	TEMPLETON: Install D-SCADA	09D	4	2019	$19						$19
14	EL NIDO: Install D-SCADA	09D	4	2019	$1						$1
15	Covelo: Install D-SCADA CB1101	09D	1	2019	$20	$2					$22
16	CORONA: Install D-SCADA	09D	7	2019	$43						$43
17	LODI: Install D-SCADA	09D	4	2019		$8					$8
18	RAWSON: Install D-SCADA	09D	5	2020	$1						$1
19	POTTER VALLEY PH: Install D-SCADA	09D	6	2020	$25	$2					$27
20	WILLOWS A: Install D-SCADA	09D	5	2020	$14						$14
21	SPRING GAP PH: Install D-SCADA	09D	4	2020	$1						$1
22	MAGUNDEN: Install D-SCADA	09D	2	2020	$38						$38
23	MILPITAS: INSTALL D-SCADA 1100-1200 & 2	09D	4	2020	$30						$30
24	TERMINOUS: Install D-SCADA 110 & 1103	09D	5	2020	$61						$61
25	Emerald Lake Install DSCADA 2 fdrs	09D	2	2021	$5						$5
26	NEW HOPE: Install D-SCADA CB 1101, 1102	09D	4	2021	$637						$637
27	HERDLYN: Install D-SCADA	09D	4	2021	$157						$157
28	SAN CARLOS: Install D-SCADA	09D	2	2021	$950	$98					$1,048
29	Cayetano – Install D-SCADA to Bus Tie Br	09D	3	2021	$651	$30					$681
30	HOWLAND RD: Install D-SCADA Cap 2/2	09D	3	2022	$581	$100					$681
31	CYMRIC: Install D-SCADA	09D	1	2022	$210	$17					$227
32	Montague D-SCADA	09D	2	2022	$182	$272					$454
33	Pittsburg: Install D-SCADA CB401 & 402	09D	3	2022	$272	$409					$681
34	SARATOGA: INSTALL D-SCADA 1100, 1200 & 1300	09D	6	2022	$24	$1,338					$1,362
35	SAN JOSE: Install D-SCADA 1100, 1200,1300 & 1400	09D	4	2022	$58	$850					$908
36	GOOSE LAKE: Install D-SCADA	09D	6	2022	$401	$806	$155				$1,362
37	Petaluma A: Install D-SCADA- CB411	09D	1	2023		$91	$136				$227
38	River Oaks DSCADA CB2100, 2200 & Bus Tie	09D	3	2023	$240	$262	$179				$681
39	FAIRWAY: Install D-SCADA 1200	09D	1	2026				$3	$85	$139	$227
40	**Sub Total Install SCADA - Substation - < $3M**	**09D**	**125**		**$5,176**	**$4,285**	**$470**	**$3**	**$85**	**$139**	$10,157
41	**Total MAT 09D Install SCADA Substation**	**09D**	**152**		**$6,841**	**$6,330**	**$470**	**$3**	**$3,301**	**$3,039**	**$19,984**
42	**Annual Total, Projects**										

Forecast Assumptions and Details
(1) This planning order reflects unidentified work and is based on an estimated unit cost of $227,000 and completing approximate 15 units.

Workpaper Table 16-15
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
MAT 09B - Replace Substation SCADA Unit Cost Forecast Basis
(Thousands of Nominal Dollars)

Line No.	MAT	Sub-program	Order	Substation	Project Description	Project Complete Year	No. of RTU	No. of Circuit Breaker	No. of Bank/Reg	Total No. of Unit	Project Complexity	Unit Cost	Project Total	Assumptions
1	09B	REPLACE SUBSTATION SCADA	31137245	Bakersfield Sub	BAKERSFIELD: REPLACE SCADA	2018	0	20	0	20	high	$ 206,497	$ 4,129,949	
2	09B	REPLACE SUBSTATION SCADA	30491539	Olema Sub	OLEMA SUB REPLACE DART RTU	2018	1	0	0	1	low	$ 255,694	$ 255,694	
3	09B	REPLACE SUBSTATION SCADA	74005220	Clayton Sub	CLAYTON REPLACE BANK METERS	2018	0	0	1	1	low	$ 185,986	$ 185,986	
4	09B	REPLACE SUBSTATION SCADA	30701926	San Andreas Sub	SAN ANDREAS SUB - REPACE DART RTU	2018	1	0	0	1	low	$ 15,705	$ 15,705	
5	09B	REPLACE SUBSTATION SCADA	30782424	Mariposa Sub	MARIPOSA SUB - REPLACE D-RTU	2018	1	2	2	5	medium	$ 83,249	$ 416,245	
6	09B	REPLACE SUBSTATION SCADA	30722974	Big Basin Sub	BIG BASIN - REPLACE PDAC ON BANK 1	2018	1	0	0	1	medium	$ 236,852	$ 236,852	
7	09B	REPLACE SUBSTATION SCADA	74002839	Sunol Sub	SUNOL: D-RTU REPLACEMENT	2019	1	1	1	3	low	$ 117,406	$ 352,219	
8	09B	REPLACE SUBSTATION SCADA	74002795	Cholame Sub	CHOLAME: D-RTU REPLACEMENT	2019	1	0	0	1	low	$ 104,285	$ 104,285	
9	09B	REPLACE SUBSTATION SCADA	74002834	Research Sub	RESEARCH: D-RTU REPLACEMENT	2019	1	0	0	1	medium	$ 345,258	$ 345,258	
10	09B	REPLACE SUBSTATION SCADA	74010416	Franklin Sub	FRANKLIN SUB - REPLACE D-RTU	2020	1	4	0	5	high	$ 249,917	$ 1,249,583	
11	09B	REPLACE SUBSTATION SCADA	74006265	Point Pinole Sub	POINT PINOLE: REPLACE ALS RTU	2020	1	3	1	5	high	$ 300,611	$ 1,503,054	
12	09B	REPLACE SUBSTATION SCADA	74010368	Meadow Lane Sub	MEADOW LANE: REPLACE D-RTU	2020	1	9	0	10	high	$ 203,627	$ 2,036,272	
13	09B	REPLACE SUBSTATION SCADA	74000401	Oakland D Sub	OAKLAND D: D-RTU REPLACEMENT	2020	1	20	0	21	high	$ 151,427	$ 3,179,971	
14	09B	REPLACE SUBSTATION SCADA	74002796	Coco Sub	COCO: REPLACE D-SCADA	2020	1	9	0	10	high	$ 205,092	2,050,923	
15	09B	REPLACE SUBSTATION SCADA	74002792	Canal Sub	CANAL: REPLACE D-RTU	2020	1	7	0	8	high	$ 241,604	$ 1,932,835	
16	09B	REPLACE SUBSTATION SCADA	74002807	El Patio Sub	EL PATIO: D-RTU REPLACEMENT	2020	1	3	0	4	high	$ 267,112	$ 1,068,447	
17	09B	REPLACE SUBSTATION SCADA	74002425	Oleta Sub	OLETA: D-RTU REPLACEMENT	2020	1	2	4	7	high	$ 179,305	$ 1,255,133	
18	09B	REPLACE SUBSTATION SCADA	74006262	Edes Sub	EDES: REPLACE ALS RTU	2020	1	10	1	12	high	$ 341,762	$ 4,101,146	
19	09B	REPLACE SUBSTATION SCADA	74015101	Valley View Sub	VALLEY VIEW SUB: REPLACE ALS RTU	2020	1	3	2	6	high	$ 228,643	$ 1,371,857	
20	09B	REPLACE SUBSTATION SCADA	74002826	Nortech Sub	NORTECH: REPLACE D-RTU	2020	1	0	0	1	low	$ 263,934	$ 263,934	
21	09B	REPLACE SUBSTATION SCADA	74002787	Bonita Sub	BONITA: REPLACE D-RTU	2020	1	1	0	2	low	$ 111,037	$ 222,074	
22	09B	REPLACE SUBSTATION SCADA	74015102	Walnut Creek Sub	WALNUT CREEK (EBMUD) REPLACE ALS RTU	2020	1	0	0	1	low	$ 208,097	$ 208,097	
23	09B	REPLACE SUBSTATION SCADA	74001986	Gabilan Sub	GABILAN: D-RTU REPLACEMENT	2020	1	0	1	2	medium	$ 233,628	$ 467,255	
24	09B	REPLACE SUBSTATION SCADA	74010441	Hat Creek #1 Sub	HAT CREEK #1 PH: REPLACE D-RTU	2020	1	1	0	2	medium	$ 193,479	$ 386,958	
25	09B	REPLACE SUBSTATION SCADA	74002797	Corral Sub	CORRAL: REPLACE D-RTU	2020	1	0	0	1	medium	$ 301,440	$ 301,440	
26														
27														
28	09B	Total Installed Projects=	**25**	Total Installed Units=	**131**	Avg Unit Cost per Installed Unit=						**$ 211,000**		(1)
29	09B	Total High Complexity Projects=	**11**	Total High Complexity Units=	**108**	Avg Unit Cost per High Complexity Project=						**$ 221,103**		(2)
30	09B	Total Med Complexity Projects=	**6**	Total Med Complexity Units=	**12**	Avg Unit Cost per Med Complexity Project=						**$ 179,501**		(3)
31	09B	Total Low Complexity Projects=	**8**	Total Low Complexity Units=	**11**	Avg Unit Cost per Low Complexity Project=						**$ 146,181**		(4)

Forecast Assumptions and Details

(1) The Average Unit cost for Substation SCADA Replacement is calculated by dividing the total project costs by the number of units. (i.e. Avg Unit Cost = Total Job Cost / Total Num of Units)
(2) For Substation SDADA Replacement with High Complexity, the unit cost is calculated by identifying total project costs with high complexity and dividing that amount by the number of units.
(3) For Substation SCADA Replacement with Medium Complexity, the unit cost is calculated by identifying total project costs with medium complexity and dividing that amount by the number of units.
(4) For Substation SCADA Replacement with Low Complexity, the unit cost is calculated by identifying total project costs with low complexity and dividing that amount by the number of units.

Complexity for SCADA Replacement MAT 09B

Complexity	Scope	Breaker Relay Cabinet	Average Unit Cost
High	Replace legacy RTU with D20MX or EATON 4260	4 or more	~ $220K
	Replace 4 or more breaker relay cabinets		
	Install IP based communication		
	Install other SCADA-related station upgrades		
	Change operability protocol and point configuration		
	Perform full SCADA operability test		
Medium	Replace legacy RTU with D20MX	< 4	~ $180K
	Replace less than 4 breaker relay cabinets		
	Install IP based communication		
	Change operability protocol and point configuration		
	Perform partial SCADA operability test		
Low	Replace legacy RTU with D20MX	1 or 0	~ $150K
	Replace one or none breaker relay cabinet		
	Minimal change to IT communication		
	No change to operability protocol or point configuration		
	Perform partial SCADA operability test		

Workpaper Table 16-16
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
MAT 09D - Install Substation SCADA Unit Cost Forecast Basis
(Thousands of Nominal Dollars)

Line No.	MAT	Sub-program	Order	Substation	Project Description	Project Complete Year	No. of Circuit Breaker	No. of Bank/Reg	No. of MOAS	Total No. of Unit	Project Complexity	Unit Cost	Project Total	Assumptions
1	09D	INSTALL SUBSTATION SCADA	74001177	Stockton A Sub	STOCKTON A: INSTALL D-SCADA 10 UNITS	2018	10	0	0	10	high	$ 287,433	$ 2,874,326	
2	09D	INSTALL SUBSTATION SCADA	30913986	Midway Sub	MIDWAY: INSTALL D-SCADA 8 UNITS	2018	4	2	2	8	high	$ 338,826	$ 2,710,610	
3	09D	INSTALL SUBSTATION SCADA	30913996	Tracy Sub	TRACY: INSTALL D-SCADA 15 UNITS	2018	14	1	0	15	low	$ 146,480	$ 2,197,197	
4	09D	INSTALL SUBSTATION SCADA	31051911	Columbus Sub	COLUMBUS: INSTALL D-SCADA 8 UNITS	2018	6	2	0	8	medium	$ 226,099	$ 1,808,794	
5	09D	INSTALL SUBSTATION SCADA	74002232	Carbona Sub	CARBONA: INSTALL D-SCADA 8 UNITS	2018	5	2	1	8	high	$ 184,476	$ 1,475,805	
6	09D	INSTALL SUBSTATION SCADA	31051909	Cedar Creek Sub	CEDAR CREEK: INSTALL D-SCADA 3 UNITS, NEW BLDG & BATTERY	2018	1	2	0	3	high	$ 484,860	$ 1,454,581	
7	09D	INSTALL SUBSTATION SCADA	30854116	Grass Valley Sub	GRASS VALLEY: INSTALL D-SCADA 6 UNITS	2018	4	2	0	6	medium	$ 241,357	$ 1,448,141	
8	09D	INSTALL SUBSTATION SCADA	30914066	Harter Sub	HARTER: INSTALL D-SCADA 6 UNITS	2018	3	1	2	6	low	$ 189,436	$ 1,136,617	
9	09D	INSTALL SUBSTATION SCADA	31051977	Nord Sub	NORD: INSTALL D-SCADA 4 UNITS	2018	2	2	0	4	medium	$ 277,694	$ 1,110,774	
10	09D	INSTALL SUBSTATION SCADA	30913993	Wellfield Sub	WELLFIELD: INSTALL D-SCADA 5 UNITS	2018	3	2	0	5	medium	$ 218,636	$ 1,093,179	
11	09D	INSTALL SUBSTATION SCADA	30913989	Stockdale Sub	STOCKDALE: INSTALL D-SCADA 6 UNITS	2018	4	2	0	6	low	$ 165,848	$ 995,086	
12	09D	INSTALL SUBSTATION SCADA	30913829	Angiola Sub	ANGIOLA: INSTALL D-SCADA 5 UNITS	2018	3	1	1	5	low	$ 197,313	$ 986,565	
13	09D	INSTALL SUBSTATION SCADA	31051919	Ganso Sub	GANSO: INSTALL D-SCADA 4 UNITS	2018	2	1	1	4	medium	$ 239,086	$ 956,343	
14	09D	INSTALL SUBSTATION SCADA	74002830	Pinedale Sub	PINEDALE: INSTALL D- SCADA 11 UNITS	2018	9	2	0	11	low	$ 86,928	956,207	
15	09D	INSTALL SUBSTATION SCADA	31015421	Hammonds Sub	HAMMONDS: INSTALL D-SCADA 5 UNITS	2018	4	1	0	5	medium	$ 187,310	$ 936,548	
16	09D	INSTALL SUBSTATION SCADA	31051915	Elk Hills Sub	ELK HILLS: INSTALL D-SCADA 3 UNITS	2018	2	1	0	3	medium	$ 305,205	$ 915,615	
17	09D	INSTALL SUBSTATION SCADA	30914065	Diamond Springs Sub	DIAMOND SPRINGS: INSTALL D-SCADA 5 UNITS	2018	3	2	0	5	low	$ 179,781	$ 898,906	
18	09D	INSTALL SUBSTATION SCADA	31051964	Hamilton Branch Sub	HAMILTON BRANCH: INSTALL D-SCADA 3 UNITS	2018	1	2	0	3	low	$ 298,944	$ 896,832	
19	09D	INSTALL SUBSTATION SCADA	74003786	Dunlap Sub	DUNLAP: INSTALL D-SCADA 3 UNITS	2018	2	1	0	3	medium	$ 296,753	$ 890,260	
20	09D	INSTALL SUBSTATION SCADA	74004522	San Joaquin Ph #3 Sub	SAN JOAQUIN PH #3: INSTALL D-SCADA 4 UNITS	2018	3	1	0	4	medium	$ 217,849	$ 871,395	
21	09D	INSTALL SUBSTATION SCADA	74000973	Kerman Sub	KERMAN: INSTALL D-SCADA 3 UNITS	2018	2	1	0	3	medium	$ 290,460	$ 871,381	
22	09D	INSTALL SUBSTATION SCADA	30914022	Newman Sub	NEWMAN: INSTALL D-SCADA 4 UNITS	2018	2	1	1	4	medium	$ 216,500	$ 866,000	
23	09D	INSTALL SUBSTATION SCADA	74001915	Kettleman Hills Sub	KETTLEMAN HILLS: INSTALL D-SCADA 3 UNITS	2018	2	1	0	3	medium	$ 273,523	$ 820,569	
24	09D	INSTALL SUBSTATION SCADA	31051908	Capay Sub	CAPAY: INSTALL D-SCADA 4 UNITS	2018	2	2	0	4	medium	$ 203,134	$ 812,538	
25	09D	INSTALL SUBSTATION SCADA	74001914	Copus Sub	COPUS: INSTALL D-SCADA 3 UNITS	2018	1	2	0	3	low	$ 268,271	$ 804,814	
26	09D	INSTALL SUBSTATION SCADA	74002231	Shady Glen Sub	SHADY GLEN: INSTALL D-SCADA 4 UNITS	2018	2	2	0	4	medium	$ 200,440	$ 801,761	
27	09D	INSTALL SUBSTATION SCADA	31051974	Mettler Sub	METTLER: INSTALL D-SCADA 3 UNITS	2018	2	1	0	3	medium	$ 251,754	$ 755,261	
28	09D	INSTALL SUBSTATION SCADA	31052038	Waterloo Sub	WATERLOO: INSTALL D-SCADA 3 UNITS	2018	2	1	0	3	medium	$ 242,686	$ 728,057	
29	09D	INSTALL SUBSTATION SCADA	30914069	Weimar Sub	WEIMAR: INSTALL D-SCADA 4 UNITS	2018	2	2	0	4	low	$ 173,227	$ 692,908	
30	09D	INSTALL SUBSTATION SCADA	74002367	Charca Sub	CHARCA SUB: INSTALL D-SCADA1 UNIT	2018	1	0	0	1	high	$ 689,467	$ 689,467	
31	09D	INSTALL SUBSTATION SCADA	74002205	Hopland Sub	HOPLAND: INSTALL D-SCADA 3 UNITS	2018	1	2	0	3	medium	$ 226,838	$ 680,513	
32	09D	INSTALL SUBSTATION SCADA	30913997	Ripon Sub	RIPON: INSTALL D-SCADA on 4 UNITS	2018	3	1	0	4	high	$ 166,783	$ 667,130	
33	09D	INSTALL SUBSTATION SCADA	74001520	Logan Creek Sub	LOGAN CREEK: INSTALL D-SCADA on 3 UNITS	2018	2	1	0	3	medium	$ 221,953	$ 665,860	
34	09D	INSTALL SUBSTATION SCADA	31051910	Chowchilla Sub	CHOWCHILLA: INSTALL D-SCADA 5 UNITS	2018	3	1	1	5	low	$ 132,648	$ 663,242	
35	09D	INSTALL SUBSTATION SCADA	31113932	Laytonville Sub	LAYTONVILLE: INSTALL D-SCADA 2 UNITS	2018	0	2	0	2	medium	$ 321,547	$ 643,095	
36	09D	INSTALL SUBSTATION SCADA	30913838	Arvin Sub	ARVIN: INSTALL D-SCADA on 3 UNITS	2018	3	0	0	3	medium	$ 213,283	$ 639,849	
37	09D	INSTALL SUBSTATION SCADA	74001307	Ames Dist Sub	AMES DIST: INSTALL SCADA 3 UNITS	2018	3	0	0	3	medium	$ 201,774	$ 605,321	
38	09D	INSTALL SUBSTATION SCADA	74001996	El Peco Sub	EL PECO: INSTALL D-SCADA 4 UNITS	2018	1	2	1	4	low	$ 146,284	$ 585,135	
39	09D	INSTALL SUBSTATION SCADA	74001537	River Oaks Sub	RIVER OAKS: INSTALL D-SCADA 4 UNITS	2018	1	1	2	4	low	$ 131,157	$ 524,629	
40	09D	INSTALL SUBSTATION SCADA	31051969	Lammers Sub	LAMMERS: INSTALL D-SCADA 3 UNITS	2018	3	0	0	3	low	$ 173,186	$ 519,557	
41	09D	INSTALL SUBSTATION SCADA	74014643	Larkin Sub	LARKIN SUB: INSTALL 2 UNITS	2018	2	0	0	2	low	$ 216,018	$ 432,037	
42	09D	INSTALL SUBSTATION SCADA	74001567	Cantua Sub	CANTUA: INSTALL SCADA 1 UNIT	2018	0	1	0	1	medium	$ 414,936	$ 414,936	
43	09D	INSTALL SUBSTATION SCADA	30913828	Alpaugh Sub	ALPAUGH: INSTALL D-SCADA 1 UNIT	2018	1	0	0	1	medium	$ 307,559	$ 307,559	
44	09D	INSTALL SUBSTATION SCADA	74002059	Carnation Sub	CARNATION: INSTALL SCADA 1 UNIT	2018	0	1	0	1	low	$ 279,722	$ 279,722	
45	09D	INSTALL SUBSTATION SCADA	31052026	Renfro Sub	RENFRO: INSTALL D-SCADA for 2 UNITS	2018	1	0	1	2	low	$ 128,347	$ 256,695	
46	09D	INSTALL SUBSTATION SCADA	74002073	Stroud Sub	STROUD SUB: INSTALL D-SCADA 6 UNITS	2018	4	2	0	6	low	$ 32,987	$ 197,925	
47	09D	INSTALL SUBSTATION SCADA	30914073	Eureka Sta E Sub	EUREKA STA E: INSTALL D-SCADA 6 UNITS	2018	4	2	0	6	low	$ 30,360	$ 182,158	
48	09D	INSTALL SUBSTATION SCADA	30898730	Laytonville Sub	LAYTONVILLE: INSTALL D-SCADA 2 UNITS	2018	2	0	0	2	low	$ 70,514	$ 141,027	
49	09D	INSTALL SUBSTATION SCADA	74001502	Famoso Sub	FAMOSO: INSTALL D-SCADA 6 UNITS	2019	5	1	0	6	high	$ 373,444	$ 2,240,666	
50	09D	INSTALL SUBSTATION SCADA	74004682	Jacobs Corner Sub	JACOBS CORNER: INSTALL SCADA 4 UNITS & NEW BLDG	2019	2	2	0	4	high	$ 497,887	$ 1,991,546	
51	09D	INSTALL SUBSTATION SCADA	74004400	Woodward Sub	WOODWARD: INSTALL D-SCADA 10 UNITS	2019	6	1	3	10	medium	$ 154,406	$ 1,544,058	
52	09D	INSTALL SUBSTATION SCADA	74002234	El Capitan Sub	EL CAPITAN: INSTALL D-SCADA 7 UNITS	2019	4	3	0	7	medium	$ 210,072	$ 1,470,505	
53	09D	INSTALL SUBSTATION SCADA	74002055	Rio Bravo Sub	RIO BRAVO: INSTALL D-SCADA 7 UNITS	2019	5	2	0	7	medium	$ 209,626	$ 1,467,383	
54	09D	INSTALL SUBSTATION SCADA	74002359	Fruitvale Sub	FRUITVALE: INSTALL D-SCADA 8 UNITS	2019	1	5	2	8	medium	$ 161,913	$ 1,295,302	
55	09D	INSTALL SUBSTATION SCADA	74001475	Auberry Sub	AUBERRY: INSTALL D-SCADA 4 UNITS	2019	2	2	0	4	high	$ 302,855	$ 1,211,418	
56	09D	INSTALL SUBSTATION SCADA	74004976	Hardwick Sub	HARDWICK: INSTALL D-SCADA 3 UNITS	2019	2	1	0	3	high	$ 393,949	$ 1,181,846	
57	09D	INSTALL SUBSTATION SCADA	31052020	Petaluma C Sub	PETALUMA C: INSTALL D-SCADA 6 UNITS	2019	5	1	0	6	medium	$ 194,078	$ 1,164,465	
58	09D	INSTALL SUBSTATION SCADA	74002448	Biola Sub	BIOLA: INSTALL D-SCADA 6 UNITS	2019	4	2	0	6	medium	$ 193,894	$ 1,163,367	
59	09D	INSTALL SUBSTATION SCADA	74002233	Dos Palos Sub	DOS PALOS: INSTALL D-SCADA 3 UNITS, BLDG & BATTERY	2019	2	1	0	3	high	$ 359,966	$ 1,079,897	
60	09D	INSTALL SUBSTATION SCADA	74002069	Norco Sub	NORCO: INSTALL D-SCADA 3 UNITS	2019	2	1	0	3	high	$ 352,985	$ 1,058,956	
61	09D	INSTALL SUBSTATION SCADA	74001470	Dairyville Sub	DAIRYVILLE: INSTALL SCADA 3 UNITS, BATTERY & PT	2019	1	2	0	3	high	$ 348,262	$ 1,044,785	
62	09D	INSTALL SUBSTATION SCADA	74002288	Bullard Sub	BULLARD SUB D-SCADA 6 UNITS	2019	4	2	0	6	low	$ 164,119	$ 984,712	
63	09D	INSTALL SUBSTATION SCADA	74001525	Vacaville Sub	VACAVILLE: INSTALL SCADA 8 UNITS	2019	2	3	3	8	medium	$ 120,614	$ 964,913	
64	09D	INSTALL SUBSTATION SCADA	31020983	Paradise Sub	PARADISE: INSTALL D-SCADA 8 UNITS	2019	6	2	0	8	low	$ 118,445	$ 947,559	
65	09D	INSTALL SUBSTATION SCADA	74001180	Wilson Sub	WILSON: INSTALL D-SCADA 4 UNITS	2019	3	1	0	4	medium	$ 220,906	$ 883,622	
66	09D	INSTALL SUBSTATION SCADA	31100655	Loyola Sub	LOYOLA: D-SCADA 4 UNITS	2019	0	2	2	4	medium	$ 214,368	$ 857,474	
67	09D	INSTALL SUBSTATION SCADA	74002141	McMullin Sub	MCMULLIN: INSTALL D-SCADA 4 UNITS	2019	3	1	0	4	medium	$ 212,500	$ 849,999	
68	09D	INSTALL SUBSTATION SCADA	74002058	Antelope Sub	ANTELOPE: INSTALL D-SCADA 3 UNITS	2019	2	1	0	3	medium	$ 272,470	$ 817,410	
69	09D	INSTALL SUBSTATION SCADA	30914067	Higgins Sub	HIGGINS: INSTALL D-SCADA 4 UNITS	2019	2	2	0	4	low	$ 191,329	$ 765,315	
70	09D	INSTALL SUBSTATION SCADA	74002062	Devils Den Sub	DEVILS DEN: INSTALL D-SCADA 5 UNITS	2019	2	3	0	5	low	$ 150,623	$ 753,116	
71	09D	INSTALL SUBSTATION SCADA	31051905	Browns Valley Sub	BROWNS VALLEY: INSTALL D-SCADA 2 UNITS	2019	1	1	0	2	low	$ 370,769	$ 741,537	
72	09D	INSTALL SUBSTATION SCADA	74002236	Dunnigan Sub	DUNNIGAN: INSTALL D-SCADA 2 UNITS	2019	1	1	0	2	medium	$ 366,181	$ 732,361	
73	09D	INSTALL SUBSTATION SCADA	74004883	Plainfield Sub	PLAINFIELD: INSTALL SCADA 2 UNITS	2019	2	0	0	2	medium	$ 364,135	$ 728,269	
74	09D	INSTALL SUBSTATION SCADA	31051907	Camphora Sub	CAMPHORA: INSTALL D-SCADA 2 UNITS	2019	1	1	0	2	high	$ 360,933	$ 721,866	
75	09D	INSTALL SUBSTATION SCADA	74002202	Maricopa Sub	MARICOPA: INSTALL D-SCADA 2 UNITS	2019	2	0	0	2	medium	$ 342,318	$ 684,636	
76	09D	INSTALL SUBSTATION SCADA	74001245	Tulare Lake Sub	TULARE LAKE: INSTALL D-SCADA 2 UNITS	2019	1	1	0	2	medium	$ 276,772	$ 553,545	
77	09D	INSTALL SUBSTATION SCADA	74000661	Westley Sub	WESTLEY: INSTALLI D-SCADA 1 UNIT	2019	1	0	0	1	medium	$ 508,594	$ 508,594	
78	09D	INSTALL SUBSTATION SCADA	74001540	Wright Sub	WRIGHT: INSTALL D-SCADA 2 UNITS	2019	1	1	0	2	medium	$ 236,083	$ 472,165	
79	09D	INSTALL SUBSTATION SCADA	74010365	Atascadero Sub	ATASCADERO: INSTALL D-SCADA 2 UNITS	2019	2	0	0	2	medium	$ 230,653	$ 461,307	
80	09D	INSTALL SUBSTATION SCADA	74001955	Arbuckle Sub	ARBUCKLE: INSTALL D-SCADA 1 UNIT	2019	1	0	0	1	medium	$ 310,018	$ 310,018	
81	09D	INSTALL SUBSTATION SCADA	74002365	Industrial Acres Sub	INDUSTRIAL ACRES: INSTALLI D-SCADA 2 UNITS	2019	1	1	0	2	low	$ 115,314	$ 230,627	
82	09D	INSTALL SUBSTATION SCADA	74002371	San Fran E Sub	SAN FRAN E: INSTALL D-SCADA 3 UNITS	2019	3	0	0	3	low	$ 53,387	$ 160,160	
83	09D	INSTALL SUBSTATION SCADA	74002199	Hamilton A Sub	HAMILTON A: INSTALL D-SCADA 3 UNITS	2020	2	1	0	3	high	$ 660,914	$ 1,982,741	
84	09D	INSTALL SUBSTATION SCADA	74003966	Pike City Sub	PIKE CITY: INSTALL D-SCADA 4 UNITS & BATTERY	2020	2	2	0	4	high	$ 448,383	$ 1,793,532	
85	09D	INSTALL SUBSTATION SCADA	74002375	Mcarthur Sub	MCARTHUR: INSTALL D-SCADA 4 UNITS	2020	2	2	0	4	high	$ 406,098	$ 1,624,393	
86	09D	INSTALL SUBSTATION SCADA	74002186	Anderson Sub	ANDERSON: INSTALL D-SCADA 4 UNITS	2020	4	0	0	4	high	$ 397,506	$ 1,590,026	
87	09D	INSTALL SUBSTATION SCADA	74002179	Elk Creek Sub	ELK CREEK: INSTALL D-SCADA 2 UNITS	2020	1	1	0	2	high	$ 781,243	$ 1,562,486	
88	09D	INSTALL SUBSTATION SCADA	74002076	Twisselman Sub	TWISSELMAN: INSTALL D-SCADA 7 UNITS	2020	2	3	2	7	medium	$ 212,162	$ 1,485,136	
89	09D	INSTALL SUBSTATION SCADA	74002786	Bogue Sub	BOGUE: INSTALL D-SCADA 7 UNITS	2020	5	2	0	7	low	$ 200,586	$ 1,404,100	
90	09D	INSTALL SUBSTATION SCADA	74002061	CMC Sub	CMC: INSTALL D-SCADA 3 UNITS	2020	2	1	0	3	high	$ 436,286	$ 1,308,857	
91	09D	INSTALL SUBSTATION SCADA	74000964	Taft Sub	TAFT: INSTALL D-SCADA 4 UNITS	2020	4	0	0	4	high	$ 318,609	$ 1,274,436	
92	09D	INSTALL SUBSTATION SCADA	74002054	Corcoran Sub	CORCORAN: INSTALL D-SCADA 5 UNITS	2020	3	2	0	5	low	$ 253,460	$ 1,267,298	
93	09D	INSTALL SUBSTATION SCADA	30914028	Molino Sub	MOLINO: INSTALL D-SCADA 7 UNITS	2020	5	2	0	7	low	$ 174,018	$ 1,218,126	
94	09D	INSTALL SUBSTATION SCADA	31051906	Bucks Creek Ph Sub	BUCKS CREEK PH: INSTALL D-SCADA 5 UNITS	2020	3	2	0	5	low	$ 217,120	$ 1,085,599	
95	09D	INSTALL SUBSTATION SCADA	74001306	Colony Sub	COLONY: INSTALL D-SCADA 4 UNITS	2020	2	2	0	4	High	$ 235,179	$ 940,715	
96	09D	INSTALL SUBSTATION SCADA	74000986	Rincon Sub	RINCON: INSTALL D-SCADA 6 UNITS	2020	4	2	0	6	low	$ 153,789	$ 922,735	
97	09D	INSTALL SUBSTATION SCADA	31051966	Honcut Sub	HONCUT: INSTALL D-SCADA 3 UNITS	2020	2	1	0	3	low	$ 296,153	$ 888,459	
98	09D	INSTALL SUBSTATION SCADA	74002178	East Quincy Sub	EAST QUINCY: INSTALL D-SCADA 2 UNITS	2020	1	1	0	2	medium	$ 435,782	$ 871,564	
99	09D	INSTALL SUBSTATION SCADA	74000481	Newhall Sub	NEWHALL: INSTALL D-SCADA 4 UNITS	2020	2	2	0	4	medium	$ 214,427	$ 857,709	
100	09D	INSTALL SUBSTATION SCADA	74004830	Barry Sub	BARRY: INSTALL D-SCADA 5 UNITS	2020	3	2	0	5	medium	$ 170,104	$ 850,521	
101	09D	INSTALL SUBSTATION SCADA	74000987	Cloverdale Sub	CLOVERDALE: INSTALL D-SCADA 6 UNITS	2020	3	2	1	6	low	$ 140,243	$ 841,461	
102	09D	INSTALL SUBSTATION SCADA	31051960	Gerber Sub	GERBER: INSTALL D-SCADA 3 UNITS	2020	2	1	0	3	low	$ 261,951	$ 785,853	
103	09D	INSTALL SUBSTATION SCADA	74000682	Wilkins Slough Sub	WILKINS SLOUGH: INSTALL D-SCADA 4 UNITS	2020	3	1	0	4	low	$ 192,600	$ 770,401	
104	09D	INSTALL SUBSTATION SCADA	74002072	San Joaquin #2 Ph Sub	SAN JOAQUIN #2 PH: INSTALL D-SCADA 2 UNITS	2020	1	1	0	2	medium	$ 343,259	$ 686,519	
105	09D	INSTALL SUBSTATION SCADA	74001099	Santa Nella Sub	SANTA NELLA: INSTALL D-SCADA 4 UNITS	2020	2	2	0	4	low	$ 158,803	$ 635,213	
106	09D	INSTALL SUBSTATION SCADA	74000724	Williams Sub	WILLIAMS: INSTALL D-SCADA 3 UNITS	2020	1	2	0	3	low	$ 196,866	$ 590,598	
107	09D	INSTALL SUBSTATION SCADA	74002364	Hartley Sub	HARTLEY: INSTALL D-SCADA 3 UNITS	2020	1	2	0	3	low	$ 147,238	$ 441,713	
108	09D	INSTALL SUBSTATION SCADA	74002228	Tupman Sub	TUPMAN SUB: INSTALL D-SCADA 2 UNITS	2020	1	1	0	2	low	$ 204,179	$ 408,359	
109	09D	INSTALL SUBSTATION SCADA	74002424	Valley Home Sub	VALLEY HOME: INSTALL D-SCADA 1 UNIT	2020	1	0	0	1	medium	$ 313,990	$ 313,990	
110														
111														
112	09D	Total Installed Projects=	**109**	Total Installed Units=	**455**	Avg Unit Cost per Installed Unit=						**$ 227,052**		(1)
113	09D	Total High Complexity Projects=	**22**	Total High Complexity Units=	**90**	Avg Unit Cost per High Complexity Project=						**$ 360,890**		(2)
114	09D	Total Med Complexity Projects=	**48**	Total Med Complexity Units=	**184**	Avg Unit Cost per Med Complexity Project=						**$ 226,297**		(3)
115	09D	Total Low Complexity Projects=	**39**	Total Low Complexity Units=	**181**	Avg Unit Cost per Low Complexity Project=						**$ 161,272**		(4)

Forecast Assumptions and Details

(1) The Average Unit cost for Substation Installation is calculated by dividing the total project costs by the number of units. (i.e. Avg Unit Cost = Total Job Cost / Total Num of Units)
(2) For Substation Installations with High Complexity, the unit cost is calculated by identifying total project costs with high complexity and dividing that amount by the number of units.
(3) For Substation Installations with Medium Complexity, the unit cost is calculated by identifying total project costs with medium complexity and dividing that amount by the number of units.
(4) For Substation Installations with Low Complexity, the unit cost is calculated by identifying total project costs with low complexity and dividing that amount by the number of units.

Complexity for SCADA Installation MAT 09D

Complexity	Scope	Other Work	Average Unit Cost
High	Install New RTU Install 4 or more breaker relay cabinets Install IP based communication Install other SCADA related station upgrades Change operability protocol & point configuration Perform full SCADA operability test	New building Battery replacement Station service transformer Bus potential	~ $360K
Medium	Install New RTU Install less than 4 breaker relay cabinets Install IP based communication Change operability protocol & point configuration Perform partial SCADA operability test	Station service transformer Bus potential HVAC	~ $226K
Low	Re-use existing RTU Install one or none breaker relay cabinets Minimal change to IT communication No change to operability protocol & point configuration Perform partial SCADA operability test	minimal station upgrades	~ $161K

Workpaper Table 16-17
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
MAT 09E - Replace Substation Protective Relays Forecast Detail
(Thousands of Nominal Dollars)

Replace Projects Less than $3M

Line No.	Proposed Work	MAT	Number of Transformer Banks	Number of Relays (4) (5)	Work Complexity (6)	Year Relays Installed	Forecasted Operational Date	YR2021	YR2022	YR2023	YR2024	YR2025	YR2026	Assumptions	Reference
1	AG WISHON PHS BK2 Relay Replacement	09E	1	4	Medium	2025	12/10/2025	$0	$0	$0	$203	$474	$0	(1,2,3,5)	
2	Bahia Sub Bk2 Relay Replacement	09E	1	4	Medium	2022	8/16/2024	$0	$0	$287	$478	$0	$0	(1,2,3,5)	
3	Bayshore Sub BK1 and BK2 Relay Rep	09E	2	8	Medium	2023	6/13/2023	$0	$340	$486	$0	$0	$0	(1,2,3,5)	
4	BIG MEADOWS: Repl Relay on TB 1	09E	1	4	Medium	2021	5/10/2021	$561	$0	$0	$0	$0	$0	(3,4)	
5	BUTTE SUBS BK3 Relay Replacement	09E	1	4	Medium	2025	12/10/2025	$0	$0	$0	$300	$500	$0	(1,2,3,5)	
6	EL DORADO PHS BK1 and BK2 Relay Replacement	09E	2	8	Medium	2024	2/13/2024	$0	$600	$600	$400	$0	$0	(1,2,3,5)	
7	Livermore Sub BK1 and BK2 Relay Rep	09E	2	8	Medium	2023	1/30/2023	$273	$327	$151	$0	$0	$0	(1,2,3,5)	
8	Montague Bank Relay Project	09E	2	8	Medium	2020	11/30/2020	$536	$0	$0	$0	$0	$0	(3,4)	
9	Oakhurst: EM_Replace Fail D20C Bk2	09E	0	1	Low	2021	6/25/2021	$13	$0	$0	$0	$0	$0	(3,4)	
10	Oakland L Sub BK1 Relay Rep	09E	2	8	Medium	2023	12/10/2023	$0	$320	$400	$0	$0	$0	(1,2,3,5)	
11	Radum Sub - Replace CB1105 with IPAC	09E	0	2	Medium	2021	5/28/2021	$556	$0	$0	$0	$0	$0	(3,4)	
12	Radum: Replace Dist relays	09E	1	4	Medium	2021	5/28/2021	$548	$0	$0	$0	$0	$0	(3,4)	
13	San Ramon BK6 Relay Replacement	09E	1	4	Medium	2023	10/17/2023	$0	$299	$472	$0	$0	$0	(1,2,3,5)	
14	Stelling Sub: Replace relays on TB2 and TB3	09E	2	8	High	2023	4/27/2023	$23	$257	$512	$0	$0	$0	(1,2,3,5)	
15	DIXON LANDING: Repl XFMR1, XFRM 2 and XFMR 3 relays	09E	3	12	Medium	2025	12/10/2025	$0	$0	$0	$0	$450	$860	(1,2,3,5)	
16	GRANT: Repl XFMR1 and XFRM 2 relays	09E	2	8	Medium	2027	12/10/2027	$0	$0	$0	$0	$0	$300	(1,2,3,5)	
17	JARVIS: Repl XFMR1 and XFMR3 relays	09E	2	8	Medium	2027	12/10/2027	$0	$0	$0	$0	$0	$800	(1,2,3,5)	
18	VINEYARD: Repl XFMR1 and XFRM 2 relays	09E	2	8	Medium	2027	12/10/2027	$0	$0	$0	$0	$0	$300	(1,2,3,5)	
19	VASONA: Repl XFMR 1 Relays	09E	1	4	Medium	2025	12/10/2025	$0	$0	$0	$150	$250	$0	(1,2,3,5)	
20	LOS GATOS: Rep XFMR1 Relays	09E	1	4	Medium	2025	12/10/2025	$0	$0	$0	$150	$250	$0	(1,2,3,5)	
21	MABURY: Repl XFMR 1 Relays	09E	1	4	Medium	2025	12/10/2025	$0	$0	$0	$150	$250	$0	(1,2,3,5)	
22	REPL/INSTL PROTECTION RELAYS	09E						$93	$396	$0	$1,883	$926	$1,170	(6)	
23	**Total Replace Protective Relays-Other**	**09E**						**$2,603**	**$2,540**	**$2,908**	**$3,714**	**$3,100**	**$3,430**		WP 16-12, Line 3

Forecast Assumptions and Details:

(1) Project cost estimates were forecast from historical work along with engineering judgment based on complexity of work. Due to the varying systems, differences in substation design architecture, and station conditions across PG&E territory, the forecast cost of distribution transformer relay replacement is approximately $1,000,000 per terminal (With a Unit cost per relay of $317,000) with some variability based on complexity. Increases in the number of projects are being driven by the need to address antiquated electromechanical relays, and microprocessor relays that have reached the end of their useful lives. Most relays are replaced in conjunction with other work such as reliability or capacity projects. The projects listed above are stand-alone or independent.

(2) Other costs have been added to projects where there are potential clearance or construction issues that may come up during the on-site review of the projects, which typically result in additional costs.

(3) Projects with fewer equipment units in the project scopes are often with higher unit cost due to economies of scale and must follow the same process and project cycle.

(4) The individual projects may include other units in scope that increase estimated project cost. Other units may involve relay replacement, building expansion and installation, battery upgrade, ground grid upgrade, HVAC installation, etc.

(5) Due the complexity of individual projects, project costs may vary. As each project is planned, engineering reviews the project scope and develops a detailed project specific estimate.

(6) Place holder for future projects in the process of being identified.

Workpaper Table 16-18
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 16, Distribution System Automation and Protection
MAT 09E - Replace Substation Protective Relays Unit Cost Forecast Basis
(Nominal Dollars)

Line No.	Sub-program	Order	Project Description	No. of Units (Relays Replaced)	No. of Banks	Project Complexity	Unit Cost (Per Terminal)	Unit Cost (Relays Replaced)	Project Total
1	REPLACE TRANSFORMER BANK PROTECTION	74010740	San Miguel Bank 1 Relay Project	2	1	Low	$ 514,600	$ 257,300	$ 514,600
2	REPLACE TRANSFORMER BANK PROTECTION	74002149	LOCKHEED #2 BANK #2 PROTECTION	4	1	High	$ 1,348,180	$ 337,045	$ 1,348,180
3	REPLACE TRANSFORMER BANK PROTECTION	74001954	NV_HAMMER REPLACE RELAYS ON TB 3	2	1	High	$ 1,096,190	$ 548,095	$ 1,096,190
4	REPLACE TRANSFORMER BANK PROTECTION	74002819	KNIGHTS LANDING: REPLACE TB1 RELAY	4	1	Low	$ 647,670	$ 161,918	$ 647,670
5	REPLACE TRANSFORMER BANK PROTECTION	74002788	BRITTON: REPLACE DIST RELAYS	4	2	Low	$ 598,160	$ 299,080	$ 1,196,321
6	REPLACE TRANSFORMER BANK PROTECTION	74002071	ROSEDALE BANK PROTECTION UPGRADE	3	1	High	$ 1,221,169	$ 407,056	$ 1,221,169
	Total Install Projects=	**6**	Total Install Units=	**19**				Avg Unit Cost per Unit =	**$ 317,059**
	Total High Complexity Projects=	**3**	Total High Complexity Units=	**9**				Avg Unit Cost per Terminal High Complexity Project=	**$ 1,221,846**
	Total Med Complexity Projects=	**0**	Total Med Complexity Units=	**0**				Avg Unit Cost per Terminal Med Complexity Project=	**None**
	Total Low Complexity Projects=	**3**	Total Low Complexity Units=	**10**				Avg Unit Cost per Terminal Low Complexity Project=	**$ 579,340**
7	REPLACE OTHER BANK PROTECTION	74003260	Oakland C ckt 3401 Relay Replacement	6	NA	High	NA	$ 224,697	$ 1,348,180
8	REPLACE OTHER BANK PROTECTION	74028061	LARKIN: INS 5 TY AUX TRANS BKS	0	NA	High	NA	NA	$ 1,221,169
9	Total Replacement Projects =	**2**						Calculated Average Unit Cost per Unit=	**$ 428,225**

Forecast Assumptions and Details:

Project cost estimates were forecast from historical work along with engineering judgment based on complexity of work. Due to the varying systems, differences in substation design architecture, and station conditions across PG&E territory, the forecast cost of distribution transformer relay replacement is approximately $1,000,000 per terminal (With a Unit cost per relay of $317,000) with some variability based on complexity. Increases in the number of projects are being driven by the need to address antiquated electromechanical relays, and microprocessor relays that have reached the end of their useful lives. Most relays are replaced in conjunction with other work such as reliability or capacity projects. The projects listed above are stand-alone or independent.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 16, DISTRIBUTION SYSTEM AUTOMATION AND PROTECTION
PROJECT SUMMARY – INSTALL SUBSTATION SCADA

Project Title: Install Substation SCADA
Major Work Categories: 09D
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This subprogram installs distribution Supervisory Control and Data Acquisition (SCADA) in various substations including Remote Terminal Unit (RTU), SCADA peripherals, feeder cabinets and ancillary equipment in support of SCADA.

The subprogram is necessary to improve the electric distribution system visibility and control and help improve the distribution grid safety, reliability, and system protection. Installing distribution SCADA provides PG&E Operations personnel with visibility into distribution system (21 KV and below). This project supports PG&E's System Automation strategy and the company's goal to achieve an automated and integrated distribution grid.

Project: Oakland L Substation Install D-SCADA (PO# 5768863)
This project is to install distribution SCADA to various feeder, bank, capacitor bank and bus tie breakers at the Oakland L Substation. This project will provide visibility and control to Distribution Operation personnel and improve the distribution grid's reliability and safety.

Install Distribution SCADA Subprogram (PO# 5504358)
Some remaining projects are being scoped and require field verification. Once validation is complete, the project implementation schedule will be prioritized based on the budget.

Justification

Distribution Automation strategies aim to enhance operational efficiency, safety, and system protection. Automating the distribution grid will support value-added response capabilities and applications.
In order to improve the safety and reliability of the electric distribution system, PG&E plans to provide SCADA operability to all substations. The scope of work will include adding full SCADA monitoring and control to all distribution breakers, motor operated air switches (MOAS), existing power transformers, and regulators. The level of automation will be determined by the project team and approved by the System Automation department.

Distribution SCADA Installation projects provide crucial support to control room, substation protective relays, instrument transformers, and station batteries by quickly detecting and isolating outages to restore power to customers.

Distribution SCADA also helps control the Failure of Electric Distribution Overhead Assets risk by providing remote controlled functionality that can be used to detect load characteristics associated with wire down events and rapidly open substation circuit breakers to isolate wire down locations.

Cost

For planning purposes, PG&E is using an estimated base unit cost of $227,052, based on a 3-year (2018-2020) average, and adds additional associated costs to certain projects for other necessary equipment upgrades such as upgrading existing antiquated infrastructure i.e. building expansion, replacement of battery

and station service transformer due to added AC/DC load. Detailed engineering project costs are developed prior to project execution.

See Workpaper Table 16-14 "Install Substation SCADA Forecast Detail", for more details.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded				Forecast							
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL												
MWC 09, PO 5768863	169	700	789	786	243	-	-	-	3,216	2,900	8,803	WP 16-14, line 1 (Note 1)
MWC 09, PO 5504358					1,422	2,045	-	-	-	-	3,467	WP 16-14, line 2
Capital Total	**169**	**700**	**789**	**786**	**1,665**	**2,045**	**-**	**-**	**3,216**	**2,900**	**12,270**	
TOTAL PROJECT COST	**169**	**700**	**789**	**786**	**1,665**	**2,045**	**-**	**-**	**3,216**	**2,900**	**12,270**	

Note 1: The total project cost of $8,799 million shown here is different from Workpaper WP 16-14 line 1 because it includes costs incurred in 2017-2020.

Benefits

The primary purpose of this project is to provide grid safety, reliability, and system protection by installing new substation SCADA. These benefits are not readily quantifiable.

Non-Cost Benefits

The installation of substation SCADA enables the monitoring and remote control of substation equipment in real-time for both normal and emergency situations. This ability facilitates the diagnosis of equipment issues and troubleshooting of electrical outages without having to dispatch field personnel.

Alternatives Considered

1 – Status Quo: Stop execution of subprogram

- Discontinuing future installations of distribution SCADA will limit PG&E's progress on electric outage management and restoration.
- Operators will not benefit from full SCADA functionality which helps them to restore power in a faster and safer manner. **Not Recommended**

2 – Extend SCADA installations over a longer time period

- Prolong the execution over a longer time period will delay the benefit for remote operability of equipment, increase various operational risks mentioned above, resulting in a less safe and reliable electric system. **Recommended**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 16, DISTRIBUTION SYSTEM AUTOMATION AND PROTECTION
PROJECT SUMMARY – REPLACE SUBSTATION SCADA

Project Title: Replace Substation SCADA
Major Work Categories: 09B
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

This subprogram replaces Distribution Supervisory Control and Data Acquisition (SCADA) equipment in various substations including Remote Terminal Units (RTU), SCADA peripherals, modernizing the aging feeder cabinets and ancillary equipment in support of SCADA.

Project: Edenvale Substation Replace RTU (PO# 5765181)
This project's scope is to replace existing distribution RTUs with a new RTU, connect all new and existing SCADA points to the new RTU, and disconnect and remove all existing obsolete SCADA equipment. This project will also replace legacy breaker cabinets with the standard protective and SCADA functionalities which will allow integration with modernized distribution applications.

Project: Trimble Substation Replace RTU (PO# 5781439)
This project's scope is to replace existing distribution RTUs with a new RTU, connect all new and existing SCADA points to the new RTU, and disconnect and remove all existing obsolete SCADA equipment. This project will also replace legacy breaker cabinets with the standard protective and SCADA functionalities which will allow integration with modernized distribution applications.

Not Yet Identified Future SCADA Replacement Projects (PO# 5504359)
More projects will be identified after current projects are validated. The project implementation schedule will be prioritized based on the budget. These projects will be necessary to maintain safe and reliable power to electric customers served from substations.

Justification

In order to maintain the safety and reliability of the electric distribution system, PG&E plans to replace obsolete distribution SCADA at various substations. The scope of work includes replacing legacy RTUs, SCADA peripheral boards, and aging breaker cabinets. The objective is to maintain optimal SCADA capabilities.

Distribution Automation strategies aim to enhance operational efficiency, safety, and system protection. Proactive replacement of older SCADA equipment at the end of its life cycle will allow the system to maintain reliability and operability. As part of the replacement program, PG&E will replace legacy breaker cabinets with the standard protective and SCADA functionalities which will allow integration with modernized distribution applications like Distribution Management System (DMS), Outage Management System (OMS), and Fault Location Isolation & Service Restoration (FLISR), and will facilitate Public Safety Power Shutoff (PSPS).

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 16, DISTRIBUTION SYSTEM AUTOMATION AND PROTECTION
PROJECT SUMMARY – REPLACE SUBSTATION SCADA

Cost

For planning purposes, PG&E is using an estimated basic unit cost of $211,000, based on a 3-year (2018-2020) average, and adds additional associated costs to certain projects for other necessary equipment upgrades such as replacing batteries and/or station service transformers due to added AC/DC load. Detailed engineering project costs are developed prior to project execution.

See Workpaper Table 16-13 "Replace Substation SCADA Forecast Detail", for more details.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded				Forecast							
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL												
MWC 09, PO 5765181	-	-	43	59	6	905	2,676	-	-	-	3,689	WP 16-13, line 1
MWC 09, PO 5781439	-	-	-	-	-	145	1,765	2,310			4,220	WP 16-13, line 2
MWC 09, PO 5504359					-	-	911	1,946	1,984	8,271	13,112	WP 16-13, line 3
Capital Total	**-**	**-**	**43**	**59**	**6**	**1,050**	**5,352**	**4,256**	**1,984**	**8,271**	**21,021**	WP 16-13, line 4
TOTAL PROJECT COST	**-**	**-**	**43**	**59**	**6**	**1,050**	**5,352**	**4,256**	**1,984**	**8,271**	**21,021**	

Benefits

The primary purpose of this project is to provide grid safety, reliability, and system protection by replacing SCADA at the end of its service life. These benefits are not readily quantifiable.

Alternatives Considered

1. Defer replacement/run to failure – Assets would not be replaced until critical failures occur, beyond the end of the useful life of the equipment. Although this may reduce the immediate need for replacements, SCADA failure can impact safety/reliability (SAIDI/SAIFI), Distribution Operations (inability to receive information or remotely control equipment via SCADA), and customers (who may experience unplanned outages). Costs required to remediate failures and outages could also increase. **Not Recommended**

2. Planned Replacement – Equipment will be replaced as planned prior to the end of the useful life, or when repairs cannot be made. This strategy maintains safe and reliable service. **Recommended**

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE

Testimony _____ Workpapers ____X_____ SOQ _____

Exhibit Number: ____PG&E-4_____ Chapter Number: ____16___

Chapter Title: Distribution System Automation and Protection

Witness Name: _David Carroll_

Page No.	Line No.	Item	As Filed	As Corrected
Errata as of November 5, 2021				
16-10	Line 25-26 of Table 16-10	Updated 2020 recorded costs references to MAT 09E & MAT 09F	MAT 09E: $2,925 MAT 09F: $890	MAT 09E: $1,306 MAT 09F: $2,509
16-11	Line 4-5 of Table 16-11	Updated 2020 recorded costs references to MAT 09E & MAT 09F	MAT 09E: -$2,415 MAT 09F: -$949	MAT 09E: -$819 MAT 09F: -$2,545
16-11	Line 11-12 of Table 16-11	Updated 2021 forecast costs references to MAT 09E & MAT 09F	MAT 09E: -$64 MAT 09F: -$473	MAT 09E: -$41 MAT 09F: -$496
16-12	Line 3 of Table 16-12	Updated 2020 recorded costs references to MAT 09E & MAT 09F	MAT 09E: $5,018 MAT 09F: $6,695	MAT 09E: $3,399 MAT 09F: $8,314
16-12	Line 3 of Table 16-12	Updated 2021 forecast costs references to MAT 09E & MAT 09F	MAT 09E: $2,603 MAT 09F: $5,747	MAT 09E: $2,580 MAT 09F: $5,769

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY, ENGINEERING AND PLANNING

TABLE OF CONTENTS

Subject	Page No.
Expense Workpapers	
Workpaper Table 17-1: Expenses by Major Work Category - Nominal Dollars	WP 17-1
Workpaper Table 17-2: Expenses by Major Work Category - Base Year Dollars	WP 17-2
Workpaper Table 17-3: Major Work Category FZ - Recorded Walk	WP 17-3
Workpaper Table 17-4: Major Work Category FZ - Forecast Walk	WP 17-4
Workpaper Table 17-5: Expense MWC FZ Summary	WP 17-5
Capital Workpapers	
Workpaper Table 17-6: Capital Expenditures by Major Work Category	WP 17-6
Workpaper Table 17-7: Forecast Capital Expenditures Summary	WP 17-7
Workpaper Table 17-8: Recorded CWIP and Forecast Capital Expenditures Details - Planning Orders Over $3 Million	WP 17-8
Workpaper Table 17-9: Recorded and Forecast Capital Expenditures Details - Other Work	WP 17-9
Workpaper Table 17-10: Capital Walk - MWC 06 Recorded	WP 17-10
Workpaper Table 17-11: Capital Walk - MWC 06 Forecast	WP 17-11
Workpaper Table 17-12: Capital Walk - MWC 46 Recorded	WP 17-12
Workpaper Table 17-13: Capital Walk - MWC 46 Forecast	WP 17-13
Workpaper Table 17-14: Capital Summary by Program Element	WP 17-14
Workpaper Table 17-15: MWC 06 Forecast Calculation	WP 17-15
Workpaper Table 17-16: MWC 46 Forecast Calculation	WP 17-16
Workpaper Table 17-17: Forecast Capital Expenditures - Other Programs	WP 17-17
Workpaper Table 17-18: Forecast Capital Expenditures - Project Details	WP 17-19
Workpaper Table 17-19: Tracking of MWC 46 Projects Identified in 2017 GRC Workpapers	WP 17-23

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY, ENGINEERING AND PLANNING

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Capital Workpapers (Continued)	
Workpaper Table 17-20: Capacitor Bank SCADA Forecast Detail (MAT 06K)	WP 17-25
Workpaper Table 17-21: Co-Gen Regulator SCADA Forecast Detail (MAT 06P)	WP 17-26
Workpaper Table 17-22: Forecast Capital Expenditures by DPA	WP 17-27
Workpaper Table 17-23: Overloaded Distribution Line Transformer Banks (MAT 06B)	WP 17-28
Workpaper Table 17-24: Mainline Loop Project Forecast Details (MAT 06I)	WP 17-29
Workpaper Table 17-25: Reduce Customer Count on Feeder Project Forecast Detail (MAT 06I)	WP 17-30
Workpaper Table 17-26: Reduce Highly Loaded Feeder Project Forecast Detail (MAT 06I)	WP 17-31
Workpaper Table 17-27: Unit Costs by Asset Type	WP 17-32
Project Summary - Enable Distributed Generation (DG) Dist Line (MAT 06P)	WP 17-33
Project Summary - Power Factor Management (MAT 06K)	WP 17-36
Project Summary - Operational Capacity Projects - Reconductor Back-Tie (MAT 06I)	WP 17-40
Project Summary - Circuit Reinforcement Project Services (PS) Managed-Convert local Systems (MAT 06E)	WP 17-43
Project Summary - Normal Capacity Deficiencies (MAT 46A and 06A)	WP 17-47
Project Summary - Emergency and Operational Capacity - Emergency Banks (MAT 46F and 06A)	WP 17-53
Project Summary - Emergency and Operational Capacity - Reduce Customer Count (MAT 46F and 06A)	WP 17-57
Project Summary - Emergency and Operational Capacity - Reduce High Loading (MAT 46F and 06A)	WP 17-61
Project Summary - New Business-Related Capacity (MAT 46H and 06H)	WP 17-65

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY, ENGINEERING AND PLANNING

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Project Summary - New Business Related Capacity - Emergent Work (MAT 46H)	WP 17-73
Project Summary – Operational Capacity - Install New Feeder (MAT 46F, and 06A)	WP 17-77

Workpaper Table 17-1
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 17
Electric Distribution Capacity, Engineering and Planning
Expenses by Major Work Category
(Thousands of Nominal Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference (A)
1	FZ	E Dist Planning & Ops Engineer	11,715	12,118	11,332	10,651	15,158	15,447	16,155	19,943	WP 17-3, WP 17-4
2	**Total**		**11,715**	**12,118**	**11,332**	**10,651**	**15,158**	**15,447**	**16,155**	**19,943**	

Workpaper Table 17-2
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 17
Electric Distribution Capacity, Engineering and Planning
Expenses by Major Work Category
(Thousands of Base Year Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast
1	FZ	E Dist Planning & Ops Engineer	13,259	13,294	12,045	10,972	15,158	15,051	15,227	18,181
2	**Total**		**13,259**	**13,294**	**12,045**	**10,972**	**15,158**	**15,051**	**15,227**	**18,181**

Workpaper Table 17-3
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering and Planning
Major Work Category FZ - Recorded Walk
MWC FZ, Electric Engineering and Planning
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$ 11,715**			
2		General Engineering (MAT FZA)	110		Minor variation in recorded amount for 2017	WP 17-5, Line 1
3		Voltage Complaint Investigation (MAT FZB)	(102)		Minor variation in recorded amount for 2017	WP 17-5, Line 2
4		Transformer Reports Management (MAT FZC)	(20)		Minor variation in recorded amount for 2017	WP 17-5, Line 3
5		Field Work Plans (MAT FZD)	346		Minor variation in recorded amount for 2017	WP 17-5, Line 4
6		Troublemen Field Work (MAT FZE)	67		Minor variation in recorded amount for 2017	WP 17-5, Line 5
7		**Net Change**	**402**			
8	**2017**	**Recorded Adjusted**	**12,118**			
9		General Engineering (MAT FZA)	(614)		Minor variation in recorded amount for 2018	WP 17-5, Line 1
10		Voltage Complaint Investigation (MAT FZB)	(74)		Minor variation in recorded amount for 2018	WP 17-5, Line 2
11		Transformer Reports Management (MAT FZC)	2		Minor variation in recorded amount for 2018	WP 17-5, Line 3
12		Field Work Plans (MAT FZD)	(116)		Minor variation in recorded amount for 2018	WP 17-5, Line 4
13		Troublemen Field Work (MAT FZE)	17		Minor variation in recorded amount for 2018	WP 17-5, Line 5
14		**Net Change**	**(785)**			
15	**2018**	**Recorded Adjusted**	**11,332**			
16		General Engineering (MAT FZA)	(481)		Minor variation in recorded amount for 2018	WP 17-5, Line 1
17		Voltage Complaint Investigation (MAT FZB)	(112)		Minor variation in recorded amount for 2019	WP 17-5, Line 2
18		Transformer Reports Management (MAT FZC)	(2)		Minor variation in recorded amount for 2019	WP 17-5, Line 3
19		Field Work Plans (MAT FZD)	(125)		Minor variation in recorded amount for 2019	WP 17-5, Line 4
20		Troublemen Field Work (MAT FZE)	39		Minor variation in recorded amount for 2019	WP 17-5, Line 5
21		**Net Change**	**(681)**			
22	**2019**	**Recorded Adjusted**	**10,651**			
23		General Engineering (MAT FZA)	3,211		Increase primarily due to beginning the hiring of addional Distribution Engineering headcount to facilitate local presence at the regional level and support increased workload	WP 17-5, Line 1
24		Voltage Complaint Investigation (MAT FZB)	796		Increase is the result of additional customer complaints due to new work-at-home requirements due to COVID-19	WP 17-5, Line 2
25		Transformer Reports Management (MAT FZC)	28		Minor variation in recorded amount for 2020	WP 17-5, Line 3
26		Field Work Plans (MAT FZD)	151		Minor variation in recorded amount for 2020	WP 17-5, Line 4
27		Troublemen Field Work (MAT FZE)	321		Minor variation in recorded amount for 2020	WP 17-5, Line 5
28		**Net Change**	**4,507**			
29	**2020**	**Recorded Adjusted**	**15,158**			

Workpaper Table 17-4
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering and Planning
Major Work Category FZ - Forecast Walk
MWC FZ, Electric Engineering and Planning
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$ 15,158**			
2		General Engineering (MAT FZA)	2,697		Increase due to continued hiring of additional Distribution Engineering headcount to facilitate local presence at the regional level and support increased workload	WP 17-5, Line 1
3		Voltage Complaint Investigation (MAT FZB)	(520)		Decrease due to forecast being based on an average of the last 5 recorded years (2017-2020)	WP 17-5, Line 2
4		Transformer Reports Management (MAT FZC)	89		Minor variation in forecast amount for 2021	WP 17-5, Line 3
5		Field Work Plans (MAT FZD)	330		Minor variation in forecast amount for 2021	WP 17-5, Line 4
6		Troublemen Field Work (MAT FZE)	(228)		Minor variation in forecast amount for 2021	WP 17-5, Line 5
7		Forecast Adjustment (MAT FZ#)	(2,078)		Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.	WP 17-5, Line 6
8		**Net Change**	**289**			
9	**2021**	**Forecast**	**15,447**			
10		General Engineering (MAT FZA)	(207)		Minor variation in forecast amount for 2022	WP 17-5, Line 1
11		Voltage Complaint Investigation (MAT FZB)	1		Minor variation in forecast amount for 2022	WP 17-5, Line 2
12		Transformer Reports Management (MAT FZC)	0		Minor variation in forecast amount for 2022	WP 17-5, Line 3
13		Field Work Plans (MAT FZD)	1		Minor variation in forecast amount for 2022	WP 17-5, Line 4
14		Troublemen Field Work (MAT FZE)	2		Minor variation in forecast amount for 2022	WP 17-5, Line 5
15		Forecast Adjustment (MAT FZ#)	911		Minor variation in forecast amount for 2022	WP 17-5, Line 6
16		**Net Change**	**708**			
17	**2022**	**Forecast**	**16,155**			
18		General Engineering (MAT FZA)	2,330		Continued cost increase to support the implementation of the new Regionalization concept	WP 17-5, Line 1
19		Voltage Complaint Investigation (MAT FZB)	37		Minor variation in forecast amount for 2023	WP 17-5, Line 2
20		Transformer Reports Management (MAT FZC)	117		Minor variation in forecast amount for 2023	WP 17-5, Line 3
21		Field Work Plans (MAT FZD)	49		Minor variation in forecast amount for 2023	WP 17-5, Line 4
22		Troublemen Field Work (MAT FZE)	88		Minor variation in forecast amount for 2023	WP 17-5, Line 5
23		Forecast Adjustment (MAT FZ#)	1,168		No forecast adjustment in 2023	WP 17-5, Line 6
24		**Net Change**	**3,788**			
25	**2023**	**Forecast**	**19,943**			

Workpaper Table 17-5
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering and Planning
Expense MWC FZ Summary
(Thousands of Dollars)

Line No.		MAT Code	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	Assumptions	Reference
1	**General Engineering**	FZA	$ 9,650	$ 9,760	$ 9,146	$ 8,665	$ 11,877	$ 14,574	$ 14,367	$ 16,696	(1)	
2	**Voltage Complaint Investigation**	FZB	$ 619	$ 517	$ 444	$ 331	$ 1,127	$ 607	$ 608	$ 645	(2)	
3	**Transformer Reports Management**	FZC	$ 20	$ -	$ 2	$ -	$ 28	$ 117	$ 117	$ 234	(3)	
4	**Field Work Plans**	FZD	$ 213	$ 559	$ 443	$ 317	$ 468	$ 798	$ 799	$ 848	(4)	
5	**Troublemen Field Work**	FZE	$ 1,214	$ 1,282	$ 1,298	$ 1,337	$ 1,658	$ 1,430	$ 1,432	$ 1,519	(5)	
6	**Forecasting Adjustment**	FZ#						$ (2,078)	$ (1,168)		(6)	Chapter 2 Section D
7	**MWC FZ - Total**		**$ 11,715**	**$ 12,118**	**$ 11,332**	**$ 10,651**	**$ 15,158**	**$ 15,447**	**$ 16,155**	**$ 19,943**	(7)	Sum of Line 1 through Line 6

Forecast Assumptions and Details:

(1) FZA are costs related to engineering and planning of the electric distribution system. The 2023 forecast reflects increased Distribution Engineering headcount to facilitate local presence at the regional level and support increased workload.
(2) FZB are costs related to voltage complaint investigations. The 2023 forecast is based on an average of the last 5 recorded years (2017-2020) because it is the best representation of forecast work activities and related costs rather than 2020 alone.
(3) FZC are costs related to potentially overloaded or idle transformer investigations. The 2023 forecast represents an increase of this work beginning in 2021 and supports the forecast transfomer replacement work described in Capital MAT 06B.
(4) FZD are costs related to field work plans. The 2023 forecast is based on last recorded year (2020) plus an increase of phase balancing work activities and related costs beginning in 2021.
(5) FZE are costs related to Troublemen field work. The 2023 forecast is based on last two recorded years (2019-2020) because it is the best representation of current and forecast work activities and related costs.
(6) Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.
(7) The total MWC FZ forecast includes escalation and primarily reflects an increase in distribution engineering resources to account for the Regionalization concept.

Workpaper Table 17-6
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 17
Electric Distribution Capacity, Engineering and Planning
Capital Expenditures by Major Work Category
(Thousands of Nominal Dollars)

			Capital Expenditures											
No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	6	E Dist Line Capacity	91,361	55,960	67,746	73,444	107,255	233,720	150,476	137,655	163,173	176,314	187,492	WP 17-10, WP 17-11
2	46	E Dist Subst Capacity	42,862	17,354	12,376	17,900	36,270	78,880	65,191	58,082	68,061	71,985	74,728	WP 17-12, WP 17-13
3		**Grand Total**	**134,223**	**73,314**	**80,122**	**91,344**	**143,525**	**312,600**	**215,667**	**195,738**	**231,234**	**248,299**	**262,219**	

Workpaper Table 17-7
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 17
Electric Distribution Capacity, Engineering and Planning
Forecast Capital Expenditures Summary
(Thousands of Nominal Dollars)

		Capital Expenditures							
Line No.	Description	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	Projects > $3 Million*	57,232	312,241	212,675	195,738	231,234	248,299	262,219	WP 17-8
2	Other Work	18,021	359	2,991	-	-	-	-	WP 17-9
3	**Total**	**75,252**	**312,600**	**215,667**	**195,738**	**231,234**	**248,299**	**262,219**	

4 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 17-8
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 17
Electric Distribution Capacity, Engineering and Planning
Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million*
(Thousands of Nominal Dollars)

					CWIP	Capital Expenditures							
Line No.	Planning Order	Description	MWC	Operative Date	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Subtotal	Reference
	MWC - 06	**E Dist Line Capacity**											
1	5502945	New Business Capacity Prj-SF	6		418	6,050	-	-	-	-	-	6,468	
2	5502961	New Business Capacity Prj-EB	6		-	3,000	-	-	-	-	-	3,000	
3	5502985	New Business Capacity Prj-CC	6		-	3,927	-	-	-	-	-	3,927	
4	5503001	New Business Capacity Prj-SJ	6		1,777	2,920	-	-	-	-	-	4,697	
5	5503017	New Business Capacity Prj-FR PM Managed	6		96	6,251	123	-	-	-	-	6,470	
6	5503027	Circuits Reinforce-PS Managed-YO	6		187	4,129	-	-	-	-	-	4,316	
7	5503035	Circuits Reinforce-PS Managed-ST	6		2	3,283	-	-	-	-	-	3,285	
8	5503043	Circuits Reinforce-PS Managed-SI	6		85	2,314	951	-	-	-	-	3,350	
9	5503049	New Business Capacity Prj-SI	6		1	3,840	1,349	-	-	-	-	5,190	
10	5503065	New Business Capacity Prj-SA	6		15	7,581	588	-	-	-	-	8,185	
11	5503067	Circuits Reinforce-PS Managed-SO	6		4	4,262	1,966	-	-	-	-	6,232	
12	5508966	New Business Capacity Prj-HB	6		120	7,998	1,296	-	-	-	-	9,414	
13	5530139	Install East Grand 1116 Feeder	6		-	4,314	-	-	-	-	-	4,314	
14	5537636	DISTRIBUTION LINE WORK - BELLEVUE BANK1	6		-	5,532	-	-	-	-	-	5,532	
15	5543424	SYSPLAN ED 06	6		-	11,124	7,852	7,131	8,460	9,181	9,780	53,529	
16	5544383	SYSPLAN ED 06B DOVHD-C09A	6		-	5,018	4,745	8,172	10,722	11,321	11,730	51,708	
17	5544384	SYSPLAN ED 06D	6		-	654	3,952	4,481	5,316	5,770	6,147	26,320	
18	5544385	SYSPLAN ED 06G	6		-	2,902	3,038	2,751	3,254	3,522	3,741	19,208	
19	5544386	SYSPLAN ED 06I	6		-	5,800	5,293	6,725	7,978	8,659	9,223	43,678	
20	5544387	SYSPLAN ED 06K	6		-	-	618	1,119	1,326	1,440	1,535	6,038	
21	5544388	SYSPLAN ED 06P	6		-	-	742	1,344	1,594	1,731	1,842	7,253	
22	5772883	Oro Loma 1118 - Reconductor for Horizon	6	Aug-2021	394	4,381	-	-	-	-	-	4,775	
23	5772954	Inst Rossmoor 1109 Fdr_Moraga Bk 5 Emg S	6	Jun-2021	4,379	5,121	-	-	-	-	-	9,500	
24	5777378	Moraga 1102_Sobrante 1101 Fdr Reinforce	6	Apr-2021	2,752	818	-	-	-	-	-	3,570	
25	5777583	Install new Highway 12 KV breaker & fee	6	Mar-2021	3,221	1,528	-	-	-	-	-	4,749	
26	5779292	Weber install new feeder	6	Jun-2021	2,014	3,262	-	-	-	-	-	5,276	
27	5779536	Calflax, Install new feeder dist line	6	May-2022	43	1,351	2,522	-	-	-	-	3,916	
28	5780358	Vasona Sub Install Feeder-Dis Wrk, Insta	6	Jun-2021	353	3,182	-	-	-	-	-	3,534	
29	5780360	Install Brentwood 2104 Fdr	6	Mar-2022	114	51	5,923	-	-	-	-	6,087	
30	5780540	Install Mission X 1127 Feeder	6	Oct-2021	4,666	1,047	-	-	-	-	-	5,713	
31	5782238	Install Jarvis 1107 Feeder	6	Oct-2021	175	5,021	-	-	-	-	-	5,196	
32	5783250	Install El Nido 1106 Feeder	6	Mar-2022	369	7,085	830	-	-	-	-	8,283	
33	5784802	ALMADEN 1112 INSTALL NEW FEEDER	6	May-2021	66	3	3,770	-	-	-	-	3,839	
34	5784958	Install Mission X 1128 Feeder	6	Feb-2021	1,849	1,736	-	-	-	-	-	3,585	
35	5785564	POTRERO: INSTALL NEW FEEDER SF A 1120	6	May-2022	425	5,653	10,013	-	-	-	-	16,092	
36	5787303	2019 Vierra 1703 new tie for industrial	6	Nov-2021	77	3,029	-	-	-	-	-	3,107	
37	5787339	Deepwater, Install New Feeder 06	6	May-2021	14	4,017	-	-	-	-	-	4,031	
38	5787581	Mission SF X 1129 Install New Fdr	6	Feb-2023	218	4,621	8,731	118	-	-	-	13,688	
39	5788853	USASA - Phase II - Reconductor - SM1104	6	Jun-2021	82	3,465	-	-	-	-	-	3,547	
40	5789606	Martin SF H 1117: Install New Feeder	6	May-2022	5	8,830	3,988	-	-	-	-	12,823	
41	5790220	Willow Pass Sub_Install 21 kV Feeders	6	Jun-2023	3	25	100	1,990	2,009	-	-	4,127	
42	5790320	06 - Distribution Work for Santa Teresa	6	Aug-2021	152	3,807	-	-	-	-	-	3,959	
43	5790352	Santa Nella Bank 1 Repacement 06 Work	6	Jun-2022	60	65	4,757	48	-	-	-	4,930	
44	5790381	Kingsburg 1113/1111 Load Reduction, Ph I	6	Sep-2021	113	3,076	-	-	-	-	-	3,190	
45	5790480	Install new Lammers 1108 Feeder	6	Jan-2022	13	6,177	55	-	-	-	-	6,245	
46	5790698	A1117 Circuit Reinforce and Extension	6	May-2022	59	122	11,064	-	-	-	-	11,246	
47	5790699	A1108 Circuit Reinforcement	6	Jan-2021	78	4,208	-	-	-	-	-	4,287	
48	5790700	A1113 Circuit Reinforcement	6	Jun-2022	2	-	6,629	995	-	-	-	7,626	
49	5790704	X1101 Circuit Reinforcement	6	Dec-2021	2	5,339	-	-	-	-	-	5,341	
50	5790710	X1107 Circuit Reinforcement_Extension	6	Oct-2021	35	57	9,348	-	-	-	-	9,441	
51	5790870	Fort Ord 2107 - 21kV Extension	6	Jun-2021	86	3,539	-	-	-	-	-	3,624	
52	5791154	Weber Sub: Install New 1115 Feeder	6	Jan-2022	69	6,137	55	-	-	-	-	6,261	
53	5791320	X-1113 Circuit Reinforcement	6	Jun-2022	1	3,502	3,293	-	-	-	-	6,796	
54	5792478	Primary Circuit Extension for 777 Harris	6	Jun-2022	2	57	4,118	-	-	-	-	4,178	
55	5794083	Garberville 1102 New Business Circuit Re	6	Jun-2024	-	-	-	14,927	23,931	-	-	38,858	
56	5795501	SYSPLAN ED 06A	6	Dec-2020	-	5,726	12,582	8,075	8,601	10,902	9,344	55,231	
57	5795502	SYSPLAN ED 06E	6	Dec-2020	-	13,538	14,058	23,993	29,641	32,174	34,271	147,675	
58	5795503	SYSPLAN ED 06H	6	Dec-2020	-	23,244	12,387	48,370	54,357	87,927	96,876	323,161	
59	5795530	Banta Replace Bank 1 - Line Work	6	Aug-2023	-	-	249	3,632	-	-	-	3,882	
60	5795540	Saratoga Sub - Install New 12 kV Feeder	6	Jul-2026	-	-	-	-	-	689	3,003	3,692	
61	5795541	Spence: Replace Bank 2 - Line Work	6	Aug-2024	-	-	-	498	2,991	-	-	3,489	
62	5795542	Tulucay Install New Feeder - Line Work	6	Aug-2023	-	-	499	3,284	-	-	-	3,783	
63	5795543	WOLFE: Install 12 kV Feeders 1115-1116	6	Jun-2025	-	-	-	-	2,991	2,997	-	5,989	
64	**Total**				**24,598**	**233,720**	**147,485**	**137,655**	**163,173**	**176,314**	**187,492**	**1,070,437**	WP 17-18
	MWC - 46	**E Dist Subst Capacity**											
65	5543518	SYSPLAN ED 46A	46		-	2,961	5,674	2,985	1,402	1,249	801	15,072	
66	5543519	SYSPLAN ED 46F	46		-	1,579	1,645	796	-	-	-	4,021	
67	5543520	SYSPLAN ED 46H	46		-	8,032	9,887	15,622	26,774	61,345	73,927	195,587	
68	5544467	SYSPLAN Energy Storage 46A	46		-	26,287	154	-	-	-	-	26,442	
69	5746645	SANTA NELLA: Replace BK1 and Inst Feeder	46	Jan-2022	473	1,795	6,980	-	-	-	-	9,248	
70	5763889	JARVIS: Install BK 2	46	Aug-2021	2,040	5,412	15	-	-	-	-	7,467	
71	5766620	SOLEDAD: Install D-BK 7	46	May-2021	5,697	1,837	-	-	-	-	-	7,535	
72	5768879	SANTA TERESA: Install New Substation	46	Sep-2021	7,471	3,759	236	-	-	-	-	11,466	
73	5769274	MONTEREY: Install 3-D-Banks & 60 KV BRK	46	Sep-2022	1,703	2,379	7,004	32	-	-	-	11,118	
74	5774720	BELLEVUE: Replace BK 1	46	Mar-2021	4,641	1,014	19	-	-	-	-	5,675	
75	5779285	DOLAN: Install New Bank	46	Jun-2021	3,669	6,332	66	-	-	-	-	10,067	
76	5779506	CALFLAX: INSTALL BANK 2	46	Apr-2022	155	3,833	2,101	4	-	-	-	6,094	
77	5780188	PUEBLO: EM Install BK 3	46	Nov-2021	703	5,551	85	-	-	-	-	6,340	
78	5782301	HURON SUB: REPLACE BK 1	46	Jun-2023	591	1,000	4,105	749	-	-	-	6,445	
79	5783898	Replace Vina Bank 1	46	Apr-2021	1,785	3,237	-	-	-	-	-	5,021	
80	5785560	Tulare Lake - Replace Bank 1	46	May-2021	3,633	2,028	-	-	-	-	-	5,662	
81	5786128	Garberville:Repl Bus_and_V_Regulator	46	Nov-2024	-	-	598	3,483	10,968	-	-	15,050	
82	5789999	Greenbrae Sub, Replace Bank 2	46	Oct-2023	1	150	1,944	4,379	-	-	-	6,474	
83	5790009	Dunnigan Sub: Install New Bank & Feeder	46	Jul-2024	-	-	150	3,234	4,986	-	-	8,369	
84	5790245	WILLOW PASS: REPLACE BANK 1 AND INSTALL	46	Jul-2024	-	75	150	3,160	4,986	-	-	8,370	
85	5790247	Rincon: Replace Bank 1	46	Jun-2022	38	361	6,811	3	-	-	-	7,213	
86	5790334	Dumbarton Sub_Replace Dumbarton Bk2	46	Jun-2023	33	297	4,366	1,780	-	-	-	6,476	
87	5790862	Mountain View - Replace Bank 1	46	Mar-2023	-	150	4,387	1,941	-	-	-	6,478	
88	5790872	BLACKWELL: Replace Bank 1	46	Jul-2025	-	-	-	149	1,944	4,396	-	6,490	
89	5790898	SPENCE: Replace Bank 2	46	Jun-2024	-	-	150	1,941	4,387	-	-	6,477	
90	5791138	Calistoga Substation, Replace Bank 1	46	Jun-2023	-	150	3,179	3,147	-	-	-	6,475	
91	5791141	Belle Haven Replace Bank 4	46	Jun-2024	-	-	150	1,941	4,387	-	-	6,477	
92	5791142	Millbrae Sub:Inst Bk 2 and 1109 Fdr	46	Jul-2024	-	-	150	3,234	4,986	-	-	8,369	
93	5792892	Banta Substation, Replace Bank 1	46	Jul-2023	-	150	1,944	4,379	-	-	-	6,473	
94	5794827	Lockeford Sub, Replace Bank 1	46	Jun-2025	0	0	0	149	3,241	4,995	-	8,385	
95	5794990	San Miguel Install Bank 2	46	Jun-2023	-	150	3,241	4,976	-	-	-	8,366	
96	**Total**				**32,634**	**78,521**	**65,191**	**58,082**	**68,061**	**71,985**	**74,728**	**449,202**	WP 17-18
97		**Grand Total**			**57,232**	**312,241**	**212,675**	**195,738**	**231,234**	**248,299**	**262,219**	**1,519,639**	

98 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 17-9
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 17
Electric Distribution Capacity, Engineering and Planning
Recorded and Forecast Capital Expenditures Details - Other Work*
(Thousands of Nominal Dollars)

			Capital Expenditures											
Line No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	6	E Dist Line Capacity	72,348	42,586	57,343	54,021	61,457	-	2,991	-	-	-	-	WP 17-17
2	46	E Dist Subst Capacity	42,694	17,131	10,695	13,206	9,532	359	-	-	-	-	-	WP 17-17
3	**Grand Total**		**115,042**	**59,717**	**68,038**	**67,227**	**70,990**	**359**	**2,991**	**-**	**-**	**-**	**-**	

4 * Excludes projects greater than $3M

Workpaper Table 17-10
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Major Work Category 06 – Recorded Walk
MWC 06 - Distribution Line Capital
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$ 91,361**			
2		Feeder Projs Assoc with Substation Work (MAT 06A)	$ 2,885		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Increase in the number of projects to serve accumulative load growth.	WP 17-14, Line 1
3		Overloaded Line Transformers (MAT 06B)	$ 293		Increase in completed transformer replacements	WP 17-14, Line 2
4		Circuit Reinforcement (DP Managed) (MAT 06D)	$ 44		Specifically identified projects as necessary to eliminate projected equipment overloads and voltage issues.	WP 17-14, Line 3
5		Circuit Reinforcement (PS Managed) (MAT 06E)	$ (1,008)		Specifically identified projects as necessary to eliminate projected equipment overloads and voltage issues.	WP 17-14, Line 4
6		Voltage Complaint Projects Involving Secondary Distribution (MAT 06G)	$ (765)		Specifically identified projects to correct voltage issues based on customer complaints.	WP 17-14, Line 5
7		New Business Related Capacity Increase (MAT 06H)	$ (36,094)		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Line work associated with substation capacity projects. Decrease in the number of projects to serve New Business-related demand.	WP 17-14, Lines 6-8
8		Operational Capacity Projects (MAT 06I)	$ 2,037		Specifically identified projects as necessary to increase the operational flexibility of the system.	WP 17-14, Line 9
9		Enable Distributed Generation (DG) Distribution Line (06P)	$ (1)		Immaterial changes	WP 17-14, Line 11
10		Line Voltage Regulator Revolving Stock Purchase	$ (2,764)		A decrease in need for new voltage regulators due to greater than average rainfall decreasing the need for new pumps in agricultural areas.	WP 17-14, Line 12
11		Cornerstone capacity (MAT 06L) [1]	$ (86)		Cornerstone carryover expenditure.	WP 17-14, Line 16
12		Cornerstone capacity, Automation (MAT 06M) [1]	$ 57		Cornerstone carryover expenditure.	WP 17-14, Line 17
13		**Net Change**	**$ (35,402)**			
14	**2017**	**Recorded Adjusted**	**$ 55,959**			
15		Feeder Projs Assoc with Substation Work (MAT 06A)	$ 3,941		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Increase in the number of projects to serve cumulative load growth.	WP 17-14, Line 1
16		Overloaded Line Transformers (MAT 06B)	$ (589)		Decrease in completed transformer replacements	WP 17-14, Line 2
17		Circuit Reinforcement (DP Managed) (MAT 06D)	$ (289)		Specifically identified projects as necessary to eliminate projected equipment overloads and voltage issues.	WP 17-14, Line 3
18		Circuit Reinforcement (PS Managed) (MAT 06E)	$ (5,122)		Specifically identified projects as necessary to eliminate projected equipment overloads and voltage issues. Decrease in completed projects.	WP 17-14, Line 4
19		Voltage Complaint Projects Involving Secondary Distribution (MAT 06G)	$ 1,312		Specifically identified projects to correct voltage issues based on customer complaints.	WP 17-14, Line 5
20		New Business Related Capacity Increase (MAT 06H)	$ 5,793		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Line work associated with substation capacity projects. Increase in the number of projects to serve New Business-related demand.	WP 17-14, Lines 6-8
21		Operational Capacity Projects (MAT 06I)	$ 4,950		Specifically identified projects as necessary to increase the operational flexibility of the system.	WP 17-14, Line 9
22		Power Factor Management (MAT 06K)	$ 65		Specifically identified locations where SCADA is to be installed on capacitors to improve power factor management.	WP 17-14, Line 10
23		DER Integration Capacity (MAT 06P)	$ 368		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 11
24		Line Voltage Regulator Revolving Stock Purchase	$ 1,259		An increased need for voltage regulators due to growth of new pumping load and indoor cultivation	WP 17-14, Line 12
25		Cornerstone capacity (MAT 06L) [1]	$ 92		Cornerstone carryover expenditure.	WP 17-14, Line 16
26		Cornerstone capacity, Automation (MAT 06M) [1]	$ 7		Cornerstone carryover expenditure.	WP 17-14, Line 17
27		**Net Change**	**$ 11,787**			
28	**2018**	**Recorded Adjusted**	**$ 67,746**			
29		Feeder Projs Assoc with Substation Work (MAT 06A)	$ (1,523)		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Decrease in completed work.	WP 17-14, Line 1
30		Overloaded Line Transformers (MAT 06B)	$ 561		Increase in completed transformer replacements	WP 17-14, Line 2
31		Circuit Reinforcement (DP Managed) (MAT 06D)	$ (35)		Immaterial changes	WP 17-14, Line 3
32		Circuit Reinforcement (PS Managed) (MAT 06E)	$ 4,605		Specifically identified projects as necessary to eliminate projected equipment overloads and voltage issues. Increase in completed projects.	WP 17-14, Line 4
33		Voltage Complaint Projects Involving Secondary Distribution (MAT 06G)	$ (526)		Specifically identified projects to correct voltage issues based on customer complaints.	WP 17-14, Line 5
34		New Business Related Capacity Increase (MAT 06H)	$ 9,062		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Line work associated with substation capacity projects. Increase in the number of projects to serve New Business-related demand.	WP 17-14, Line 6-8
35		Operational Capacity Projects (MAT 06I)	$ (403)		Specifically identified projects as necessary to increase the operational flexibility of the system.	WP 17-14, Line 9
36		Power Factor Management (MAT 06K)	$ 13		Specifically identified locations where SCADA is to be installed on capacitors to improve power factor management.	WP 17-14, Line 10
37		DER Integration Capacity (MAT 06P)	$ (108)		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 11
38		Line Voltage Regulator Revolving Stock Purchase	$ (5,936)		A decrease in need for new voltage regulators due to a return to average rainfall resulting in decreased need for new pumps in agricultural areas.	WP 17-14, Line 12
39		Cornerstone capacity (MAT 06L) [1]	$ (1)		Cornerstone carryover expenditure.	WP 17-14, Line 16
40		Cornerstone capacity, Automation (MAT 06M) [1]	$ (12)		Cornerstone carryover expenditure.	WP 17-14, Line 17
41		**Net Change**	**$ 5,698**			
42	**2019**	**Recorded Adjusted**	**$ 73,444**			
43		Feeder Projs Assoc with Substation Work (MAT 06A)	$ 4,138		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Increase in the number of projects to serve cumulative load growth.	WP 17-14, Line 1
44		Overloaded Line Transformers (MAT 06B)	$ 215		Increase in completed transformer replacements	WP 17-14, Line 2
45		Circuit Reinforcement (DP Managed) (MAT 06D)	$ (177)		Specifically identified projects as necessary to eliminate projected equipment overloads and voltage issues.	WP 17-14, Line 3
46		Circuit Reinforcement (PS Managed) (MAT 06E)	$ 11,823		Specifically identified projects as necessary to eliminate projected equipment overloads and voltage issues. Increase in completed projects.	WP 17-14, Line 4
47		Voltage Complaint Projects Involving Secondary Distribution (MAT 06G)	$ (608)		Specifically identified projects to correct voltage issues based on customer complaints.	WP 17-14, Line 5
48		New Business Related Capacity Increase (MAT 06H)	$ 11,807		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Line work associated with substation capacity projects. Increase in the number of projects to serve New Business related demand.	WP 17-14, Lines 6-8
49		Operational Capacity Projects (MAT 06I)	$ (2,268)		Specifically identified projects as necessary to increase the operational flexibility of the system.	WP 17-14, Line 9
50		Power Factor Management (MAT 06K)	$ (34)		Immaterial changes	WP 17-14, Line 10
51		DER Integration Capacity (MAT 06P)	$ 654		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 11
52		Line Voltage Regulator Revolving Stock Purchase	$ 8,275		An increase in need for new voltage regulators due to increasing indoor cultivation as well as a return to drought conditions resulting in increased installation of agricultural water pumps.	WP 17-14, Line 12
53		Cornerstone capacity, Automation (MAT 06M) [1]	$ (3)		Cornerstone carryover expenditure.	WP 17-14, Line 17
54		Voltage Correct Primary (MAT 06F) & OH Power Factor Inst (MAT 06J)	$ (12)		Immaterial changes	WP 17-14, Lines 14-15
55		**Net Change**	**$ 33,811**			
56	**2020**	**Recorded Adjusted**	**$ 107,255**			WP 17-14, Line 19

Workpaper Table 17-11
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Major Work Category 06 – Forecast Walk
MWC 06 - Distribution Line Capital
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$ 107,255**			
2		Feeder Projs Assoc with Substation Work (MAT 06A)	$ 25,955		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Completion of capacity projects from previous years that were rescheduled from prior years due to emergency repair and wildfire hardening work.	WP 17-14, Line 1
3		Overloaded Line Transformers (MAT 06B)	$ 4,159		Includes existing transformer replacement, but also includes year-over-year acceleration of replacements to due to Wildfire risk reduction and climate vulnerability.	WP 17-14, Line 2
4		Circuit Reinforcement (DP Managed) (MAT 06D)	$ (1,355)		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 3
5		Circuit Reinforcement (PS Managed) (MAT 06E)	$ 6,384		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Completion of rescheduled projects.	WP 17-14, Line 4
6		Voltage Complaint Projects Involving Secondary Distribution (MAT 06G)	$ 716		Specifically identified projects to correct voltage issues based on customer complaints.	WP 17-14, Line 5
7		New Business Related Capacity Increase (MAT 06H)	$ 89,861		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Line work associated with substation capacity projects. Increase in the number of projects to serve New Business demand as well as increase due to completion of rescheduled projects.	WP 17-14, Lines 6-8
8		Operational Capacity Projects (MAT 06I)	$ 1,289		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 9
9		Power Factor Management (MAT 06K)	$ (43)		No significant change	WP 17-14, Line 10
10		DER Integration Capacity (MAT 06P)	$ (930)		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 11
11		Line Voltage Regulator Revolving Stock Purchase	$ 418		Forecast consistent with two-year average (2017-2018)	WP 17-14, Line 12
12		Voltage Correct Primary (MAT 06F) & OH Power Factor Inst (MAT 06J)	$ 12		Immaterial changes	WP 17-14, Lines 14-15
13		**Net Change**	**$ 126,465**			
14	**2021**	**Forecast**	**$ 233,720**			
15		Feeder Projs Assoc with Substation Work (MAT 06A)	$ (16,527)		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Decrease due to completion of rescheduled projects and forecasted return to more historic spend.	WP 17-14, Line 1
16		Overloaded Line Transformers (MAT 06B)	$ (272)		Includes existing transformer replacement, but also includes year-over-year acceleration of replacements to due to HFTD ignitions and climate vulnerability.	WP 17-14, Line 2
17		Circuit Reinforcement (DP Managed) (MAT 06D)	$ 3,297		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 3
18		Circuit Reinforcement (PS Managed) (MAT 06E)	$ (10,550)		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Decrease due to forecasted return to more historic spend.	WP 17-14, Line 4
19		Voltage Complaint Projects Involving Secondary Distribution (MAT 06G)	$ 137		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 5
20		New Business Related Capacity Increase and Forecast Emergent Work (MAT 06H)[2]	$ (56,909)		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Line work associated with substation capacity projects. Decrease due to forecasted return to more historic spend.	WP 17-14, Lines 6-8
21		Operational Capacity Projects (MAT 06I)	$ (507)		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 9
22		Power Factor Management (MAT 06K)	$ 618		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 10
23		DER Integration Capacity (MAT 06P)	$ 742		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 11
24		Line Voltage Regulator Revolving Stock Purchase	$ (3,273)		Forecast consistent with two year average (2017-2018)	WP 17-14, Line 12
25		**Net Change**	**$ (83,244)**			
26	**2022**	**Forecast**	**$ 150,476**			
27		Feeder Projs Assoc with Substation Work (MAT 06A)	$ (13,195)		Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.	WP 17-14, Line 1
28		Overloaded Line Transformers (MAT 06B)	$ 3,427		Includes existing transformer replacement, but also includes year-over-year acceleration of replacements to due to HFTD ignitions and climate vulnerability.	WP 17-14, Line 2
29		Circuit Reinforcement (DP Managed) (MAT 06D)	$ 530		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 3
30		Circuit Reinforcement (PS Managed) (MAT 06E)	$ 7,018		Forecast consistent with actual projects.	WP 17-14, Line 4
31		Voltage Complaints (MAT 06G)	$ (287)		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 5
32		New Business Related Capacity Increase and Forecast Emergent Work (MAT 06H)[2]	$ (12,128)		Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.	WP 17-14, Lines 6-8
33		Operational Capacity Projects (MAT 06I)	$ 1,432		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 9
34		Power Factor Management (MAT 06K)	$ 501		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 10
35		DER Integration Capacity (MAT 06P)	$ 601		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 11
36		Line Voltage Regulator Revolving Stock Purchase	$ (720)		Forecast consistent with two year average (2017-2018)	WP 17-14, Line 12
37		**Net Change**	**$ (12,821)**			
38	**2023**	**Forecast**	**$ 137,655**			
39		Feeder Projs Assoc with Substation Work (MAT 06A)	$ 545		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 1
40		Overloaded Line Transformers (MAT 06B)	$ 2,550		Includes existing transformer replacement, but also includes year-over-year acceleration of replacements to due to HFTD ignitions and climate vulnerability.	WP 17-14, Line 2
41		Circuit Reinforcement (DP Managed) (MAT 06D)	$ 835		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 3
42		Circuit Reinforcement (PS Managed) (MAT 06E)	$ 5,648		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 4
43		Voltage Complaint Projects Involving Secondary Distribution (MAT 06G)	$ 503		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 5
44		New Business Related Capacity Increase and Forecast Emergent Work (MAT 06H)[2]	$ 12,398		Return to 2022 spending level after 2023 decrease due to affordability challenge	WP 17-14, Lines 6-8
45		Operational Capacity Projects (MAT 06I)	$ 1,253		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 9
46		Power Factor Management (MAT 06K)	$ 207		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 10
47		DER Integration Capacity (MAT 06P)	$ 251		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 11
48		Line Voltage Regulator Revolving Stock Purchase	$ 1,328		Forecast consistent with two year average (2017-2018)	WP 17-14, Line 12
49		**Net Change**	**$ 25,518**			
50	**2024**	**Forecast**	**$ 163,173**			
51		Feeder Projs Assoc with Substation Work (MAT 06A)	$ 981		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 1
52		Overloaded Line Transformers (MAT 06B)	$ 599		Includes existing transformer replacement, but also includes year-over-year acceleration of replacements to due to HFTD ignitions and climate vulnerability.	WP 17-14, Line 2
53		Circuit Reinforcement (DP Managed) (MAT 06D)	$ 454		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 3
54		Circuit Reinforcement (PS Managed) (MAT 06E)	$ 2,532		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 4
55		Voltage Complaint Projects Involving Secondary Distribution (MAT 06G)	$ 268		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 5
56		New Business Related Capacity Increase and Forecast Emergent Work (MAT 06H)[2]	$ 6,653		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Line work associated with substation capacity projects. Increase in the number of projects to serve New Business demand	WP 17-14, Lines 6-8
57		Operational Capacity Projects (MAT 06I)	$ 681		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 9
58		Power Factor Management (MAT 06K)	$ 114		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 10
59		DER Integration Capacity (MAT 06P)	$ 136		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 11
60		Line Voltage Regulator Revolving Stock Purchase	$ 722		Forecast consistent with two-year average (2017-2018)	WP 17-14, Line 12
61		**Net Change**	**$ 13,141**			
62	**2025**	**Forecast**	**$ 176,314**			
63		Feeder Projs Assoc with Substation Work (MAT 06A)	$ 755		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 1
64		Overloaded Line Transformers (MAT 06B)	$ 409		Includes existing transformer replacement, but also includes year-over-year acceleration of replacements to due to HFTD ignitions and climate vulnerability.	WP 17-14, Line 2
65		Circuit Reinforcement (DP Managed) (MAT 06D)	$ 376		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 3
66		Circuit Reinforcement (PS Managed) (MAT 06E)	$ 2,097		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 4
67		Voltage Complaint Projects Involving Secondary Distribution (MAT 06G)	$ 219		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 5
68		New Business Related Capacity Increase and Forecast Emergent Work (MAT 06H)[2]	$ 5,952		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Line work associated with substation capacity projects. Increase in the number of projects to serve New Business demand	WP 17-14, Lines 6-8
69		Operational Capacity Projects (MAT 06I)	$ 564		Forecast consistent with three-year average expenditure. Includes escalation	WP 17-14, Line 9
70		Power Factor Management (MAT 06K)	$ 94		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 10
71		DER Integration Capacity (MAT 06P)	$ 111		Specifically identified locations where SCADA is required to address operational needs	WP 17-14, Line 11
72		Line Voltage Regulator Revolving Stock Purchase	$ 599		Forecast consistent with two-year average (2017-2018)	WP 17-14, Line 12
73		**Net Change**	**$ 11,178**			
74	**2026**	**Forecast**	**$ 187,492**			WP 17-14, Line 19

Workpaper Table 17-12
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Major Work Category 46 – Recorded Walk
MWC 46 - Distribution Substation Capital
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$ 42,862**			WP 17-14, Line 29
2		Normal Capacity Deficiencies (MAT 46# and 46A)	$ (12,409)		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Decrease in the number of projects to serve accumulative load growth.	WP 17-14, Lines 20-21
3		Emergency and Operational Capacity (MAT 46F)	$ (458)		Specifically identified projects as necessary to provide emergency or operational capacity. Decrease in the number of projects to support this work.	WP 17-14, Line 22
4		New Business Related Capacity (Includes Emergent Work) (MAT 46H)	$ (13,623)		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Decrease in the number of projects to serve New Business-related demand.	WP 17-14, Line 23
5		Land Purchases and New Distribution Substation (MAT 46N)	$ 1,114		Specifically identified projects to purchase land and/or construct new substation as necessary to eliminate projected equipment overload conditions. Increase in the expenditure and/or the number of projects to serve accumulative load growth.	WP 17-14, Line 24
6		Support for Transmission and Substation Related Work (MAT 46T)	$ (130)		Specifically identified projects as necessary to provide support to Transmission or Substation Asset Management related projects. Decrease in the number of projects to support this work.	WP 17-14, Line 25
7		Cornerstone [1]	$ (2)		Cornerstone carryover expenditure.	WP 17-14, Line 27
8		**Net Change**	**$ (25,508)**			
9	**2017**	**Recorded Adjusted**	**$ 17,354**			WP 17-14, Line 29
10		Normal Capacity Deficiencies (MAT 46# and 46A)	$ (4,884)		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Decrease in the number of projects to serve accumulative load growth.	WP 17-14, Lines 20-21
11		Emergency and Operational Capacity (MAT 46F)	$ 4,594		Specifically identified projects as necessary to provide emergency or operational capacity. Increase in the number of projects to support this work.	WP 17-14, Line 22
12		New Business Related Capacity (Includes Emergent Work) (MAT 46H)	$ (1,255)		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Decrease in the number of projects to serve New Business-related demand.	WP 17-14, Line 23
13		Land Purchases and New Distribution Substation (MAT 46N)	$ (3,148)		Specifically identified projects to purchase land and/or construct new substation as necessary to eliminate projected equipment overload conditions. Decrease in the expenditure and/or the number of projects to serve accumulative load growth.	WP 17-14, Line 24
14		Support for Transmission and Substation Related Work (MAT 46T)	$ (286)		Specifically identified projects as necessary to provide support to Transmission or Substation Asset Management related projects. Decrease in the number of projects to support this work.	WP 17-14, Line 25
15		Cornerstone [1]	$ -		Cornerstone carryover expenditure.	WP 17-14, Line 27
16		**Net Change**	**$ (4,978)**			
17	**2018**	**Recorded Adjusted**	**$ 12,376**			WP 17-14, Line 29
18		Normal Capacity Deficiencies (MAT 46# and 46A)	$ 4,989		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Increase in the number of projects to serve accumulative load growth.	WP 17-14, Lines 20-21
19		Emergency and Operational Capacity (MAT 46F)	$ 1,230		Specifically identified projects as necessary to provide emergency or operational capacity. Increase in the number of projects to support this work.	WP 17-14, Line 22
20		New Business Related Capacity (Includes Emergent Work) (MAT 46H)	$ 1,009		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Increase in the number of projects to serve New Business-related demand.	WP 17-14, Line 23
21		Land Purchases and New Distribution Substation (MAT 46N)	$ (1,767)		Specifically identified projects to purchase land and/or construct new substation as necessary to eliminate projected equipment overload conditions. Decrease in the expenditure and/or the number of projects to serve accumulative load growth.	WP 17-14, Line 24
22		Support for Transmission and Substation Related Work (MAT 46T)	$ 63		No specifically identified projects to provide support to Transmission or Substation Asset Management related projects. Carryover credit from previous years.	WP 17-14, Line 25
23		**Net Change**	**$ 5,524**			WP 17-14, Line 27
24	**2019**	**Recorded Adjusted**	**$ 17,900**			WP 17-14, Line 29
25		Normal Capacity Deficiencies (MAT 46# and 46A)	$ 138		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Decrease in the number of projects to serve accumulative load growth.	WP 17-14, Lines 20-21
26		Emergency and Operational Capacity (MAT 46F)	$ 4,823		Specifically identified projects as necessary to provide emergency or operational capacity. Increase in the number of projects to support this work.	WP 17-14, Line 22
27		New Business Related Capacity (Includes Emergent Work) (MAT 46H)	$ 13,649		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Increase in the number of projects to serve New Business related demand.	WP 17-14, Line 23
28		Land Purchases and New Distribution Substation (MAT 46N)	$ (239)		Specifically identified projects to purchase land and/or construct new substation as necessary to eliminate projected equipment overload conditions. Decrease in the expenditure and/or the number of projects to serve accumulative load growth.	WP 17-14, Line 24
29		Support for Transmission and Substation Related Work (MAT 46T)	$ -		No specifically identified projects to provide support to Transmission or Substation Asset Management related projects.	WP 17-14, Line 25
30		**Net Change**	**$ 18,370**			WP 17-14, Line 27
31	**2020**	**Recorded Adjusted**	**$ 36,270**			WP 17-14, Line 29

Workpaper Table 17-13
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Major Work Category 46 – Forecast Walk
MWC 46 - Distribution Substation Capital
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$ 36,270**			WP 17-14, Line 29
2		Normal Capacity Deficiencies (MAT 46# and 46A)	$ 27,792		Specifically identified projects as necessary to eliminate projected equipment overload conditions. Increase due to Renz (Llagas) Energy Storage Project.	WP 17-14, Lines 20-21
3		Emergency and Operational Capacity (MAT 46F)	$ 5,831		Specifically identified projects as necessary to provide emergency or operational capacity. Increase in the number of projects to support this work.	WP 17-14, Line 22
4		New Business Related Capacity (Includes Emergent Work) (MAT 46H)	$ 9,003		Specifically identified projects as necessary to eliminate projected equipment overload conditions based on New Business applications. Increase in the number of projects to serve New Business-related demand.	WP 17-14, Line 23
5		Land Purchases and New Distribution Substation (MAT 46N)	$ (16)		Specifically identified projects to purchase land and/or construct new substation as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 24
6		**Net Change**	**$ 42,610**			
7	**2021**	**Forecast**	**$ 78,880**			WP 17-14, Line 29
8		Normal Capacity Deficiencies (MAT 46A)	$ (5,959)		Specifically identified projects as necessary to eliminate projected equipment overload conditions	WP 17-14, Line 21
9		Emergency and Operational Capacity (MAT 46F)	$ (9,005)		Specifically identified projects as necessary to provide emergency or operational capacity. Decrease in the number of projects to support this work.	WP 17-14, Line 22
10		New Business Related Capacity (Includes Emergent Work) (MAT 46H)	$ 1,305		Increase in the number of New Business applications for service that will require capacity work to serve	WP 17-14, Line 23
11		Land Purchases and New Distribution Substation (MAT 46N)	$ (30)		Specifically identified projects to purchase land and/or construct new substation as necessary to eliminate projected equipment overload conditions. No identified projects	WP 17-14, Line 24
12		**Net Change**	**$ (13,690)**			
13	**2022**	**Forecast**	**$ 65,191**			WP 17-14, Line 29
14		Normal Capacity Deficiencies (MAT 46A)	$ (13,146)		Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.	WP 17-14, Line 21
15		Emergency and Operational Capacity (MAT 46F)	$ (7,791)		Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.	WP 17-14, Line 22
16		New Business Related Capacity (Includes Emergent Work) (MAT 46H)	$ 13,828		Increase in the number of New Business applications for service that will require capacity work to serve	WP 17-14, Line 23
17		Land Purchases and New Distribution Substation (MAT 46N)	$ -		Specifically identified projects to purchase land and/or construct new substation as necessary to eliminate projected equipment overload conditions. No identified projects	WP 17-14, Line 24
18		**Net Change**	**$ (7,108)**			
19	**2023**	**Forecast**	**$ 58,082**			WP 17-14, Line 29
20		Normal Capacity Deficiencies (MAT 46A)	$ (7,411)		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 21
21		Emergency and Operational Capacity (MAT 46F)	$ 2,264		Specifically identified projects as necessary to provide emergency or operational capacity. Increase in the number of projects to support this work.	WP 17-14, Line 22
22		Emergent Work Program, New Business Related (MAT 46H)	$ 15,126		Increase in the number of new business applications for service that will require capacity work to serve	WP 17-14, Line 23
23		**Net Change**	**$ 9,979**			
24	**2024**	**Forecast**	**$ 68,061**			WP 17-14, Line 29
25		Normal Capacity Deficiencies (MAT 46A)	$ (2,687)		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 21
26		Emergency and Operational Capacity (MAT 46F)	$ 1,755		Specifically identified projects as necessary to provide emergency or operational capacity. Increase in the number of projects to support this work.	WP 17-14, Line 22
27		New Business Related Capacity (Includes Emergent Work) (MAT 46H)	$ 4,857		Increase in the number of New Business applications for service that will require capacity work to serve	WP 17-14, Line 23
28		**Net Change**	**$ 3,924**			
29	**2025**	**Forecast**	**$ 71,985**			WP 17-14, Line 29
30		Normal Capacity Deficiencies (MAT 46A)	$ (4,844)		Specifically identified projects as necessary to eliminate projected equipment overload conditions.	WP 17-14, Line 21
31		Emergency and Operational Capacity (MAT 46F)	$ (4,995)		Specifically identified projects as necessary to provide emergency or operational capacity. Decrease in the number of projects to support this work.	WP 17-14, Line 22
32		New Business Related Capacity (Includes Emergent Work) (MAT 46H)	$ 12,582		Increase in the number of New Business applications for service that will require capacity work to serve	WP 17-14, Line 23
33		**Net Change**	**$ 2,742**			
34	**2026**	**Forecast**	**$ 74,728**			WP 17-14, Line 29

Workpaper Table 17-14
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Capital Summary by Program Element
(Thousands of Nominal Dollars)

MWC 06

Line No.		Recorded					Forecast - Including Escalation						
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Reference
		Actual	Actual	Actual	Actual	Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	
1	06A-Feeder Projs Assoc with Substation Work	$ 4,391	$ 7,276	$ 11,216	$ 9,694	$ 13,832	$ 39,787	$ 23,260	$ 10,066	$ 10,610	$ 11,591	$ 12,347	WP 17-15, line 1
2	06B-Overloaded Line Transformers	$ 378	$ 672	$ 83	$ 644	$ 859	$ 5,018	$ 4,745	$ 8,172	$ 10,722	$ 11,321	$ 11,730	WP 17-15, line 2
3	06D-Circuit Reinforcement- Distribution Planning (DP) Managed	$ 2,466	$ 2,510	$ 2,221	$ 2,187	$ 2,010	$ 654	$ 3,952	$ 4,481	$ 5,316	$ 5,770	$ 6,147	WP 17-15, line 3
4	06E-Circuit Reinforcement- Project Services (PS) Managed	$ 10,845	$ 9,837	$ 4,715	$ 9,320	$ 21,142	$ 27,526	$ 16,975	$ 23,993	$ 29,641	$ 32,174	$ 34,271	WP 17-15, line 4
5	06G-Voltage Complaint Projects Involving Secondary Distribution	$ 2,771	$ 2,006	$ 3,319	$ 2,793	$ 2,185	$ 2,902	$ 3,038	$ 2,751	$ 3,254	$ 3,522	$ 3,741	WP 17-15, line 5
6	06H - New Business Related Capacity Increase (line work only)	$ 40,887	$ 19,820	$ 26,353	$ 33,222	$ 43,933	$ 78,167	$ 7,529	$ -	$ -	$ -	$ -	WP 17-15, line 6
7	06H - New Business Related Capacity Increase (Unidentified - Emergent Work)						$ 23,244	$ 12,387	$ 48,370	$ 54,357	$ 87,927	$ 96,876	WP 17-15, line 7
8	06H - New Business Related Capacity Increase (Feeder Projs Assoc with Substation Work)	$ 19,594	$ 4,566	$ 3,826	$ 6,020	$ 7,116	$ 39,499	$ 64,085	$ 23,503	$ 29,914	$ 2,997	$ -	WP 17-15, line 8
9	06I-Operational Capacity Projects	$ 194	$ 2,231	$ 7,181	$ 6,778	$ 4,511	$ 5,800	$ 5,293	$ 6,725	$ 7,978	$ 8,659	$ 9,223	WP 17-15, line 9
10	06K-Power Factor Management	$ -	$ -	$ 65	$ 77	$ 43	$ -	$ 618	$ 1,119	$ 1,326	$ 1,440	$ 1,535	WP 17-15, line 10
11	06P-Enable Distributed Generation (DG) Distribution Line	$ 17	$ 16	$ 384	$ 276	$ 930	$ -	$ 742	$ 1,344	$ 1,594	$ 1,731	$ 1,842	WP 17-15, line 11
12	Line Voltage Regulator Revolving Stock	$ 9,873	$ 7,108	$ 8,367	$ 2,431	$ 10,706	$ 11,124	$ 7,852	$ 7,131	$ 8,460	$ 9,181	$ 9,780	WP 17-15, line 12
13	**Sub-Total**	**$ 91,416**	**$ 56,043**	**$ 67,731**	**$ 73,441**	**$ 107,267**	**$ 233,720**	**$ 150,476**	**$ 137,655**	**$ 163,173**	**$ 176,314**	**$ 187,492**	
14	06F - Voltage Correct Primary	$ -	$ -	$ -	$ -	$ (11)							
15	06J- OH Power Factor Inst	$ -	$ -	$ -	$ -	$ (1)							
16	06L - Cornerstone Capacity [1]	$ (6)	$ (91)	$ 1	$ -	$ -							
17	06M - Cornerstone Capacity, Automation [1]	$ (50)	$ 7	$ 15	$ 3	$ -							
18	**Sub-Total**	**$ (55)**	**$ (84)**	**$ 16**	**$ 3**	**$ (12)**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	
19	**Total**	**$ 91,361**	**$ 55,959**	**$ 67,746**	**$ 73,444**	**$ 107,255**	**$ 233,720**	**$ 150,476**	**$ 137,655**	**$ 163,173**	**$ 176,314**	**$ 187,492**	

MWC 46

		Recorded					Forecast - Including Escalation						
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Reference
		Actual	Actual	Actual	Actual	Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	
20	46# - Energy Storage	$ -	$ -	$ 8	$ 185	$ 696	$ -	$ -	$ -	$ -	$ -	$ -	WP 17-16, line 1
21	46A - Normal Capacity Deficiencies	$ 19,221	$ 6,812	$ 1,921	$ 6,732	$ 6,359	$ 34,848	$ 28,888	$ 15,743	$ 8,332	$ 5,645	$ 801	WP 17-16, line 2
22	46F - Emergency and Operational Capacity	$ 1,754	$ 1,295	$ 5,890	$ 7,120	$ 11,942	$ 17,773	$ 8,768	$ 977	$ 3,241	$ 4,995	$ -	WP 17-16, line 3
23	46H - New Business Related Capacity (Includes Emergent Work)	$ 17,447	$ 3,824	$ 2,569	$ 3,578	$ 17,226	$ 26,230	$ 27,534	$ 41,363	$ 56,488	$ 61,345	$ 73,927	WP 17-16, lines 4-5
24	46N - Land Purchases and New Distribution Substations	$ 4,085	$ 5,199	$ 2,052	$ 285	$ 46	$ 30	$ -	$ -	$ -	$ -	$ -	WP 17-16, line 6
25	46T - Support for Transmission and Substation Related Work	$ 353	$ 223	$ (63)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	WP 17-16, line 7
26	**Sub-Total**	**$ 42,860**	**$ 17,354**	**$ 12,376**	**$ 17,900**	**$ 36,270**	**$ 78,880**	**$ 65,191**	**$ 58,082**	**$ 68,061**	**$ 71,985**	**$ 74,728**	
27	46B - Cornerstone [1]	$ 2	$ -	$ -	$ -	$ -							
28	**Sub-Total - Initiatives**	**$ 2**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	
29	**MWC 46 Total**	**$ 42,862**	**$ 17,354**	**$ 12,376**	**$ 17,900**	**$ 36,270**	**$ 78,880**	**$ 65,191**	**$ 58,082**	**$ 68,061**	**$ 71,985**	**$ 74,728**	

Totals with Escalation

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Reference
		Actual	Actual	Actual	Actual	Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	
30	MWC 06	$ 91,416	$ 56,043	$ 67,731	$ 73,441	$ 107,267	$ 233,720	$ 150,476	$ 137,655	$ 163,173	$ 176,314	$ 187,492	
31	MWC 06 - 06F/ 06J / 06L / 06M	$ (55)	$ (84)	$ 16	$ 3	$ (12)	$ -	$ -	$ -	$ -	$ -	$ -	
32	MWC 46	$ 42,860	$ 17,354	$ 12,376	$ 17,900	$ 36,270	$ 78,880	$ 65,191	$ 58,082	$ 68,061	$ 71,985	$ 74,728	
33	MWC 46 - Cornerstone [1]	$ 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
34	**Total MWC 46 and 06**	**$ 134,223**	**$ 73,313**	**$ 80,122**	**$ 91,344**	**$ 143,525**	**$ 312,600**	**$ 215,667**	**$ 195,738**	**$ 231,234**	**$ 248,299**	**$ 262,219**	

MWC 46 - Project Summary for Categories for projects with Expenditures >$3M

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Reference
		Actual	Actual	Actual	Actual	Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	
42	Normal Capacity Deficiencies	$ 11,335	$ 6,373	$ 1,055	$ 5,246	$ 3,851	$ 32,812	$ 24,899	$ 13,558	$ 7,080	$ 4,846	$ 800	WP 17-47
43	Emergency and Operational Capacity - Reduce Customer Count	$ -	$ 7	$ 293	$ 1,617	$ 1,208	$ 7,912	$ 8,218	$ 32	$ -	$ -	$ -	WP 17-57
44	Emergency and Operational Capacity - Emergency Banks	$ 21	$ 318	$ 1,130	$ 4,820	$ 9,305	$ 8,402	$ 104	$ 149	$ 3,241	$ 4,995	$ -	WP 17-53
45	New Business-Related Capacity	$ 11,056	$ 9,207	$ 242	$ 780	$ 16,341	$ 25,913	$ 27,085	$ 26,667	$ 30,714	$ 1,650	$ -	WP 17-65
46	New Business Related Capacity - Emergent Work	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 12,396	$ 24,835	$ 59,135	$ 72,982	WP 17-73
47	**Sub-Total - MWC 46 Projects >$3M**	**$ 22,412**	**$ 15,905**	**$ 2,720**	**$ 12,463**	**$ 30,705**	**$ 75,039**	**$ 60,306**	**$ 52,802**	**$ 65,870**	**$ 70,626**	**$ 73,782**	Sum of Lines 42 through 46

Workpaper Table 17-15
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
MWC 06 Forecast Calculation
(Thousands of Nominal dollars)

Line No.	MWC 06	Description	Recorded by MAT Code: 2016 Actuals	2017 Actuals	2018 Actuals	2019 Actuals	2020 Actuals	Recorded Adjusted - 2018-2019 Escalated and 2020 Actuals: 2018 Actuals Escalated to 2020	2019 Actuals Escalated to 2020	2020 Actuals	Forecast Basis: 2018-2020 3 Year Average	Escalated Forecast: 2021-2022 Forecast Including Escalation: 2021 Forecast	2022 Forecast	2023-2026 Forecast Including Escalation: 2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Used 3 Year Average & Escalation as basis for forecast?	Notes	Assumptions	Reference
1	06A-Feeder Projs Assoc with Substation Work	Bank and Feeder Work	$ 4,391	$ 7,276	$ 11,216	$ 9,694	$ 13,832	$ 12,259	$ 10,014	$ 13,832	$ 12,035	$ 39,787	$ 23,260	$ 10,066	$ 10,610	$ 11,591	$ 12,347	NO	Specifically Identified Projects	(1) (2)	
2	06B-Overloaded Line Transformers	OH/UG	$ 378	$ 672	$ 83	$ 644	$ 859	$ 90	$ 665	$ 859	$ 538	$ 5,018	$ 4,745	$ 8,172	$ 10,722	$ 11,321	$ 11,730	NO		(7)	WP 17-28
3	06D-Circuit Reinforcement-Distribution Planning (DP) Managed	Small Reconductoring & New Distribution	$ 2,466	$ 2,510	$ 2,221	$ 2,187	$ 2,010	$ 2,428	$ 2,259	$ 2,010	$ 2,232	$ 654	$ 3,952	$ 4,481	$ 5,316	$ 5,770	$ 6,147	NO		(3)	
4	06E-Circuit Reinforcement Project Services (PS) Managed	Large Reconductoring & New Distribution	$ 10,845	$ 9,837	$ 4,715	$ 9,320	$ 21,142	$ 5,153	$ 9,627	$ 21,142	$ 11,974	$ 27,526	$ 16,975	$ 23,993	$ 29,641	$ 32,174	$ 34,271	NO		(3)	
5	06G-Voltage Complaints Projects Involving Secondary Distribution	Secondary	$ 2,771	$ 2,006	$ 3,319	$ 2,793	$ 2,185	$ 3,627	$ 2,885	$ 2,185	$ 2,899	$ 2,902	$ 3,038	$ 2,751	$ 3,254	$ 3,522	$ 3,741	YES		(4)	
6	06H - New Business Related Capacity Increase (Line work only)	Reconductoring & New Distribution	$ 40,887	$ 19,820	$ 26,353	$ 33,222	$ 43,933	$ 28,802	$ 34,318	$ 43,933	$ 35,684	$ 78,167	$ 7,529	$ -	$ -	$ -	$ -	NO		(1) (5) (11)	
7	06H - New Business Related Capacity Increase (Unidentified - Emergent Work)	Reconductoring & New Distribution	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 23,244	$ 12,387	$ 48,370	$ 54,357	$ 87,927	$ 96,876	NO		(1) (5) (11)	
8	06H -New Business Related Capacity Increase (Feeder Projs Assoc with Substation Work)	Bank and Feeder Work	$ 19,594	$ 4,566	$ 3,826	$ 6,020	$ 7,116	$ 4,182	$ 6,219	$ 7,116	$ 5,839	$ 39,499	$ 64,085	$ 23,503	$ 29,914	$ 2,997	$ -	NO		(1) (5) (11)	
9	06I-Operational Capacity Projects	Reconductoring & New Distribution	$ 194	$ 2,231	$ 7,181	$ 6,778	$ 4,511	$ 7,848	$ 7,002	$ 4,511	$ 6,454	$ 5,800	$ 5,293	$ 6,725	$ 7,978	$ 8,659	$ 9,223	YES		(1) (6)	WP 17-29 to WP 17-31
10	06K-Power Factor Management	Capacitor and Capacitor Control	$ -	$ -	$ 65	$ 77	$ 43	$ 71	$ 80	$ 43	$ 64	$ -	$ 618	$ 1,119	$ 1,326	$ 1,440	$ 1,535	NO	Unit Cost based on high level project scope	(1) (6) (9)	WP 17-25
11	06P-Enable Distributed Generation (DG) Dist Line	Regulator and Regulator Control	$ 17	$ 16	$ 384	$ 276	$ 930	$ 419	$ 285	$ 930	$ 545	$ -	$ 742	$ 1,344	$ 1,594	$ 1,731	$ 1,842	NO	Unit Cost based on high level project scope	(1) (6) (10)	WP 17-26
12	# - Line Voltage Regulator Revolving Stock	Material	$ 9,873	$ 7,108	$ 8,367	$ 2,431	$ 10,706	$ 9,145	$ 2,511	$ 10,706	$ 7,454	$ 11,124	$ 7,852	$ 7,131	$ 8,460	$ 9,181	$ 9,780	YES		(1) (8)	
13		**MAT 06H Totals**	$ 60,480	$ 24,387	$ 30,180	$ 39,241	$ 51,049	$ 32,984	$ 40,536	$ 51,049	$ 41,523	$ 140,910	$ 84,001	$ 71,873	$ 84,271	$ 90,924	$ 96,876		Sume of lines 6-8		
14		**MWC 06 Sum**	$ 91,416	$ 56,043	$ 67,731	$ 73,441	$ 107,267	$ 74,024	$ 75,865	$ 107,267	$ 85,719	$ 233,720	$ 150,476	$ 137,655	$ 163,173	$ 176,314	$ 187,492		Sum of lines 1-10		

Electric Construction Cost Escalation Factors

	Year	Electric Distribution Escalation Factor
Escalate 2016 to Constant 2020 $	2016	1.164
Escalate 2017 to Constant 2020 $	2017	1.127
Escalate 2018 to Constant 2020 $	2018	1.093
Escalate 2019 to Constant 2020 $	2019	1.033
2020 Constant Dollar (2020=1)	2020	1.000

Forecast Assumptions and Reference

(1) Overall 2018-2020 expenditures were significantly lower than forecast due to resource constraints caused by wildfire hardening and emergency response.
(2) Forecast for 06A based on specific cost estimates for individual projects. For additional details on specific project forecast, please refer to Project Summaries, WP Table 17-17 "Forecast Capital Expenditures - Other Projects", and WP Table 17-18 "Forecast Capital Expenditures - Projects Detail".
(3) Forecast based on a return to normal resourcing
(4) Forecast based approximately on a three-year average (2017-2019) plus escalation
(5) Line work under MAT 06H is identified in three categories: 1) Line work associated with substation work for New Business-related capacity work (line 8), 2) Line work not associated with substation projects for New Business-related capacity work; and 3) Unidentified "Emergent Work" for future New Business-related capacity.
(6) Work that has been specifically identified. Forecast is based on a unit cost analysis using inputs from similar projects.
(7) Includes year-over-year acceleration of replacements to due to HFTD wildfire risk and climate vulnerability
(8) Forecast based roughly on a two-year average (2017-2018) plus escalation because 2019 and 2020 were anomolous due to underspend and then carryover
(9) Forecast assumes replacement cost of $33,000 per capacitor bank to enable SCADA, 20 units in 2022, 34 units in 2023, 40 units in 2024, 44 units in 2025, 46 units in 2026
(10) Forecast assumes replacement cost of $150,000 per regulator bank to enable SCADA, 5 units in 2022, 9 units in 2023, 10 units in 2024, 11 units in 2025, 12 units in 2026
(11) Forecast reflects an increasing rate of new applications for service that require capacity work to serve.

Workpaper Table 17-16
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
MWC 46 Forecast Calculation
(Thousands of Nominal Dollars)

Line No.	MWC 46	Description	Recorded by MAT Code					Recorded Adjusted - 2018-2019 Escalated and 2020 Actuals			Forecast Basis	Escalated Forecast						Assumptions	Reference
			2016 Actuals	2017 Actuals	2018 Actuals	2019 Actuals	2020 Actuals	2018 Actuals Escalated to 2020	2019 Actuals Escalated to 2020	2020 Actuals	2018-2020 3 Year Average	2021-2022 Forecast including Escalation		2023-2026 Forecast Including Escalation					
												2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast		
1	46# - Energy Storage	Renz (Llagas) Energy Storage	$ -	$ -	$ 8	$ 185	$ 696	$ 9	$ 192	$ 696	$ 299	$ -	$ -	$ -	$ -	$ -	$ -	Project forecast under 46A Planning Order	WP 17-20, line 62
2	46A - Normal Capacity Deficiencies	Bank and Feeder Work identified based on load forecasting	$ 19,221	$ 6,812	$ 1,921	$ 6,732	$ 6,359	$ 2,099	$ 6,954	$ 6,359	$ 5,137	$ 34,848	$ 28,888	$ 15,743	$ 8,332	$ 5,645	$ 801	Specifically Identified Projects	WP 17-20
3	46F - Emergency and Operational Capacity	Bank and Feeder Work identified to ensure emergency capacity and operational flexibility in the system	$ 1,754	$ 1,295	$ 5,890	$ 7,120	$ 11,942	$ 6,437	$ 7,354	$ 11,942	$ 8,578	$ 17,773	$ 8,768	$ 977	$ 3,241	$ 4,995	$ -	Specifically Identified Projects	WP 17-20
4	46H - New Business Related Capacity	Bank and Feeder Work identified to meet customer applications	$ 17,447	$ 3,824	$ 2,569	$ 3,578	$ 17,226	$ 2,807	$ 3,696	$ 17,226	$ 7,910	$ 18,198	$ 17,647	$ 25,740	$ 29,715	$ -	$ -	(2)	WP 17-20
5	46H - New Business Related (Includes Emergent Work)	Bank and Feeder Work as yet to be identified, based on historical expenditures, and identified capacity projects < $3M	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,032	$ 9,887	$ 15,622	$ 26,774	$ 61,345	$ 73,927	(1) (2)	WP 17-20, line 80 and WP 17-75
6	46N - Land Purchases and New Distribution Substation	Work to support new substation siting and construction	$ 4,085	$ 5,199	$ 2,052	$ 285	$ 46	$ 2,242	$ 295	$ 46	$ 861	$ 30	$ -	$ -	$ -	$ -	$ -	(3)	
7	46T - Support for Transmission and Substation Related Work	Bank and Feeder work to support Substation or Transmission projects that require reconfiguration of distribution assets	$ 353	$ 223	$ (63)	$ -	$ -	$ (69)	$ -	$ -	$ (23)	$ -	$ -	$ -	$ -	$ -	$ -	(4)	
8		**Sub-Total 46H**	**$ 17,447**	**$ 3,824**	**$ 2,569**	**$ 3,578**	**$ 17,226**	**$ 2,807**	**$ 3,696**	**$ 17,226**	**$ 7,910**	**$ 26,230**	**$ 27,534**	**$ 41,363**	**$ 56,488**	**$ 61,345**	**$ 73,927**		
9		**MWC 46 Sum**	**$ 42,860**	**$ 17,354**	**$ 12,376**	**$ 17,900**	**$ 36,270**	**$ 13,526**	**$ 18,491**	**$ 36,270**	**$ 22,762**	**$ 78,880**	**$ 65,191**	**$ 58,082**	**$ 68,061**	**$ 71,985**	**$ 74,728**		

Electric Construction Cost Escalation Factors

	Year	Electric Distribution Escalation Factor
Escalate 2016 to Constant 2020 $	2016	1.164
Escalate 2017 to Constant 2020 $	2017	1.127
Escalate 2018 to Constant 2020 $	2018	1.093
Escalate 2019 to Constant 2020 $	2019	1.033
2020 Constant Dollar (2020=1)	2020	1.000

Forecast Assumptions and Reference

(1) Forecast reflects timing criteria for new substation projects; newly identified projects require less funding in the short term and increased funding in the outer years as construction starts.
(2) Forecast reflects an increasing rate of new applications for service that require capacity work to serve.
(3) New Distribution Substation projects are typically identified several years in advance. At this time no New Distribution Substation projects are planned.
(4) Transmission and Substation projects are typically identified several years in advance. At this time no Transmission and/or Substation projects need to replace or reconfigured distribution assets.

Workpaper Table 17-17
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Forecast Capital Expenditures - Projects Less Than $3M; Including Escalation
(Thousands of Nominal Dollars)

								CAPITAL EXPENDITURES									
No.	Planning Order	Project Description	MWC	DPA	Functional Group	Operative Date	UCC	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Comment	Reference
1	5795538	San Luis Obispo 1106 Feeder Installation - Line Work	06A	San Luis Obispo	EDP	5/1/23	301			$ 50	$ 2,000					WP 17-20, Line 5
2	5791998	Replace Vina Bank 1 - Line Work	06A	Corning 12 KV	EDP	7/1/21	301		$ 62							WP 17-20, Line 34
3	5791524	Alpaugh Sub Install Feeder-Dis Work	06A	Corcoran	EDP	10/1/22	301	$ -	$ 98	$ 1,802						WP 17-20, Line 19
4	5791418	Storey Sub, Install New 12 kV Feeder - Line Work	06A	Storey	EDP	5/1/23	301	$ -	$ -	$ 100	$ 900					WP 17-20, Line 79
5	5791019	Zamora Sub: Install New 12 kV Feeder - Line Work	06A	Yolo AG (North)	EDP	5/1/24	301					$ 500				WP 17-20, Line 41
6	5795536	Morgan Hill: Install New 21kV Feedr 2103 - Line Work	06A	Morgan Hill/Gilroy	EDP	6/1/23	301			$ 250	$ 1,000					WP 17-20, Line 64
7	5790664	Lockeford Sub, Replace Bank 1 - Line Work	06A	Lodi	EDP	5/1/25	301					$ 500	$ 2,000			WP 17-20, Line 68
8	5780328	FMC Sub, Install New Feeder - Line Work	06A	Downtown San Jose 12 KV	EDP	6/1/23	301			$ 50	$ 900					WP 17-20, Line 63
9	5795539	San Miguel Install Bank 2 - Line Work	06A	Paso Robles	EDP	6/1/23	301				$ 1,000					WP 17-20, Line 34
10	5786338	Install Bank at Monterey Sub, Distrib	06A	Monterey 4KV	EDP	12/31/22	301	$ 1,346	$ 1,554							WP 17-20, Line 3
11	5779534	Dairyland, Install new feeder dist line	06A	Chowchilla	EDP	4/1/22	301	$ 54	$ 2,772							WP 17-20, Line 77
12	5781479	Pueblo Bank 2> 10MW Deficiency	06A	Napa	EDP	6/1/22	301	$ 17		$ 2,751						WP 17-20, Line 30
13	5783940	2020 Dinuba 1103 Fdr (was 1107)	06A	Reedley	EDP	6/1/21	301	$ 103	$ 7	$ 1,377						WP 17-20, Line 14
14	5537283	Valley Springs 1102 Dist Work	06A	Jackson	EDP	1/31/22	301	$ -	$ 100	$ 1,348						WP 17-20, Line 67
15	5780359	Bogue, Install New Feeder	06A	Yuba City	EDP	6/1/22	301	$ 25	$ 17	$ 1,327						WP 17-20, Line 57
16	5779679	Rainbow, Install new feeder distribution	06A	Sanger	EDP	6/1/21	301	$ 51	$ 998							WP 17-20, Line 15
17	5788621	Monterey Sub Phase 1: Install 21/4kV	06A	Monterey 4KV	EDP	12/31/22	301	$ 10	$ 20	$ 2,869						WP 17-20, Line 3
18	5780327	Camp Evers Sub Install Feeder-Dis Work	06A	Santa Cruz Area	EDP	5/1/22	301	$ 2	$ 98	$ 695						WP 17-20, Line 41
19	5503048	Transformer Repl Overloaded-SI	06B	-	EDP		301	$ 1	$ -							
20	5500879	Circuits Reinforce-DP Managed-ST	06D	-	EDP		301	$ 1	$ 448							
21	5500855	Circuits Reinforce-DP Managed-KE	06D	-	EDP		301	$ 12	$ 17	$ 180						
22	5500837	Circuits Reinforce-DP Managed-DA	06D	-	EDP		301	$ 1	$ 189							
23	5500877	Circuits Reinforce-DP Managed-SI	06D	-	EDP		301	$ -	$ 0							
24	5787760	Cassidy 2107 and 2108 cutover Ph 4	06E	Rio Mesa	EDP	10/1/22	301	$ 763	$ 49	$ 1,928						
25	5770018	Install Mesa 1104 Feeder PH2	06E	Oceano	EDP	6/1/21	301	$ 1,685	$ 1,122							
26	5779293	Avena 4kV Cut-over	06E	Manteca 17 KV	EDP	12/1/22	301	$ 53	$ 2,514							WP 17-45
27	5785940	Tulare Lake 1108 Create New Tie	06E	Kettleman	EDP	12/1/21	301	$ 250	$ 1,901							
28	5787580	Cassidy 2107 and 2108 cutover Ph 3	06E	Rio Mesa	EDP	10/1/22	301	$ 427	$ 903	$ 826						
29	5794614	Tracy 4KV Cut-over (AKA 74015807)	06E	Tracy	EDP	11/1/22	301	$ 38	$ 29	$ 2,121						WP 17-45
30	5503059	Circuits Reinforce-PS Managed-SA	06E	-	EDP		301	$ 9	$ 1	$ 1,979						
31	5769082	Station "M" rebuild	06E	Martin	EDP	3/4/21 COMPLETE	301	$ 1,098	$ 443							
32	5503011	Circuits Reinforce-PS Managed-FR	06E	-	EDP		301	$ 2	$ 1,394							
33	5790703	X1110 Circuit Reinforcement_Extension	06E	Mission	EDP	6/1/22	301	$ 2		$ 1,038						
34	5787799	Cassidy 2107 and 2108 cutover Ph 6	06E	Rio Mesa	EDP	10/1/22	301	$ 8	$ 41	$ 364	$ 618					
35	5502963	Circuits Reinforce-PS Managed-MI	06E	-	EDP		301	$ 11	$ 274	$ 701						
36	5502939	Circuits Reinforce-PS Managed-SF	06E	-	EDP		301	$ 3		$ 907						
37	5503051	Circuits Reinforce-PS Managed-NV	06E	-	EDP		301	$ 1	$ 751							
38	5791363	Bakersfield distribution circuit outlet	06E	Urban Bakersfield East	EDP	12/1/23	301	$ 15	$ 1	$ 0	$ 711					
39	5787798	Cassidy 2107 and 2108 cutover Ph 5	06E	Rio Mesa	EDP	10/1/22	301	$ 21	$ 567							
40	5503019	Circuits Reinforce-PS Managed-LP	06E	-	EDP		301	$ 14	$ (121)	$ 662						
41	5508963	Circuits Reinforce-PS Managed-HB	06E	-	EDP		301	$ -	$ 431							
42	5790419	TRACY 4KV CUT-OVER - Phase III	06E	Tracy	EDP	11/1/22	301	$ 4	$ 43	$ 192						WP 17-45
43	5790418	TRACY 4KV CUT-OVER - Phase II	06E	Tracy	EDP	11/1/22	301	$ 3	$ 43	$ 192						WP 17-45
44	5778171	Tracy 4kV Cut-Over	06E	Tracy	EDP	11/1/22	301	$ -	$ 1	$ 1						WP 17-45
45	5502979	Circuits Reinforce-PS Managed-CC	06E	-	EDP		301	$ -	$ 3							
46	5502949	Voltage Correct Secondary-PN	06G	-	EDP		301	$ 6								
47	5792379	Jarvis - Install 1102	06H	Fremont 12 kV	EDP	6/1/22	301		$ 100	$ 2,865						
48	5791145	Vierra Sub line work for new feeder	06H	Manteca 17 KV	EDP	5/1/22	301			$ 100	$ 1,100					WP 17-20, Line 70
49	5795533	Dunnigan Sub: Install New Bank & Feeder - Line Work	06H	South Colusa	EDP	4/1/24	301				$ 100	$ 1,100				WP 17-20, Line 40
50	5789738	DOLAN: Install New Bank - Line Work	06H	Prunedale	EDP	10/1/21	301		$ 1,225							WP 17-20, Line 2
51	5795531	Belle Haven Replace Bank 4 - Line Work	06H	South Pen East 12 KV	EDP	5/1/24	301					$ 1,000				WP 17-20, Line 37
52	5795535	Millbrae Sub:Inst Bk 2 and 1109 Fdr - Line Work	06H	North Pen East 4 KV	EDP	5/1/24	301				$ 100	$ 1,500				WP 17-20, Line 38
53	5795532	Calistoga Substation, Replace Bank 1 - Line Work	06H	Silverado	EDP	5/1/23	301			$ 150	$ 1,000					WP 17-20, Line 32
54	5790780	Greenbrae Sub, Replace Bank 2 - Line Work	06H	Marin (Southern)	EDP	4/1/23	301				$ 500					WP 17-20, Line 31
55	5795537	Ripon Sub: Install New 17kV Feeder - Line Work	06H	Manteca 17 KV	EDP	5/1/24	301					$ 500				WP 17-20, Line 71
56	5795534	Hollister 2107 Feeder Installation - Line Work	06H	Hollister	EDP	6/1/23	301			$ 150	$ 750					WP 17-20, Line 5
57	5503033	New Business Capacity Prj-YO PM Managed	06H	-	EDP		301	$ 29	$ 1,589	$ 1,312						
58	5787582	35115631 Kingsburg 1111 & 1113 Capacity	06H	Kingsburg	EDP	6/1/21	301	$ 677	$ 1,674							
59	5792198	Millbrae 1105 ckt Extension	06H	North Pen East 12 KV	EDP	6/1/21	301	$ 4	$ 2,634							
60	5503081	New Business Capacity Prj-NB	06H	-	EDP		301	$ 7	$ 2,514							
61	5503009	New Business Capacity Prj-KE PM Managed	06H	-	EDP		301	$ 122	$ 1,041	$ 1,244						
62	5794335	CORCORAN 1112/1116 – reconductor and new	06H	Corcoran	EDP	6/1/21	301	$ 29	$ 2,417							
63	5503041	New Business Capacity Prj-ST	06H	-	EDP		301	$ 16	$ 1,289	$ 829						
64	5789502	Dixon Landing 2105 Extend Feeder	06H	Milpitas 21 KV	EDP	6/1/21	301	$ 51	$ 2,150							
65	5787807	Coalinga NO2 1106 Pistachio Plant	06H	Coalinga	EDP	6/1/21	301	$ 43	$ 2	$ 2,028						
66	5768822	Bair 1101 Feeder Ext. to Harbor View	06H	South Pen East 12 KV	EDP	5/1/22	301	$ -	$ 32	$ 1,844						
67	5790380	Tejon 1107 Distribution Work	06H	Arvin	EDP	5/1/22	301	$ 55	$ 1,720							WP 17-20, Line 21
68	5788795	Tulare Lake 1104 Reinforcement	06H	Kettleman	EDP	6/1/21	301	$ 42	$ 1,392							
69	5502947	Circuits Reinforce-PS Managed-PN	06H	-	EDP		301	$ 3	$ 0	$ 1,301						
70	5503057	New Business Capacity Prj-NV	06H	-	EDP		301	$ 0	$ 835							
71	5787302	Merced 1114: Reconductoring and Equipmen	06H	Merced 12 KV	EDP	6/1/21	301	$ 325	$ 584							
72	5503073	New Business Capacity Prj-SO	06H	-	EDP		301	$ 1	$ 774							
73	5789020	Newark 2111 Install New Feeder	06H	Fremont 21 KV	EDP	6/1/21	301	$ 12	$ 589							WP 17-20, Line 28
74	5536703	7th Standard 2102: Convert 3 wire to 4 w	06H	Urban Bakersfield Northwest	EDP	6/1/21	301	$ -	$ 587							
75	5502953	New Business Capacity Prj-PN	06H	-	EDP		301	$ 0		$ 159						
76	5503025	New Business Capacity Prj-LP PM Managed	06H	-	EDP		301	$ 2	$ 140							
77	5758159	Install Rio Bravo Feeder	06H	Lerdo	EDP	5/14/19 COMPLETE	301	$ -	$ 120							
78	5790701	A1119 Circuit Reinforcement	06H	Potrero	EDP	12/1/21	301	$ 10	$ 38							
79	5746706	MWC 06-Replace Santa Nella Bank #2	06H	Canal	EDP	5/1/22	301	$ -	$ 0	$ 1	$ 0					WP 17-20, Line 78

Workpaper Table 17-17
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Forecast Capital Expenditures - Projects Less Than $3M; Including Escalation
(Thousands of Nominal Dollars)

								CAPITAL EXPENDITURES								
No.	Planning Order	Project Description	MWC	DPA	Functional Group	Operative Date	UCC	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Comment	Reference
80	5533518	Wilkins Slough 1102 Reconductoring	06H	Yolo/Colusa River AG	EDP	10/30/2019 COMPLETE	301	$ -	$ (78)							
81	5787440	Oceano 1108 Feeder Extension	06H	Oceano	EDP	12/20/20 COMPLETE	301	$ -	$ (126)							
82	5502962	Operational Capacity Proj-EB	06I	-	EDP		301	$ 51	$ 121	$ 1,595	$ 791					
83	5503082	Operational Capacity Proj-NB	06I	-	EDP		301	$ 125	$ 2,064							
84	5503010	Operational Capacity Proj-KE	06I	-	EDP		301	$ 1,392	$ 76							
85	5502978	Operational Capacity Proj-DI	06I	-	EDP		301	$ 152	$ 935	$ 284						
86	5503050	Operational Capacity Proj-SI	06I	-	EDP		301	$ 1	$ 1,312							
87	5502946	Operational Capacity Proj-SF	06I	-	EDP		301	$ 32	$ (0)	$ 1,201						
88	5503066	Operational Capacity Proj-SA	06I	-	EDP		301	$ 2		$ 1,166						
89	5503018	Operational Capacity Proj-FR	06I	-	EDP		301	$ 723	$ 392							
90	5503034	Operational Capacity Proj-YO	06I	-	EDP		301	$ 35	$ 1	$ 669						
91	5503026	Operational Capacity Proj-LP	06I	-	EDP		301	$ 76	$ 137	$ 394						
92	5502986	Operational Capacity Proj-CC	06I	-	EDP		301	$ 26	$ 396							
93	5530179	East Grand 1106 Reduce LD 600A	06I	North Pen East 12 KV	EDP	5/1/21	301	$ 23	$ 364							WP 17-3, Line 1
94	5503042	Operational Capacity Proj-ST	06I	-	EDP		301	$ 5	$ (0)							
95	5523517	Enable DG Dist Line-YO	06P	-	EDP		301	$ 19	$ -	$ -						
96	5523503	Enable DG Dist Line-FR	06P	-	EDP		301	$ 26	$ -	$ -						
97			**06 Total**					**$ 10,152**	**$ 45,814**	**$ 41,003**	**$ 11,471**	**$ 5,100**	**$ 2,000**	**$ -**		
98	5779505	Alpaugh Sub:Install Alpaugh 1102 Fdr	46A	Corcoran	EDP	10/1/22	301	$ 21	$ 150	$ 1,223	$ -	$ 6				WP 17-20, Line 19
99	5787238	ROCKLIN: Install New 12 kV Feeder	46A	South Placer	EDP	5/1/25	301	$ -		$ -	$ 150	$ 450	$ 800			WP 17-20, Line 59
100	5790740	Potrero A1113 Recable inside Sub	46A	Potrero	EDP	12/1/21	301	$ -	$ 473	$ 832						WP 17-20, Line 54
101	5790746	Mission X 1120 Recable inside Sub	46A	Mission	EDP	12/1/21	301	$ -	$ 473	$ 832						WP 17-20, Line 48
102	5791298	San Luis Obispo 1106 Feeder Installation	46A	San Luis Obispo	EDP	5/1/23	301	$ -	$ 150	$ 450	$ 800					WP 17-20, Line 23
103	5791238	Storey Sub, Install New 12 kV Feeder	46A	Storey	EDP	5/1/23	301	$ -	$ 150	$ 450	$ 800					WP 17-20, Line 79
104	5790861	Saratoga Sub - Install New 12 kV Feeder	46A	Cupertino	EDP	5/1/26	301	$ -				$ 150	$ 450	$ 800		WP 17-20, Line 10
105	5787239	Zamora Sub: Install New 12 kV Feeder	46A	Yolo AG (North)	EDP	5/1/24	301	$ -		$ 150	$ 450	$ 800				WP 17-20, Line 41
106	5790899	MORGAN HILL: Install New 21kV Feedr 2103	46A	Morgan Hill/Gilroy	EDP	6/1/23	301	$ -	$ 150	$ 450	$ 800					WP 17-20, Line 64
107	5779283	VASONA: Install New Feeder	46A	Los Gatos	EDP	12/1/21	301	$ 563	$ -							WP 17-20, Line 7
108	5786670	Lammers: Install 1108 Feeder	46A	Tracy	EDP	4/1/22	301	$ 2	$ 100	$ 1,298						WP 17-20, Line 74
109	5779504	DAIRYLAND: Install Feeder	46A	Chowchilla	EDP	4/1/22	301	$ 30	$ 625	$ 12						WP 17-20, Line 77
110	5780325	Camp Evers Sub - Install Feeder	46F	Santa Cruz Area	EDP	5/1/22	301	$ 79	$ 121	$ 1,200						WP 17-20, Line 4
111	5772980	ROSSMOOR: INST 1109 FDR AND REINF TIES	46F	Walnut Creek 12 KV	EDP	10/1/21	301	$ 1,169	$ 383							WP 17-20, Line 11
112	5780318	BOGUE: Install Feeder	46F	Yuba City	EDP	6/1/22	301	$ 440	$ 787							WP 17-20, Line 57
113	5780362	FMC Sub, Install New Feeder	46F	Downtown San Jose 12 KV	EDP	6/1/23	301	$ -	$ 150	$ 450	$ 800					WP 17-20, Line 63
114	5786238	Valley Springs: Install 1102 Feeder	46F	Jackson	EDP	1/31/22	301	$ 9	$ -	$ -						WP 17-20, Line 67
115	5780363	Brentwood Sub Install Brentwood 2104 Fdr	46F	Brentwood	EDP	5/1/22	301	$ 328	$ 651							WP 17-20, Line 12
116	5792380	Jarvis install 1102	46H	Fremont 12 KV	EDP	6/1/22	301		$ 500	$ 700						WP 17-20, Line 27
117	5790914	WOLFE: Install 12 kV Feeders 1115, 1116	46H	Cupertino	EDP	5/1/25	301	$ -			$ 150	$ 1,000	$ 1,650			WP 17-20, Line 9
118	5790251	Tejon: Install 1107 Circuit Breaker	46H	Arvin	EDP	5/1/22	301	$ 16	$ 193	$ 2,074	$ 17					WP 17-20, Line 21
119	5785511	POTRERO: INSTALL NEW FEEDER A 1120 BRK	46H	Potrero	EDP	6/1/22	301	$ 189	$ 1,736	$ 121						WP 17-20, Line 52
120	5790020	Vierra Sub: Install New 17kV Feeder	46H	Manteca 17 KV	EDP	5/1/22	301	$ 2		$ 598	$ 800					WP 17-20, Line 70
121	5790021	Ripon Sub: Install New 17kV Feeder	46H	Manteca 17 KV	EDP	5/1/24	301	$ -		$ 150	$ 450	$ 800				WP 17-20, Line 71
122	5790741	Potrero A1119 Recable inside Sub	46H	Potrero	EDP	12/1/21	301	$ -	$ 475	$ 835						WP 17-20, Line 55
123	5787198	Deepwater Sub, Install New 12 kV Feeder	46H	West Sacramento	EDP	12/1/22	301	$ 486	$ 1,025							WP 17-20, Line 39
124	5790738	Potrero A1117 Recable inside Sub	46H	Potrero	EDP	8/1/22	301	$ -		$ 898	$ 408					WP 17-20, Line 56
125	5790744	Mission X 1101 Recable inside Sub	46H	Mission	EDP	12/1/21	301	$ -		$ 1,306						WP 17-20, Line 49
126	5791243	Mission X1113 Re-cable inside sub	46H	Mission	EDP	12/1/21	301	$ -	$ 473	$ 832						WP 17-20, Line 47
127	5790739	Potrero A1108 Recable Inside Sub	46H	Potrero	EDP	12/1/21	301	$ -	$ 451	$ 832						WP 17-20, Line 53
128	5788964	Newark Sub Install Newark 2111 Fdr	46H	Fremont 21 KV	EDP	6/1/21	301	$ 217	$ 1,047							WP 17-20, Line 28
129	5792398	Hollister 2107 Feeder Installation	46H	Hollister	EDP	6/1/23	301	$ -	$ 150	$ 450	$ 800					WP 17-20, Line 5
130	5789638	Martin (SF H) 1117: Install New Feeder	46H	Martin	EDP	6/1/22	301	$ -	$ 600	$ 800						WP 17-20, Line 43
131	5784872	MISSION SF X X1129 INSTALL FEEDER	46H	Mission	EDP	6/1/22	301	$ 263	$ 853	$ 4						WP 17-20, Line 46
132	5784519	MISSION SF X X1127 INSTALL FEEDER	46H	Mission	EDP	9/27/20 COMPLETE	301	$ 672	$ 350							WP 17-20, Line 44
133	5768811	HIGHWAY: Add New Feeder	46H	Vallejo	EDP	12/1/21	301	$ 910	$ 91	$ 4						WP 17-20, Line 29
134	5784931	MISSION SF X X1128 INSTALL FEEDER	46H	Mission	EDP	2/17/21 COMPLETE	301	$ 611	$ 180							WP 17-20, Line 45
135	5792882	Tulucay, Install New Feeder	46H	Napa	EDP	5/1/23	301	$ -	$ 150	$ 200	$ 350					WP 17-20, Line 33
136	5534939	East Grand Sub_EG1116_1117 FDRS	46H	North Pen East 12 KV	EDP	12/1/21	301	$ -	$ 167							WP 17-20, Line 35
137			**46 Total**					**$ 6,007**	**$ 12,804**	**$ 17,153**	**$ 6,775**	**$ 3,206**	**$ 2,900**	**$ 800**		
138			**Capacity Total**					**$ 16,160**	**$ 58,618**	**$ 58,156**	**$ 18,245**	**$ 8,306**	**$ 4,900**	**$ 800**		

Comment Details

(1) Projects are individually identified based on current load forecasting methodology; specific cost estimates are developed for each project.
(2) System Planning Orders for non-specific projects in each division, grouped in one order for forecasting purposes.
(3) System Planning Orders for non-specific projects in each division (escalation), grouped in one order for forecasting purposes.

Workpaper Table 17-18
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Forecast Capital Expenditures- Projects Detail, Including Escalation
(Thousands of Nominal Dollars)

Line No.	Division	Project Description	DPA	Substation	Project Result of Em Def (Y or N)	Project Result of >5000 Cust or >600 A per Fdr (Y or N)	Project >$3M (Y or N)	EV Related	Maximum Deficiency in GNA Window (2021-2025) (MW)	Maximum Deficiency in GNA Window (2021-2025) (%)	RBA	MWC 06 (Specific PO)	MWC 46 (Specific PO)	Proposed Work
1	Central Coast	Install Soledad Bk 7 (formerly Replace Soledad Bank #2)	Soledad/Greenfield	Soledad	Y	N	Y	N	11.5	-		5781858 5786181	5747659 5766520	Install Soledad Bank #7 45 MVA 115/21 kV transformer to eliminate an 18 MW emergency deficiency
2	Central Coast	Dolan Rd. Sub - Install New Bank	Prunedale	Dolan Road	N	N	Y	N	8.6	31		5789738	5779285	Install new 45 MVA bank and 12 kV feeder
3	Central Coast	Rebuild Monterey Substation/Del Monte Cust Count Reduction	Monterey 4KV	Monterey	N	Y	Y	N	-	-		5758745 5786338 5788621	5769274	Rebuild Monterey Substation, replace 4 kV station equipment with 12 kV banks and breakers to reduce the number of customers on several Del Monte circuits to less than 6000
4	Central Coast	Camp Evers - Install New Circuit: 2107	Santa Cruz Area	Camp Evers	N	Y	N	N	-	-		5780327	5780325	Install new Camp Evers 2107 to reduce customer count on Camp Evers 2106 to less than 6000 customers
5	Central Coast	Hollister - Install New Feeder on Bank 2	Hollister	Hollister	N	N	N	Y	20.6	48		5795534	5792398	Extend 12 kV substation bus, install new feeder breaker, and extend feeder to new cannabis greenhouses and EV fleet charging
6	Central Coast	Spence Bank 2 Replacement	Salinas	Spence	N	N	Y	N	11.4	97		5795541	5790898	Replace Spence Bank 2, extend new 1106 feeder to new cannabis greenhouses
7	DeAnza	Vasona Sub - Install New Feeder (1108)	Los Gatos	Vasona	N	N	Y	Y	2.5	16		5780358	5779283	Install new breaker in existing switchgear, extend feeder to offload Los Gatos substation transformers
8	DeAnza	Mountain View - Replace Bk 1	Mountain View	Mountain View	N	N	Y	Y	7.5	25		-	5790962	Replace 30 MVA bank with 45 MVA bank in order to serve new EV charging. No line work.
9	DeAnza	Wolfe Install 2 New Circuits: 1115 and 1116 for Vallco	Cupertino	Wolfe	N	N	Y	N	2.7	24		5795543	5790914	Extend 12 kV bus, install two feeder breakers and extend feeders to serve new development load at site of old Vallco Mall
10	DeAnza	Saratoga Sub - Install new feeder	Cupertino	Saratoga	N	N	Y	N	2.6	21		5795540	5790861	Extend 12 kV bus, install one feeder breaker and extend feeder to offload other Saratoga circuits
11	Diablo	Moraga Bk 5 Emerg - Install Rossmoor 1109 Fdr	Walnut Creek 12 KV	Rossmoor	Y	N	Y	N	13.4	-		5772954 5773378	5747115 5772980	Extend 12 kV bus, install one feeder breaker and extend feeder to create ties with Moraga feeders
12	Diablo	Install Brentwood 2104 Feeder	Brentwood	Brentwood	N	Y	Y	N	-	-		5780360	5780363	Extend 12 kV bus, install one feeder breaker and extend feeder to transfer load from Brentwood 2112 feeder to reduce load and customer count
13	Diablo	Replace Willow Pass Bank 1	Clayton/Willow Pass	Willow Pass	N	N	Y	N	10.2	34		5790220	5790245	Reconfigure 115 kV bus, replace Willow Pass Bank 2 with a 45 MVA transformer, install 21 kV overhead bus and three 21 kV feeders, extend feeders, install two 21/12 kV autobanks
14	Fresno	Install Dinuba 1103	Reedley	Dinuba	N	N	N	N	1.1	9		5783940	5779204	Extend 12 kV bus, install one feeder breaker and extend feeder to relieve overloads on Dinuba 1104.
15	Fresno	Install Rainbow 1103	Sanger	Rainbow	N	N	N	N	2.4	8		5779679	5779284	Extend 12 kV bus, install one feeder breaker and extend feeder to relieve overloads on Sanger Bank 1
16	Fresno	Replace Tulare Lake Bank 1	Kettleman	Tulare Lake	N	N	Y	Y	5.5	52		5788795	5785560	Replace Tulare Lake Bank 1 with 30 MVA and replace Tulare Lake 1100 & 1104 circuit breakers to serve new EV charging load
17	Fresno	Huron Sub - Replace Bank 1	Gates	Huron	N	N	Y	N	0.7	4		-	5782301	Replace Huron Bk 1 due to reverse-flow overload at maximum PV generation and min load
18	Fresno	Cadfiax - Install New Bank: Bank 2	Gates	Cadfiax	N	N	Y	Y	9.7	49		5779536	5779506	Install new Cadfiax Bank 2 and two new 12 kV circuits to serve new EV charging load
19	Fresno	Install Alpaugh 1102	Corcoran	Alpaugh	N	N	Y	N	1.9	16		5791524	5779505	Install new circuit breaker and extend feeder to offload Corcoran circuits
20	Humboldt	Garberville Circuit & Substation Reinforcement	Garberville	Garberville	N	N	Y	N	6.8	55		5794083	5786128	Install transmission circuit switcher, new substation bank and new autotransformer. Install 65,000' of express feeder, 87,815' of reconductoring in order to serve indoor cultivation load
21	Kern	Teion Sub - Install 1107 Feeder	Arvin	Teion	N	N	Y	Y	2.4	23		5790380	5790251	Install 12 kV circuit breaker in available bay and extend feeder to serve new EV charging load
22	Kern	Replace Blackwell Bank 1 for PV reverse flow bank loading	Blackwell	Blackwell	N	N	Y	N	1.1	9		-	5790872	Replace Blackwell Bank 1 for reverse-flow overload at maximum PV generation and min load
23	Los Padres	Install San Luis Obispo 1106 Feeder	San Luis Obispo	San Luis Obispo	N	N	Y	Y	2.4	28		5795538	5791298	Expand substation yard fence, extend 12 kV bus, install one feeder breaker and extend feeder to offload Foothill Bank 1
24	Los Padres	San Miguel - Install 30 MVA Bank	Paso Robles	San Miguel	N	N	Y	N	2.6	16		5795539	5794990	Expand substation fence, extend 12kV bus, install 12 kV breaker, extend feeder to offload San Miguel Bank 1
25	Mission	Replace Jarvis Bank #2	Fremont 12 KV	Jarvis	N	Y	Y	N	-	-		5763923 5782238	5763889	Replace Jarvis Bank #2 with a 45 MVA transformer and extend Feeder Jarvis 1107 to reduce customer counts below 6000 customers on multiple Jarvis circuits
26	Mission	Replace Dumbarton Bank 2	Fremont 12 KV	Dumbarton	N	N	Y	N	1.9	7		-	5790334	Replace Dumbarton Bank 2 with a 45 MVA transformer
27	Mission	Jarvis Sub:Install Jarvis 1102 Feeder	Fremont 12 KV	Jarvis	N	N	Y	N	2.3	8		5792379	5792380	Install new 12 kV breaker and extend feeder to serve new load
28	Mission	Install Newark 2111 Feeder	Fremont 21 KV	Newark	N	N	N	N	10.6	53		5789020	5788964	Install new circuit breaker for Newark 2111 on existing 12 kV bus, extend feeder to serve new load
29	North Bay	Add new feeder breaker on Highway bank 1	Vallejo	Highway	N	N	Y	N	1.9	16		5777583	5768811	Install new 12 kV breaker and extend feeder to serve new load
30	North Bay	Pueblo Install New Bank: Bank 3	Napa	Pueblo	Y	N	Y	N	14.9	-		5781479	5780188	Install Pueblo Bank 3 - 45 MVA transformer and one feeder to address emergency bank loss
31	North Bay	Replace Greenbrae Bank 2	Marin (Southern)	Greenbrae	N	N	Y	N	2.0	13		5790780	5789999	Replace Bank 2 to serve new load
32	North Bay	Replace Calistoga Bank 1 and Install 1 new feeder	Silverado	Calistoga	N	N	Y	N	2.6	16		5795532	5791138	Replace Calistoga Bank 1 with a 30 MVA transformer, install 1 new 12kV breaker, and extend feeder to serve new load
33	North Bay	Install Tulucay 1102	Napa	Tulucay	N	N	Y	N	8.0	53		5795542	5792882	Extend feeder from existing breaker to serve new load
34	North Valley	Replace Vina Bank 1	Corning 12 KV	Vina	N	N	Y	N	0.2	7		5791998	5783898	Replace Vina Bank 1
35	Peninsula	Install East Grand 1116 & East Grand 1117	North Pen East 12 KV	East Grand	N	N	Y	N	7.6	59		5530139	5534939	Install East Grand 1116 and 1117 feeder in spare switchgear cells. Extend East Grand 1116 and 1117 feeders to serve new load
36	Peninsula	INSTALL NEW BAIR1101 CIRCUIT	South Pen East 12 KV	Bair	N	N	N	N	8.0	66		5768822	-	Extend new Bair 1101 circuit from existing circuit breaker to serve new load
37	Peninsula	Belle Haven Bk 4, Repl w 30MVA and Inst BH 1109 Fdr	South Pen East 12 KV	Belle Haven	N	N	Y	N	1.7	11		5795531	5791141	Replace Belle Haven Bk3 with 30 MVA bank, add 12 kV circuit breaker, extend feeder to serve new load
38	Peninsula	Millbrae Sub: Install Bank 2 and Millbrae 1109 Fdr	North Pen East 12 KV	Millbrae	N	N	Y	N	7.7	66		5795535	5791142	Install new substation transformer and new circuit breaker. Extend new feeder to serve new load
39	Sacramento	Install Deepwater 1110 & 1111	West Sacramento	Deepwater	N	N	Y	N	3.9	30		5787339	5787198	Install two circuit breakers on Deepwater Bank 3, extend feeders to serve new load
40	Sacramento	Replace Dunnigan Bank 1 and Install 1102 Feeder	South Colusa	Dunnigan	N	N	Y	Y	1.6	20		5795533	5790009	Replace Dunnigan Bank 1, install 1102 feeder breaker, and extend feeder to serve new EV and cannabis load
41	Sacramento	Install Zamora 1108	Yolo AG (North)	Zamora	N	N	N	N	0.1	1		5791019	5787239	Install new circuit breaker to transfer circuit from Bank 1 to Bank 2
42	San Francisco	Embarcadero Z_21118 Recable inside Sub	Embarcadero	Embarcadero (SF Z)	N	N	N	N	0.4	4		5790709	5790749	Recable feeder to serve new load
43	San Francisco	Install New Feeder Martin (SF H) 1117	Martin (SF H)	Martin (SF H)	N	N	Y	N	7.7	64		5789862 5789606	5789638	Extend 12 kV Bus, install 12 kV Breakers, extend feeder to serve new load
44	San Francisco	Oceanwide Center SF New Feeder Mission X 1127	Mission	Mission (SF X)	N	N	Y	N	4.6	47		- 5780540	- 5784519	Install new feeder at SF Mission X substation, X 1127 utilizing the SP4 spare feeder bay, extend feeder to Oceanwide Center
45	San Francisco	Install New Feeder Mission (SF X) 1128	Mission	Mission (SF X)	N	N	Y	N	1.8	18		5784958	5784931	Extend feeder to serve new load
46	San Francisco	Install New Feeder Mission (SF X) 1129	Mission	Mission (SF X)	N	N	Y	N	6.8	115		5787581	5784872	Extend feeder to serve new load
47	San Francisco	Mission X1113 Circuit Reinforcement	Mission	Mission (SF X)	N	N	Y	Y	4.9	40		5791320	5791243	Recable feeder to serve new load
48	San Francisco	Mission X 1120 Recable inside Sub	Mission	Mission (SF X)	N	N	Y	N	1.4	27		5790706	5790746	Recable feeder to serve new EV load
49	San Francisco	Mission X 1101 Recable inside Sub	Mission	Mission (SF X)	N	N	Y	N	10.7	104		5790704	5790744	Recable feeder to serve new load
50	San Francisco	MISSION X 1110 CIRCUIT EXTENSION	Mission	Mission (SF X)	N	N	N	N	0.8	8		5790703	-	Extend feeder to mitigate overload
51	San Francisco	Mission X 1107 Recable inside Sub	Mission	Mission (SF X)	N	N	Y	Y	2.5	32		5790710	5790750	Recable feeder to serve new EV load
52	San Francisco	POTRERO: INSTALL NEW FEEDER A 1120	Potrero	Potrero (SF A)	N	N	Y	Y	7.4	77		5785564	5785511	Install 12 kV CB, reactor, relay package and extend feeder to serve new EV load
53	San Francisco	Potrero A1108 Recable inside Sub	Potrero	Potrero (SF A)	N	N	Y	N	3.8	40		5790699	5790739	Recable feeder to serve new load
54	San Francisco	Potrero A1113 Recable inside Sub	Potrero	Potrero (SF A)	N	N	Y	N	6.7	115		5790700	5790740	Recable feeder to serve new load
55	San Francisco	Potrero A1119 Recable inside Sub	Potrero	Potrero (SF A)	N	N	N	N	1.7	20		5790701	5790741	Recable feeder to serve new load
56	San Francisco	Potrero A1117 Recable inside Sub	Potrero	Potrero (SF A)	N	N	Y	N	7.0	10		5790698	5790738	Recable and extend feeder to serve new load
57	Sierra	Install Boque 1108	Yuba City	Boque	N	Y	N	N	0.6	4		5780359	5780318	Install new Bogue 1108 breaker to reduce Bogue 1105 overload and bring load below 600A
58	Sierra	Carlett - Reconductor Back-Tie	Bear River	Carlett	N	N	Y	N	6.0	-		5503050 5544396	-	Reconductor back tie to new Placer Vineyard subdivision
59	Sierra	Install Rocklin 1105 or Replace Del Mar Bank 2	South Placer	Rocklin	N	N	N	N	0.2	2		-	5787238	Install new feeder on Rocklin Bank 1 to off-load Rocklin Bank 2
60	San Jose	Install distribution bank at Santa Teresa Sub	South San Jose 21 KV	Santa Teresa	N	N	Y	N	12.6	28		5763812 5790320	5768879	Fence and grade new substation site. Install 1-45 MVA 115/21 kV bank and 2 feeder breakers, extend feeders to serve three new data centers
61	San Jose	Build feeder from existing breaker - Almaden 1112	West San Jose	Almaden	N	N	Y	Y	1.0	9		5784802	-	Extend feeder from existing breaker to mitigate overload and serve new EV load
62	San Jose	Renz Energy Storage (Llagas)	Morgan Hill/Gilroy	Llagas	N	N	Y	N	9.6	22		-	5544467 5781158	Install 20 MW Renz Battery Energy Storage System at Llagas Substation
63	San Jose	FMC Install New 1102 Circuit	Downtown San Jose 12 KV	FMC	N	Y	N	N	-	-		5780328	5780362	Install new circuit breaker and extend feeder at FMC Sub to reduce loading on FMC 1101 to below 600A
64	San Jose	Morgan Hill Install New 2103 Circuit	Morgan Hill/Gilroy	Morgan Hill	N	N	N	N	6.5	15		5795536	5790899	Install one 21 kV feeder breaker in existing breaker bay and extend feeder to relieve overloads on Morgan Hill Bank 3
65	Sonoma	Replace Bellevue Bank #1	Bellevue/Cotati	Bellevue	Y	N	Y	N	10.8	-		5537636	5774720	Replace Bellevue Bank #1 with a 115-21 kV, 45 MVA transformer to eliminate an emergency deficiency of 10.8 MW for the loss of Bellevue Bank 3 or 4. Isolate bank 1 bus section from bank 2 and build an UG bus tie from bank 1 to bank 3
66	Sonoma	Rincon Bank 1, 1101, 1102 replacement and install new feeder 1105	Santa Rosa	Rincon	N	N	Y	N	6.2	39		-	5790247	Install 115kV CB, 45MVA Bank, 3 Feeder Breaker, 12kV Bus Structure, 1 New Feeder
67	Stockton	Install Valley Springs 1102	Jackson	Valley Springs	N	N	N	N	-	-		5537283 5537280	5786238	Install new circuit to increase emergency capacity and operational flexibility with adjacent Calaveras Cement circuit
68	Stockton	Replace Lockeford Bank for greater than 10 MW Emergency Deficiency	Lodi	Lockeford	Y	N	N	N	14.8	-		5790664	5794827	Install new Lockeford Bank 1 and new circuit breakers for 14.8 MW emergency defiency caused by loss of Lockeford Bank 4
69	Stockton	Vierra 1701 Install Mainline	Manteca 17 KV	Vierra	N	N	Y	N	3.5	46		5787303	-	Install 5.750 feet of mainline to serve new industrial park
70	Stockton	Install 1-12kV feeder - Vierra Bank 2	Manteca 17 KV	Vierra	N	N	N	N	8.0	48		5791145	5790020	Extend new feeder from existing switchgear to serve new load
71	Stockton	Install 1-12kV feeder - Ripon Bank 1	Manteca 17 KV	Ripon	N	N	N	N	3.3	23		5795537	5790021	Install new circuit breaker and extend feeder to create Rpon 1705 to serve new load
72	Stockton	Install Weber 1111 on existing breaker	South Stockton 12 KV	Weber	N	N	Y	N	1.6	13		5779292	-	Extend new feeder from existing switchgear to serve new load
73	Stockton	Install Weber 1115 on existing breaker	South Stockton 12 KV	Weber	N	N	Y	N	2.0	16		5791154	-	Extend new feeder from existing switchgear to serve new load
74	Stockton	Install Lammers 1108 and 1104 breakers	Tracy	Lammers	N	N	Y	N	5.5	44		5790480	5786670	Install two circuit breakers and extend two feeders to relieve overloads on Lammers Bank 1
75	Stockton	Reolace Banta Bank 1	Tracy	Banta	N	N	Y	N	2.6	30		5795530	5792892	Replace Banta Bank 1 to serve new load
76	Yosemite	Install El Nido 1106	Chowchilla	El Nido	N	N	Y	N	2.3	22		5783250	5784167	Install new 12 kV circuit breaker and extend feeder to transfer load off of Santa Rita 1102 and relieve Santa Rita Bank 1
77	Yosemite	Install Dairyland 1110	Chowchilla	Dairyland	N	N	Y	N	1.8	13		5779534	5779504	Install new 12 kV circuit breaker and extend feeder to transfer load off of Dairyland 1109 feeder
78	Yosemite	Santa Nella Bank #1 Replacement and install two 12 kV feeders	Canal	Santa Nella	N	N	Y	Y	4.8	37		5746706 5790352	5746645	Replace Bank 1, install transmission circuit switcher and two 12 kV breakers to serve new EV load
79	Yosemite	Install 1-12 kV feeder - Storey Bank 1	Storey	Storey	N	N	N	N	2.3	18		5791418	5791238	Install 12 kV breaker and extend feeder to mitigate overload on Storey Bank 1
80	Various	MWC 46 Emergent Replacements (rerun 1 and 2)	Various	Various								-	5543520	
81	TOTAL													
82	NOTES:													
83	1) Only emergent project totals are shown. PO 5543520 total includes 46H projects < $3M which have been removed from total for clarity into truly "emergent" work													
84	2) Total Project Costs do not include transmission substation work (MWC 61) or transmission line work (MWC 60) required for new substation transformers													
85	3) The following projects were identified subsequent to the GRC filing but are identified here for completeness and alignment with the 2021 DIDF process and the 2021 GNA/DDOR reports													

Workpaper Table 17-18
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Forecast Capital Expenditures- Projects Detail, Including Escalation
(Thousands of Nominal Dollars)

Line No.	Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)	Oper Date	MAT	2020 CWIP		2021		2022		2023		2024		2025		2026		Totals			Comments
				Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Project	MWC 06	MWC 46	
1	B	3/30/21 Complete	46F	$1	$5,697	-	$1,837	-	-	-	-	-	-	-	-	-	-	$ 7,535	$ 1	$ 7,534	
2	B	11/1/21	46H	$7	$3,669	$ 1,225	$ 6,332	$ -	$ 66	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,299	$ 1,232	$ 10,067	
3	B	2/1/23	46F	$1,356	$1,703	$ 1,574	$ 2,379	$ 2,869	$ 7,004		$ 32	-	-	-	-	-	-	$ 16,917	$ 5,799	$ 11,118	
4	F	5/1/22	46F	$2	$74	$98	$121	$695	$1,200	$0	$0	$0	$0	$0	$0	$0	$0	$ 2,190	$ 795	$ 1,395	
5	F	6/1/23	46H	-	-	$0	$150	$150	$450	$750	$800	$0	$0	$0	$ -	$0	$ -	$ 2,300	$ 900	$ 1,400	
6	B	5/1/24	46H	-	-	$0	$0	$0	$150	$498	$1,941	$2,991	$4,387	$0	$ -	$0	$ -	$ 9,967	$ 3,489	$ 6,478	
7	F	12/1/21	46A	$353	$563	$3,182	$0	$0	$0	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 4,098	$ 3,534	$ 563	
8	B	6/1/23	46A	-	-	-	$ 150	-	$ 4,387	-	$ 1,941	-	$ -	-	$ -	$ -	$ -	$ 6,478	$ -	$ 6,478	
9	F	6/1/25	46H	-	-	$0	$0	$0	$0	$0	$150	$2,991	$1,000	$2,997	$1,650	$0	$0	$ 8,788	$ 5,988	$ 2,800	
10	F	5/1/26	46A	-	-	$0	$0	$0	$0	$0	$0	$0	$150	$689	450	$3,003	800	$ 5,092	$ 3,692	$ 1,400	
11	F	10/1/21	46F	$7,132	$1,169	$5,939	-	-	-	-	-	-	-	-	-	-	-	$ 14,240	$ 13,071	$ 1,169	
12	F	5/1/22	46F	$114	$328	$51	$651	$5,923	$0	$0	$0	$0	$0	$0	0	$0	0	$ 7,066	$ 6,087	$ 979	
13	B	6/1/24	46A	$3	-	$25	$75	$100	$150	$1,990	$3,160	$2,009	$4,986	$0	$0	$0	$0	$ 12,498	$ 4,127	$ 8,371	
14	F	6/1/21	46A	$103	-	$7	$0	$1,377	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ 1,487	$ 1,487	$ -	
15	F	6/1/21	46A	$51	-	$998	-	$0	-	$0	-	$0	-	$0	-	$0	$ -	$ 1,049	$ 1,049	$ -	
16	B	12/1/21	46H	$39	$3,633	$1,392	$2,028	$0	$0	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 7,093	$ 1,432	$ 5,662	
17	B	12/1/22	46A	-	$591	-	$1,000	-	$4,105	-	$749	-	$0	-	$ -	$0	$ -	$ 6,445	$ -	$ 6,445	
18	B	5/1/22	46H	$43	$155	$1,351	$3,833	$2,522	$ 2,101	$0	$4	$0	$0	$0	0	$0	0	$ 10,010	$ 3,916	$ 6,094	
19	F	10/1/22	46A	-	$20	$98	$150	$1,802	$1,223	-	-	-	$6	-	-	-	-	$ 3,299	$ 1,900	$ 1,399	
20	B	6/1/24	46H	-	-	$ -	$ -	$ -	$ 598	$ 14,927	$ 3,483	$ 23,931	$ 10,968	$ -	$ -	$ -	$ -	$ 53,907	$ 38,858	$ 15,049	
21	F	5/1/22	46H	$51	$16	$ 1,720	$ 193	$ -	$ 2,074	$ -	$ 17	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,071	$ 1,771	$ 2,300	
22	B	6/1/25	46A	-	-	-	-	-	-	-	$ 149	-	$ 1,944	-	$ 4,396	$ -	$ -	$ 6,489	$ -	$ 6,489	
23	F	5/1/23	46A	-	-	-	$150	$50	$450	$2,000	$800	$0	$0	$0	$0	$0	$0	$ 3,450	$ 2,050	$ 1,400	
24	B	6/1/23	46A	-	-	$0	$150	$0	$3,241	$1,000	$4,975	$0	$0	$0	$0	$0	$0	$ 9,366	$ 1,000	$ 8,366	
25	B	12/31/21	46F	$183	$2,040	$5,021	$5,412	-	$15	-	-	-	-	-	-	$0	$ -	$ 12,671	$ 5,204	$ 7,467	
26	B	5/1/22	46A	-	$33	-	$297	-	$4,366	-	$1,780	-	$0	-	$ -	$0	$ -	$ 6,475	$ -	$ 6,475	
27	F	6/1/22	46H	$1	-	$100	$500	$2,865	$700	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 4,166	$ 2,966	$ 1,200	
28	F	6/1/21	46H	$12	$217	$ 589	$ 1,047	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,865	$ 601	$ 1,264	
29	F	12/1/21	46H	$3,221	$910	$1,528	$91	$0	$4	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 5,754	$ 4,749	$ 1,004	
30	B	6/1/22	46F	$17	$703	$0	$5,551	$2,751	$85	$0	$0	$0	$0	$0	$0	$0	$0	$ 9,109	$ 2,769	$ 6,340	
31	B	4/1/23	46H	-	$1	$ -	$ 150	$ -	$ 1,944	$ 500	$ 4,379	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,974	$ 500	$ 6,474	
32	B	5/1/23	46H	-	-	$0	$150	$150	$3,179	$1,000	$3,147	$0	$0	$0	0	$0	0	$ 7,626	$ 1,150	$ 6,476	
33	F	5/1/23	46H	-	-	$0	$150	$499	$200	$3,284	$350	$0	$0	$0	$0	$0	$0	$ 4,483	$ 3,783	$ 700	
34	B	5/11/2021 Complete	46A	$12	$1,785	$62	$3,237	$0	$0	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 5,095	$ 74	$ 5,021	
35	F	12/1/21	46H	-	-	$4,314	$167	$0	$0	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 4,481	$ 4,314	$ 167	
36	F	5/1/22	09H	-	-	$ 32	-	$ 1,844	-	-	-	-	-	-	-	-	-	$ 1,876	$ 1,876	$ -	
37	B	5/1/24	46H	-	-	-	-	-	$ 150	-	$ 1,941	$1,000	$ 4,387	$ -	-	-	-	$ 7,478	$ 1,000	$ 6,478	
38	B	5/1/24	46H	-	-	-	-	-	$ 150	$ 100	$ 3,234	$1,500	$ 4,986	-	-	-	-	$ 9,970	$ 1,600	$ 8,370	
39	F	12/1/22	46H	$14	$486	$ 4,017	$ 1,025	$ -	$ -	$ -	$ -	$0	$ -	$ -	$ -	$ -	$ -	$ 5,542	$ 4,031	$ 1,511	
40	B	4/1/24	46H	-	-	$0	$0	$0	$150	$100	$3,234	$1,100	$4,986	$0	$0	$0	$0	$ 9,570	$ 1,200	$ 8,370	
41	F	5/1/24	46A	-	-	$0	$0	$0	$150	$0	$450	$500	$800	$0	$0	$0	$0	$ 1,900	$ 500	$ 1,400	
42	O	6/1/26	46H	$1	-	-	-	-	-	-	-	-	-	$200	$500	$800	$1,000	$ 2,501	$ 1,001	$ 1,500	
43	F	6/1/22	46H	$6	-	$8,830	$600	$3,988	$ 800	-	-	-	-	-	-	-	-	$ 14,223	$ 12,823	$ 1,400	
44	F	9/27/2020 Complete	46H	$4,666	$672	$ 1,047	$350	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,735	$ 5,713	$ 1,022	
45	F	2/17/2021 Complete	46H	$1,849	$611	$1,736	$180	$0	$0	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 4,376	$ 3,585	$ 791	
46	F	6/1/22	46H	$218	$263	$4,621	$853	$8,731	$4	$118	$0	$0	$0	$0	$ -	$0	$ -	$ 14,808	$ 13,688	$ 1,120	
47	O	12/1/21	46H	$1	-	$3,502	$473	$3,293	$832	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 8,102	$ 6,796	$ 1,306	2020 GNA deficiency values used due to 2020 load drop
48	O	12/1/21	46H	$2	-	$0	$473	$2,991	$832	$0	$0	$0	$0	$0	$0	$0	$0	$ 4,299	$ 2,993	$ 1,306	
49	O	12/1/21	46H	$2	-	$5,339	$0	$0	$1,306	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 6,647	$ 5,341	$ 1,306	
50	O	12/1/21	06E	$2	-	$0	-	$1,038	-	-	-	-	-	-	-	-	-	$ 1,040	$ 1,040	$ -	2020 GNA deficiency values used due to 2020 load drop
51	O	8/1/22	46H	$36	-	$57	-	$9,348	-	-	-	-	-	-	-	-	-	$ 9,440	$ 9,440	$ -	
52	F	6/1/22	46H	$425	$189	$5,653	$1,736	$10,013	$121	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 18,138	$ 16,092	$ 2,046	
53	O	12/1/21	46H	$78	-	$ 4,208	$ 451	$ -	$ 832	$ -	$ -	$ -	$ -	$0	$ -	$0	$ -	$ 5,570	$ 4,287	$ 1,283	
54	O	12/1/21	46H	$2	-	$0	$473	$6,629	$832	$995	$0	$0	$0	$0	$ -	$0	$ -	$ 8,931	$ 7,626	$ 1,306	
55	O	12/1/21	46H	$10	-	$38	$475	$0	$835	$0	$0	$0	$0	$0	$ -	$0	$ -	$ 1,358	$ 48	$ 1,309	
56	O	8/1/22	46H	$59	-	$122	-	$11,064	$ 898	-	$408	-	-	-	-	-	-	$ 12,551	$ 11,245	$ 1,306	2020 GNA deficiency values used due to 2020 load drop
57	F	6/1/22	46F	$25	$440	$17	$787	$1,327	-	-	-	-	-	-	-	-	-	$ 2,596	$ 1,369	$ 1,227	
58	O	6/1/26	06I	-	-	-	-	-	-	-	-	-	-	$1,000	-	$3,460	-	$ 4,460	$ 4,460	$ -	
59	F	5/1/25	46A	-	-	-	-	-	-	-	$150	-	$450	-	$800	$0	$0	$ 1,400	$ -	$ 1,400	
60	NS	10/1/21	46H	$153	$7,471	$3,807	$3,759	-	$ 236	-	-	-	-	-	-	-	-	$ 15,426	$ 3,960	$ 11,466	
61	F	12/1/21	06A	$66	-	$3	-	$3,770	-	$0	-	$0	-	$0	-	$0	$0	$ 3,839	$ 3,839	$ -	
62	O	4/1/22	46A 46I	-	$833	-	$26,287	-	$ 154	-	-	-	-	-	-	-	-	$ 27,274	$ -	$ 27,274	
63	F	6/1/23	46F	-	-	$0	$150	$50	$ 450	$900	$800	$0	$0	$0	$0	$0	$0	$ 2,350	$ 950	$ 1,400	
64	F	6/1/23	46A	-	-	$0	$150	$250	$ 450	$1,000	$800	$0	$0	$0	$0	$0	$0	$ 2,650	$ 1,250	$ 1,400	
65	B	12/31/21	46F	-	$4,641	$5,532	$1,014	$0	$ 19	$0	$0	$0	$0	$0	$0	$0	$0	$ 11,207	$ 5,532	$ 5,675	
66	B	5/1/22	46A	-	$38	-	$362	-	$ 6,811	-	$3	-	$0	-	$0	$0	$0	$ 7,214	$ -	$ 7,214	
67	F	1/31/22	46F	$0	$9	$100	$0	$1,348	$ -	-	$0	-	-	-	-	-	-	$ 1,457	$ 1,448	$ 9	
68	B	5/1/25	46F	-	-	-	-	$0	$ 0	$0	$149	$500	$3,241	$2,000	$4,995	$0	$0	$ 10,885	$ 2,500	$ 8,385	
69	O	10/1/21	06H	$77	-	$3,029	-	-	-	-	-	-	-	-	-	-	-	$ 3,106	$ 3,106	$ -	
70	F	5/1/22	46H	$1	$1	$0	$0	$100	$ 598	$1,100	$800	$0	$0	$0	$0	$0	$0	$ 2,601	$ 1,201	$ 1,399	
71	F	5/1/24	46H	-	-	-	-	-	$ 150	$0	$450	$500	$800	$0	$0	$0	$0	$ 1,900	$ 500	$ 1,400	
72	F	12/31/21	06H	$2,014	-	$3,262	-	-	-	-	-	-	-	-	-	-	-	$ 5,276	$ 5,276	$ -	
73	F	12/31/21	06H	$69	-	$6,137	-	$55	-	-	-	-	-	-	-	-	-	$ 6,261	$ 6,261	$ -	
74	F	4/1/22	46A	$13	$2	$6,177	$330	$55	$ 1,298	$0	$0	$0	$0	$0	$0	$0	$0	$ 7,874	$ 6,245	$ 1,630	
75	B	5/1/24	46H	-	-	-	$150	$249	$ 1,944	$3,632	$4,379	$0	$0	$0	$0	$0	$0	$ 10,354	$ 3,881	$ 6,473	
76	F	12/31/21	46A	$369	-	$7,085	-	$830	-	-	-	-	-	-	-	$0	$0	$ 8,283	$ 8,283	$ -	
77	F	4/1/22	46A	$54	$30	$2,772	$625	$0	$ 12	$0	$0	$0	$0	$0	$0	$0	$0	$ 3,493	$ 2,825	$ 667	
78	B	5/1/22	46H	$60	$473	$65	$1,795	$4,757	$ 6,980	$48	-	-	-	-	-	-	-	$ 14,178	$ 4,930	$ 9,248	
79	F	5/1/23	46A	-	-	$0	$150	$100	$ 450	$900	$800	$0	$0	$0	$0	$0	$0	$ 2,400	$ 1,000	$ 1,400	
80				-	-	-	-	-	-	-	$12,396	-	$24,835	-	$59,135	-	$72,928	$ 169,294	$ -	$ 169,294	Only Emergent Work Shown, 46H projects < $3M removed from Planning Order total
81			**Sum of column**	**$22,971**	**$39,466**	**$106,462**	**$78,599**	**$93,584**	**$65,139**	**$34,842**	**$57,850**	**$37,022**	**$67,926**	**$6,886**	**$71,926**	**$7,263**	**$74,728**	**$764,665**	**$309,031**	**$455,635**	
82																					
83																					
84																					
85																					

Workpaper Table 17-18
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Forecast Capital Expenditures- Projects Detail, Including Escalation
(Thousands of Nominal Dollars)

Line No.	Division	Project Description	DPA	Substation	Project Result of Em Def (Y or N)	Project Result of >5000 Cust or >600 A per Fdr (Y or N)	Project >$3M (Y or N)	EV Related	Maximum Deficiency in GNA Window (2021-2025) (MW)	Maximum Deficiency in GNA Window (2021-2025) (%)	RBA	MWC 06 (Specific PO)	MWC 46 (Specific PO)	Proposed Work
86	Central Coast	Replace Hollister Bank 2	Hollister	Hollister	N	N	N	N	20.6	46		5795534 Emergent	5792398 Emergent	Replace Hollister Bank 2 to serve new indoor cultivation load. Will be added to scope of new Hollister feeder. PO 5792398
87	Central Coast	Install Gabilan Bank 2	Salinas	Gabilan	N	N	N	N	4.5	28		5796929 Emergent	5796872 Emergent	Extend fence, install transmission protection, new substation transformer, and extend feeder to serve indoor cultivation load
88	Central Coast	Replace Green Valley Bank 3	Watsonville (12/21KV)	Green Valley	N	N	N	N	6.2	21		Emergent	5796728 Emergent	Replace Green Valley Bank 3 with 45 MVA transformer to serve new indoor cultivation load
89	Central Coast	Chualar Sub - Re-establish Substation	Salinas	Chualar	N	N	N	N	10.6	32		Emergent	5796900 Emergent	Extend fence, install transmission protection, new substation transformer, and extend feeder to serve new indoor cultivation load
90	DeAnza	Loyola 4 kV Cutover	Loyola 4 kV	Loyola	N	N	Y	N	1.5	33		5796158 & 5795502	-	Convert 4 kV system to 12 kV to offload Loyola 4 kV substation transformer and circuits
91	DeAnza	Vasona Sub - Install New Feeder (1109) - Line work only	Los Gatos	Vasona	N	N	N	N	403.0	35		5795503 Emergent	-	Install new feeder from existing breaker on Vasona Bank 2 switchgear extend feeder to offload Saratoga 1104 to serve new load
92	DeAnza	Ames Substation - Install New 1103 Circuit	Mountain View	Ames	N	N	N	N	2.6	22		Emergent	Emergent	Install new feeder breaker and extend circuit to offload Whisman feeders to serve new load
93	Diablo	Install Lone Tree 2106 Feeder	Brentwood	Lone Tree	N	N	Y	N	7.8	37		5795332 Emergent	5795149 Emergent	Install new feeder from existing switchgear oand extend feeder to serve new load
94	East Bay	Edes:Install Edes 1102 Feeder	Oakland Edes-J	Edes	N	N	N	N	8.8	20		5796192 Emergent	5796278 Emergent	Install new feeder breaker and extend circuit to serve new cannabis load
95	East Bay	San Pablo: Install San Pablo 1104 feeder	Richmond North	San Pablo	N	N	N	N	-	-		5796193 Emergent	5796279 Emergent	Install new feeder breaker and extend circuit to serve new load
96	Fresno	Install Giffen Bank 2	Gates	Giffen	N	N	Y	N	6.0	34		5796928 Emergent	5796869 Emergent	Install transmission protection, new substation transformer, and extend feeder to offload Giffen Bank 1
97	Fresno	Install Airways Bank 3	Clovis	Airways	N	N	Y	N	2.5	19		5796927 Emergent	5796868 Emergent	Install transmission protection, new substation transformer, and extend feeder to offload Airwave feeders
98	Fresno	Replace Coalinga #1 Bank 2	Coalinga	Coalinga #1	N	N	N	N	0.5	5		Emergent	5796871 Emergent	Replace substation transformer
99	Fresno	Fisarden - Install 2114 Feeder	Fisarden	Fisarden	N	N	N	N	2.4	12		Emergent	5796901 Emergent	Install new feeder breaker and extend circuit to offload Fisarden feeders
100	Humboldt	Rio Dell Sub and Circuit Reinformant	Newburn/Rio Dell	Rio Dell	N	N	Y	N	3.0	29		5796386 Emergent	5795447 Emergent	Install transmission protection, new substation transformer, and extend feeder to offload Rio Dell Bank 1 and serve new indoor cultivation load
101	Kern	San Bernard - Install Bank 2	Arvin	San Bernard	N	N	N	N	2.9	16		5795884 Emergent	5796538 Emergent	Install San Bernard Bank 2 and two new feeder breakers to offload San Bernard Bank 1
102	Kern	Semitropic 1108 Capacity Increase	Wasco	Semitropic	N	N	Y	N	1.6	16		5796877 Emergent	5545589 Emergent	Reolace Bus Disconnects and reconductor 4 miles
103	Kern	Wheeler Ridge Bank and Feeder Capacity Increase	Arvin	Wheeler Ridge	N	N	N	N	0.4	1		5796924 Emergent	5545590 Emergent	Replace Bus Disconnects and reconductor 3 miles
104	Kern	Lakeview - Install 1110 Feeder	Arvin	Lakeview	N	N	Y	N	1.0	8		5796926 Emergent	5796870 Emergent	Install new 12 kV breaker in existing bay and reconductor approximately 4 miles
105	North Bay	Install new feeder at Napa 1104	Napa	Napa	N	N	N	N	1.0	11		Emergent		Install 1 new 3-way switch and extend feeder from existing breaker
106	North Valley	Replace Nord Bank 2	Chico	Nord	N	N	N	N	1.5	10		Emergent	5797201 Emergent	Replace Nord Bank 2
107	Peninsula	Sneath Lane:Replace Bank 1 and 2 transformer purchase	North Pen West 12 KV	Sneath Lane	N	N	N	N	-	-		-	5795938 Emergent	Cost difference between the 16 MVAs and 30 MVAs. Transformers to be replaced on asset replacement
108	Peninsula	Sneath Lane:Install Sneath Lane 1103 at Bank 1	North Pen West 12 KV	Sneath Lane	N	N	Y	N	7.7	66		5792141 Emergent	5796103 Emergent	Install breaker and extend feeder to serve new high tech campus
109	Peninsula	Install Bair 1105 Feeder	South Pen East 12 KV	Bair	N	N	N	N	9.1	89		5792142 Emergent	5796102 Emergent	Install New Feeder 1106 at Bank 3, utilizing Spare Feeder Bay, extend feeder
110	Sacramento	Replace Plainfield Bank 1 and Install 1 new feeder	Woodland	Plainfield	N	N	Y	N	4.7	36		Emergent	Emergent	Replace Plainfield Bank 1 with a 30 MVA transformer. Install 1 new feeder using the idle 1102 breaker and 34,000 feet of line work.
111	San Francisco	Install Larkin Y 1142	Larkin	Larkin	N	N	N	N	2.4	32		Emergent	Emergent	Install Y1142 outlet from switchgear. 2100 feet of new cable in new trench
112	San Jose	Mc Kee Sub - Install new 1102 Circuit	East San Jose	Mc Kee	N	N	N	N	1.8	15		Emergent	Emergent	Extend Bank 1 bus, install CB
113	San Jose	Montague Bank 2 - Replace for Operational Capacity	Milpitas 21 KV	Montague	Y	N	N	N	15.0	-		-	5795153 Emergent	Replace Montague Bank 2 with 75 MVA
114	Sonoma	Replace Rincon Bank 2	Santa Rosa	Rincon	N	N	N	N	5.9	37		Emergent	Emergent	Replace transformer to mitigate overload
115	Sonoma	Replace Fulton Bank 5	Fitch Mountain/Fulton	Fulton	N	N	N	N	0.3	1		Emergent	Emergent	Replace transformer to mitigate overload
116	Stockton	Carbona Bank Replacement	Tracy	Carbona	N	N	N	N	1.8	6		5795858 Emergent	5795867 Emergent	Install transmission circuit switcher and 12kV switchgear, rework UG outlets for 4 feeders, 1extend new feeder for new load
117	Stockton	Install Weber 1106 on existing breaker	South Stockton 12 KV	Weber	N	N	Y	N	7.6	62		5796782 Emergent	-	Extend feeder from existing breaker to serve new load
118	Stockton	Replace French Camp Bank 1 and install new feeder	South Stockton 12 KV	French Camp	N	N	Y	N	1.3	8		Emergent	5796819 Emergent	Replace French Camp Bank 1 to mitigate overload
119	Stockton	Install new bank and 2 new feeders at Vierra	Manteca 17 KV	Vierra	N	N	Y	N	2.2	8		Emergent	5796821 Emergent	Install new bank at Vierra to serve new load
120	Yosemite	Install New Bank & Feeder at Ortega	Canal	Ortega	N	N	Y	Y	2.1	13		Emergent	Emergent	Replace substation transformer to serve new EV load
121	Yosemite	Replace Newhall Bank 3 and install new feeder	Newhall	Newhall	N	N	Y	N	0.8	6		Emergent	5796820 Emergent	Replace transformer to mitigate overload
122	Yosemite	Install New Bank and feeder at Bonita Substation	Storey	Bonita	N	N	Y	N	3.5	22		Emergent	5796823 Emergent	Install transformer to serve new load
123	Yosemite	Replace Hammonds Bank 1	Mendota	Hammonds	N	N	Y	N	3.8	24		Emergent	5796822 Emergent	Replace transformer to mitigate overload
124	TOTAL													

Workpaper Table 17-18
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Forecast Capital Expenditures- Projects Detail, Including Escalation
(Thousands of Nominal Dollars)

Line No.	Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)	Oper Date		2020 CWIP		2021		2022		2023		2024		2025		2026		Totals			Comments
			MAT	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Project	MWC 06	MWC 46	
86	B	6/1/23	46H	-	-	-	$ 150	-	$ 2,000	-	$ 4,350	-	-	-	-	-	-	$ 6,500	$ -	$ 6,500	
87	B	5/1/24	46H	-	-	-	-	-	$ 150	-	$ 2,000	-	$ 4,350	-	-	-	-	$ 6,500	$ -	$ 6,500	
88	B	5/1/24	46H	-	-	-	-	-	$ 150	-	$ 2,000	-	$ 4,350	-	-	-	-	$ 6,500	$ -	$ 6,500	
89	B	5/1/24	46H	-	-	-	-	-	$ 150	-	$ 2,000	-	$ 4,350	-	-	-	-	$ 6,500	$ -	$ 6,500	
90	O	6/1/23	06E	-	-	-	-	-	-	$ 5,270	-	-	-	-	-	-	-	$ 5,270	$ 5,270	$ -	
91	O	6/1/23	06H	-	-	-	-	$ 650	-	$ 1,000	-	-	-	-	-	$ -	-	$ 1,650	$ 1,650	$ -	
92	F	5/1/25	46H	-	-						$ 50		$ 350	$ 1,000	$ 1,000			$ 2,400	$ 1,000	$ 1,400	
93	F	4/1/22	46H	-	-	$ 10	$ 10	$ 3,625	$ 25	-	-	-	-	-	-	-	-	$ 3,670	$ 3,635	$ 35	
94	F	6/1/23	46H	-	-	$ 10	$ 10	$ 300	$ 200	$ 1,545	$ 740	-	-	-	-	-	-	$ 2,805	$ 1,855	$ 950	
95	F	6/1/23	46H	-	-	$ 10	$ 10	$ 50	$ 200	$ 406	$ 740	-	-	-	-	-	-	$ 1,416	$ 466	$ 950	Project restores FLISR scheme disabled by temporary transfers
96	B	4/1/24	46A	-	-				$ 150	$ 500	$ 2,000	$ 3,000	$ 6,250	-	-	$ -	$ -	$ 11,900	$ 3,500	$ 8,400	
97	B	5/1/24	46A	-	-	-	-	-	$ 150	$ 500	$ 2,000	$ 3,000	$ 6,250	-	-	$ -	$ -	$ 11,900	$ 3,500	$ 8,400	
98	B	5/1/24	46H	-	-	-	-	-	$ 150	-	$ 2,000	-	$ 4,350	-	-	$ -	$ -	$ 6,500	$ -	$ 6,500	
99	F	5/1/23	46A				$ 50		$ 350	$ 1,000	$ 1,000				-			$ 2,400	$ 1,000	$ 1,400	
100	B	5/1/23	46H	-	-	-	$ 150	$ 500	$ 2,000	$ 3,000	$ 6,250	-	-	-	-	-	-	$ 11,900	$ 3,500	$ 8,400	
101	B	5/1/23	46A	-	-	-	$ 150	$ 50	$ 2,000	$ 150	$ 6,250	-	-	-	-	-	-	$ 8,600	$ 200	$ 8,400	
102	O	5/1/23	46H							$ 3,096	$ 50							$ 3,146	$ 3,096	$ 50	
103	O	5/1/23	46H							$ 2,322	$ 50							$ 2,372	$ 2,322	$ 50	
104	F	5/1/24	46H								$ 150	$ 3,096	$ 1,250					$ 4,496	$ 3,096	$ 1,400	
105	F	5/1/22	06A	-	-	-	-	$ 150	-	-	-	-	-	-	-	-	-	$ 150	$ 150	$ -	
106	B	5/1/25	46A	-	-	-	-	-	-	-	$ 150	-	$ 2,000	-	$ 4,350	$ -	$ -	$ 6,500	$ -	$ 6,500	
107	O	12/1/22	46A	-	-	-	-	-	$ 2,000	-	-	-	-	-	-	-	-	$ 2,000	$ -	$ 2,000	
108	F	6/1/23	46H	-	-	$ 10	$ 10	$ 300	$ 200	$ 3,380	$ 740	-	-	-	-	-	-	$ 4,640	$ 3,690	$ 950	Replaces Millbrae Project, line 38
109	F	5/1/22	06H	-	-	-	-	$ 1,000	-	-	-	-	-	-	-	-	-	$ 1,000	$ 1,000	$ -	
110	B	5/1/24	46A	-	-				$ 150		$ 2,000	$ 5,440	$ 4,350					$ 11,940	$ 5,440	$ 6,500	
111	F	5/1/23	46H	-	-	$ 638	$ 1,000	$ 1,000	$ 400									$ 3,038	$ 1,638	$ 1,400	
112	F	5/2/23	46A	-	-		$ 50	$ 50	$ 350	$ 1,000	$ 1,000							$ 2,450	$ 1,050	$ 1,400	
113	B	5/1/25	46F	-	-	-	-	-	-	-	$ 150	-	$ 2,000	-	$ 4,350	-	-	$ 6,500	$ -	$ 6,500	
114	B	5/1/25	46A	-	-	-	-	-	-	-	$ 150	-	$ 2,000	-	$ 4,350	$ -	$ -	$ 6,500	$ -	$ 6,500	
115	B	5/1/25	46H	-	-	-	-	-	-	-	$ 150	-	$ 2,000	-	$ 4,350	$ -	$ -	$ 6,500	$ -	$ 6,500	
116	B	5/1/22	46H	-	-	-	$ 250	$ 1,000	$ 2,000	$ 1,200	$ 5,950	-	-	-	-	-	-	$ 10,400	$ 2,200	$ 8,200	
117	F	3/31/23	06H	-	-	-	-	$ 2,300	-	$ 5,000	-	-	-	-	-	-	-	$ 7,300	$ 7,300	$ -	
118	B	5/1/24	46A	-	-	-	-	-	$ 150	-	$ 2,000	$ 4,350	-	-	-	$ -	$ -	$ 6,500	$ 4,350	$ 2,150	
119	B	5/1/24	46H	-	-	-	-	-	$ 150	$ 500	$ 2,000	$ 3,000	$ 6,250	-	-	$ -	$ -	$ 11,900	$ 3,500	$ 8,400	
120	B	5/1/23	46H	-	-	-	$ 150	$ 500	$ 2,000	$ 3,000	$ 6,250	-	-	-	-	-	$ -	$ 11,900	$ 3,500	$ 8,400	
121	B	6/1/24	46A	-	-	-	-	-	$ 150	-	$ 2,000	$ 4,350	-	-	-	-	-	$ 6,500	$ 4,350	$ 2,150	
122	B	6/1/24	46H	-	-			-	$ 150	$ 500	$ 2,000	$ 3,000	$ 6,250					$ 11,900	$ 3,500	$ 8,400	
123	B	6/1/24	46A	-	-	-	-	-	$ 150		$ 2,000	$ 4,350		-	-	-	-	$ 6,500	$ 4,350	$ 2,150	
124			Sum of column	$ -	$ -	$ 678	$ 1,990	$ 11,475	$ 15,525	$ 33,369	$ 58,170	$ 33,586	$ 56,350	$ 1,000	$ 18,400	$ -	$ -	$ 230,543	$ 80,108	$ 150,435	

Workpaper Table 17-19
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Tracking of MWC 46 Projects Identified in 2020 GRC Workpapers
(Thousands of Nominal Dollars)

Line No.	Division	Project Description	DPA	Substation	Project Result of Em Def - 2020-2022	Project Result of >6000 Cust per	Project >63M	Deficiency	Deficiency	MWC 06 (Specific PO)	MWC 46 (Specific PO)	Proposed Work	Included in 2020 GRC Y/N?	Deferred Work? Y/N	Oper Date 2023 GRC	Oper Date 2020 GRC
					(Y or N)	(Y or N)	(Y or N)	(MW)	(%)							
1	Central Coast	46 - Install Spence Bank 2 Capacity	Salinas	Spence	N	N	N	7.1 [3]	60.0	5757020	5757018	Install Spence Bank 2 with a 30 MVA transformer at an existing substation site	Y	Y	3/25/19 Complete	10/1/18
2	Central Coast	Rebuild Monterey Substation	Seaside Marina 12 kV	Monterey	N	Y	N	NA	NA	5758745	5769274 5779273	Rebuild Monterey Substation , replace 4 kV station equipment with 12 kV banks and breakers to reduce the number of customers on several Del Monte circuits to less than 6000	Y	Y	2/1/23	6/1/20
3	Central Coast	Replace Soledad Bank #2	Soledad	Soledad	Y	N	N	11.5		5781858	5766620	Replace Soledad Bank #2 with a 45 MVA transformer to eliminate an 11.5 MW emergency deficiency	Y	Y	3/30/21 Complete	5/1/20
4	Central Coast	Install Camp Evers 2107	Santa Cruz	Camp Ever	N	Y	N			5780327	5780325	Install Camp Evers 2107 to reduce the number of customers on Camp Evers 2106 to less than 6000	Y	N	5/1/22	5/1/22
5	Central Coast	Install bank at Dolan Road Substation	Prundale	Dolan Roac	N	N	N	4.0	40.0	5780338	5779285	Install new bank at Dolan Road Substation	Y	N	11/1/21	5/1/21
6	Central Coast	Replace Gonzales Bank	Gonzales	Gonzales	N	N	N	2.7	17.0	5780398	5779286	Replace Gonzales Bank #3	Y	Y	To be cancelled and replaced by Chualar Sub Emergent Project	5/1/21
7	De Anza	Install Vasona Feeder	Los Gatos	Vasona	N	N	N	1.1 [6]	7.0	5780358	5779283	Install new feeder at Vasona	Y	N	12/1/21	5/1/21
8	Diablo	Concord Naval Weapons Station Land Reuse Plan - Commercial/Residential Development	Concord	NWS	N	N	N				5520789	Work with developer to purchase a new substation site at the Concord Naval Weapons previous location to support new development plan.	Y	Y	On-hold pending city action	12/1/19
9	Diablo	Rebuild Lakewood Substation	Walnut Creek 12 kV	Lakewood	Y	N	Y	16.9			5768812	Install 30 MVA 12/21 kV autobank, tie the 12 and 21 kV buses together to eliminate an emergency deficiency of 16.9 MW	Y	N	12/25/19 Complete	5/1/19
10	Diablo	Install Rossmoor 1109 Feeder	Walnut Creek 12 kV	Rossmoor	Y	N	N	13.4		5773378 5772954	5772980	Install Rossmoor 1109 to eliminate an emergency deficiency of 13.4 MW	Y	Y	6/1/21	5/1/20
11	Diablo	Install Brentwood 2104 feeder	Brentwood	Brentwood	N	Y	N			5780360	5780363	Install new feeder at Brentwood to reduce the load on Brentwood 2112 to 600 A or less	Y	Y	5/1/22	5/1/21
12	Fresno	Install Airways 1107	Clovis	Airways	N	N	N	4.6	38.0	5756541	5756552	Install Airways 1107 and 1104 from existing switchgear, distribution line work only.	Y	Y	6/1/20 Complete	6/1/19
13	Fresno	Install Gates Feeder 1103	Gates	Gates	N	N	N	1.2	8.0	5756944	5756941	Install Gates 12 kV feeder. Ag pumping related.	Y	Y	7/9/19 Complete	5/1/18
14	Fresno	Install Dinuba Feeder	Reedley	Dinuba	N	N	N	1.0	8.0	5779205	5779204	Install Dinuba 1107 feeder	Y	Y	6/1/21	6/1/20
15	Fresno	Install Alpaugh 1102 feeder	Corcoran	Alpaugh	N	N	N	1.6	13.7	5779535	5779505	Install new feeder at Alpaugh Substation	Y	N	10/1/22	4/1/24
16	Fresno	Install Calflax Bank 2	Gates	Calflax	N	N	N	4.6	26.0	5779536	5779506	Install new Bank #2 at Calflax Substation	Y	N	5/1/22	4/1/23
17	Fresno	Replace Huron Bank 1	Gates	Huron	N	N	N	3.3	17.0		5774679	Replace Huron Bank 1 due to off peak overloaded	Y	Y	4/1/22	2/1/21
18	Fresno	Install Rainbow Feeder	Sanger	Rainbow	N	N	N	5.4	18.0	5779679	5779284	Install new feeder at Rainbow	Y	Y	6/1/21	6/1/20
19	Kern	Replace Old River Bank 1	Arvin	Old River	N	N	N				5778327	Replace Old River Bank 1 with a 30 MVA transformer. Oil Pumping related (Carryover)	Y	N	6/25/15 Complete	6/25/15
20	Kern	Install Rio Bravo Feeder	Lerdo	Rio Bravo	N	N	N	1.5	7.0	5758159	5758189	Install Rio Bravo feeder at customer's request	Y	N	5/14/19 Complete	6/1/19
21	Los Padres	Install Estrella Substation	Paso Robles	Estrella	N	N	N	7.3	3.4	5757622	5767212	Construct Estrella Substation - 1-45 MVA transformer and fully populated switchgear enclosure	Y	Y	On-hold	5/1/24
22	Mission	Replace Jarvis Bk 2 w/ 45 MVA and New Feeder	Fremont 12 kV	Jarvis	N	Y	Y			5763923	5763889	Replace Jarvis Bank 2 with a 45 MVA transformer and 1-12 kV feeder to reduce the number of customers to less than 6000	Y	Y	12/31/21	5/1/20
23	North Bay	Install 1-12 kV feeder - Ignacio Substation	Northern Marin	Ignacio	N	N	N			5747845	5747846	Install 1-12 kV feeder at Ignacio Substation (Carryover)	Y	N	11/1/17 Complete	11/1/17
24	North Bay	Install new feeder breaker on Highway Bank 1	Vallejo	Highway	N	N	N	0.7	6.0	5777583	5768811	Install 1-12 kV feeder at Highway Substation.	Y	Y	10/1/21	6/1/19
25	North Bay	Install Pueblo Bank 3	Napa	Pueblo	Y	N	N	17.5			5780188	Install Pueblo Bank #3 with a 45 MVA transformer to eliminate a 17.5 MW Emergency Bank loss deficiency	Y	N	6/1/22	6/1/22
26	North Valley	Install new Logan Creek Feeder	Willows	Logan Cree	N	N	N	2.6	13.0	5777682	5777658	Install new feeder at Logan Creek for ag processing customer	Y	N	1/16/19 Complete	5/1/19
27	Peninsula	Menlo Substation: Replace Bank #1	South Peninsula 4 kV	Menlo	N	N	N			5733934	5767869	Replace Menlo Bank #1 with a 30 MVA transformer (Carryover)	Y	N	7/17/17 Complete	7/17/17
28	Peninsula	Install Bay Meadows Feeder	Central Peninsula 12 kV	Bay Meadow	N	N	N			5764664	5773146	Install Bay Meadows feeder (carryover)	Y	N	12/1/18 Complete	12/1/18
29	Sacramento	Replace Maxwell Bank 2	North Colusa	Maxwell	N	N	N			5757908		Replace Maxwell Bank 2 with a 30 MVA transformer. Ag pumping related.	Y	N	7/1/18 Complete	7/1/18
30	San Francisco	Larkin Sub-New 12kV Feeder-Medical Facility	Larkin	Larkin	N	N	N			5737718	5738400	Install 1-12 kV feeder to serve new load at CPMC Hospital in SF	Y	N	CANCELLED	3/1/18
31	San Francisco	Potrero Substation: Replace A-1104 Reactor	Potrero	Potrero	N	N	N				5520292	Install reactor at A-1104	Y	Y	3/19/20 Complete	6/1/19
32	San Francisco	Install new feeder at Mission Substion X1126	Mission	Mission	N	N	N			5773020		Install new feeder at Mission to serve new stadium	Y	N	11/28/18 Complete	5/1/18
33	San Jose	Install Energy Storage in the area served by Llagas	Gilroy	Llagas	N	N	N	5.9 [4]	13	5733977	5781158	Install Energy Storage to offset demand and reduce loading on Llagas.	Y	N	5/1/22	5/1/22
34	San Jose	Install New Feeder on Edenvale Bank 2	South San Jose 21 kV	Edenvale	N	N	N	2.0	10.0	5757384	5757481	Install Edenvale 21 kV feeder to serve new load two large customers	Y	Y	3/26/2019 Complete	5/1/18
35	San Jose	Install distribution bank at Santa Teresa	South San Jose 21 kV	Santa Teres	N	N	N	5.5 [5]	12.0	5763812	5768879	Install a distribution bank at Santa Teresa Substation to serve the expansion for new customer	Y	N	10/1/21	5/1/24
36	San Jose	Install new feeder at FMC	Downtown San Jose 12 kV	FMC	N	Y	N			5780328	5780362	Install 1-12 kV feeder at FMC to reduce the load on FMC 1101 and El Patio 1112 to 600 A or less	Y	N	6/1/23	6/1/23
37	Sierra	Install Bogue 1108	Yuba City	Bogue	N	Y	N			5780359	5780318	Install 1-12 kV feeder at Bogue to reduce the load on Bogue 1105 to 600 A or less	Y	Y	6/1/22	6/1/21
38	Sierra	Pine Hill Substation site development	Clarksville/Shingle Springs	Pine Hill	N	N	N			5733943	5731103	Permit new Pine Hill Substation site in El Dorado County	Y	N	Cancelled	Cancelled
39	Sonoma	Replace Bellevue Bank #2	Bellevue/Cotati	Bellevue	Y	N	Y	10.8		5779678	5774720	Replace Bellevue Bank #2 to eliminate an 10.8 MW emergency deficiency	Y	Y	2/25/21 Complete	6/1/20
40	Sonoma	Install Rincon Bk #3	Santa Rosa	Rincon	N	N	N			5733967	5738568	Install Rincon Bank #3 - 16 MVA transformer,	Y	N	5/1/22	Cancelled
41	Sonoma	Windsor Substation - Purchase a new sub site and Construct Substation	Fitch Mountain / Fulton	Windsor	N	N	N	5.2	17.0	5733965	5767700 5707549	Construct new Windsor Substation; 1- 45 MVA bank and 12 kV feeders.	Y	N	6/7/2018 Complete	5/31/18
42	Stockton	Install Lammers 1108 feeder	Tracy	Lammers	N	N	N	0.6	5.0	5736725		Install new feeder at Lammers on existing switchgear, no substation work required	Y	Y	4/1/22	6/1/21
43	Yosemite	Replace Santa Nella Bank #1 and install 1-/12 kV feeder	Canal	Santa Nella	N	N	N	1.3	4.3	5746706	5746645	Replace existing Santa Nella Bank #1 with a 30 MVA unit and install 1-12 kV feeder. Ag pumping related	Y	N	5/1/22	5/1/22
44	Yosemite	Install Dairyland 1114	Chowchilla	Dairyland	N	N	N	3.7	13.0	5779534	5779504	Install new feeder on Diaryland	Y	N	4/1/22	4/1/22
45	Yosemite	Replace El Nido Bank 1	Chowchilla	El Nido	N	N	N	2.7	17.0		5773882	Replace El Nido Bank #2 to support future ag pumping load	Y	N	4/14/20 Complete	6/1/20
46	Yosemite	Install Le Grand Bank 2	Chowchilla	Le Grand	N	N	N			5758598	5758703	Install Le Grand Bank 2 with a 30 MVA transformer. Ag pumping related	Y	N	4/1/17 Complete	4/1/17
47	Yosemite	Install Cottle Bank #3	Oakdale	Cottle	N	N	N	2nd Day Em 30.6	2nd Day Em	5758599	5758702 5766590	Install Cottle Bank 3 with a 75 MVA transformer	Y	N	4/1/2018 Complete	10/1/18
48	All	Emergent Work		Various	N	N	N			5516381	5510661	Substation related: Funding for emergent work for any given year	Y	N	12/31/26	12/31/22

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(Thousands of Nominal Dollars)

Including escalation

Line No.	2023 GRC MAT	2020 GRC MAT	2020 GRC 2017 CWIP		2020 GRC 2018 Forecast		2020 GRC 2019 Forecast		2020 GRC 2020 Forecast		2020 GRC 2021 Forecast		2020 GRC 2022 Forecast		2020 Actuals		2023 GRC 2021 Forecast		2023 GRC 2022 Forecast		2023		2024		2025		2026		2023 GRC Project Forecast Totals			Comments
			Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Project	MWC 06	MWC 46	
1	46A	46A	$223	$1,241	$0	$5,880		$ 321									-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
2	46F	46F		$10		$ 498		$ 960	$ 551	$ 6,691		$ 107			$ 1,356	$ 1,703	$ 1,574	$ 2,379	$ 2,869	$ 7,004	-	$ 32	-	-	-	-	-	-	$ 13,858	$ 4,443	$ 9,415	
3	46F	46F		$7		$ 269		$ 691	$ 551	$ 4,095		$ 42			$ 1	$ 5,697	-	$ 1,837	-	-	-	-	-	-	-	-	-	-	$ 1,837	$ -	$ 1,837	
4	46F	46F								$111		$228	$812	$569	$ 2	$ 74	$ 98	$ 121	$ 695	$ 1,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,114	$ 793	$ 1,321	
5	46H	46H						$376	$110	$3,444	$565	$2,833			$ 7	$ 3,669	$ 1,225	$ 6,332	$ -	$ 66	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,624	$ 1,225	$ 6,399	
6	46H	46H						$129		$3,477		$2,527			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	
7	46A	46A						$75	$110	$221	$2,826	$550			$ 353	$ 563	$ 3,182	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,182	$ 3,182	$ -	
8	46N	46N				$ 366		$ 922		$ 74					-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
9	46F	46F		$301		$ 574		$ 3,560		$ 18					-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
10	46F	46F	$18	$132		$ 186	$ 2,682	$ 389	$ 3,898	$ 761		$ 37			$ 7,132	$ 1,169	$ 5,939	-	-	-	-	-	-	-	-	-	-	-	$ 5,939	$ 5,939	$ -	
11	46F	46F						$108		$222	$509	$514			$ 114	$ 328	$ 51	$ 651	$ 5,923	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,625	$ 5,974	$ 651	
12	46H	46H	$11				$6,007								-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
13	46A	46A	$143	$176	$3,466	$806		$26							-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
14	46A	46A						$215	$551	$536					$ 103	-	$ 7	$ -	$ 1,377	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,384	$ 1,384	$ -	
15	46A	46A												$23	-	$ 20	-	$ 150	-	$ 1,223	-	-	-	$ 6	-	-	-	-	$ 1,379	$ -	$ 1,379	
16	46A	46A								$22		$136	$58	$3,670	$ 43	$ 155	$ 1,351	$ 3,833	$ 2,522	$ 2,101	$ -	$ 4	$ -	$ -	$ -	$ -	$ -	$ -	$ 9,811	$ 3,873	$ 5,938	
17	46A	46A						$377		$3,449		$2,837			-	$ 591	-	$ 1,000	-	$ 4,105	-	$ 749	-	$ -	-	$ -	$ -	$ -	$ 5,854	$ -	$ 5,854	
18	46A	46A						$215	$551	$536					$ 51	-	$ 998	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	$ 998	$ 998	$ -	
19	46H	46H				$663		$ 658							-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
20	46H	46H	$31	$268		$21	$2,923	$312							-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
21	46N	46N				$ 1				$ 387		$ 852		$ 2,915	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
22	46F	46F		$5		$ 864		$ 3,845	$ 1,101	$ 1,207		$ 54			$ 183	$ 2,040	$ 5,021	$ 5,412	-	$ 15	-	-	-	-	-	-	$ -	$ -	$ 10,448	$ 5,021	$ 5,427	
23	46A	46A	$495			$ 23									-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
24	46H	46H	$6	$21		$405	$543	$1,134							$ 3,221	$ 910	$ 1,528	$ 91	$ -	$ 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,622	$ 1,528	$ 94	
25	46F	46F						$54		$389		$3,562		$2,931	$ 17	$ 703	$ -	$ 5,551	$ 2,751	$ 85	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,388	$ 2,751	$ 5,637	
26	46H	46H	$19		$1,462			$767							-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
27	46A	46A			$ 22	$ 365									-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
28	46F	46F	$2,685	$30	$1,438	$296									-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
29	46H	46H			$348										-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
30	46H	46H	$1,227	$52	$107										-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
31	46A	46A						$108							-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
32	46H	46H			$2,187										-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
33	46A	46A		$6		$ 0				$ 1,132		$ 27,679			-	$ 833	-	$ 26,287	-	$ 154	-	-	-	-	-	-	-	-	$ 26,441	$ -	$ 26,441	
34	46H	46H	$20	$296	$887	$722									-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	$ -	
35	46H	46H	$6	$296		$25		$27		$30		$31		$263	$ 153	$ 7,471	$ 3,807	$ 3,759	-	$ 236	-	-	-	-	-	-	-	-	$ 7,802	$ 3,807	$ 3,995	
36	46F	46F										$114	$116	$ 234	-	-	$ -	$ 150	$ 50	$ 450	$ 900	$ 800	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,350	$ 950	$ 1,400	
37	46F	46F						$ 108		$ 222	$565	$ 514			$ 25	$ 440	$ 17	$ 787	$ 1,327	-	-	-	-	-	-	-	-	-	$ 2,131	$ 1,344	$ 787	
38	46N	46N				$ 52									-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
39	46F	46F		$12		$455		$3,132	$551	$2,577					-	$ 4,641	$ 5,532	$ 1,014	$ -	$ 19	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,565	$ 5,532	$ 1,034	
40	46A	46A		$59		$5									-	$ 38	-	$ 362	-	$ 6,811	-	$ 3	-	$ -	-	-	-	-	$ 7,176	$ -	$ 7,176	
41	46N	46N	$2,802	$15,216	$ 978	$738									-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
42	46A	06A							$110		$2,826				$ 13	$ 2	$ 6,177	$ 330	$ 55	$ 1,298	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,860	$ 6,232	$ 1,628	
43	46A	46A	$1	$217	$ 0	$ 17		$ 22		$ 46		$ 2,364	$2,901	$ 1,687	$ 60	$ 473	$ 65	$ 1,795	$ 4,757	$ 6,980	$ 48	-	-	-	-	-	-	-	$ 13,645	$ 4,870	$ 8,775	
44	46A	46A								$77		$227	$3,017	$565	$ 54	$ 30	$ 2,772	$ 625	$ -	$ 12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,409	$ 2,772	$ 637	
45	46A	46A		$1		$535		$2,296		$795		$15			-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
46	46H	46H				$4									-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
47	46F	46F	$56	$786	$1,293	$4,496		$109							-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ -	$ -	
48	46H	46H				$1,787		$ 2,801		$4,626		$12,253		$17,701			-	-	-	-	-	$ 12,396	-	$ 24,835	-	$ 59,135	-	$ 72,928	$ 169,294	$ -	$ 169,294	

Workpaper Table 17-20
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Electric Distribution Capacity
Capacitor Bank SCADA Forecast Detail (MAT 06K)
(Thousands of Base Dollars, Unescalated)

Line No.	Capacitor Bank SCADA Installation Based on Load and Bank Size									
	Division	Distribution Planning Area (DPA)	Bank Name and Number	Total Number of Capacitor Banks	Total kVAR	2020 Recorded Peak Load	Rated Normal Bank Capability	KVAR by Bank by Load	Approximate number of banks identified for SCADA installation	Year
1	De Anza	Cupertino	WOLFE BANK 1	12	12,900	29.2	44.6	4800	4	2022
2	Kern	Urban Bakersfield East	BAKERSFIELD BANK 3	11	10,800	44.75	74.3	7200	6	2022
3	Kern	Urban Bakersfield East	BAKERSFIELD BANK 2	9	8,400	47.64	74.3	7200	6	2022
4	Los Padres	San Luis Obispo	SAN LUIS OBISPO BANK 4	19	15,600	31.22	44.5	4800	4	2022
5	Los Padres	Santa Maria	SANTA MARIA BANK 2	15	13,500	29.81	44.6	4800	4	2023
6	Los Padres	Santa Maria	SANTA MARIA BANK 3	25	22,800	33.73	44.6	4800	4	2023
7	Kern	Urban Bakersfield Northwest	7TH STANDARD BANK 1	16	17,100	34.3	44.6	4800	4	2023
8	Kern	Urban Bakersfield East	BAKERSFIELD BANK 1	9	9,000	41.44	74.3	4800	4	2023
9	North Valley	Oroville 12 KV	WYANDOTTE BANK 3	22	16,200	33	44.6	4800	4	2023
10	Sierra	Yuba City	BOGUE BANK 1	20	19,500	34.24	44.6	4800	4	2023
11	Sierra	Yuba City	BOGUE BANK 2	20	18,900	32.47	44.6	4800	4	2023
12	Yosemite	Atwater	ATWATER BANK 1	23	24,300	38.48	44.6	4800	4	2023
13	North Valley	Oroville 12 KV	WYANDOTTE BANK 1	14	11,100	23.69	44.6	2400	2	2023
14	Sierra	Lincoln	LINCOLN BANK 1	14	11,700	23.24	29.7	2400	2	2024
15	Sierra	Lincoln	LINCOLN BANK 2	2	2,100	23.06	44.6	2400	2	2024
16	Sierra	Marysville	MARYSVILLE BANK 1	24	18,300	19.67	29.7	2400	2	2024
17	Sierra	Marysville	OLIVEHURST BANK 2	14	11,100	21.63	29.7	2400	2	2024
18	Sierra	Yuba City	PEASE BANK 3	17	13,200	18.84	26.4	2400	2	2024
19	Yosemite	Atwater	ATWATER BANK 2	18	16,800	26.18	28.7	2400	2	2024
20	Yosemite	Chowchilla	CHOWCHILLA BANK 1	27	21,500	34.73	44.6	2400	2	2024
21	Yosemite	Chowchilla	DAIRYLAND BANK 1	23	20,100	24.25	29.7	2400	2	2024
22	Yosemite	Chowchilla	DAIRYLAND BANK 2	14	12,000	20.14	29.7	2400	2	2024
23	Yosemite	Chowchilla	LE GRAND BANK 1	16	15,000	25.21	44.6	2400	2	2024
25	Sierra	South Placer	PLEASANT GROVE BANK 3	9	12,900	30.46	44.6	7200	6	2024
26	Sierra	South Placer	PLEASANT GROVE BANK 1	8	12,000	34	44.6	4800	4	2024
27	Sierra	South Placer	PLEASANT GROVE BANK 2	6	10,800	35.2	44.6	4800	4	2024
28	Fresno	Figarden	FIGARDEN BANK 1	19	22,200	54.81	65.3	7200	6	2024
24	Yosemite	Merced 12 KV	WILSON BANK 3	15	15,300	17.8	19.3	2400	2	2025
29	Fresno	Figarden	FIGARDEN BANK 2	11	15,900	52.3	63.4	7200	6	2025
30	Fresno	Figarden	FIGARDEN BANK 3	10	14,100	45.04	65.3	7200	6	2025
31	Diablo	Concord	LAKEWOOD BANK 1	12	18,300	35.75	44.6	4800	3	2025
32	Diablo	Concord	LAKEWOOD BANK 1	12	18,300	35.75	44.6	4800	1	2025
33	Diablo	Concord	LAKEWOOD BANK 4	10	15,900	30.35	49.5	4800	4	2025
34	Fresno	Central Fresno	BARTON BANK 1	29	33,000	38.98	44.6	4800	4	2025
35	Fresno	Central Fresno	BARTON BANK 2	22	22,800	36.34	41.1	4800	4	2025
36	Fresno	Central Fresno	BULLARD BANK 2	22	25,200	35.37	39.6	4800	4	2025
37	Fresno	Central Fresno	BULLARD BANK 3	20	21,300	36.22	44.6	4800	4	2025
38	Fresno	Central Fresno	MANCHESTER BANK 2	23	24,900	34.96	44.6	4800	4	2025
39	Central Coast	Gonzales	GONZALES BANK 4	7	5,100	13.85	15.8	2400	2	2025
40	Fresno	Central Fresno	MANCHESTER BANK 3	23	21,000	36.94	44.6	4800	4	2026
41	Fresno	Clovis	AIRWAYS BANK 1	14	13,500	39.68	44.6	4800	4	2026
42	Fresno	Sanger	SANGER BANK 1	20	17,700	30.82	29.7	4800	4	2026
43	Fresno	South Fresno	CALIFORNIA AVE BANK 1	22	21,000	37.47	44.6	4800	4	2026
44	Fresno	South Fresno	CALIFORNIA AVE BANK 2	22	24,000	33.05	44.6	4800	4	2026
45	Fresno	South Fresno	WEST FRESNO BANK 1	26	26,100	39.56	41.0	4800	4	2026
46	Fresno	South Fresno	WEST FRESNO BANK 2	23	25,200	37.68	44.6	4800	4	2026
47	Fresno	Woodward	BULLARD BANK 1	19	21,900	30.62	41.3	4800	4	2026
48	Sacramento	Davis	DAVIS BANK 1	25	27,000	41.97	44.5	4800	4	2026
49	Sacramento	Davis	DAVIS BANK 2	26	23,100	31.93	44.6	4800	4	2026
50	Sacramento	Davis	DAVIS BANK 3	17	15,900	29.9	44.6	4800	4	2026
51	Sacramento	West Sacramento	WEST SACRAMENTO BANK 3	15	16,200	29.1	44.6	4800	2	2026
52							**Subtotal for 2023-2026**	**175,200**	**164**	

	Approximate Costs by Year	Number of Units by Year
2022	**$660,000**	**20**
2023	**$1,122,000**	**34**
2024	**$1,320,000**	**40**
2025	**$1,452,000**	**44**
2026	**$1,518,000**	**46**

Assumptions and Details
(1) Unescalated unit costs from WP Table 17-27, Line 18
(2) This work is included under MAT 06K

$33,000 per capacitor bank

Workpaper Table 17-21
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 14, Electric Distribution Capacity, Engineering, and Planning
Electric Distribution Capacity
Co-Gen Regulator SCADA Forecast Detail (MAT 06P)
(Thousands of Base Dollars, Unescalated)

Line No.	Distribution Line Regulator SCADA Installation							
	Division	Distribution Planning Area (DPA)	Feeder Name	Regulator Operating Number	Year to Date Highest Average Backfeed in Amps	Regulator Configuration (Open or Closed Delta)	Unit Cost Based on Reg Configuration	Replacement Year
1	Central Coast	Salinas	BUENA VISTA 1106	R32	-37	Closed	$150,000	2022
2	Central Coast	Soledad/Greenfield	SOLEDAD 2102	R300	-1	Open	$150,000	2022
3	Sacramento	Peabody	Peabody 2107	R1004	-105	Closed	$150,000	2022
4	Sacramento	Peabody	Peabody 2107	R1017	-105	Closed	$150,000	2022
5	Los Padres	Sisquoc	SISQUOC 1102	R556	-71	Open	$150,000	2022
6	Los Padres	Paso Robles	PASO ROBLES 1104	R465	-48	Closed	$150,000	2023
7	Kern	Lerdo	TUPMAN 1104	W887	-171	Open	$150,000	2023
8	Kern	Wasco	GANSO 1104	W839	-52	Open	$150,000	2023
9	Kern	Lerdo	RIO BRAVO 1106	W831	-115	Open	$150,000	2023
10	Los Padres	Paso Robles	SAN MIGUEL 1104	R408	-22	Open	$150,000	2023
11	Yosemite	Atwater	ATWATER 1102	R969	-91	Closed	$150,000	2023
12	Yosemite	Atwater	ATWATER 1102	8545	-19	Closed	$150,000	2023
13	Yosemite	Atwater	ATWATER 1102	R8055	-128	Open	$150,000	2023
14	Yosemite	Chowchilla	DAIRYLAND 1113	8610	-85	Open	$150,000	2023
15	Yosemite	Chowchilla	DAIRYLAND 1112	R52384	-85	Closed	$150,000	2024
16	Yosemite	Chowchilla	DAIRYLAND 1113	R5655	-75	Closed	$150,000	2024
17	Yosemite	Atwater	CRESSEY 2104	8002	-149	Closed	$150,000	2024
18	Yosemite	Atwater	CRESSEY 2104	8029	-117	Closed	$150,000	2024
19	Yosemite	Atwater	CRESSEY 2104	R776	-125	Open	$150,000	2024
20	Yosemite	Atwater	CRESSEY 2104	R676	-116	Closed	$150,000	2024
21	Fresno	Kettleman	TULARE LAKE 1106	R785	-117	Closed	$150,000	2024
22	Fresno	Kettleman	TULARE LAKE 1106	R580	-115	Closed	$150,000	2024
23	Fresno	Kettleman	TULARE LAKE 1106	R708	-91	Open	$150,000	2024
24	Yosemite	Atwater	ATWATER 1102	R9862	-116	Closed	$150,000	2024
25	Yosemite	Atwater	ATWATER 1102	R986	-106	Closed	$150,000	2025
26	Yosemite	Merced 12 KV	MERCED 1114	8675	-80	Closed	$150,000	2025
27	Yosemite	Merced 12 KV	MERCED 1114	R1089	-77	Closed	$150,000	2025
28	Yosemite	Chowchilla	CHOWCHILLA 1104	8341	-80	Open	$150,000	2025
29	Yosemite	Chowchilla	CHOWCHILLA 1104	R8605	-92	Open	$150,000	2025
30	Stockton	Linden	MORMON 1101	R724	-65	Closed	$150,000	2025
31	Yosemite	Merced Falls	MERCED FALLS 1102	8056	-51	Closed	$150,000	2025
32	Stockton	Manteca 17 KV	AVENA 1701	R112	-24	Closed	$150,000	2025
33	Stockton	Lodi	LOCKEFORD SUB 2102	R195	-166	Open	$150,000	2025
34	Fresno	Kingsburg	KINGSBURG 1111	84S	-136	Closed	$150,000	2025
35	Fresno	Gates	GATES 1106	R727	-128	Open	$150,000	2025
36	Fresno	Henrietta	HENRIETTA 1106	R1914	-110	Closed	$150,000	2026
37	Sacramento	Davis	DAVIS 1107	R559	-105	Closed	$150,000	2026
38	Sacramento	South Colusa	CORTINA 1101	R3002	-98	Open	$150,000	2026
39	Fresno	Kerman	KERMAN 1106	214R	-96	Open	$150,000	2026
40	Stockton	Angels Camp	STANISLAUS 1701	R315	-95	Closed	$150,000	2026
41	Sacramento	Davis	DAVIS 1107	R368	-95	Closed	$150,000	2026
42	Fresno	Henrietta	GUERNSEY 1101	98C	-95	Open	$150,000	2026
43	North Valley	McArthur	MC ARTHUR 1102	R783	-84	Closed	$150,000	2026
44	Yosemite	Chowchilla	DAIRYLAND 1109	R773	-77	Open	$150,000	2026
45	Sacramento	South Colusa	ARBUCKLE 1104	R9896	-75	Closed	$150,000	2026
46	Fresno	Coalinga	COALINGA NO 2 1107	R285	-73	Open	$150,000	2026
47	Yosemite	Newman	NEWMAN 1102	R356	-73	Closed	$150,000	2026
48	**2023-2026 Project Total**						**$6,300,000**	

	Approximate Costs by Year	Number of Units by Year
2022	**$ 750,000**	**5**
2023	**$ 1,350,000**	**9**
2024	**$ 1,500,000**	**10**
2025	**$ 1,650,000**	**11**
2026	**$ 1,800,000**	**12**

Assumptions and Details

(1) Open-delta regualtor configurations will be updated to PG&E's current standard configuration of closed-delta during SCADA control upgrade.
(2) Closed-delta regulator configurations will be upgraded with SCADA control
(3) Unescalated unit costs from WP Table 17-27, Line 21
(4) This work is included under MAT 06P

Workpaper Table 17- 22
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Forecast Capital Expenditures by DPA, Including Escalation
(Thousands of Nominal Dollars)

Line No.	DPA	Division	2020 CWIP		2021		2022		2023		2024		2025		2026		Totals		
			Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Dist MWC 06	Sub MWC 46	Project	Dist MWC 06	Sub MWC 46
1		Hollister	$ -	$ -	$ -	$ 150	$ 150	$ 450	$ 750	$ 800	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,300	$ 900	$ 1,400
2		Monterey 4KV	$ 1,356	$ 1,703	$ 1,574	$ 2,379	$ 2,869	$ 7,004	$ -	$ 32	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,917	$ 5,799	$ 11,118
3		Prunedale	$ 7	$ 3,669	$ 1,225	$ 6,332	$ -	$ 66	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,299	$ 1,232	$ 10,067
4		Salinas	$ -	$ -	$ -	$ -	$ -	$ 150	$ 498	$ 1,941	$ 2,991	$ 4,387	$ -	$ -	$ -	$ -	$ 9,967	$ 3,489	$ 6,478
5		Santa Cruz Area	$ 2	$ 74	$ 98	$ 121	$ 695	$ 1,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,190	$ 795	$ 1,395
6		Soledad/Greenfield	$ 1	$ 5,697	$ -	$ 1,837	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,535	$ 1	$ 7,534
7		**Central Coast Division Total**	**$ 1,366**	**$ 11,143**	**$ 2,897**	**$ 10,819**	**$ 3,714**	**$ 8,870**	**$ 1,248**	**$ 2,773**	**$ 2,991**	**$ 4,387**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 42,673**	**$ 12,215**	**$ 30,458**
7		Cupertino	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 150	$ 2,991	$ 1,150	$ 3,686	$ 2,100	$ 3,003	$ 800	$ 10,077	$ 6,677	$ 3,400
8		Los Gatos	$ 353	$ 563	$ 3,182	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,098	$ 3,534	$ 563
9		Mountain View	$ -	$ -	$ -	$ 150	$ -	$ 4,387	$ -	$ 1,941	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,478	$ -	$ 6,478
10		**De Anza Division Total**	**$ 353**	**$ 563**	**$ 3,182**	**$ 150**	**$ -**	**$ 4,387**	**$ -**	**$ 1,941**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 10,575**	**$ 3,534**	**$ 7,041**
11		Brentwood	$ 114	$ 328	$ 51	$ 651	$ 5,923	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,066	$ 6,087	$ 979
12		Clayton/Willow Pass	$ 3	$ -	$ 25	$ 75	$ 100	$ 150	$ 1,990	$ 3,160	$ 2,009	$ 4,986	$ -	$ -	$ -	$ -	$ 12,498	$ 4,127	$ 8,371
13		Walnut Creek 12 kV	$ 7,132	$ 1,169	$ 5,939	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,240	$ 13,071	$ 1,169
14		**Diablo Division Total**	**$ 7,248**	**$ 1,497**	**$ 6,015**	**$ 726**	**$ 6,023**	**$ 150**	**$ 1,990**	**$ 3,160**	**$ 2,009**	**$ 4,986**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 33,804**	**$ 23,285**	**$ 10,519**
15		Corcoran	$ -	$ 20	$ 98	$ 150	$ 1,802	$ 1,223	$ -	$ -	$ -	$ 6	$ -	$ -	$ -	$ -	$ 3,299	$ 1,900	$ 1,399
16		Gates	$ 43	$ 746	$ 1,351	$ 4,833	$ 2,522	$ 6,206	$ -	$ 753	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,455	$ 3,916	$ 12,539
17		Kerman	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18		Kettleman	$ 39	$ 3,633	$ 1,392	$ 2,028	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,093	$ 1,432	$ 5,662
19		Reedley	$ 103	$ -	$ 7	$ -	$ 1,377	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,487	$ 1,487	$ -
20		Sanger	$ 51	$ -	$ 998	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,049	$ 1,049	$ -
21		**Fresno Division Total**	**$ 236**	**$ 4,399**	**$ 3,847**	**$ 7,012**	**$ 5,701**	**$ 7,429**	**$ -**	**$ 753**	**$ -**	**$ 6**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 29,383**	**$ 9,784**	**$ 19,599**
22		Garberville	$ -	$ -	$ -	$ -	$ -	$ 598	$ 14,927	$ 3,483	$ 23,931	$ 10,968	$ -	$ -	$ -	$ -	$ 53,907	$ 38,858	$ 15,049
23		**Humboldt Division Total**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 598**	**$ 14,927**	**$ 3,483**	**$ 23,931**	**$ 10,968**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 53,907**	**$ 38,858**	**$ 15,049**
24		Arvin	$ 51	$ 16	$ 1,720	$ 193	$ -	$ 2,074	$ -	$ 17	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,071	$ 1,771	$ 2,300
25		Blackwell	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 149	$ -	$ 1,944	$ -	$ 4,396	$ -	$ -	$ 6,489	$ -	$ 6,489
26		**Kern Division Total**	**$ 51**	**$ 16**	**$ 1,720**	**$ 193**	**$ -**	**$ 2,074**	**$ -**	**$ 166**	**$ -**	**$ 1,944**	**$ -**	**$ 4,396**	**$ -**	**$ -**	**$ 10,560**	**$ 1,771**	**$ 8,789**
27		Paso Robles	$ -	$ -	$ -	$ 150	$ -	$ 3,241	$ 1,000	$ 4,975	$ -	$ -	$ -	$ -	$ -	$ -	$ 9,366	$ 1,000	$ 8,366
28		San Luis Obispo	$ -	$ -	$ -	$ 150	$ 50	$ 450	$ 2,000	$ 800	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,450	$ 2,050	$ 1,400
29		**Los Padres Division Total**	**$ -**	**$ -**	**$ -**	**$ 300**	**$ 50**	**$ 3,691**	**$ 3,000**	**$ 5,775**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 12,816**	**$ 3,050**	**$ 9,766**
30		Fremont 12 kV	$ 184	$ 2,073	$ 5,121	$ 6,209	$ 2,865	$ 5,081	$ -	$ 1,780	$ -	$ -	$ -	$ -	$ -	$ -	$ 23,312	$ 8,170	$ 15,142
31		Fremont 21 kV	$ 12	$ 217	$ 589	$ 1,047	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,865	$ 601	$ 1,264
32		**Mission Division Total**	**$ 184**	**$ 2,073**	**$ 5,121**	**$ 6,209**	**$ 2,865**	**$ 5,081**	**$ -**	**$ 1,780**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 23,312**	**$ 8,170**	**$ 15,142**
33		Marin (Southern)	$ -	$ 1	$ -	$ 150	$ -	$ 1,944	$ 500	$ 4,379	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,974	$ 500	$ 6,474
34		Napa	$ 17	$ 703	$ -	$ 5,701	$ 3,250	$ 285	$ 3,284	$ 350	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,592	$ 6,552	$ 7,040
35		Silverado	$ -	$ -	$ -	$ 150	$ 150	$ 3,179	$ 1,000	$ 3,147	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,626	$ 1,150	$ 6,476
36		Vallejo	$ 3,221	$ 910	$ 1,528	$ 91	$ -	$ 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,754	$ 4,749	$ 1,004
37		**North Bay Division Total**	**$ 3,238**	**$ 1,614**	**$ 1,528**	**$ 6,092**	**$ 3,400**	**$ 5,412**	**$ 4,784**	**$ 7,876**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 33,945**	**$ 12,951**	**$ 20,994**
38	Corning 12 KV		$ 12	$ 1,785	$ 62	$ 3,237	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,095	$ 74	$ 5,021
39		**North Valley Division Total**	**$ 12**	**$ 1,785**	**$ 62**	**$ 3,237**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 5,095**	**$ 74**	**$ 5,021**
40		North Pen East 12 KV	$ -	$ -	$ 4,314	$ 167	$ -	$ 150	$ 100	$ 3,234	$ 1,500	$ 4,986	$ -	$ -	$ -	$ -	$ 14,451	$ 5,914	$ 8,537
41		South Pen East 12 KV	$ -	$ -	$ 32	$ -	$ 1,844	$ 150	$ -	$ 1,941	$ 1,000	$ 4,387	$ -	$ -	$ -	$ -	$ 9,354	$ 2,876	$ 6,478
42		**Peninsula Division Total**	**$ -**	**$ -**	**$ 4,346**	**$ 167**	**$ 1,844**	**$ 300**	**$ 100**	**$ 5,175**	**$ 2,500**	**$ 9,373**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 23,805**	**$ 8,790**	**$ 15,015**
43		South Colusa	$ -	$ -	$ -	$ -	$ -	$ 150	$ 100	$ 3,234	$ 1,100	$ 4,986	$ -	$ -	$ -	$ -	$ 9,570	$ 1,200	$ 8,370
44		West Sacramento	$ 14	$ 486	$ 4,017	$ 1,025	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,542	$ 4,031	$ 1,511
45		Yolo AG (North)	$ -	$ -	$ -	$ -	$ -	$ 150	$ -	$ 450	$ 500	$ 800	$ -	$ -	$ -	$ -	$ 1,900	$ 500	$ 1,400
44		**Sacramento Division Total**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 150**	**$ 100**	**$ 3,234**	**$ 1,100**	**$ 4,986**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 9,570**	**$ 1,200**	**$ 8,370**
45		Embarcadero	$ 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 200	$ 500	$ 800	$ 1,000	$ 701	$ 201	$ 500
46		Martin (SF H)	$ 5	$ -	$ 8,830	$ 600	$ 3,988	$ 800	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,223	$ 12,823	$ 1,400
47		Mission	$ 6,775	$ 1,546	$ 16,303	$ 2,329	$ 25,401	$ 2,975	$ 118	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 55,447	$ 48,597	$ 6,850
48		Potrero	$ 574	$ 189	$ 10,022	$ 3,135	$ 27,706	$ 3,519	$ 995	$ 408	$ -	$ -	$ -	$ -	$ -	$ -	$ 46,548	$ 39,297	$ 7,250
49		**San Francisco Division Total**	**$ 7,355**	**$ 1,735**	**$ 35,155**	**$ 6,064**	**$ 57,095**	**$ 7,294**	**$ 1,113**	**$ 408**	**$ -**	**$ -**	**$ 200**	**$ 500**	**$ 800**	**$ 1,000**	**$ 116,920**	**$ 100,919**	**$ 16,001**
50		Downtown San Jose 12 kV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
51		Morgan Hill/Gilroy	$ -	$ 833	$ -	$ 26,437	$ 250	$ 604	$ 1,000	$ 800	$ -	$ -	$ -	$ -	$ -	$ -	$ 29,924	$ 1,250	$ 28,674
52		South San Jose 21 kV	$ 153	$ 7,471	$ 3,807	$ 3,759	$ -	$ 236	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,426	$ 3,960	$ 11,466
53		West San Jose	$ 66	$ -	$ 3	$ -	$ 3,770	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,839	$ 3,839	$ -
54		**San Jose Division Total**	**$ 219**	**$ 8,304**	**$ 3,810**	**$ 30,196**	**$ 4,020**	**$ 840**	**$ 1,000**	**$ 800**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 49,188**	**$ 9,049**	**$ 40,140**
55		Bear River	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,000	$ -	$ 3,460	$ -	$ 1,000	$ 1,000	$ -
56		South Placer	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 150	$ -	$ 450	$ -	$ -	$ 800	$ -	$ -	$ -	$ 1,400	$ -	$ 1,400
57		Yuba City	$ 25	$ 440	$ 17	$ 787	$ 1,327	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,596	$ 1,369	$ 1,227
58		**Sierra Division Total**	**$ 25**	**$ 440**	**$ 17**	**$ 787**	**$ 1,327**	**$ -**	**$ -**	**$ 150**	**$ -**	**$ 450**	**$ 1,000**	**$ 800**	**$ 3,460**	**$ -**	**$ 4,996**	**$ 2,369**	**$ 2,627**
59		Bellevue/Cotati	$ -	$ 4,641	$ 5,532	$ 1,014	$ -	$ 19	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,207	$ 5,532	$ 5,675
60		Santa Rosa	$ -	$ 38	$ -	$ 362	$ -	$ 6,811	$ -	$ 3	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,214	$ -	$ 7,214
61		**Sonoma Division Total**	**$ -**	**$ 4,679**	**$ 5,532**	**$ 1,376**	**$ -**	**$ 6,830**	**$ -**	**$ 3**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 18,421**	**$ 5,532**	**$ 12,889**
62		Jackson	$ -	$ 9	$ 100	$ -	$ 1,348	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,457	$ 1,448	$ 9
61		Lodi	$ -	$ -	$ -	$ -	$ -	$ 0	$ -	$ 149	$ 500	$ 3,241	$ 2,000	$ 4,995	$ -	$ -	$ 10,885	$ 2,500	$ 8,385
62		Manteca 17 KV	$ 78	$ 1	$ 3,029	$ -	$ 100	$ 748	$ 1,100	$ 1,250	$ 500	$ 800	$ -	$ -	$ -	$ -	$ 7,607	$ 4,807	$ 2,799
63		South Stockton 12 kV	$ 2,083	$ -	$ 9,398	$ -	$ 55	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,537	$ 11,537	$ -
64		Tracy	$ 13	$ 2	$ 6,177	$ 480	$ 304	$ 3,242	$ 3,632	$ 4,379	$ -	$ -	$ -	$ -	$ -	$ -	$ 18,228	$ 10,126	$ 8,103
65		**Stockton Division Total**	**$ 2,175**	**$ 12**	**$ 18,704**	**$ 480**	**$ 1,807**	**$ 3,990**	**$ 4,732**	**$ 5,778**	**$ 1,000**	**$ 4,041**	**$ 2,000**	**$ 4,995**	**$ -**	**$ -**	**$ 49,714**	**$ 30,418**	**$ 19,296**
66		Canal	$ 60	$ 473	$ 65	$ 1,795	$ 4,757	$ 6,980	$ 48	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,178	$ 4,930	$ 9,248
67		Chowchilla	$ 422	$ 30	$ 9,857	$ 625	$ 830	$ 12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,776	$ 11,109	$ 667
68		Storey	$ -	$ -	$ -	$ 150	$ 100	$ 450	$ 900	$ 800	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,400	$ 1,000	$ 1,400
69		**Yosemite Division Total**	**$ 482**	**$ 503**	**$ 9,922**	**$ 2,570**	**$ 5,687**	**$ 7,442**	**$ 948**	**$ 800**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 28,354**	**$ 17,039**	**$ 11,315**
70		**Grand Total**	**$ 22,944**	**$ 38,763**	**$ 101,856**	**$ 76,378**	**$ 93,534**	**$ 64,539**	**$ 33,942**	**$ 44,054**	**$ 33,531**	**$ 41,141**	**$ 3,200**	**$ 10,691**	**$ 4,260**	**$ 1,000**	**$ 557,039**	**$ 289,007**	**$ 268,032**

Workpaper Table 17-23
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Overloaded Distribution Line Transformer Banks (06B)
(Thousands of Base Dollars, Unescalated)

Line No.	Division	Overloaded Transformer Count (1)	Transformer Loading >100%<=120% (2)	Transformer Loading >120%<=150% (2)	Transformer Loading >150%
1	CENTRAL COAST	4,605	1,789	1,162	1,654
2	DE ANZA	4,402	1,776	1,400	1,226
3	DIABLO	7,499	3,652	2,320	1,527
4	EAST BAY	3,051	921	630	1,500
5	FRESNO	14,431	4,986	3,599	5,846
6	HUMBOLDT	4,645	1,856	1,333	1,456
7	KERN	5,479	2,123	1,330	2,026
8	LOS PADRES	3,915	1,560	1,060	1,295
9	MISSION	4,930	2,396	1,343	1,191
10	NORTH BAY	4,705	2,000	1,320	1,385
11	NORTH VALLEY	7,202	3,015	1,977	2,210
12	PENINSULA	4,002	1,540	1,078	1,384
13	SACRAMENTO	4,644	1,776	1,251	1,617
14	SAN FRANCISCO	2,489	634	473	1,382
15	SAN JOSE	8,734	3,369	2,664	2,701
16	SIERRA	8,317	3,803	2,236	2,278
17	SONOMA	5,186	2,140	1,501	1,545
18	STOCKTON	9,308	3,665	2,416	3,227
19	YOSEMITE	9,315	3,609	2,484	3,222
20	**SYSTEM**	**116,859**	**46,610**	**31,577**	**38,672**
21					

	Line Description	2018 Actual	2019 Actual	2020 Actual	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Assumptions
22	Average Cost per Replacement	$34	$34	$34	$34	$34	$34	$34	$34	$34	(1)
23	Number of Transformers Replaced	2	19	25	148	140	240	315	333	345	(2)
24	06B-Overloaded Transformers Actual/Forecast Expenditures	$83	$644	$859	$5,018	$4,745	$8,172	$10,722	$11,321	$11,730	

Forecast Details and Assumptions

(1) Blended Unit Cost, OH and UG from WP Table 17-27. Line 30, Line 57

(2) Overloaded Transformer count may change over time due to results of ongoing investigation into customer connections and EDGIS mapping information.

Workpaper Table 17-24
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Mainline Loop Project Forecast Details (MAT 06I)
(Thousands of Base Dollars, Unescalated)

Line No.	Division	DPA	Circuit	Work Description	Total Project Cost	No. Customers on Radial	Project Year
1	Diablo	Concord	Tidewater 2110	Tidewater 2110 - Fairview 2206 Install UG 1200' 3-600Al w/ trench, and install OH 1100' of overhead conductor along Morello Ave. Install 1-SCADAMATE, 1 UG Fuse Sw	$685	379	2021
2	Los Padres	Santa Maria	Santa Maria 1112	Install ~300 ft. 3-1/0 Al cable E/O Alvin and Broadway, intercept line to South.	$72	648	2021
3	Mission	Hayward	Grant 1106	Connect Grant 1106 200 amp radial to Grant 1106 mainline. This project will install 1-200A interrupter w/ new box, 1- 200A junction in existing box, 150' of 1/0EPR w/ trench, 2 SB's and 1 pole.	$160	652	2021
4	North Bay	Marin (Northen)	Ignacio 1101	Install 3-3way sw and sw-int-sw at Ignacio Blvd S/O Laurelwood Dr, and trench approximately 400' along Montura Way between Ignacio Blvd and Marin Oaks Dr. Reconductor OH 850' along Marin Oaks Dr S/O Montura Way, and install OH recloser on Marin Oaks Dr 2/P/E/O Gregg Place. Install OH switch on Fairview Dr S/O Birdie Drive.	$420	1,142	2021
5	Sierra	South Placer	Del Mar 2106	Install Mainline backtie to Del Mar 2106 feeder branch beyond SW 1624 - 1084 customers on a radial	$672	1,084	2021
6	Los Padres	Santa Maria	Santa Maria 1112	Install mainline backtie for Marian Medical Center, Santa Maria CA. This critical load is a primary service beyond SW 11758 (radial). Install 3-WAY SCADA switch near primary service (available box). Install 600Al EPR cable using existing 6" spare conduit on Palisade Dr to intersection of Cypress Way (333ft). Trench and install 992ft of 600Al EPR cable along Cypress Way and install 3-WAY SCADA switch near J1065 to complete backtie.	$360	1	2022
7	Sacramento	Davis	Davis 1102	Intsall 850 feet oF UG cable in a new trench to create tie to Davis 1101	$200	774	2022
8	Yosemite	Sonora	Curtis 1704	Curtis 1704 has a mainline radial with 782 existing customers along Greenley Rd.. This project will install Install 1500ft of new 600AL and 6" conduit along Greenley Rd closing the circuit loop. It will install a riser and Switch.	$320	782	2022
9	East Bay	Richmond North	Point Pinole 1101	This project proposes to complete the primary loop by pulling 2,018 ft of 1100 EPR UG cable on existing conduit, trench/bore 800 ft of 1100 EPR UG cable , iinstall a normally open riser switch between Point Pinole 1101 and 1102 circuit.	$832	660	2022
10	Mission	Fremont 12 kV	Fremont 1109	Install 2520 ft. of 1100 EPR, exist. 6" duct; SW 7068 to C/O 10956.	$497	527	2022
11	San Francisco	Martin	San Francisco L 1103	Daly City 1109 - SF L1103 - reconductor 2000' of #4 AR with 397A Capitol from Sagamore to Garfield, radials 6135 (235 cust) and 6617 (376 cust)	$569	600	2022
12				**2021-2022 Project Total**	**$4,787**	**5,570**	
				2023	**$2,778**	**(3)(4)**	
				2024	**$2,778**	**(3)(4)**	
				2025	**$2,778**	**(3)(4)**	
				2026	**$2,778**	**(3)(4)**	

Forecast Details and Assumptions
(1) Specifically identified projects that do not comply with design standards.
(2) Unescalated Unit Costs
(3) Additional projects not to be added until existing project backlog is reduced
(4) Additional project expenditure estimated based on 2022 forecast

Workpaper Table 17-25
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Reduce Customer Count on Feeder Project Forecast Detail (MAT 06I)
(Thousands of Base Dollars, Unescalated)

Line No.	Division	DPA	Circuit	Work Description	Total Project Cost (whole $)	No. Customers before Work	No. Customers after Work	Project Year
1	East Bay	Oakland Edes-J	Oakland J 1116	Extend mainline and add switches to facilitate transfer of 957 customers from Oakland J 1116 to Oakland j 1104	$1,100	7,646	5,593	2022
2	East Bay	K-X	Oakland X1115	Reinforce Oakland X 1107 to facilitate transfer of 1850 customers from Oakland X 1115 to Oakland X 1107	$500	7,433	5,432	2022
3	Mission	Hayward	San Leandro U 1107	Transfer 1263 customers from San Leandro 1107 to San Leandro 1151. Install UG swtiches from J50925 to solide blades 50931. Minor trenching may be required to tie both circuits to new switches	$200	6,349	4,967	2023
4	San Francisco	Mission	San Francisco X 1113	Reinforce Y 1108 and A 1118 to transfer 749 customers from X 1113 to Y 1108 and A 1118	$1,400	7,144	6,395	2023
5	Central Coast	Watsonville (12/21kV)	Rob Roy 2105	Transfer 1989 customers from Rob Roy 2105 to Rob Roy 2104. Install 3000 ft of 715 Al and one SCADA switch and one recloser	$500	8,851	6,862	2024
6	Central Coast	Salinas	Salinas 1102	Replace SW3845 with a Nova Recloser and booster (B24) with a regulator for voltage and transfer load/customers from Salinas 1102 to Salians 1109. This will transfer 2000 customers from Sal1102 to Sal1109	$250	6,863	4,863	2024
7	Los Padres	Oceano	Oceano 1106	Near SW 10168, upgrade 1/0Al and 2Al to 600Al. Transfer 736 customers to Oceano 1108 by CLOSE 10168 and OPEN LR 66476. Install SCADA for FLISR	$425	6,930	6,194	2024
8	North Bay	Marin (Central)	San Rafael 1108	Reinforce existing San Rafael 1110 feeder by replacing existing station outlet cables to 3-1100 AL, replace station riser, trench and install 1100' of new 3-1100 AL cables, replace SW 1589 with SCADA MSO, and redo a set of jumpers at SW 2123.	$1,686	6,240	4,699	2022
9	San Francisco	Martin (SF H)	San Francisco H 1107	Replace 250' underground 3-1/0Al with 3-600Al from ug sw 15686 to riser cutout 2615, and replace cutout 2615 with Part 57. Transfer 805 customers from H1107 to H1105 (close 1561 and open 1747). H1107 after:5657 customers and H1105 after:5735 customers.	$150	7,102	6,297	2024
10	San Francisco	Martin (SF H)	San Francisco H 1108	Replace cutout 6469 and bypass switch 3579 (combo) on P1102 with Nova Recloser package and replace switch 1075 (H1106) with Nova Recloser package. Transfer 1141 customers (~1.8MW) from H1106 to P1102 close sw 3643 and open new recloser at switch location 1075. Transfer 1340 customers (~1.5MW) from H1108 to H1106 (close recloser 10399 and open recloser 10335). H1108 after: 5313 customers, H1106 after: 4057 customers, and P1102 after: 4864 customers.	$180	6,758	5,617	2024
11	San Jose	South San Jose 21kV	Edenvale 2108	Install SCADA MSO Switch on existing riser pole with SBD-43461 to facilitate transfer of 622 customers from Edenvale 2108 to Evergreeen 2105	$95	6,643	6,021	2024
12				**2022 Project Total**	**$3,286**			
				2023	**$1,600**			
				2024	**$1,600**			
				2025	**$1,600**	**(3) (4)**		
				2026	**$1,600**	**(3) (4)**		

Forecast Details and Assumptions
(1) Specifically identified projects that do not comply with design standards.
(2) Projects included here reflect those that require only distribution line work. Projects to reduce highly loaded feeders that also require a substation increase are included on WP Table 17-18
(3) Additional projects not to be added until existing project backlog is reduced
(4) Additional project expenditure estimated based on 2023-2024 average forecast

Workpaper Table 17-26
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Reduce Highly Loaded Feeder Project Forecast Detail (MAT 06I)
(Thousands of Base Dollars, Unescalated)

Line No.	Division	DPA	Circuit	Work Description	Feeder load before work (Amps)	Feeder load after work (Amps)	Total Project Cost (whole $)	Project Year
1	Peninsula	North Peninsula East 12 kV	East Grand 1106	The proposal would be to install tie with East Grand 1115 and split it into two circuits: one to the north on East Grand 1106 and one to the south on East Grand 1115.	803	600	$364	2021
2	Diablo	Pittsburg	Kirker 2103	Complete a Backtie Project Between Kirker 2108 & Kirker 2103 (PM#30945957), then perform load transfers to offload Kirker 2103 to Kirker 2108 and to Kirker 2105.	659	586	$864	2022
3				**2021-2022 Project Total**			**$1,228**	
				2023	**$614**	**(3) (4)**		
				2024	**$614**	**(3) (4)**		
				2025	**$614**	**(3) (4)**		
				2026	**$614**	**(3) (4)**		

Forecast Details and Assumptions

(1) Specifically identified projects that do not comply with design standards.
(2) Projects included here reflect those that require only distribution line work. Projects to reduce highly loaded feeders that also require a substation increase are included on WP Table 13-13
(3) Additional projects not to be added until existing project backlog is reduced
(4) Additional project expenditure estimated based on 2021-2022 average forecast

Workpaper Table 17-27
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 17, Electric Distribution Capacity, Engineering, and Planning
Unit Cost and Forecast Details by Asset Type

Line No.	Description	Unit Cost	Per
1	New Substation Total	$27,000,000	Substation
2	Construction	$18,600,000	Substation
3	Regulatory	$6,000,000	Substation
4	Land	$2,400,000	5 Acre Parcel
5			
6	Substation Transformers	$11,800,000	Transformer, = < 45 MVA with Switchgear
7		$8,400,000	Transformer, = < 45 MVA Outdoor Bus, Install
8		$6,500,000	Transformer, = < 45 MVA Outdoor Bus, Replace
9			
10	Circuit Switcher or Breaker	$2,200,000	High Side Circuit Switcher or Circuit Breaker
11	Breakers	$1,400,000	Low Side Circuit Breaker
12	Recable SF Circuit outlet in indoor substations	$1,100	Foot
13			
14	Non-Bay		
15	OH New	$160	Foot
16	OH Reconductor	$160	Foot
17			
18	OH Capacitor (Cap)	$33,000	Capacitor
19	OH Switch	$30,000	Switch
20	OH SCADA Switch	$45,000	Switch
21	OH Regulator	$150,000	3 Regulator Bank
22	OH Recloser	$80,000	Recloser
23	OH Fuse/Disconnect	$10,000	Fuse/Disconnect
24	OH SCADA, no equipment replacement	$15,000	Location
25	Reclocate Capacitor	$18,000	Capacitor
26			
27	UG New w/trench	$320	Foot
28	UG New no trench	$260	Foot
29			
30	Service transformer replace	$34,000	Service Transformer Replacement (blended overhead and underground)
31	Autotransformer	$850,000	Autotransformer
32	UG Switch	$80,000	Switch
33	UG SCADA Switch	$130,000	Switch
34	UG Interrupter	$120,000	Interrupter
35	PM Capacitor	$65,000	Capacitor
36			
37	Bay		
38	OH New	$220	Foot
39	OH Reconductor	$220	Foot
40	OH New - SF Only	$500	Foot
41	OH Reconductor - SF Only	$500	Foot
42			
43	OH Capacitor (Cap)	$33,000	Capacitor
44	OH Switch	$30,000	Switch
45	OH SCADA Switch	$45,000	Switch
46	OH Regulator	$150,000	3 Regulator Bank
47	OH Recloser	$80,000	Recloser
48	OH Fuse/Disconnect	$10,000	Fuse/Disconnect
49	OH SCADA, no equipment replacement	$15,000	Location
50	Reclocate Capacitor	$18,000	Capacitor
51			
52	UG New w/trench	$410	Foot
53	UG New w/trench - SF Only	$780	Foot
54	UG New no trench	$315	Foot
55	UG New no trench - SF Only	$600	Foot
56			
57	Service transformer replace	$34,000	Service Transformer Replacement (blended overhead and underground)
58	Autotransformer	$850,000	Autotransformer
59	UG Switch	$80,000	Switch
60	UG SCADA Switch	$130,000	Switch
61	UG Interrupter	$120,000	Interrupter
62	PM Capacitor	$65,000	Capacitor

(1) All regulators are purchased in MAT 06#, therefore unit costs identified here exclude the cost of material.
(2) Unit Costs are an average of recorded costs of similar work.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – ENABLE DISTRIBUTED GENERATION (DG) DIST LINE

Project Title: Enable Distributed Generation (DG) Dist Line
Major Work Categories: MWC 06 (MAT 06P)
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

Projects in this category are intended to improve voltage control of distribution line regulator banks by installing and enabling SCADA control. Regulators set for cogeneration operation installed in a mainline section of distribution line that can be temporarily reconfigured during switching to reverse the source side of the device require a setting change to ensure proper operation. Installing SCADA controls on a limited number of strategically identified regulator bank controls will allow PG&E to better manage the overall system voltage during reconfiguration of the system.

The funding request for 2023- 2026 totals $6.5 million and will be sufficient to install SCADA on roughly 42 regulator bank controls.

Project Description Table

	Division	Project Description	DPA	Substation	Deficiency		Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)
1					(MW)	(%)	
2	Various	Install SCADA control on existing Regulator Banks	Various	Various	N/A	N/A	O

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – ENABLE DISTRIBUTED GENERATION (DG) DIST LINE

Justification

This projects addresses a specific distribution system need to improve voltage control. The benefit of installing SCADA on regulator controls includes better voltage control via remote access without the need for a field visit.

Risk – Providing the ability to remotely and quickly make control settings changes on regulator banks reduces the risk of voltage issues due to improper regulator settings. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned and emergency switching to remotely operate regulator banks.

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line are necessary to meet minimum voltage requirements support compliance with PG&E's Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. These projects support safety and reliability and address issues in these areas.

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
Regulator Bank SCADA MWC 06, PO 5544388							$742	$1,344	$1,594	$1,730	$1,842	$7,252	WP 17-8 Line 21 WP 17-15 Line 11
Enable DG Dist Line-CC PO 5523499			$46	$27	$136							$209	
Enable DG Dist Line-FR PO 5523503	$1	$1	$164	$5	$260							$431	
Enable DG Dist Line-KE PO 5523505	$1	$7	$76	$2	$161							$247	
Enable DG Dist Line-LP PO 5523506	$14		$8	$126	$370							$518	
Enable DG Dist Line-NV PO 5523509			$3	$108	-$1							$110	
Enable DG Dist Line-SA PO 5523511	$1	$8	$70	$1	$3							$83	
Enable DG Dist Line-SI PO 5523513												$0	
Enable DG Dist Line-ST PO 5523516			$5									$5	
Enable DG Dist Line-YO PO 5523517			$12	$6	$1							$19	
MWC 06 Total	**$17**	**$16**	**$384**	**$275**	**$930**	**$0**	**$742**	**$1,344**	**$1,594**	**$1,730**	**$1,842**	**$8,874**	
TOTAL PROJECT COST	**17**	**16**	**384**	**275**	**930**	**-**	**742**	**1,344**	**1,594**	**1,730**	**1,842**	**8,874**	

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – ENABLE DISTRIBUTED GENERATION (DG) DIST LINE

Additional Cost Information:

Please see "Workpaper Table 17-21: Co-Gen Regulator SCADA Forecast Detail" for additional project details. The forecasted costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects.

Benefits

- The primary purpose of these projects is to meet customer demand and provide adequate service by:
  - Maintaining primary distribution voltage to meet PG&E's Electric Tariff Rule 2.
  - Increasing operational flexibility and system resiliency.

Alternatives Considered

The alternative to adding SCADA functionality to regulator banks is to maintain status quo, whereby all control setting changes are completed manually during a field visit. This is not recommended.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – POWER FACTOR MANAGEMENT

Project Title: Power Factor Management
Major Work Categories: MWC 06 (MAT 06K)
Planning Order Numbers:
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

Projects in this category are intended to improve power factor management of distribution line capacitor banks by installing and enabling SCADA control. With input from Transmission Operations and California Independent Service Operator (CAISO), Distribution Capacity Planning analyzed and ranked all PG&E distribution circuits in terms of power factor performance. PG&E's Distribution Engineers are currently evaluating capacitor control settings connected to each substation bank at a rate of 400 per year. Each control setting change requires a field visit to manually modify the controls. Installing SCADA controls on a limited number of strategically identified capacitor bank controls per feeder will allow PG&E to better manage the overall system power factor.

The funding request for 2023- 2026 totals $5.4 million and will be sufficient to install SCADA on roughly 164 capacitor bank controls.

Project Description Table

	Division	Project Description	DPA	Substation	Deficiency		Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)
1					(MW)	(%)	
2	Various	Install SCADA control on existing Capacitor Banks	Various	Various	N/A	N/A	O

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – POWER FACTOR MANAGEMENT

Justification

This project addresses a specific distribution system need to improve power factor management. The benefit of improving power factor management includes better voltage control throughout the daily load profile on the distribution as well as the transmission systems.

Risk – Providing the ability to remotely and quickly make control settings changes on capacitor banks reduces the risk of voltage issues due to excessive Volt-Ampere Reactive (VAR) at the substation and transmission levels. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned and emergency switching to remotely operate capacitor banks.

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line are necessary to meet minimum voltage requirements support compliance with PG&E's Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. This project supports safety and reliability and addresses issues in these areas.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – POWER FACTOR MANAGEMENT

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
Capacitor Bank SCADA MWC 06, PO 5544387							$618	$1,119	$1,326	$1,440	$1,535	$6,038	WP17-8 Line 20 WP 17-15 Line 10
Power Factor Management -DI PO 5505241				$23								$23	
Power Factor Management -EB PO 5505242				$36								$36	
Power Factor Management -DA PO 5505245				$3									
Power Factor Management -FR PO 5505247			$9	$7	$1								
Power Factor Management -KE PO 5505248			$1		$17								
Power Factor Management -LP PO5505249				$1	$22								
Power Factor Management -YO PO 5505251			$42	$0	$1								
Power Factor Management -NV PO 5505252			$5		$2								
Power Factor Management -SA PO 5505253			$4	$2								$6	
Power Factor Management -SI 5505254			$4	$5	$1							$10	
MWC 06 Total	**$0**	**$0**	**$65**	**$77**	**$44**	**$0**	**$618**	**$1,119**	**$1,326**	**$1,440**	**$1,535**	**$6,113**	
TOTAL PROJECT COST	**$0**	**$0**	**$65**	**$77**	**$44**	**$0**	**$618**	**$1,119**	**$1,326**	**$1,440**	**$1,535**	**$6,113**	

Additional Cost Information:

Please see “Workpaper Table 17-20: Capacitor Bank SCADA Forecast Detail” for additional project details. The forecasted costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects. Please see “Workpaper Table 17-27: Unit Costs by Asset Type” for substation and distribution line unit costs.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – POWER FACTOR MANAGEMENT

Benefits

- The primary purpose of these projects is to meet customer demand and provide adequate service by:
  - Maintaining primary distribution voltage to meet PG&E's Electric Tariff Rule 2.
  - Increasing operational flexibility and system resiliency by increasing remote monitoring and control of capacitor banks.

Alternatives Considered

The alternative to adding SCADA functionality to capacitor banks is to maintain status quo, whereby all control setting changes are completed manually during a field visit. This is not recommended.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – OPERATIONAL CAPACITY PROJECTS – RECONDUCTOR BACK-TIE

Project Title: Operational Capacity Projects: Reconductor Back-tie
Major Work Categories: MWC 06 (MAT 06I)
Planning Order Numbers: 5503050
Project Start Date: 2025
Project Completion Date: 2026
Operative Date (only applies to Capital): December 1, 2026

Project Description

This project includes reconductoring roughly 5 miles of overhead distribution line to provide an adequate back-tie to 6 MW of load and 1500 customers on Catlett 1102, including the Placer Vineyard development. The Placer Vineyards project was originally approved by the Board of Supervisors on July 16, 2007. The project is located in southwestern Placer County and contains approximately 5,230 acres. Development includes a mixed-use planned community including 14,132 residential units, 274 acres of commercial uses, 919 acres of park and open space land, and 851 acres of quasi-public uses (i.e. public facilities/services, schools, roadways, religious facilities). The existing Catlett 1105 conductor is not sized appropriately to serve all the customers and load during periods of peak demand. During past outage events, this back-tie has been used to provide emergency capacity to a subset of these customers.

This project to increase back-tie distribution line capacity has anticipated expenditures greater than $3 million and is included in the table below.

Project Description Table

1	Division	Project Description	DPA	Substation	Deficiency		Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)
2					(MW)	(%)	
3	Sierra	Catlett 1105 Back Tie	Bear River	Catlett	6		O

Justification

The project included in the Project Description table above addresses a specific forecast distribution line deficiency measured in terms of MW of overload as compared to emergency thermal ratings. The advantages of increasing distribution line capacity include reliability, operational flexibility, and enhanced ability to perform planned clearances.

Risk – Increasing the normal capacity of the distribution system reduces the risk of equipment failure due to overload conditions. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned and emergency switching to offload adjacent equipment. Projects that include upgrading distribution conductor reduce the risk of overhead conductor failure.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – OPERATIONAL CAPACITY PROJECTS – RECONDUCTOR BACK-TIE

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line necessary to meet minimum voltage requirements support compliance with PG&E's Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. This project is necessary for reliability as it has a major impact to a large number of customers.

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded				Forecast							
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL												
Catlett Reconductoring MWC 06, PO 5503050				-	-	-	-		1,000	3,460	4,460	WP 17-20 Line 58
Capital Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1,000**	**3,460**	**4,460**	
TOTAL PROJECT COST	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1,000**	**3,460**	**4,460**	

Additional Cost Information:

Please see "Workpaper Table 17-18: Forecast Capital Expenditures – Project Details" for additional project details. The forecasted costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects. Please see "Workpaper Table 17-27: Unit Costs by Asset Type" for substation and distribution line unit costs.

Benefits

- The primary purpose of these projects is to meet customer demand and provide adequate service by:
  - Mitigating equipment overload conditions, thereby reducing the risk of equipment failure.
  - Maintaining primary distribution voltage to meet PG&E's Electric Tariff Rule 2.
  - Increasing operational flexibility and system resiliency.

Alternatives Considered

PG&E's annual process to identify new capacity projects begins after the annual system peak has occurred and forecasting is complete. Prior to proposing equipment upgrades, PG&E attempts to mitigate overload and low voltage conditions through all available system re-configuration through switching between transformer banks and circuits.

1 – Upgrade facilities for location specific forecast overload conditions.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – OPERATIONAL CAPACITY PROJECTS – RECONDUCTOR BACK-TIE

- Unit cost analysis to replace or install new facilities to mitigate specifically identified overloaded equipment at various locations to determine least cost alternative.
- Evaluate alternatives to mitigate specific overloads including cost, operational flexibility benefits, and reliability benefits.

2 – Evaluate DERs

- PG&E considers DER solutions for all capacity projects via the Distribution Investment Deferral Framework (DIDF). Projects with forecast completion dates in 2024 and later years will be considered for inclusion as a Candidate Deferral Opportunity in the 2021 DDOR (Distribution Deferral Opportunity Report) which will be filed August 15, 2021.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – CIRCUIT REINFORCEMENT PROJECT SERVICES (PS) MANAGED – CONVERT LOCAL SYSTEMS

Project Title: Circuit Reinforcement Project Services (PS) Managed – Convert Local Systems
Major Work Categories: MWC 06 (MAT 06E)
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

Projects in this category are intended to increase distribution line equipment capacity to meet customer demand growth by converting a local 4 kV system to 12 or 17 kV. The projects in this category propose to convert three small pockets of aging 4 kV systems to 12 or 17 kV. Due to 4 kV system limitations, load growth in these types of areas often requires extending the surrounding higher voltage primary into the 4 kV area to serve new load or converting the 4 kV to the higher voltage primary of the surrounding area. In addition, eliminating 4 kV can also reduce substation and distribution line equipment stock necessary in local areas.

The normal capacity work PG&E forecasts for the 2023 GRC will continue to provide the necessary system expansion to meet customer demand growth by addressing expected equipment overload conditions and voltage compliance requirements. Transformer bank and feeder projects are individually identified based on load forecasting studies compared to area and equipment thermal ratings.

PG&E's load forecasting methodology projects future load at the transformer bank and circuit level. As forecast load exceeds 100 percent of the thermal rating on any individual piece of equipment, a normal capacity deficiency is identified. Project timing and projected operative dates are based on the year the deficiency is forecast. Using a high-level analysis of the deficiency and the scope of possible solutions, a cost is estimated considering unit costs as well as local knowledge of the potential site of the upgrade. As projects move through the alternative selection and engineering process, scope and estimated costs continue to be refined, increasing the accuracy of the forecasted expenditures.

Projects to increase distribution line capacity with anticipated expenditures greater than $3 million are included in table the below. These are projects with forecast normal capacity or voltage deficiencies as identified, and are at various stages of engineering, scope identification, cost estimating, and/or construction.

The Tracy and Avena cut-overs were included as projects in the 2020 GRC with completion dates in 2019 but were rescheduled to 2022 due to emergency and wildfire hardening project priorities. The Loyola 4kV cut-over project is an emergent project and will be funded from the MAT 06E emergent bucket (PO 5795502), but has been included here for completeness.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY PROJECT SUMMARY – CIRCUIT REINFORCEMENT PROJECT SERVICES (PS) MANAGED – CONVERT LOCAL SYSTEMS

Project Description Table

1	Division	Project Description	DPA	Substation	Deficiency		Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)
2					(MW)	(%)	
3	DeAnza	Loyola 4 kV Cut-over	Los Altos (4kV)	Loyola	1.5	33	O
4	Stockton	Tracy 4 kV Cut-over	Tracy	Tracy			O
5	Stockton	Avena 4 kV Cut-over	Manteca 17 kV	Avena			O

Justification

Projects included in the Project Description table above address either a specific forecast substation 4 kV transformer overload, a distribution line low voltage and starting current motor flicker issue, or eliminate temporary 12/4 kV transformer facilities located inside an existing substation. The advantages of increasing distribution line capacity include reliability, operational flexibility, and enhanced ability to perform planned clearances.

Risk – Increasing the normal capacity of the distribution system reduces the risk of equipment failure due to overload conditions. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned and emergency switching to offload adjacent equipment. Projects that include upgrading distribution conductor reduce the risk of overhead conductor failure.

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line are necessary to meet minimum voltage requirements support compliance with PG&E's Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. These projects support safety and reliability and address issues in these areas.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – CIRCUIT REINFORCEMENT PROJECT SERVICES (PS) MANAGED – CONVERT LOCAL SYSTEMS

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
Loyola 4 kV Cut-over MWC 06, PO 5796158								5,270				5,270	WP 17-21, Line 90
Tracy 4 kV Cut-over MWC 06, PO 5778171			15	11	(26)	1	1					2	WP 17-17, Line 44
MWC 06, PO 5781984			6	4	1	1						12	
MWC 06, PO 5790418					3	43	192					238	WP 17-17, Line 43
MWC 06, PO 5790419					4	43	192					239	WP 17-17, Line 42
MWC 06, PO 5794614					38	29	2,121					2,188	WP 17-17, Line 29
Avena 4 kV Cut-over MWC 06, PO 5779293				30	16	12	2,514					2,572	WP 17-17, Line 26
MWC 06 Total	-	-	21	45	36	129	5,020	5,270	-	-	-	10,521	
TOTAL PROJECT COST	-	-	21	45	36	129	5,020	5,270	-	-	-	10,521	

Additional Cost Information:

Please see "Workpaper Table 17-18: Forecast Capital Expenditures – Project Details" for additional project details. The forecasted costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects. Please see "Workpaper Table 17-27: Unit Costs by Asset Type" for substation and distribution line unit costs.

Benefits

- The primary purpose of these projects is to meet customer demand and provide adequate service by:
  - Maintaining primary distribution voltage to meet PG&E's Electric Tariff Rule 2.
  - Increasing operational flexibility and system resiliency.

Alternatives Considered

PG&E's annual process to identify new capacity projects begins after the annual system peak has occurred and forecasting is complete. Prior to proposing equipment upgrades, PG&E attempts to mitigate overload and low voltage conditions through all available system re-configuration through switching between transformer banks and circuits.

Most projects consider alternatives at more than one substation location and evaluate these alternatives for cost and other system benefits prior to selection.

1 – Upgrade facilities for location specific forecast overload conditions.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – CIRCUIT REINFORCEMENT PROJECT SERVICES (PS) MANAGED – CONVERT LOCAL SYSTEMS

- Unit cost analysis to replace or install new facilities to mitigate specifically identified overloaded equipment at various locations to determine least cost alternative.
- Evaluate alternatives to mitigate specific overloads including cost, operational flexibility benefits, and reliability benefits.

2 – Evaluate DERs

- PG&E considers DER solutions for all capacity projects via the Distribution Investment Deferral Framework (DIDF). Projects with forecast completion dates in 2024 and later years will be considered for inclusion as a Candidate Deferral Opportunity in the 2021 DDOR (Distribution Deferral Opportunity Report) which will be filed August 15, 2021.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NORMAL CAPACITY DEFICIENCIES

Project Title: Normal Capacity Deficiencies
Major Work Categories: MWC 46 (MAT 46A) and MWC 06 (MAT 06A)
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

Projects in this category are intended to increase distribution substation equipment capacity to meet customer demand growth.

The normal capacity work PG&E forecasts for the 2023 GRC will continue to provide the necessary system expansion to meet customer demand growth by addressing expected equipment overload conditions and voltage compliance requirements. Transformer bank and feeder projects are individually identified based on load forecasting studies compared to area and equipment thermal ratings.

PG&E's load forecasting methodology projects future load at the transformer bank and circuit level. As forecast load exceeds 100 percent of the thermal rating on any individual piece of equipment, a normal capacity deficiency is identified. Project timing and projected operative dates are based on the year the deficiency is forecast. Using a high-level analysis of the deficiency and the scope of possible solutions, a cost is estimated considering unit costs as well as local knowledge of the potential site of the upgrade. As projects move through the alternative selection and engineering process, scope and estimated costs continue to be refined, increasing the accuracy of the forecasted expenditures. Substation project initiation generally begins within 3 years of the projected operative date.

Projects to increase transformer bank and/or feeder capacity with anticipated expenditures greater than $3 million are included in table the below. These are projects with forecast normal capacity deficiencies as identified, and are at various stages of engineering, scope identification, cost estimating, and/or construction. Note that some substation related projects have a distribution line component (MWC 06); both the substation and line work are considered parts of the same project.

Projects located at Calflax and Santa Nella Substations were included as Normal Capacity (MAT 46A) projects in the 2020 GRC but have subsequently been moved to New Business Capacity (MAT 46H) because the capacity work at each substation is now predominately driven by a single large new business application for new transportation electrification load.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NORMAL CAPACITY DEFICIENCIES

Project Description Table

1	Division	Project Description	DPA	Substation	Deficiency		Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)
2					(MW)	(%)	
3	DeAnza	Vasona Substation – Install 1102 Feeder	Los Gatos	Vasona	2.5	16	F
4	DeAnza	Mountain View Sub – Replace Bank 1	Mountain View	Mountain View	7.5	25	B
5	DeAnza	Saratoga Sub - Install new feeder	Saratoga	Saratoga	2.6	21	F
6	Diablo	Willow Pass Sub – Replace Bank 1	Clayton/Willow Pass	Willow Pass	10.2	34	B
7	Fresno	Huron Substation – Replace Bank 1	Gates	Huron	0.7	4	B
8	Fresno	Install Alpaugh 1102	Corcoran	Alpaugh	1.9	16	F
9	Kern	Blackwell Substation – Replace Bank 1	Blackwell	Blackwell	1.1	9	B
10	Los Padres	Install San Luis Obispo 1106 Feeder	San Luis Obispo	San Luis Obispo	2.4	28	F
11	Los Padres	San Miguel Substation – Install Bank 2	Paso Robles	San Miguel	2.6	16	B
12	Mission	Dumbarton Substation – Replace Bank 2	Fremont 12 kV	Dumbarton	1.9	7	B
13	North Valley	Vina Substation – Replace Bank 1	Corning 12 kV	Vina	0.2	7	B
14	San Jose	Llagas Substation – Install Renz Energy Storage	Morgan Hill/Gilroy	Llagas	9.6	22	B
15	San Jose	Build feeder from existing breaker - Almaden 1112	West San Jose	Almaden	1.0	9	F
16	Sonoma	Rincon Bank 1, 1101, 1102 replacement and install new feeder 1105	Santa Rosa	Rincon	6.2	39	B
17	Stockton	Lammers Substation – Install Lammers 1108	Tracy	Lammers	5.5	44	F
18	Yosemite	El Nido Substation – Install El Nido 1106	Chowchilla	El Nido	2.3	22	F
19	Yosemite	Dairyland Substation – Install New 1110	Chowchilla	Dairyland	1.8	13	F

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NORMAL CAPACITY DEFICIENCIES

Justification

Projects included in the Project Description table above address a specific forecast substation deficiency measured in terms of MW and percent of overload as compared to normal thermal ratings. The advantages of increasing substation capacity include reliability, operational flexibility, and enhanced ability to perform planned clearances.

Risk – Increasing the normal capacity of the distribution system reduces the risk of equipment failure due to overload conditions. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned and emergency switching to offload adjacent equipment. Projects that include upgrading distribution conductor reduce the risk of overhead conductor failure.

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line necessary to meet minimum voltage requirements support compliance with PG&E's Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. Some of these projects are necessary for reducing safety issues, and others are necessary for reliability as they have a major impact to a large number of customers.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NORMAL CAPACITY DEFICIENCIES

Cost

Major Project Spending Estimates

(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
Vasona Substation													
MWC 46, PO 5779283			23	179	413							615	WP 17-20, Line 7
MWC 06, PO 5780358			5	28	349	3,182						3,564	WP 17-20, Line 7
Mountain View Substation													
MWC 46, PO 5790862						150	4,387	1,941				6,478	WP 17-20, Line 8
Saratoga Substation													
MWC 46, PO 5790861									150	450	800	1,400	WP 17-20, Line 10
MWC 06, PO 5795540										689	3,003	3,692	WP 17-20, Line 10
Willow Pass Substation													
MWC 46, PO 5790245						75	150	3,160	4,986			8,371	WP 17-20, Line 13
MWC 06, PO 5790220					3	25	100	1,990	2,009			4,127	WP 17-20, Line 13
Huron Substation MWC 46, PO 5782301			30	489	112	1,000	4,105	749				6,485	WP 17-20, Line 17
Alpaugh Substation													
MWC 46, PO 5779505					21	150	1,223					1,394	WP 17-20, Line 19
MWC 06, PO 5791524						98	1,802					1,900	WP 17-20, Line 19
Blackwell Substation													
MWC 46, PO 57**90872**								149	1,944	4,396		6,489	WP 17-20, Line 22
San Luis Obispo Substation													
MWC 46, PO 5791298						150	450	800				1,400	WP 17-20, Line 23
MWC 06, PO 5795538							50	2,000				2,050	WP 17-20, Line 23
San Miguel Substation													
MWC 46, PO 5794990						150	3,241	4,976				8,367	WP 17-20, Line 24
MWC 06, PO 5795539								1,000				1,000	WP 17-20, Line 24
Dumbarton Substation													
MWC 46, PO 5790334					35	297	4,366	1,780				6,478	WP 17-20, Line 26
Vina Substation													
MWC 46, PO 5783898				89	1,772	3,237						5,098	WP 17-20, Line 34
MWC 06, PO 5791998					13	62						75	WP 17-20, Line 34
Llagas Substation													
MWC 46, PO 5781158 PO 5544467			8	185	696	26,287	154					27,330	WP 17-20, Line 62
Almaden Substation													
MWC 06, PO 5784802			9	48	26	3	3,771					3,857	WP 17-20, Line 61
Rincon Substation													
MWC 46, PO 5790247					41	361	6,811	3				7,216	WP 17-20, Line 66
Lammers Substation													
MWC 46, PO 5786670					2	330						332	WP 17-20, Line 74
MWC 06, PO 5790480					14	6,177	55					6,246	WP 17-20, Line 74
El Nido Substation MWC 46, PO 5784167				322	56							378	WP 17-20, Line 76
MWC 06, PO 5783250				47	352	7,085	830					8,314	WP 17-20 Line 76
Dairyland Substation													
MWC 46, PO 5779504					32	625	12					669	WP 17-20, Line 77
MWC 06, PO 5779534			3		54	2,772						2,829	WP 17-20, Line 77
MWC 46 Total	-	-	**61**	**1,264**	**3,180**	**32,812**	**24,899**	**13,558**	**7,080**	**4,846**	**800**	**88,500**	
MWC 06 Total	-	-	**17**	**123**	**811**	**19,404**	**6,608**	**4,990**	**2,009**	**689**	**3,003**	**37,654**	
TOTAL PROJECT COST	-	-	**78**	**1,387**	**3,991**	**52,216**	**31,507**	**18,548**	**9,089**	**5,535**	**3,803**	**126,154**	

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NORMAL CAPACITY DEFICIENCIES

Additional Cost Information

Please see "Workpaper Table 17-18: Forecast Capital Expenditures – Project Details" for additional project details. Substation projects (MWC 46) are typically multi-year in duration, with total cost of the project spread over the anticipated timeline. The forecasted costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects. Please see "Workpaper Table 17-27: Unit Costs by Asset Type" for substation and distribution line unit costs.

Benefits

- The primary purpose of these projects is to meet customer demand and provide adequate service by:
  - Mitigating equipment overload conditions, thereby reducing the risk of equipment failure.
  - Maintaining primary distribution voltage to meet PG&E's Electric Tariff Rule 2.
  - Increasing operational flexibility and system resiliency.

Alternatives Considered

PG&E's annual process to identify new capacity projects begins after the annual system peak has occurred and forecasting is complete. Prior to proposing equipment upgrades, PG&E attempts to mitigate overload and low voltage conditions through all available system re-configuration through switching between transformer banks and circuits. The remaining forecast overloaded equipment for the next 3 to 5 years is identified for further analysis.

Generally, substation equipment upgrades require 3 years to engineer, procure material, and construct. Some minor substation upgrades take less time and new substations generally require five to seven years due to permitting requirements. Project initiation starts with a detailed alternative analysis, generally within the 3-year timeframe prior to the forecast completion date.[i]

Most projects consider alternatives at more than one substation location and evaluate these alternatives for cost and other system benefits prior to selection.

Through the annual DIDF Process, projects will also evaluate a distributed energy resource (DER) alternative to determine cost and feasibility of peak demand reduction.

1 – Upgrade facilities for location specific forecast overload conditions.

- Unit cost analysis to replace or install new facilities to mitigate specifically identified overloaded equipment at various locations to determine least cost alternative.
- Evaluate alternatives to mitigate specific overloads including cost, operational flexibility benefits, and reliability benefits.

2 – Evaluate DERs

- PG&E considers DER solutions for all capacity projects via the Distribution Investment Deferral Framework (DIDF). Projects with forecast completion dates in 2024 and later years will be

considered for inclusion as a Candidate Deferral Opportunity in the 2021 DDOR (Distribution Deferral Opportunity Report) which will be filed August 15, 2021.

PG&E has also identified one bank project as part of the 2017 Energy Storage Request for Offer (RFO): Llagas. Offers of Energy Storage Systems (ESS) will be evaluated upon completion of the RFO bidding period prior to moving forward with planned system upgrades and investments. In this case, the California Public Utilities Commission approved D.18-10-009 "*Decision Approving Energy Storage Agreements and Associated Cost Recovery Agreements"* on October 11, 2018. This decision approves PG&E's proposed 20 MW Llagas energy storage project.

[i] Detailed alternatives for projects beyond the three-year window are generally evaluated for new substation projects only. Performing detailed analysis on outer year projects that are not expected to incur significant expenditures until future years is premature. Such efforts would require expenditures with no commensurate benefits. The distribution system is dynamic. Forecast deficiencies may not materialize and the system may change for other reasons. These changes may provide other means for addressing the deficiency.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – EMERGENCY AND OPERATIONAL CAPACITY – EMERGENCY BANKS

Project Title: Emergency and Operational Capacity - Emergency Banks
Major Work Categories: MWC 46 (MAT 46F) and MWC 06
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

Projects in this category are intended to increase distribution substation transformer bank or feeder capacity to address emergency bank deficiencies greater than 10 MW. The emergency transformer bank and/or capacity work PG&E is forecasting for the 2023 GRC will increase capacity at locations in urban and suburban areas that have greater than a 10 MW deficiency for any single transformer bank outage. Emergency transformer bank projects are individually identified based on load forecasting studies compared to area and equipment thermal ratings assuming the largest single transformer is out of service.

PG&E's load forecasting methodology projects future load at the bank and circuit level. Using a high-level analysis of the emergency deficiency and the scope of possible solutions, cost is estimated considering unit costs as well as local knowledge of the potential site of the upgrade. As projects move through the alternative selection and engineering process, scope and estimated costs continue to be refined, increasing the accuracy of the forecast expenditures. Project initiation begins generally within 3 years of the projected operative date.

Projects to increase emergency bank capacity with anticipated expenditures greater than $3 million are included in table the below. These are projects with forecast emergency capacity deficiencies as identified in the table and are at various stages of engineering, scope identification, cost estimating, and/or construction. Note that most substation related work has a distribution line component (MWC 06); both the substation and line work are considered parts of the same project.

Soledad and Bellevue projects were included as projects in the 2020 GRC with completion dates in 2020 but were rescheduled due to emergency and wildfire hardening project priorities. Both Soledad and Bellevue are now complete and in service.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – EMERGENCY AND OPERATIONAL CAPACITY – EMERGENCY BANKS

Project Description Table

1	Division	Project Description	DPA	Substation	Deficiency		Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)
2					(MW)	(%)	
3	Central Coast	Replace Soledad Bank #2	Soledad	Soledad	11.5		B
4	North Bay	Install Pueblo Bank 3	Napa	Pueblo	14.9		B
5	Sonoma	Replace Bellevue Bank #2	Bellevue /Cotati	Bellevue	10.8		B
6	Stockton	Lockeford Sub, Replace Bank 1	Lodi	Lockeford	14.8		B

Justification

Projects included in the Project Description table above address a specific forecast emergency transformer bank deficiency measured in terms of MW. The drivers to increase substation emergency capacity include reliability, operational flexibility, and enhanced ability to perform planned clearances. An emergency deficiency exists when the forecast peak load exceeds available capacity if the largest “non-firm” substation transformer is removed from service. A substation transformer is considered “non-firm” if there is no spare transformer available to be placed into service at the substation during an emergency bank loss.

Risk – Increasing emergency bank capacity of the distribution system reduces the risk of additional equipment failure due to emergency overload conditions. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned switching to offload adjacent equipment. Projects that include upgrading distribution conductor reduce the risk of overhead conductor failure.

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line are necessary to meet minimum voltage requirements support compliance with PG&E’s Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. While only some projects are necessary for reducing safety issues, all of these projects are necessary for reliability as they have a major impact to a large number of customers.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – EMERGENCY AND OPERATIONAL CAPACITY – EMERGENCY BANKS

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
Soledad Substation													
MWC 46, PO 5766620	$6	1	168	744	4,863	1,837						7,619	WP 17-20, Line 1
MWC 06, PO 5786181				23	2,048							2,071	WP 17-20, Line 1
MWC 06, PO 5788618					1							1	WP 17-20, Line 1
Pueblo Substation													
MWC 46, PO 5780188			6	99	688	5,551	85					6,429	WP 17-20, Line 30
MWC 06, PO 5781479					19		2,751					2,770	WP 17-20, Line 30
Bellevue Substation													
MWC 46, PO 5774720		13	265	1,033	3,497	1,014	19					5,841	WP 17-20, Line 65
MWC 06, PO 5537636				6	115	5,531						5,652	WP 17-20, Line 65
Lockeford Substation													
MWC 46, PO 5768812								149	3,241	4,995		8,385	WP 17-20, Line 68
MWC 46 Total	**6**	**14**	**439**	**1,876**	**9,048**	**8,402**	**104**	**149**	**3,241**	**4,995**	**-**	**28,274**	
MWC 06 Total	**-**	**-**	**-**	**29**	**2,183**	**5,531**	**2,751**	**-**	**-**	**-**	**-**	**10,494**	
TOTAL PROJECT COST	**6**	**14**	**439**	**1,905**	**11,231**	**13,933**	**2,855**	**149**	**3,241**	**4,995**	**-**	**38,768**	

Additional Cost Information:

Please see "Workpaper Table 17-18: Forecast Capital Expenditures – Project Details" for additional project details. Substation projects (MWC 46) are typically multi-year in duration, with total cost of the project spread over the anticipated timeline. The forecast costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects. Please see "Workpaper Table 17-27: Unit Costs by Asset Type" for substation and distribution line unit costs.

Benefits

- The primary purpose of these projects is to eliminate the emergency bank deficiency projected to be greater than 10 MW, identified at five urban/suburban substations. This work is intended to improve customer satisfaction and has no direct cost savings anticipated. Reducing the number of banks with greater than 10 MW of emergency deficiency improves reliability and customer satisfaction by reducing length of outage time for mobile transformer deployment.
  - Reduce SAIDI, SAIFI, and CAIFI.
  - Increase operational flexibility and system resiliency.
  - Enhance ability to perform planned clearances.
  - Limit the number of the largest substation transformer emergency deficiencies to avoid overextending the mobile transformer fleet.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – EMERGENCY AND OPERATIONAL CAPACITY – EMERGENCY BANKS

Alternatives Considered

Prior to proposing equipment upgrades for substation transformer emergency deficiencies, overload and low voltage conditions are mitigated through system reconfiguration by switching between substation transformers and circuits. Emergency deficiencies are defined in terms of load and customers that remain out of service after available switching has occurred. Bank loss studies that identify locations in urban and suburban areas where the emergency transformer bank deficiency is 10 MW or greater are further analyzed to determine feasible solutions.

Generally, substation equipment upgrades are multi-year projects that require 3 years to engineer, procure material, and construct. Some minor substation upgrades take less time and new substations generally require five to seven years due to permitting requirements. Project initiation starts with a detailed alternative analysis, generally within the 3-year timeframe prior to the forecast completion date.[i]

Most projects consider alternatives at more than one substation location and evaluate these alternatives for cost and other system benefits prior to selection.

Through the annual DIDF Process, projects will also evaluate a distributed energy resource (DER) alternative to determine cost and feasibility of supporting un-served load during emergency conditions.

1 – Upgrade facilities for location specific forecast overload conditions.

- Unit cost analysis to replace or install new facilities to mitigate specifically identified overloaded equipment at various locations to determine least cost alternative.
- Evaluate alternatives to mitigate specific overloads including cost, operational flexibility benefits, and reliability benefits.

2 Evaluate DERs

- PG&E considers DER solutions for all capacity projects via the Distribution Investment Deferral Framework (DIDF). Projects with forecast completion dates in 2024 and later years will be considered for inclusion as a Candidate Deferral Opportunity in the 2021 DDOR (Distribution Deferral Opportunity Report) which will be filed August 15, 2021.

[i] Detailed alternative analyses for projects beyond the three-year window are generally evaluated for new substation projects only. Performing detailed analysis on outer year projects that are not expected to incur significant expenditures until future years is premature. Such efforts would require expenditures with no commensurate benefits. The distribution system is dynamic. Forecast deficiencies may not materialize and the system may change for other reasons. These changes may provide other means for addressing the deficiency.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – EMERGENCY AND OPERATIONAL CAPACITY – REDUCE CUSTOMER COUNT

Project Title: Emergency and Operational Capacity - Reduce Customer Count
Major Work Categories: MWC 46 (MAT 46F) and MWC 06
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

Projects in this category are intended to increase distribution substation transformer bank and/or feeder capacity to maintain the number of customers on a feeder to no more than 6,000. These projects address high customer count on various feeders. Each feeder with greater than 6,000 customers was reviewed to determine possible solutions, including re-configuration of the distribution system via switching between circuits to balance the number of customers or loading per feeder while maintaining capacity and voltage limits. The proposed projects are the result of the system analysis. Using a high-level analysis of the proposed project scope, a cost is estimated considering unit costs as well as local knowledge of the potential site of the upgrade. As projects move through the alternative selection and engineering process, scope and estimated costs continue to be refined, increasing the accuracy of the forecast expenditures. Project initiation begins generally within 3 years of the projected operative date.

Projects to increase bank and/or feeder capacity with anticipated expenditures greater than $3 million are included in table the below. These projects are at various stages of engineering, scope identification, cost estimating, and/or construction. Note that most substation related work has a distribution line component (MWC 06); both the substation and line work are considered parts of the same project.

Monterey and Jarvis projects were included as projects in the 2020 GRC with completion dates in 2020 but were rescheduled due to emergency and wildfire hardening project priorities. Jarvis is scheduled for completion in 2021 and Monterey is scheduled for completion in 2023.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – EMERGENCY AND OPERATIONAL CAPACITY – REDUCE CUSTOMER COUNT

Project Description Table

	Division	Project Description	DPA	Substation	Deficiency		- Bank, F - Feeder, L - Land, NS - New Substation, O -
1					(MW)	(%)	
2	Central Coast	Rebuild Monterey Substation	Seaside Marina 12 kV	Monterey	NA	NA	B
3	Mission	Replace Jarvis Bk 2 w/ 45 MVA and New Feeder	Fremont 12 kV	Jarvis	NA	NA	B
4	Central Coast	Install Camp Evers 2107	Santa Cruz	Camp Evers	NA	NA	F

Justification

Projects included in the Project Description table above increase area capacity to allow re-configuration to the distribution system to reduce the number of customers per feeder in the local area to less than 6,000 customers. Reductions in the number of customers served by any one feeder will generate reductions in SAIDI, SAIFI, and CAIDI and improve customer satisfaction.

Risk – Increasing normal capacity of the distribution system reduces the risk of equipment failure due to overload conditions. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned switching to offload adjacent equipment. Projects that include upgrading distribution conductor reduce the risk of overhead conductor failure.

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line necessary to meet minimum voltage requirements support compliance with PG&E's Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. While some projects are necessary for reducing safety issues, all of these projects are necessary for reliability as they have a major impact to a large number of customers.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – EMERGENCY AND OPERATIONAL CAPACITY – REDUCE CUSTOMER COUNT

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded				Forecast							
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL												
Monterey Substation MWC 46, PO 5746941	$1	-$3									(2)	WP 17-20, Line 3
MWC 46, PO 5762974	$6	$291	$899	$507	$2,379	$7,003	$32				11,117	WP 17-20, Line 3
MWC 06, PO 5786338		$3	$17	$1,361	$ 1,554						2,935	WP 17-20, Line 3
MWC 06, PO 5788621				$10	$ 20	$ 2,869					2,899	WP 17-20, Line 3
Jarvis Substation MWC 46, PO 5763889		$5	$716	$624	5,412	15					6,772	WP 17-20, Line 25
MWC 06, PO 5763923		$10		$1							11	WP 17-20, Line 25
MWC 06, PO 5782238		$3	$16	$170	5,021						5,210	WP 17-20, Line 25
Camp Evers Substation MWC 46, PO 5780325			$2	$77	121	1,200					1,400	WP 17-20, Line 4
MWC 06, PO 5780327				$2	98	695					795	WP 17-20, Line 4
MWC 46 Total	**$7**	**$293**	**$1,617**	**$1,208**	**$7,912**	**$8,218**	**$32**	**$0**	**$0**	**$0**	**$19,287**	
MWC 06 Total	**$0**	**$16**	**$33**	**$1,544**	**$6,693**	**$3,564**	**$0**	**$0**	**$0**	**$0**	**$11,850**	
TOTAL PROJECT COST	**$7**	**$309**	**$1,650**	**$2,752**	**$14,605**	**$11,782**	**$32**	**$0**	**$0**	**$0**	**$31,137**	

Additional Cost Information:

Please see “Workpaper Table 17-18: Forecast Capital Expenditures – Project Details” for additional project details. Substation projects (MWC 46) are typically multi-year in duration, with total cost of the project spread over the anticipated timeline. The forecast costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects. Please see “Workpaper Table 17-27: Unit Costs by Asset Type” for substation and distribution line unit costs.

Benefits

- The primary purpose of these projects is to reduce the number of customers served by a single circuit and is intended to improve customer satisfaction and have no direct cost savings anticipated. Benefits include:
  - Reduce SAIDI, SAIFI, and CAIFI.
  - Increase operational flexibility and system resiliency.
  - Enhance ability to perform planned clearances.

Alternatives Considered

Circuits serving greater than 6000 customers are first mitigated through available re-configuration of the distribution system to balance the load and customer counts among facilities via switching between circuits

prior to proposing equipment upgrades. Possible solutions are evaluated for cost and other system benefits prior to selection.

Generally, substation equipment upgrades are multi-year projects that require 3 years to engineer, procure material, and construct. Some minor substation upgrades take less time and new substations generally require five to seven years due to permitting requirements. Project initiation starts with a detailed alternative analysis, generally within the 3-year timeframe prior to the forecast completion date.[i]

Most projects consider alternatives at more than one substation location and evaluate these alternatives for cost and other system benefits prior to selection.

1 – Upgrade facilities for location specific forecast overload conditions.

- Unit cost analysis to replace or install new facilities to mitigate specifically identified overloaded equipment at various locations to determine least cost alternative.
- Evaluate alternatives to mitigate specific overloads including cost, operational flexibility benefits, and reliability benefits.

2 Evaluate DERs

- PG&E considers DER solutions for all capacity projects via the Distribution Investment Deferral Framework (DIDF). Projects with forecast completion dates in 2024 and later years will be considered for inclusion as a Candidate Deferral Opportunity in the 2021 DDOR (Distribution Deferral Opportunity Report) which will be filed August 15, 2021.

[i] Detailed alternative analyses for projects beyond the three-year window are generally evaluated for new substation projects only. Performing detailed analysis on outer year projects that are not expected to incur significant expenditures until future years is premature. Such efforts would require expenditures with no commensurate benefits. The distribution system is dynamic. Forecast deficiencies may not materialize and the system may change for other reasons. These changes may provide other means for addressing the deficiency.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – EMERGENCY AND OPERATIONAL CAPACITY – REDUCE HIGH LOADING

Project Title: Emergency and Operational Capacity - Reduce High Loading
Major Work Categories: MWC 46 (MAT 46F) and MWC 06
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

Projects in this category are intended to increase distribution substation transformer bank and/or feeder capacity in strategic locations to improve system flexibility to switch load between feeders during planned clearances or outage events by limiting feeder loaded to no more than 600 amps. These projects address high loading on various feeders. Each feeder with greater than 600 amps was reviewed to determine possible solutions, including re-configuration of the distribution system via switching between circuits to balance the number of customers or loading per feeder while maintaining capacity and voltage limits. The proposed projects are the result of the system analysis. Using a high-level analysis of the proposed project scope, a cost is estimated considering unit costs as well as local knowledge of the potential site of the upgrade. As projects move through the alternative selection and engineering process, scope and estimated costs continue to be refined, increasing the accuracy of the forecast expenditures. Project initiation begins generally within 3 years of the projected operative date.

Projects to increase bank and/or feeder capacity with anticipated expenditures greater than $3 million are included in table the below. These projects are at various stages of engineering, scope identification, cost estimating, and/or construction. Note that most substation related work has a distribution line component (MWC 06); both the substation and line work are considered parts of the same project.

Brentwood and Bogue projects were included as projects in the 2020 GRC with completion dates in 2021 but were rescheduled due to emergency and wildfire hardening project priorities. Both projects are scheduled for completion in 2022.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – EMERGENCY AND OPERATIONAL CAPACITY – REDUCE HIGH LOADING

Project Description Table

	Division	Project Description	DPA	Substation	Deficiency		- Bank, F - Feeder, L - Land, NS - New Substation, O -
1					(MW)	(%)	
2	Diablo	Install Brentwood 2104 feeder	Brentwood	Brentwood			F
3	San Jose	Install new feeder at FMC	Downtown San Jose 12 kV	FMC			F
4	Sierra	Install Bogue 1108	Yuba City	Bogue			F

Justification

Projects included in the Project Description table above increase area capacity to allow re-configuration to the distribution system to reduce the load per feeder in the local area to less than 600 amps. Reductions in the load served by any one feeder will generate reductions in SAIDI, SAIFI, and CAIDI and improve customer satisfaction.

Risk – Increasing normal capacity of the distribution system reduces the risk of equipment failure due to overload conditions. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned switching to offload adjacent equipment. Projects that include upgrading distribution conductor reduce the risk of overhead conductor failure.

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line are necessary to meet minimum voltage requirements support compliance with PG&E's Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. These projects are necessary for reliability as they have a major impact on a large number of customers.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – EMERGENCY AND OPERATIONAL CAPACITY – REDUCE HIGH LOADING

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded				Forecast							
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL												
Brentwood Substation MWC 46, PO 5780363			$156	$194	$651						$1,001	WP 17-20, Line 12
MWC 06, PO 5780360		$34	-$6	$101	$51	$5,940					$6,120	WP 17-20, Line 12
FMC Substation MWC 46, PO 5780362					$150	$450	$800				$1,400	WP 17-20, Line 63
MWC 06, PO 5780328						$50	$900				$950	WP 17-20, Line 63
BogueSubstation MWC 46, PO 5780318		$3	$33	$453	$787						$1,276	WP 17-20, Line 57
MWC 06, PO 5780359		$3	$12	$14	$17	$1,327					$1,373	WP 17-20, Line 57
MWC 46 Total	**$0**	**$3**	**$189**	**$647**	**$1,588**	**$450**	**$800**	**$0**	**$0**	**$0**	**$3,677**	
MWC 06 Total	**$0**	**$37**	**$6**	**$115**	**$68**	**$7,317**	**$900**	**$0**	**$0**	**$0**	**$8,443**	
TOTAL PROJECT COST	**$0**	**$40**	**$195**	**$762**	**$1,656**	**$7,767**	**$1,700**	**$0**	**$0**	**$0**	**$12,120**	

Additional Cost Information:

Please see "Workpaper Table 17-18: Forecast Capital Expenditures – Project Details" for additional project details. Substation projects (MWC 46) are typically multi-year in duration, with total cost of the project spread over the anticipated timeline. The forecast costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects. Please see "Workpaper Table 17-27: Unit Costs by Asset Type" for substation and distribution line unit costs.

Benefits

- The primary purpose of these projects is to reduce the number of customers served by a particular feeder and is intended to improve customer satisfaction and have no direct cost savings anticipated. Benefits include:
  - Reduce SAIDI, SAIFI, and CAIFI.
  - Increase operational flexibility and system resiliency.
  - Enhance ability to perform planned clearances.

Alternatives Considered

Circuits serving greater than 600 amps are first mitigated through available re-configuration of the distribution system to balance the load and customer counts among facilities via switching between circuits prior to proposing equipment upgrades. Possible solutions are evaluated for cost and other system benefits prior to selection.

Generally, substation equipment upgrades are multi-year projects that require 3 years to engineer, procure material, and construct. Some minor substation upgrades take less time and new substations generally

require five to seven years due to permitting requirements. Project initiation starts with a detailed alternative analysis, generally within the 3-year timeframe prior to the forecast completion date.[i]

Most projects consider alternatives at more than one substation location and evaluate these alternatives for cost and other system benefits prior to selection.

1 – Upgrade facilities for location specific forecast overload conditions.
- Unit cost analysis to replace or install new facilities to mitigate specifically identified overloaded equipment at various locations to determine least cost alternative.
- Evaluate alternatives to mitigate specific overloads including cost, operational flexibility benefits, and reliability benefits.

2 – Evaluate DERs.
- PG&E considers DER solutions for all capacity projects via the Distribution Investment Deferral Framework (DIDF). Projects with forecast completion dates in 2024 and later years will be considered for inclusion as a Candidate Deferral Opportunity in the 2021 DDOR (Distribution Deferral Opportunity Report) which will be filed August 15, 2021.

[i] Detailed alternative analyses for projects beyond the three-year window are generally evaluated for new substation projects only. Performing detailed analysis on outer year projects that are not expected to incur significant expenditures until future years is premature. Such efforts would require expenditures with no commensurate benefits. The distribution system is dynamic. Forecast deficiencies may not materialize and the system may change for other reasons. These changes may provide other means for addressing the deficiency.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS-RELATED CAPACITY

Project Title: New Business-Related Capacity
Major Work Categories: MWC 46 (MAT 46H) and MWC 06 (MAT 06H)
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

Projects in this category are intended to increase distribution substation transformer bank and/or feeder capacity to meet customer demand growth. Projects listed in MAT 46H are necessary to serve single large new business customer load forecasts.

The transformer bank and/or feeder capacity work PG&E forecasts for the 2023 GRC will continue to provide the necessary system expansion to meet customer demand growth by addressing expected equipment overload conditions and voltage compliance requirements. Transformer bank and feeder projects are individually identified based on load forecasting studies compared to area and equipment thermal ratings.

PG&E's load forecasting methodology projects future load at the transformer bank and circuit level. As forecast load exceeds 100% of the thermal rating on any individual piece of equipment, a normal capacity deficiency is identified. Project timing and projected operative dates are based on the year the deficiency is forecast. Using a high-level analysis of the deficiency and the scope of possible solutions, a cost is estimated considering unit costs as well as local knowledge of the potential site of the upgrade. As projects move through the alternative selection and engineering process, scope and estimated costs continue to be refined, increasing the accuracy of the forecasted expenditures. Project initiation begins generally within 3 years of the projected operative date.

Projects to increase transformer bank and/or feeder capacity with anticipated expenditures greater than $3 million are included in table the below. These are projects with forecast normal capacity deficiencies as identified, and are at various stages of engineering, scope identification, cost estimating, and/or construction. Note that most substation related projects have a distribution line component (MWC 06); both the substation and line work are considered parts of the same project.

The project located at Dolan Substation was also included in the 2020 GRC with an operational date forecast in 2021.[1] The work to extend the Weber 1101 circuit was rescheduled to 2021[2] due to emergency repair and wildfire hardening work.

[1] WP 17-20, line 2, Exhibit (PG&E-4)

[2] WP 17-20, line 72, Exhibit (PG&E-4)

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS-RELATED CAPACITY

Project Description Table

1	Division	Project Description	DPA	Substation	Deficiency		Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)
2					(MW)	(%)	
3	Central Coast	Dolan Rd. Sub - Install New Bank	Prunedale	Dolan Road	8.6	31	B
4	Central Coast	Spence Bank 2 Replacement	Salinas	Spence	11.4	97	B
5	DeAnza	Wolfe Install 2 New Circuits: 1115 and 1116 for Vallco	Cupertino	Wolfe	2.7	24	F
6	Fresno	Replace Tulare Lake Bank 1	Kettleman	Tulare Lake	5.5	52	B
7	Fresno	Calflax - Install New Bank: Bank 2	Gates	Calflax	9.7	49	B
8	Humboldt	Garberville Circuit & Substation Reinforcement	Garberville	Garberville	6.8	55	B
9	Kern	Tejon Sub - Install 1107 Feeder	Arvin	Tejon	2.4	23	F
10	Mission	Jarvis Sub: Install Jarvis 1102 Feeder	Fremont 12 kV	Jarvis	2.3	8	F
11	North Bay	Add new feeder breaker on Highway bank 1	Vallejo	Highway	1.9	16	F
12	North Bay	Replace Greenbrae Bank 2	Marin (Southern)	Greenbrae	2.0	13	B
13	North Bay	Replace Calistoga Bank 1 and Install 1 new feeder	Silverado	Calistoga	2.6	13	B
14	North Bay	Install Tulucay 1102	Napa	Tulucay	8.0	53	F
15	Peninsula	Install East Grand 1116 & East Grand 1117	North Pen East 12 KV	East Grand	7.6	59	F
16	Peninsula	Belle Haven Bk 4_Repl w 30MVA and Inst BH 1109 Fdr	South Pen East 12 KV	Belle Haven	1.7	11	B
17	Peninsula	Millbrae Sub: Install Bank 2 and Millbrae 1109 Fdr	North Pen East 12 KV	Millbrae	7.7	66	B
18	Sacramento	Install Deepwater 1110 & 1111	West Sacramento	Deepwater	3.9	30	F
19	Sacramento	Replace Dunnigan Bank 1 and Install 1102 Feeder	South Colusa	Dunnigan	1.6	20	B
20	San Francisco	Install New Feeder Martin (SF H) 1117	Martin (SF H)	Martin (SF H)	7.7	64	F
21	San Francisco	Oceanwide Center SF New Feeder Mission X 1127	Mission	Mission (SF X)	4.6	47	F
22	San Francisco	Install New Feeder Mission (SF X) 1128	Mission	Mission (SF X)	1.8	18	F

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS-RELATED CAPACITY

23	San Francisco	Install New Feeder Mission (SF X) 1129	Mission	Mission (SF X)	6.8	115	F
24	San Francisco	Mission X1113 Circuit Reinforcement	Mission	Mission (SF X)	4.9	40	O
25	San Francisco	Mission X 1120 Recable inside Sub	Mission	Mission (SF X)	1.4	27	O
26	San Francisco	Mission X 1101 Recable inside Sub	Mission	Mission (SF X)	10.7	104	O
27	San Francisco	Mission X 1107 Recable inside Sub	Mission	Mission (SF X)	2.5	32	O
28	San Francisco	Potrero: Install New Feeder A 1120	Potrero	Potrero (SF A)	7.4	77	F
29	San Francisco	Potrero A1108 Recable inside Sub	Potrero	Potrero (SF A)	3.8	40.0	O
30	San Francisco	Potrero A1113 Recable inside Sub	Potrero	Potrero (SF A)	3.8	40	O
31	San Francisco	Potrero A1117 Recable inside Sub	Potrero	Potrero (SF A)	0.7	10	O
32	San Jose	Install distribution bank at Santa Teresa Sub	South San Jose 21 KV	Santa Teresa	12.6	28	NS
33	Stockton	Vierra 1703 Install Mainline	Manteca 17 KV	Vierra	3.5	46	O
34	Stockton	Install Weber 1111 on existing breaker	South Stockton 12 KV	Weber	1.6	13	F
35	Stockton	Install Weber 1115 on existing breaker	South Stockton 12 KV	Weber	2.0	16	F
36	Stockton	Replace Banta Bank 1	Tracy	Banta	2.6	30	B
37	Yosemite	Santa Nella Bank #1 Replacement and install two 12 kV feeders	Canal	Santa Nella	4.8	37	B

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS-RELATED CAPACITY

Justification

Projects included in the Project Description table above address a specific forecast transformer bank deficiency measured in terms of MW and percent of overload as compared to normal thermal ratings. The advantages of increasing substation capacity include reliability, operational flexibility, and enhanced ability to perform planned clearances.

Risk – Increasing normal capacity of the distribution system reduces the risk of equipment failure due to overload conditions. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned and emergency switching to offload adjacent equipment. Projects that include upgrading distribution conductor reduce the risk of overhead conductor failure.

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line are necessary to meet minimum voltage requirements support compliance with PG&E's Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. While these projects support safety and reliability, they are not necessary to address issues in these areas.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS-RELATED CAPACITY

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
Dolan Substation													
MWC 46, PO 5779285			2	155	3,615	6,332	66	-	-	-	-	10,171	WP 17-20, Line 2
MWC 06, PO 5789738					5	1,225	-	-	-	-	-	1,230	WP 17-20, Line 2
Spence Substation													
MWC 46, PO 5790898						-	150	1,941	4,387	-	-	6,478	WP 17-20, Line 6
MWC 06, PO 5795541						-	-	498	2,991	-	-	3,489	WP 17-20, Line 6
Wolfe Substation													
MWC 46, PO 5790914						-	-	150	1,000	1,650	-	2,800	WP 17-20, Line 9
MWC 06, PO 5795543						-	-	-	2,991	2,997	-	5,988	WP 17-20, Line 9
Tulare Lake Substation													
MWC 46, PO 5785560				80	3,988	2,028	-	-	-	-	-	6,097	WP 17-20, Line 16
MWC 06, PO 5788795				3	40	1,392	-	-	-	-	-	1,436	WP 17-20, Line 16
Calflax Substation													
MWC 46, PO 5779506			2	0	163	3,833	2,101	4	-	-	-	6,104	WP 17-20, Line 18
MWC 06, PO 5779536					46	1,351	2,522	-	-	-	-	3,919	WP 17-20, Line 18
Garberville Substation													
MWC 46, PO 5786128						-	598	3,483	10,968	-	-	15,049	WP 17-20, Line 20
MWC 06, PO 5794083						-	-	14,927	23,931	-	-	38,858	WP 17-20, Line 20
Tejon Substation													
MWC 46, PO 5790251					17	193	2,074	17	-	-	-	2,301	WP 17-20, Line 21
MWC 06, PO 5790380					55	1,720	-	-	-	-	-	1,775	WP 17-20, Line 21
Jarvis Substation													
MWC 46, PO 5792380						500	700	-	-	-	-	1,200	WP 17-20, Line 27
MWC 06, PO 5792379					1	100	2,865	-	-	-	-	2,966	WP 17-20, Line 27
Highway Substation													
MWC 46, PO 5768811						91	4	-	-	-	-	94	WP 17-20, Line 29
MWC 06, PO 5777583						1,528	-	-	-	-	-	1,528	WP 17-20, Line 29
Greenbrae Substation													
MWC 46, PO 5789999					1	150	1,944	4,379	-	-	-	6,474	WP 17-20, Line 31
MWC 06, PO 5790780						-	-	500	-	-	-	500	WP 17-20, Line 31
Calistoga Substation													
MWC 46, PO 5791138						150	3,179	3,147	-	-	-	6,476	WP 17-20, Line 32
MWC 06, PO 5795532						-	150	1,000	-	-	-	1,150	WP 17-20, Line 32

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS-RELATED CAPACITY

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
Tulucay Substation													WP 17-20,
MWC 46, PO 5792882						150	200	350	-	-	-	700	Line 33
MWC 06, PO 5795542						-	499	3,284	-	-	-	3,783	WP 17-20, Line 33
East Grand Substation													WP 17-20,
MWC 46, PO 5534939					50	167	-	-	-	-	-	217	Line 35
MWC 06, PO 5530139			36	7	52	4,314	-	-	-	-	-	4,409	WP 17-20, Line 35
Belle Haven Substation													WP 17-20,
MWC 46, PO 5791141						-	150	1,941	4,387	-	-	6,478	Line 37
MWC 06, PO 5795531						-	-	-	1,000	-	-	1,000	WP 17-20, Line 37
Millbrae Substation													WP 17-20,
MWC 46, PO 5791142						-	150	3,234	4,986	-	-	8,370	Line 38
MWC 06, PO 5795535						-	-	100	1,500	-	-	1,600	WP 17-20, Line 38
Deepwater Substation													WP 17-20,
MWC 46, PO 5787198					519	1,025	-	-	-	-	-	1,544	Line 39
MWC 06, PO 5787339				2	14	4,017	-	-	-	-	-	4,033	WP 17-20, Line 39
Dunnigan Substation													WP 17-20,
MWC 46, PO 5790009						-	150	3,234	4,986	-	-	8,370	Line 40
MWC 06, PO 5795533						-	-	100	1,100	-	-	1,200	WP 17-20, Line 40
Martin (SF H) Substation													WP 17-20,
MWC 46, PO 5789638						600	800	-	-	-	-	1,400	Line 43
MWC 06, PO 5789862													WP 17-20,
5789606					5	8,830	3,988	-	-	-	-	12,823	Line 43
Mission Substation X 1127													WP 17-20,
MWC 46, PO 5784519				538	229	350	-	-	-	-	-	1,117	Line 44
MWC 06, PO 5780540			331	1,827	2,701	1,047	-	-	-	-	-	5,906	WP 17-20, Line 44
Mission Substation X 1128													WP 17-20,
MWC 46, PO 5784931				67	587	180	-	-	-	-	-	834	Line 45
MWC 06, PO 5784958				21	1,847	1,736	-	-	-	-	-	3,604	WP 17-20, Line 45
Mission Substation X 1129													WP 17-20,
MWC 46, PO 5784872					281	853	4	-	-	-	-	1,138	Line 46
MWC 06, PO 5787581				5	228	4,621	8,731	118	-	-	-	13,704	WP 17-20, Line 46
Mission Substation X 1113													WP 17-20,
MWC 46, PO 5791243						473	832	-	-	-	-	1,306	Line 47
MWC 06, PO 5791320					2	3,502	3,293	-	-	-	-	6,796	WP 17-20, Line 47
Mission Substation X 1120													WP 17-20,
MWC 46, PO 5790746						473	832	-	-	-	-	1,306	Line 48
MWC 06, PO 5790706					2	-	2,991	-	-	-	-	2,993	WP 17-20, Line 48
Mission Substation X 1101													WP 17-20,
MWC 46, PO 5790744						-	1,306	-	-	-	-	1,306	Line 49
MWC 06, PO 5790704					2	5,339	-	-	-	-	-	5,341	WP 17-20, Line 49
Mission Substation X 1107													WP 17-20,
MWC 46, PO 5790750						-	-	-	-	-	-	-	Line 51
MWC 06, PO 5790710					37	57	9,348	-	-	-	-	9,443	WP 17-20, Line 51

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS-RELATED CAPACITY

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
Potrero Substation A1120													
MWC 46, PO 5785511				72	130	1,736	121	-	-	-	-	2,059	WP 17-20, Line 52
MWC 06, PO 5785564				96	366	5,653	10,013	-	-	-	-	16,128	WP 17-20, Line 52
Potrero Substation A 1108													
MWC 46, PO 5790739						451	832	-	-	-	-	1,283	WP 17-20, Line 53
MWC 06, PO 5790699					84	4,208	-	-	-	-	-	4,292	WP 17-20, Line 53
Potrero Substation A 1113													
MWC 46, PO 5790740						473	832	-	-	-	-	1,306	WP 17-20, Line 54
MWC 06, PO 5790700					2	-	6,629	995	-	-	-	7,626	WP 17-20, Line 54
Potrero Substation A 1117													
MWC 46, PO 5790738						-	898	408	-	-	-	1,306	WP 17-20, Line 56
MWC 06, PO 5790698					63	122	11,064	-	-	-	-	11,249	WP 17-20, Line 56
Santa Teresa Substation													
MWC 46, PO 5768879	117	178	179	469	6,515	3,759	236	-	-	-	-	11,452	WP 17-20, Line 60
MWC 06, PO 5763812 5790320		6	0	18	145	3,807	-	-	-	-	-	3,975	WP 17-20, Line 60
Vierra Substation													
MWC 06, PO 5787303				12	72	3,029	-	-	-	-	-	3,113	WP 17-20, Line 69
Weber Substation 1111													
MWC 06, PO 5779292			73	39	1	3,262	-	-	-	-	-	3,375	WP 17-20, Line 72
Weber Substation 1115													
MWC 06, PO 5791154					74	6,137	55	-	-	-	-	6,265	WP 17-20, Line 73
Banta Substation													
MWC 46, PO 5792892						150	1,944	4,379	-	-	-	6,473	WP 17-20, Line 75
MWC 06, PO 5795530						-	249	3,632	-	-	-	3,881	WP 17-20, Line 75
Santa Nella Substation													
MWC 46, PO 5746645	45	20	22	13	246	1,795	6,980	-	-	-	-	9,123	WP 17-20, Line 78
MWC 06, PO 5746706 5790352	0	1	4	10	58	65	4,757	48	-	-	-	4,944	WP 17-20, Line 78
MWC 46 Total	**$162**	**$198**	**$206**	**$1,395**	**$16,341**	**$25,913**	**$27,085**	**$26,667**	**$30,714**	**$1,650**	**$0**	**$130,331**	
MWC 06 Total	**$0**	**$7**	**$444**	**$2,040**	**$5,899**	**$67,064**	**$67,154**	**$25,202**	**$33,513**	**$2,997**	**$0**	**$204,321**	
TOTAL PROJECT COST	**$162**	**$205**	**$650**	**$3,435**	**$22,240**	**$92,977**	**$94,239**	**$51,869**	**$64,227**	**$4,647**	**$0**	**$334,652**	

Additional Cost Information:

Please see "Workpaper Table 17-18: Forecast Capital Expenditures – Project Details" for additional project details. Substation projects (MWC 46) are typically multi-year in duration, with total cost of the project spread over the anticipated timeline. The forecasted costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects. Please see "Workpaper Table 17-27: Unit Costs by Asset Type" for substation and distribution line unit costs.

Benefits

- The primary purpose of these projects is to meet customer demand and provide adequate service by:
  - Mitigating equipment overload conditions, thereby reducing the risk of equipment failure.
  - Maintaining primary distribution voltage to meet PG&E's Electric Tariff Rule 2.
  - Increasing operational flexibility and system resiliency.

Alternatives Considered

PG&E's annual process to identify new projects begins after the annual system peak has occurred and forecasting is complete. Prior to proposing equipment upgrades, overload and low voltage conditions are

mitigated through all available system re-configuration through switching between transformer banks and circuits. The remaining forecast overloaded equipment for the next 3 to 5 years is identified for further analysis. Generally, substation equipment upgrades are multi-year projects that require 3 years to engineer, procure material, and construct. Some minor substation upgrades take less time and new substations generally require five to seven years due to permitting requirements. Project initiation starts with a detailed alternative analysis, generally within the 3-year timeframe prior to the forecast completion date.[i]

Most projects consider alternatives at more than one substation location and evaluate these alternatives for cost and other system benefits prior to selection.

Through the annual DIDF Process, projects will also evaluate a distributed energy resource (DER) alternative to determine cost and feasibility of peak demand reduction.

1 – Upgrade facilities for location specific forecast overload conditions.

- Unit cost analysis to replace or install new facilities to mitigate specifically identified overloaded equipment at various locations to determine least cost alternative.
- Evaluate alternatives to mitigate specific overloads including cost, operational flexibility benefits, and reliability benefits.

2 – Evaluate DERs.

- PG&E considers DER solutions for all capacity projects via the Distribution Investment Deferral Framework (DIDF). Projects with forecast completion dates in 2024 and later years will be considered for inclusion as a Candidate Deferral Opportunity in the 2021 DDOR (Distribution Deferral Opportunity Report) which will be filed August 15, 2021.

[i] Detailed alternative analyses for projects beyond the three-year window are generally evaluated for new substation projects only. Performing detailed analysis on outer year projects that are not expected to incur significant expenditures until future years is premature. Such efforts would require expenditures with no commensurate benefits. The distribution system is dynamic. Forecast deficiencies may not materialize and the system may change for other reasons. These changes may provide other means for addressing the deficiency.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS RELATED CAPACITY - EMERGENT WORK

Project Title: New Business-Related Capacity - Emergent Work
Major Work Categories: MWC 46 (MAT 46H) and MWC 06 (MAT 06H)
Planning Order Numbers: 5510661 & 554320
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

The Emergent Work forecast is to provide funding for new business-related capacity increases that have not yet been specifically identified

In recent years, PG&E has seen a significant increase in new business applications that result in capacity work. Transportation electrification, increases in indoor cultivation, agricultural pumping applications caused by drought conditions, high tech campuses and data centers, the expansion of internet delivery companies, and state and local infrastructure projects are driving capacity work. These types of emergent loads have required PG&E to modify or increase capacity-driven work in certain specific locations in any given year. In the past, PG&E's Capacity Program reallocated resources to these emergent work projects by modifying work plans already in place. By allocating a portion of the funding in MWC 46 to MAT 46H for "Emergent Work", PG&E can reduce the changes in the Capacity Program work plan and more efficiently plan a project life cycle. The Emergent Work funding for substation work is forecast based upon evaluation of historical spending patterns.

PG&E's load forecasting methodology projects future load at the transformer bank and circuit level. As forecast load exceeds 100% of the thermal rating on any individual piece of equipment, a normal capacity deficiency is identified. Project timing and projected operative dates are based on the year the deficiency is forecast. Using a high-level analysis of the deficiency and the scope of possible solutions, a cost is estimated considering unit costs as well as local knowledge of the potential site of the upgrade. As projects move through the alternative selection and engineering process, scope and estimated costs continue to be refined, increasing the accuracy of the forecasted expenditures. Substation project initiation generally begins within 3 years of the projected operative date.

In the 2020 GRC, 46H and 06H emergent capacity funding was planned under two unique planning orders. In the 2023 GRC, 46H and 06H "SYSPLAN" orders were created. These orders combine both emergent work and identified work with forecasted spend < $3 million.

In the tables below, the Emergent Capacity portion and the identified projects are broken out of the total "SYSPLAN" order forecasts. For the identified projects with forecasts less than $3M that are embedded in these planning orders, please see 17-18 and 17-19.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS RELATED CAPACITY - EMERGENT WORK

Project Description Table

	Division	Project Description	DPA	Substation	Deficiency		Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)
1					(MW)	(%)	
2	All	Emergent Work		Various			O

Justification

Projects to support new business applications will address a specific forecasted normal bank or circuit deficiency measured in terms of MW and percent of overload as compared to normal thermal ratings.

Risk – Increasing the normal capacity of the distribution system reduces the risk of equipment failure due to overload conditions. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned and emergency switching to offload adjacent equipment. Projects that include upgrading distribution conductor reduce the risk of overhead conductor failure.

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line are necessary to meet minimum voltage requirements support compliance with PG&E's Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. While this project supports safety and reliability, it is not necessary to address issues in these areas.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS RELATED CAPACITY - EMERGENT WORK

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
Emergent Work Program MWC 46H, PO 5543520						-	-	12,396	24,835	59,135	72,982	169,348	WP 17-20, Line 80
Identified Projects < $3M MWC 46H, PO 5543520						8,032	9,887	3,226	1,939	2,210	945	26,239	WP 17-18, Lines 116-136
TOTAL MWC 46H SYSPLAN PO 5543520 TOTAL	**-**	**-**	**-**	**-**	**-**	**8,032**	**9,887**	**15,622**	**26,774**	**61,345**	**73,927**	**195,587**	**WP 17-8 Line 67**
Emergent Work Program MWC 06H, PO 5795503						-	-	43,926	49,017	86,969	96,167	276,079	
Identified Projects < $3M MWC 06H, PO 5795503						23,244	12,387	4,444	5,340	958	709	47,082	WP 17-17 and 17-18, Lines 47-81
TOTAL MWC 06H SYSPLAN PO 5795503 Total	**-**	**-**	**-**	**-**	**-**	**23,244**	**12,387**	**48,370**	**54,357**	**87,927**	**96,876**	**323,161**	**WP 17-8 Line 58**

Additional Cost Information:

Emergent capacity projects are identified "Workpaper Table 17-18: Forecast Capital Expenditures – Project Details" Lines 86-123 and have rough dates, scope, and forecasted dollars associated with them. These project attributes will be better defined and scoped by the time of the 2021 DIDF Filing. Emergent projects will be funded from the MWC 06H and MWC 46H emergent capacity buckets.

Substation projects (MWC 46) are typically multi-year in duration, with total cost of the project spread over the anticipated timeline. The forecasted costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects. Please see "Workpaper Table 17-27: Unit Costs by Asset Type" for substation and distribution line unit costs.

Benefits

- The primary purpose of these projects is to meet customer demand and provide adequate service by:
  - Mitigating equipment overload conditions, thereby reducing the risk of equipment failure.
  - Maintaining primary distribution voltage to meet PG&E's Electric Tariff Rule 2.
  - Increasing operational flexibility and system resiliency.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – NEW BUSINESS RELATED CAPACITY - EMERGENT WORK

Alternatives Considered

PG&E's annual process to identify new capacity projects begins after the annual system peak has occurred and forecasting is complete. Prior to proposing equipment upgrades, PG&E attempts to mitigate overload and low voltage conditions through all available system re-configuration through switching between transformer banks and circuits. The remaining forecast overloaded equipment for the next 3 to 5 years is identified for further analysis.

Generally, substation equipment upgrades require 3 years to engineer, procure material, and construct. Some minor substation upgrades take less time and new substations generally require five to seven years due to permitting requirements. Project initiation starts with a detailed alternative analysis, generally within the 3-year timeframe prior to the forecast completion date.[i]

Most projects consider alternatives at more than one substation location and evaluate these alternatives for cost and other system benefits prior to selection.

1 – Upgrade facilities for location specific forecast overload conditions.

- Unit cost analysis to replace or install new facilities to mitigate specifically identified overloaded equipment at various locations to determine least cost alternative.
- Evaluate alternatives to mitigate specific overloads including cost, operational flexibility benefits, and reliability benefits.

2 – Evaluate DERs

- PG&E considers DER solutions for all capacity projects via the Distribution Investment Deferral Framework (DIDF). Projects with forecast completion dates in 2024 and later years will be considered for inclusion as a Candidate Deferral Opportunity in the 2021 DDOR (Distribution Deferral Opportunity Report) which will be filed August 15, 2021.

[i] Detailed alternative analyses for projects beyond the three-year window are generally evaluated for new substation projects only. Performing detailed analysis on outer year projects that are not expected to incur significant expenditures until future years is premature. Such efforts would require expenditures with no commensurate benefits. The distribution system is dynamic. Forecast deficiencies may not materialize and the system may change for other reasons. These changes may provide other means for addressing the deficiency.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – OPERATIONAL CAPACITY – INSTALL NEW FEEDER

Project Title: Operational Capacity – Install New Feeder
Major Work Categories: MWC 46 (MAT 46F) and MWC 06 (06A)
Planning Order Numbers: 5786238/5537283
Project Start Date: June 2020
Project Completion Date: June 2022
Operative Date (only applies to Capital): January 2022

Project Description

This project installs a new feeder in the Jackson area to improve operational flexibility and service reliability to customers on Valley Springs 1101. This new Valley Springs 1102 circuit will Increase emergency capacity and operational flexibility with the adjacent Calaveras Cement circuit. Normal loading on the Valley Springs 1101, and the adjacent Calaveras Cement 1101 and Corral 1102 circuits are over the recommended 75% of emergency capacity, as outlined in drawing 050864 – Guide for Planning Area Distribution Facilities. This results in constrained facilities in the area and operational issues during unplanned outages.

This project to install a new feeder is anticipated to have expenditures less than $3 million but is included in the table below for completeness and to provide an example of one type of work covered by MAT 46F.

Project Description Table

1	Division	Project Description	DPA	Substation	Deficiency		Project Type (B - Bank, F - Feeder, L - Land, NS - New Substation, O - Other)
2					(MW)	(%)	
3	Stockton	Install Valley Springs 1102	Jackson	Valley Springs			F

Justification

The project included in the Project Description table above increases area capacity to allow re-configuration to the distribution system to improve customer satisfaction.

Risk – Increasing normal capacity of the distribution system reduces the risk of equipment failure due to overload conditions. This work also increases operational flexibility and system resiliency by providing facilities that can be used during planned switching to offload adjacent equipment. Projects that include upgrading distribution conductor reduce the risk of overhead conductor failure.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – OPERATIONAL CAPACITY – INSTALL NEW FEEDER

Compliance – Projects that include installing voltage regulating devices and/or upgrading distribution line necessary to meet minimum voltage requirements support compliance with PG&E's Electric Tariff Rule 2.

Safety and Reliability: Each project is evaluated in terms of safety and reliability to determine the extent of system risk reduced by completion of the proposed work. This project is necessary for reliability as it has a major impact to a large number of customers.

. **Cost**

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
CAPITAL													
Valley Springs MWC 06, PO 5537283					21	100	1,348					1,469	WP 17-20, Line 67
MWC 46 PO 5786238					9							9	WP 17-20, Line 67
Capital Total	-	-	-	-	30	100	1,348	-	-	-	-	1,478	
TOTAL PROJECT COST	-	-	-	-	30	100	1,348	-	-		-	1,478	

Additional Cost Information:

Please see "Workpaper Table 17-18: Forecast Capital Expenditures – Project Details" for additional project details. Substation projects (MWC 46) are typically multi-year in duration, with total cost of the project spread over the anticipated timeline. The forecast costs are based on estimates of specific equipment and work required or unit costs calculated from recent past recorded costs from similar projects. Please see "Workpaper Table 17-27: Unit Costs by Asset Type" for substation and distribution line unit costs.

Benefits

- The primary purpose of this project is to increase operational capacity and is intended to improve customer satisfaction and have no direct cost savings anticipated. Benefits include:
  - Reduce SAIDI, SAIFI, and CAIFI.
  - Increase operational flexibility and system resiliency.
  - Enhance ability to perform planned clearances.

Alternatives Considered

PG&E's annual process to identified new capacity projects begins after the annual system peak had occurred and forecasting is complete. Prior to proposing equipment upgrades, PG&E attempts to mitigate overload and low voltage conditions through available system re-configuration through switching between transformer banks and feeders.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 17, ELECTRIC DISTRIBUTION CAPACITY
PROJECT SUMMARY – OPERATIONAL CAPACITY – INSTALL NEW FEEDER

Generally, substation equipment upgrades are multi-year projects that require 3 years to engineer, procure material, and construct. Some minor substation upgrades take less time and new substations generally require five to seven years due to permitting requirements. Project initiation starts with a detailed alternative analysis, generally within the 3-year timeframe prior to the forecast completion date.[i]
Most projects consider alternatives at more than one substation location and evaluate these alternatives for cost and other system benefits prior to selection.

Most projects consider alternatives at more than one substation location and evaluate these alternatives for cost and other system benefits prior to selection.

Through the annual DIDF Process, projects will also evaluate a distributed energy resource (DER) alternative to determine cost and feasibility of peak demand reduction.

1 – Upgrade facilities for location specific forecast overload conditions.

- Unit cost analysis to replace or install new facilities to mitigate specifically identified overloaded equipment at various locations to determine least cost alternative.
- Evaluate alternatives to mitigate specific overloads including cost, operational flexibility benefits, and reliability benefits.

2 – Evaluate DERs

- PG&E considers DER solutions for all capacity projects via the Distribution Investment Deferral Framework (DIDF). Projects with forecast completion dates in 2024 and later years will be considered for inclusion as a Candidate Deferral Opportunity in the 2021 DDOR (Distribution Deferral Opportunity Report) which will be filed August 15, 2021.

[i] Detailed alternative analyses for projects beyond the three-year window are generally evaluated for new substation projects only. Performing detailed analysis on outer year projects that are not expected to incur significant expenditures until future years is premature. Such efforts would require expenditures with no commensurate benefits. The distribution system is dynamic. Forecast deficiencies may not materialize and the system may change for other reasons. These changes may provide other means for addressing the deficiency.

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 18, NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS

TABLE OF CONTENTS

Subject	Page No.
Expense Workpapers	
Workpaper Table 18-1: Expenses by Major Work Category - Nominal Dollars	WP 18-1
Workpaper Table 18-2: Expenses by Major Work Category - Base Year Dollars	WP 18-2
Workpaper Table 18-3: Major Work Category EV - Recorded Walk	WP 18-3
Workpaper Table 18-4: Major Work Category EV - Forecast Walk	WP 18-4
Workpaper Table 18-5: MWC EV- Summary and Overview of Forecasting Methodology	WP 18-5
Workpaper Table 18-6: MWC EV- Summary of Forecasted Expense by Category	WP 18-6
Workpaper Table 18-7: MWC EV/MAT EVA - Forecast of NB Applications Rates and Expenditures Forecast	WP 18-7
Workpaper Table 18-8: MWC EV/MAT EVB- Forecast of Total Number of Electric Accounts and Expenditure Forecast - MAT EVB	WP 18-8
Workpaper Table 18-9: MWC EV/MAT EVB- Derivation of PEV Application Processing Rate and Forecasted Expenditures - MAT EVB	WP 18-9
Workpaper Table 18-10: Major Work Category EW - Recorded Walk	WP 18-10
Workpaper Table 18-11: Major Work Category EW - Forecast Walk	WP 18-11
Workpaper Table 18-12: MWC EW - Summary and Overview of Forecasting Methodology	WP 18-12
Workpaper Table 18-13: MWC EW - Summary of Forecasted Expenses by Category	WP 18-13
Workpaper Table 18-14: MWC EW - Calculation of Relocation WRO Expense Expenditures - MWC EW	WP 18-14
Workpaper Table 18-15: MWC EW - Historic and Forecasted EGI Application Rates and Forecasted Expenditures	WP 18-15

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 18, NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Expense Workpapers (continued)	
Workpaper Table 18-16: MWC EW - Historic and Forecasted State Infrastructure and Forecasted Expenditures	WP 18-16
Capital Workpapers	
Workpaper Table 18-17: Capital Expenditures by Major Work Category	WP 18-17
Workpaper Table 18-18: Forecast Capital Expenditures Summary	WP 18-18
Workpaper Table 18-19: Recorded CWIP and Forecast Capital Expenditures Details – Planning Orders Over $3 Million	WP 18-19
Workpaper Table 18-20: Recorded and Forecast Capital Expenditures Details - Other Work	WP 18-20
Workpaper Table 18-21: Major Work Category 16 - Recorded Walk	WP 18-21
Workpaper Table 18-22: Major Work Category 16 - Forecast Walk	WP 18-22
Workpaper Table 18-23: MWC 16 - Summary and Overview of Forecast Methodology	WP 18-23
Workpaper Table 18-24: MWC 16 - Summary of New Business MAT Code Types and Units of Measurement	WP 18-24
Workpaper Table 18-25: MWC 16 - Summary of Forecast Capital Expenditures by Category - MWC 16	WP 18-25
Workpaper Table 18-26: MWC 16 - Derivation of Routine Residential and Non- Residential Expenditures from Unit Costs Forecast - MWC 16	WP 18-26
Workpaper Table 18-27: MWC 16 - Historic and Forecasted Residential and Non-Residential NB Units and Work Mix Ratios by Type	WP 18-27
Workpaper Table 18-28: MWC 16 - Derivation of Forecast Unit Costs for MWC 16	WP 18-28
Workpaper Table 18-29: MWC 16 - Utility Connects Forecasting Model - Rosen Consulting Group	WP 18-29

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 18, NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Capital Workpapers (continued)	
Workpaper Table 18-30: MWC 16 - Derivation of PEV-Related Expenditures - MWC 16	WP 18-42
Workpaper Table 18-31: MWC 16 - Derivation of Transformer Purchase Expenditures: Recorded and Forecasted Program Expenditures	WP 18-43
Workpaper Table 18-32: MWC 16 - Derivation of Transformer Purchase Expenditures: Recorded Transformer Issues by Program Type	WP 18-44
Workpaper Table 18-33 MWC 16 - Derivation of Transformer Purchase Expenditures: Recorded Transformer Usage Rate/Million Dollar Expenditure by Program and Transformer Type	WP 18-45
Workpaper Table 18-34: MWC 16 - Derivation of Transformer Purchase Expenditures: Coefficient of Usage to Purchase by Transformer Type	WP 18-46
Workpaper Table 18-35: MWC 16 - Derivation of Transformer Purchase Expenditures: Forecasted Transformer Purchases by Program Type	WP 18-47
Workpaper Table 18-36 MWC 16 - Derivation of Transformer Purchase Expenditures: Derivation of Unit Cost and Total Expenditures by Transformer Type	WP 18-48
Workpaper Table 18-37: MWC 16 - Derivation of Transformer Scrapping Expenditures- MWC 16	WP 18-49
Workpaper Table 18-38: Major Work Category 10 - Recorded Walk	WP 18-50
Workpaper Table 18-39: Major Work Category 10 - Forecast Walk	WP 18-51
Workpaper Table 18-40: MWC 10 - Summary and Overview of Forecasting Methodology	WP 18-52
Workpaper Table 18-41: MWC 10 - Units of Measures/Split of Capital WRO into New Business (NB) and Government Related Categories	WP 18-53
Workpaper Table 18-42: MWC 10 - Summary of Forecasted Capital Expenditures by Category - MWC 10	WP 18-54
Workpaper Table 18-43: MWC 10 - Derivation of NB- Related and Government Related Expenditures - MWC10	WP 18-55

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 18, NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Capital Workpapers (continued)	
Workpaper Table 18-44: MWC 10 - WRO Forecast Model - Rosen Consulting Group	WP 18-56
Workpaper Table 18-45: MWC 10 - Summary of Major Project Expenditures	WP 18-64
Workpaper Table 18-46: MWC 10 - Summary of State Infrastructure Projects Expenditures	WP 18-65
Project Summary – California High Speed Rail (HSR)	WP 18-66
Project Summary – Caltrain Electrification	WP 18-68
Project Summary – Google - South Bay Redevelopment Program	WP 18-70
Project Summary - BART Silicon Valley Phase II Extension	WP 18-72
Index Template	WP 18-74

Workpaper Table 18-1
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 18
New Business & Work at the Request of Others
Expenses by Major Work Category
(Thousands of Nominal Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference
1	EV	Manage Service Inquiries	8,998	9,835	11,074	10,240	12,986	10,879	10,894	13,878	WP 18-3, WP 18-4
2	EW	E TD WRO	12,607	4,390	8,759	6,107	15,521	8,106	8,118	10,283	WP 18-10, WP 18-11
3	**Total**		**21,605**	**14,225**	**19,833**	**16,347**	**28,507**	**18,985**	**19,013**	**24,161**	

Workpaper Table 18-2
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 18
New Business & Work at the Request of Others
Expenses by Major Work Category
(Thousands of Base Year Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast
1	EV	Manage Service Inquiries	10,705	11,166	11,992	10,696	12,986	10,497	10,108	12,433
2	EW	E TD WRO	14,311	5,756	9,762	6,497	15,521	7,759	7,121	8,462
3	**Total**		**25,016**	**16,922**	**21,755**	**17,193**	**28,507**	**18,255**	**17,230**	**20,896**

Workpaper Table 18-3
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 18, Electric New Business and Work at the Request of Others
Major Work Category EV - Recorded Walk
MWC EV - Manage Service Inquiries
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**8,998**			
2		NB Service Inquiry (MAT EVA)	(49)		Minor variations from previous year	From: WP 18-6, Line 1
3		OK to Serve Routine (MAT EVB)	602		Driven by application processing cost increase	From: WP 18-6, Line 2
4		OK to Serve PEV (MAT EVB)	122		Driven by increase in applications	From: WP 18-6, Line 3
5		Other	162		Timing of PMC Adjustment (1)	From: WP 18-6, Line 4
6	**2017**	**Recorded Adjusted**	**9,835**			
7		NB Service Inquiry (MAT EVA)	503		Driven by customer inquires and applications related to economic growth	From: WP 18-6, Line 1
8		OK to Serve Routine (MAT EVB)	589		Driven by customer requests for additional load or upgrading services	From: WP 18-6, Line 2
9		OK to Serve PEV (MAT EVB)	402		Driven by increase in applications	From: WP 18-6, Line 3
10		Other	(255)		Timing of PMC Adjustment (1)	From: WP 18-6, Line 4
11	**2018**	**Recorded Adjusted**	**11,074**			
12		NB Service Inquiry (MAT EVA)	(103)		Minor variations from previous year	From: WP 18-6, Line 1
13		OK to Serve Routine (MAT EVB)	(1,177)		Decrease in customer requests for additional load or upgrading services	From: WP 18-6, Line 2
14		OK to Serve PEV (MAT EVB)	(544)		Driven by decrease in applications	From: WP 18-6, Line 3
15		Other	990		Timing of PMC Adjustment (1)	From: WP 18-6, Line 4
16	**2019**	**Recorded Adjusted**	**10,240**			
17		NB Service Inquiry (MAT EVA)	(62)		Minor variations from previous year	From: WP 18-6, Line 1
18		OK to Serve Routine (MAT EVB)	2,506		Driven by application processing cost increase	From: WP 18-6, Line 2
19		OK to Serve PEV (MAT EVB)	(217)		Driven by decrease in applications	From: WP 18-6, Line 3
20		Other	519		Timing of PMC Adjustment (1)	From: WP 18-6, Line 4
17	**2020**	**Recorded Adjusted**	**12,986**			

(1) PMC Adjustment
Per-Meter-Charge (PMC) Revenues are offset against Customer Fund Management (CFM) expenditures.
Overcollection of Revenues to costs are transferred to Customer Advances Liability Account.
Undercollection of Revenues to costs are transferred to Customer Accounts Receivable.
Revenue/Cost collection nets to zero over time.

Workpaper Table 18-4
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 18, Electric New Business and Work at the Request of Others
Major Work Category EV - Forecast Walk
MWC EV - Manage Service Inquiries
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**12,986**			
2		NB Service Inquiry (MAT EVA)	836		Unit forecast lower than 2020 Actuals	From: WP 18-6, Line 1
3		OK to Serve Routine (MAT EVB)	(2,492)		Unit Cost Reduction Initiatives	From: WP 18-6, Line 2
4		OK to Serve PEV (MAT EVB)	1,365		Increase in forecasted PEV based on historical	From: WP 18-6, Line 3
5		Other	(608)		Timing of PMC Adjustment (1)	From: WP 18-6, Line 4
6		Aligned to 2021 Budget	(1,208)		2021 Target Budget Adjustment: Model Input Changes	From: WP 18-6, Line 6
7	**2021**	**Forecast**	**10,879**			
8		NB Service Inquiry (MAT EVA)	(376)		Unit forecast higher than 2021 based on meter set forecast	From: WP 18-6, Line 1
9		OK to Serve Routine (MAT EVB)	(139)		Immaterial variance	From: WP 18-6, Line 2
10		OK to Serve PEV (MAT EVB)	(678)		Decrease in forecasted PEV based on CEC IEP Report	From: WP 18-6, Line 3
11		Aligned to 2021 Budget	1,208		2021 Target Budget Adjustment: Model Input Changes	From: WP 18-6, Line 6
12	**2022**	**Forecast**	**10,894**			
13		NB Service Inquiry (MAT EVA)	1,555		Unit forecast higher than 2022 based meter sets forecast	From: WP 18-6, Line 1
14		OK to Serve Routine (MAT EVB)	1,266		Unit Cost Increases/Escalation	From: WP 18-6, Line 2
15		OK to Serve PEV (MAT EVB)	163		Immaterial variance	From: WP 18-6, Line 3
16	**2023**	**Forecast**	**13,878**			

(1) PMC Adjustment
Per-Meter-Charge (PMC) Revenues are offset against Customer Fund Management (CFM) expenditures.
Overcollection of Revenues to costs are transferred to Customer Advances Liability Account.
Undercollection of Revenues to costs are transferred to Customer Accounts Receivable.
Revenue/Cost collection nets to zero over time.

Workpaper Table 18-5
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
MWC EV - Summary and Overview of Forecasting Methodology

Line No.

1 **Step 1** **Application Related Expenditures - MAT EVA**

Step 1A **Determine Application Processing Rate from Recorded Connects and Applications**

Description: PG&E determines an application processing rate utilizing the observed correlation between total recorded NB connects (gas and electric) and the number of applications processed through PG&E Building and Renovation Service Center (BRSC). A three year average application processing rate is used for forecasting purposes.

Related Workpaper: Workpaper Table 18-7: MWC EV/MAT EVA – Forecast of NB Applications Rates and Expenditure Forecast

Step 1B **Determine Forecasted Applications and Expenditures**

Description: PG&E uses the total NB forecast connects from the gas and electric NB forecast for MWC's 29 and 16, and the application processing rate calculated in Step 1A to determine a forecast of applications to be processed. The year-over-year change in application forecasting rates is then used to derive forecasted expenditures.

Related Workpaper: Workpaper Table 18-7: MWC EV/MAT EVA – Forecast of NB Applications Rates and Expenditure Forecast

2 **Step 2** **OK to Serve (Routine) Expenditures - MAT EVB**

Step 2A **Determine Year-Over-Year Change in OK to Serve Work**

Description: PG&E utilizes a forecast of total electric accounts to index routine OK to Serve expenditures. The total electric accounts forecast is provided by PG&E Rate Architecture and Load Forecasting department.

Related Workpaper: Workpaper Table 18-8: MWC EV/MAT EVB – Forecast of Total Number of Electric Accounts and Expenditure Forecast

3 **Step 3** **OK to Serve (PEV) Expenditures - MAT EVB**

Step 3A **Determine Average Cost per PEV Load Check**

Description: Utilizing recorded costs for all OK to Serve work in MAT EVB, PG&E determines an average cost of OK to Serve load checks. For PEV related load checks a complexity adder of 50% is used for forecasting purposes to compensate for additional work involving rate changes for new PEV customers.

Related Workpaper: Workpaper Table 18-9: MWC EV/MAT EVB -Derivation of PEV Application Processing Rate and Forecasted Expenditures

Step 3B **Determine Rate of PEV Load Checks**

Description: PG&E compares the number of residential customers placed on the residential Electric Vehicle (EV) Rate Schedule to the total number of PEV load checks in Step 3A. A three year average of this rate is utilized to convert projected PEV sales, and projected EV Rate Schedule customers, to forecast the number of PEV related load checks in Step 3C below.

Related Workpaper: Workpaper Table 18-9: MWC EV/MAT EVB -Derivation of PEV Application Processing Rate and Forecasted Expenditures

Step 3C **Forecast of PEVs and Conversion to EV Rate Schedule**

Description: PG&E's Clean Energy Transportation Department provides the total and forecasted PEVs in PG&E's service territory for the period of 2016 through 2023, as well as the number of customers expected to be placed on the EV rate schedule. This number is used with the upgrade rate determined in Step 3B to forecast the number of PEV related load checks.

Related Workpaper: Workpaper Table 18-9: MWC EV/MAT EVB -Derivation of PEV Application Processing Rate and Forecasted Expenditures

Step 3D **Develop PEV Forecast**

Description: Utilizing the average cost per upgrade in Step 3A, the rate of PEV load checks in Step 3B, and the number of customers converting to the EV rate schedule in Step 3C, PG&E develops the OK to Serve (PEV) expenditure forecast.

Related Workpaper: Workpaper Table 18-9: MWC EV/MAT EVB -Derivation of PEV Application Processing Rate and Forecasted Expenditures

Workpaper Table 18-6
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
MWC EV- Summary of Forecasted Expense by Category
MWC EV Manage Service Inquiries
(Thousands of Dollars)

		2016	2017	2018	2019	2020	2021	2022	2023		
Line No.	**Description**	**Recorded**					**Forecast**			**Assumptions**	**Notes**
1	MAT EVA - NB Service Inquiry	$ 2,686	$ 2,637	$ 3,140	$ 3,037	$ 2,975	$ 3,811	$ 3,435	$ 4,990		
2	MAT EVB - OK to Serve Routine	$ 6,842	$ 7,444	$ 8,033	$ 6,857	$ 9,363	$ 6,871	$ 6,733	$ 7,999		
3	MAT EVB - OK to Serve PEV	$ 278	$ 400	$ 802	$ 257	$ 40	$ 1,405	$ 726	$ 889		
4	Other	$ (808)	$ (646)	$ (901)	$ 89	$ 608					
5	Total	$ 8,998	$ 9,835	$ 11,074	$ 10,240	$ 12,986	$ 12,087	$ 10,894	$ 13,878		[Line 1 + Line 2 + Line 3 + Line 4]
6	Aligned to 2021 Budget						$ (1,208)			(1)	
7	Total Adjusted Expenditure/Forecast ($000)	$ 8,998	$ 9,835	$ 11,074	$ 10,240	$ 12,986	$ 10,879	$ 10,894	$ 13,878		[Line 5 + Line 6]
8	Difference from Prior Year		$ 837	$ 1,239	$ (834)	$ 2,746	$ (2,107)	$ 15	$ 2,984		

Assumptions and Details
(1) The 2021 forecast has been adjusted to 2021 budget amounts due to difference between current GRC forecast model inputs and those model inputs available when budget targets were originally determined.

Workpaper Table 18-7
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
MWC EV/MAT EVA - Forecast of NB Applications Rates and Expenditures Forecast
MWC EV / MAT EVA - New Business Service Inquiry

		2016	2017	2018	2019	2020	2021	2022	2023		
Line No.	**Description**	**Recorded**					**Forecast**			**Assumptions**	**Notes**
1	Electric Residential Connects	37,554	37,254	39,958	41,954	41,521	37,303	52,756	57,434	(1)	
2	Electric Non-Residential Connects	10,077	9,350	8,856	8,317	8,456	7,025	8,278	8,343	(1)	
3	Gas Residential Connects	25,403	29,087	32,007	30,115	28,186	27,930	35,395	37,042	(1)	
4	Gas Non-Residential Connects	2,768	2,632	2,131	2,118	1,697	1,100	1,439	1,416	(1)	
5	Total Combined Connects	75,802	78,323	82,952	82,504	79,860	73,358	97,868	104,235		[Line 1 + Line 2 + Line 3 + Line 4]
6	Applications	12,105	16,629	17,865	15,573	17,883	15,283	20,389	21,716	(2)	Forecast: Line 5 / Line 7 (2020)
7	Average Application Ratio (2018 - 2020)					4.8					[3 year average Line 5] / [3 Year average Line 6]
8	% Change in Applications		37.4%	7.4%	-12.8%	14.8%	-14.5%	33.4%	6.5%		
9	Forecasting & Escalation Adjustments						$ 1,269	$ (1,649)	$ 1,331		
10	Expenditure/Forecast ($000)	$ 2,686	$ 2,637	$ 3,140	$ 3,037	$ 2,975	$ 3,811	$ 3,435	$ 4,990		Recorded: [Line 9] Forecasted: [(Prior Year Line 10 x (1 + Line 8))+ Line 9]
11	Difference from Prior Year $(000)		$ (49)	$ 503	$ (103)	$ (62)	$ 836	$ (376)	$ 1,555		

Assumptions and Details
(1) Connect Forecast data is taken from RCG Utility Connects Forecasting Model dated February 2021 (see WP 18-29 – Utility Connects Forecasting Model – Rosen Consulting Group)
(2) SAP Notifications (project numbers) created and linked to new business capital projects

Workpaper Table 18-8
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Forecast of Total Number of Electric Accounts and Expenditure Forecast
MWC EV / MAT EVB - OK to Serve Routine
(Thousands of Dollars)

		2016	2017	2018	2019	2020	2021	2022	2023			
Line No.	**Description**	**Recorded**					**Forecast**			**Assumptions**	**Notes**	**Reference**
1	Number of Electric Customer Billings	5,410,433	5,441,284	5,491,268	5,516,961	5,552,214	5,580,762	5,632,254	5,688,648	(1)		
2	Percent Change in Accounts		0.6%	0.9%	0.5%	0.6%	0.5%	0.9%	1.0%		(Current Year Line 1-Prior Year Line 1)/Prior Year Line 1	
3	Incremental Customer Forecast ($000)						$ 9,451	$ 9,539	$ 9,634		2021: Prior Year Line 8 x (1 + Line 2) 2022: Prior Year Line 3 x (1 + Line 2) 2023: Prior Year Line 3 x (1 + Line 2)	
4	Forecasting Adjustment						$ (1,175)	$ (2,080)	$ (746)	(2)		
5	Forecast ($000)						$ 8,276	$ 7,459	$ 8,888	(3)		
6	EVB OK to Serve Routine Costs ($000)	$ 6,842	$ 7,444	$ 8,033	$ 6,857	$ 9,363	$ 6,871	$ 6,733	$ 7,999		Line 5 - Line 4	
7	Plus PEV Related Costs ($000)	$ 278	$ 400	$ 802	$ 257	$ 40	$ 1,405	$ 726	$ 889			From: WP 18-9, Line 13
8	Prior Year Expenditure/Forecast ($000)	$ 7,120	$ 7,844	$ 8,835	$ 7,114	$ 9,403	$ 8,276	$ 7,459	$ 8,888	(3)		From: WP 18-9, Line 1
9	Difference from Prior Year ($000)		$ 724	$ 991	$ (1,721)	$ 2,289	$ (1,127)	$ (817)	$ 1,429			

Assumptions and Details
(1) Source: Rate Architecture and Load Forecasting department - Annual Average Customer Billings (February 2021)
(2) Adjustments to current forecast model inputs driven by authorized targets and Escalation model input differences.
(3) Align 2021-2023 customer billing forecast to customer application volume merged with Affordability Cost Initiatives.

Workpaper Table 18-9
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of PEV Application Processing Rate and Forecasted Expenditures - MAT EVB
MWC EV / MAT EVB - OK to Serve PEV

		2016	2017	2018	2019	2020	2021	2022	2023		
Line No.	**Description**	**Recorded**					**Forecast**			**Assumptions**	**Notes**
1	MAT EVB Expenditures/Forecast ($ 000's)	$ 7,120	$ 7,844	$ 8,835	$ 7,114	$ 9,403	$ 8,276	$ 7,459	$ 8,888		Forecast: Line 2 x Line 3
2	Total EVB Requests Processed	35,879	35,201	37,869	32,296	32,434	34,200	32,977	33,203	(1)	
3	Average Cost per EVB Request ($)	$ 200	$ 220	$ 230	$ 220	$ 290	$ 240	$ 230	$ 270		2021: 2017-2020 Average 2022: (4.2%) Affordability vs 2021 2023: (6.8%) Affordability vs 2020
4	Complexity adder	50%	50%	50%	50%	50%	50%	50%	50%	(2)	
5	Estimated Processing Cost per PEV Request ($)	$ 300	$ 330	$ 345	$ 330	$ 435	$ 360	$ 345	$ 405		Forecast: [Line 3 x (1 + Line 4)]
6	Total PEVs in PG&E Service Territory	111,355	150,890	217,080	274,636	321,035	332,815	387,618	459,686	(3)	
7	Total PEV Owners on EV Rate	31,757	40,799	52,417	60,528	67,384	125,894	155,075	185,500		Forecast: [Line 6 X Line 8]
8	Proportion PEV Owners on EV Rate	29%	27%	24%	22%	21%	22%	22%	22%	(4)	Recorded: [Line 7 / Line 6] Forecasted: 2018-2020 Average
9	Incremental PEV's in PG&E Service Territory	29,966	39,535	66,190	57,556	45,917	241,418	130,259	135,808		[Current Year Line 6 - Prior Year Line 6]
10	Incremental PEV's assigned to EV Rate	8,555	10,690	15,983	12,685	9,652	54,083	29,181	30,424		[Line 8 x Line 9]
11	PEV Applications Processed	926	1,212	2,324	780	92	3,902	2,105	2,195	(5)	Forecast: [Line 10 x Line 12]
12	Application Rate	11%	11%	15%	6%	1%	7%	7%	7%	(6)	Recorded: [Line 11 / Line 10] Forecast: 2018-2020 Average
13	Prior Year Expenditure/Forecast ($000)	$ 278	$ 400	$ 802	$ 257	$ 40	$ 1,405	$ 726	$ 889		[Line 11 x Line 5 / $1000]
14	Difference from Prior Year ($000)	$ (8)	$ 122	$ 402	$ (544)	$ (217)	$ 1,365	$ (678)	$ 163		[Current Year Line 13 - Prior Year Line 13]

Assumptions and Details

(1) SAP data for linked and completed Notifications to MAT EVB orders (Recorded).Three-Year Rolling Average (Forecast).

(2) PEV processing is more difficult than routine OK to Service work due to several factors: a) contact can be initiated by PG&E vs. customer-initiated; and, b) explanation of rate options not generally part of routine EVB contacts.

(3) PEV sales data supplied by PG&E's Clean Energy Transportation Department which is based on California Energy Commission's 2019 Integrated Energy Policy Report. After the forecast was finalized, PG&E concluded that it would be more appropriate to base its assumptions about PEV deployment on internal modelling and data which has been shared with the Commission. PG&E will file errata updating the assumptions and recalculating its forecast as necessary.

(4) Enrollment forecast reflects average proportion of EV's from past three years, 2018-2020 (Forecast).

(5) SAP Notifications linked to EVB orders and completed with PEV related work type code.

(6) Forecast uses 2018 to 2020 average application rate

Workpaper Table 18-10
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 18, Electric New Business and Work at the Request of Others
Major Work Category EW - Recorded Walk
MWC EW - E TD WRO - Maintenance
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount	Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**12,607**		
2		Expense Relocations (MWC EW)	469	Increase driven by more Non-Reimbursed jobs	From: WP 18-13, Line 1
3		Electric Grid Interconnection (MWC EW)	(8,378)	Application fees received	From: WP 18-13, Line 2
4		State Infrastructure (MWC EW)	(39)	Minor variations from previous year	From: WP 18-13, Line 3
5		Other	(269)	Minor variations from previous year	From: WP 18-13, Line 4
6	**2017**	**Recorded Adjusted**	**4,390**		
7		Expense Relocations (MWC EW)	1,409	Increase driven by more Non-Reimbursed jobs	From: WP 18-13, Line 1
8		Electric Grid Interconnection (MWC EW)	2,686	Increase driven by timing of costs vs application fees	From: WP 18-13, Line 2
9		State Infrastructure (MWC EW)	(91)	Minor variations from previous year	From: WP 18-13, Line 3
10		Other	366	Minor variations from previous year	From: WP 18-13, Line 4
11	**2018**	**Recorded Adjusted**	**8,759**		
12		Expense Relocations (MWC EW)	1,539	Increase driven by more Non-Reimbursed jobs	From: WP 18-13, Line 1
13		Electric Grid Interconnection (MWC EW)	(3,949)	Decrease driven by timing of costs vs application fees	From: WP 18-13, Line 2
14		State Infrastructure (MWC EW)	(209)	Decrease driven by timing of reimbursements received	From: WP 18-13, Line 3
15		Other	(33)	Minor variations from previous year	From: WP 18-13, Line 4
16	**2019**	**Recorded Adjusted**	**6,107**		
17		Expense Relocations (MWC EW)	3,449	Increase driven by more Non-Reimbursed jobs	From: WP 18-13, Line 1
18		Electric Grid Interconnection (MWC EW)	6,343	Increase driven by timing of costs vs application fees	From: WP 18-13, Line 2
19		State Infrastructure (MWC EW)	303	Increase driven by timing of reimbursements received	From: WP 18-13, Line 3
20		Other	(680)	Minor variations from previous year	From: WP 18-13, Line 4
21	**2020**	**Recorded Adjusted**	**15,521**		

Workpaper Table 18-11
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 18, Electric New Business and Work at the Request of Others
Major Work Category EW - Forecast Walk
MWC EW - E TD WRO - Maintenance
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**15,521**			
2		Expense Relocations (MWC EW)	672		Increase related to anticipated WRO work	From: WP 18-13, Line 1
3		Electric Grid Interconnection (MWC EW)	(2,353)		Forecast anticipates that Costs will equal Credits	From: WP 18-13, Line 2
4		State Infrastructure (MWC EW)	177		Forecast is anticipated	From: WP 18-13, Line 3
5		Forecasting & Escalation Adjustments	(5,911)		Affordability initiatives	From: WP 18-13, Line 5
6	**2021**	**Forecast**	**8,106**			
7		Expense Relocations (MWC EW)	(2,309)		Decrease related to anticipated WRO work	From: WP 18-13, Line 1
8		Electric Grid Interconnection (MWC EW)	0		No Changes	From: WP 18-13, Line 2
9		State Infrastructure (MWC EW)	0		No Changes	From: WP 18-13, Line 3
10		Forecasting & Escalation Adjustments	2,321		Planned Affordability Initiatives offset by escalation	From: WP 18-13, Line 5
11	**2022**	**Forecast**	**8,118**			
12		Expense Relocations (MWC EW)	(185)		Minor variations from previous year	From: WP 18-13, Line 1
13		Electric Grid Interconnection (MWC EW)	0		No Changes	From: WP 18-13, Line 2
14		State Infrastructure (MWC EW)	0		No Changes	From: WP 18-13, Line 3
15		Forecasting & Escalation Adjustments	2,350		Planned Affordability Initiatives offset by escalation	From: WP 18-13, Line 5
16	**2023**	**Forecast**	**10,283**			

Workpaper Table 18-12
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
MWC EW - Summary and Overview of Forecasting Methodology

Line No.

1 **Step 1** **Relocation Related Expenditures - MWC EW**

Step 1A **Determine Index of Base Capital WRO Work for Expense Forecast**

Description: PG&E utilizes the recorded and forecasted expenditures from the capital WRO forecast (MWC 10) to develop an index for forecasting relocation expense WRO. The capital WRO index excludes Major Projects and State Infrastructure Projects within the forecast to avoid large variations in the expense forecast.
Related Workpaper: Workpaper Table 18-14: MWC EW – Calculation of Relocation WRO Expense Expenditures

Step 1B **Determine Forecast of Expense Relocation Expenditures**

Description: Using the index created in Step 1A, PG&E makes a forecast of relocation related expense expenditures from recorded results in 2020. Expense adjustments for one-time expenditures not related to the index are included.
Related Workpaper: Workpaper Table 18-14: MWC EW – Calculation of Relocation WRO Expense Expenditures

2 **Step 2** **Electric Generation Interconnection (EGI) Related Expenditures - MWC EW**

Step 2A **Determine Year-Over-Year Change in EGI Related Interconnection Work**

Description: PG&E utilizes a forecast from its EGI Department to determine the number of generation interconnections by generation type. The year-over-year changes are used in the forecasted expenditures in Step 2B below.
Related Workpaper: Workpaper Table 18-15: MWC EW – Historic and Forecasted EGI Application Rates and Forecasted Expenditures

Step 2B **Determine EGI Related Expenditures**

Description: Utilizing the year-over-year change in generation interconnections, PG&E forecasts total EGI expenditures from 2020 recorded data.
Related Workpaper: Workpaper Table 18-15: MWC EW – Historic and Forecasted EGI Application Rates and Forecasted Expenditures

Step 2C **EGI Related Credits**

Description: Utilizing the year-over-year change in application credits, PG&E forecasts total EGI credits based on historicals and market trends as they related to applications
Related Workpaper: Workpaper Table 18-15: MWC EW – Historic and Forecasted EGI Application Rates and Forecasted Expenditures

Workpaper Table 18-13
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Summary of Forecasted Expenses by Category
MWC EW - E TD WRO - Maintenance
(Thousands of Dollars)

		2016	2017	2018	2019	2020	2021	2022	2023		
Line No.	**Description**	**Recorded**					**Forecast**			**Assumptions**	**Notes**
1	MWC EW - Expense Relocations	$ 7,012	$ 7,481	$ 8,890	$ 10,429	$ 13,878	$ 14,550	$ 12,242	$ 12,056		
2	MWC EW - Electric Grid Interconnection	$ 5,651	$ (2,727)	$ (41)	$ (3,990)	$ 2,353	$ (0)	$ (0)	$ (0)		
3	MWC EW - State Infrastructure	$ 38	$ (2)	$ (93)	$ (303)	$ -	$ 177	$ 177	$ 177		
4	Other	$ (93)	$ (362)	$ 3	$ (29)	$ (709)					
5	Forecasting & Escalation Adjustments						$ (6,620)	$ (4,300)	$ (1,950)	(1)	
6	Total	$ 12,607	$ 4,390	$ 8,759	$ 6,107	$ 15,521	$ 8,106	$ 8,118	$ 10,283		[Line 1 + Line 2 + Line 3]
7	Change From Prior Year		$ (8,217)	$ 4,369	$ (2,653)	$ 9,415	$ (7,415)	$ 12	$ 2,164		

Assumptions and Details
(1) Adjustments to current forecast model inputs driven by authorized targets and Escalation model input differences.

Workpaper Table 18-14
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Calculation of Relocation WRO Expense Expenditures - MWC EW
(Thousands of Dollars)

		2016	2017	2018	2019	2020	2021	2022	2023			
Line No.	**Description**	**Recorded**					**Forecast**			**Assumptions**	**Notes**	**Reference**
1	MWC 10 Expenditures and Forecast	$ 99,694	$ 97,298	$ 121,047	$ 120,864	$ 145,630	$ 155,690	$ 145,048	$ 132,769			WP18-54 Line 8
2	less Major Projects and State Infrastructure Programs	$ 8,365	$ 8,439	$ 4,980	$ 11,176	$ (340)	$ 2,648	$ 16,290	$ 5,961	(1)		
3	Net Base MWC 10 Expenditures and Forecast	$ 91,328	$ 88,858	$ 116,067	$ 109,688	$ 145,969	$ 153,042	$ 128,757	$ 126,808		[Line 1 - Line 2]	
4	Percent Change from Prior Year – MWC EW Relocation Index		-2.7%	30.6%	-5.5%	33.1%	4.8%	-15.9%	-1.5%		(Current Year Line 3- Prior Year Line 3) / Prior Year Line 3	
5	Relocation Expense Total Expenditures and Forecast – MWC EW	$ 7,012	$ 7,481	$ 8,890	$ 10,429	$ 13,878	$ 14,550	$ 12,242	$ 12,056		Forecast: [Prior Year Line 5 x (1 + Line 4) x (1 + Line 5)]	
8	Difference from Prior Year		$ 469	$ 1,409	$ 1,539	$ 3,449	$ 672	$ (2,309)	$ (185)			

Assumptions and Details
1) Major Projects and State Infrastructure are excluded from relocation index to avoid inflation of expense forecast due to large unrelated capital expenditures

Workpaper Table 18-15
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Historic and Forecasted EGI Application Rates and Forecasted Expenditures - MWC EW

		2016	2017	2018	2019	2020	2021	2022	2023			
Line No.	Description	Recorded					Forecast			Assumptions	Notes	Reference
1	Projected Number of EGI NEM Applications Received	75,173	63,212	65,021	77,280	82,239	60,000	60,000	60,000	(1) (2)		[Line 2 + Line 3]
2	SNEM	73,391	58,817	60,345	70,582	67,744	55,905	55,905	55,905	(3)		
3	Other Rule 21	1,782	4,395	4,676	6,698	14,495	4,095	4,095	4,095	(4)		
4	Increase in Applications (%)		-16%	3%	19%	6%	-27%	0%	0%			
5	SNEM		-20%	3%	17%	-4%	-17%	0%	0%			
6	Other Rule 21		147%	6%	43%	116%	-72%	0%	0%			
7	Expenditure Forecast:											
8	SNEM	$ 974	$ (7,422)	$ (8,896)	$ (10,505)	$ (10,735)	$ (7,706)	$ (7,706)	$ (7,706)	(5)		
9	Other Rule 21	$ 4,341	$ 1,640	$ 1,393	$ 2,030	$ 2,264	$ 1,688	$ 1,688	$ 1,688	(6)		
10	Pre-parallel Inspections	$ 336	$ 446	$ 194	$ 200	$ 119	$ 280	$ 280	$ 280	(7)		
11	EGI Labor		$ 2,609	$ 3,276	$ 2,172	$ 2,881	$ 2,686	$ 2,686	$ 2,686	(8)		
12	SNEM Credits			$ 3,992	$ 2,112	$ 7,823	$ 3,052	$ 3,052	$ 3,052	(9)		
13	AM EW (D) - Monthly				$ -	$ 0	$ -	$ -	$ -			
14	EGI Expenditures and Forecast (EW)	$ 5,651	$ (2,727)	$ (41)	$ (3,990)	$ 2,353	$ (0)	$ (0)	$ (0)			Sum [Lines 8 - Lines 13]
15	Difference from Prior Year		$ (8,378)	$ 2,686	$ (3,949)	$ 6,343	$ (2,353)	$ -	$ -			[Current Line 14 - Prior Year Line 14]

Assumptions and Details

(1) NEM - Net Energy Metering. Metering for the receipt and delivery of electricity between Producer and Distribution Provider pursuant to California Public Utilities Code (PUC) sections 2827, 2827.8, or 2827.10.
(2) EGI - Electric Generation Interconnection: Application forecast is provided by PG&E's EGI Department.
(3) SNEM - Standard Net Energy Metering: Generation interconnections under PG&E's Electric Rule 21 for solar and/or wind electric generating facilities of 30 kilowatts or less.
(4) Other Rule 21 generation interconnections that do not meet the requirements of SNEM.
(5) The % Increase in Applications for 2021-2023 for SNEM and for Other Rule 21 are each based on their respective year-over-year change in application volume observed in the 2017 to 2021 period
(6) The % Increase in Applications for 2021-2023 for SNEM and for Other Rule 21 are each based on their respective year-over-year change in application volume observed in the 2017 to 2021 period
(7) The Expenditure Forecast for 2021 – 2023 for SNEM and for Other Rule 21 are based on their respective 3-year average of actual expenses for 2017 – 2019 period.
(8) Forecast is based on 3 year average 2017 to 2019
(9) Forecast is based on 3 year average 2017 to 2019

Workpaper Table 18-16
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Historic and Forecasted State Infrastructure and Forecasted Expenditures
MWC EW - E TD WRO - Maintenance
(Thousands of Dollars)

		2016	2017	2018	2019	2020	2021	2022	2023
Line No.	Description	Recorded					Forecast		
1	VTA - BART to Silicon Valley Phase II						$ 60	$ 60	$ 60
2	CalTrain	$ 7	$ 43	$ 30	$ 50				
3	Google (Diridon Redevelopment)			$ (27)	$ (344)		$ 117	$ 117	$ 117
4	High Speed Rail	$ 30	$ (45)	$ (96)	$ (9)				
5	WaterFix	$ 1							
6	MWC EW - State Infrastructure	$ 38	$ (2)	$ (93)	$ (303)	$ -	$ 177	$ 177	$ 177

Workpaper Table 18-17
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 18
New Business & Work at the Request of Others
Capital Expenditures by Major Work Category
(Thousands of Nominal Dollars)

			Capital Expenditures											
No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	10	E Dist WRO General	99,694	97,298	121,047	120,864	145,630	155,690	145,048	132,769	139,842	150,827	176,341	WP 18-50, WP 18-51
2	16	E Dist Customer Connects	359,943	362,270	434,560	461,986	536,190	511,868	600,122	666,795	714,625	767,943	796,132	WP 18-21, WP 18-22
3		**Grand Total**	**459,637**	**459,568**	**555,607**	**582,850**	**681,819**	**667,558**	**745,170**	**799,564**	**854,467**	**918,770**	**972,473**	

Workpaper Table 18-18
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 18
New Business & Work at the Request of Others
Forecast Capital Expenditures Summary
(Thousands of Nominal Dollars)

		Capital Expenditures							
Line No.	Description	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	Projects > $3 Million*	5,350	602,513	742,436	796,236	852,518	918,770	972,473	WP 18-19
2	Other Work	6,791	65,046	2,734	3,328	1,949	-	-	WP 18-20
3	**Total**	**12,141**	**667,558**	**745,170**	**799,564**	**854,467**	**918,770**	**972,473**	

4 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 18-19
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 18
New Business & Work at the Request of Others
Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million*
(Thousands of Nominal Dollars)

Line No.	Planning Order	Description	MWC	Operative Date	CWIP 2020 Recorded Adjusted	Capital Expenditures 2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Subtotal	Reference
	MWC - 10	**E Dist WRO General**											
1	5505564	10-WRO Fully Reimb.-SJ	10		(402)	11,379	-	-	-	-	-	10,977	
2	5505578	10-WRO Partially Reimb.-EB	10		488	3,435	-	-	-	-	-	3,922	
3	5505597	10-WRO Non-Reimb.-MI	10		1,539	1,602	-	-	-	-	-	3,142	
4	5505600	10-WRO Non-Reimb.-SJ	10		3,546	3	-	-	-	-	-	3,548	
5	5505606	10-WRO Non-Reimb.-NV	10		54	3,495	-	-	-	-	-	3,549	
6	5505608	10-WRO Non-Reimb.-SI	10		26	5,793	-	-	-	-	-	5,819	
7	5541713	Order Detail Planning 2020 - 2026	10		-	4,187	-	-	-	-	-	4,187	
8	5541714	Order Detail Plannin 2020 - 2026	10		-	13,075	-	-	-	-	-	13,075	
9	5541716	Order Detail Planning 2020-2026	10		-	7,185	-	-	-	-	-	7,185	
10	5541717	Order Detail Planning 2020-2026	10		-	5,640	-	-	-	-	-	5,640	
11	5543449	SYSPLAN ED 10C	10		-	22	4,539	3,113	28	-	-	7,702	
12	5543453	SYSPLAN ED 10J	10		-	97,204	127,894	126,327	133,958	150,828	176,341	812,552	
13	5543460	SYSPLAN ED 10Q	10		-	136	9,882	-	3,907	(0)	(0)	13,925	
14	5784098	EP SR 84 LIVERMORE	10	Oct-2021	100	3,667	-	-	-	-	-	3,767	
15	5791158	Google San Jose Redev. MWC 10 Plug	10	Jun-2021	-	5,280	-	-	-	-	-	5,280	
16	**Total**				**5,350**	**162,104**	**142,314**	**129,441**	**137,893**	**150,827**	**176,341**	**904,270**	WP 18-54
	MWC - 16	**E Dist Customer Connects**											
17	5500809	Purchase Transformers	16		-	104,857	-	-	-	-	-	104,857	
18	5508479	SYSPLN - E-PN-16C	16		-	6,173	-	-	-	-	-	6,173	
19	5508482	E-SF-16C	16		-	4,531	-	-	-	-	-	4,531	
20	5508485	E-DI-16C	16		-	3,616	-	-	-	-	-	3,616	
21	5508488	E-EB-16C	16		-	5,521	-	-	-	-	-	5,521	
22	5508491	SYSPLN - E-MI-16C	16		-	7,226	-	-	-	-	-	7,226	
23	5508494	E-CC-16C	16		-	3,040	-	-	-	-	-	3,040	
24	5508497	SYSPLN - E-DA-16C	16		-	9,737	-	-	-	-	-	9,737	
25	5508500	SYSPLN - E-SJ-16C	16		-	8,889	-	-	-	-	-	8,889	
26	5508503	SYSPLN - E-FR-16C	16		-	4,771	-	-	-	-	-	4,771	
27	5508524	E-SI-16C	16		-	4,761	-	-	-	-	-	4,761	
28	5508527	SYSPLN - E-NB-16C	16		-	3,758	-	-	-	-	-	3,758	
29	5508819	Transformer Scrapping	16		-	4,995	-	-	-	-	-	4,995	
30	5509022	SYSPLN - E-HB-16C	16		-	3,595	-	-	-	-	-	3,595	
31	5509560	SYSPLN - E-PN-16H	16		-	6,118	-	-	-	-	-	6,118	
32	5509579	E-SF-16H	16		-	15,681	-	-	-	-	-	15,681	
33	5509581	E-EB-16H	16		-	9,448	-	-	-	-	-	9,448	
34	5509582	SYSPLN - E-MI-16H	16		-	4,648	-	-	-	-	-	4,648	
35	5509583	E-CC-16H	16		-	3,792	-	-	-	-	-	3,792	
36	5509584	E-DA-16H	16		-	6,216	-	-	-	-	-	6,216	
37	5509585	E-SJ-16H	16		-	6,411	-	-	-	-	-	6,411	
38	5509586	SYSPLN - E-FR-16H	16		-	5,418	-	-	-	-	-	5,418	
39	5509588	E-LP-16H	16		-	3,459	-	-	-	-	-	3,459	
40	5509589	SYSPLN - E-ST-16H	16		-	3,887	-	-	-	-	-	3,887	
41	5509591	SYSPLN - E-NV-16H	16		-	4,240	-	-	-	-	-	4,240	
42	5509592	SYSPLN - E-SA-16H	16		-	3,385	-	-	-	-	-	3,385	
43	5509594	E-NB-16H	16		-	5,100	-	-	-	-	-	5,100	
44	5509595	E-SO-16H	16		-	3,147	-	-	-	-	-	3,147	
45	5515722	PLANNING USE ONLY-E-Betterment-16Z	16		-	7,566	-	-	-	-	-	7,566	
46	5515736	E-FR-16J	16		-	5,849	-	-	-	-	-	5,849	
47	5515737	SYSPLN - E-FR-16R	16		-	3,093	-	-	-	-	-	3,093	
48	5515769	SYSPLN - E-MI-16R	16		-	3,443	-	-	-	-	-	3,443	
49	5515798	SYSPLN - E-YO-16J	16		-	4,720	-	-	-	-	-	4,720	
50	5543462	SYSPLAN ED 16	16		-	(114)	5,020	5,047	5,099	5,185	5,300	25,537	
51	5543463	SYSPLAN ED 160	16		-	36,749	151,579	167,408	176,532	185,645	186,253	904,167	
52	5543464	SYSPLAN ED 161	16		-	215	14,053	40,061	50,273	66,480	90,016	261,098	
53	5543471	SYSPLAN ED 16C	16		-	43,916	174,969	190,615	209,290	227,716	228,363	1,074,869	
54	5543474	SYSPLAN ED 16H	16		-	69,186	191,153	192,790	193,522	193,637	194,258	1,034,546	
55	5543782	SYSPLAN ED 16R	16		-	7,816	45,467	50,863	57,351	64,078	65,985	291,560	
56	5543783	SYSPLAN ED 16S	16		-	1,550	17,880	20,011	22,558	25,202	25,955	113,157	
57	**Total**				**-**	**440,409**	**600,122**	**666,795**	**714,625**	**767,943**	**796,132**	**3,986,025**	WP 18-25
58		**Grand Total**			**5,350**	**602,513**	**742,436**	**796,236**	**852,518**	**918,770**	**972,473**	**4,890,296**	

59 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 18-20
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 18
New Business & Work at the Request of Others
Recorded and Forecast Capital Expenditures Details - Other Work*
(Thousands of Nominal Dollars)

			Capital Expenditures											
Line No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	10	E Dist WRO General	85,224	84,485	110,778	107,207	127,290	(6,413)	2,734	3,328	1,949	-	-	WP 18-54
2	16	E Dist Customer Connects	264,160	264,158	326,387	351,734	423,431	71,459	-	-	-	-	-	WP 18-25
3	**Grand Total**		**349,384**	**348,643**	**437,165**	**458,941**	**550,721**	**65,046**	**2,734**	**3,328**	**1,949**	**-**	**-**	

4 * Excludes projects greater than $3M

Workpaper Table 18-21
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 18, Electric New Business and Work at the Request of Others
Major Work Category 16 - Recorded Walk
MWC 16 - Electric New Business
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**359,943**			
2		Residential Connects	14,008		Customer driven growth in Residential connects	WP 18-25, Line 1
3		Non-Residential Connects	(10,603)		Customer driven decrease in Non-Residential connects	WP 18-25, Line 2
4		PEV	(1,075)		Customer driven decline and decrease in PEV	WP 18-25, Line 3
5		Transformer Purchases	2,554		Increase in demand usage based on growth in all categories of transformers (1)	WP 18-25, Line 4
6		Transformer Scrapping	(148)		Minor variations from previous year	WP 18-25, Line 5
7		Other	(2,409)		Decrease in Sand-Gravel-Spoils and Oil Filled Shipping Equipment Allocations	WP 18-25, Line 7
8	**2017**	**Recorded Adjusted**	**362,270**			
9		Residential Connects	38,839		Customer driven growth in Residential connects	WP 18-25, Line 1
10		Non-Residential Connects	27,732		Customer driven growth in Non-Residential connects	WP 18-25, Line 2
11		PEV	(50)		Minor variations from previous year	WP 18-25, Line 3
12		Transformer Purchases	10,425		Increase in demand usage based on growth in all categories of transformers (1)	WP 18-25, Line 4
13		Transformer Scrapping	(200)		Minor variations from previous year	WP 18-25, Line 5
14		Other	(4,457)		Decrease in Sand-Gravel-Spoils and Oil Filled Shipping Equipment Allocations	WP 18-25, Line 7
15	**2018**	**Recorded Adjusted**	**434,560**			
16		Residential Connects	(4,415)		Customer driven decrease in Residential connects	WP 18-25, Line 1
17		Non-Residential Connects	19,554		Customer driven growth in Non-Residential connects	WP 18-25, Line 2
18		PEV	11,389		Customer driven acceptance and increase in PEV	WP 18-25, Line 3
19		Transformer Purchases	(587)		Decrease in demand usage based on growth in all categories of transformers (1)	WP 18-25, Line 4
20		Transformer Scrapping	1,337		Increase in scrapping volume (23%) and unit cost (11%)	WP 18-25, Line 5
21		Other	147		Minor variations from previous year	WP 18-25, Line 7
22	**2019**	**Recorded Adjusted**	**461,986**			
23		Residential Connects	44,996		Customer driven growth in Residential connects	WP 18-25, Line 1
24		Non-Residential Connects	19,768		Customer driven growth in Non-Residential connects	WP 18-25, Line 2
25		PEV	6,307		Customer driven acceptance and increase in PEV	WP 18-25, Line 3
26		Transformer Purchases	3,027		Increase in demand usage based on growth in all categories of transformers (1)	WP 18-25, Line 4
27		Transformer Scrapping	(170)		Minor variations from previous year	WP 18-25, Line 5
28		Other	277		Minor variations from previous year	WP 18-25, Line 7
29	**2020**	**Recorded Adjusted**	**536,190**			

(1) Transformer Types:
OH – Overhead Distribution Transformers
Current – Current Transformers (instrument transformers)
Pad Mount – Pad Mounted Distribution Transformers
UG – Underground Distribution Transformers

Workpaper Table 18-22
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 18, Electric New Business and Work at the Request of Others
Major Work Category 16 - Forecast Walk
MWC 16 - Electric New Business
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**536,190**			
2		Residential Connects	(30,017)		Decrease based on economic model indicating a decrease in units combined with a 3-year average unit cost.	WP 18-25, Line 1
3		Non-Residential Connects	(43,974)		Decrease based on economic model indicating a decrease in units combined with a 3-year average unit cost.	WP 18-25, Line 2
4		PEV	(14,104)		Increase in PEV expenditures due to a forecast increase in the number of PEVs within PG&E's service territory and escalation.	WP 18-25, Line 3
5		Transformer Purchases	34,289		Overall distribution program growth combined with increasing volume of Current and Pad Mount transformers.	WP 18-25, Line 4
6		Transformer Scrapping	120		Minor variations from previous year.	WP 18-25, Line 5
7		Other	(895)		Sand-Gravel-Spoils and Oil Filled Shipping Equipment Allocations are not included in Forecast	WP 18-25, Line 7
8		2021 Budget Adjustment	30,258		Reflects the current GRC forecast model inputs vs the model inputs available when the budget was originally determined. Timing between 2021 and 2022.	WP 18-25, Line 8
9	**2021**	**Forecast**	**511,868**			
10		Residential Connects	71,050		Increase based on economic model indicating an increase in units combined with a 3-year average unit cost.	WP 18-25, Line 1
11		Non-Residential Connects	28,963		Increase based on economic model indicating an increase in units combined with a 3-year average unit cost.	WP 18-25, Line 2
12		PEV	8,871		Decrease in PEV expenditures driven by a forecast decrease in the number of new PEVs within PG&E's service territory.	WP 18-25, Line 3
13		Transformer Purchases	10,155		Overall distribution program growth combined with increasing volume of Current and Pad Mount transformers.	WP 18-25, Line 4
14		Transformer Scrapping	37		Minor variations from previous year.	WP 18-25, Line 5
15		2021 Budget Adjustment	(30,258)		Reflects the currect GRC forecast model inputs vs the model inputs available when the budget was originally determined. Timing between 2021 and 2022.	WP 18-25, Line 8
16		Forecasting & Escalation Adjustments	(563)		Adjustments to current forecast model inputs driven by authorized targets and Escalation model input differences.	WP 18-25, Line 9
17	**2022**	**Forecast**	**600,122**			
18		Residential Connects	23,019		Increase based on economic model indicating an increase in units combined with a 3-year average unit cost.	WP 18-25, Line 1
19		Non-Residential Connects	1,502		Increase based on economic model indicating an increase in units combined with a 3-year average unit cost.	WP 18-25, Line 2
20		PEV	26,017		Increase in PEV expenditures due to a forecast increase in the number of PEVs within PG&E's service territory and escalation.	WP 18-25, Line 3
21		Transformer Purchases	17,343		Overall distribution program growth combined with increasing volume of Current and Pad Mount transformers.	WP 18-25, Line 4
22		Transformer Scrapping	23		Minor variations from previous year.	WP 18-25, Line 5
23		Forecasting & Escalation Adjustments	(1,232)		Adjustments to current forecast model inputs driven by authorized targets and Escalation model input differences.	WP 18-25, Line 9
24	**2023**	**Forecast**	**666,795**			
25		Residential Connects	27,312		Increase based on economic model indicating an increase in units combined with a 3 year average unit cost.	WP 18-25, Line 1
26		Non-Residential Connects	463		Increase based on economic model indicating an increase in units combined with a 3 year average unit cost.	WP 18-25, Line 2
27		PEV	10,213		Decrease in PEV expenditures driven by a forecast decrease in the number of new PEVs within PG&E's service territory.	WP 18-25, Line 3
28		Transformer Purchases	8,929		Overall distribution program growth combined with increasing volume of Current and Pad Mount transformers.	WP 18-25, Line 4
29		Transformer Scrapping	45		Minor variations from previous year.	WP 18-25, Line 5
30		Forecasting & Escalation Adjustments	868		Adjustments to current forecast model inputs driven by authorized targets and Escalation model input differences.	WP 18-25, Line 9
31	**2024**	**Forecast**	**714,625**			
32		Residential Connects	27,149		Increase based on economic model indicating an increase in units combined with a 3-year average unit cost.	WP 18-25, Line 1
33		Non-Residential Connects	(278)		Decrease based on economic model indicating a decrease in units combined with a 3-year average unit cost.	WP 18-25, Line 2
34		PEV	16,207		Increase in PEV expenditures due to a forecast increase in the number of PEVs within PG&E's service territory and escalation.	WP 18-25, Line 3
35		Transformer Purchases	8,792		Overall distribution program growth combined with increasing volume of Current and Pad Mount transformers.	WP 18-25, Line 4
36		Transformer Scrapping	75		Minor variations from previous year.	WP 18-25, Line 5
37		Forecasting & Escalation Adjustments	1,373		Adjustments to current forecast model inputs driven by authorized targets and Escalation model input differences.	WP 18-25, Line 9
38	**2025**	**Forecast**	**767,943**			

Workpaper Table 18-23
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
MWC 16 - Summary and Overview of Forecast Methodology

Line No.

1 **Step 1** **Residential and Non-Residential Expenditures**

Step 1A **RCG Data - Connect Forecast**
Description: PG&E utilizes Rosen Consulting Group's (RCG) proprietary econometric model to forecast Residential and Non-Residential connect units. The model was developed through in-depth study of the statistical relationship between
RCG Units: Residential
Non-Residential
Related Workpaper: Workpaper Table 18-29: MWC 16 – Utility Connects Forecasting Model – Rosen Consulting Group (refer to Page 9 for the summary of the units)

Step 1B **Determine Residential Connect Units by Sub-Category**
Description: Utilizing historic information, PG&E further breaks down recorded Residential connect units into three subcategories, and determines the annual proportion of each in relation to the others.
PG&E Forecasting Categories: Residential Subdivision Backbone
Residential Subdivision Services
Residential - Other
Non-Residential
Related Workpaper: Workpaper Table 18-27: MWC 16 – Historic and Forecasted Residential and Non-Residential NB Units and Work Mix Ratios by Type

Step 1C **Unit Cost Evaluation**
Description: Utilizing recorded connect units and expenditures by forecasting categories, PG&E then evaluates the unit cost for each category to determine the proper methodology to use for forecasting. PG&E compares unit costs and
Process: 1) Historic unit costs for each category are restated in constant 2020 dollars using escalation factors
Related Workpaper: Workpaper Table 18-28: MWC 16 - Derivation of Forecasted Unit Costs for MWC 16

Step 1D **Develop Residential and Non-Residential Expenditure Forecast by Category**
Description: Utilizing the units determined in Step 1B and the unit costs determined in Step 1C, PG&E forecasts expenditures for each category.
Related Workpaper: Workpaper Table 18-26: MWC 16 – Derivation of Routine Residential and Non-Residential Expenditures from Unit and Unit Cost Forecasts

2 **Step 2** **Plug-In Electric Vehicle (PEV) Expenditures**

Step 2A **Determine Average Cost per PEV Upgrade**
Description: Utilizing recorded costs for capital PEV upgrades in MWC 16, PG&E determines an average cost per upgrade by comparing annual expenditures to the number of projects initiated each year. A three year average cost is used f
Related Workpaper: Workpaper Table 18-30: MWC 16 Derivation of PEV-Related Expenditures

Step 2B **Determine Rate of Capital PEV Upgrades**
Description: PG&E compares the number of residential customers placed on the Electric Vehicle (EV) Rate Schedule to the total number of PEV capital upgrades initiated from Step 2A. A three year average of this rate is utilized to convert
Related Workpaper: Workpaper Table 18-30: MWC 16 – Derivation of PEV-Related Expenditures

Step 2C **Forecast of PEVs and Conversion to EV Rate Schedule**
Description: PG&E's Clean Energy Transportion Department provides a forecast of total PEVs in PG&E's service territory for the period of 2021 through 2026 as well as the number of customers expected to be placed on the EV rate schedul
Related Workpaper: Workpaper Table 18-30: MWC 16 – Derivation of PEV-Related Expenditures

Step 2D **Forecast Electric Vehicle Charging Networks**
Description: PG&E's Clean Energy Transportion Department provides a forecast of ports and costs planned to support Assembly Bill AB841 in PG&E's service territory for the period of 2023 through 2026.
Related Workpaper: Workpaper Table 18-30: MWC 16 – Derivation of PEV-Related Expenditures

Step 2E **Develop PEV Forecast**
Description: Utilizing the average cost per upgrade in Step 2A, the rate of capital upgrades in Step 2B, the number of customers converting to the EV rate schedule in Step 2C, and the EVCN ports/costs in Step 2D, PG&E develops the PEV
Related Workpaper: Workpaper Table 18-30: MWC 16 – Derivation of PEV-Related Expenditures

3 **Step 3** **Transformer Purchase Expenditures**

Step 3A **Determine the Historic Transformer Usage Rate by Program**
Description: PG&E utilizes the recorded costs by Program, and the transformers issued by Program and transformer type, to determine an average usage rate for each program. A three-year average usage rate by transformer type is used
Related Workpapers: Workpaper Table 18-31: MWC 16 – Derivation of Transformer Purchase Expenditures: Recorded and Forecasted Program Expenditures
Workpaper Table 18-32: MWC 16 – Derivation of Transformer Purchase Expenditures: Recorded Transformer Issues by Program and Type
Workpaper Table 18-33: MWC 16 – Derivation of Transformer Purchase Expenditures: Recorded Transformer Usage Rate/Million Dollar Expenditure by Program and Transformer Type

Step 3B **Determine the Overall Historic Coefficient of Usage to Purchases**
Description: Transformers issued to projects in various Programs can be a combination of newly purchased units, and units that are recycled and reused. Not all transformers issued to Programs are new purchases. PG&E compares the tot
Related Workpapers: Workpaper Table 18-34: MWC 16 – Derivation of Transformer Purchase Expenditures: Coefficient of Usage to Purchases by Transformer Type

Step 3C **Develop Forecast of Transformer Unit Purchases by Program and Type**
Description: Utilizing the Usage Rates from Step 3A, the Coefficient of Usage in Step 3B, and PG&E's total forecasted expenditures by Program to determine a unit forecast of transformers to be purchased by type and program.
Related Workpapers: Workpaper Table 18-31: MWC 16 – Derivation of Transformer Purchase Expenditures: Recorded and Forecasted Program Expenditures
Workpaper Table 18-32: MWC 16 – Derivation of Transformer Purchase Expenditures: Recorded Transformer Issues by Program and Type
Workpaper Table 18-33: MWC 16 – Derivation of Transformer Purchase Expenditures: Recorded Transformer Usage Rate/Million Dollar Expenditure by Program and Transformer Type
Workpaper Table 18-34: MWC 16 – Derivation of Transformer Purchase Expenditures: Coefficient of Usage to Purchases by Transformer Type
Workpaper Table 18-35: MWC 16 – Derivation of Transformer Purchase Expenditures: Forecasted Transformer Purchases by Program and Type

Step 3D **Develop Unit Cost and Forecasted Expenditures**
Description: PG&E uses the following process to determine the average unit cost of transformers by type and the overall transformer purchase expenditure forecast.
Process:
Related Workpapers: Workpaper Table 18-36: MWC 16 – Derivation of Transformer Purchase Expenditures: Derivation of Unit Cost and Total Expenditures by Transformer Type

4 **Step 4** **Transformer Scrapping Expenditures**

Step 4A **Determine the Historic Transformer Scrapping Unit Cost**
Description: PG&E utilizes recorded scrapping expenditures and units scrapped to determine transformer scrapping unit costs. Unit costs are restated in 2020 dollars using escalation rates, with a three year average rate used for forecasting
Related Workpapers: Workpaper Table 18-37: MWC 16 – Derivation of Transformer Scrapping Expenditures

Step 4B **Determine the Forecasted Transformer Scrapping Units**
Description: PG&E utilizes a linear correlation by year and the number of units scrapped by year to develop a forecast of scrapped units.
Related Workpapers: Workpaper Table 18-37: MWC 16 – Derivation of Transformer Scrapping Expenditures

Step 4C **Determine the Forecasted Transformer Scrapping Expenditures**
Description: Utilizing the transformer scrapping unit costs determine in Step 4A and the unit scrapping forecast in Step 4B, PG&E generates the transformer scrapping expenditure forecast.
Related Workpapers: Workpaper Table 18-37: MWC 16 – Derivation of Transformer Scrapping Expenditures

Workpaper Table 18-24
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Summary of New Business MAT Code Types and Units of Measurement

Line No.	MWC	MAT	Forecast Category	Description	Unit of Measure
1	16	161	PEV - Residential	Elec Veh_RES_No exist OL	Total circuit ft. installed
2	16	162	PEV - Residential	Elec Veh_RES_Pre-exist OL	Total circuit ft. installed
3	16	164	PEV - Non-Residential	Elec Veh_NonRES_Pre-exist OL	Total circuit ft. installed
4	16	165	PEV - Non-Residential	Elec Veh_NB-E-CI Self-Standing	Total circuit ft. installed
5	16	166	Residential - Other	NB-E-Res OH Svc R16-EP	Total circuit ft. installed
6	16	167	Residential - Other	NB-E-Res UG Svc R16-EP	Total circuit ft. installed
7	16	16B	Residential - Other	NB-E-Res OH R15 with R16 MLX	Total circuit ft. installed
8	16	16C	Residential - Other	NB-E-Res OH Svc R16 only	Total circuit ft. installed
9	16	16D	Residential - Other	NB-E-Res UG Svc R16 only	Total circuit ft. installed
10	16	16G	Non-Residential	NB-E-CI OH R15 and/or R16 MLX	Total circuit ft. installed
11	16	16H	Non-Residential	NB-E-CI UG R15 and/or R16 MLX	Total circuit ft. installed
12	16	16J	Non-Residential	NB-E-Ag OH R15 and/or R16 MLX	Total circuit ft. installed
13	16	16K	Non-Residential	NB-E-Ag UG R15 and/or R16 MLX	Total circuit ft. installed
14	16	16O	Residential - Other	NB-E-ST Lights / TC1	Number of Street Lights
15	16	16P	Residential - Other	NB-E-Res UG R15/16 MLX < 5 lots	Total circuit ft. installed
16	16	16Q	Residential - Other	NB-E-ResUG R15/16 MLX - Apts	Total circuit ft. installed
17	16	16R	Residential - Subdivision Backbone	NB-E-Res UG R15/16 MLX >= 5 lots	Total circuit ft. installed
18	16	16S	Residential - Subdivision Services	Prod Subdivision Res Svc Completion-E	Number of Services installed
19	16	16T	Non-Residential	NB-E-FF Irrigation Cntrl / CATV	Number of Services installed
20	16	16W	Non-Residential	NB-E-ATT B Cntrlzd UG	Total circuit ft. installed
21	16	16X	Non-Residential	NB-E-ATT B Cntrlzd OH	Total circuit ft. installed
22	16	16Y	Residential - Other	NB-E-Res Simple OH Svc	
23	16	16Z	Non-Residential	NB-E-NB Betterment	
24	EV	EVA	Service Inquiry	Service Inquiry	Number of New Business Projects Created
25	EV	EVB	OK to Serve - Routine	OK to Serve	Number of Inquiries
26	EV	EVB	OK to Serve - PEV	OK to Serve	Number of Inquiries

Workpaper Table 18-25
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Summary of Forecast Capital Expenditures by Category - MWC 16
(Thousands of Dollars)

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026			
Line No.	Description	Recorded					Forecast						Assumptions	Notes	Reference
1	Residential Connects	$ 104,085	$ 118,093	$ 156,932	$ 152,517	$ 197,513	$ 167,495	$ 238,545	$ 261,565	$ 288,877	$ 316,026	$ 318,507			From: WP 18-26, Line 10
2	Non-Residential Connects	$ 149,905	$ 139,302	$ 167,034	$ 186,589	$ 206,357	$ 162,383	$ 191,346	$ 192,848	$ 193,311	$ 193,033	$ 193,172			From: WP 18-26, Line 13
3	PEV	$ 2,705	$ 1,631	$ 1,581	$ 12,970	$ 19,277	$ 5,173	$ 14,044	$ 40,061	$ 50,273	$ 66,480	$ 90,016			From: WP 18-42, Line 24
4	Transformer Purchases	$ 91,863	$ 94,416	$ 104,842	$ 104,254	$ 107,281	$ 141,570	$ 151,725	$ 169,068	$ 177,997	$ 186,789	$ 186,981			From: WP 18-48, Line 8
5	Transformer Scrapping	$ 4,049	$ 3,901	$ 3,701	$ 5,038	$ 4,868	$ 4,988	$ 5,025	$ 5,048	$ 5,094	$ 5,169	$ 5,270			From: WP 18-49, Line 2
6	Total	$ 352,607	$ 357,343	$ 434,090	$ 461,368	$ 535,295	$ 481,610	$ 600,686	$ 668,590	$ 715,552	$ 767,497	$ 793,946		[Line 1 + Line 2 + Line 3 + Line 4 + Line 5]	
7	Other	$ 7,337	$ 4,927	$ 470	$ 618	$ 895							(1)		
8	2021 Budget Adjustment						$ 30,258						(2)		
9	Forecasting & Escalation Adjustments							$ (563)	$ (1,795)	$ (927)	$ 446	$ 2,186	(3)		
10	Total Adjusted	$ 359,943	$ 362,270	$ 434,560	$ 461,986	$ 536,190	$ 511,868	$ 600,122	$ 666,795	$ 714,625	$ 767,943	$ 796,132		[Line 6 + Line 7 + Line 8 + Line 9]	

Assumptions and Details
(1) Sand-Gravel-Spoils and Oil Filled Equipment Shipping Allocations [Utility Procedure: FIN-1109P-01]
(2) The 2021-2026 forecast has been adjusted to reflect the currect GRC forecast model inputs vs the model inputs available when the budget was originally determined.
(3) Adjustments to current forecast model inputs driven by authorized targets and Escalation model input differences.

Workpaper Table 18-26
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of Routine Residential and Non-Residential Expenditures from Unit Costs Forecasts - MWC 16

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026		
Line No.	Description	Recorded					Forecast						Notes	Reference
1	Residential - Subdivision Backbone Units	11,193	13,742	13,986	12,375	12,852	11,546	16,330	17,778	19,492	21,167	21,173		From: WP 18-27, Line 3
2	Residential - Subdivision Backbone Unit Cost	$ 2,755	$ 2,015	$ 2,190	$ 2,479	$ 3,052	$ 2,714	$ 2,787	$ 2,862	$ 2,939	$ 3,018	$ 3,099	Recorded: [(Line 3 x $1000) / Line 1]	From: WP 18-28, Line 2
3	Residential - Subdivision Backbone ($000's)	$ 30,831	$ 27,684	$ 30,625	$ 30,676	$ 39,221	$ 31,336	$ 45,512	$ 50,881	$ 57,287	$ 63,882	$ 65,615	Forecast: [(Line 1 x Line 2) / $1000]	
4	Residential - Subdivision Services Units	11,193	14,122	17,088	13,072	12,852	11,546	16,330	17,778	19,492	21,167	21,173		From: WP 18-27, Line 4
5	Residential - Subdivision Services Unit Cost	$ 1,199	$ 865	$ 874	$ 1,040	$ 1,119	$ 1,067	$ 1,096	$ 1,126	$ 1,156	$ 1,187	$ 1,219	Recorded: [(Line 6 x $1000) / Line 4]	From: WP 18-28, Line 6
6	Residential - Subdivision Services ($000's)	$ 13,423	$ 12,213	$ 14,939	$ 13,590	$ 14,377	$ 12,320	$ 17,898	$ 20,018	$ 22,533	$ 25,125	$ 25,810	Forecast: [(Line 4 x Line 5 / $1000]	
7	Residential - Other Units	26,361	23,132	22,870	28,885	28,669	25,757	36,426	39,656	43,481	47,217	47,230		From: WP 18-27, Line 5
8	Residential - Other Unit Cost	$ 2,270	$ 3,380	$ 4,870	$ 3,748	$ 5,020	$ 4,808	$ 4,808	$ 4,808	$ 4,808	$ 4,808	$ 4,808	Recorded: [(Line 9 x $1000) / Line 7]	From: WP 18-28, Line 10
9	Net Residential - Other ($000's)	$ 59,830	$ 78,195	$ 111,369	$ 108,250	$ 143,915	$ 123,840	$ 175,136	$ 190,666	$ 209,057	$ 227,019	$ 227,082	Forecast: [Line 7 x Line 8 / $1000]	
10	Subtotal Residential Expenditures ($000's)	$ 104,085	$ 118,093	$ 156,932	$ 152,517	$ 197,513	$ 167,495	$ 238,545	$ 261,565	$ 288,877	$ 316,026	$ 318,507	[Line 3 + Line 6 + Line 9]	
11	Non-Residential Units	10,077	9,350	8,856	8,317	8,456	7,025	8,278	8,343	8,363	8,351	8,357		From: WP 18-27, Line 9
12	Non-Residential Unit Cost	$ 14,876	$ 14,899	$ 18,861	$ 22,435	$ 24,404	$ 23,115	$ 23,115	$ 23,115	$ 23,115	$ 23,115	$ 23,115	Recorded: [(Line 15 x $1000) / Line 13]	From: WP 18-28, Line 14
13	Non-Residential ($000's)	$ 149,905	$ 139,302	$ 167,034	$ 186,589	$ 206,357	$ 162,383	$ 191,346	$ 192,848	$ 193,311	$ 193,033	$ 193,172	Forecast: [(Line 13 x Line 14 / $1000]	
14	Total Residential and Non-Residential ($000's)	$ 253,990	$ 257,395	$ 323,967	$ 339,106	$ 403,869	$ 329,878	$ 429,891	$ 454,413	$ 482,188	$ 509,059	$ 511,679	[Line 12 + Line 15]	

Workpaper Table 18-27
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Historic and Forecasted Residential and Non-Residential NB Units and Work Mix Ratios by Type

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026		
Line No.	**Description**	**Recorded**					**Forecast**						**Assumptions**	**Notes**
1	Overall Residential Connections	37,554	37,254	39,958	41,957	41,521	37,303	52,756	57,434	62,973	68,384	68,403	(1)	[Line 4+ Line 5]
2	Residential Growth Rates	9.3%	-0.8%	7.3%	5.0%	-1.0%	-10.2%	41.4%	8.9%	9.6%	8.6%	0.0%		
3	Subdivision Backbone Lots	11,193	13,742	13,986	12,375	12,852	11,546	16,330	17,778	19,492	21,167	21,173		Forecast: [Line 4 x Line 6]
4	Subdivision Service Connections	11,193	14,122	17,088	13,072	12,852	11,546	16,330	17,778	19,492	21,167	21,173		Forecast: [Line 1 x Line 7]
5	Other Residential Connections	26,361	23,132	22,870	28,885	28,669	25,757	36,426	39,656	43,481	47,217	47,230	(2)	Forecast: [Line 1 - Line 4]
6	% Subdivision Backbone to Services	100%	97%	82%	95%	100%	100%	100%	100%	100%	100%	100%	(3)	Recorded: [Line 3 / Line 4]
7	% Subdivision Services to Overall	30%	38%	43%	31%	31%	31%	31%	31%	31%	31%	31%	(4)	Recorded: [Line 4 / Line 1]
8	% Other Residential to Overall	70%	62%	57%	69%	69%	69%	69%	69%	69%	69%	69%	(4)	Recorded: [Line 5 / Line 1]
9	Overall Non-Residential Connections	10,077	9,350	8,856	8,317	8,456	7,025	8,278	8,343	8,363	8,351	8,357	(1)	
10	Non-Residential Growth Rates	-5.1%	-7.2%	-5.3%	-6.1%	1.7%	-16.9%	17.8%	0.8%	0.2%	-0.1%	0.1%		

Assumptions and Details

(1) Forecasted units are a function of annual changes in building permits, payroll employment, and unemployment statistics as modeled by RCG. See RCG Utility Connects Forecasting Model dated February 2021 (WP Figure 18-29).

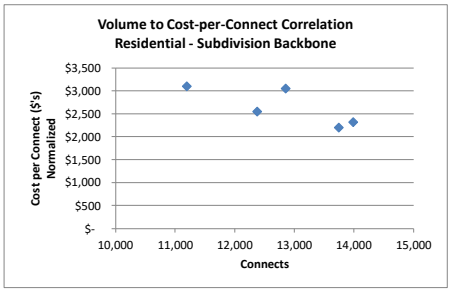
(2) Subdivision Backbone work reflects the first work phase of the subdivision process. Overall residential connections only include the second phase of the process, Subdivision Service Connections.

(3) Forecast period rounded up to 100%

(4) Forecast is based on a 2-year average

Workpaper Table 18-28
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of Forecast Unit Costs for MWC 16

Line No.	Residential - Subdivision Backbone	2016	2017	2018	2019	2020	Basis	2021	2022	2023	2024	2025	2026	Reference
		Recorded						Forecast						
1	Connects	11,193	13,742	13,986	12,375	12,852		11,546	16,330	17,778	19,492	21,167	21,173	
2	Cost per Connect - Base	$ 2,755	$ 2,015	$ 2,190	$ 2,479	$ 3,052		**$ 2,714**	**$ 2,787**	**$ 2,862**	**$ 2,939**	**$ 3,018**	**$ 3,099**	
3	Cost per Connect - Normalized to 2020	$ 3,100	$ 2,201	$ 2,323	$ 2,553	$ 3,052	**3-Yr Avg**	$ 2,643	$ 2,643	$ 2,643	$ 2,643	$ 2,643	$ 2,643	
4	Historic/Forecasted Escalation	3.0%	3.0%	3.0%	3.0%			2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	



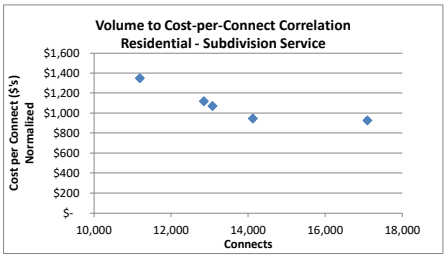
Correlation: -79%
Correlation < |90%|, use three year normalized average as base

[1]The equation for the correlation coefficient is:

$$Correl(X,Y) = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2 \sum (y-\bar{y})^2}}$$

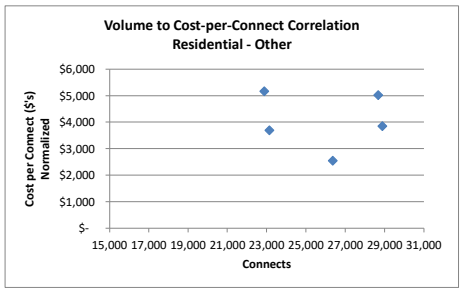
where x and y are the sample means AVERAGE(array1) and AVERAGE(array2). The correlation coefficient is a number between 0 and 1. If there is no relationship between the predicted values and the actual values the correlation coefficient is 0 or very low (the predicted values are no better than random numbers). As the strength of the relationship between the predicted values and actual values increases so does the correlation coefficient. A perfect fit gives a coefficient of |1.0|. Thus the higher the correlation coefficient the better. For purposes of unit cost to volume, a correlation |90%| or greater assumes a high degree of relationship.

Line No.	Residential - Subdivision Services	2016	2017	2018	2019	2020	Basis	2021	2022	2023	2024	2025	2026	Reference
		Recorded						Forecast						
5	Connects	11,193	14,122	17,088	13,072	12,852		11,546	16,330	17,778	19,492	21,167	21,173	
6	Cost per Connect - Base	$ 1,199	$ 865	$ 874	$ 1,040	$ 1,119		**$ 1,067**	**$ 1,096**	**$ 1,126**	**$ 1,156**	**$ 1,187**	**$ 1,219**	
7	Cost per Connect - Normalized to 2020	$ 1,350	$ 945	$ 927	$ 1,071	$ 1,119	**3-Yr Avg**	$ 1,039	$ 1,039	$ 1,039	$ 1,039	$ 1,039	$ 1,039	
8	Historic Escalation	3.0%	3.0%	3.0%	3.0%			2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	



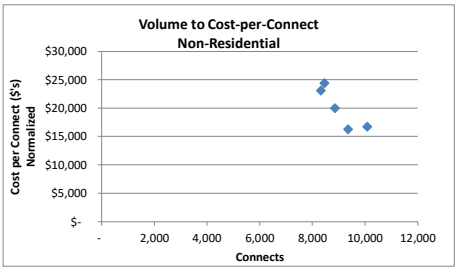
Correlation: -86%
Correlation < |90%|, use three year normalized average as base

Line No.	Residential - Other	2016	2017	2018	2019	2020	Basis	2021	2022	2023	2024	2025	2026	Reference
		Recorded						Forecast						
9	Connects	26,361	23,132	22,870	28,885	28,669		25,757	36,426	39,656	43,481	47,217	47,230	
10	Cost per Connect - Base	$ 2,270	$ 3,380	$ 4,870	$ 3,748	$ 5,020		**$ 4,808**	**$ 4,808**	**$ 4,808**	**$ 4,808**	**$ 4,808**	**$ 4,808**	
11	Cost per Connect - Normalized to 2020	$ 2,554	$ 3,694	$ 5,166	$ 3,860	$ 5,020	**3-Yr Avg**	$ 4,682	$ 4,682	$ 4,682	$ 4,682	$ 4,682	$ 4,682	
12	Historic/Forecasted Escalation	3.0%	3.0%	3.0%	3.0%			2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	



Correlation: -8%
Correlation < |90%|, use three year normalized average as base

Line No.	Non-Residential	2016	2017	2018	2019	2020	Basis	2021	2022	2023	2024	2025	2026	Reference
		Recorded						Forecast						
13	Connects	10,077	9,350	8,856	8,317	8,456		7,025	8,278	8,343	8,363	8,351	8,357	
14	Cost per Connect - Base	$ 14,876	$ 14,899	$ 18,861	$ 22,435	$ 24,404		**$ 23,115**	**$ 23,115**	**$ 23,115**	**$ 23,115**	**$ 23,115**	**$ 23,115**	
15	Cost per Connect - Normalized to 2020	$ 16,743	$ 16,280	$ 20,010	$ 23,108	$ 24,404	**3-Yr Avg**	$ 22,507	$ 22,507	$ 22,507	$ 22,507	$ 22,507	$ 22,507	
16	Historic/Forecasted Escalation	3.0%	3.0%	3.0%	3.0%			2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	



Correlation: -89%
Correlation < |90%|, use three year normalized average as base

R C G

Utility Connects Forecasting Model

February 2021

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Summary

- Rosen Consulting Group (RCG) constructed a set of utility connects forecasting models utilizing public and private external economic indicators. The models are updated and recalibrated regularly to incorporate current data and Pacific Gas & Electric (PG&E) utility connects data.

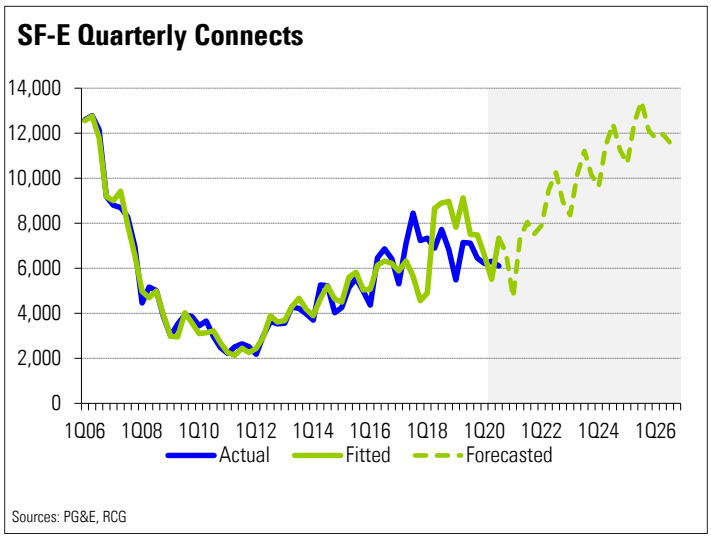
- Service area connects are modeled for four main connect types: residential electric (RE), residential gas (RG), nonresidential electric (NRE) and nonresidential gas (NRG) through 2026.

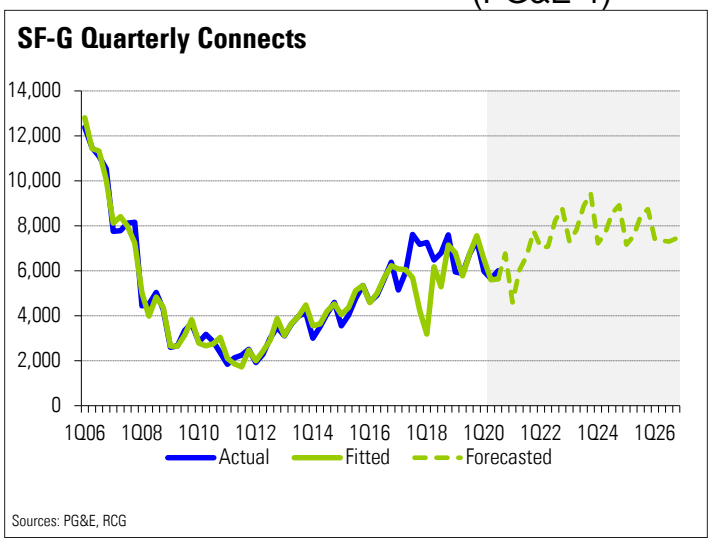
- Residential connects are modelled using residential permitting and employment growth. Non-residential connects are modelled using non-residential permitting and initial claims for unemployment insurance.

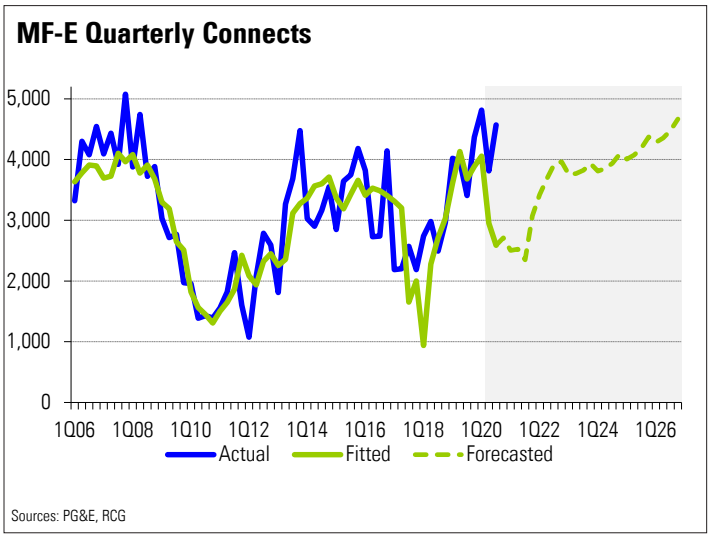
- The unprecedented economic uncertainty caused by the COVID-19 pandemic and business restrictions enacted to combat the pandemic led to volatility in economic indicators as well as connects activity. RCG incorporated as much quantifiable information as possible to project connects forecasts, but it should be noted that the pandemic may have a lasting impact on connects activity.

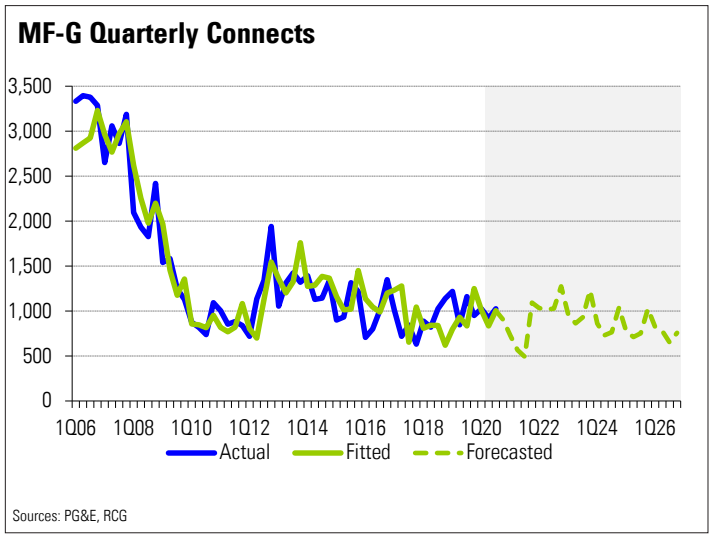
- Following the volatile 2020, forecasts call for a decrease in connects in 2021 followed by a moderate recovery thereafter. Reduced business activity delayed some connects activity in 2020 while other projects were pulled forward, driving an additional element of uncertainty as the region recovers from the pandemic. The strong demand for housing should persist through the coming years, maintaining elevated residential connects activity. Non-residential connects activity should slowly recover for electric connects but likely will slow over the longer term for natural gas connects as more developers electrify projects.

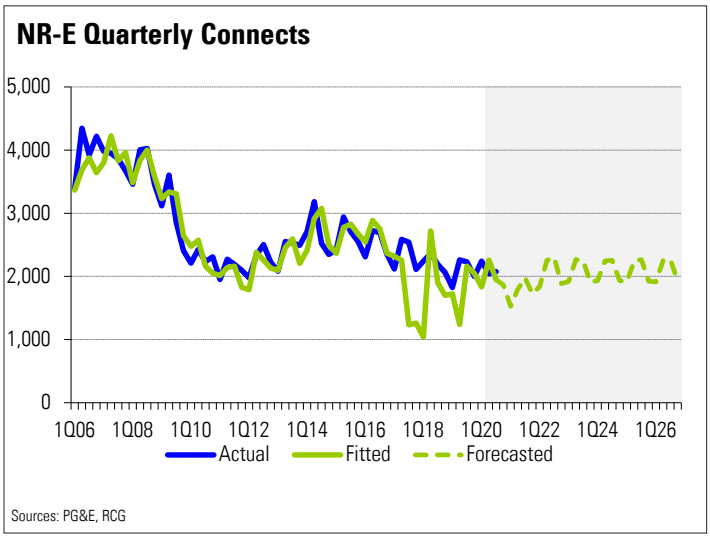
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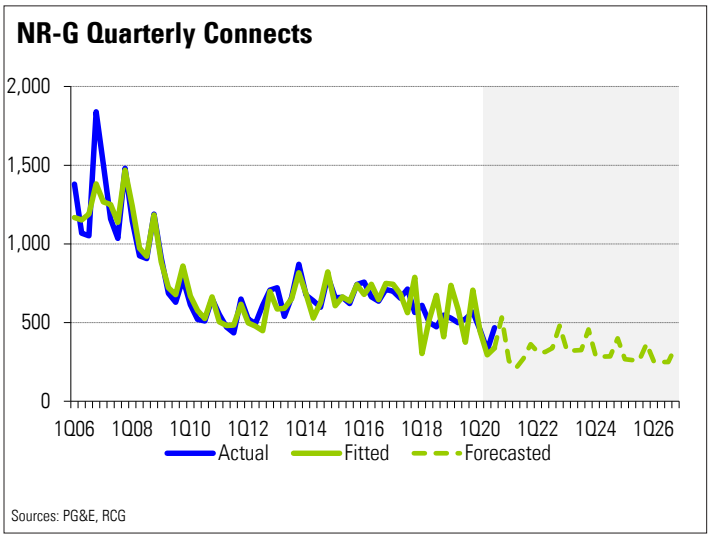












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Utility Connects Forecasting Model

I. Introduction

Rosen Consulting Group (RCG) constructed predictive time series models to forecast PG&E utility connects utilizing historical relationships between utility connects and independent economic indicators, along with RCG forecasts of relevant indicators. The model produces separate forecasts for four main connect types: residential electric (RE), residential gas (RG), nonresidential electric (NRE) and nonresidential gas (NRG). The residential model is derived from separate models for single family homes and multifamily developments. The models produce monthly near-term projections through mid-2022 and quarterly projections through 2026.

II. Input Data

PG&E Connects

PG&E provided monthly utility connects data through year-end 2020. The utility connects data are categorized by type of utility connect and geographic area. Within the geographic areas, utility connects are segmented by PG&E Divisions and Areas. Each Area is comprised of several Divisions, and each geography was determined to be contiguous areas that, in sum, equaled the PG&E service coverage area.

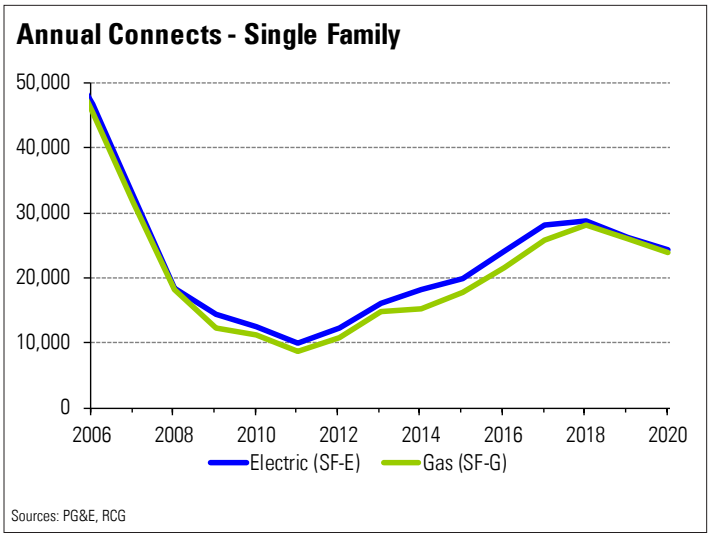
The connects data utilized by RCG to develop the forecasts spanned from 2003 to 2020. During this time period, RE averaged 3,415 connects per month, RG 2,821 connects per month, NRE 940 connects per month and NRG 272 connects per month. As highlighted by the minimum and maximum monthly connects figures, a wide range of monthly activity can be seen throughout the previous 18 years.

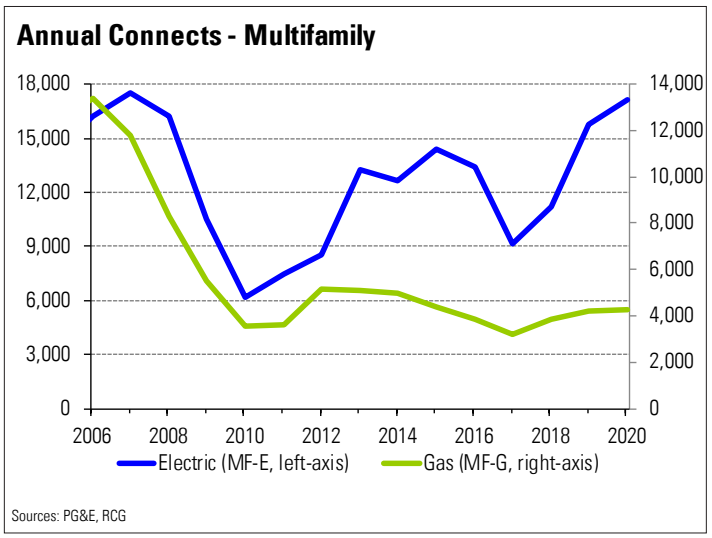
From 2003 to 2020, PG&E completed more than 1.6 million utility connects, or nearly 90,000 connects per year. Residential connects accounted for roughly 84% of the connects during this period. Electric connects, including residential and non-residential types, accounted for approximately 58% of total connects. The

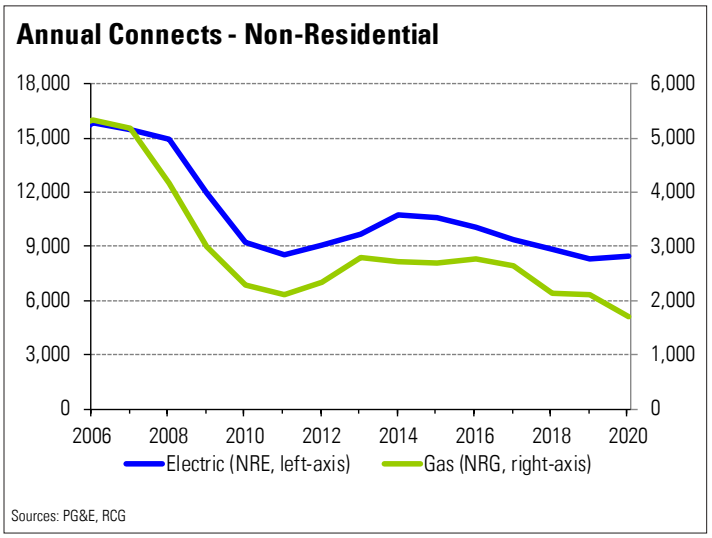
Descriptive Statistics
Monthly Connects by Type, Jan. 2003-Dec. 2020

Service Class	Type	Average	Min. / Max.		Std. Dev.	Coeff. Of Variation
Residential	Electric	3,415	839	6,930	1,538	0.450
	Gas	2,821	775	7,179	1,687	0.598
Nonresidential	Electric	940	470	1,598	247	0.263
	Gas	272	87	744	122	0.449

Sources: PG&E, RCG calculations







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bulk of the gas connects were for residential unit types.

Residential connects decreased substantially following the housing bubble of the mid-2000s, and had slowly recovered during the last decade. Residential connects activity peaked in single family by 2018, but multifamily continued to surge as the apartment development boom throughout the region accelerated. Non-residential connects also decreased from the mid-2000s, but had stabilized during the last few years.

The last several years of connects highlights the cyclical nature of utility connects. Economic forces can drive swings in real estate development activity, which flow through to utility connects. Additionally, non-economic forces can also impact connects, as we have seen most recently with the COVID-19 pandemic as well as shifts in regulatory environments that can disincentivize fossil fuels.

III. Methodology

This section describes the methodology for creating the forecasting models for utility connects.

Model Development

RCG used an iterative model selection process to specify the final forecast models. As the initial step, all potential IVs that might explain PG&E connects were collected and separately tested against connects to determine the strongest candidates, based on bivariate correlation and plausibility, for inclusion in a multivariate model. In total, more than 145 IVs were tested against the four major connects types at lags from zero to eight quarters.

From the wide range of variables collected and tested, those selected for inclusion in the final forecasting models demonstrated a strong, statistically significant relationship with connects. Moreover, the variables plausibly drive demand for connects, and the measured direction of the relationship meets prior expectations (e.g., increased connects track increased construction activity).

In developing the initial connects model, RCG analyzed independent data with the potential for significant predictive power. These data included economic, demographic, financial and real estate market data from public agencies and private sources. The data were examined for optimum frequency of publication as well. In some cases, RCG analyzed various transformations of the data and tested lag factors.

After testing variables individually and identifying the top IV candidates, RCG tested multivariate models utilizing combinations of IVs and lags to identify the best multivariate fit, taking into account the interaction between IVs. RCG used statistical testing to measure outperformance and rank competing models that take into account both the magnitude of outperformance and the likelihood that it was due to chance. RCG also iteratively reintroduced IVs and tested them against the residuals of the leading candidate models to identify IVs that might incrementally improve the fit of the top-performing models. The final forecast models were evaluated on how well they fit the data in the estimation period (in-sample fit), as well as the likelihood that the key model relationships would remain stable through the forecast period (out-of-sample forecast evaluation). The scope for out-of-sample forecast testing is limited by data availability, but initial testing with the data available suggests that the preferred models should outperform competing models during the forecast period.

RCG constructed the original connects models as multivariate regressions. This technique yields an equation whereby the number of RE connects in a particular quarter are given by the value of one or more indicator variables (IVs), each multiplied by a coefficient. A two-variable linear regression equation with a constant takes the form $RE = A + X*Var1 + Y*Var2$, where *RE* is the number of quarterly RE connects, *A* is the constant term, *X* and *Y* are coefficients on IVs *Var1* and *Var2*, respectively. The constant term and coefficients (*A*, *X*, *Y*) are estimated using statistical analysis software to produce the tightest fit between predicted and actual values within the estimation range.

RCG modeled connects at a quarterly frequency in order to smooth out month-to-month noise and increase the precision of model estimates. Some candidate IVs were also not available at the higher monthly frequency and therefore quarterly connects facilitated testing against a wider range of independent economic indicators. Quarterly connects were calculated as the sum of the three relevant months, and monthly IV series were aggregated as appropriate to facilitate standardized testing.

RCG used the cubic spline method to interpolate monthly forecasts from the quarterly connects forecasts. A cubic spline interpolates values between known data points to create a smooth forecast path. It should be noted that the interpolated values are approximations, rather than actual outputs of the quarterly connects models.

Consistent with efforts to smooth the underlying data for model estimation and provide the most reliable top-level forecasts, RCG used a share-down method to generate Area and Division forecasts from the total PG&E Service Area forecasts. RCG investigated the feasibility of using a "bottom-up" approach to generate division- and/or area-level forecasts by directly forecasting the four connect types for each of the Areas or Divisions, but ultimately concluded that the overall results were less reliable using this method. First, there is the technical issue of mapping county and metropolitan area IV data to the PG&E areas and divisions. PG&E Areas and Divisions do not follow county lines, as do

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Single Family Connects Forecasting Models

Variable	Lag	Single Family Electric (SF-E)	Single Family Gas (SF-G)
Intercept	n/a	470	100
		(0.009)	(0.524)
Seas. Dummy	n/a		517
			(0.001)
Single Family Permits	0 qtrs	0.45	0.21
		(0.000)	(0.000)
	1 qtr	0.37	0.38
		(0.000)	(0.000)
	2 qtrs		0.20
			(0.000)
Employment Growth	8 qtrs	49	55
		(0.140)	(0.061)
Observations		58	58
Parameters		4	6
Adj. R^2		94.8%	96.0%
Joint F-stat		350.8	280.6
		(0.000)	(0.000)

Notes: Models estimated from 2006Q1-2020Q4. P-values in parenthesis.
Sources: PG&E, RCG

available economic data including the IV data, so it is impossible to precisely map the IVs to PG&E sub-geographies. Second, and somewhat related, the magnitude of sampling and non-sampling errors increase relative to the underlying trend at more granular geographic levels, increasing uncertainty around the model estimates and the potential for misspecification that biases the forecasts. In other words, the ratio of noise to signal increases at finer geographies, which decreases the precision of model estimates. If the models are biased across areas or divisions in a random way, then these biases will likely cancel out when aggregated to the total service area. Much more likely, however, is that the area or division forecasts are biased systematically in the same direction, which leads to a bias in the same direction in the total service area forecasts. For example, noisy data may cause the relationship between residential permits and connects to be estimated as weaker than it is, leading to less sensitivity to permitting and under-forecasting of utility connects.

For the reasons described, RCG preferred to directly estimate connects for the total PG&E service area, thus increasing confidence in forecasts at the aggregate level, and "share down" the total connects to PG&E Areas and Divisions. RCG analyzed historical Area and Division shares and modelled future shares using historical data and RCG expectations for regional differences in economic conditions and construction activity.

The wide range of connects volume per type over the relevant history underscores the volatility as well as influences of economic conditions on utility connects. For this reason, RCG examined and excluded a time-trend model which assumes a predetermined trend in average levels. Similarly, RCG examined and excluded a highly restrictive assumption that an average level of utility connects will be constant across the recent past and future. The RCG model construct is likely more reliable as a tool to forecast forward and less likely to overfit the estimation period and extrapolate a trend to future years that does not persists.

The connects models were estimated utilizing data from 2006 to 2020. RCG continued to omit data for the 2003 to 2005 period, as it has done in past years, due to the potential for reduced reliability and accuracy of this data as noted by PG&E. Additionally, it should be noted that utility connects data for the most recent months are often revised and can cause fluctuations in the levels that RCG utilizes within the models.

With additional historical data on utility connects as well as shifts in real estate developer preferences, RCG enhanced the residential model to incorporate individual single family and multifamily forecast models. Additionally, RCG constructed an autoregressive time-series model of the forecast errors for each connect type, such that recent forecast errors can be utilized to provide updated forecasts in real time, reflecting the most recent trends in activity. The autoregressive model utilizes forecast errors from the previous six quarters to forecast the quarter-ahead forecast error. This process has little impact on longer range forecasts and is intended to decrease the likelihood that the model produces near-term forecast errors.

As single family permits and connects remain tightly linked, the general model construct remained the same. The homogeneity of single family homes throughout the region in terms of utilization of electric or gas utilities provides a favorable modeling environ-

Multifamily Connects Forecasting Models

Variable	Lag	Multifamily Electric (MF-E)	Multifamily Gas (MF-G)
Connects, 4 qtr trailing avg.	1 qtr		0.88
			(0.000)
Intercept	n/a	1,211	
		(0.000)	
Seas. Dummy	n/a		198
			(0.037)
Multifamily Permits, 5Q MA	4 qtrs	0.43	
		(0.000)	
Multifamily Permits, 2Q Dif	0 qtrs		0.07
			(0.106)
Employment Growth	2 qtrs		30
			(0.017)
	3 qtrs	91	
		(0.035)	
Observations		59	59
Parameters		3	4
Adj. R^2		57.3%	95.0%
Joint F-stat		39.9	443.6
		(0.000)	(0.000)

Notes: Models estimated from 2006Q1-2020Q4. P-values in parenthesis.
Sources: PG&E, RCG

Nonresidential Connects Forecasting Models

Variable	Lag	Electric (RE)	Gas (RG)
Connects, 4 qtr trailing avg.	1 qtr	0.94	0.92
		(0.000)	(0.000)
Seas. Dummy	n/a	312	139
		(0.000)	(0.000)
Nonresidential Permits, 2Q Dif	1 qtr	0.14	0.15
		(0.263)	(0.003)
Initial Claims	0 qtrs	-0.40	
		(0.168)	
	2 qtrs		-0.12
			(0.317)
Observations		59	59
Parameters		4	4
Adj. R^2		97.2%	96.0%
Joint F-stat		1536.5	656.1
		(0.000)	(0.000)

Notes: Models estimated from 2006Q1-2020Q4. P-values in parenthesis.
Sources: PG&E, RCG

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ment as correlations remain very strong.

On the multifamily side, the surge in multifamily housing in recent years revealed several trends. With the vast majority of units permitted as residential apartments, the shift in development away from condos constrained gas connects. Multifamily gas connects remained stable during the past six years even as real estate development volume surged. Additionally, the scale of apartment development during the past few years, generally skewing towards larger building sizes, extended the time to build. Notably, multifamily permitting activity began to run ahead of electric connects, highlighting the growing lag caused by longer development timelines. As the average multifamily project size has increased in recent years, a recalibration of the specified lag to utility connects was justified.

Natural Gas Regulations

The rise in municipal regulation of natural gas utilization in residential and non-residential buildings continued, potential altering the long-term relationship between building activity and gas connects. RCG examined in-place and under consideration municipal regulations throughout the PG&E service area. Regulations were varied, with some fairly strict regulations and others much more lax. Most municipalities allowed some length of phase in period, as well as allowed previously permitted projects to continue without alteration. Also, many cities included provisions for exceptions or waivers depending upon type of building or other conditions. Given the wide range of regulations, recent implementation in some cities and the potential for future implementation by a growing number of cities, an adjustment to the model construct at this time would be preliminary.

As an alternative, RCG reviewed development activity in the relevant municipalities and determined the share of activity that could be at risk of modification. RCG also analyzed development trends and incorporated guidance from market participants, those that actively build residential and non-residential buildings, to determine the potential that a developer may seek variance from the electrification mandates or if the regulations would deter development. For projects beyond the planning review phase, most participants acknowledged that they would not revise plans unless required by the relevant agency. As such, in the near term following implementation of regulations, it is likely that the lag between planning approval and actual construction that would trigger a utility connect will remain somewhat consistent to historical trends.

In order to adjust connects projections following the typical lag in development activity, RCG developed shares, or loss factors, of residential and non-residential permit volumes that may be at risk given the electrification requirements. The factors varied by municipality based upon the degree of severity of the ordinances, variance allowances and implementation window. For cities citing a preference for all electric rather than a ban of natural gas, the share of activity at risk was much lower. Additionally, RCG examined single family, multifamily and non-residential permits as distinct types, generating loss factors for each type. In some cases, broad exceptions for commercial uses led to a smaller loss factor for non-residential building permits. The factors were phased in over time, at a somewhat lagged pace relative to implementation of municipal ordinances due to the aforementioned backlog of permits.

The potential downward adjustment of gas connects resulting from regulation may not be as significant as expected in the near term given the range of ordinances and implementation. Additionally, the potential for development to occur in neighboring cities without such regulations to meet regional demand may also offset an immediate decline. As the backlog of permits are absorbed and new developments move towards electrification, the number of gas connects is likely to decrease.

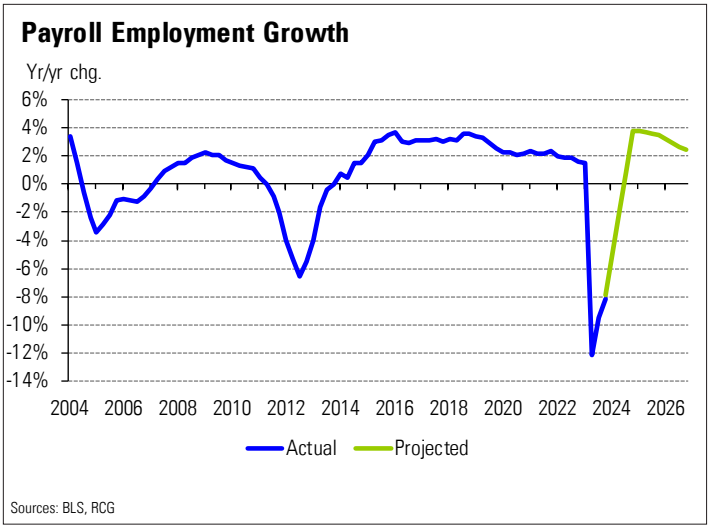
RCG IV Forecasts and Outlook

RCG selected IVs with the most reliable predictive ability after adjusting for potential lags in the data. In order to generate connects forecasts beyond the lagged periods, RCG utilized proprietary models to forecast underlying IVs. These models generate IV forecasts for payroll employment, unemployment insurance claims, residential permits and non-residential permits.

The IV forecast models incorporate a broad macroeconomic and real estate market perspective. RCG's outlook reflects an objective perspective of market conditions independent of implications for utility connects.

The unprecedented nature of the COVID-19 crisis continues to generate implications for the regional economy. The initial optimism of a vaccine has fallen back to reality as the rollout has been slower than expected by some. Even as business restrictions are slowly lifted, long-term impacts of the restrictions will suppress business and consumer confidence for some time. The unemployment rate in California and throughout the service region remained elevated, and even increased slightly at year-end 2020. Throughout the pandemic, the bulk of job losses were concentrated within service industries, including retail, hospitality and restaurants. These industries will take some time to recover even once consumers perceive it is safe to return to these activities. While no industry has escaped the induced recession, individuals able to work remotely have fared better through the last several months. These industries, particularly technology, financial services and professional services, have recovered to employment levels roughly on par with the start of the pandemic. The bifur-

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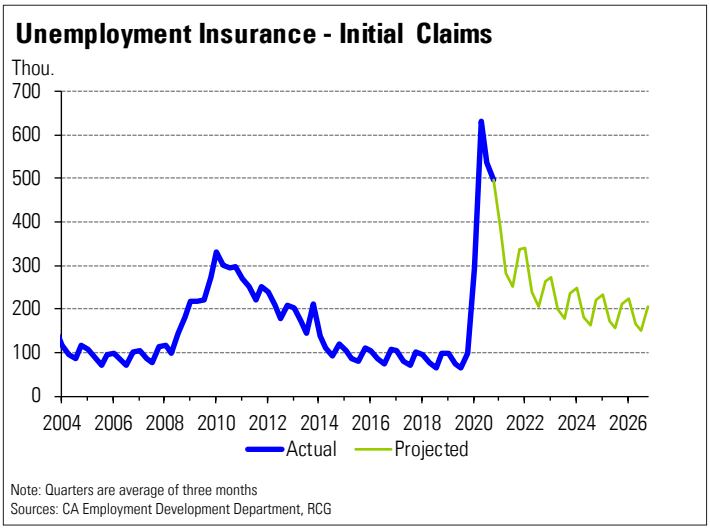


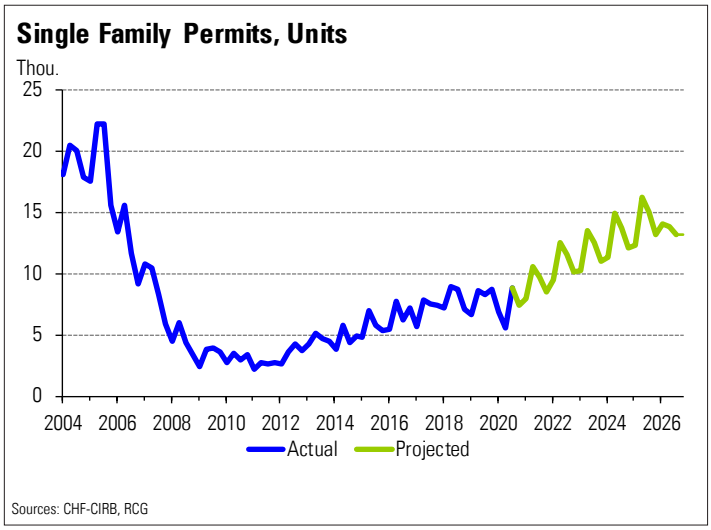
cated economic performance continues to exacerbate some of the economic inequities. Government assistance measures, including enhanced unemployment benefits as well as stimulus check, have helped some households survive job losses. Additionally, foreclosure moratoria and mortgage forbearance programs have kept some families in homes despite loss of income.

The current economic trajectory can be attributed primarily to the outlook for the pandemic. As the vaccine rollout accelerates, and transmission rates decline, business restrictions will be lifted throughout the region which will lead to some recovery in employment. Conversely, if COVID-19 variants prove resistant to vaccines, and infection rates surge, this would lead to additional job loss. While employment recovered somewhat after the initial layoffs in early 2020, regional employment remained approximately 8% lower through year-end. RCG expects a moderate recovery in the near term as some business activity returns to normal levels. RCG forecasts employment growth of 3.8% and 3.5% in 2021 and 2022, respectively. Thereafter, employment growth should return to a more sustainable level, slowing to 2.4% in 2023 and 2.2% in 2024.

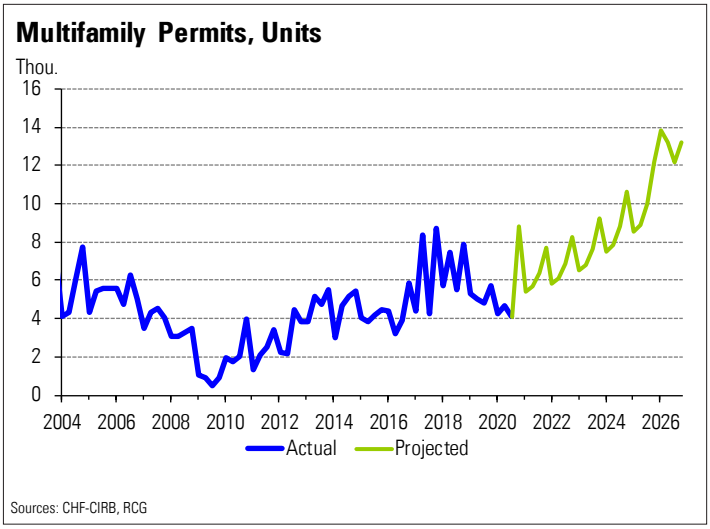
Unemployment insurance claims surged to unprecedented levels in mid-2020 as a range of industries were forced to shutter temporarily due to the pandemic. Following the peak of more than 630,000 initial claims per month in the second quarter of 2020, claims fell to 370,000 by the fourth quarter. While a marked improvement, unemployment claims remain higher than during any other recession in recent history. Through the near term, initial claims may remain elevated as businesses that survived thus far due to stimulus measures including the CARES Act and rounds of the Paycheck Protection Program may close as government support tapers. Additionally, the pandemic has accelerated shifts in the retail landscape that will likely translate to additional darkened storefronts. RCG forecasts initial claims to remain elevated at roughly 337,000 in 2021. Initial claims should decrease slowly, reaching 263,000 in 2022, 237,000 in 2023 and approach the 200,000 range in 2024 and 2025.

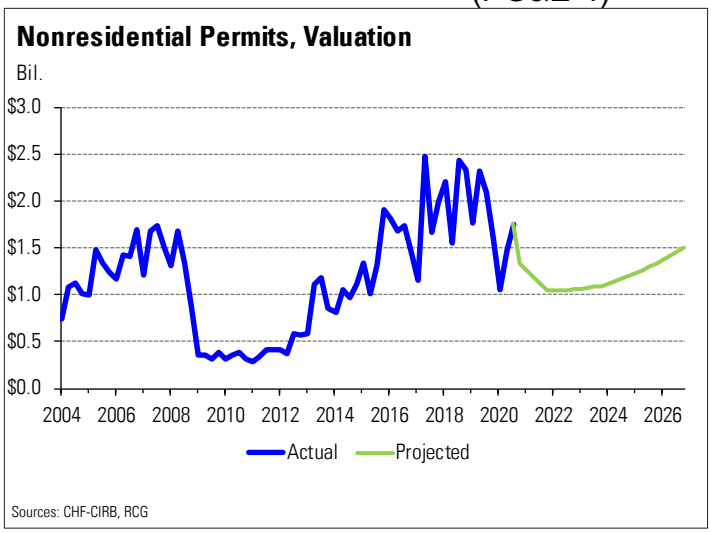
On the real estate front, the pandemic had a range of impacts on development. During the initial months of the pandemic, most construction projects were halted, but were able to restart by mid-year. The pause along with scarcity of imported building materials for some months extended the timeline for many development projects. Following several years of sluggish activity, the single family building segment surged as families sheltering-in-place in smaller living spaces sought suburban homes with extra rooms for home offices or classrooms and access to outdoor space. While still much lower than the housing bubble of the mid-2000s, single family permit volume reached nearly 29,000 units in 2020 due to the surge in the second half of the year. RCG expects consumers to remain focused on larger living spaces and, coupled with a low mortgage rate, demand for single family homes should remain elevated. As consumer confidence also recovers, and with finances for many upper income households strong despite the pandemic, permitting activity should accelerate to nearly 37,000 units in 2021 and 44,000 in 2022. With the potential for households to continue to return to the region as well as a recovery in international migration, permit issuance should reach 47,000 in 2023, 52,000 in 2024 and 57,000 in 2025. The push by public and private sector leaders for more units to address the chronic short-





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fall of housing construction should help maintain higher levels of permitting activity in the coming years. Consumer preferences for ownership as well as larger spaces in less dense neighborhoods should persist as well, underscoring the potential for single family permitting volume to return to more normalized levels in line with demographic trends.

In contrast to single family trends, the multifamily sector was the focus of development activity and consumer demand for several years prior to the pandemic. Large-scale urban developments became much more common during the last decade, with the bulk of construction cranes in the skyline helping to build multifamily units. The COVID-19 pandemic shifted consumer preference away from denser urban environments and smaller unit sizes. Currently, renter demand for studio and one-bedroom apartments with smaller areas remain low. The extended development timeline for projects in much of the region has led to permitting activity far in advance of potential completion dates. Some developers betting on a strong recovery of demand, for example, continued to work through the permitting process even as renter demand declined. While some of these projects may be at risk of delay or cancellation as the trajectory of renter demand becomes more apparent once the pandemic is over, housing in the region is undersupplied and RCG expects most projects to proceed to the construction phase. Multifamily permitting volume in 2020 was on par with 2019, a year that was somewhat lower due to enhanced regulations that pulled some activity forward to the proceeding years. RCG forecasts a modest recovery in multifamily permitting to 25,000 units in 2021. Permit activity in 2022 should be stable as renter demand will have yet to fully recover in the region. By 2023, activity should accelerate to 30,000 units and increase to 35,000 in 2024 and nearly 40,000 units in 2025. At the higher levels, multifamily permit totals should return to more typical paces of construction in the region based upon population growth and household formation rates.

The COVID-19 pandemic caused a substantial decline in non-residential construction activity. Store and restaurant openings were postponed and office relocations cancelled. While a surge in spending to reconfigure indoor spaces to provide spacing and enhanced ventilation for customers and employees was evident, it could not make up for the lost activity. Prior to the onset of the pandemic, non-residential construction activity had decreased steadily as several large-scale transformational projects delivered. In 2020, non-residential permit valuation fell to $5.6 billion from $7.8 billion the year prior. With few business openings slated for 2021 and many large corporate moves delayed or cancelled, RCG projects non-residential activity will decline further to $4.6 billion and further to $4.2 billion in 2022. By 2023, activity should stabilize at $4.3 billion and begin to recover in 2024 and 2025 with $4.7 billion and $5.1 billion of permit valuations, respectively. The extension of remote working options for many employees will limit the demand for office space as well as curtail spending on interior upgrades and enhancements. Additionally, the long-term impact of the pandemic and business restrictions on the retail, restaurant and entertainment industries should not be understated, and will constrain non-residential permit demand for several years.

IV. Forecast Model Results

The forecast models project some recovery in residential connects, primarily in the single family segment. Annual RE connects should decrease in 2021 to 37,000, with an increase in the single family segment and a decrease in the multifamily segment. As the broader economy normalizes, utility connects activity should as well. The model projects a recover in RE connects to 53,000 in 2022 and 57,000 in 2023. Connects are projected to increase to 63,000 in 2024 and stabilize at roughly 68,000 in 2025 and 2026.

RG connects should decrease in 2021 as well, falling to less than 28,000 connects. While RG connects are projected to rebound somewhat in 2022 and 2023 as demand for housing recovers, the longer term impact of electrification will constrain gas connects. As more local governments restrict fossil fuel usage, the number

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Annual Connects by Type - History and Forecast

Connect Type	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Forecast 2021	2022	2023	2024	2025	2026
SF-E	18,502	14,286	12,552	9,881	12,339	16,025	18,206	19,933	24,119	28,104	28,783	26,192	24,376	27,674	36,601	39,889	44,756	48,658	46,673
SF-G	18,283	12,254	11,220	8,732	10,700	14,853	15,200	17,692	21,536	25,883	28,133	25,937	23,912	25,281	29,987	31,705	30,685	30,454	28,077
MF-E	16,229	10,488	6,167	7,450	8,538	13,236	12,645	14,422	13,435	9,150	11,175	15,762	17,145	9,629	16,155	17,545	18,217	19,726	21,730
MF-G	8,277	5,501	3,527	3,584	5,138	5,114	5,004	4,364	3,867	3,204	3,874	4,178	4,274	2,649	5,408	5,337	4,403	3,938	3,701
NR-E	14,947	11,983	9,179	8,512	9,035	9,654	10,756	10,620	10,077	9,350	8,856	8,317	8,456	7,025	8,278	8,343	8,363	8,351	8,357
NR-G	4,164	3,005	2,297	2,108	2,331	2,792	2,705	2,681	2,768	2,632	2,131	2,118	1,697	1,100	1,439	1,416	1,234	1,132	1,076

Note: 2020 forecast reflects actual connects through 4Q20.
Sources: PG&E, RCG

of gas connects per new housing unit will decrease as well. The forecast model projects RG connects to decrease to 35,000 in 2024, 34,000 in 2025 and 32,000 in 2026.

The non-residential segment is expected to take a different trajectory according to the forecast model. NRE connects should decrease to 7,000 in 2021 before recovering to 8,300 in 2022. NRE connects will remain somewhat stable at this low level through the next several years. From 2023 through 2026, NRE should average roughly 8,300 connects.

Similarly, NRG connects are projected to decrease substantially in 2021 to 1,100. While NRG activity should recover in 2022 and stabilize in 2023, the trend of electrification in commercial buildings will constrain future growth potential. Additionally, development of some building types, such as restaurants, may remain low for some time. As fewer non-residential projects include gas, NRG connects should decrease to 1,200 in 2024, 1,100 in 2025 and less than 1,100 in 2026.

The economic recovery from the COVID-19 pandemic may take some time, yet utility connects may recover ahead of the broader economy. The backlog of residential projects should drive an increase in residential connects, particularly for electric. The non-residential sector may remain constrained for the next few years. The increasing regulation of gas utilization in residential and non-residential buildings should also place downward pressure on RG and NRG in the coming years.

V. Model Discussion

The reliability of the RCG forecast model is dependent upon several key factors, including the reliability and accuracy of input data. Additionally, the persistence of relationships over time as related to the next few years is a key assumption.

Internal PG&E reporting procedures are assumed to be sufficient to prevent systematic biases or a high degree of sampling error. The monthly connects data are inherently volatile, and RCG mitigated this volatility by aggregating monthly data into a quarterly frequency. Additionally, RCG elected to perform projections for the PG&E service area and to assign shares of the projections to Areas and Divisions. Heightened volatility in connects data was observed in the early years of the dataset, specifically the 2003 to 2005 period. This coincided with information from PG&E concerning potential issues with the early portion of the dataset. The potential for data issues in this time period led RCG to exclude the 2003 to 2005 data from the model.

The independent variables are also subject to potential errors or data issues. Some of the IVs are revised by the data sources as additional information are gathered. These revisions are generally considered to be typical for the monthly datasets. While historical revisions do not typically change datasets in a material manner, the COVID-19 pandemic and impact on data gathering techniques is unprecedented within the timeframe of data utilized by the model. The potential for larger shifts in revisions will remain for some time and it is unknown at this time if future revisions will be of a greater magnitude due to the pandemic issues. Substantial revisions to the IVs would alter the model specifications and could produce less reliable forecasts in the interim.

The utility connects models were constructed utilizing quarterly data and output near-term forecasts at a quarterly frequency. The requirement for monthly frequencies drove RCG to incorporate a cubic spline. The cubic spline interpolates quarterly values into monthly values. It should be noted that this means that the model does not output monthly projections, but instead utilizes a method that could add a potential error source in the forecasts.

Another potential source of error is the need for RCG to forecast underlying IVs utilized within the model. The IV forecasts are derived from models accounting for historical relationships between the model IVs and their own set of independent variables. If there were systematic errors between the RCG IV projections and actual values, there would also be potential for the connects model to deviate over the forecast period.

The COVID-19 pandemic introduced unprecedented volatility in the broader economy and specifically in the connects activity and IVs. Some portion of the decline in activity was due to business

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restrictions rather than actual decrease in activity. Similarly, the IVs, in particular unemployment insurance claims, spiked temporarily as mass furloughs rippled through the state. While many of these job losses were permanent, a large portion were temporary furloughs solely caused by business restrictions as well as the expansion of unemployment insurance coverage to some individuals that may not have qualified pre-pandemic. A portion of these shifts are expected to be temporary and, as such, the implication on future connects should be offset. RCG adjusted a portion of activity based upon analysis of underlying data and alternative metrics for similar datasets. This one-time adjustment is necessary in RCG's opinion but could also introduce unforeseen forecast errors.

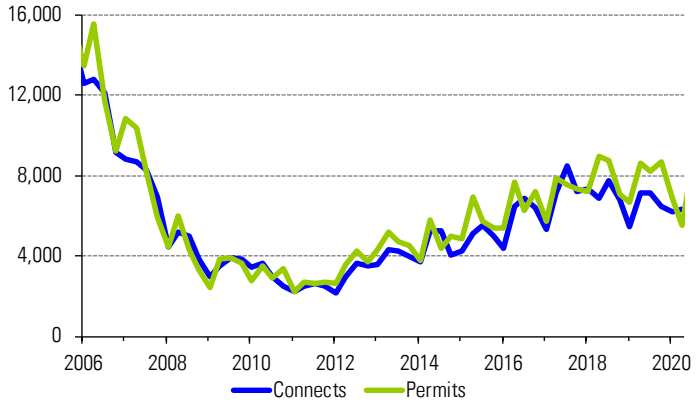
The growing trend of regulating natural gas and fossil fuels in new buildings has begun to impact the relationship between building permits and gas connects. There is a lag in this reduction as a large share of permits were issued prior to enactment of municipal regulations. Additionally, municipal restrictions often have waivers and exceptions, leading to an inconsistent impact on the relationship within each city or town. RCG examined individual regulations to determine the potential impact on connects as well as the size of these cities relative to the service area. Based on these findings, RCG implemented adjustment factors to offset the potential future gas connects that may be reduced due to regulation. Given the in-process implementation by some cities as well as an unknown number of cities that may enact electrification requirements during the forecast years, the adjustment factor is an additional source of potential model error.

In order to alleviate as many of the issues described as possible, RCG utilized out-of-sample testing techniques to guide model decisions. RCG avoided selecting model constructs that fit the estimation period but demonstrated unreliable out-of-sample predictability. Some RCG model decisions, such as the inclusion of multiple lag factors, were made to mitigate concerns of overfitting the estimation period or relying on spurious correlations. RCG selected models and modeling techniques that it believes will be most robust in terms of predictive power amidst the evolving relationship between connects and variables. RCG also elected to minimize incorporating assumptions or forecasts as much as possible given the required forecast horizon. As with any model, the ultimate performance will be dependent upon many factors including the reliability of data and persistence of historical relationships between IVs and utility connects.

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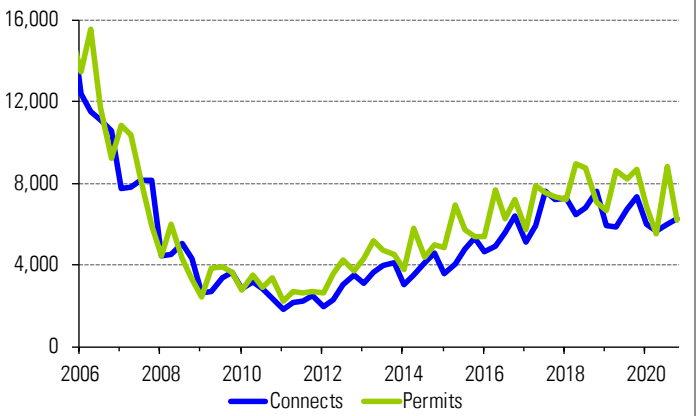
Appendix A

Single Family Electric Connects vs. Permits



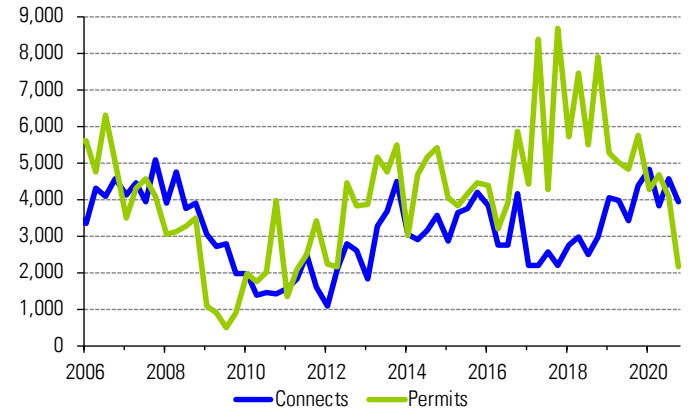
Sources: PG&E, CHF-CIRB, RCG

Single Family Gas Connects vs. Permits



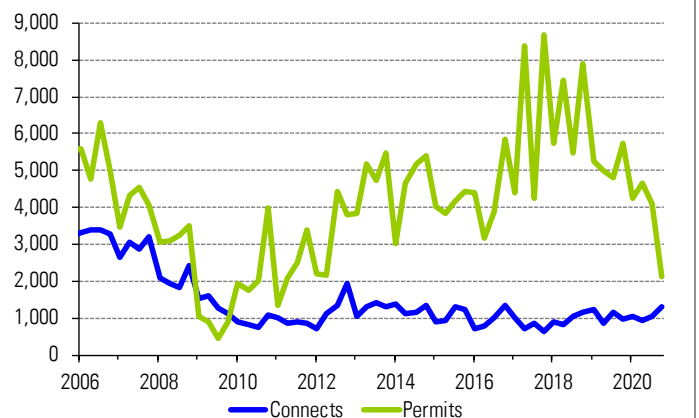
Sources: PG&E, CHF-CIRB, RCG

Multifamily Electric Connects vs. Permits



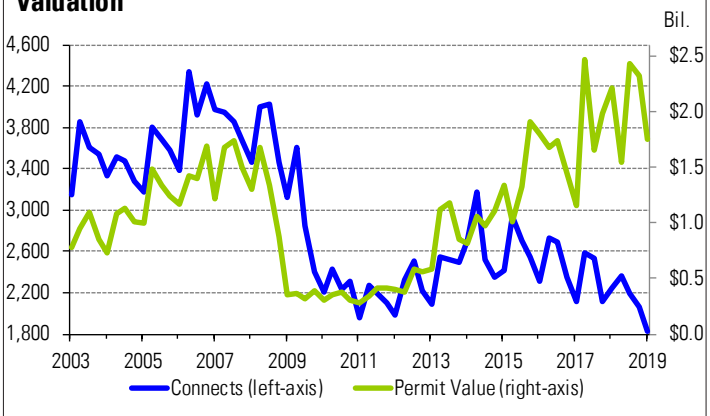
Sources: PG&E, CHF-CIRB, RCG

Multifamily Gas Connects vs. Permits



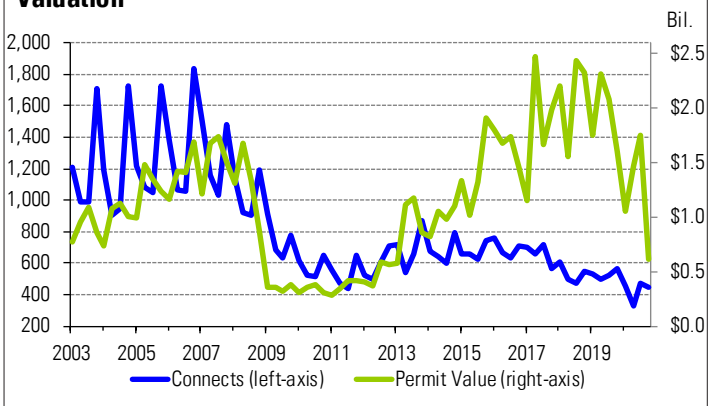
Sources: PG&E, CHF-CIRB, RCG

Nonresidential Electric Connects vs. Permit Valuation



Sources: PG&E, CHF-CIRB, RCG

Nonresidential Gas Connects vs. Permit Valuation



Sources: PG&E, CHF-CIRB, RCG

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	Total Payroll Employment, non-seasonally adjusted	Unemployment Insurance, Initial Claims	Residential Construction Permits (Units)	Nonresidential Construction Permits (Valuation)
Measure:	Total number of jobs recorded on payrolls	First-time claims for unemployment insurance; measures emerging unemployment	Number of housing units authorized for construction	Valuation of nonresidential buildings authorized for construction; excludes permits for alterations
Source:	California Employment Development Department http://www.labormarketinfo.edd.ca.gov/LMID/Employment_by_Industry_Data.html	California Employment Development Department http://www.edd.ca.gov/about_edd/Quick_Statistics_Information_by_County.htm	California Homebuilders Foundation-Construction Industry Research Board http://www.mychf.org/go/cirb/	California Homebuilders Foundation-Construction Industry Research Board http://www.mychf.org/go/cirb/
Source Frequency:	Monthly	Monthly	Monthly	Monthly
Source Granularity:	Metropolitan statistical area or metropolitan division	County	County	County
Transformations applied:	Raw quarterly series is average of three months; Four-quarter rate of change	Raw quarterly series is average of three months	Raw quarterly series is sum of three months	Raw quarterly series is sum of three months

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Workpaper Table 18-30
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of PEV-Related Expenditures - MWC 16

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026			
Line No.	Description	Recorded					Forecast						Assumptions	Notes	Reference
1	Expenditure/Forecast Net PEV Upgrade Cost ($ 000's)	$ 2,705	$ 1,631	$ 1,581	$ 12,970	$ 19,277	$ 5,173	$ 14,044	$ 21,044	$ 31,206	$ 47,321	$ 70,734	(1)	Forecast: Line 2 + Line 3	
2	RES Expenditure/Forecast PEV Upgrade Cost ($000's)	$ 2,664	$ 1,568	$ 1,444	$ 2,508	$ 1,023	$ 1,744	$ 8,940	$ 12,156	$ 15,837	$ 20,618	$ 25,228		Forecast: (Line 12 * Line 20)/1000	
3	NON-RES Expenditure/Forecast PEV Upgrade Cost ($000's)	$ 41	$ 63	$ 137	$ 10,462	$ 18,254	$ 3,429	$ 5,104	$ 8,888	$ 15,369	$ 26,703	$ 45,506		Forecast: (Line 13 * Line 21)/1000	
4	LDV PEVs in PG&E Service Territory	111,355	150,890	217,080	274,636	320,550	332,083	386,528	457,989	554,276	689,947	879,757	(2)		From: WP 18-9, Line 6
5	MDHD PEVs in PG&E Service Territory					485	732	1,090	1,697	2,719	4,448	7,317	(3)		
6	TOTAL PEVs in PG&E Service Territory	111,355	150,890	217,080	274,636	321,035	332,815	387,618	459,686	556,995	694,395	887,074		Line 4 + Line 5	
7	Total PEV Owners on EV Rate	31,757	40,799	52,417	60,528	67,384	126,468	155,782	186,345	212,581	238,439	259,395	(3)		
8	Proportion of PEV Owners on EV Rate	29%	27%	24%	22%	21%	38%	40%	41%	38%	34%	29%		Recorded: Line 6 / Line 7 Forecast: 2018-2020 Average	
9	Incremental LDV PEVs in PG&E Service Territory	29,966	39,535	66,190	57,556	45,914	11,533	54,445	71,461	96,287	135,671	189,810		Current Year Line 4 - Prior Year Line 4	
10	Incremental MDHDs in PG&E Service Territory					485	247	358	607	1,022	1,729	2,869		Current Year Line 5 - Prior Year Line 5	
11	Incremental PEVs assigned to EV Rate	8,555	10,690	15,983	12,685	9,637	4,382	21,881	28,968	36,749	46,586	55,504		Line 8 x Line 9	
12	RESIDENTIAL upgrade reinforcements initiated	101	118	142	77	35	58	290	384	487	617	736		Forecast: Line 11 x Line 17 (2020)	
13	NON-RESIDENTIAL upgrade reinforcements initiated	1	10	189	155	244	45	65	110	185	312	518		Forecast: Line 10 x Line 18 (2020)	
14	RES Upgrade Reinforcement Rate	0.3%	0.3%	0.2%	0.1%	0.1%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%		Line 9 x Line 12	
15	NON-RES Upgrade Reinforcement Rate					50.3%	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%		Line 10 x Line 13	
16	TOTAL Upgrade Reinforcement Rate - RES/NON-RES	1.2%	1.2%	2.1%	1.8%	2.9%								(Line 11 + Line 12 + Line 13) / Line 11	
17	2018 to 2020 RES Average Upgrade Rate					1.3%								Average: 2018-2019 Line 16, 2020 Line 14	
18	2018 to 2020 NON-RES Average Upgrade Rate					18.1%								Average: 2018-2019 Line 16, 2020 Line 15	
19	Escalation Rate						2.7%	2.7%	2.7%	2.7%	2.7%	2.7%			
20	RES Average Cost per Upgrade	$ 26,376	$ 13,288	$ 10,169	$ 32,571	$ 29,229	$ 30,018	$ 30,828	$ 31,661	$ 32,515	$ 33,393	$ 34,295		Recorded: Line 2 x $1000 / Line 12 2021-2026 Forecast: Prior Year Line 20 x (1+ escalation)	
21	NON-RES Average Cost per Upgrad	$ 41,000	$ 6,300	$ 725	$ 67,497	$ 74,811	$ 76,831	$ 78,906	$ 81,036	$ 83,224	$ 85,471	$ 87,779		Recorded: Line 3 x $1000 / Line 13 2021-2026 Forecast: Prior Year Line 20 x (1+ escalation)	
22	EVCN Phase 2 Ports								17,000	17,000	17,000	17,000	(3)		
23	EVCN Phase 2 Total Cost								$ 19,017	$ 19,067	$ 19,159	$ 19,282	(3)		
24	Total PEV Upgrade and EVCN Phase 2 Cost	$ 2,705	$ 1,631	$ 1,581	$ 12,970	$ 19,277	$ 5,173	$ 14,044	$ 40,061	$ 50,273	$ 66,480	$ 90,016		Line 1 x Line 23	

Assumptions and Details

(1) Total annual costs of projects with Plug-in Vehicle (PEV) related MAT codes or NB MAT with Project Notification linked to a PEV-related work type.

(2) PEV sales data supplied by PG&E's Clean Energy Transportation Department which is based on California Energy Commission's 2019 Integrated Energy Policy Report. After the MWC 16 forecast was finalized, PG&E concluded that it would be more appropriate to base its assumptions about PEV deployment on internal modelling and data which has been shared with the Commission. PG&E will file errata updating the assumptions and recalculating its forecast as necessary.

(3) Source: PG&E's Clean Energy Transportion Department. After the MWC 16 forecast was finalized, PG&E concluded that it would be more appropriate to base its assumptions about PEV deployment on internal modelling and data which has been shared with the Commission. PG&E will file errata

Workpaper Table 18-31
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of Transformer Purchase Expenditures
Recorded and Forecasted Program Expenditures

			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	
Line No.	Program	MWC	Recorded					Forecast						Assumptions
1	New Business - Electric (excluding transformers)	16	$ 256,695	$ 259,026	$ 325,547	$ 352,075	$ 423,146	$ 335,962	$ 444,277	$ 493,634	$ 556,687	$ 553,150	$ 558,290	
2	Emergency	17, BH	$ 232,219	$ 241,413	$ 246,940	$ 283,945	$ 314,817	$ 261,191	$ 268,773	$ 276,581	$ 283,495	$ 290,583	$ 297,847	(1)
3	Maintenance/Poles	07, 2A, 2B, 2C	$ 256,642	$ 281,523	$ 543,564	$ 764,229	$ 630,444	$ 808,804	$ 872,274	$ 939,620	$ 931,083	$ 951,924	$ 845,990	(1)
4	Major Emergency	95	$ 55,964	$ 278,618	$ 309,428	$ 286,780	$ 55,723	$ 314,967	$ 314,232	$ 337,159	$ 342,455	$ 328,643	$ 348,559	(1)
5	WRO	10, EW	$ 113,201	$ 102,452	$ 130,776	$ 127,663	$ 162,594	$ 116,715	$ 160,873	$ 158,557	$ 166,311	$ 168,468	$ 178,606	
6	Reliability & Hardening	08, 49, 56	$ 225,287	$ 158,471	$ 152,045	$ 448,244	$ 693,086	$ 1,050,996	$ 863,153	$ 976,936	$ 1,022,671	$ 1,021,928	$ 1,023,897	(1)
7	Capacity	6	$ 91,346	$ 55,959	$ 67,666	$ 73,444	$ 107,255	$ 185,040	$ 151,267	$ 160,008	$ 168,471	$ 177,257	$ 187,549	(1)
8	Rule 20A	30	$ 31,123	$ 28,255	$ 32,610	$ 45,758	$ 38,273	$ 54,412	$ 58,427	$ 61,757	$ 62,800	$ 61,754	$ 59,781	(1)
9	Substation Mgmt.	48, 54, 58, 59	$ 158,765	$ 205,430	$ 204,313	$ 210,499	$ 238,181	$ 230,888	$ 244,472	$ 249,352	$ 255,196	$ 259,974	$ 229,550	(1)
10	S-Orders	JM	$ 131,512	$ 139,681	$ 167,974	$ 228,213	$ 238,045							(1)
11	Other	25, 5, JJ, NULL	$ 9,236	$ 5,285	$ 37,542	$ 39,086	$ 36,597	$ 38,172	$ 39,250	$ 37,935	$ 38,758	$ 39,586	$ 40,417	(1)
	TOTAL		$ 1,561,990	$ 1,756,113	$ 2,218,405	$ 2,859,936	$ 2,938,162	$ 3,397,148	$ 3,416,999	$ 3,691,540	$ 3,827,928	$ 3,853,267	$ 3,770,488	

Assumptions and Details
(1) Forecast figures for non-NB/WRO programs were those available when the transformer forecast was developed and may not reflect final forecast submitted for PG&E 2023 GRC filing.

Workpaper Table 18-32
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of Transformer Purchase Expenditures
Recorded Transformer Issues (1) by Program and Type

Line No.	Program	Transformer Type	2016	2017	2018	2019	2020
1	New Business - Electric	OH	5,225	4,062	3,771	3,821	3,578
2		Current	101	98	221	599	266
3		Pad Mount	1,509	1,483	2,139	1,527	1,382
4		UG	218	214	216	305	196
5	New Business - Electric Total		7,053	5,857	6,347	6,252	5,422
6	Emergency	OH	4,234	104	136	92	275
7		Current	3	6	3		6
8		Pad Mount	583	278	283	209	211
9		UG	530	184	202	143	130
10	Emergency Total		5,350	572	624	444	622
11	Maintenance/Poles	OH	3,480	1,876	3,424	3,906	3,628
12		Current	6	5	4	-	3
13		Pad Mount	889	6	30	11,424	1
14		UG	265	-	1	-	1
15	Maintenance/Poles Total		4,640	1,887	3,459	15,330	3,633
16	Major Emergency	OH	1,189	186	105	444	757
17		Current	-		75	18	6
18		Pad Mount	52	15,992	100	108	328
19		UG	85	83	184	38	65
20	Major Emergency Total		1,326	16,261	464	608	1,156
21	WRO	OH	725	592	669	650	609
22		Current	77	69	37	53	21
23		Pad Mount	195	202	213	199	153
24		UG	39	43	67	57	50
25	WRO Total		1,036	906	986	959	833
26	Reliability & Hardening	OH	510	1,328	1,452	3,123	4,450
27		Current	57	9	12	12	3
28		Pad Mount	46	867	1,128	824	515
29		UG	102	238	281	407	241
30	Reliability & Hardening Total		715	2,442	2,873	4,366	5,209
31	Capacity	OH	626	183	404	230	343
32		Current	14	7	12	198	219
33		Pad Mount	17	14	7	6	5
34		UG	15	14	3	1	4
35	Capacity Total		672	218	426	435	571
36	Rule 20A	OH	16	1,187	29	35	8
37		Current	-	6	3	-	-
38		Pad Mount	21	27	42	76	32
39		UG	38	9	28	30	48
40	Rule 20A Total		75	1,229	102	141	88
41	Substation Mgmt.	OH	25	103	112	92	128
42		Current	2		1	1	-
43		Pad Mount	2	3	2	-	2
44		UG	-	-	-	-	-
45	Substation Mgmt. Total		29	106	115	93	130
46	S-Orders	OH	1,788	29	69	105	57
47		Current			144	12	-
48		Pad Mount	19	8	4	6	6
49		UG	18	4	1	8	3
50	S-Orders Total		1,825	41	218	131	66
51	Other	OH	436	747	95	3,638	47
52		Current	9,495	5,952	103	258	47
53		Pad Mount	20	3,586	58	52	57
54		UG	21	27	69	24	23
55	Other Total		9,972	10,312	325	3,972	174
56	Totals	OH	18,254	10,397	10,266	16,136	13,880
57		Current	9,755	6,152	615	1,151	571
58		Pad Mount	3,353	22,466	4,006	14,431	2,692
59		UG	1,331	816	1,052	1,013	761
60	Grand Total		32,693	39,831	15,939	32,731	17,904

Assumptions and Details

(1) Transformer "issues" refers to the number of units assigned and issued to projects in a program during a given year. It is not a direct indication of actual purchases of new transformer units. Transformers are considered revolving stock. Any given transformer unit issued on a project, may be a newly purchased unit, or may be a unit removed in the field and refurbished for reuse.

Workpaper Table 18-33
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of Transformer Purchase Expenditures
Recorded Transformer Usage Rate/Million Dollar Expenditure (1) by Program and Transformer Type

Line No.	Program	Transformer Type	2016	2017	2018	2019	2020	3-year Average
1	New Business - Electric	OH	20.4	15.7	11.6	10.9	8.5	10.3
2		Current	0.4	0.4	0.7	1.7	0.6	1.0
3		Pad Mount	5.9	5.7	6.6	4.3	3.3	4.7
4		UG	0.8	0.8	0.7	0.9	0.5	0.7
5	New Business - Electric Total		27.5	22.6	19.5	17.8	12.8	16.7
6	Emergency	OH	18.2	0.4	0.6	0.3	0.9	0.6
7		Current	0.0	0.0	0.0	0.0	0.0	0.0
8		Pad Mount	2.5	1.2	1.1	0.7	0.7	0.9
9		UG	2.3	0.8	0.8	0.5	0.4	0.6
10	Emergency Total		23.0	2.4	2.5	1.6	2.0	2.0
11	Maintenance/Poles	OH	13.6	6.7	6.3	5.1	5.8	5.7
12		Current	0.0	0.0	0.0	0.0	0.0	0.0
13		Pad Mount	3.5	0.0	0.1	14.9	0.0	5.0
14		UG	1.0	0.0	0.0	0.0	0.0	0.0
15	Maintenance/Poles Total		18.1	6.7	6.4	20.1	5.8	10.7
16	Major Emergency	OH	21.2	0.7	0.3	1.5	13.6	5.2
17		Current	0.0	0.0	0.2	0.1	0.1	0.1
18		Pad Mount	0.9	57.4	0.3	0.4	5.9	2.2
19		UG	1.5	0.3	0.6	0.1	1.2	0.6
20	Major Emergency Total		23.7	58.4	1.5	2.1	20.7	8.1
21	WRO	OH	6.4	5.8	5.1	5.1	3.7	4.7
22		Current	0.7	0.7	0.3	0.4	0.1	0.3
23		Pad Mount	1.7	2.0	1.6	1.6	0.9	1.4
24		UG	0.3	0.4	0.5	0.4	0.3	0.4
25	WRO Total		9.2	8.8	7.5	7.5	5.1	6.7
26	Reliability & Hardening	OH	2.3	8.4	9.5	7.0	6.4	7.6
27		Current	0.3	0.1	0.1	0.0	0.0	0.0
28		Pad Mount	0.2	5.5	7.4	1.8	0.7	3.3
29		UG	0.5	1.5	1.8	0.9	0.3	1.0
30	Reliability & Hardening Total		3.2	15.4	18.9	9.7	7.5	12.1
31	Capacity	OH	6.9	3.3	6.0	3.1	3.2	4.1
32		Current	0.2	0.1	0.2	2.7	2.0	1.6
33		Pad Mount	0.2	0.3	0.1	0.1	0.0	0.1
34		UG	0.2	0.3	0.0	0.0	0.0	0.0
35	Capacity Total		7.4	3.9	6.3	5.9	5.3	5.8
36	Rule 20A	OH	0.5	42.0	0.9	0.8	0.2	0.6
37		Current	0.0	0.2	0.1	0.0	0.0	0.0
38		Pad Mount	0.7	1.0	1.3	1.7	0.8	1.3
39		UG	1.2	0.3	0.9	0.7	1.3	0.9
40	Rule 20A Total		2.4	43.5	3.1	3.1	2.3	2.8
41	Substation Mgmt.	OH	0.2	0.5	0.5	0.4	0.5	0.5
42		Current	0.0	0.0	0.0	0.0	0.0	0.0
43		Pad Mount	0.0	0.0	0.0	0.0	0.0	0.0
44		UG	0.0	0.0	0.0	0.0	0.0	0.0
45	Substation Mgmt. Total		0.2	0.5	0.6	0.4	0.5	0.5
46	Other	OH	47.2	141.3	2.5	93.1	1.3	32.3
47		Current	1,028.0	1,126.2	2.7	6.6	1.3	3.5
48		Pad Mount	2.2	678.5	1.5	1.3	1.6	1.5
49		UG	2.3	5.1	1.8	0.6	0.6	1.0
50	Other Total		1,079.7	1,951.2	8.7	101.6	4.8	38.3

Assumptions and Details
(1) Usage Rate = Transformer issues by program and type [WP 18-32] (divided by Total Annual Program Expenditures [WP 18-31] divided by 1000).

Workpaper Table 18-34
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of Transformer Purchase Expenditures
Coefficient of Usage to Purchases by Transformer Type

Line No.	Description	Transformer Type	2016	2017	2018	2019	2020	5-year Average	Assumptions	Notes	Reference
1	Units Issued	OH	18,254	10,397	10,266	16,136	13,880	13,787	(1)		From: WP 18-44, Line 56
2		Current	9,755	6,152	615	1,151	571	3,649			From: WP 18-44, Line 57
3		Pad Mount	3,353	22,466	4,006	14,431	2,692	9,390			From: WP 18-44, Line 58
4		UG	1,331	816	1,052	1,013	761	995			From: WP 18-44, Line 59
5	Units Purchased	OH	16,129	18,194	20,445	22,772	23,165	20,141	(2)		
6		Current	7,328	8,553	10,162	9,674	7,730	8,689			
7		Pad Mount	2,767	3,133	4,077	2,758	3,043	3,156			
8		UG	1,129	1,247	1,449	1,442	1,177	1,289			
9	Coefficient of Usage:	OH	0.88	1.75	1.99	1.41	1.67	1.54	(3)	[Line 5 / Line 1]	
10	Units Purchased / Units Issued	Current	0.75	1.39	16.52	8.40	13.54	8.12		[Line 6 / Line 2]	
11		Pad Mount	0.83	0.14	1.02	0.19	1.13	0.66		[Line 7 / Line 3]	
12		UG	0.85	1.53	1.38	1.42	1.55	1.34		[Line 8 / Line 4]	

Assumptions and Details

(1) Transformer "issues" refers to the number of units assigned and issued to projects in a program during a given year. It is not a direct indication of actual purchases of new transformer units. Transformers are considered revolving stock. Any given transformer unit issued on a project may be a newly purchased unit or a unit removed in the field and refurbished for reuse.

(2) Actual transformers purchased each year by type. Since transformers are revolving stock they are not purchased for any particular program, or project, and can only be captured for the entire purchase program Source: Supply Chain Management.

(3) Comparison of transformer issues to actual purchases. The Coefficient of Usage allows for conversion of a individual program financial expenditure and transformer issues to a purchase amount.

Workpaper Table 18-35
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of Transformer Purchase Expenditures
Forecasted Transformer Purchases (1) by Program and Type

Line No.	Program	Transformer Type	2021	2022	2023	2024	2025	2026	Assumptions
1	New Business - Electric	OH	5,331	7,050	7,833	8,834	8,778	8,859	
2		Current	2,737	3,619	4,021	4,534	4,506	4,547	
3		Pad Mount	1,049	1,387	1,541	1,738	1,727	1,743	
4		UG	300	397	441	497	494	499	
5	New Business - Electric Total		9,417	12,453	13,836	15,604	15,504	15,649	
6	Emergency	OH	235	241	248	255	261	267	
7		Current	22	23	23	24	25	25	
8		Pad Mount	147	151	155	159	163	167	
9		UG	203	209	215	220	226	232	
10	Emergency Total		607	624	642	658	675	692	
11	Maintenance/Poles	OH	7,131	7,691	8,285	8,210	8,393	7,459	
12		Current	27	29	31	31	31	28	
13		Pad Mount	2,673	2,883	3,105	3,077	3,146	2,796	
14		UG	1	1	1	1	1	1	
15	Maintenance/Poles Total		9,832	10,604	11,423	11,319	11,572	10,284	
16	Major Emergency	OH	2,503	2,498	2,680	2,722	2,612	2,770	
17		Current	352	351	377	383	367	390	
18		Pad Mount	457	456	489	497	477	506	
19		UG	267	267	286	291	279	296	
20	Major Emergency Total		3,580	3,571	3,832	3,892	3,735	3,961	
21	WRO	OH	837	1,153	1,136	1,192	1,207	1,280	
22		Current	261	360	355	372	377	400	
23		Pad Mount	106	146	144	151	153	162	
24		UG	66	91	90	94	96	101	
25	WRO Total		1,270	1,751	1,726	1,810	1,834	1,944	
26	Reliability & Hardening	OH	6,192	5,085	5,755	6,025	6,020	6,032	(2)
27		Current	157	129	145	152	152	152	(2)
28		Pad Mount	1,157	951	1,076	1,126	1,125	1,128	(2)
29		UG	731	600	680	711	711	712	(2)
30	Reliability & Hardening Total		8,237	6,765	7,656	8,015	8,009	8,025	
31	Capacity	OH	1,169	956	1,011	1,064	1,120	1,185	
32		Current	2,462	2,013	2,129	2,242	2,359	2,496	
33		Pad Mount	9	8	8	9	9	10	
34		UG	8	6	7	7	8	8	
35	Capacity Total		3,649	2,983	3,155	3,322	3,495	3,698	
36	Rule 20A	OH	52	56	59	60	59	57	
37		Current	14	15	15	16	15	15	
38		Pad Mount	45	49	51	52	51	50	
39		UG	68	73	77	78	77	74	
40	Rule 20A Total		179	192	203	206	203	196	
41	Substation Mgmt.	OH	181	191	195	200	203	180	
42		Current	6	6	7	7	7	6	
43		Pad Mount	1	1	1	1	1	1	
44		UG	0	0	0	0	0	0	
45	Substation Mgmt. Total		188	199	203	207	211	186	
46	Other	OH	1,900	1,954	1,888	1,929	1,970	2,012	
47		Current	1,098	1,129	1,092	1,115	1,139	1,163	
48		Pad Mount	37	38	37	38	39	39	
49		UG	53	54	52	54	55	56	
50	Other Total		3,088	3,175	3,069	3,136	3,203	3,270	
51	Sub-Total by Type	OH	25,531	26,875	29,091	30,490	30,625	30,102	
52		Current	7,135	7,673	8,195	8,876	8,978	9,222	
53		Pad Mount	5,682	6,069	6,609	6,849	6,892	6,602	
54		UG	1,697	1,699	1,849	1,954	1,946	1,979	
55	Grand Total		40,045	42,316	45,745	48,169	48,441	47,905	

Assumptions and Details

(1) Transformer unit purchases by program are estimated using the forecasted expenditures by program (WP Table 18-31) x Usage Rate by Program (WP Table 18-33) x the Coefficient of Usage (WP Table 18-34).
(2) Due to the high cost of other System Hardening components, PG&E applied a factor that is 50% of the factor utilized for other portfolio overhead programs.

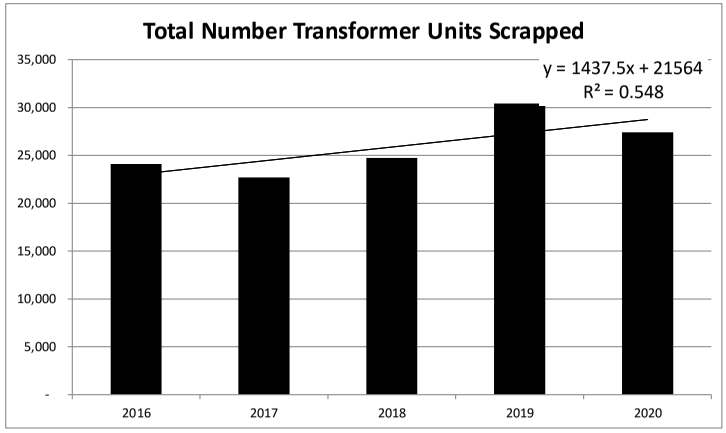
Workpaper Table 18-36
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of Transformer Purchase Expenditures
Derivation of Unit Cost and Total Expenditures by Transformer Type

		2016	2017	2018	2019	2020		2021	2022	2023	2024	2025	2026			
Line No.	Transformer Type	Recorded					3-year Average	Forecast						Assumptions	Notes	Reference
1	Expenditures															
2	OH	$ 40,521,479	$ 40,487,924	$ 37,103,559	$ 41,838,048	$ 42,552,725		$ 50,029,206.44	$ 53,522,220.45	$ 59,415,956.02	$ 62,749,642.47	$ 65,949,215.71	$ 66,573,843.19		Forecast: [Line 16 x Line 51 (WP 18-36)]	
3	Current	$ 1,102,559	$ 1,273,376	$ 924,324	$ 877,100	$ 956,055		$ 783,210.97	$ 848,598.68	$ 928,374.44	$ 998,340.31	$ 1,072,104.95	$ 1,130,955.95		Forecast: [Line 17 x Line 52 (WP 18-36)]	
4	Pad Mount	$ 38,847,676	$ 41,486,184	$ 45,485,063	$ 35,549,670	$ 34,736,862		$ 71,827,942.25	$ 78,065,615.68	$ 87,190,185.17	$ 91,262,639.09	$ 95,873,834.93	$ 94,317,354.52		Forecast: [Line 18 x Line 53 (WP 18-36)]	
5	UG	$ 11,391,010	$ 11,168,914	$ 11,933,800	$ 13,337,029	$ 16,452,328		$ 18,929,795.40	$ 19,288,468.15	$ 21,533,692.01	$ 22,986,623.14	$ 23,894,024.60	$ 24,958,401.11		Forecast: [Line 19 x Line 54 (WP 18-36)]	
6	Total Transformer Expenditures/Forecast ($000's)	$ 91,862,724	$ 94,416,398	$ 95,446,746	$ 91,601,847	$ 94,697,970		$ 141,570,155	$ 151,724,903	$ 169,068,208	$ 177,997,245	$ 186,789,180	$ 186,980,555		[Line 2 + Line 3 + Line 4 + Line 5]	
7	Adjustments			$ 9,394,872	$ 12,652,498	$ 12,583,101								(1)		
8	Total Transformer Expenditures/Forecast ($000's	$ 91,862,724	$ 94,416,398	$ 104,841,618	$ 104,254,345	$ 107,281,071		$ 141,570,155	$ 151,724,903	$ 169,068,208	$ 177,997,245	$ 186,789,180	$ 186,980,555		[Line 6 + Line 7]	To: WP 18-25, Line 4
9	Nominal Unit Cost														Total Spend/Coefficient of Usage	
10	OH	$ 2,512,337	$ 2,225,345	$ 1,814,799	$ 1,837,258	$ 1,836,940									[Line 2 * $1000 / Line 5 (WP 18-34)]	
11	Current	$ 150,458	$ 148,881	$ 90,959	$ 90,666	$ 123,681									[Line 3 * $1000 / Line 6 (WP 18-34)]	
12	Pad Mount	$ 14,039,637	$ 13,241,680	$ 11,156,503	$ 12,889,656	$ 11,415,334									[Line 4 * $1000 / Line 7 (WP 18-34)]	
13	UG	$ 10,089,469	$ 8,956,627	$ 8,235,887	$ 9,248,980	$ 13,978,189									[Line 5 * $1000 / Line 8 (WP 18-34)]	
14	Escalation Rate		3.0%	3.0%	3.0%	3.0%		2.7%	2.7%	2.7%	2.7%	2.7%	2.7%			
15	2020 Levelized and Escalated Unit Costs															
16	OH	$ 2,827,657	$ 2,431,694	$ 1,925,320	$ 1,892,376	$ 1,836,940	$ 1,884,879	$ 1,935,771	$ 1,988,036	$ 2,041,713	$ 2,096,840	$ 2,153,454	$ 2,211,598		2021:3-Year Average * Escalation Rate	
17	Current	$ 169,342	$ 162,686	$ 96,498	$ 93,386	$ 123,681	$ 104,522	$ 107,344	$ 110,242	$ 113,219	$ 116,275	$ 119,415	$ 122,639		2022-2026: Prior Year * Escalation Rate	
18	Pad Mount	$ 15,801,735	$ 14,469,541	$ 11,835,934	$ 13,276,345	$ 11,415,334	$ 12,175,871	$ 12,504,620	$ 12,842,244	$ 13,188,985	$ 13,545,088	$ 13,910,805	$ 14,286,397			
19	UG	$ 11,355,786	$ 9,787,149	$ 8,737,452	$ 9,526,449	$ 13,978,189	$ 10,747,363	$ 11,037,542	$ 11,335,556	$ 11,641,616	$ 11,955,939	$ 12,278,750	$ 12,610,276			

Assumptions and Details
(1) 2018-2020 Supply Chain Management reports material charged at point of goods receipt plus 13% Material Burden; the adjustment reflects Capital overheads/burdens to align with the Program's Financial Statement reporting.

Workpaper Table 18-37
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Derivation of Transformer Scrapping Expenditures - MWC 16

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026			
Line No.	Description	Recorded					Forecast						Assumptions	Notes	Reference
1	Total Number Transformer Units Scrapped	24,105	22,692	24,733	30,429	27,424	28,752	28,204	27,588	27,104	26,781	26,588	(1)		
2	Transformer Scrapping Expenditures /Forecast($ 000's)	$ 4,049	$ 3,901	$ 3,701	$ 5,038	$ 4,868	$ 4,988	$ 5,025	$ 5,048	$ 5,094	$ 5,169	$ 5,270		Forecast: Line 1 * Line 5	To: WP 18-25, Line 5
3	Transformer Scrapping Unit Cost	$ 168	$ 172	$ 150	$ 166	$ 178								Recorded: (Line 2 x $1000)/Line 1	
4	Unit Cost Levelized to 2020 Base	$ 189	$ 188	$ 159	$ 171	$ 178								2016-2019: Line 3 * Escalation 2020: Actual	
5	Three-Year Average Unit Cost					$ 169	$ 173	$ 178	$ 183	$ 188	$ 193	$ 198		3-year average unit cost * Escalation	



Assumptions and Details
(1) Forecasted scrapping units are estimated by taking the linear correlation of units over time Units (y) = (1437.5 * Year(x)) + 21564. "x" = 1 - 10 for the years 2016 - 2026 respectively.

Workpaper Table 18-38
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 18, Electric New Business and Work at the Request of Others
Major Work Category 10 - Recorded Walk
MWC 10 - Electric WRO
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**99,694**			
2		NB Related WRO	6,859		Growth driven by fewer credits (lower percent reimbursements)	WP 18-54, Line 1
3		Government-Related WRO	(11,103)		Decrease driven by customer demand within Government-related work	WP 18-54, Line 2
4		Major Projects	(4,917)		Decrease in work due to completion of Comanche Pkwy South Wallace	WP 18-54, Line 3
5		State Infrastructure Projects	4,991		Increase in work due to work related to CalTrain	WP 18-54, Line 4
6		Other	1,774		Minor variations from previous year (1)	WP 18-54, Line 5
7	**2017**	**Recorded Adjusted**	**97,298**			
8		NB Related WRO	24,689		Growth driven by fewer credits (lower percent reimbursements)	WP 18-54, Line 1
9		Government-Related WRO	884		Decrease driven by increased credits	WP 18-54, Line 2
10		Major Projects	(744)		Decrease driven by Transbay and Central Subway	WP 18-54, Line 3
11		State Infrastructure Projects	(2,715)		Timing of work	WP 18-54, Line 4
12		Other	1,635		Minor variations from previous year (1)	WP 18-54, Line 5
13	**2018**	**Recorded Adjusted**	**121,047**			
14		NB Related WRO	(1,567)		Decreased driven by customer demand within NB-related work	WP 18-54, Line 1
15		Government-Related WRO	(3,434)		Decrease driven by customer demand within Government-related work	WP 18-54, Line 2
16		Major Projects	(262)		Minor variations from previous year	WP 18-54, Line 3
17		State Infrastructure Projects	6,458		Increase related to work on the CalTrain project	WP 18-54, Line 4
18		Other	(1,378)		Minor variations from previous year (1)	WP 18-54, Line 5
19	**2019**	**Recorded Adjusted**	**120,864**			
20		NB Related WRO	21,525		Increase driven by customer demand in NB-related work	WP 18-54, Line 1
21		Government-Related WRO	16,192		Increase driven by customer demand in Government-related work	WP 18-54, Line 2
22		Major Projects	164		Minor variations from previous year	WP 18-54, Line 3
23		State Infrastructure Projects	(11,679)		CalTrain work completed in prior year	WP 18-54, Line 4
24		Other	(1,436)		Minor variations from previous year (1)	WP 18-54, Line 5
25	**2020**	**Recorded Adjusted**	**145,630**			

(1) Other: Costs related to Standard Cost Variance, PM order moves between Planning orders or out of MWC, costs not classified as one of the four groupings, and/or timing issue between RCG forecast and finalization of control file.

Workpaper Table 18-39
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 18, Electric New Business and Work at the Request of Others
Major Work Category 10 - Forecast Walk
MWC 10 - Electric WRO
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**145,630**			
2		NB-Related WRO	(32,046)		Decrease in customer driven volume based on RCG model	WP 18-54, Line 1
3		Government-Related WRO	(10,749)		Decrease in government driven volume based on RCG model	WP 18-54, Line 2
4		Major Projects	(297)		Minor variations from previous year	WP 18-54, Line 3
5		State Infrastructure Projects	3,285		Increase driven by High Speed Rail projects	WP 18-54, Line 4
6		Other	138		Minor variations from previous year	WP 18-54, Line 5
7		2021 Budget Adjustment	49,730		The 2021 forecast has been adjusted to 2021 budget amounts due to the differeance between the currect GRC forecast model inputs and those model inputs available when the budget was originally determined	WP 18-54, Line 6
8	**2021**	**Forecast**	**155,690**			
9		NB-Related WRO	2,334		Increase in customer driven volume based on RCG model	WP 18-54, Line 1
10		Government-Related WRO	15,814		Increase in government driven volume based on RCG model	WP 18-54, Line 2
11		State Infrastructure Projects	13,642		Driven based on timing of the Google project	WP 18-54, Line 4
12		2021 Budget Adjustment	(49,730)		The 2021 forecast has been adjusted to 2021 budget amounts due to the differeance between the currect GRC forecast model inputs and those model inputs available when the budget was originally determined	WP 18-54, Line 6
13		Forecasting & Escalation Adjustments	7,298		Escalation	WP 18-54, Line 7
14	**2022**	**Forecast**	**145,048**			
15		NB-Related WRO	5,439		Increase in customer driven volume based on RCG model	WP 18-54, Line 1
16		Government-Related WRO	(10,004)		Decrease in government driven volume based on RCG model	WP 18-54, Line 2
17		State Infrastructure Projects	(10,329)		Driven based on timing of the Google project	WP 18-54, Line 4
18		Forecasting & Escalation Adjustments	2,616		Escalation	WP 18-54, Line 7
19	**2023**	**Forecast**	**132,769**			
20		NB-Related WRO	6,530		Increase in customer driven volume based on RCG model	WP 18-54, Line 1
21		Government-Related WRO	(2,658)		Decrease in government driven volume based on RCG model	WP 18-54, Line 2
22		State Infrastructure Projects	(656)		Driven based on timing of the Google project	WP 18-54, Line 4
23		Forecasting & Escalation Adjustments	3,857		Escalation	WP 18-54, Line 7
24	**2024**	**Forecast**	**139,842**			
25		NB-Related WRO	6,931		Increase in customer driven volume based on RCG model	WP 18-54, Line 1
26		Government-Related WRO	4,784		Increase in government driven volume based on RCG model	WP 18-54, Line 2
27		State Infrastructure Projects	(5,305)		No costs forecasted in 2025 or beyond	WP 18-54, Line 4
28		Forecasting & Escalation Adjustments	4,576		Escalation	WP 18-54, Line 7
29	**2025**	**Forecast**	**150,827**			
30		NB-Related WRO	18,004		Increase in customer driven volume based on RCG model	WP 18-54, Line 1
31		Government-Related WRO	420		Increase in government driven volume based on RCG model	WP 18-54, Line 2
32		Forecasting & Escalation Adjustments	7,089		Escalation	WP 18-54, Line 4
						WP 18-54, Line 7
33	**2026**	**Forecast**	**176,341**			

Workpaper Table 18-40
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
MWC 10 - Summary and Overview of Forecasting Methodology

Line No.

1 **Step 1** **Developer and Government Related WRO Expenditures**

Step 1A **RCG Data - Gross Dollar Forecast**

Description: PG&E utilizes Rosen Consulting Group's (RCG) proprietary econometric model for the forecasting WRO spend. The model was developed through in-depth study of the statistical relationship between PG&E's historical spend and leading economic indicators. PG&E uses this gross dollar forecast as a basis in its forecast for New Business and Government related WRO expenditures

Step 1B **Credits / Reimbursements**

Description: PG&E utilizes a historical 3-year average of credits and reimbursements from Developers and Government agencies related costs to calculate the percent and respective dollars associated with NB and Government related WRO work.

Step 1C **Net Spend**

Description: PG&E calculates the net spend by subtracting the credits derived in Step 1B from the Gross spend in Step 1A. The result is the total PG&E forecast spend for NB and Governmental related WRO work forecasted.

Related Workpaper: Workpaper Table 18-44: MWC 10 – WRO Forecast Model - Rosen Consulting Group

2 **Step 2** **Major Project Expenditures**

Step 2A **Determine Expenditures for Major Projects**

Description: PG&E utilizes information from its Project Management organization for known major projects. This project information is captured in a project summary document.

Related Workpaper: Workpaper Table 18-45: MWC 10 – Summary of Major Project Expenditures
Project Summary and Cost/Benefit Analysis - Central Subway – San Francisco

3 **Step 3** **State Infrastructure**

Step 3A **Description**: PG&E utilizes information from its Electric Distribution Project Management organization for known State Infrastructure projects. This project information is captured in a project summary document.

Related Workpaper: Workpaper Table 18-46: MWC 10 - Summary of Major Project Expenditures
Project Summary and Cost/Benefit Analysis - Diridon Area Redevelopment
Project Summary and Cost/Benefit Analysis - Caltrain Electrification
Project Summary and Cost/Benefit Analysis - California High-Speed Rail
Project Summary and Cost/Benefit Analysis - VTA - BART to Silicon Valley Phase II

Workpaper Table 18-41
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Summary of WRO MAT Code Types
Units of Measures / Split of Capital WRO into New Business (NB) and Government Related Categories

Line No.	MWC	MAT	Forecast Category	Description	Unit of Measure	Reimbursement Type			Assumptions
1						Full	Partial	Non	
2	10	10H	NB Related	WRO-Rule 20B	Total circuit ft. installed	n/a	NB	n/a	(1)
3	10	10I	NB Related	WRO-Rule 20C	Total circuit ft. installed	n/a	NB	n/a	(1)
4	10	10J	NB & Gov Related	WRO-Overhead Relocation - E	Total circuit ft. installed	NB	Gov	Gov	(1) (2)
5	10	10K	NB & Gov Related	WRO-Underground Relocation - E	Total circuit ft. installed	NB	Gov	Gov	(1) (2)
6	10	10L	NB & Gov Related	WRO-Pole Only Relocation - E	# of Poles relocated	NB	Gov	Gov	(1) (2)
7	10	10M	NB & Gov Related	WRO-Cust Req. Removal of Facilities-E	Circuit Feet Removed	NB	Gov	Gov	(1) (2)
8	10	10N	NB & Gov Related	WRO-Cogeneration - E	# of Projects	NB	Gov	Gov	(1) (2)
9	10	10O	NB & Gov Related	WRO E OH CAP Cap Proj>$100K	Total circuit ft. installed	NB	Gov	Gov	(1) (2)
10	10	10P	NB & Gov Related	WRO E UG CAP Cap Proj>$100K	Total circuit ft. installed	NB	Gov	Gov	(1) (2)
11	10	10Q	NB & Gov Related	3rd Party WRO Pd. On Actuals	Total circuit ft. installed	NB	Gov	Gov	(1) (2)
12	EW	EW0	Relocation	WRO - Division WRO Inquiries	# of Inquiries				
13	EW	EW1	Relocation	WRO Relocate E OH Service - E	# of Projects				
14	EW	EW2	Relocation	WRO Reloccate E UG Service - E	# of Projects				
15	EW	EW3	Relocation	WRO Rule 13 E Temp Svc < 1 Year - E	# of Projects				
16	EW	EW4	Relocation	WRO Raise Frames & Covers - E	# of Locations				
17	EW	EWP	Relocation	WRO Land Services Inquiries	# of Inquiries				
18	EW	EWS	Relocation	WRO Elec Sup & Work Around SF - E	# of Locations				
19	EW	EWT	Relocation	3rd Party WRO Pd. On Actuals	Footage Relocated				

Assumptions and Details
(1) NB - WRO work primarily driven or associated with new business development.
(2) Gov - WRO work primarily driven or associated with governmental requests.

Workpaper Table 18-42
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Summary of Forecasted Capital Expenditures by Category - MWC 10
(Thousands of Dollars)

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026		
Line No.	Description	Recorded					Forecast						Assumptions	Notes
1	NB-Related WRO	$ 25,125	$ 31,984	$ 56,673	$ 55,107	$ 76,632	$ 44,586	$ 46,919	$ 52,359	$ 58,889	$ 65,819	$ 83,823		
2	Government-Related WRO	$ 66,938	$ 55,835	$ 56,718	$ 53,284	$ 69,476	$ 58,727	$ 74,540	$ 64,536	$ 61,878	$ 66,662	$ 67,082		
3	Major Projects	$ 6,056	$ 1,139	$ 395	$ 134	$ 297	$ -	$ -	$ -	$ -	$ -	$ -		
4	State Infrastructure Projects	$ 2,309	$ 7,300	$ 4,585	$ 11,043	$ (637)	$ 2,648	$ 16,290	$ 5,961	$ 5,305	$ -	$ -		
5	Other	$ (734)	$ 1,040	$ 2,675	$ 1,298	$ (138)							(1)	
6	2021 Budget Adjustment						$ 49,730						(2)	
7	Forecasting & Escalation Adjustments							$ 7,298	$ 9,913	$ 13,770	$ 18,346	$ 25,435	(3)	
8	Total - GRC Forecast	$ 99,694	$ 97,298	$ 121,047	$ 120,864	$ 145,630	$ 155,690	$ 145,048	$ 132,769	$ 139,842	$ 150,827	$ 176,341		[Line 1 + Line 2 + Line 3 + Line 4]

Assumptions and Details
(1) Other reflects the reduction of CEMA Costs and additional rounding
(2) The 2021 forecast has been adjusted to 2021 budget amounts due to the differance between the currect GRC forecast model inputs and those model inputs available when the budget was originally determined.
(3) Adjustments to current forecast model inputs driven by authorized targets and Escalation model input differences.

Workpaper Table 18-43
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18 New Business and Work at the Request of Others
Derivation of NB-Related and Government-Related Expenditures - MWC10
(THOUSANDS OF NOMINAL DOLLARS)

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026			
Line No.	Description	Recorded					Forecast						Assumptions	Notes	Reference
1	New Business-Related WRO Gross Expenditures	$ 73,804	$ 76,071	$ 95,150	$ 93,018	$ 122,676	$ 73,788	$ 77,650	$ 86,651	$ 97,459	$ 108,929	$ 138,725			WP 18-63 Figure 11
2	Credits / Reimbursements	$ (48,680)	$ (44,087)	$ (38,477)	$ (37,912)	$ (46,044)	$ (29,203)	$ (30,731)	$ (34,293)	$ (38,571)	$ (43,110)	$ (54,902)		Forecast : [Line 1 X Line 3]	
3	% Credits / Reimbursements	-66%	-58%	-40%	-41%	-38%	-40%	-40%	-40%	-40%	-40%	-40%		(2018-2020) 3 year average	
4	New Business-Related WRO Net Expenditures	$ 25,125	$ 31,984	$ 56,673	$ 55,107	$ 76,632	$ 44,586	$ 46,919	$ 52,358	$ 58,889	$ 65,819	$ 83,823		Forecast: [Line 1 + Line 2 + Escalation and overheads]	
5	Government-Related WRO Gross Expenditures	$ 78,338	$ 67,457	$ 74,820	$ 68,413	$ 86,939	$ 75,418	$ 95,727	$ 82,879	$ 79,465	$ 85,609	$ 86,149			WP 18-63 Figure 11
6	Credits	$ (11,400)	$ (11,622)	$ (18,102)	$ (15,129)	$ (17,464)	$ (16,692)	$ (21,186)	$ (18,343)	$ (17,587)	$ (18,947)	$ (19,067)		Forecast : [Line 5 X Line 7]	
7	Credit %	-15%	-17%	-24%	-22%	-20%	-22%	-22%	-22%	-22%	-22%	-22%		(2018-2020) 3 year average	
8	Government-Related WRO Net Expenditures	$ 66,938	$ 55,835	$ 56,718	$ 53,284	$ 69,476	$ 58,727	$ 74,540	$ 64,536	$ 61,878	$ 66,662	$ 67,082		Forecast: [Line 5 + Line 6 + Escalation and overheads]	

R C G

Work at the Request of Others (WRO) Forecasting Model Methodology

February 2021

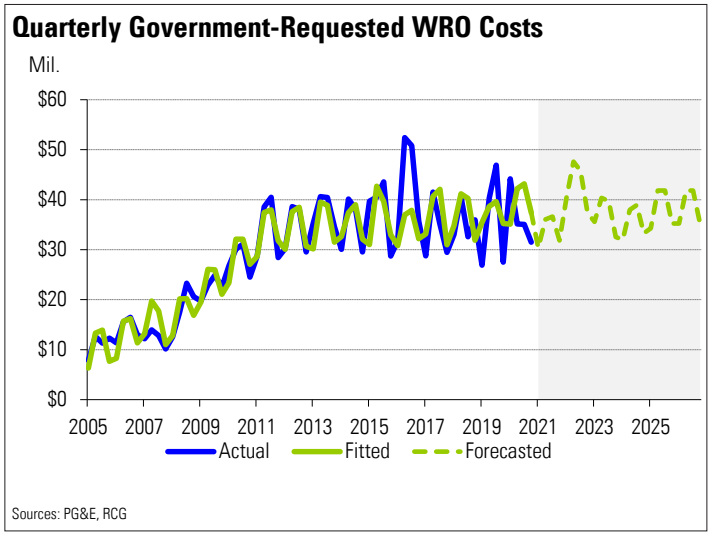
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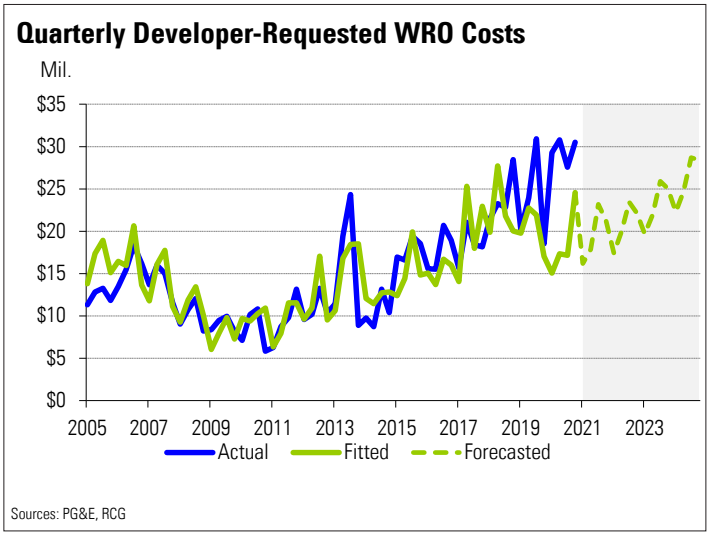
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Summary

- Rosen Consulting Group (RCG) constructed a set of WRO cost forecasting models utilizing external indicators based on public and private sector demand drivers for WRO requests. The models are updated and recalibrated regularly to incorporate current data and Pacific Gas & Electric (PG&E) WRO cost data.
- PG&E Service Area WRO costs are modeled at a quarterly frequency for public (government) and private (developer) requestor types. Forecasts are also apportioned between gas and electric and four PG&E-defined Areas.
- Developer-requested WRO costs are modelled utilizing residential permitting and a producer price index. Government-requested WRO costs are modelled using primarily federal transportation grants.
- The COVID-19 pandemic brought additional uncertainty and volatility to WRO costs and indicator variables in the past year. Some projects that would generate WRO costs to PG&E were likely delayed or cancelled due to the pandemic, while others were pulled forward from future years as requesting parties leveraged the lower levels of activity to complete projects in a more efficient manner. The potential for strained municipal finances as well as lower tax receipts, including gasoline taxes, heighten the risk of longer term impacts on government-requested WRO.
- Following an unexpectedly strong 2020, total WRO costs are projected to decrease in 2021 to $213 million. Total WRO is forecasted to rebound temporarily in 2022 before decreasing once more in 2023. Total WRO costs should increase through the next several years, reaching a total forecasted level of $1.5 billion from 2021 through 2026.





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Work at the Request of Others (WRO) Forecasting Model

I. Introduction

Rosen Consulting Group (RCG) constructed predictive time series models to forecast work at the request of others (WRO) cost data utilizing historical relationships between gross WRO costs and independent indicators, along with RCG forecasts of relevant IVs. The forecast models produce projections for public (government) and private (developer) WRO costs. Within each category, projections are further segmented by type - electric and gas. The models produce forecasts at a monthly frequency in the near term and quarterly through 2026 and apportioned to the PG&E Areas.

II. Input Data

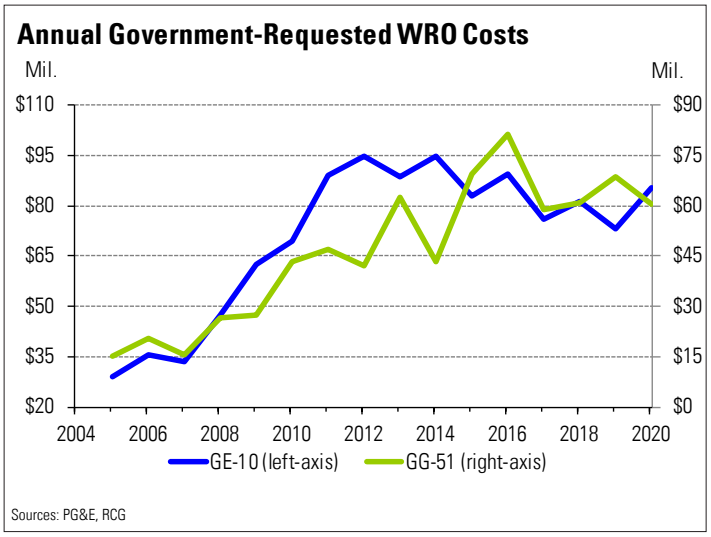
PG&E WRO Costs

PG&E provided monthly gross WRO costs through year-end 2020. The WRO data are categorized by type of request, budget level, major work category, reimbursement type and geographic area. WRO costs were also assigned by PG&E to four Areas, which were determined to be contiguous geographic areas that, in sum, equaled the PG&E service coverage area.

The WRO data available to RCG spanned from 2005 to 2020. For the WRO model, RCG excluded projects of a unique nature or budgeting process. These projects were indicated by PG&E or flagged with unique codes that would indicate their unique nature. Such projects can drive large cost outlays, and therefore significant volatility in the historical data series. The timeline of these unique projects are generally not influenced by external or economic factors, and this lack of corresponding trends means that tracking such projects individually is the recommended approach.

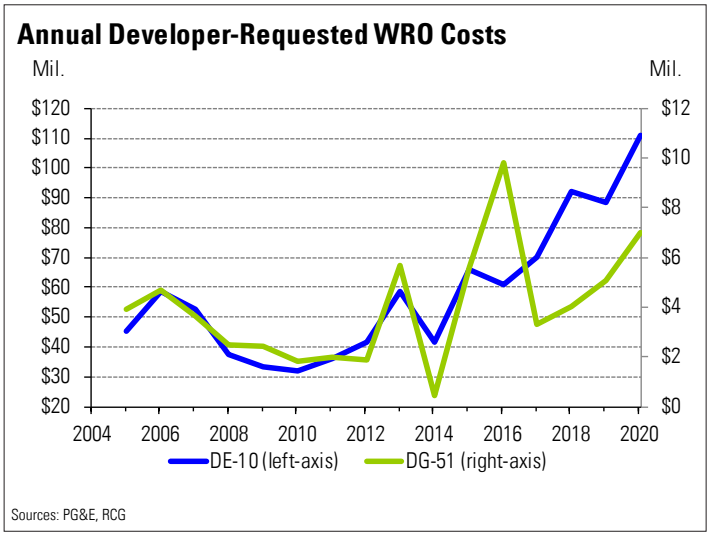
The remaining WRO data were aggregated by requesting party category and by type. As per PG&E, any party can request PG&E perform work to relocate existing equipment or extend utilities to service new sites or development projects. The requesting parties can be categorized generally as government-requested, including state and local government or public agencies, and developer-requested, including private developers or individuals. Developer-requested WRO are typically reimbursed by the requesting parties while government-requested WRO is typically only partially reimbursed or entirely non-reimbursed.

Variations in reimbursement levels within categories prevent RCG from utilizing net costs in the analysis. Because of the reimbursement procedures, the data examined, and therefore the data modeled, are gross WRO costs. In addition, IVs may correlate to gross costs but would generally have little to zero predictive power for net costs that are dependent upon a variable shared cost structure.



Revisions to the recorded WRO data posed a challenge in the model examination as well. WRO costs can be assigned an initial budget code by PG&E that is revised in subsequent months. When these costs are reclassified, the amount is credited and debited from the original category to the new category. Some costs can be removed entirely as well, potentially leading to negative values for some categories. These offsetting accounting entries can span differing time periods, leading to excess volatility in gross WRO costs.

From 2005 to 2020, PG&E completed nearly $1.9 billion of government-requested WRO and $990 million of developer-requested WRO. Developer-requested WRO surged in 2019 and reached a recorded high of $118 million in 2020. This increase led to developer-requested WRO accounting for 45% of total WRO costs, the highest share since 2008. Last year, government-requested WRO was flat compared with the previous year, totaling $146 million.



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The COVID-19 pandemic and ensuing business restrictions increased volatility within the last year. In typical recessions, one may expect some uptick in government-requested WRO as a form of stimulus while developer-requested activity would fall in line with economic conditions. However, in 2020 developer-requested WRO increased by 26% as private entities proceeded with large-scale projects in spite of the pandemic. At the same time, public sector entities also took advantage of fewer cars and people on the roads to complete projects planned prior to the pandemic.

III. Methodology

This section describes the methodology for creating the forecasting models for WRO.

Model Development

RCG used multivariate linear regression to construct the quarterly WRO cost models. This technique yields an equation whereby the amount of WRO costs in a particular quarter are predicted by the value of one or more indicator variables (IVs), each multiplied by a coefficient. The initial step involved examining economic, demographic, financial, fiscal and real estate market data. RCG collected and analyzed data from a variety of sources, including public agencies and private data sources. The data gathered included monthly, quarterly and annual frequencies, and examined for optimum frequencies. Transformations were applied as well to test predictive power, including seasonal adjustments and level differences or the rate of change. Potential IVs were tested separately against developer-requested and government requested WRO in order to determine the data series with the best predictive power. RCG examined 182 data series with lags of up to 12 quarters, yielding more than 15,000 univariate regressions.

RCG classified each IV into one of four categories: business cycle, real estate cycle, government spending, and input cost trends. Variables within each category measure similar trends and can be highly correlated. In order to efficiently identify the strongest candidate IVs within each category, and mitigate estimation bias due to collinearity, RCG conducted initial multivariate model testing with no more than one variable per category per model. RCG estimated models with all corresponding permutations of IVs during this phase of testing, or more than 40,000 multivariate models.

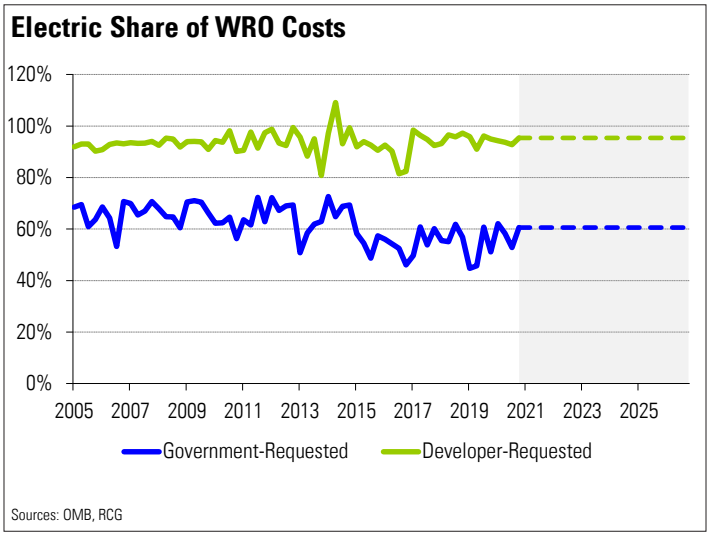
The coefficients are estimated to produce the tightest fit between predicted and actual WRO costs within the estimation range. RCG modeled quarterly costs at the level of requesting party, and shared down forecasts to gas and electric-related costs and the four PG&E-defined Areas. The models were estimated on data from 2005 to 2020.

RCG ultimately selected final models with the strongest in-sample fit and theoretical plausibility. From the wide range of variables collected and tested, those selected for inclusion in the final forecasting models demonstrated a strong, statistically significant relationships with WRO costs, government- or developer-requested. Moreover, the variables plausibly drive demand for corresponding WRO costs, and the measured direction of the relationship meets logical expectations.

Developer- and government-requested WRO costs demonstrate very different trends and demand drivers, and are therefore best modeled separately. Previously described concerns with the gross cost data precluded direct forecasting of more detailed budget codes, however. Internal PG&E accounting practices and the method by which costs are assigned and reassigned to budget categories contributed to increased variance in month-to-month and year-to-year WRO costs at more granular budget-code levels, and even resulted in some negative cost outlays. RCG chose to model gross costs by requesting party in order to mitigate these concerns as much as possible. RCG explored constructing separate gas and electric models within the developer-driven and government-driven cost categories, but determined that overall projections were less reliable. Testing confirmed no statistically significant improvement in fit from modeling gas and electric separately within requesting parties.

Given the relatively high degree of persistence in the shares by type, RCG projected electric shares to continue at a level similar to the past few years. Note there is increased volatility in recent years within the series, but much of this is attributed to the previously described revisions and allocation methods utilized by PG&E. For example, in 2014 the electric share of WRO costs reached 110%, a result of an above average reallocation within the developer-requested gas projects.

RCG modeled WRO costs at a quarterly frequency in order to smooth out month-to-month noise and increase the precision of model estimates. Some candidate IVs were not available at monthly frequencies and focusing on quarterly and annual data frequencies allowed RCG to examine a broader range of potential IVs. Quarterly



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WRO costs were calculated as the sum of the three relevant months. Monthly IV series were aggregated as appropriate while annual IV series were interpolated to quarterly frequencies to facilitate standardized IV testing.

Area-level forecasts for WRO costs were generated using a share-down method, whereby the total amount of developer-requested and government-requested WRO costs in a given quarter were apportioned to each Area using forecasted shares. These allocations were determined based on historical ranges and RCG expectations for area-level differences in economic conditions and construction activity going forward. Some historical periods with large negative costs in particular Areas were removed or smoothed over for purposes of projecting shares.

RCG investigated the feasibility of using a "bottom-up" approach to generate area-level forecasts, whereby WRO cost forecasts for each category are generated separately for the four Areas, but determined that the approach was unlikely to produce reliable results. In addition to previously noted excess volatility in the data arising from internal recording practices, which is exacerbated at the Area-level, the PG&E Area boundaries are not consistent with geographic boundaries of metropolitan area economic indicators, so it is impossible to precisely map the IVs to PG&E sub-geographies.

RCG used the cubic spline method to interpolate monthly forecasts from the quarterly WRO cost forecasts. A cubic spline interpolates values to create a smooth continuous path between known data points. It should be noted that the interpolated values are fitted approximations, rather than direct outputs of the quarterly WRO models.

RCG constructed an autoregressive time-series model of forecast errors for each request type such that recent forecast errors may be used to provide updated forecasts in real time, reflecting recent trends in activity. The autoregressive model uses the forecast errors from the previous six quarters to forecast the quarter-ahead forecast error. This has little impact on longer range forecasts and is intended to decrease the likelihood that the model produces near-term forecast errors.

Developer-requested WRO includes all work requested by private parties, and are often driven by the real estate development cycle. The best fit to capture the real estate cycle was multifamily permits. RCG also tested other construction indicators, such as single family permits or non-residential permit valuations, and none added additional statistically significant explanatory power to the model. In recent years, multifamily permitting surged throughout the service region. The vast majority of multifamily units were rental apartments and, particularly in urban environments, the size of projects increased.

As WRO costs are recorded as nominal costs and multifamily permits are measured in units, an inflation adjustment provided stronger model results. RCG tested a number of price indices at various lags, and annual changes in the produce price index (PPI) with a substantial lag provided the greatest explanatory power. Additionally, developer-requested WRO displayed a seasonal pattern independent of other explanatory factors.

RCG WRO Model Details

Request Origination	Variable	Coefficient	P-Value	Transformation / Lag	Confidence Interval (95%)	
DEV	Intercept	2.32	0.291	N/A	-2.04	6.67
	Seasonal Factor	1.60	0.006	Linear Trend	0.47	2.73
	MF Permits	2.43	0.000	NSA; No Lag	1.70	3.17
	PPI	0.18	0.420	NSA; 4Q/4Q; Lag 7 qtrs	-0.26	0.61
	Adjusted R^2	42.3%				
	F-Stat	16.2	0.000			
GOV	Intercept	-42.96	0.000	N/A	-52.45	-33.47
	Seasonal Factor	6.59	0.000	Q2/3 Dummy	4.14	9.05
	Fed. Trans. Grants	1.21	0.000	Interpolated; Lag 4 qtrs	1.04	1.37
	Adjusted R^2	79.8%				
	F-Stat	123.2	0.000			

Note: Estimation Range 2005Q1-2020Q4
Sources: PG&E, RCG

Government-requested WRO includes work requested by state and local government agencies. As noted previously, the reimbursement of such projects can vary. Many of the government-requested WRO are larger scale projects, typically requiring specific funding availability in advance of commencement. As such, RCG focused on IVs that may indicate the funding environment for public sector infrastructure projects.

RCG examined a range of data series on federal, state, and local spending, bond issuance and special allocations. Unfortunately, much of the available data on transportation funding is skewed by allocations to purposes unlikely to predict PG&E costs, such as debt service payments on previously issued bonds. Federal transportation spending, primarily grants to state and local governments, was found to have the strongest correlation to government-requested WRO. The broad nature of the grants also may capture political sentiment for large-scale projects that would indicate future WRO costs.

With many infrastructure projects unable to proceed with matching federal funds, federal transportation grants are an important indicator of potential WRO demand. The relationship between funding and WRO costs was strongest with a one year lag. Additionally government-requested WRO exhibited seasonality, and RCG utilized a seasonal adjustment to smooth the series and allow for greater relevance to the IVs.

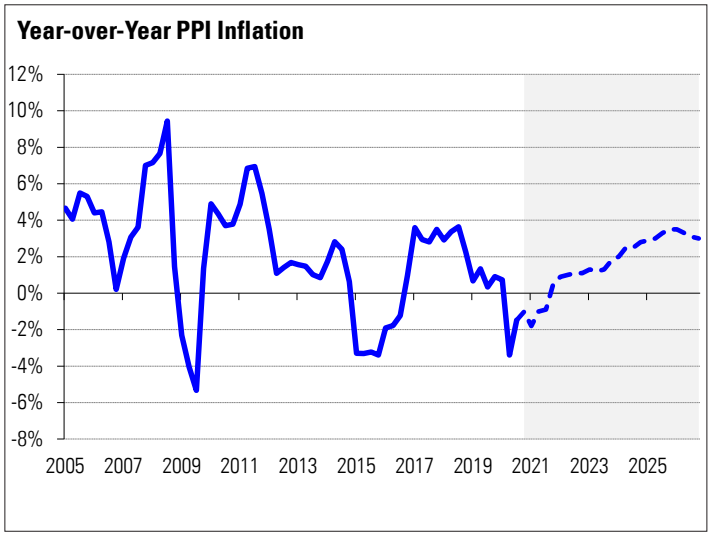
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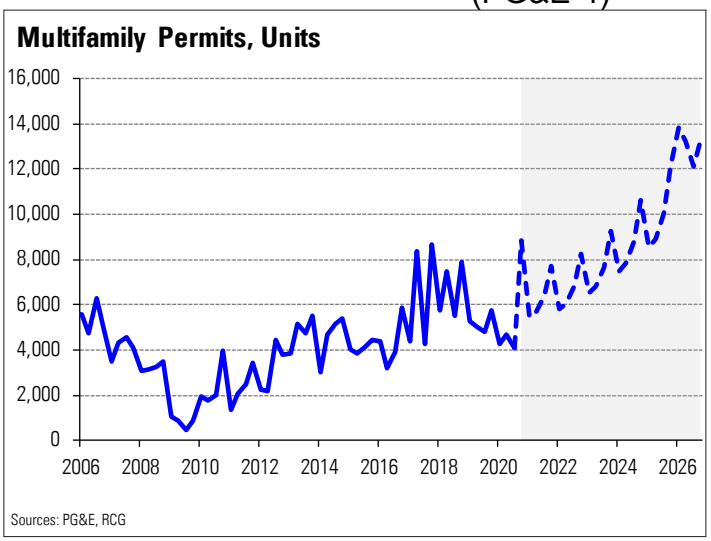
RCG IV Forecasts and Outlook

RCG focused on selecting IVs with the most reliable leading predictive ability after adjusting for potential lags in the data. In order to produce forecasts beyond the lag periods, RCG utilized proprietary models to forecast underlying IVs. These models forecast multifamily permits and PPI. RCG then estimated future federal transportation grans utilizing current and historical versions of the President's Budget generated by the Office of Management and Budget (OMB).

The IV forecast models incorporate a broad macroeconomic and real estate market perspective. RCG's outlook reflects an objective perspective of market conditions independent of implications for WRO costs.

The unprecedented nature of the COVID-19 crisis continues to generate implications for the regional economy. The initial optimism of a vaccine has fallen back to reality as the rollout has been slower than expected by some. Even as business restrictions are slowly lifted, long-term impacts of the restrictions will suppress business and consumer confidence for some time. The unemployment rate in California and throughout the service region remained elevated, and even increased slightly at year-end 2020. Throughout the pandemic, the bulk of job losses were concentrated within service industries, including retail, hospitality and restaurants. These industries will take some time to recover even once consumers perceive it is safe to return to these activities. While no industry has escaped the induced recession, individuals able to work remotely have fared better through the last several months. These industries, particularly technology, financial services and professional services, have recovered to employment levels roughly on par with the start of the pandemic. The bifurcated economic performance continues to exacerbate some of the economic inequities. Government assistance measures, including enhanced unemployment benefits as well as stimulus check, have helped some households survive job losses. Additionally, foreclosure moratoria and mortgage forbearance programs have kept some families in homes despite loss of income.



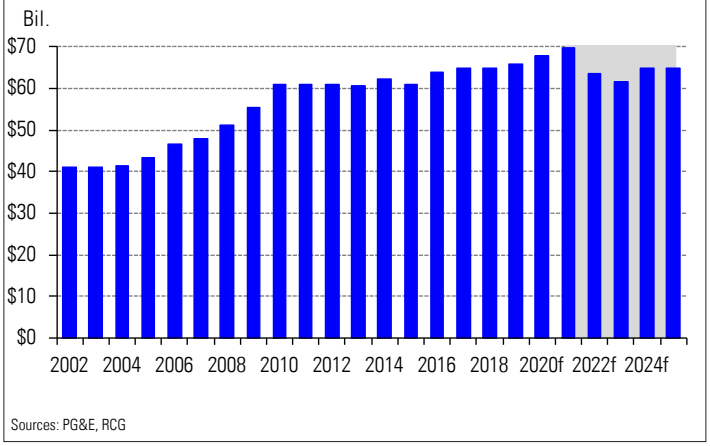


The current economic trajectory can be attributed primarily to the outlook for the pandemic. As the vaccine rollout accelerates, and transmission rates decline, business restrictions will be lifted throughout the region which will lead to some recovery in employment. Conversely, if COVID-19 variants prove resistant to vaccines, and infection rates surge, this would lead to additional job loss. The PPI remained lower in 2020 than the previous year, as reduced consumption of some inputs during the pandemic curtailed producer pricing. For much of 2020, energy costs remained at the lowest point in a decade but began to trend higher towards the end of the year. While inflation has been tame for an extended period, supply disruptions and consumer shifts have placed upward pressure on prices in recent months. Producer prices may face upward pressure, particularly as energy prices recover and commodities pricing continues to accelerate.

In contrast to single family trends, the multifamily sector was the focus of development activity and consumer demand for several years prior to the pandemic. Large-scale urban development became much more common during the last decade, with the bulk of construction cranes in the skyline helping to build multifamily units. The COVID-19 pandemic shifted consumer preference away from denser urban environments and smaller unit sizes. Currently, renter demand for studio and one-bedroom apartments with smaller areas remain low. The extended development timeline for projects in much of the region has led to permitting activity far in advance of potential completion dates. Some developers betting on a strong recovery of demand, for example, continued to work through the permitting process even as renter demand declined. While some of these projects may be at risk of delay or cancellation as the trajectory of renter demand becomes more apparent once the pandemic is over, housing in the region is undersupplied and RCG expects most projects to proceed to the construction phase. Multifamily permitting volume in 2020 was on par with 2019, a year that was somewhat lower due to enhanced regulations that pulled some activity forward to the proceeding years. RCG forecasts a modest recovery in multifamily permitting to 25,000 units in 2021. Permit activity in 2022 should be stable as renter demand will have yet to fully recover in

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Federal Transportation Grants to State/Local Governments

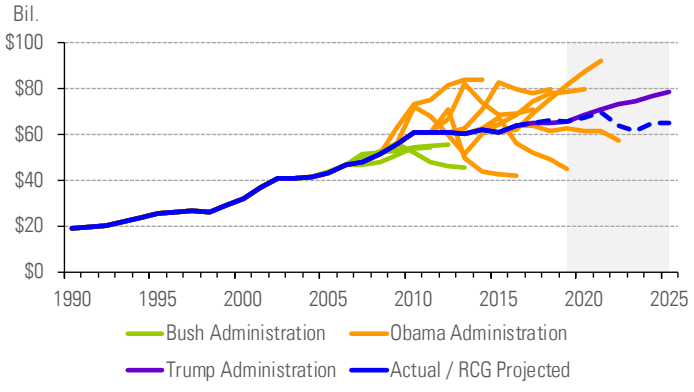


Sources: PG&E, RCG

the region. By 2023, activity should accelerate to 30,000 units and increase to 35,000 in 2024 and nearly 40,000 units in 2025. At the higher levels, multifamily permit totals should return to more typical paces of construction in the region based upon population growth and household formation rates.

The President's Budget released each year typically outlines future spending priorities, and can be used to set parameters around transportation funding. The budget reflects the Executive Branch's priorities, but ultimately Congress writes and passes the federal budget each fiscal year. While each budget tends to be aspirational and rarely tracks well with specific funding years, averaging the projected trend in outlays across several budgets can be a fairly reliable guide. However, the transition of administrations can shift priorities rapidly, as happened between the Obama and Trump administrations, for example. The Biden administration has yet to release the President's Budget for FY 2022, and while infrastructure is expected to become a priority for the administration, the funding levels remain unknown. Due to this uncertainty, RCG focused on historical budgets as guideposts. The rising federal deficit may constrain transportation infrastructure grants, leading to a slight decrease in the coming years.

Projected Federal Outlay for Transportation Grants



Sources: PG&E, RCG

IV. Forecast Model Results

The forecast models project a decrease in total WRO in 2021following the unexpectedly strong 2020 results. Total WRO should rebound somewhat in 2022 to $254 million before decreasing once again in 2023. From 2024 through 2026, total WRO is projected to increase by an average of 8% per year.

In 2020, developer-requested WRO reached a more than 15-year high of $118 million. Although residential construction volume should continue to drive a share of WRO, developer-requested WRO will decrease to $79 million, a level on par with the 2017 to 2018 period. Overall, the lackluster business and real estate market conditions in 2021 due to the lingering effects of the pandemic will reduce developer-requested WRO substantially. Following this year, developer-requested WRO should recover steadily, reaching $83 million in 2022 and $93 million in 2023. Thereafter, the model projects further increases to $104 million in 2024, $116 million in 2025 and $148 million in 2026.

Government-requested WRO is projected to decrease in 2021 following a somewhat stable 2020. By year-end, the forecast model projects costs to fall to $135 million before a temporary rebound to $171 million in 2022. Government-requested WRO should decrease again in 2023 and 2024, before recovering to average approximately $154 million in 2025 and 2026.

V. Model Discussion

The reliability of the WRO forecast model is dependent upon several factors, including the reliability and accuracy of input data and the persistence of historical relationships through the forecast period. The changes to the historical WRO dataset from adjusting WRO categories as a project progresses introduces some degree of forecast errors. The impact for total WRO costs should be minimal, however, unless costs are moved in or out of the WRO program.

Despite the revisions to historical costs, PG&E reporting procedures are assumed to be sufficient to prevent systematic biases or a high degree of sampling error. Some degree of sampling error is expected in any data generating process and was accounted for in the modeling process. The volatility from the monthly WRO data was mitigated by aggregating monthly data into a quarterly frequency. Additionally, by excluding large-scale projects with unique cost drivers reduced volatility.

Based upon information shared with RCG, a change to internal accounting practices in 2015 altered the process to allocate costs across PG&E programs, including WRO. Revisions to 2014 and 2015 cost data were incorporated into the model construct; however, restated data prior to 2014 were unavailable due to technical limitations of PG&E systems. Total WRO costs for 2014 were revised lower to $180 million from $206 million following the change in

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Annual WRO Costs by Requesting Party - History and Forecast, Mil. $

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Forecast 2021	2022	2023	2024	2025	2026
Total	$114.0	$126.0	$146.4	$174.2	$179.9	$214.9	$179.9	$224.0	$241.4	$208.0	$238.3	$235.2	$264.0	$213.4	$254.1	$240.8	$246.2	$269.5	$302.3
Dev	$40.0	$36.0	$33.9	$38.0	$43.4	$64.1	$42.0	$71.5	$70.7	$73.3	$96.0	$93.6	$118.2	$78.5	$83.0	$92.6	$104.1	$116.4	$148.2
Dev - E	$37.6	$33.5	$32.1	$36.0	$41.6	$58.4	$41.6	$66.0	$60.9	$69.9	$92.0	$88.5	$111.2	$73.8	$77.7	$86.7	$97.5	$108.9	$138.7
Dev - G	$2.5	$2.4	$1.8	$2.0	$1.9	$5.7	$0.5	$5.6	$9.8	$3.3	$4.0	$5.1	$7.0	$4.7	$5.3	$5.9	$6.7	$7.4	$9.5
Govt	$73.9	$90.0	$112.5	$136.2	$136.5	$150.9	$137.9	$152.5	$170.7	$134.8	$142.2	$141.6	$145.8	$134.9	$171.2	$148.2	$142.1	$153.1	$154.1
Govt - E	$47.4	$62.6	$69.3	$89.1	$94.6	$88.4	$94.6	$82.9	$89.4	$76.1	$81.3	$73.0	$85.5	$75.4	$95.7	$82.9	$79.5	$85.6	$86.1
Govt - G	$26.5	$27.4	$43.1	$47.1	$41.9	$62.4	$43.3	$69.6	$81.3	$58.6	$60.9	$68.6	$60.4	$59.4	$75.5	$65.3	$62.6	$67.5	$67.9

Sources: PG&E, RCG

accounting practices. The timing of this break in the data precludes exclusion from the model estimation. As RCG continues to estimate the models on the full history of WRO costs, it is important to note that the model estimates are therefore less precise due to this break in the PG&E data.

The independent variables are also subject to potential errors or data issues that require revision. Some of the IVs are revised by the data source as additional information are gathered. These types of revisions are common for monthly frequency data series. While historical revisions to the IVs rarely cause material changes in trends, the COVID-19 pandemic and impact on data gathering techniques is unprecedented within the timeframe of data utilized by the model. The potential larger revisions will remain for some time and it is unknown if future revisions will be of greater magnitude due to the pandemic issues. Substantial revisions to the IVs would alter the model specifications and could produce less reliable forecasts.

The WRO cost models were constructed using quarterly and annual data, and the output values are also quarterly in frequency. The requirement for monthly near-term forecasts drove RCG to incorporate a cubic spline. The cubic spline interpolates quarterly values into monthly values. It should be noted that the model does not output monthly projections directly, but instead utilizes a method that produces results fitting the trend rather than capturing the month-to-month volatility.

RCG elected to perform projections for the PG&E service coverage area and assign shares to PG&E Areas and for electric and gas types. This method assumes a relatively constant relationship between total WRO and electric and gas costs across the four Areas. These relationships may be subject to unexpected changes even though historical trends indicate some stability in these relationships.

The model utilizes IV forecasts generated by RCG as well as OMB projections of expenditures. The IV forecasts are derived from models accounting for historical relationships between the model IVs and their own set of independent variables. Differences between RCG projects and actual values would bias the WRO forecasts.

The COVID-19 pandemic introduced unprecedented volatility throughout the broader economy. Public and private sector entities altered plans for WRO in 2020, at times accelerating or delaying projects, which shifted the starting level of the forecast horizon. There may be a backlog of projects that manifest as economic activity normalizes or, conversely, stretched balance sheets may cause the cancellation of some projects. The pandemic will have short- and long-term implications for business activity in the service area that may drive shifts in WRO levels.

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Workpaper Table 18-45
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Summary of Major Project Expenditures - MWC 10

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	
Line No.	**Description**	**Recorded**					**Forecast**						**Notes**
1	Transbay Transit Center - San Francisco	$ 382	$ 296	$ 14	$ -	$ 7	$ -	$ -	$ -	$ -	$ -	$ -	
2	Central Subway - San Francisco	$ 1,095	$ 831	$ 382	$ 134	$ 290	$ -	$ -	$ -	$ -	$ -	$ -	
3	Comanche Pkwy South Wallace	$ 4,580	$ 12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
4	Total Major Project Expenditures/Forecast ($000's)	$ 6,056	$ 1,139	$ 395	$ 134	$ 297	$ -	$ -					[Line 1 + Line 2 + Line 3]

Workpaper Table 18-46
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 18, New Business and Work at the Request of Others
Summary of State Infrastructure Projects Expenditures - MWC 10

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	
Line No.	Description	Recorded					Forecast						Notes
1	California High-Speed Rail	$ (148)	$ 2	$ (115)	$ 195	$ (91)	$ 2,648	$ 4,310	$ 2,881	$ 25	$ -	$ -	
2	Caltrain Electrification	$ 2,457	$ 7,298	$ 4,700	$ 10,848	$ (545)	$ -	$ -	$ -	$ -	$ -	$ -	
3	Google (Diridon Area Redevelopment)							$ 11,980	$ 3,080	$ 5,280	$ -	$ -	
4	VTA - BART to Silicon Valley Phase II										$ -	$ -	
5	Total State Infrastructure Projects Expenditures/Forecast ($000's)	$ 2,309	$ 7,300	$ 4,585	$ 11,043	$ (637)	$ 2,648	$ 16,290	$ 5,961	$ 5,305	$ -	$ -	[Line 1 + Line 2 + Line 3 + Line 4]

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 18, ELECTRIC NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS
PROJECT SUMMARY – CALIFORNIA HIGH-SPEED RAIL (HSR)

Project Title: California High-Speed Rail (HSR)
Major Work Categories: 10
Planning Order Numbers: 5759218, 5759219, 5759220, 5746904, 5768579, 5761681, 5765705
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): As Installed

Project Description

The HSR program is a state-driven infrastructure investment plan, with a timeline expected to extend until 2050 as high-speed rail service is provided throughout the state of California. The California High-Speed Rail Authority (CHSRA), a state agency, has requested relocation of gas and electric facilities, (distribution and transmission) as well as the construction of new or upgraded gas and electric utility facilities in order to enable energy delivery as requested by the CHSRA.

Justification

This work is mandatory. PG&E is required to provide service for and address the relocation requests from agencies of the State of California.

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
CAPITAL	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
California High-Speed Rail	$ (148)	$ 2	$ (115)	$ 195	$ (91)	$2,648	$4,310	$2,881	$ 25	$ -	$ -	$ 9,707	
Capital Total	$ (148)	$ 2	$ (115)	$ 195	$ (91)	$2,648	$4,310	$2,881	$ 25	$ -	$ -	$ 9,707	
TOTAL PROJECT COST	$ (148)	$ 2	$ (115)	$ 195	$ (91)	$2,648	$4,310	$2,881	$ 25	$ -	$ -	$ 9,707	WP 18-65 Line 1

Cost Assumptions:

PG&E's 2023 GRC Electric Distribution forecast for the HSR project is for utility relocation work that will be performed by HSR and its contractors, with PG&E acting in an oversight and verification role. CHSRA will reimburse PG&E's costs, less credits for depreciation, salvage, and betterment. The forecast reflects the anticipated amount of those credits.

The forecast reflects a combination of existing detailed cost estimates for known components of the project, and estimates provided by the project manager (the subject matter expert for the projects) based upon current knowledge of the schedule and scope for the remainder of the project using work since the inception of the project as a guide for cost forecast.

PACIFIC GAS AND ELECTRIC COMPANY

EXHIBIT (PG&E-4), CHAPTER 18, ELECTRIC NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS

PROJECT SUMMARY – CALIFORNIA HIGH-SPEED RAIL (HSR)

Benefits

This is a mandatory project for work at the request of others (WRO). A benefit analysis was not prepared for this project.

Alternatives Considered

Due to the mandatory nature and specific requirements of this project, no alternatives were considered

PACIFIC GAS AND ELECTRIC COMPANY

EXHIBIT (PG&E-4), CHAPTER 18, ELECTRIC NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS

PROJECT SUMMARY – CALTRAIN ELECTRIFICATION

Project Title: Caltrain Electrification
Major Work Categories: 10
Planning Order Numbers: 5773790, 5771998, 5773791
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): As installed

Project Description

Caltrain, a commuter rail line, is electrifying its existing corridor between San Francisco and San Jose. PG&E is working with Caltrain on two traction power substation interconnections to power their trains. An electrified Caltrain system will set the stage for a future blended service with California High-Speed Rail (CHSR).

To electrify the existing Caltrain corridor, Caltrain is constructing an Overhead Catenary System over its existing tracks, which has resulted in "conflicts" with some of the PG&E's overhead electric distribution and transmission lines that cross the Caltrain right-of-way. PG&E provided environmental planning, project management, estimating, engineering, material procurement, and construction services for the line relocation work needed.

PG&E performed the overhead electric facility relocation work at its sole cost and expense in accordance with the terms of the agreement dated November 19, 1931 ("1931 Agreement") entered between Joint Peninsula Corridor Joint Power's Board ("JPB") (which governs the Caltrain project) predecessor in interest, Southern Pacific Company and PG&E authorizing electric crossings over the JPB rail corridor. Most relocations of PG&E's facilities that conflicted with its project occurred between 2017 through 2019. The remaining work is closeout tasks as well as some one-off requests from Caltrain as they complete their construction tasks.

Justification

This work is mandatory. PG&E is required to provide service for and address the relocation requests from agencies of the State of California.

Costs

	Recorded					Forecast							
CAPITAL	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
Caltrain Electrification	$ 2,457	$ 7,298	$ 4,700	$ 10,848	$ (545)	$ -	$ -	$ -	$ -	$ -	$ -	$ 24,758	
Capital Total	$ 2,457	$ 7,298	$ 4,700	$ 10,848	$ (545)	$ -	$ -	$ -	$ -	$ -	$ -	$ 24,758	
TOTAL PROJECT COST	$ 2,457	$ 7,298	$ 4,700	$ 10,848	$ (545)	$ -	$ -	$ -	$ -	$ -	$ -	$ 24,758	WP 18-65 Line 2

Additional Cost Information

During 2021 and 2022, PG&E may incur costs for remaining close-out tasks and a few miscellaneous requests from Caltrain as they continue their construction tasks. This reflects estimates provided by the subject matter expert for the projects based upon current knowledge of the schedule and scope for the remainder of the project using similar work as a guide for cost forecast.

PACIFIC GAS AND ELECTRIC COMPANY

EXHIBIT (PG&E-4), CHAPTER 18, ELECTRIC NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS

PROJECT SUMMARY – CALTRAIN ELECTRIFICATION

Benefits

This is a mandatory project under PG&E's tariffs, franchise agreements, and other specific agreements for work at the request of others. A benefit analysis was not prepared for this project.

Alternatives Considered

Due to the mandatory nature and specific requirements of this project, no alternatives were considered.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 18, ELECTRIC NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS
PROJECT SUMMARY – GOOGLE – SOUTH BAY REDEVELOPMENT PROGRAM

Project Title: Google – South Bay Redevelopment Program (aka: Diridon Area Redevelopment)
Major Work Categories: 10, EW
Planning Order Numbers: 5775240
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): As Installed

Project Description

The Google – South Bay Redevelopment Program currently consists of five districts, which will consist of mixed-use plans that will include housing, office space, open space, retail, and other active uses. The five districts will be located in San Jose, Sunnyvale, and Mountain View.
Anticipated PG&E scope for the overall program includes:

- Asset relocation where identified during design (Substation, Electric and Gas Distribution and Transmission facilities, Telecom)
- Permanent distribution service

Justification

This work is mandatory. PG&E is required to provide service for and address the relocation requests under its franchise agreement with the City of San Jose.

Costs

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE													
Google (Diridon Area Redevelopment)	$ -	$ -	$ (27)	$ (344)	$ -	$ 117	$ 117	$ 117	$ 117	$ 117	$ 117	$ 330	
Expense Total	$ -	$ -	$ (27)	$ (344)	$ -	$ 117	$ 117	$ 117	$ 117	$ 117	$ 117	$ 330	WP 18-16 Line 3
CAPITAL													
Google (Diridon Area Redevelopment)	$ -	$ -	$ -	$ -	$ -	$ -	$11,980	$ 3,080	$ 5,280	$ -	$ -	$20,340	
Capital Total	$ -	$ -	$ -	$ -	$ -	$ -	$11,980	$ 3,080	$ 5,280	$ -	$ -	$20,340	WP 18-65 Line 3
TOTAL PROJECT COST	**$ -**	**$ -**	**$ (27)**	**$ (344)**	**$ -**	**$ 117**	**$12,097**	**$ 3,197**	**$ 5,397**	**$ 117**	**$ 117**	**$20,670**	

Cost Assumptions:

The 2021-2026 forecast reflects cost estimates for known components of the project, and estimates provided by the project manager (the subject matter expert for the projects) based upon current knowledge of the schedule and scope for the remainder of the project using similar work as a guide. Agreement has not yet been reached on as to which party will bear the costs for PG&E electric distribution facility relocations; however, given that these facilities are in franchise, the forecast assumes that PG&E will bear the relocation costs.

PACIFIC GAS AND ELECTRIC COMPANY

EXHIBIT (PG&E-4), CHAPTER 18, ELECTRIC NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS

PROJECT SUMMARY – GOOGLE – SOUTH BAY REDEVELOPMENT PROGRAM

Benefits

This project is at the request of a third party, A benefit analysis was not prepared for this project.

Alternatives Considered

Due to the mandatory nature and specific requirements of this project, no alternatives were considered.

PACIFIC GAS AND ELECTRIC COMPANY

EXHIBIT (PG&E-4), CHAPTER 18, ELECTRIC NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS

PROJECT SUMMARY – BART SILICON VALLEY PHASE II EXTENSION

Project Title: BART Silicon Valley Phase II Extension
Major Work Categories: MWC 10 & EW
Planning Order Numbers: 5775120 & 5045689
Project Start Date: December 2021
Project Completion Date: December 2024
Operative Date (only applies to Capital): Operative as installed

Project Description

The BART Silicon Valley Phase II Extension (BSVII) is a six mile extension of current BART service from North Berryessa station to Santa Clara. The majority of the extension will be underground running through the City of San Jose. Several of PG&E's gas and electric utilities will need to be relocated, protected in place, or abandoned as part of this extension.

Justification

The BSVII project will link North San Jose with Santa Clara to serve the increasing demand for public transportation in the Silicon Valley area.

Risks

1. Land rights under FMC substation may delay tunnel construction.
2. Clearances and other delays may push back schedule.
3. Additional remediation may be required near former PG&E MGP site
4. Multiple points of interconnections may increase or decrease the cost of the project significantly.

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE													
VTA - BART to Silicon Valley Phase II	$ -	$ -	$ -	$ -	$ -	$ 60	$ 60	$ 60	$ 60	$ -	$ -	$ 240	
Expense Total	$ -	$ -	$ -	$ -	$ -	$ 60	$ 60	$ 60	$ 60	$ -	$ -	$ 240	WP 18-16 Line 1
CAPITAL													
VTA - BART to Silicon Valley Phase II	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Capital Total	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	WP 18-65 Line 4
TOTAL PROJECT COST	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 60**	**$ 60**	**$ 60**	**$ 60**	**$ -**	**$ -**	**$ 240**	

Additional Cost Information:

- The costs are derived from the orginal estimate for this work from 2017
- Work is assumed to begin 2021 (engineering)
- Relocation work is anticipated either late 2021 or early 2022

PACIFIC GAS AND ELECTRIC COMPANY

EXHIBIT (PG&E-4), CHAPTER 18, ELECTRIC NEW BUSINESS AND WORK AT THE REQUEST OF OTHERS

PROJECT SUMMARY – BART SILICON VALLEY PHASE II EXTENSION

- Cost estimates are net amount and assume a 50/50 split between PG&E and VTA.
- Estimates are Class 5.

Benefits

- There may not be cost reductions or cost savings as a result of this WRO. The relocation of the utilites required is directly result of a government project.

Alternatives Considered

- None

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE

Testimony _____ **Workpapers** ____X_____ **SOQ** _____

Exhibit Number: ____PG&E-4_____ **Chapter Number:** ____18___

Chapter Title: **New Business And Work At The Request Of Others**

Witness Name: **Josh Jones**

Page No.	Line No.	Item	As Filed	As Corrected
Errata as of November 5, 2021				
18-9	Line 6	Total PEVs in PG&E Service Territory	2020 Actual 320,553 2021 Forecast 561,971 2022 Forecast 692,230 2023 Forecast 828,038	2020 Actual 321,035 2021 Forecast 332,815 2022 Forecast 367,618 2023 Forecast 459,686
18-25	Line 3	PEV	2021 Forecast $25,869 2022 Forecast $17,379 2023 Forecast $39,825 2024 Forecast $38,942 2025 Forecast $44,094 2026 Forecast $46,612	2021 Forecast $5,173 2022 Forecast $14,044 2023 Forecast $40,061 2024 Forecast $50,273 2025 Forecast $66,480 2026 Forecast $90,016
18-25	Line 10	Total Adjusted	2021 Forecast $532,564 2022 Forecast $603,457 2023 Forecast $666,559 2024 Forecast $703,294 2025 Forecast $745,557 2026 Forecast $752,728	2021 Forecast $511,868 2022 Forecast $600,122 2023 Forecast $666,795 2024 Forecast $714,625 2025 Forecast $767,943 2026 Forecast $796,132
18-30	Line 4	LDV PEVs in PG&E Service Territory	2020 Actual 320,553 2021 Forecast 561,971 2022 Forecast 692,230 2023 Forecast 828,038 2024 Forecast 944,620 2025 Forecast 1,059,522 2026 Forecast 1,152,641	2020 Actual 320,550 2021 Forecast 332,083 2022 Forecast 386,528 2023 Forecast 457,989 2024 Forecast 554,276 2025 Forecast 689,947 2026 Forecast 879,757
18-30	Line 5	MDHD PEVs in PG&E Service Territory	2020 Actual 925 2021 Forecast 1,481 2022 Forecast 2,164 2023 Forecast 3,146 2024 Forecast 4,172 2025 Forecast 5,743 2026 Forecast 7,760	2020 Actual 485 2021 Forecast 732 2022 Forecast 1,090 2023 Forecast 1,697 2024 Forecast 2,719 2025 Forecast 4,448 2026 Forecast 7,317

18-30	Line 24	Total PEV Upgrade and EVCN Phase 2 Cost	2021 Forecast $25,869 2022 Forecast $17,379 2023 Forecast $39,825 2024 Forecast $38,942 2025 Forecast $44,094 2026 Forecast $46,612	2021 Forecast $5,173 2022 Forecast $14,044 2023 Forecast $40,061 2024 Forecast $50,273 2025 Forecast $66,480 2026 Forecast $90,016

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 19, RULE 20A

TABLE OF CONTENTS

Subject	Page No.
Capital Workpapers	
Workpaper Table 19-1: Capital Expenditures by Major Work Category, 2016-2026	WP 19-1
Workpaper Table 19-2: Forecast Capital Expenditures Summary, 2020-2026	WP 19-2
Workpaper Table 19-3: Recorded CWIP and Forecast Capital Expenditure Details - Planning Orders Over $3 Million	WP 19-3
Workpaper Table 19-4: Recorded and Forecast Capital Expenditures Details - Other Work	WP 19-4
Workpaper Table 19-5: Major Work Category 30 – Recorded Walk	WP 19-5
Workpaper Table 19-6: Major Work Category 30 – Forecast Walk	WP 19-6
Workpaper Table 19-7: MWC 30 Capital Summary	WP 19-7
Workpaper Table 19-8: Planned Expenditures and Balancing Account Carryover	WP 19-8
Workpaper Table 19-9: Rule 20A Planning Order Detail Groupings	WP 19-9
Expense Workpapers	
Workpaper Table 19-10: Expenses by Major Work Category in Nominal Dollars, 2016-2023	WP 19-11
Workpaper Table 19-11: Expenses by Major Work Category in Base Year Dollars, 2016-2023	WP 19-12
Workpaper Table 19-12: MWC IG Expense Summary	WP 19-13
Project Summaries	
Project Summary – Rule 20A	WP 19-14

Workpaper Table 19-1
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 19
Rule 20A
Capital Expenditures by Major Work Category
(Thousands of Nominal Dollars)

			Capital Expenditures											
No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	30	E Dist WRO Rule 20A	31,123	28,255	32,610	45,758	38,273	47,288	39,954	39,876	40,957	42,060	43,204	WP 19-5, WP 19-6
2		**Grand Total**	**31,123**	**28,255**	**32,610**	**45,758**	**38,273**	**47,288**	**39,954**	**39,876**	**40,957**	**42,060**	**43,204**	

Workpaper Table 19-2
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 19
Rule 20A
Forecast Capital Expenditures Summary
(Thousands of Nominal Dollars)

		Capital Expenditures							
Line No.	Description	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	Projects > $3 Million*	34,417	47,288	39,954	39,876	40,957	42,060	43,204	WP 19-3, line 42
2	Other Work	6,672	-	-	-	-	-	-	WP 19-4
3	**Total**	**41,088**	**47,288**	**39,954**	**39,876**	**40,957**	**42,060**	**43,204**	

4 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast is greater than $3 million.

Workpaper Table 19-3
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 19, Rule 20A
Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million*
(Thousands of Nominal Dollars)

Line No.	Planning Order	Description	MWC	Operative Date	CWIP 2020 Recorded Adjusted	Capital Expenditures 2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Subtotal	Reference
	MWC - 30	**E Dist WRO Rule 20A**											
1	5543621	SYSPLAN R20A 30A	30		-	(9,608)	(21,760)	5,035	2,704	31,478	43,192	51,041	WP 19-9
2	5717278	WRO Rule 20A - Central Coast	30	Dec-2027	381	33	686	317	2,720	39	-	4,176	WP 19-9
3	5717279	WRO Rule 20A - De Anza	30	Aug-2021	666	4,138	791	-	-	-	-	5,595	WP 19-9
4	5717281	WRO Rule 20A - East Bay	30	Dec-2023	529	1,369	1,490	2,761	5,093	1,071	-	12,314	WP 19-9
5	5717282	WRO Rule 20A - Fresno	30	Dec-2024	89	1,202	0	706	5,531	145	-	7,673	WP 19-9
6	5717284	WRO Rule 20A - Los Padres	30	Dec-2024	215	1	-	182	2,601	53	-	3,052	WP 19-9
7	5717285	WRO Rule 20A - Mission	30	Dec-2022	541	31	4,242	248	-	-	-	5,063	WP 19-9
8	5717287	WRO Rule 20A - Sonoma	30	Jul-2024	114	9	542	1,908	3,971	-	-	6,544	WP 19-9
9	5717288	WRO Rule 20A - North Valley	30	Apr-2024	0	0	855	2,682	2,550	-	-	6,087	WP 19-9
10	5717292	WRO Rule 20A - San Jose	30	May-2023	79	2	33	3,622	2,180	4,287	11	10,214	WP 19-9
11	5717293	WRO Rule 20A - Sierra	30	Jan-2021	5,864	709	-	-	-	-	-	6,573	WP 19-9
12	5717294	WRO Rule 20A - Stockton	30	Oct-2025	735	60	1,197	987	2,239	3,760	-	8,978	WP 19-9
13	5767578	BAILEY RD CONTRA COSTA CNTY R20A	30	Mar-2021	7,921	703	-	-	-	-	-	8,624	WP 19-9
14	5767579	GRIZZLY PEAK BLVD BERKELEY R20A	30	Apr-2024	1,783	572	6,764	2,600	246	-	-	11,966	WP 19-9
15	5767581	R20A - MAIN ST, SODA BAY	30	Mar-2023	486	113	4,586	79	-	-	-	5,264	WP 19-9
16	5767589	WOLFE RD SUNNYVALE R20A	30	Aug-2022	747	3,409	4,075	-	-	-	-	8,230	WP 19-9
17	5768918	DAN WARD RD MERCED COUNTY R20A	30	Jul-2024	4	-	211	757	3,454	955	-	5,381	WP 19-9
18	5768920	JEFFERSON ST NAPA R20A	30	May-2022	477	1,809	3,012	-	-	-	-	5,298	WP 19-9
19	5769479	MIDDLEFIELD RD PH2 SAN MATEO COUNTY R	30	Nov-2022	803	17	4,959	-	-	-	-	5,779	WP 19-9
20	5770721	CIVIC CENTER SANTA MARIA R20A	30	Sep-2022	61	135	710	2,891	1,643	-	-	5,440	WP 19-9
21	5773022	SPRUCE AVE SO SAN FRANCISCO R20A	30	Feb-2024	1	-	556	1,315	2,334	-	-	4,205	WP 19-9
22	5773319	BLACKSTONE AVE & ABBY ST FRESNO	30	Feb-2023	737	7,970	6,442	140	-	-	-	15,289	WP 19-9
23	5773661	BRADLEY RD SANTA BARBARA CNTY R20A	30	Jun-2021	496	5,821	-	-	-	-	-	6,317	WP 19-9
24	5774462	SOUTH MAIN ST MILPITAS R20A	30	Nov-2022	371	2,071	2,422	-	-	-	-	4,865	WP 19-9
25	5774658	NORTH ESPLANADE DIST 17 CHICO R20A	30	Sep-2022	8	233	4,285	-	-	-	-	4,526	WP 19-9
26	5774659	WARNER ST DIST 18 CHICO R20A	30	Jun-2021	1,232	3,889	-	-	-	-	-	5,121	WP 19-9
27	5775498	34TH STREET BAKERSFIELD R20A	30	Jul-2022	379	2,971	246	-	-	-	-	3,595	WP 19-9
28	5776175	FULTON RD SANTA ROSA R20A	30	Feb-2021	2,181	2,530	-	-	-	-	-	4,711	WP 19-9
29	5776998	4TH ST EUREKA R20A	30	Apr-2021	4,318	1,898	-	-	-	-	-	6,216	WP 19-9
30	5780282	Downtown Stockton City of Stockton R20A	30	Jul-2021	2,257	4,713	-	-	-	-	-	6,970	WP 19-9
31	5781983	Missouri Flat Rd El Dorado Cnty R20A	30	May-2022	218	5,902	167	-	-	-	-	6,287	WP 19-9
32	5782681	Freestone Sonoma CNTY R20A	30	Sep-2022	162	186	3,988	66	-	-	-	4,401	WP 19-9
33	5783488	Church St Fresno R20A	30	Apr-2022	113	295	2,644	-	-	-	-	3,052	WP 19-9
34	5783489	Geneva Ave PH 2 Daly City R20A	30	Apr-2023	6	-	(113)	4,664	-	-	-	4,557	WP 19-9
35	5783491	Reedley Sports Park Reedley R20A	30	Oct-2024	16	1	47	274	3,073	18	-	3,428	WP 19-9
36	5784380	NOVATO BLVD NOVATO R20A	30	Feb-2022	212	3,368	41	-	-	-	-	3,621	WP 19-9
37	5789243	HWY 99 EAST TEHAMA COUNTY R20A	30	Mar-2024	100	115	610	3,366	368	-	-	4,560	WP 19-9
38	5790337	MONTEREY RD SAN JOSE R20A	30	Mar-2023	113	56	4,048	73	-	-	-	4,290	WP 19-9
39	5791195	NICASIO VALLEY RD MARIN COUNTY R20A	30	Dec-2025	0	131	464	2,808	250	253	-	3,907	WP 19-9
40	5792865	WILLIAMS RD PH 1 SALINAS R20A	30	Jun-2023	1	435	1,715	2,396	-	-	-	4,547	WP 19-9
41	**Total**				**34,417**	**47,288**	**39,954**	**39,876**	**40,957**	**42,060**	**43,204**	**287,755**	WP 19-9
42		**Grand Total**			**34,417**	**47,288**	**39,954**	**39,876**	**40,957**	**42,060**	**43,204**	**287,755**	WP 19-9

43 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 19-4
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 19
Rule 20A
Recorded and Forecast Capital Expenditures Details - Other Work*
(Thousands of Nominal Dollars)

			Capital Expenditures											
Line No.	**MWC**	**MWC Description**	**2016 Recorded Adjusted**	**2017 Recorded Adjusted**	**2018 Recorded Adjusted**	**2019 Recorded Adjusted**	**2020 Recorded Adjusted**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**2024 Forecast**	**2025 Forecast**	**2026 Forecast**	**Reference**
														WP 19-7, line 4
1	30	E Dist WRO Rule 20A	10,454	10,105	26,750	40,504	14,001	-	-	-	-	-	-	WP 19-7, line 8
2	**Grand Total**		**10,454**	**10,105**	**26,750**	**40,504**	**14,001**	**-**	**-**	**-**	**-**	**-**	**-**	

3 * Excludes projects greater than $3M

Workpaper Table 19-5
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 19, Rule 20A
Major Work Category 30 – Recorded Walk
MWC 30 - E Dist WRO Rule 20A
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**31,123**			
2		Project Work	(2,868)		Rule 20A recorded expenditures vary from year to year as they are dependent upon the level of customer work requested and the ability of PG&E to complete the work in any given year.	WP 19-7 Line 9
3	**2017**	**Recorded Adjusted**	**28,255**			
4		Project Work	4,355		Rule 20A recorded expenditures vary from year to year as they are dependent upon the level of customer work requested and the ability of PG&E to complete the work in any given year.	WP 19-7 Line 9
5	**2018**	**Recorded Adjusted**	**32,610**			
6		Project Work	13,148		Rule 20A recorded expenditures vary from year to year as they are dependent upon the level of customer work requested and the ability of PG&E to complete the work in any given year.	WP 19-7 Line 9
7	**2019**	**Recorded Adjusted**	**45,758**			
8		Project Work	(7,486)		Rule 20A recorded expenditures vary from year to year as they are dependent upon the level of customer work requested and the ability of PG&E to complete the work in any given year.	WP 19-7 Line 9
9	**2020**	**Recorded Adjusted**	**38,273**			

Workpaper Table 19-6
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 19, Rule 20A
Major Work Category 30 – Forecast Walk
MWC 30 - E Dist WRO Rule 20A
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount (1)		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**38,273**			
2		Project Work	9,015		2021 forecast is based on current customer demand for identified work adjusted for work that is not anticipated to proceed based on historical experience.	WP 19-7 Line 9
3	**2021**	**Forecast**	**47,288**			
4		Project Work	(7,334)		2022 forecast is based on current customer demand for identified work adjusted for work that is not anticipated to proceed based on historical experience.	WP 19-7 Line 9
5	**2022**	**Forecast**	**39,954**			
6		Project Work	(78)		No significant change	WP 19-7 Line 9
7	**2023**	**Forecast**	**39,876**			
8		Project Work	1,082		No significant change	WP 19-7 Line 9
9	**2024**	**Forecast**	**40,957**			
10		Project Work	1,102		No significant change	WP 19-7 Line 9
11	**2025**	**Forecast**	**42,060**			
12		Project Work	1,144		No significant change	WP 19-7 Line 9
13	**2026**	**Forecast**	**43,204**			

Note: (1) PG&E's current workplan includes not only amounts requested in this GRC, but also carryover amounts from the existing one-way Rule 20A balancing account. See WP 19-8.

Workpaper Table 19-7
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 19, Rule 20A
MWC 30 Capital Summary
(Thousands of Dollars)

Line	Project Work	2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1													
2	**Project Work**	**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**2024 Forecast**	**2025 Forecast**	**2026 Forecast**	**Reference**
3	Project Work equal to or greater than $3M	$ 20,669	$ 18,150	$ 5,860	$ 5,255	$ 24,272	$ 56,896	$ 61,714	$ 34,841	$ 38,254	$ 10,581	$ 11	WP 19-9, line 42
4	Project Work less than $3M	$ 10,452	$ 10,114	$ 26,743	$ 40,503	$ 13,996	$ -	$ -	$ -	$ -	$ -	$ -	WP 19-9, line 100
5	Portfolio Forecast Adjustment	$ -	$ -	$ -	$ -	$ -	$ (9,608)	$ (21,760)	$ 5,035	$ 2,704	$ 31,478	$ 43,192	WP 19-9, line 103
6	**MWC 30 Subtotal - Project Work**	**$ 31,122**	**$ 28,264**	**$ 32,603**	**$ 45,758**	**$ 38,268**	**$ 47,288**	**$ 39,954**	**$ 39,876**	**$ 40,957**	**$ 42,060**	**$ 43,204**	WP 19-9. line 104
7													
8	Additional Recorded Work	$ 1	$ (8)	$ 7	$ 0	$ 4	$ -	$ -	$ -	$ -	$ -	$ -	WP 19-9, line 109
9	**MWC 30 - Total**	**$ 31,123**	**$ 28,255**	**$ 32,610**	**$ 45,758**	**$ 38,273**	**$ 47,288**	**$ 39,954**	**$ 39,876**	**$ 40,957**	**$ 42,060**	**$ 43,204**	

Workpaper Table 19-8
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 19, Rule 20A
Planned Expenditures and Balancing Account Carryover
(In Whole Dollars)

Line No.												Notes	Reference
1													
2	2020-2026 Annual Labor & Non-Labor Escalation:			5.80%	3.30%	2.80%	2.60%	2.70%	2.70%	2.70%	2.70%	(1)	
3													
4		2017 GRC			2020 GRC			2023 GRC					
5		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026		
6	Beginning Balancing Account Carryover	N/A	29,663,665	50,060,470	55,149,944	50,362,092	37,386,091	32,665,442	28,786,629	24,807,997	20,718,298	(2)	
7	2017-2022 Adopted Forecast	57,919,000	53,804,000	52,067,000	33,420,000	34,312,000	35,233,000	N/A	N/A	N/A	N/A		
8	2023-2026 GRC Forecast	N/A	N/A	N/A	N/A	N/A	N/A	39,875,918	40,957,478	42,059,686	43,203,506		WP 19-9, Line 104
9	MWC 30 Actual/Planned Expenditures	(28,255,335)	(32,610,208)	(45,758,461)	(38,272,588)	(47,288,001)	(39,953,649)	(43,754,732)	(44,936,110)	(46,149,385)	(47,395,418)	(3), (4), (5)	
10	MWC IG Actual Expenditures	-	(796,987)	(1,219,064)	64,736	-	-	-	-	-	-		
11	Ending Balancing Account Carryover	29,663,665	50,060,470	55,149,944	50,362,092	37,386,091	32,665,442	28,786,629	24,807,997	20,718,298	16,526,386		
12													
13													
14					3-Year Average, 2018-2020 Expenditures								
15					2018	2019	2020	2021	2022	2023			
16	Escalate 2018 MWC 30 Actual Expenditures to 2023 dollars				(32,610,208)	(34,501,601)	(35,640,153)	(36,638,078)	(37,590,668)	(38,605,616)		(6)	
17	Escalate 2019 MWC 30 Actual Expenditures to 2023 dollars				N/A	(45,758,461)	(47,268,490)	(48,592,008)	(49,855,400)	(51,201,496)		(6)	
18	Escalate 2020 MWC 30 Actual Expenditures to 2023 dollars				N/A	N/A	(38,272,588)	(39,344,220)	(40,367,170)	(41,457,084)		(6)	
19									3-Year Average	(43,754,732)			
20													
21													
22	**NOTES:**												
23	(1) Escalation factors from IHS Global Insight's Power Planner Q1 2020 Forecast												
24	(2) Line 6 beginning balancing account carryover from prior year Line 11												
25	(3) The 2023 $43,754,732 planned expenditures is the 3-Year average of 2018 Actual, 2019 Actual, and 2020 Actual Expenditures from Line 19												
26	(4) The 2024-2026 planned expenditures were derived by applying the (Line 2) escalation factor to the previous years' planned expenditure result.												
27	(5) Actual/Planned Expenditures are expressed as negative values in this table												
28	(6) Before calculating the (Line 19) 3-Year average, the 2018-2020 Expenditures are escalated to 2023 dollars by applying the Line 2 escalation factors												

Workpaper Table 19-9
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 19, Rule 20A
Rule 20A Planning Order Detail Groupings
(Thousands of Dollars)

Line No.		2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Notes	Reference
1	**Project Work**													
2	**Project Work => $3M**													
3	5717278 - WRO RULE 20A - CENTRAL COAST	$ 1,423	$ 1,422	$ 102	$ 24	$ 34	$ 33	$ 686	$ 317	$ 2,720	$ 39	$ -		
4	5717279 - WRO RULE 20A - DE ANZA	$ 1,778	$ 185	$ 150	$ 42	$ 299	$ 4,138	$ 791	$ -	$ -	$ -	$ -		
5	5717281 - WRO RULE 20A - EAST BAY	$ 408	$ 1,115	$ 17	$ 51	$ 322	$ 1,369	$ 1,490	$ 2,761	$ 5,093	$ 1,071	$ -		
6	5717282 - WRO RULE 20A - FRESNO	$ 5,975	$ 4,920	$ (70)	$ (19)	$ 10	$ 1,202	$ 0	$ 706	$ 5,531	$ 145	$ -		
7	5717284 - WRO RULE 20A - LOS PADRES	$ 1,814	$ 3,892	$ 560	$ 11	$ 17	$ 1	$ -	$ 182	$ 2,601	$ 53	$ -		
8	5717285 - WRO RULE 20A - MISSION	$ 4,239	$ 3,276	$ (180)	$ 57	$ 49	$ 31	$ 4,242	$ 248	$ -	$ -	$ -		
9	5717287 - WRO RULE 20A - SONOMA	$ 30	$ 11	$ (58)	$ 6	$ 11	$ 9	$ 542	$ 1,908	$ 3,971	$ -	$ -		
10	5717288 - WRO RULE 20A - NORTH VALLEY	$ 15	$ 0	$ 0	$ 0	$ 0	$ 0	$ 855	$ 2,682	$ 2,550	$ -	$ -		
11	5717292 - WRO RULE 20A - SAN JOSE	$ 2,190	$ 318	$ 2,528	$ 238	$ 587	$ 2	$ 33	$ 3,622	$ 2,180	$ 4,287	$ 11		
12	5717293 - WRO RULE 20A - SIERRA	$ 1,130	$ 1,474	$ 149	$ 2,326	$ 4,977	$ 709	$ -	$ -	$ -	$ -	$ -		
13	5717294 - WRO RULE 20A - STOCKTON	$ 240	$ 55	$ 59	$ 39	$ 60	$ 60	$ 1,197	$ 987	$ 2,239	$ 3,760	$ -		
14	5767578 - BAILEY RD CONTRA COSTA CNTY R20A	$ 246	$ 259	$ 329	$ 1,155	$ 6,232	$ 703	$ -	$ -	$ -	$ -	$ -		
15	5767579 - GRIZZLY PEAK BLVD BERKELEY R20A	$ 389	$ 434	$ 304	$ 128	$ 432	$ 572	$ 6,764	$ 2,600	$ 246	$ -	$ -		
16	5767581 - R20A - MAIN ST, SODA BAY	$ 89	$ 53	$ 45	$ 46	$ 52	$ 113	$ 4,586	$ 79	$ -	$ -	$ -		
17	5767589 - WOLFE RD SUNNYVALE R20A	$ 123	$ 94	$ 70	$ 127	$ 321	$ 3,409	$ 4,075	$ -	$ -	$ -	$ -		
18	5768918 - DAN WARD RD MERCED COUNTY R20A	$ 3	$ 1	$ 0	$ 0	$ 0	$ -	$ 211	$ 757	$ 3,454	$ 955	$ -		
19	5768920 - JEFFERSON ST NAPA R20A	$ 110	$ 145	$ 74	$ 39	$ 141	$ 1,809	$ 3,012	$ -	$ -	$ -	$ -		
20	5769479 - MIDDLEFIELD RD PH2 SAN MATEO COUNTY R20A	$ 466	$ 107	$ 130	$ 50	$ 155	$ 17	$ 4,959	$ -	$ -	$ -	$ -		
21	5770721 - CIVIC CENTER SANTA MARIA R20A	$ 0	$ 11	$ 1	$ 4	$ 49	$ 135	$ 710	$ 2,891	$ 1,643	$ -	$ -		
22	5773022 - SPRUCE AVE SO SAN FRANCISCO R20A	$ 1	$ 0	$ 0	$ 0	$ 0	$ -	$ 556	$ 1,315	$ 2,334	$ -	$ -		
23	5773319 - BLACKSTONE AVE & ABBY ST FRESNO	$ 0	$ 186	$ 365	$ 156	$ 148	$ 7,970	$ 6,442	$ 140	$ -	$ -	$ -		
24	5773661 - BRADLEY RD SANTA BARBARA CNTY R20A	$ -	$ 90	$ 200	$ 61	$ 193	$ 5,821	$ -	$ -	$ -	$ -	$ -		
25	5774462 - SOUTH MAIN ST MILPITAS R20A	$ -	$ 15	$ 117	$ 147	$ 118	$ 2,071	$ 2,422	$ -	$ -	$ -	$ -		
26	5774658 - NORTH ESPLANADE DIST 17 CHICO R20A	$ -	$ 0	$ 7	$ 0	$ 1	$ 233	$ 4,285	$ -	$ -	$ -	$ -		
27	5774659 - WARNER ST DIST 18 CHICO R20A	$ -	$ 0	$ 145	$ 114	$ 1,029	$ 3,889	$ -	$ -	$ -	$ -	$ -		
28	5775498 - 34TH STREET BAKERSFIELD R20A	$ -	$ 15	$ 143	$ 60	$ 186	$ 2,971	$ 246	$ -	$ -	$ -	$ -		
29	5776175 - FULTON RD SANTA ROSA R20A	$ -	$ 21	$ 168	$ 45	$ 2,002	$ 2,530	$ -	$ -	$ -	$ -	$ -		
30	5776998 - 4TH ST EUREKA R20A	$ -	$ 51	$ 274	$ 94	$ 3,996	$ 1,898	$ -	$ -	$ -	$ -	$ -		
31	5780282 - DOWNTOWN STOCKTON CITY OF STOCKTON R20A	$ -	$ -	$ 90	$ 96	$ 2,145	$ 4,713	$ -	$ -	$ -	$ -	$ -		
32	5781983 - MISSOURI FLAT RD EL DORADO CNTY R20A	$ -	$ -	$ 85	$ 30	$ 118	$ 5,902	$ 167	$ -	$ -	$ -	$ -		
33	5782681 - FREESTONE SONOMA CNTY R20A	$ -	$ -	$ 56	$ 11	$ 106	$ 186	$ 3,988	$ 66	$ -	$ -	$ -		
34	5783488 - CHURCH ST FRESNO R20A	$ -	$ -	$ 0	$ 26	$ 95	$ 295	$ 2,644	$ -	$ -	$ -	$ -		
35	5783489 - GENEVA AVE PH 2 DALY CITY R20A	$ -	$ -	$ 0	$ 5	$ 1	$ -	$ (113)	$ 4,664	$ -	$ -	$ -		
36	5783491 - REEDLEY SPORTS PARK REEDLEY R20A	$ -	$ -	$ 0	$ 15	$ 1	$ 1	$ 47	$ 274	$ 3,073	$ 18	$ -		
37	5784380 - NOVATO BLVD NOVATO R20A	$ -	$ -	$ -	$ 70	$ 155	$ 3,368	$ 41	$ -	$ -	$ -	$ -		
38	5789243 - HWY 99 EAST TEHAMA COUNTY R20A	$ -	$ -	$ -	$ -	$ 107	$ 115	$ 610	$ 3,366	$ 368	$ -	$ -		
39	5790337 - MONTEREY RD SAN JOSE R20A	$ -	$ -	$ -	$ -	$ 121	$ 56	$ 4,048	$ 73	$ -	$ -	$ -		
40	5791195 - NICASIO VALLEY RD MARIN COUNTY R20A	$ -	$ -	$ -	$ -	$ 0	$ 131	$ 464	$ 2,808	$ 250	$ 253	$ -		
41	5792865 - WILLIAMS RD PH 1 SALINAS R20A	$ -	$ -	$ -	$ -	$ 1	$ 435	$ 1,715	$ 2,396	$ -	$ -	$ -		
42	**Total Project Work => $3M**	**$ 20,669**	**$ 18,150**	**$ 5,860**	**$ 5,255**	**$ 24,272**	**$ 56,896**	**$ 61,714**	**$ 34,841**	**$ 38,254**	**$ 10,581**	**$ 11**		
43	**Project Work < $3M**													
44	5717280 - WRO RULE 20A - DIABLO	$ 1,250	$ 263	$ 1,462	$ 86	$ 894	$ -	$ -	$ -	$ -	$ -	$ -		
45	5717283 - WRO RULE 20A - KERN	$ 3,274	$ 98	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
46	5717286 - WRO RULE 20A - NORTH BAY	$ 3	$ 75	$ (60)	$ 4	$ 11	$ -	$ -	$ -	$ -	$ -	$ -		
47	5717289 - WRO RULE 20A - PENINSULA	$ 2,921	$ 3,582	$ 3,203	$ (8)	$ 69	$ -	$ -	$ -	$ -	$ -	$ -		
48	5717290 - WRO RULE 20A - SACRAMENTO	$ 0	$ 0	$ (3)	$ 0	$ 0	$ -	$ -	$ -	$ -	$ -	$ -		
49	5717291 - SFR-WRO RULE 20A - SAN FRANCISCO	$ -	$ 11	$ 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
50	5717295 - WRO RULE 20A - YOSEMITE	$ 965	$ 1,085	$ (230)	$ (581)	$ 20	$ -	$ -	$ -	$ -	$ -	$ -		
51	5737739 - WRO RULE 20A - HUMBOLDT	$ (2)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
52	5767580 - HESPERIAN BLVD ALAMEDA CNTY R20A	$ 124	$ 76	$ 149	$ 3,208	$ 765	$ -	$ -	$ -	$ -	$ -	$ -		
53	5767582 - MARIN AVE PH1 ALBANY R20A	$ 49	$ 771	$ 2,084	$ 12	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
54	5767583 - MIDDLEFIELD RD REDWOOD CITY R20A	$ 86	$ 103	$ 2,302	$ 3,158	$ 2,445	$ -	$ -	$ -	$ -	$ -	$ -		
55	5767584 - MISSION ST PH 3 SANTA CRUZ R20A	$ 6	$ 7	$ 7	$ 6	$ 9	$ -	$ -	$ -	$ -	$ -	$ -		
56	5767585 - MONTEREY RD SAN JOSE R20A	$ 106	$ 223	$ 183	$ 40	$ 109	$ -	$ -	$ -	$ -	$ -	$ -		
57	5767586 - MAIN AND BEACH STREETS, MORRO BAY R20A	$ 162	$ 120	$ (315)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
58	5767587 - ROAD 26 MADERA CNTY R20A	$ 217	$ 94	$ 3,063	$ (187)	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
59	5767588 - SHELL BEACH RD PISMO BEACH R20A	$ 102	$ 234	$ 1,610	$ 3,470	$ 56	$ -	$ -	$ -	$ -	$ -	$ -		
60	5767590 - STINE RD BAKERSFIELD R20A	$ 94	$ 1,055	$ 3,490	$ 11	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
61	5767641 - LOBO AVE MERCED R20A	$ 89	$ 178	$ 242	$ 4,527	$ 106	$ -	$ -	$ -	$ -	$ -	$ -		
62	5768919 - REED AVE, REEDLEY R20A	$ 70	$ 711	$ 1,633	$ 28	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
63	5769100 - GARZOLI AVE MCFARLAND R20A	$ 55	$ 202	$ 455	$ 10	$ 2,034	$ -	$ -	$ -	$ -	$ -	$ -		
64	5769478 - 12TH ST FORTUNA HUMBOLDT COUNTY R20A	$ 239	$ 197	$ 82	$ 3,671	$ (329)	$ -	$ -	$ -	$ -	$ -	$ -		
65	5769480 - MOSS LANDING MONTEREY COUNTY R20A	$ 595	$ 82	$ 231	$ 2,203	$ 3,427	$ -	$ -	$ -	$ -	$ -	$ -		
66	5772678 - BRIDGE ST COLUSA R20A	$ 46	$ 386	$ 1,568	$ 4,133	$ 26	$ -	$ -	$ -	$ -	$ -	$ -		

Workpaper Table 19-9
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 19, Rule 20A
Rule 20A Planning Order Detail Groupings
(Thousands of Dollars)

Line No.		2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Notes	Reference
67	5773664 - BRUCE RD DIST 16 CHICO R20A	$ -	$ 210	$ 2,622	$ 1,910	$ (809)	$ -	$ -	$ -	$ -	$ -	$ -		
68	5774027 - SECOND ST PH 2 YUBA CITY R20A	$ -	$ 0	$ (0)	$ 0	$ 0	$ -	$ -	$ -	$ -	$ -	$ -		
69	5774028 - ALMOND ST PARADISE R20A	$ -	$ 146	$ 293	$ 5,004	$ (699)	$ -	$ -	$ -	$ -	$ -	$ -		
70	5774029 - GREEN VALLEY RD EL DORADO CNTY R20A	$ -	$ 91	$ 111	$ 18	$ 36	$ -	$ -	$ -	$ -	$ -	$ -		
71	5775228 - LINCOLN PARK LOS ALTOS R20A	$ -	$ 6	$ 0	$ 0	$ (6)	$ -	$ -	$ -	$ -	$ -	$ -		
72	5775300 - MISSION BLVD DIST 30 HAYWARD	$ -	$ 12	$ 1,428	$ 1,321	$ 24	$ -	$ -	$ -	$ -	$ -	$ -		
73	5776174 - DOHERTY DR LARKSPUR R20A	$ -	$ 2	$ 6	$ 5	$ 1	$ -	$ -	$ -	$ -	$ -	$ -		
74	5776686 - BAY AVE CAPITOLA R20A	$ -	$ 0	$ 56	$ 51	$ 55	$ -	$ -	$ -	$ -	$ -	$ -		
75	5776687 - ELM AVE COALING R20A	$ -	$ 0	$ 0	$ 0	$ 0	$ -	$ -	$ -	$ -	$ -	$ -		
76	5776838 - DIAMOND SPRINGS PKWY PH1C EL DORADO CNTY	$ -	$ 45	$ 78	$ 23	$ 1,090	$ -	$ -	$ -	$ -	$ -	$ -		
77	5776839 - BROAD ST NEVADA CITY R20A	$ -	$ 34	$ 35	$ 8	$ 6	$ -	$ -	$ -	$ -	$ -	$ -		
78	5777078 - BONANZA ST WALNUT CREEK R20A	$ -	$ 6	$ (6)	$ (0)	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
79	5777581 - ANTOINETTE LN SO. SAN FRANCISCO R20A	$ -	$ 0	$ 157	$ 1,528	$ 960	$ -	$ -	$ -	$ -	$ -	$ -		
80	5777920 - CIVIC CENTER PLAZA LINCOLN R20A	$ -	$ 3	$ 116	$ 40	$ 47	$ -	$ -	$ -	$ -	$ -	$ -		
81	5777923 - LIVE OAK BLVD LIVE OAK R20A	$ -	$ 7	$ 363	$ 6,284	$ (910)	$ -	$ -	$ -	$ -	$ -	$ -		
82	5779401 - SIERRA COLLEGE LOOMIS R20A	$ -	$ -	$ 72	$ 9	$ 26	$ -	$ -	$ -	$ -	$ -	$ -		
83	5780240 - BONANZA ST WALNUT CREEK R20A	$ -	$ -	$ 96	$ 132	$ 82	$ -	$ -	$ -	$ -	$ -	$ -		
84	5780241 - DOHERTY DR LARKSPUR R20A	$ -	$ -	$ 33	$ 176	$ 101	$ -	$ -	$ -	$ -	$ -	$ -		
85	5780242 - LINCOLN PARK LOS ALTOS R20A	$ -	$ -	$ 9	$ 67	$ 3,372	$ -	$ -	$ -	$ -	$ -	$ -		
86	5781080 - STATE ROUTE 43 KERN COUNTY R20A	$ -	$ -	$ 83	$ 42	$ 82	$ -	$ -	$ -	$ -	$ -	$ -		
87	5782086 - NEWT'S EXPRESSWAY WINTERS R20A	$ -	$ -	$ 0	$ 51	$ 17	$ -	$ -	$ -	$ -	$ -	$ -		
88	5782087 - E COTATI AVE ROHNERT PARK R20A	$ -	$ -	$ 33	$ 44	$ 628	$ -	$ -	$ -	$ -	$ -	$ -		
89	5783490 - MNT RANCH RD PH 1 CALAVERAS CNTY R20A	$ -	$ -	$ 0	$ 0	$ 0	$ -	$ -	$ -	$ -	$ -	$ -		
90	5786578 - MISSION RD SOUTH SAN FRANCISCO R20A	$ -	$ -	$ -	$ -	$ 0	$ -	$ -	$ -	$ -	$ -	$ -		
91	5789241 - FREMONT BLVD FREMONT R20A	$ -	$ -	$ -	$ -	$ 46	$ -	$ -	$ -	$ -	$ -	$ -		
92	5789242 - PERALTA BLVD FREMONT R20A	$ -	$ -	$ -	$ -	$ 62	$ -	$ -	$ -	$ -	$ -	$ -		
93	5789803 - MARKET ST CONCORD R20A	$ -	$ -	$ -	$ -	$ 26	$ -	$ -	$ -	$ -	$ -	$ -		
94	5790864 - SKYWAY PARADISE R20A	$ -	$ -	$ -	$ -	$ 33	$ -	$ -	$ -	$ -	$ -	$ -		
95	5791196 - REDWOOD HWY MARIN COUNTY R20A	$ -	$ -	$ -	$ -	$ 2	$ -	$ -	$ -	$ -	$ -	$ -		
96	5792687 - WOLFE RD PH 2 SUNNYVALE R20A	$ -	$ -	$ -	$ -	$ 58	$ -	$ -	$ -	$ -	$ -	$ -		
97	5792896 - BULLARD AVE CLOVIS R20A	$ -	$ -	$ -	$ -	$ 22	$ -	$ -	$ -	$ -	$ -	$ -		
98	5794499 - DOWNTOWN STOCKTON PH 2 STOCKTON R20A	$ -	$ -	$ -	$ -	$ 1	$ -	$ -	$ -	$ -	$ -	$ -		
99	5794500 - DOWNTOWN STOCKTON PH 3 STOCKTON R20A	$ -	$ -	$ -	$ -	$ 1	$ -	$ -	$ -	$ -	$ -	$ -		
100	**Total Project Work < $3M**	**$ 10,452**	**$ 10,114**	**$ 26,743**	**$ 40,503**	**$ 13,996**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**		
101	**Portfolio Forecast Adjustment**													
102	5543621 - SYSPLAN R20A 30A	$ -	$ -	$ -	$ -	$ -	$ (9,608)	$ (21,760)	$ 5,035	$ 2,704	$ 31,478	$ 43,192		
103	**Total Portfolio Forecast Adjustment**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ (9,608)**	**$ (21,760)**	**$ 5,035**	**$ 2,704**	**$ 31,478**	**$ 43,192**		
104	**MWC 30 Subtotal - Project Work**	**$ 31,122**	**$ 28,264**	**$ 32,603**	**$ 45,758**	**$ 38,268**	**$ 47,288**	**$ 39,954**	**$ 39,876**	**$ 40,957**	**$ 42,060**	**$ 43,204**	(1)	WP 19-8, Line 8
105	**Additional Recorded Work**													
106	5509275 - MAPPING - OTHER MAPPING - SCV MWC 30	$ 1	$ (9)	$ 6	$ (1)	$ (3)	$ -	$ -	$ -	$ -	$ -	$ -		
107	5513200 - MWC 30 - CUSTOMER MARKETING	$ 0	$ 0	$ 1	$ 1	$ 1	$ -	$ -	$ -	$ -	$ -	$ -		
108	5537406 - RULE 20A PROGRAM SUPPORT-MWC30	$ -	$ -	$ -	$ 1	$ 6	$ -	$ -	$ -	$ -	$ -	$ -		
109	**MWC 30 Subtotal - Additional Recorded Work**	**$ 1**	**$ (8)**	**$ 7**	**$ 0**	**$ 4**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**		
110	**MWC 30 Total**	**$ 31,123**	**$ 28,255**	**$ 32,610**	**$ 45,758**	**$ 38,273**	**$ 47,288**	**$ 39,954**	**$ 39,876**	**$ 40,957**	**$ 42,060**	**$ 43,204**		

NOTES:
(1) Total Portfolio has been adjusted to align with the program forecast targets, please refer to WP 19-8

Workpaper Table 19-10
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 19
Rule 20A
Expenses by Major Work Category
(Thousands of Nominal Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference
1	IG	Manage Var Bal Acct Processes			797	1,219	(65)				WP 19 -13
2	**Total**				**797**	**1,219**	**(65)**				

Workpaper Table 19-11
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 19
Rule 20A
Expenses by Major Work Category
(Thousands of Base Year Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast
1	IG	Manage Var Bal Acct Processes			829	1,212	(65)			
2	**Total**				**829**	**1,212**	**(65)**			

Workpaper Table 19-12
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 19, Rule 20A
MWC IG Rule 20A Expense Summary
(Thousands of Dollars)

Line No.		2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Notes	Reference
1														
2														
3	5260972 - MWC 30 Cancelled Orders	$ -	$ -	$ 790	$ 605	$ (76)	$ -	$ -	$ -	$ -	$ -	$ -	(1)	
4	5261121 - MWC 30 GRC Audit			$ 7	$ 614	$ 11							(2)	
5	**MWC IG Rule 20A Total Expenses**	**$ -**	**$ -**	**$ 797**	**$ 1,219**	**$ (65)**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**		1

NOTES:

(1) As communities request projects to be cancelled, the expenditures for cancelled projects are expensed to MWC IG. This activity is not forecasted.

(2) Expenses for the audit of the Rule 20A program ordered by the 2017 GRC audit decision.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 19, RULE 20A
PROJECT SUMMARY – RULE 20A

Project Title: Rule 20A
Major Work Categories: 30
Planning Order Numbers: Various
Project Start Date: Various
Project Completion Date: Various
Operative Date (only applies to Capital): Various

Project Description

Rule 20A is one of three CPUC programs (Rule 20B and Rule 20C are the others) that convert overhead electric distribution facilities to underground. Rule 20A projects are based on qualifying resolutions passed by communities that designate specific boundaries for overhead to underground conversion projects.

Justification

The Rule 20A Program adopted by the Commission in 1967 (CPUC Decision 73078, 67 PUC 490) provides that utilities will jointly convert existing overhead electric distribution facilities to underground when a specific project has been determined to be in the general public interest This program is considered for beautification purposes only.

The key objectives of PG&E's Rule 20A Program are to ensure that overhead to underground conversion projects requested by a city or county government:

- are in the general public interest
- qualify under PG&E's tariff criteria
- are supported by a city or county adopted ordinance
- can be completed within the city or county's available Rule 20A work credit balance

Cost

The capital forecasts for specific projects are based on engineering estimates.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 19, RULE 20A
PROJECT SUMMARY – RULE 20A

Major Project Spending Estimates

	Recorded					Forecast						
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
CAPITAL												
5717278 - WRO RULE 20A - CENTRAL COAST	$ 1,423	$ 1,422	$ 102	$ 24	$ 34	$ 33	$ 686	$ 317	$ 2,720	$ 39	$ -	$ 6,799
5717279 - WRO RULE 20A - DE ANZA	$ 1,778	$ 185	$ 150	$ 42	$ 299	$ 4,138	$ 791	$ -	$ -	$ -	$ -	$ 7,383
5717281 - WRO RULE 20A - EAST BAY	$ 408	$ 1,115	$ 17	$ 51	$ 322	$ 1,369	$ 1,490	$ 2,761	$ 5,093	$ 1,071	$ -	$ 13,697
5717282 - WRO RULE 20A - FRESNO	$ 5,975	$ 4,920	$ (70)	$ (19)	$ 10	$ 1,202	$ 0	$ 706	$ 5,531	$ 145	$ -	$ 18,400
5717284 - WRO RULE 20A - LOS PADRES	$ 1,814	$ 3,892	$ 560	$ 11	$ 17	$ 1	$ -	$ 182	$ 2,601	$ 53	$ -	$ 9,132
5717285 - WRO RULE 20A - MISSION	$ 4,239	$ 3,276	$ (180)	$ 57	$ 49	$ 31	$ 4,242	$ 248	$ -	$ -	$ -	$ 11,961
5717287 - WRO RULE 20A - SONOMA	$ 30	$ 11	$ (58)	$ 6	$ 11	$ 9	$ 542	$ 1,908	$ 3,971	$ -	$ -	$ 6,429
5717288 - WRO RULE 20A - NORTH VALLEY	$ 15	$ 0	$ 0	$ 0	$ 0	$ 0	$ 855	$ 2,682	$ 2,550	$ -	$ -	$ 6,102
5717292 - WRO RULE 20A - SAN JOSE	$ 2,190	$ 318	$ 2,528	$ 238	$ 587	$ 2	$ 33	$ 3,622	$ 2,180	$ 4,287	$ 11	$ 15,995
5717293 - WRO RULE 20A - SIERRA	$ 1,130	$ 1,474	$ 149	$ 2,326	$ 4,977	$ 709	$ -	$ -	$ -	$ -	$ -	$ 10,766
5717294 - WRO RULE 20A - STOCKTON	$ 240	$ 55	$ 59	$ 39	$ 60	$ 60	$ 1,197	$ 987	$ 2,239	$ 3,760	$ -	$ 8,696
5767578 - BAILEY RD CONTRA COSTA CNTY R20A	$ 246	$ 259	$ 329	$ 1,155	$ 6,232	$ 703	$ -	$ -	$ -	$ -	$ -	$ 8,925
5767579 - GRIZZLY PEAK BLVD BERKELEY R20A	$ 389	$ 434	$ 304	$ 128	$ 432	$ 572	$ 6,764	$ 2,600	$ 246	$ -	$ -	$ 11,869
5767581 - R20A - MAIN ST, SODA BAY	$ 89	$ 53	$ 45	$ 46	$ 52	$ 113	$ 4,586	$ 79	$ -	$ -	$ -	$ 5,063
5767589 - WOLFE RD SUNNYVALE R20A	$ 123	$ 94	$ 70	$ 127	$ 321	$ 3,409	$ 4,075	$ -	$ -	$ -	$ -	$ 8,218
5768918 - DAN WARD RD MERCED COUNTY R20A	$ 3	$ 1	$ 0	$ 0	$ 0	$ -	$ 211	$ 757	$ 3,454	$ 955	$ -	$ 5,381
5768920 - JEFFERSON ST NAPA R20A	$ 110	$ 145	$ 74	$ 39	$ 141	$ 1,809	$ 3,012	$ -	$ -	$ -	$ -	$ 5,331
5769479 - MIDDLEFIELD RD PH2 SAN MATEO COUNTY R20A	$ 466	$ 107	$ 130	$ 50	$ 155	$ 17	$ 4,959	$ -	$ -	$ -	$ -	$ 5,885
5770721 - CIVIC CENTER SANTA MARIA R20A	$ 0	$ 11	$ 1	$ 4	$ 49	$ 135	$ 710	$ 2,891	$ 1,643	$ -	$ -	$ 5,444
5773022 - SPRUCE AVE SO SAN FRANCISCO R20A	$ 1	$ 0	$ 0	$ 0	$ 0	$ -	$ 556	$ 1,315	$ 2,334	$ -	$ -	$ 4,205
5773319 - BLACKSTONE AVE & ABBY ST FRESNO	$ 0	$ 186	$ 365	$ 156	$ 148	$ 7,970	$ 6,442	$ 140	$ -	$ -	$ -	$ 15,408
5773661 - BRADLEY RD SANTA BARBARA CNTY R20A	$ -	$ 90	$ 200	$ 61	$ 193	$ 5,821	$ -	$ -	$ -	$ -	$ -	$ 6,365
5774462 - SOUTH MAIN ST MILPITAS R20A	$ -	$ 15	$ 117	$ 147	$ 118	$ 2,071	$ 2,422	$ -	$ -	$ -	$ -	$ 4,890
5774658 - NORTH ESPLANADE DIST 17 CHICO R20A	$ -	$ 0	$ 7	$ 0	$ 1	$ 233	$ 4,285	$ -	$ -	$ -	$ -	$ 4,527
5774659 - WARNER ST DIST 18 CHICO R20A	$ -	$ 0	$ 145	$ 114	$ 1,029	$ 3,889	$ -	$ -	$ -	$ -	$ -	$ 5,177
5775498 - 34TH STREET BAKERSFIELD R20A	$ -	$ 15	$ 143	$ 60	$ 186	$ 2,971	$ 246	$ -	$ -	$ -	$ -	$ 3,622
5776175 - FULTON RD SANTA ROSA R20A	$ -	$ 21	$ 168	$ 45	$ 2,002	$ 2,530	$ -	$ -	$ -	$ -	$ -	$ 4,766
5776998 - 4TH ST EUREKA R20A	$ -	$ 51	$ 274	$ 94	$ 3,996	$ 1,898	$ -	$ -	$ -	$ -	$ -	$ 6,312
5780282 - DOWNTOWN STOCKTON CITY OF STOCKTON	$ -	$ -	$ 90	$ 96	$ 2,145	$ 4,713	$ -	$ -	$ -	$ -	$ -	$ 7,044
5781983 - MISSOURI FLAT RD EL DORADO CNTY R20A	$ -	$ -	$ 85	$ 30	$ 118	$ 5,902	$ 167	$ -	$ -	$ -	$ -	$ 6,301
5782681 - FREESTONE SONOMA CNTY R20A	$ -	$ -	$ 56	$ 11	$ 106	$ 186	$ 3,988	$ 66	$ -	$ -	$ -	$ 4,412
5783488 - CHURCH ST FRESNO R20A	$ -	$ -	$ 0	$ 26	$ 95	$ 295	$ 2,644	$ -	$ -	$ -	$ -	$ 3,060
5783489 - GENEVA AVE PH 2 DALY CITY R20A	$ -	$ -	$ 0	$ 5	$ 1	$ -	$ (113)	$ 4,664	$ -	$ -	$ -	$ 4,557
5783491 - REEDLEY SPORTS PARK REEDLEY R20A	$ -	$ -	$ 0	$ 15	$ 1	$ 1	$ 47	$ 274	$ 3,073	$ 18	$ -	$ 3,429
5784380 - NOVATO BLVD NOVATO R20A	$ -	$ -	$ -	$ 70	$ 155	$ 3,368	$ 41	$ -	$ -	$ -	$ -	$ 3,635
5789243 - HWY 99 EAST TEHAMA COUNTY R20A	$ -	$ -	$ -	$ -	$ 107	$ 115	$ 610	$ 3,366	$ 368	$ -	$ -	$ 4,567
5790337 - MONTEREY RD SAN JOSE R20A	$ -	$ -	$ -	$ -	$ 121	$ 56	$ 4,048	$ 73	$ -	$ -	$ -	$ 4,298
5791195 - NICASIO VALLEY RD MARIN COUNTY R20A	$ -	$ -	$ -	$ -	$ 0	$ 131	$ 464	$ 2,808	$ 250	$ 253	$ -	$ 3,907
5792865 - WILLIAMS RD PH 1 SALINAS R20A	$ -	$ -	$ -	$ -	$ 1	$ 435	$ 1,715	$ 2,396	$ -	$ -	$ -	$ 4,547
Other Planning Orders Under $3M	$ 10,452	$ 10,114	$ 26,743	$ 40,503	$ 13,996	$ -	$ -	$ -	$ -	$ -	$ -	$ 101,809
Portfolio Forecast Adjustment	$ -	$ -	$ -	$ -	$ -	$ (9,608)	$ (21,760)	$ 5,035	$ 2,704	$ 31,478	$ 43,192	$ 51,041
TOTAL PROJECT COSTS	**$ 31,122**	**$ 28,264**	**$ 32,603**	**$ 45,758**	**$ 38,268**	**$ 47,288**	**$ 39,954**	**$ 39,876**	**$ 40,957**	**$ 42,060**	**$ 43,204**	**$ 429,354**

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 19, RULE 20A
PROJECT SUMMARY – RULE 20A

Benefits

Customer Satisfaction: Communities that participate in the Rule 20A program benefit by improved visual aesthetic of the qualifying areas, either alone or in combination with other improvement projects being undertaken by the community.

Alternatives Considered

Rule 20A Forecast is based on expected customer demand. Customer Satisfaction would be negatively impacted if the requested overhead to underground conversion were not performed or executed in a timely manner due to budget limitations. Rule 20A is in a one-way balancing account and therefore any costs exceeding the one-way balancing account would come from shareholders.

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 20, ELECTRIC DISTRIBUTION DATA MANAGEMENT AND TECHNOLOGY

TABLE OF CONTENTS

Subject	Page No.
Expense Workpapers	
Workpaper Table 20-1: Expenses by Major Work Category - Nominal Dollars	WP 20-1
Workpaper Table 20-2: Expenses by Major Work Category - Base Year Dollars	WP 20-2
Workpaper Table 20-3: Major Work Category GE - Recorded Walk	WP 20-3
Workpaper Table 20-4: Major Work Category GE - Forecast Walk	WP 20-4
Workpaper Table 20-5: Expenses by Major Work Category JV - Recorded Walk	WP 20-5
Workpaper Table 20-6: Expenses by Major Work Category JV - Forecast Walk	WP 20-6
Workpaper Table 20-7: MWC GE - Electric Distribution Mapping Forecast Details	WP 20-7
Workpaper Table 20-8: Expenses by Major Work Category JV - Forecast Details	WP 20-8

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 20, ELECTRIC DISTRIBUTION DATA MANAGEMENT AND TECHNOLOGY

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Capital Workpapers	
Workpaper Table 20-9: Capital Expenditures by Major Work Category	WP 20-9
Workpaper Table 20-10: Forecast Capital Expenditures Summary	WP 20-10
Workpaper Table 20-11: Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million	WP 20-11
Workpaper Table 20-12: Recorded and Forecast Capital Expenditures Details - Other Work	WP 20-12
Workpaper Table 20-13: Capital Major Work Category 2F - Recorded Walk	WP 20-13
Workpaper Table 20-14: Capital Major Work Category 2F - Forecast Walk	WP 20-14
Workpaper Table 20-15: Capital Major Work Category 21 - Recorded Walk	WP 20-15
Workpaper Table 20-16: Capital Major Work Category 21 - Forecast Walk	WP 20-16
Workpaper Table 20-17: Capital Major Work Category 2F - Forecast Details	WP 20-17
Workpaper Table 20-18: Capital Major Work Category 21 - Forecast Details	WP 20-18

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 20, ELECTRIC DISTRIBUTION DATA MANAGEMENT AND TECHNOLOGY

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Project Summary – GIS Technical Enhancements	WP 20-19
Project Summary – GIS Asset Data Improvements	WP 20-23
Project Summary – Data Management and Analytics	WP 20-28
Project Summary – Asset Management & Risk Analysis	WP 20-32
Project Summary – Billing and Rates	WP 20-36
Project Summary – Customer Service	WP 20-39
Project Summary – Field Work Management	WP 20-42
Project Summary – Safety, Governance, Regulatory, and Compliance	WP 20-46

Workpaper Table 20-1
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20
Electric Distribution Data Management and Technology
Expenses by Major Work Category
(Thousands of Nominal Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference
1	GE	E Dist Mapping	2,827	2,249	4,326	175	8,845	15,888	14,108	21,524	WP 20-3, WP 20-4
2	JV	Maintain IT Apps & Infra	2,233	6,054	5,860	1,647	2,810	3,777	3,333	4,501	WP 20-5, WP 20-6
3	**Total**		**5,060**	**8,303**	**10,186**	**1,822**	**11,655**	**19,665**	**17,441**	**26,026**	

Workpaper Table 20-2
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20
Electric Distribution Data Management and Technology
Expenses by Major Work Category
(Thousands of Base Year Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast
1	GE	E Dist Mapping	3,067	2,393	4,395	195	8,845	15,841	13,728	20,411
2	JV	Maintain IT Apps & Infra	2,408	6,397	5,963	1,639	2,810	3,752	3,222	4,235
3	**Total**		**5,476**	**8,790**	**10,358**	**1,834**	**11,655**	**19,593**	**16,951**	**24,646**

Workpaper Table 20-3
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 20, Electric Distribution Data Management and Technology
Major Work Category GE - Recorded Walk
MWC GE - E Dist Mapping
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded/Adjusted**	**2,827**			
2		Base Mapping	(508)		Reduction in electric mapping internal work based on demand.	WP 20-7 Line 2
3		GIS Asset Data Improvements	(70)		Completion of Geospatial Corrections project.	WP 20-7 Line 4
4		**Net Change**	**(578)**			
5	**2017**	**Recorded/Adjusted**	**2,249**			
6		Base Mapping	(717)		Completion of Franchise Footage Expense Work Project including manual annexations.	WP 20-7 Line 2
7		GIS Asset Data Improvements	2,694		Increase due to implementation of Field Asset Inventory project.	WP 20-7 Line 4
8		Data Management and Analytics	100		Immaterial Change.	WP 20-7 Line 5
9		**Net Change**	**2,077**			
10	**2018**	**Recorded/Adjusted**	**4,326**			
11		Base Mapping	(414)		Completion of MAP Review and Refresh Process and Emergency Response for Mapping Personnel.	WP 20-7 Line 2
12		GIS Technical Enhancements	36		Implementation of Offline Web Viewer project.	WP 20-7 Line 3
13		GIS Asset Data Improvements	(3,773)		Decrease due to cancellation of Field Asset Inventory and directional change to conflation & inspection-related work.	WP 20-7 Line 4
14		Data Management and Analytics	0		No significant change.	WP 20-7 Line 5
15		**Net Change**	**(4,151)**			
16	**2019**	**Recorded/Adjusted**	**175**			
17		Base Mapping	894		Increase in Electric Mapping Internal Work due wildifre-related map corrections.	WP 20-7 Line 2
18		GIS Technical Enhancements	675		GIS Change Management for stability project and CPUC Data Request Support.	WP 20-7 Line 3
19		GIS Asset Data Improvements	3,048		Increase due to conflation Tier 2/3 Work and SF Streetlight Reconciliation.	WP 20-7 Line 4
20		Data Management and Analytics	4,052		Implementation of DM&A Organization including data quality improvements, data governance structures, and data product development.	WP 20-7 Line 5
21		**Net Change**	**8,670**			
22	**2020**	**Recorded/Adjusted**	**8,845**			

Workpaper Table 20-4
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 20, Electric Distribution Data Management and Technology
Major Work Category GE - Forecast Walk
MWC GE - E Dist Mapping
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded**	**8,845**			
2		Base Mapping	210		Increase in spending on map corrections for asset data corrections driven by enhanced system inspections.	WP 20-7 Line 2
3		GIS Technical Enhancements	189		Increase in GIS system change requests.	WP 20-7 Line 3
4		GIS Asset Data Improvements	6,438		Increase due to Tier 1 conflation, East Bay Underground, and Streetlight projects.	WP 20-7 Line 4
5		Data Management and Analytics	2,348		Implementation of WSD Data Standards work and implementation of enterprise data standards.	WP 20-7 Line 5
6		Forecast Adjustment/Escalation	(2,143)		Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.	WP 20-7 Line 6
7		**Net Change**	**7,043**			
8	**2021**	**Forecast**	**15,888**			
9		Base Mapping	0		No significant change.	WP 20-7 Line 2
10		GIS Technical Enhancements	0		No significant change.	WP 20-7 Line 3
11		GIS Asset Data Improvements	0		No significant change.	WP 20-7 Line 4
12		Data Management and Analytics	(1,777)		WSD automation work completed.	WP 20-7 Line 5
13		Forecast Adjustment/Escalation	(3)		No significant change.	WP 20-7 Line 6
14		**Net Change**	**(1,780)**			
15	**2022**	**Forecast**	**14,108**			
16		Base Mapping	(1,250)		Enhanced Inspection Plan work moving to GIS Asset Data Improvements.	WP 20-7 Line 2
17		GIS Technical Enhancements	5,865		Implementation of NextGen GIS project.	WP 20-7 Line 3
18		GIS Asset Data Improvements	125		Immaterial change in forecast.	WP 20-7 Line 4
19		Data Management and Analytics	530		Immaterial change in forecast.	WP 20-7 Line 5
20		Forecast Adjustment/Escalation	2,146		No forecast adjustment in 2023.	WP 20-7 Line 6
21		**Net Change**	**7,416**			
22	**2023**	**Forecast**	**21,524**			

Workpaper Table 20-5
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 20, Electric Distribution Data Management and Technology
Major Work Category JV - Recorded Walk
MWC JV - Maintain and Operate Applications and Infrastructure
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Explanation	Reference
1	**2016**	**Recorded**	**2,233**			
2		All Programs	3,820		MWC JV comprises a number of individual IT projects in any given year with some projects reaching completion, some in-flight, and additional projects launching. Increase in expense includes spending on a number of new projects, including Arcos 2.0, DCC COE Integration, Smart Distribution Ops, and Express Connects.	WP 20-8 Line 12
3	**2017**	**Recorded**	**6,054**			
4		All Programs	(194)		No significant change.	WP 20-8 Line 12
5	**2018**	**Recorded**	**5,860**			
6		All Programs	(4,212)		Decrease in spending associated with completion of a number of technology projects, primarily Arcos 2.0, Express Connects, Smart Distribution Ops, Permiting Process Initiative, and EES Phase 2.	WP 20-8 Line 12
7	**2019**	**Recorded**	**1,647**			
8		All Programs	1,163		Increase in spending primarily associated with spending on new technology projects, primarily including Asset Failure Analysis for Distribution, EDGIS/LBGIS Infra/App Re-Arch Phase 2, and Joint Pole EES Integration.	WP 20-8 Line 12
9	**2020**	**Recorded Adjusted**	**2,810**			

Workpaper Table 20-6
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 20, Electric Distribution Data Management and Technology
Major Work Category JV - Forecast Walk
MWC JV - Maintain and Operate Applications and Infrastructure
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**2,810**			
2		All Programs	967		MWC JV comprises a number of individual IT projects in any given year with some projects reaching completion, some in-flight, and additional projects launching. Increase in expense includes spending on Smart Connect, EO Mobile Offline Viewer, and offset by decreased spending on projects nearing completion, e.g. EDGIS Rearchitecture.	WP 20-8 Line 12
3	**2021**	**Forecast**	**3,777**			
4		All Programs	(444)		Decrease is due to reduced spending on the Asset Management and Risk Analysis (JUMP Phase 2, Track 2) and Data Enablement (GeoHub for New Business) value streams, partially offset by an increase in spending on Field Work Management (Job Force).	WP 20-8 Line 12
5	**2022**	**Forecast**	**3,333**			
6		All Programs	1,169		Increase in spending due to increased spending on Field Work Management value stream (Graphic Work Design Platform, JobForce).	WP 20-8 Line 12
7	**2023**	**Forecast**	**4,501**			

Workpaper Table 20-7
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management and Technology
MWC GE - Electric Distribution Mapping Forecast Details
(Thousands of Nominal Dollars)

Line No.		2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	Assumptions	Reference
1	**MWC GE - Electric Distribution Mapping**										
2	Base Mapping	$ 2,174	$ 1,666	$ 949	$ 536	$ 1,430	$ 1,640	$ 1,640	$ 391	(1)	
3	GIS Technical Enhancements	$ -	$ -	$ -	$ 36	$ 711	$ 900	$ 900	$ 6,765		WP 20-19
4	GIS Asset Data Improvements	$ 652	$ 583	$ 3,277	$ (496)	$ 2,552	$ 8,991	$ 8,991	$ 9,115		WP 20-23
5	Data Management and Analytics	$ -	$ -	$ 100	$ 100	$ 4,152	$ 6,500	$ 4,723	$ 5,253		WP 20-28
6	Forecast Adjustment	$ -	$ -	$ -	$ -	$ -	$ (2,143)	$ (2,146)	$ -	(2)	Chapter 2 Section D
7	**Total MWC GE**	**$ 2,827**	**$ 2,249**	**$ 4,326**	**$ 175**	**$ 8,845**	**$ 15,888**	**$ 14,108**	**$ 21,524**		

Forecast Assumptions and Details:

(1) Base Mapping includes activities such as annexations (city/county boundary and tax changes) and delineations (internal mapping information to external agencies, e.g.. engineering firms, other utilities) and asset data corrections based on field verifications. The forecast decrease from 2021 to 2023 is due to the allocation of funds being reflected in the GIS Asset Data Improvement function, since the work is primarily due to a temporary increase of map corrections from the enhanced inspection plan. Once the project is completed, the cost will be reflected back in the Base Mapping function.

(2) Through the process of prioritizing work across areas and in accordance with the 2023 GRC forecast process outlined in Exhibit (PG&E-4) Chapter 2, negative forecasts were added to ensure the total forecasts did not exceed the POR forecast.

Workpaper Table 20-8
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management and Technology
Major Work Category JV - Forecast Details
(Thousands of Nominal Dollars)

Line No.	Description	Recorded 2016	Recorded 2017	Recorded 2018	Recorded 2019	Recorded 2020	Forecast 2021	Forecast 2022	Forecast 2023	Assumptions	Reference
1	**Information Technology**										
2	Asset Management & Risk Analysis	$ 445	$ 1,144	$ 605	$ 618	$ 1,455	$ 444	$ 420	$ 372		WP 20-32
3	Billing & Rates	$ 123	$ 442	$ 243	$ 1	$ 69	$ 44	$ 100	$ 100		WP 20-36
4	Customer Service	$ -	$ 254	$ 272	$ 153	$ 0	$ 273	$ 199	$ 120		WP 20-39
5	Data Enablement	$ 0	$ 241	$ 1	$ 5	$ 27	$ 448	$ -	$ -	(1)	
6	Enterprise Resource Management	$ 108	$ 176	$ -	$ 198	$ 406	$ -	$ -	$ -	(2)	
7	Event Management	$ 32	$ -	$ -	$ -	$ 51	$ -	$ -	$ -	(3)	
8	Field Work Management	$ 720	$ 1,710	$ 1,928	$ 224	$ 132	$ 785	$ 1,158	$ 2,267		WP 20-42
9	IT Electric Distribution Non-WF NPAE	$ 806	$ 349	$ 790	$ 413	$ 669	$ 700	$ 700	$ 701	(4)	
10	Safety, Gov, Reg, Compliance	$ -	$ 441	$ 654	$ 36	$ -	$ 1,084	$ 756	$ 941		WP 20-46
11	System Operation & Control	$ -	$ 1,296	$ 1,366	$ 0	$ -	$ -	$ -	$ -	(5)	
12	**Total MWC JV**	**$ 2,233**	**$ 6,054**	**$ 5,860**	**$ 1,647**	**$ 2,810**	**$ 3,777**	**$ 3,333**	**$ 4,501**		

Forecast Assumptions and Details

(1) Data Enablement: The work being forecast in 2021 is a new project, GeoHub for Business. This project forecast was developed using the IT Project Estimating Tool. Currently, no work is planned in this Value Stream during the GRC period. The Data Enablement Value Stream focuses on the technology solutions used to manage PG&E data, data relationships, and data quality; to make data accessible for analysis; to perform automated analysis; and to present data and analytic results in understandable formats from which users can derive insight for decision-making.

(2) Enterprise Resource Management: PG&E is currently not forecasting any project-based technology investments in the Enterprise Resource Management Value Stream during the 2023-2026 GRC period. The Enterprise Resource Management Value Stream focuses on the technology solutions used to plan, understand, and manage PG&E's human, financial, and physical resources.

(3) Event Management: PG&E is currently not forecasting any project-based technology investments in the Event Management Value Stream during the 2023-2026 GRC period. The Event Management Value Stream focuses on the technology solutions used to coordinate planned events (such as maintenance outages) and to manage the Company's response to emergencies, utility asset failures, service disruptions, and other unplanned system-wide or localized events.

(4) NPAE: Non-Project Application Enhancements refer to minor System-of-Record enhancements requested by users on an ad-hoc basis. PG&E's forecast for this work is based on an anticipated need for NPAE spending roughly in line with 2020 recorded costs.

(5) System Operation & Control: PG&E is currently not forecasting any project-based technology investments in the System Operation & Control Value Stream during the 2023-2026 GRC period. The System Operation and Control Value Stream focuses on the technology solutions that directly enable the monitoring, operation, and control of PG&E's gas, electric, and generation systems, including the edge networks that connect monitoring, automation, and other field devices to PG&E's core data networks.

Workpaper Table 20-9
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 20
Electric Distribution Data Management and Technology
Capital Expenditures by Major Work Category
(Thousands of Nominal Dollars)

			Capital Expenditures											
No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	21	Misc Capital	-	-	10	18	3	-	1,604	1,953	2,392	2,938	3,620	WP 20-15, WP 20-16
2	2F	Build IT Apps & Infra	21,715	21,077	19,586	5,084	22,788	17,696	21,997	17,987	16,597	16,499	18,506	WP 20-13, WP 20-14
3		**Grand Total**	**21,715**	**21,077**	**19,596**	**5,102**	**22,791**	**17,696**	**23,602**	**19,941**	**18,989**	**19,438**	**22,126**	

Workpaper Table 20-10
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 20
Electric Distribution Data Management and Technology
Forecast Capital Expenditures Summary
(Thousands of Nominal Dollars)

		Capital Expenditures							
Line No.	Description	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	Projects > $3 Million*	11,347	16,860	23,602	19,941	18,989	19,438	22,126	WP 20-11
2	Other Work	10,870	836	-	-	-	-	-	WP 20-12
3	**Total**	**22,217**	**17,696**	**23,602**	**19,941**	**18,989**	**19,438**	**22,126**	

4 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 20-11
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 20
Electric Distribution Data Management and Technology
Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million*
(Thousands of Nominal Dollars)

					CWIP	Capital Expenditures							
Line No.	Planning Order	Description	MWC	Operative Date	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Subtotal	Reference
	MWC - 21	**Misc Capital**											
1	5795511	SYSPLAN ED 21# IT	21	Dec-2020	-	-	1,604	1,953	2,392	2,938	3,620	12,508	
2	**Total**				**-**	**-**	**1,604**	**1,953**	**2,392**	**2,938**	**3,620**	**12,508**	WP 20-18
	MWC - 2F	**Build IT Apps & Infra**											
3	5786478	ElecOps - Smart Connect (One Portal) CAP	2F	Dec-2021	3,878	-	-	-	-	-	-	3,878	
4	5790139	EDGIS/LBGIS Infra/App Re-Arch Ph 2 (CAP)	2F	Dec-2022	7,468	-	-	-	-	-	-	7,468	
5	5793280	Field Work Management_ED (C)	2F	Dec-2020	-	1,138	2,974	5,023	4,215	1,585	1,610	16,545	
6	5793283	Customer Service_ED (C)	2F	Dec-2020	-	5,336	3,273	625	-	980	3,080	13,294	
7	5793284	Billing & Rates_ED (C)	2F	Dec-2020	-	2,807	2,278	1,250	3,511	5,940	5,810	21,596	
8	5793287	Asset Mgt & Risk Analysis_ED_R (C)	2F	Dec-2020	-	402	2,975	2,133	2,888	2,000	2,000	12,398	
9	5793958	Business Technology Cap	2F	Dec-2020	-	7,178	-	-	-	-	-	7,178	
10	5795562	SYSPLAN ED 2F#	2F	Dec-2020	-	-	10,497	8,956	5,983	5,994	6,006	37,437	
11	**Total**				**11,347**	**16,860**	**21,997**	**17,987**	**16,597**	**16,499**	**18,506**	**119,793**	WP 20-17
12		**Grand Total**			**11,347**	**16,860**	**23,602**	**19,941**	**18,989**	**19,438**	**22,126**	**132,301**	

13 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 20-12
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 20
Electric Distribution Data Management and Technology
Recorded and Forecast Capital Expenditures Details - Other Work*
(Thousands of Nominal Dollars)

			Capital Expenditures											
Line No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	21	Misc Capital	-	-	10	18	3	-	-	-	-	-	-	WP 20-18
2	2F	Build IT Apps & Infra	21,715	21,077	19,586	4,835	11,693	836	-	-	-	-	-	WP 20-17
3	**Grand Total**		**21,715**	**21,077**	**19,596**	**4,853**	**11,696**	**836**	**-**	**-**	**-**	**-**	**-**	

4 * Excludes projects greater than $3M

Workpaper Table 20-13
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management and Technology
Major Work Category 2F - Recorded Walk
MWC 2F - Develop and Enhance Applications and Infrastructure
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Explanation	Reference
1	**2016**	**Recorded**	**21,715**			
2		All Programs	(638)		MWC 2F comprises a number of individual IT projects in any given year with some projects reaching completion, some in-flight, and additional projects launching. The decline in yearly spending is due to projects nearing or reaching completion, incl. Enterprise Estimating Solution (EES) and FAS Timecard Automation Pilot, partially offset by increased spending in other projects, incl. Pole Loading Calculator, EGI SAp Infrastructure ENOS, Phase 4 and Express Connects.	WP 20-17 Line 12
3	**2017**	**Recorded**	**21,077**			
4		All Programs	(1,492)		Decline in yearly spending is due to a number of projects reaching completion, incl. EGI SAP Infrastructure ENOS, Phase 4, System Tools for Asset Risk, and EES. This is partially offset by increased spending in other projects, incl. EES Phase 2, Express Connects, and JUMP.	WP 20-17 Line 12
5	**2018**	**Recorded**	**19,586**			
6		All Programs	(14,502)		Decline in yearly spending is due to a number of significant projects nearing completion, incl. EES Phase 2, Express Connects, and EGI SAP Infrastructure ENOS, Phase 4.	WP 20-17 Line 12
7	**2019**	**Recorded**	**5,084**			
8		All Programs	17,704		Increase in yearly spending due to increased spending on a number of new and in-flight projects, incl. EGI 2019 Tariff Changes, Smart Connect (One Portal), EDGIS/LBGIS infra/App re-Arch, Phase 2, Meter Set Upgrades and EES Contracts.	WP 20-17 Line 12
9	**2020**	**Recorded Adjusted**	**22,788**			

Workpaper Table 20-14
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management and Technology
Major Work Category 2F - Forecast Walk
MWC 2F - Develop and Enhance Applications and Infrastructure
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**22,788**			
2		All Programs	(5,092)		MWC 2F comprises a number of individual IT projects in any given year with some projects reaching completion, some in-flight, and additional new projects launching. Decrease in spending is due to completion of projects, including EDGIS/LBGIS Infra/App Re-Acrh Phase 2 and Meter Set Technology Upgrade.	WP 20-17 Line 12
3	**2021**	**Forecast**	**17,696**			
4		All Programs	4,301		Increase in forecast spending is due to spending on new projects, including JUMP Phase 2 (Asset Management and Risk Analysis value stream), JobForce and External Application Design Tool (Field Work Management value stream).	WP 20-17 Line 12
5	**2022**	**Forecast**	**21,997**			
6		All Programs	(4,010)		Decline in spending due to projects completing, including JUMP Phase 2 (Asset Management and Risk Analysis value stream), JobForce and External Application Design Tool (both Field Work Management value stream).	WP 20-17 Line 12
7	**2023**	**Forecast**	**17,987**			
8		All Programs	(1,391)		Decline in spending due to projects that are expected to reach completion, including the External Applicant Design Tool (EES Lite) and the Preapplication Tool (Customer Service value stream). Planned new technology investments include development of a modernized, integrated and graphics-based construction design software (Graphic Work Design Platform).	WP 20-17 Line 12
9	**2024**	**Forecast**	**16,597**			
10		All Programs	(97)		Electric Operations IT project spending is expected to remain flat. Planned new technology capability investments include a digital twin model of PG&E distribution grid (Asset Management & Risk Analytics value stream) and continued digitization and integration of work management processes and digital design platforms.	WP 20-17 Line 12
11	**2025**	**Forecast**	**16,499**			
12		All Programs	2,007		A forecast increase in technology investment is anticipated to achieve a number of Electric Distribution's long term technology strategies, including full digitization and integration of work management processes for all work types.	WP 20-17 Line 12
13	**2026**	**Forecast**	**18,506**			

Workpaper Table 20-15
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 20, Electric Distribution Data Management and Technology
Major Work Category 21 - Recorded Walk
MWC 21 - Misc. Capital
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2017**	**Recorded/Adjusted**	**0**			
2		Base Mapping	10		Immaterial change in recorded dollars.	WP 20-18 Line 1
3		**Net Change**	**10**			
4	**2018**	**Recorded/Adjusted**	**10**			
5		Base Mapping	8		Immaterial change in recorded dollars.	WP 20-18 Line 1
6		**Net Change**	**8**			
7	**2019**	**Recorded/Adjusted**	**18**			
8		Base Mapping	(15)		Immaterial change in recorded dollars.	WP 20-18 Line 1
9		**Net Change**	**(15)**			
10	**2020**	**Recorded/Adjusted**	**3**			

Workpaper Table 20-16
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 20, Electric Distribution Data Management and Technology
Major Work Category 21 - Forecast Walk
MWC 21 - Misc. Capital
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded**	**3**			
2		Base Mapping	(3)		Immaterial change in forecast.	WP 20-18 Line 1
3		**Net Change**	**(3)**			
4	**2021**	**Forecast**	**0**			
5		Base Mapping	233		First year of capital forecast costs needed for Base Mapping activities.	WP 20-18 Line 1
6		GIS Technical Enhancements	349		First year of capital forecast costs needed for GIS Technical Enhancements activities.	WP 20-18 Line 2
7		Data Management and Analytics	1,023		First year of capital forecast costs needed for Data Management and Analytics activities.	WP 20-18 Line 3
8		**Net Change**	**1,604**			
9	**2022**	**Forecast**	**1,604**			
10		Base Mapping	31		Forecast increase due to escalation.	WP 20-18 Line 1
11		GIS Technical Enhancements	46		Forecast increase due to escalation.	WP 20-18 Line 2
12		Data Management and Analytics	272		Forecast increase due to escalation.	WP 20-18 Line 3
13		**Net Change**	**349**			
14	**2023**	**Forecast**	**1,953**			
15		Base Mapping	34		Forecast increase due to escalation.	WP 20-18 Line 1
16		GIS Technical Enhancements	50		Forecast increase due to escalation.	WP 20-18 Line 2
17		Data Management and Analytics	355		Forecast increase due to escalation.	WP 20-18 Line 3
18		**Net Change**	**439**			
19	**2024**	**Forecast**	**2,392**			
20		Base Mapping	38		Forecast increase due to escalation.	WP 20-18 Line 1
21		GIS Technical Enhancements	57		Forecast increase due to escalation.	WP 20-18 Line 2
22		Data Management and Analytics	451		Forecast increase due to escalation.	WP 20-18 Line 3
23		**Net Change**	**546**			
24	**2025**	**Forecast**	**2,938**			
25		Base Mapping	43		Forecast increase due to escalation.	WP 20-18 Line 1
26		GIS Technical Enhancements	64		Forecast increase due to escalation.	WP 20-18 Line 2
27		Data Management and Analytics	575		Forecast increase due to escalation.	WP 20-18 Line 3
28		**Net Change**	**681**			
29	**2026**	**Forecast**	**3,620**			

Workpaper Table 20-17
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management and Technology
Major Work Category 2F – Forecast Details
(Thousands of Nominal Dollars)

Line No.	Description	Recorded 2016	Recorded 2017	Recorded 2018	Recorded 2019	Recorded 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Assumptions	Reference
1	**Information Technology**													
2	Asset Management & Risk Analysis	$ 4,163	$ 9,034	$ 4,450	$ 803	$ 7,576	$ 1,890	$ 4,602	$ 2,819	$ 3,682	$ 3,049	$ 3,275		WP 20-32
3	Billing & Rates	$ 4,870	$ 3,342	$ 2,858	$ 2,267	$ 5,046	$ 4,719	$ 7,264	$ 5,347	$ 6,403	$ 6,055	$ 6,514		WP 20-36
4	Customer Service	$ -	$ 604	$ 1,979	$ 541	$ 3,679	$ 8,942	$ 5,530	$ 831	$ 1,000	$ 1,980	$ 3,080		WP 20-39
5	Data Enablement	$ -	$ 586	$ 17	$ -	$ -	$ 232	$ -	$ -	$ -	$ -	$ -	(1)	
6	Enterprise Resource Management	$ 4,102	$ 469	$ 697	$ 237	$ 10	$ -	$ -	$ -	$ -	$ -	$ -	(2)	
7	Event Management	$ 1,588	$ -	$ -	$ -	$ 594	$ -	$ -	$ -	$ -	$ -	$ -	(3)	
8	Field Work Management	$ 6,990	$ 4,094	$ 2,534	$ 466	$ 5,128	$ 1,913	$ 4,601	$ 8,990	$ 5,512	$ 5,416	$ 5,637		WP 20-42
9	Safety, Gov, Reg, Compliance	$ -	$ 516	$ 2,428	$ 664	$ -	$ -	$ -	$ -	$ -	$ -	$ -	(4)	
10	Solution Delivery/Operations	$ 2	$ 70	$ 797	$ 75	$ 755	$ -	$ -	$ -	$ -	$ -	$ -	(5)	
11	System Operation & Control	$ -	$ 2,362	$ 3,826	$ 31	$ -	$ -	$ -	$ -	$ -	$ -	$ -	(6)	
12	**Total MWC 2F**	**$ 21,715**	**$ 21,077**	**$ 19,586**	**$ 5,084**	**$ 22,788**	**$ 17,696**	**$ 21,997**	**$ 17,987**	**$ 16,597**	**$ 16,499**	**$ 18,506**		

Forecast Assumptions and Details

(1) Data Enablement: The work being forecast in 2021 is a new project, GeoHub for Business. This project forecast was developed using the IT Project Estimating Tool. Currently, no work is planned in this Value Stream during the GRC period. The Data Enablement Value Stream focuses on the technology solutions used to manage PG&E data, data relationships, and data quality; to make data accessible for analysis; to perform automated analysis; and to present data and analytic results in understandable formats from which users can derive insight for decision-making.

(2) Enterprise Resource Management: PG&E is currently not forecasting any project-based technology investments in the Enterprise Resource Management Value Stream during the 2023-2026 GRC period. The Enterprise Resource Management Value Stream focuses on the technology solutions used to plan, understand, and manage PG&E's human, financial, and physical resources.

(3) Event Management: PG&E is currently not forecasting any project-based technology investments in the Event Management Value Stream during the 2023-2026 GRC period. The Event Management Value Stream focuses on the technology solutions used to coordinate planned events (such as maintenance outages) and to manage the Company's response to emergencies, utility asset failures, service disruptions, and other unplanned system-wide or localized events.

(4) Safety, Gov, Reg, Compliance: PG&E is currently not forecasting any capital project-based technology investments in the Safety, Gov, Reg, Compliance Value Stream during the 2023-2026 GRC period. See WP 20-46 for the Project Summary describing the expense forecast in this Value Stream. The Safety, Governance, Regulatory, and Compliance Value Stream focuses on the technology solutions used to manage workforce health and safety; to manage public safety and environmental impacts; to manage Company records, compliance, and corrective action programs; to support regulatory and legal proceedings; and to manage relationships with external stakeholders.

(5) Solution Delivery/Operations: PG&E is currently not forecasting any project-based technology investments in the Solution Delivery/Operations Value Stream during the 2023-2026 GRC period. The Solution Delivery and Operations Value Stream focuses on the foundational software and IT infrastructure used to develop, integrate, deploy, and operate IT solutions within PG&E-owned data centers, PG&E field sites, and third-party commercial cloud environments.

(6) System Operation & Control: PG&E is currently not forecasting any project-based technology investments in the System Operation & Control Value Stream during the 2023-2026 GRC period. The System Operation & Control Value Stream focuses on the technology solutions that directly enable the monitoring, operation, and control of PG&E's gas, electric, and generation systems, including the edge networks that connect monitoring, automation, and other field devices to PG&E's core data networks.

Workpaper Table 20-18
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management and Technology
Major Work Category 21 – Forecast Details
(Thousands of Nominal Dollars)

Line No.	MWC 21 - Electric Distribution Mapping	Recorded 2016	Recorded 2017	Recorded 2018	Recorded 2019	Recorded 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Assumptions	Reference
1	Base Mapping	$ -	$ -	$ 10	$ 18	$ 3	$ -	$ 233	$ 263	$ 297	$ 335	$ 378	(1)	
2	GIS Technical Enhancements	$ -	$ -	$ -	$ -	$ -	$ -	$ 349	$ 395	$ 445	$ 502	$ 566		WP 20-19
3	Data Management and Analytics	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,023	$ 1,295	$ 1,650	$ 2,101	$ 2,676		WP 20-28
4	**Total MWC 21**	**$ -**	**$ -**	**$ 10**	**$ 18**	**$ 3**	**$ -**	**$ 1,604**	**$ 1,953**	**$ 2,392**	**$ 2,938**	**$ 3,620**		

Forecast Assumptions and Details

(1) Base Mapping includes activities such as annexations (city/county boundary and tax changes) and delineations (internal mapping information to external agencies, e.g.. engineering firms, other utilities) and asset data corrections based on field verifications. These activities will continue in the forecast years and the forecast is based on historical costs, while accounting for incremental efficiencies from stabilized technology and process improvements.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management and Technology
Program Summary – GIS Technical Enhancements

Program Title: GIS Technical Enhancements
Major Work Categories: GE, 21
Planning Order Numbers: 5054274, 5057089, 5057090, 5795511
Project Start Date: 2019
Project Completion Date: 2026
Operative Date (only applies to Capital): Operative as Installed

Project Description

The Geographic Information Systems (GIS) Technical Enhancements program involves various GIS activities – including system and data model upgrades, and investments in analytics tools – to improve overall performance and function of PG&E's GIS systems.The enhancements help to enhance risk informed data-driven decisions around critical assets, as well as to meet compliance requirements and provide downstream systems the data necessary for any regulatory requirement.

Justification

This program is made up of two types of costs: GIS System Ehancements and GIS Analytics.

GIS System Enhancements: The GIS team continually monitors and improves the tools used to map and manage electric facility data. Requests for new tools or modifications of the existing GIS electric system are implemented as enhancements during scheduled GIS releases. The team uses different project management capabilities including Agile project management methodologies that will aid to increase development speed, expand collaboration, and foster the ability to better respond to changes in work. Enhancements planned during the 2023 GRC period include:

- Next Generation (NextGen) GIS: PG&E plans to modernize and standardize core components of its multiple GIS systems that currently rely on obsolete third-party mapping and map editing technologies. Currently assets are represented geometrically as points, lines and polygons (the "Geometric Network" data model." PG&E's primary GIS vendor, ESRI has developed a standardized data model purpose-built for utilities called the "Utility Network" data model. This effort will migrate existing PG&E's GIS from the legacy Geometric Network data model to the modern Utility Network data model and upgrade associated editing software to a compatible version. The Utility Network data model will enable increased granularity of data. Approved expense funding will be used to perform training, data migration, change management, and business process updates that are required to migrate ED GIS, and Substation GIS to the next generation GIS technology platform.
- Data Quality Dashboards: Dashboards provide the ability to measure asset data quality in GIS against seven data quality dimensions – completeness, conformity, consistency, uniqueness, timeliness, synchronization and accuracy. Introducing EDGIS data into Palantir Foundry data tools (described in the Data Management and Analytics-related sections of Chapter 20) will enable building data dashboards and performing historical analysis.
- Graphic Work Design: Graphic Work Design (GWD) involves software tools that enable automation of creating GIS data from CAD design tools where engineering relationships between components and subcomponents exist. Lists of components and subcomponents approved for PG&E use are maintained in SAP, and integrated by GWD engineering. Integration with GIS provides accurate placement of existing assets and eliminates re-drawing during asset design process. Original design

and design changes through As-Builts are also integrated, with GIS eliminating mapping from paper drawings.

- Asset Data Management & Improvement (ADM&I) Work Plans, Schedules, and Metrics: This involves configuring ADM&I, work plans, data extrapolations, new data designs, and data testing from SAP to support a risk-based prioritization to manage GIS ADM&I work schedules, as well as development and maintenance of automated and centralized visualization tools that measure critical work activities for effective and efficient quality outcomes.

GIS Analytics: GIS Analytics includes the capital costs needed to support the GIS team. The forecast includes advanced software, servers, and hardware, such as high end laptops, desktop CPUs, etc. to deliver expedient solutions for Meteorology and PSPS teams during emergency operations. GIS team initiatives provide support to a variety of business clients for risk management, system operations, and customer experience improvements among others. GIS team solutions deliver spatially-enabled views into PG&E's asset datasets. In addition, these solutions bring spatial snapshots of PG&E's assets together into one common geographic context. Orienting these datasets in geographic space allows for overlay with an infinite number of required non-asset spatial datasets, from landbase (streets, parcels) to environmental, cultural, and demographic layers.

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE													
MWC GE, PO 5054274				36	711	900						1,647	
MWC GE, PO 5057089 & 5057090							900	6,765				7,665	
												-	
Expense Total	**-**	**-**	**-**	**36**	**711**	**900**	**900**	**6,765**	**-**	**-**	**-**	**9,312**	WP 20-7, Line 2
CAPITAL													
MWC 21, PO 5795511							349	395	445	502	566	2,257	
Capital Total	**N/A**	**N/A**	**N/A**	**N/A**	**-**	**-**	**349**	**395**	**445**	**502**	**566**	**2,257**	WP 20-18, Line 2
TOTAL PROJECT COST	**-**	**-**	**-**	**36**	**711**	**900**	**1,249**	**7,160**	**445**	**502**	**566**	**11,569**	

The primary driver of the GIS Technical Enhancement forecast is the NextGen GIS effort, planned to begin in 2023. See Exhibit 7, Chapter 8, Section C.3.b.3. for additional information on this effort. The forecast for NextGen GIS was developed using the IT Project Estimating Tool (PET). PG&E used the IT PET to document estimate assumptions and generate labor and non-labor cost forecasts for this project. To calculate labor costs, the PET captures labor hours by activity and resource type, multiplies that by standard labor rates, and adds in standard overhead factors. To calculate non-labor costs, the PET captures contract costs by type (such as software licenses or third-party services), material costs by unit

quantity and unit price, and standard overheads such as materials burden and AFUDC. Other factors, such as escalation and capital/expense ratios, are calculated based on standard rates and accounting guidance. See Exhibit (PG&E-7), Chapter 8 for additional information regarding the PET. PG&E can provide the specific PET output produced for this project upon request.

The forecast for the additional GIS Technical Enhancements activities described here is an estimate based on subject matter expertise. The technical solutions for these activities could involve various tools, including Tableau, Power Bi, or Palantir Foundry, which PG&E will evaluate based on the enhancement needed.

Benefits

1. NextGen GIS
    - Continues vendor support without the prospect of additional, specific “out of support” agreements.
    - New depth of data to promote additional levels of understanding which also facilitates integrations with operations systems like ADMS.
    - Rule based platform for enforcing Traceable, Verifiable and Complete requirements.
    - Rule and relationship ability to enforce data details and accuracy requirements.
    - Facilitate consistent look, feel and capability of data across all types of user platforms - Desktop, Server, and Mobility
    - Services-based data delivery to any business application thereby reducing business costs associated with equipment and system maintenance.
    - Improvement in user satisfaction and reduced enhancement/change management requests through modern interfaces and data environment built using customer engagement feedback.
    - Visibility for any business applications across the entire system including the network, associated equipment/compatible units and stations/facilities using containers.
    - Platform for process simplification/streamlining through modeling relationships between equipment and infrastructure using a new concept called associations
    - Ability to integrate with other PG&E content platforms using services model.
    - Team process and content integration through a common data environment for Transmission & Distribution, and Gas & Electric.

2. Data Quality Dashboards:
    - Identifies opportunities to improve data quality.
    - Analyzes asset and operational data to inform asset failure and implement efficiencies into field programs through predictive/preventative maintenance.
    - Identifies and promotes information to reduce or mitigate operational risk, increase efficiency, and reduce costs, and create actionable intelligence for improving public and employee safety.
    - Improves system inspections by ensuring a direct alignment between GIS and SAP systems for a complete and accurate asset data.

3. Graphic Work Design
    - Increases efficiency and time reduction in the construction and planning process.

- Better understanding and fewer construction complications by designing within the existing data environment so that current GIS content is available during design.
- Efficiency through the integration of currently segregated workflows via direct integration with the GIS system – workforce efficiency and reduced costs related to data migration.

4. ADM&I Work Plans, Schedules, Metrics:
    - Allows risk base prioritization of the work targeting public and employee safety first
    - Improves effectiveness of the organization by aggregating and scheduling different types of work by circuit and/or asset which helps targeting work by circuit and asset risk
    - Integration with other critical programs such as system inspection and PSPS so data can be complete and accurate before their work execution.
    - Improves efficiencies by having all types of work by asset allowing staff to perform programmatic work more targeted with cycle time reductions through economies of scale.

5. GIS Analytics:
    - Enables interal & external clients processes for distributed generation
    - Provides detailed data request to annual wildfire mitigation plan
    - Deliver on the quarterly CPUC wildfire safety division GIS submission
    - Provide detail Electric Operation asset staticis to support asset management
    - Maintains non-asset data that enables work management, customer experiences, and the safety strategy

Alternatives Considered

For several years, ESRI has been moving away from ArcGIS Desktop (i.e., ArcMap and related tools), which uses the Geometric Network data model, to ArcGIS Pro, which uses the Utility Network data model. Editing data in the Utility Network data model is possible only with ArcGIS Pro and ESRI will no longer support ArcGIS Desktop after 2026. Costs to move to an alternative platform would greatly exceed proposed migration costs as ESRI solutions are deployed across PG&Es entire business landscape. In addition, alternative platforms do not provide a roadmap to the functionality of ArcGIS Pro. Thus, there are no cost-effective alternatives to moving forward with the NextGen GIS project.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Data Management and Technology
Project Summary – GIS Asset Data Improvements

Project Title: GIS Asset Data Improvements
Major Work Categories: GE
Planning Order Numbers: 5251013, 5057089, 5057090
Project Start Date: 2013
Project Completion Date: 2026
Operative Date (only applies to Capital): OAI

Project Description

GIS Asset Data Improvements support the accuracy and completeness of asset information, maps, and records in the integrated Electric Distribution GIS. These improvements are necessary to maintain the accuracy of PG&E's asset data, including date of installation, manufacturer, and model number. This asset information is vital to identifying which assets needs to be replaced and when. In the event of a repair, accurate asset data helps crews know what equipment to take to the job site.

PG&E previously forecast work similar in objective to the GIS Asset Data Improvement program in the 2020 GRC under the name Field Asset Inventory (FAI). FAI was a project intended to deliver a complete field inventory of the electric distribution overhead system and manually correct asset data discrepancies between PG&E's actual assets in the field and asset records in the SAP and ED Asset Management/GIS databases. Ultimately the FAI project was deferred due to contractor concerns and budgeting constraints. Since that time, PG&E has decided to attempt to achieve the same goals of the FAI project by conflating electric distribution overhead support structures to their correct geographic location leveraging remote sensing and GPS technology as opposed to a manual field asset inventory. This work is ongoing and will continue through the GRC period. In addition, the increased scope of PG&E's Enhanced Inspection Plan has driven a need for four additional asset data improvement efforts which PG&E is forecasting for as part of the GIS Asset Data Improvement program. The intent of each effort is to add to available asset information and correct discrepancies between actual assets in the field and PG&E's asset registry. The first effort will update GIS records and databases from a system-wide streetlight inventory while ensuring that the systems of record remain in sync. The second effort will consist of an inventory of underground electric distribution facilities in the bay area region to improve GIS asset data associated with those facilities. The third effort is to address an increase in Request for Work (RW) map corrections. The last effort is to develop, implement and maintain critical features and attributes in GIS.

Justification

In 2015, PG&E implemented the ED AM/GIS project. This project consolidated and reconciled asset information previously managed in multiple data sources, including SAP, Distribution Assets Reconciliation Tool (DART), Centralized Electric Distribution System Analysis (CEDSA), and various paper records. The ED AM/GIS project relied completely on data available in various offices and software systems. At the time it was converting the data from these sources into the ED AM/GIS, PG&E knew that the data would not be 100 percent accurate due to the number and variety of different data sources, and identified the need for a field inventory to verify that data.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Data Management and Technology
Project Summary – GIS Asset Data Improvements

An original Proof of Concept (POC) was performed in 2016 to examine the accuracy of the data in ED AM/GIS, identify opportunities to enhance the data, and prioritize areas of improvement in the field. In the POC, 61 percent of all assets inventoried had at least one associated attribute that needed to be updated or completed. Ten percent of all equipment and structures that were checked in the field needed to be added to ED AM/GIS, and 9 percent of all equipment and structures in ED AM/GIS were discovered to be non-existent or duplicative and needed to be deleted. Some of the data discrepancies from the POC were determined to be the result of poles that had been previously mapped in the wrong location. ED-GIS data is derived from legacy maps and in rural areas the true geographic position of poles was, in many cases, significantly different from where ED-GIS showed it to be. FAI was initially proposed as a field inventory of assets to identify and correct these discrepancies.

In 2019 PG&E began a technology POC to determine if the location of electric distribution support structures in GIS could be efficiently and accurately updated using remote sensing and GPS data in conjunction with established electric GIS mapping processes instead of through a manual field inventory. In 2020, a project was started to "conflate" all (approximately 600,000) electric distribution support structures (i.e., poles, transformers, switched, reclosers, conductors) in HFTD Tier 2 and Tier 3 areas to their true geographic location. The goal of the project is to eventually conflate all the electric distribution support structures in PG&E's service area. Ensuring the location of assets on our maps are directly relatable to field conditions, will provide the basis for additional risk-based asset information collection through our annual inspection programs. As the wildfire risk has increased so is the need to have a higher degree of data for critical components of the electric overhead grid. This enhanced data source will help with predictive analytics needed to proactively replace facilities or increase system inspection cycles. This enhancement will also help managing non-wildfire risk in other critical locations.

The Underground Asset and Streetlight Inventory efforts will address GIS data quality gaps in these two asset families. Reducing the data gaps will be accomplished by field inventories along with updates to the GIS asset records. The underground inventory, which consists of legacy documentation review and field inspections of underground vaults, is confined to the East Bay cities of Oakland and Berkeley. The Streetlight project has an inventory program already underway that has collected asset data for several large cities. These data inventories are being incorporated and reconciled into ED-GIS and SAP/CC&B. Eliminating data quality gaps will reduce safety risk and enable improved operation, maintenance, and inspection of these assets.

Tracking and completion of RW map corrections is critical to having a complete, accurate, traceable, and verifiable asset register as these enhance asset information that field personnel provides. Corrections would need to be validated in the SAP database to ensure complete alignment between GIS and SAP, since SAP information is used for maintenance plans including system inspections.

Work to develop, implement and maintain critical features and attributes in GIS is necessary for quantitative risk management decisions As the asset risk models mature, the need for a more surgical understanding of asset characteristics at an electrical component level will increase, driving the need for a more comprehensive asset data collections and upkeep.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Data Management and Technology
Project Summary – GIS Asset Data Improvements

The GIS Asset Data Improvement program will improve the accuracy and completeness of the data in PG&E's systems of record. The overall program will support PG&E's goal of improving the accuracy, quality, and completeness of asset information in ED AM/GIS, SAP, and other systems. The distribution operations and preventative maintenance programs, among others, are built around records that identify equipment and show its associated characteristics. Therefore, incorrect information in ED AM/GIS can introduce both operational and financial risk to the company.

Cost

In 2020, PG&E spent approximately $2.5 million to conflate 450,000 electric distribution poles in HFTD areas with a unit price of roughly $5.50 per pole. The price for this work was impacted by COVID-19 and process/staffing constraints. The forecast for conflation in 2023 is based on a total of 1.8 million poles at a target price of approximately $1.77 per pole, for a total of $3.2 million.

Costs for the Underground Inventory effort will be validated with a POC in 2021 but are currently estimated to be $2.7 million in 2023. This forecast is based off anticipated costs associated with physical manhole inspections, design drawing development, and GIS ingestion at approximately $1,000/manhole.

The Streetlight Inventory effort is budgeting $0.5 million per year, based on expected costs of inventory and GIS ingestion for 50K units at approximately $10/unit.

Activities associated with the RW map correction and development, implementation, and maintenance of critical features in GIS are forecast to cost approximately $2.0 million in 2023. This forecast is based on SME estimated costs associated with approximately 17,000 RW corrections, as well as a Plan/Analyze phase and pilot for the critical features.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Data Management and Technology
Project Summary – GIS Asset Data Improvements

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE													
MWC GE, PO 5251013	652	583	3,277	(496)	2,552	8,991						15,559	
MWC GE, PO 5057089 & 5057090							8,991	9,115				18,106	
												-	
Expense Total	**652**	**583**	**3,277**	**(496)**	**2,552**	**8,991**	**8,991**	**9,115**	**-**	**-**	**-**	**33,665**	WP 20-7, Line 4
CAPITAL													
N/A												-	
Capital Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
TOTAL PROJECT COST	**652**	**583**	**3,277**	**(496)**	**2,552**	**8,991**	**8,991**	**9,115**	**-**	**-**	**-**	**33,665**	

Benefits

The GIS Asset Data Improvement project is forecast to provide the following benefits:

Primary Benefit Areas	Project Benefits
Public and Employee Safety	• Improved public safety by improving records accuracy for operations, engineering, asset management, service planning, construction, and maintenance decisions and activities. • Improved employee safety by providing accurate information so that operations, maintenance, and construction activities are planned correctly, and appropriate safety equipment is available.
Risk and Compliance	• Improved compliance monitoring of maintenance procedures by providing accurate information to be sure appropriate maintenance and inspection activities are implemented at the appropriate time.
Environmental and Social Benefits	• Improved construction planning, optimization of construction placement by providing accurate field inventory data for physical landscape attributes.
Reliability	• Improved reliability by providing accurate information about equipment in the field to plan and implement operations, design and appropriate equipment maintenance or replacement.
Customer Experience	• Improve customer service by providing accurate location of electric outages and system changes.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Data Management and Technology
Project Summary – GIS Asset Data Improvements

Alternatives Considered

One alternative to the current approach of the GIS Asset Data Improvements program is to proceed at a slower pace than currently planned. This approach would not align with PG&E's enhanced Inspection Plan and would create a significant backlog of asset registry updates which would prevent traceable, verifiable, complete, and accurate asset data from being implemented in PG&E's systems of record. A slower approach to this work would also have a negative downstream impact on work groups like distribution operations and preventative maintenance programs that rely on accurate asset data.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Data Management and Technology
Project Summary – Data Management and Analytics

Project Title: Data Management and Analytics
Major Work Categories: GE, 21
Planning Order Numbers: 5054424, 5056245, 5057089, 5057090, 5795511
Project Start Date: 2021
Project Completion Date: 2026
Operative Date (only applies to Capital): 2021

Project Description

In 2020 PG&E established a data management organization at the enterprise level, with a Director of Data Governance. The Enterprise Data Management organization is responsible for developing enterprise level data strategy, policies, standards, and objectives. In parallel, EO has developed a Data Management and Analytics (DM&A) organization to guide electric data strategy, and data management efforts. The DM&A organization will establish overall priorities, standards, and processes to effectively manage data critical to asset and risk management. Implementation of the electric data strategy will be led by the DM&A organization in partnership with the Enterprise Data Management team, IT business partners and EO business units. Centralization of the data management function helps align data strategies across EO and the enterprise and improves PG&E's ability to make data-driven decisions around asset-related risk management.

Activities that the DM&A organization plans to pursue during the 2021-2026 period include:

- Implementation of Asset Data Asset Management Plan (AMP): This is an umbrella initiative guiding the application of best practices for asset management and data, including understanding the inventory of critical data assets, the condition of the data including its quality and the risks associated with the data and designing/implementing programs, standards, and processes to optimize the management of data assets.
- Implementation of Data Management Standards, Processes, and Tools: The implementation of data management standards, processes, and tools are intended to systematically detect and remediate data quality issues. PG&E will improve data quality through creation and implementation of data quality rules in its data platform and key source systems. PG&E will also identify at-risk data assets that require remediation, and design and implement solutions to improve data quality.
- Implementation of Data Platform: In order to effectively manage assets and asset risk, PG&E must bring together physical, operational, lifecycle, and environmental data elements from existing disparate purpose-built data systems into a single environment to better enable access to data in support of asset planning, risk management, and operations, and embedded data analytics for ad hoc analyses. To this end, a core element of PG&E's enterprise data management strategy is an Enterprise Data Platform – Palantir Foundry – that will allow PG&E to establish key connections between disparate data sets.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Data Management and Technology
Project Summary – Data Management and Analytics

Justification

The main outcomes that are being delivered through the Asset Knowledge Management organization are those of achieving external commitments (e.g. CPUC) and enhancing data-driven decision-making capabilities in support of asset and risk management, including but not limited to wildfire mitigation and safety.

Electric Ops Data Management and Analytics will achieve at least level 2.5 maturity in the data capabilities relating to CPUC compliance by the end of 2023. This will reflect a level beyond minimum regulatory requirements and in some areas consistent with best practice/benchmark. Specifically:

Data collection and curation: PG&E will have a centralized repository of accurate situational, operational, and other data relevant to wildfire risk and PSPS. PG&E will collect data from all sensors located on PG&E electric lines and equipment, weather stations, etc., and be able to utilize advanced analytics to drive decision-making in short term. PG&E will be able to receive and share data using real-time API protocols with a select number of stakeholders

Data transparency and analytics: PG&E will have all wildfire-related data that is used catalogued in a single document including an explanation of the sources and assumptions made. All PG&E wildfire-related analyses, algorithms, and data processing are explained and documented. PG&E will have an IT system for sharing data in real time across at least two levels of permissions, including utility-regulator permissions, and first responder permissions.

Near-Miss tracking:
PG&E will be able to track near miss data for all near misses with wildfire ignition potential and track event characteristics and fuel loads and moisture to enable simulation of wildfire potential given an ignition. This will include capturing data related to the specific mode of failure. PG&E will also have some degree of ability to predict the probability of such a near miss in causing an ignition.

Data sharing with research community:
PG&E will participate, and in some areas possibly fund, in collaborative research that addresses utility ignited wildfires

The rest of the data management capabilities defined in the capability model will, by end of 2026, achieve an average level of at least 2 “Beyond minimum regulatory requirements but not consistent with best practice/benchmark.”

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Data Management and Technology
Project Summary – Data Management and Analytics

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE													
MWC GE, PO 5054424	-	-	100	100	1,115	4,700						6,015	
MWC GE, PO 5056245	-	-	-	-	3,037	1,800						4,837	
MWC GE, PO 5057089 & 5057090	-	-	-	-	-		4,723	5,253				9,976	
												-	
Expense Total	**-**	**-**	**100**	**100**	**4,152**	**6,500**	**4,723**	**5,253**	**-**	**-**	**-**	**20,828**	WP 20-7, Line 5
CAPITAL													
MWC 21, PO 5795511	-	-	-	-	-	-	1,023	1,295	1,650	2,101	2,676	8,745	
Capital Total	**-**	**-**	**-**	**-**	**-**	**-**	**1,023**	**1,295**	**1,650**	**2,101**	**2,676**	**8,745**	WP 20-18, Line 3
TOTAL PROJECT COST	**-**	**-**	**100**	**100**	**4,152**	**6,500**	**5,746**	**6,548**	**1,650**	**2,101**	**2,676**	**29,573**	

The forecast for Data Management and Analytics work in MWC GE was developed by first establishing target milestones in data management principles within the timeframe of the GRC, based on the Gartner Data Governance Maturity Model and the Data Management Framework discussed in the 2021 Wildfire Mitigation Plan.1 Once target milestones were established, PG&E used internal and external subject matter expertise to estimate costs to reach and sustain those milestones. This process was iterated to optimize capability development within the timing and budget constraints of the GRC.

The forecast for Data Management and Analytics work in MWC 21 is based on SME estimate of hours needed for foundational data engineering work for Foundry-based data products.

Benefits

There are no quantified cost savings or revenue generation benefits from this project. These investments are foundational and enabling for the business and comprise four main aspects of value:

- Data Governance: Establish and enforce organizational roles and responsibilities, policies, processes and procedures to ensure that well understood, fit-for-purpose data exists and is available.
- Data Acquisition: Create governed data pipelines for flow of data from the frontline workers, through systems and to central data systems to ensure data access, and implement processes to ensure that data confirms to PG&E standards making it fit for storage and purpose
- Data Storage & Accessibility: Ensure “certified”, robust and accurate sources of critical data are stored in a governed environment, organized in alignment to business processes and easily accessible.

[1] PG&E’s 2021 Wildfire Mitigation Plan Report, R. 18-10-007 (Feb. 5, 2021), Section 7.3.7.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Data Management and Technology
Project Summary – Data Management and Analytics

- Data Quality: Implement processes and standards to ensure data quality meets threshold rules ensuring it is fit-for-purpose, and to identify and resolve issues affecting the ability of quality of the data.

Alternatives Considered

Alternative 1 – Do nothing: With this program, Electric Operations is seeking to advance its capability to make effective data-driven decisions. Investment is required to mature foundational data management capabilities to ensure that data is well-governed, high-quality, accessible and can be translated into insights to inform decisions.

The alternative to investing in this program is to continue producing data insights through historically siloed systems with limited governance, lower quality data, and less effective translation of data into insights to inform decision making. This could result in ineffective decision-making based on incomplete data, missed opportunities to improve risk management outcomes, under-utilization of our analytic and engineering human resources, and an inability to more effectively share data with external partners (e.g., Wildfire Safety Division (WSD), California Department of Forestry and Fire Protection (CAL FIRE), local government agencies).

Alternative 2 – Roll out program at a slower pace: Slower development of the program will delay our ability to leverage data to make effective decisions. This would delay improved outcomes associated data-informed risk management outcomes, efficient/effective human resource utilization, and effective sharing of data with external partners (e.g., Wildfire Safety Division (WSD), California Department of Forestry and Fire Protection (CAL FIRE), local government agencies).

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Program Summary – Asset Management & Risk Analysis

Value Stream Program: Asset Management & Risk Analysis
Major Work Categories: JV, 2F
Planning Order Numbers: 5793287,5055413
Project Start Date: 2023
Project Completion Date: 2026
Operative Date (only applies to Capital): Operative as installed.

Program Description

The Asset Management & Risk Analysis Value Stream focuses on technology solutions used to manage the lifecycle of utility assets; to track their location, condition, specifications, and relationships to other assets; and to understand and manage asset-related risks. Asset Management & Risk Analysis activities include but are not limited to:

- Providing visibility of assets through map-based field information and real-time asset situational awareness;
- Optimizing the planning, upkeep, and replacement of assets based on data-driven analytics and risk assessments of asset failure;
- Meeting grid interconnection compliance requirements and customer needs; and
- Working with various stakeholders (e.g., other utilities, telecom companies) to ensure that shared utility poles are accurately designed and appropriately loaded.

Electric Distribution investments in the Asset Management & Risk Analysis Value Stream are aimed at enhancing the maturity of the Asset Management business capabilities needed to run Electric Operations' business and to fulfill Electric Operations' business strategy.

Examples of projects that Electric Operations is pursuing in this Value Stream are:

Joint Use Map & Portal (JUMP): CPUC Decision 17-06-028 "Orders Instituting Investigation into the Creation of a Shared Database or Statewide Census of Utility Poles and Conduit in California" mandates the more efficient sharing of of shared pole and conduit information with other utilities and accelerates the application process for new or modified attachments on shared poles. The current process is still too costly and labor intensive and additional JUMP investments will enable further reductions in associated costs through process improvements. A web portal now provides other utilities and third parties with real-time access to a shared database of pole and attachment data and automates parts of the application process, substantially reducing application cycle time. During the 2023-2026 rate cycle PG&E plans to develop and implement the following additional JUMP functionality:

- Phase 3 will enable (1) integration of all utility and third-party pole attachment data into the Pole Loading Database (PLDB) and (2) real-time calculation and external communication of wind loading calculations. JUMP technology will migrate to a new Geomart environment as required to migrate to the next generation of software for security, performance and supportability reasons, and to a new self-service web environment that will enable the newly proposed "One Touch Make Ready" proposal. Project completion is expected by Q1/2023, assuming a CPUC decision to proceed is issued by by Q3/2021.

- Phase 4 will leverage the new joint pole solution developed in earlier phases to simplify and automate the inbound intent process by enabling third-party submission and processing through the web portal, including online design evaluation indicating the liklihoood of intent approval, to further reduce the application cycle time. Phase 4 will also incorporate conduit loading information into JUMP. Project completion is expected around Q4/2023, assuming a CPUC decision to proceed is issued by Q3/2022.

Streetlight Asset Registry & Maintenance: PG&E considers streetlights as a separate asset family due their role in public safety. However, an integrated asset data registry and data collection system to enable the effective management of this asset family does not currently exist. There is a need to capture, monitor, and manage asset condition data, inspection data, maintenance data, and replacement data for streetlights. Streetlight pole inspections began in 2018 to assess the condition of the oldest metallic poles. From a public safety standpoint, there is a need to continue this effort and establish a program to enable effective management of streetlights as an asset class.
PG&E plans to develop a data management solution that interacts with its EDGIS (locational and attribute data), SAP (work management), and CC&B (asset ownership) enterprise IT systems to manage streetlight asset data and assess public safety risks. The system will: 1) map asset location and attribute data in GIS; 2) track historical inspection data, including photos and video; 3) manage and schedule asset inspections based on inspection cycle, geographic location, and asset condition; 4) provide contractor access to PG&E mobile tools to capture field inspection data and asset condition; and 5) provide asset status reporting and analytics capabilities.

Rule 20A Data Management: The Rule 20A program schedules, plans, and executes overhead to underground conversion beautification projects at the behest of cities and counties. Tracking of financial data, project details, project status, and other key metrics is required to allow determination of project progress, efficiency, and unit costs. The Rule 20A program does not currently have a convenient way of tracking this information.

Future Technology Investments: Additional technology investments in Asset Management & Risk Analytics will focus on delivering the overall vision and objective of this Value Stream which is to optimize the use of all asset related data, including SAP, GIS, operational data, three-dimensional data and imagery, for integration into a comprehensive engineering infrastructure model (also referred to as a “Digital Twin”). Digital Twin models of the distribution grid can reduce operational and safety risks by helping understand the real-time impact at a granular level of sudden changes operating conditions caused by weather, vegetation, DER impacts, fault conditions, etc. A critical use of these models will be to reduce fire ignition risks as described more fully in Chapter 4 of this exhibit and in PG&E’s Wildfire Mitigation Plan. Additional IT investments will be needed to support the development of PG&Es Digital Twin, including in the collection and analysis of growing levels of distributed sensor data that remotely monitor grid operating conditions in real time.

Justification

Investments in the Asset Management & Risk Analysis Value Stream support required and important safety, risk mitigation, regulatory compliance, customer satisfaction, and operational efficiency enhancements.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Program Summary – Asset Management & Risk Analysis

Joint Utility Pole Mapping

- Compliance: The JUMP projects are implementing CPUC mandates to create a shared database and statewide census of utility poles and conduit in California, and real-time access by competitive communications providers to California utility pole and conduit information, consistent with the Commission's Safety Regulations.
- Risk: Wildfire risk is a top priority to PG&E. As discussed in PG&E's 2020 RAMP Report, A.20-06-012 (June 30, 2020), incorrect pole loading calculations due to erroneous or missing information on attachments to poles used jointly with other utilities and third parties could contribute to pole failures, which is a potential cause of Wildfires. Unauthorized pole attachments to joint poles are particularly problematic. The JUMP technology project will streamline the sharing of pole loading data with joint tenants or joint owners and help prevent incorrect loading of poles used jointly with other utilities and third parties.
- Safety: JUMP projects are expected to provide safety benefits as they may help reduce Wires Down events and minimize fire ignitions by preventing incorrect loading of poles.

Streetlight Asset Registry & Maintenance

- Safety: PG&E installs, tracks, and maintains and operates streetlights fo the purpose of purpose of public safety. The new asset management system will enable asset condition analytics to be performed and condition based maintenance programs to be implemented that will help prevent unanticipated streetlight failures and associated public safety situations. PG&E's customers expect and require for their safety that streetlights are properly maintained. The proposed asset management system will provide PG&E the capability of proactively managing streetlight assets and better meeting customer needs.

Rule 20 A Data Management

- Risk Management: This project reduces the risk of not being able to provide required data to the CPUC.

Cost

PG&E used the IT Project/Program Estimating Tool (PET) to document estimate assumptions and generate labor and non-labor cost forecasts for this program. To calculate labor costs, the PET captures labor hours by activity and resource type, multiplies that by standard labor rates, and adds in standard overhead factors. To calculate non-labor costs, the PET captures contract costs by type (such as software licenses or third-party services), material costs by unit quantity and unit price, and standard overheads such as materials burden and AFUDC. Other factors, such as escalation and capital/expense ratios, are calculated based on standard rates and accounting guidance. See Exhibit (PG&E-7), Chapter 8 for additional information regarding the PET. PG&E can provide the specific PET output produced for this program upon request.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Program Summary – Asset Management & Risk Analysis

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE													
MWC JV, VARIOUS POs	445	1,144	605	618	1,455							4,267	
MWC JV, PO 5055413						416	220	348				984	
MWC JV, PO 5056220, 5056769, 5057102						28	200	25				253	
												-	
Expense Total	**445**	**1,144**	**605**	**618**	**1,455**	**444**	**420**	**372**	**-**	**-**	**-**	**5,503**	WP 20-8, Line 2
CAPITAL													
MWC 2F, VARIOUS POs	4,163	9,034	4,450	803	7,576							26,026	
MWC 2F, PO 5793287						402	2,975	2,133	2,888	2,000	2,000	12,398	
MWC 2F, PO 5793958, 5793959, 5795562						1,489	1,627	686	794	1,049	1,275	6,920	
Capital Total	**4,163**	**9,034**	**4,450**	**803**	**7,576**	**1,890**	**4,602**	**2,819**	**3,682**	**3,049**	**3,275**	**45,344**	WP 20-17, Line 2
TOTAL PROJECT COST	**4,608**	**10,178**	**5,055**	**1,421**	**9,031**	**2,334**	**5,022**	**3,191**	**3,682**	**3,049**	**3,275**	**50,847**	

Benefits

The projects in this Value Stream have the following potential financial savings. Other non-financial benefits are described in the Justification section:

JUMP: These projects are expected to have soft savings resulting from streamlining and automating the data collection and input processes for joint pole intent forms and will contribute to savings in head count reductions. Improved data collection processes will also reduce errors in data entry and the need for rework. The Map and Pole Information supplied to other utilities is currently a manual, labor intensive process. Better decision-making may aid in lowering asset lifecycle costs.

Streetlight Asset Registry and Maintenance: This project is expected to result in better asset decision-making and may aid in lowering streetlight asset lifecycle costs and increase operational efficiency.

Alternatives Considered

Status Quo: Foregoing these projects would interrupt and/or prevent the upgrade and automation of key business processes required by the Electric Distribution organization to meet efficiency challenge goals, ensure regulatory compliance, secure public safety and mitigate risks. PG&E does not recommend this option.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Project Summary – Billing & Rates

Value Stream Program: Billing & Rates
Major Work Categories: JV, 2F
Planning Order Numbers: 5778670, 5778671, 5778672, 5778673 & 5259543
Project Start Date: 2021
Project Completion Date: 2026
Operative Date (only applies to Capital): Operative as Installed

Project Description

The Billing & Rates Value Stream focuses on the technology solutions used to manage gas and electric rates, to track customer energy usage, to generate customer bills, and to process customer financial transactions and billing exceptions. Electric Distribution's (ED's) investments in the Billing & Rates Value Stream are to ensure that changes mandated by the CPUC to the interconnection process are implemented within PG&E's supporting infrastructure in compliance with ordered deadlines.

Examples of projects Electric Distribution Operations is pursuing in this Value Stream include:

EGI Tariff Changes: The Electric Grid Interconnection (EGI) Department is automating workflow and interfaces to manage interconnection requests under PG&E's Rule 21, Wholesale Distribution Tariff (WDT), and CAISO's Wholesale Transmission Tariff as mandated by the CPUC and FERC. The evolving interconnection landscape has already resulted in numerous ordered changes. PG&E anticipates that mandated CPUC tariff changes will continue to occur during the 2023-2026 rate cycle and our budget forecast is based on this expectation. This program is important for PG&E to continue to meet regulatory compliance and the ability to report, monitor and provide transparency to internal compliance teams and regulators. As part of the project forecast, PG&E will address changes to Rule 21, Schedule Net Energy Metering (NEM), Schedule NEM FC, and the WDT that impact the technologies that support interconnection processing.

The following are some examples of tariff changes that PG&E could address through this project.

Consumer Protection:

- D. 20-08-001 Billing Calculator
- D. 20-02-011 Self Service Portal

Rule 21 Working Groups:

- AL 5553-E Modification to Rule 21 Pursuant to the Working Group 1 D. 19-03-013.
- AL 5988-E Advice Letter Modifying Electric Rule 21 Pursuant to Decision 20-09-035 for Working Group 2 and 3 (due 30 days from Issuance)
- AL 6014-E Advice Letter Modifying Electric Rule 21 Pursuant to Decision 20-09-035 for Working Group 2 and 3 (due 60 days from Issuance)
- AL 5915-E Advice Letter Modifying Electric Rule 21 Pursuant to Decision 20-09035 for Working Group 2 and 3 (due 120 Days from Issuance) for Ordering Paragraphs 5, 6, 8 and 11.
- AL 6058-E Advice Letter Modifying Electric Rule 21 Pursuant to Decision 20-09035 for Working Group 2 and 3 Ordering Paragraphs 15 and 16 (due 120 Days from Issuance)

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Project Summary – Billing & Rates

- AL 6093-E Modifications to Electric Rule 21 Pursuant to Resolution E-5000 Ordering Paragraphs 6, 7, and 8 for IEEE 1547.1 Standards
- R.17-07-007 Proposed Decision WORKING GROUP 4

Justification

PG&E was authorized funding for work related to tariff changes in the 2020 GRC. Due to the ongoing annual nature of CPUC tariff changes, the need for funding will continue in the 2023 GRC period.

The program's main benefits are meeting Commission mandates, enhancing customer experience, and supporting grid development and operations in compliance with future CPUC and FERC orders regarding the interconnection of generation to PG&E's distribution and transmission grid. Complying with the tariff ensures that our process and procedures, along with underlying technology, match up with the public version of the rule and ensure consistency and transparency for all stakeholders. This includes capturing data as required by various regulations as well as recording any documentation associated with that data.

Cost

PG&E used the IT Project/Program Estimating Tool (PET) to document estimate assumptions and generate labor and non-labor cost forecasts for this program. To calculate labor costs, the PET captures labor hours by activity and resource type, multiplies that by standard labor rates, and adds in standard overhead factors. To calculate non-labor costs, the PET captures contract costs by type (such as software licenses or third-party services), material costs by unit quantity and unit price, and standard overheads such as materials burden and AFUDC. Other factors, such as escalation and capital/expense ratios, are calculated based on standard rates and accounting guidance. See Exhibit (PG&E-7), Chapter 8 for additional information regarding the PET. PG&E can provide the specific PET output produced for this program upon request.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Project Summary – Billing & Rates

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper
EXPENSE													
MWC JV VARIOUS POs	123	442	243	1	69							878	
MWC JV PO 5055410						33						33	
MWC JV PO 5056220, 5056769, 5057102						11	100	100				211	
												-	
Expense Total	**123**	**442**	**243**	**1**	**69**	**44**	**100**	**100**	**-**	**-**	**-**	**1,122**	WP 20-8, Line 3
CAPITAL													
MWC 2F VARIOUS POs	4,870	3,342	2,858	2,267	5,046							18,383	
MWC 2F, PO 5793284						2,807	2,278	1,250	3,511	5,940	5,810	21,596	
MWC 2F, POs 5793958, 5793959, 5795562						1,912	4,986	4,097	2,892	115	704	14,705	
Capital Total	**4,870**	**3,342**	**2,858**	**2,267**	**5,046**	**4,719**	**7,264**	**5,347**	**6,403**	**6,055**	**6,514**	**54,684**	WP 20-17, Line 3
TOTAL PROJECT COST	**4,993**	**3,784**	**3,101**	**2,267**	**5,115**	**4,763**	**7,364**	**5,447**	**6,403**	**6,055**	**6,514**	**55,806**	

Benefits

This program has no hard financial savings. Other non-financial benefits are described in the Justification section.

Alternatives Considered

Status Quo: Failure to make these changes would result in the manual processing and tracking of projects (e.g., Standard NEM appraisals) which will increase project cycle times and potentially result in non-compliance events and fines. PG&E does not recommend this option.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Project Summary – Customer Service

Value Stream Program: Customer Service
Major Work Categories: JV, 2F
Planning Order Numbers: 5793283, 5055409
Project Start Date: 2023
Project Completion Date: 2023
Operative Date (only applies to Capital): Operative as Installed

Value Stream Description

The Customer Service Value Stream focuses on the technology solutions used to manage customer relationships and accounts, to enable customer self-service, to operate customer contact centers, to manage customer communications, and to support PG&E customer service representatives.. Technology investments during the 2023-2026 General Rate Case period will focus on:

- Improving the customer new service application process and reducing the time required to process customer service applications
- Providing customers with tools, including online tools, that will enable them to better engage/intertact with new and more streamlined service application processes.
- Developing opportunities to provide better customer value by better understanding PG&E customer's touch points and interactions across the enterprise.

Examples of projects that Electric Operations is pursuing in the Customer Service Value Stream include:

Smart Connect: This project is creating a single integrated portal to streamline and simplify customer service applications that include both load and generation, in particular distributed renewable generation. It eliminates the multiple portals and applications that were previously required for service applications. Smart Connect will simplify the demands on customers applying for new service requests, increase transparency and improve business efficiency by alleviating manually intensive intake and evaluations processes and by reducing new service application cycle time. Smart Connect is a continuation of Express Connections & EGI Front End Upgrades described during in the 2020-2022 rate case and is expected to conclude in 2022.

New Customer Service Preapplication Tool: As California moves to reach decarbonization goals and existing customers need to make informed decisions building electrification conversions, Service Planning will need new tools to efficiently respond to customer requests. PG&E has already made significant strides in this area during the last rate cycle by developing a single integrated application portal to streamline and simplify customer service applications that include both load and generation and that provides a complete customer view tailored to multiple stakeholders. In the 2023-2026 rate cycle, PG&E plans to facilitate the customer application process by enabling applicant designers and respective firms to have appropriate access to input templates and the ability to appropriately utilize PG&E estimating software features and functions. These customer-generated estimates will then be integrated into the standard PG&E workflow to help reduce duplication of effort and reduce service application times. - PG&E also plans to develop pre-application tools that provide customers with quick-turnaround project assessments of project costs and benefits before they need to decide to move forward with the more comprehensive and costly full application process.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Project Summary – Customer Service

Future Technology Investments: Additional outer year technology investments are anticipated to further tailor and streamline service application processes to customer needs and to provide more dynamic customer-facing portals where applicants can get real-time visibility into their service application process. PG&E's continuing goal is to enable further reductions in new service application processing times, as well as to satisfy any future new CPUC requirements.

Justification

The investments made in the customer service Value Stream will enhance customer service by simplifying, streamlining, and speeding up new service application and project submission processes. Customers will also be provided tools that facilitate quick-turnaround initial project assessments. The projects target improvements in business efficiency and business risk by eliminating duplicative, manual, and error-prone data entry steps.

Cost

PG&E used the IT Project/Program Estimating Tool (PET) to document estimate assumptions and generate labor and non-labor cost forecasts for this program. To calculate labor costs, the PET captures labor hours by activity and resource type, multiplies that by standard labor rates, and adds in standard overhead factors. To calculate non-labor costs, the PET captures contract costs by type (such as software licenses or third-party services), material costs by unit quantity and unit price, and standard overheads such as materials burden and AFUDC. Other factors, such as escalation and capital/expense ratios, are calculated based on standard rates and accounting guidance. See Exhibit (PG&E-7), Chapter 8 for additional information regarding the PET. PG&E can provide the specific PET output produced for this program upon request.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE													
MWC JV, PO 5256894	-	254	272	153	0							679	
MWC JV PO 5055409, 5056220, 5056769, 5057102	-	-	-	-	-	273	199	120				592	
												-	
Expense Total	**-**	**254**	**272**	**153**	**0**	**273**	**199**	**120**	**-**	**-**	**-**	**1,271**	WP 20-8, Line 4
CAPITAL													
MWC 2F, PO 5786478, 5791620	-	604	1,979	541	3,679							6,803	
MWC 2F, POs 5793958, 5793959, 5795562, 5793283	-					8,942	5,530	831	1,000	1,980	3,080	21,364	
Capital Total	**-**	**604**	**1,979**	**541**	**3,679**	**8,942**	**5,530**	**831**	**1,000**	**1,980**	**3,080**	**28,167**	WP 20-17, Line 4
TOTAL PROJECT COST	**-**	**858**	**2,251**	**694**	**3,680**	**9,215**	**5,729**	**951**	**1,000**	**1,980**	**3,080**	**29,438**	

This project will benefit both transmission and distribution. The costs included in PG&E's 2023 GRC (shown here) represent the distribution share of the total project cost.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Project Summary – Customer Service

Benefits

This project has no hard financial savings. Other non-financial benefits are described in the Justification section.

Alternatives Considered

Status Quo: Failure to make these changes would prolong the use of manual business processes where integration and automation would enhance business efficiency and transparency. PG&E does not recommend this option.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Program Summary – Field Work Managament

Value Stream Program: Field Work Management
Major Work Categories: JV, 2F
Planning Order Numbers: 5793280, 5055406
Project Start Date: 2023
Project Completion Date: 2026
Operative Date (only applies to Capital): Operative as Installed

Program Description

The Field Work Management Value Stream focuses on technology solutions used to plan and execute field work safely and efficiently, to document performed work completely and accurately, and to manage the flow of information between field crews and the back-office. Field Work Management encompasses service planning, customer-requested work initiation, design, cost estimation, construction management, and project completion and invoicing activities. A key strategic goal of the Field Work Management Value Stream is the digitization of all forms to streamline and integrate processes, increase transparency and consistency, and reduce errors. Electric Distribution's main focus on work in the Field Work Management's IT Value Stream can be summarized as:

- Work Planning, Engineering & Design: Improve planning and scheduling capabilities through the unification and standardization of tools;
- Work Execution: Facilitate more effective and efficient work delivery through increased integration and digitization of tools and processes, enabling improved compliance adherence, simplified field operations, and risk reduction; and
- Emergency Preparedness & Response: Respond to all emergencies safely, quickly, and transparently to meet the needs of the communities by leveraging technology and communication infrastructure.

The work described in this Value Stream portfolio summary addresses the targeted needs of Electric Distribution operations. In the next rate cycle, this work will also support the switch to a more regionalized business operations model. Field Work Management technology investment is also implemented at the enterpise level and this work is described in Exhibit 7, chapter 8. Examples of projects Electric Distribution operations is pursuing in this Value Stream include:

Service Planning & Design (SP&D) Work Management Platform: SP&D will continue to improve its new service application work-planning and scheduling management software platform introduced during the 2020-2022 rate cycle as part of the Smart Distribution Operations (SDO) project. This initiative integrates elements of PG&E's ERP and CRM platforms to improve Electric Distribution's application processes, streamline workflow, increase job visibility and planning efficiency, and improve project execution and closure in order to enhance customer service and reduce new service project cycle times. Further improvements in these areas will be achieved during the 2023-2026 rate cycle by:

- Expanding the user community to include the estimating and clerical parts of the Service Planning organization to create a common, integrated SP&D work planning and scheduling platform for SP&D.
- Expanding customer relationship management and productivity tools to aid project management and customer communication.
- Adding real-time data analytics and predictive indicator capabilities for real-time interactive dashboard monitoring of all work status and alerts.

- Integrating with customer contract and financial management, application portal (Smart Connect), and other tools and applications supporting project work.

Graphic Work Design Platform: PG&E plans to replace its current electrical distribution construction design and estimating toolset with a more modern, integrated and graphics-based construction design software. This new software will significantly improve design consistency and efficiency, incorporating factors such as standards, optimal design, material usage cost-effectiveness, and automated design audits to produce an integrated and complete set of construction drawings and estimation documents.The integrated tools will streamline and automate the design and estimating processes, improve record keeping and enable design consistency across projects.The project will have three phases, all anticipated to be completed during the 2023-2026 rate cycle:

- Development of the core graphical design software platform with automated performance of electrical design calculations, design rules and standards, component connectivity & sizing, and materials selection. Create all necessary drawings for construction, customers, and records management;
- Integration of design application with the EES to automate materials estimating and ordering;
- Integration of design output with GIS to automatically update & map asset records and mapping.
- Support integration with Mobile Enterprise Solutions.

Applicant Design Pricing Tools: The current new service application process does not support pre-application requests that can help customers obtain preliminary assessments before deciding to move forward with a new project. PG&E plans to develop a new, automated application workstream for customer pre-application requests that evaluates the impact to existing service and distribution facilities and provides a ballpark cost estimate based on the customer's identified scope of work.

PG&E also plans to enhance its Enterprise Estimating Solution (EES) to provide Applicant Designers with appropriate remote access to input templates and the the ability to appropriately utilize the EES features and functions. The goal is to make it easier for Applicant Designers to do business with PG&E by processing estimates directly and inputting application information that can subsequently be integrated into the standard PG&E workflow, from Estimating through Construction. Duplicative and multiple manual data entry steps will be reduced, streamlining the application process and reducing the scope for errors. It is also expected to help reduce applicant design pricing cycle-times. This work will continue work that was started in the Service Planning & Design (SP&D) Initiative Integration project discussed in the previous rate-cycle application.

The 2021 forecasted costs in the table below includes the EES Contracts project which implements a rules-based calculator to address errors in the EES software application used by Electric Operations (EO) to determine distribution construction costs and customer contracts. The forecast also includes work to complete integration of the Joint Pole database with SAP to meet the latest CPUC requirements and facilitate automation of Joint Pole-related project cost estimates when requested by other IOUs.

Future Technology Investments: Outer year technology investments in Field Work Management are expected to accelerate the end-to-end digitization of work management processes and the integration with digital mobile devices used for field work and data collection. All paper forms and work packages will ultimately be digitized and enriched with real-time incorporation of GIS and other data sets. This work will expand to incorporate all

work types, including system inspections, maintenance and construction, and clerical. The capture of as-built construction drawings will be digitized on mobile devices. Asset management planning will be integrated with work management systems to give visibility into all future planned work. This will enable bundling and optimization of work planning and facilitate improved asset risk management and increased grid safety. Digitization and integration of work and asset management systems will allow deeper business analytics and reporting and will enable early visibility of work planning dependencies and conflicts. This work is being done in coordination with the PG&E's Digital Catalyst Mobile development team.

Justification

The Field Work Management Value Stream investments described here utilize IT to streamline, integrate, and digitize work management processes to make them more efficient, robust and transparent. The projects described will benefit multiple areas, including:

- Safety will be improved through improved, risk-informed work management and prioritization, more accurate designs, greater work flow transparency, and more reliable customer and crew communications.
- Customer satisfaction will be improved by enabling more reliable information sharing with customers as well as through an improved ability to meet customer commitment dates.
- Operational excellence will be improved by streamlining the way PG&E manages its work, eliminating redundant or wasteful tasks, reducing manual work steps, improving coordination, reducing re-work, and improving efficiency. Job packages will be more complete and accurate enabling optimized bundling of work and decreased rescheduling through the standardization and documentation of processes.
- Risks will be mitigated through better project communication and coordination as well as through greater project transparency and oversight. Data integrity in SAP, PG&E's system or record for asset management, will be improved.
- Compliance: Early dependency screening will reduce the risk of not having permits ready and improved our ability to execute compliance work on-time.

Cost

PG&E used the IT Project/Program Estimating Tool (PET) to document estimate assumptions and generate labor and non-labor cost forecasts for this program. To calculate labor costs, the PET captures labor hours by activity and resource type, multiplies that by standard labor rates, and adds in standard overhead factors. To calculate non-labor costs, the PET captures contract costs by type (such as software licenses or third-party services), material costs by unit quantity and unit price, and standard overheads such as materials burden and AFUDC. Other factors, such as escalation and capital/expense ratios, are calculated based on standard rates and accounting guidance. See Exhibit (PG&E-7), Chapter 8 for additional information regarding the PET. PG&E can provide the specific PET output produced for this program upon request.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management & Technology
Program Summary – Field Work Managament

Major Project Spending Estimates

(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE													
MWC JV, VARIOUS POs	720	1,710	1,928	224	132							4,714	
MWC JV, PO 5055406, 5056220, 5056769, 5057102						785	1,158	2,267				4,209	
												-	
Expense Total	**720**	**1,710**	**1,928**	**224**	**132**	**785**	**1,158**	**2,267**	**-**	**-**	**-**	**8,924**	**WP 20-8, Line 8**
CAPITAL													
MWC 2F, VARIOUS POs	6,990	4,094	2,534	466	5,128							19,213	
MWC 2F, POs 5793280, 5793958, 5793959, 5795562						1,913	4,601	8,990	5,512	5,416	5,637	32,068	
Capital Total	**6,990**	**4,094**	**2,534**	**466**	**5,128**	**1,913**	**4,601**	**8,990**	**5,512**	**5,416**	**5,637**	**51,281**	**WP 20-17, Line 8**
TOTAL PROJECT COST	**7,710**	**5,805**	**4,462**	**690**	**5,260**	**2,697**	**5,759**	**11,257**	**5,512**	**5,416**	**5,637**	**60,205**	

Benefits

Financial: The process improvement and technology work will contribute to savings due to headcount reductions and through improved, more efficient processes. Optimized work planning and scheduling will reduce manual work, eliminate tasks, reduce errors, and decrease reschedules across the system. PG&E estimates that these improvements will generate savings via reduction of re-scheduling work, reduction of rework, and overall efficiency.

Other: Other non-financial benefits are described in the Justification section.

Other Alternatives Considered

Status Quo. IT technology investments and upgrades are key to achieving increased customer service, operational performance, and improved safety. Process improvements supported by technology upgrades made in the previous rate cycle yielded substantial benefits and demonstrate the soundness of that strategy. PG&E does not recommend maintaining the status quo.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management and Technology
Project Summary – Safety, Governance, Regulatory, and Compliance

Value Stream Program: Safety, Governance, Regulatory, and Compliance
Major Work Categories: JV, 2F
Planning Order Numbers: 5795561, 5058273
Project Start Date: 2023
Project Completion Date: 2026
Operative Date (only applies to Capital): Operative as Installed

Project Description

The Safety, Governance, Regulatory, and Compliance Value Stream focuses on the technology solutions used to manage workforce health and safety; to manage public safety and environmental impacts; to manage Company records, compliance, and corrective action programs; to support regulatory and legal proceedings; and to manage relationships with external stakeholders. The table below summarizes PG&E's costs for Electric Distribution's investments in this Value Stream.

Electric Distribution Operations' projects in this Value Stream include:

Mobile & Offline Document Viewer: To ensure the safety and wellbeing of employees and the public, relevant field personnel need to have access to up-to-date, controlled technical information even when working out of range (in remote locations). This ensures that work is completed with up-to-date requirements and procedures. Using the proposed technology solution, all documents that reside in the Technical Information Library will be electronically accessible to field users via mobile devices. The need to carry paper manuals will be reduced. This project provides seamless, full automated integration with Documentum ensuring that electronic documents - push updated through a centrally managed document management system - are always the latest version.

Justification

The program's main benefits relate to safety, risk management and compliance:

- Mobile and offline access to technical documents is critical to employee and public safety, as well as adherence with and compliance to approved requirements and procedures. It is also necessary for PASS 55 certification. This solution should help our mutual aid groups achieve faster response when needed.
- Field Employee (PG&E, Contractors and mutual aid groups) Safety: The solution will enable vendor on- and off-boarding activities to be monitored and provide any "in-the-field" employee with access to the most current, up to date processes and procedures for work execution from a Mobile device. This will mitigate the risk associated with field employees and contractors using out-of-date procedures.
- The solution will enable monitoring of when individual users access the system through enhanced Auditing (PASS 55) reports.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case
Exhibit (PG&E-4), Chapter 20, Electric Distribution Data Management and Technology
Project Summary – Safety, Governance, Regulatory, and Compliance

Cost

PG&E used the IT Project/Program Estimating Tool (PET) to document estimate assumptions and generate labor and non-labor cost forecasts for this program. To calculate labor costs, the PET captures labor hours by activity and resource type, multiplies that by standard labor rates, and adds in standard overhead factors. To calculate non-labor costs, the PET captures contract costs by type (such as software licenses or third-party services), material costs by unit quantity and unit price, and standard overheads such as materials burden and AFUDC. Other factors, such as escalation and capital/expense ratios, are calculated based on standard rates and accounting guidance. See Exhibit (PG&E-7), Chapter 8 for additional information regarding the PET. PG&E can provide the specific PET output produced for this program upon request.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE													
MWC JV, VARIOUS POs	-	441	654	36								1,132	
MWC JV, POs 5058273, 5056220, 5056769, 5057102						1,084	756	941				2,781	
												-	
Expense Total	**-**	**441**	**654**	**36**	**-**	**1,084**	**756**	**941**	**-**	**-**	**-**	**3,912**	**WP 20-8 Line 10**
CAPITAL													
MWC 2F, PO 5773835	-	516	1,365	20	-							1,901	
MWC 2F, PO 5777043			1,064	644		-	-	-	-	-	-	1,708	
Capital Total	**-**	**516**	**2,428**	**664**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3,609**	**WP 20-17 Line 9**
TOTAL PROJECT COST	**-**	**958**	**3,082**	**700**	**-**	**1,084**	**756**	**941**	**-**	**-**	**-**	**7,521**	

Benefits

This project has no hard financial savings. Non-financial benefits are described in the Justification section.

Other Alternatives Considered

Status Quo: Failure to fund this project could result in increased safety risks and increased risk of possible compliance violations due to a lack of resources available to effectively manage compliance-related programs. PG&E does not recommend this option.

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN

TABLE OF CONTENTS

Subject	Page No.
Expense Workpapers	
Workpaper Table 21-1: Expenses by Major Work Category - Nominal Dollars	WP 21-1
Workpaper Table 21-2: Expenses by Major Work Category - Base Year Dollars	WP 21-2
Workpaper Table 21-3: Recorded Expense Walk by Major Work Category	WP 21-3
Workpaper Table 21-4: Forecast Expense Walk by Major Work Category	WP 21-4
Workpaper Table 21-5: Integrated Grid Platform and Grid Modernization Plan - Expense Summary	WP 21-5
Capital Workpapers	
Workpaper Table 21-6: Capital Expenditures by Major Work Category	WP 21-6
Workpaper Table 21-7: Forecast Capital Expenditures Summary	WP 21-7
Workpaper Table 21-8: Recorded CWIP and Forecast Capital Expenditures Details - Planning Orders Over $3 Million	WP 21-8
Workpaper Table 21-9: Recorded and Forecast Capital Expenditures Details - Other Work	WP 21-9
Workpaper Table 21-10: Recorded Capital Walk by Major Work Category	WP 21-10
Workpaper Table 21-11: Forecast Capital Walk by Major Work Category	WP 21-11
Workpaper Table 21-12: Integrated Grid Platform and Grid Modernization Plan - Capital Summary	WP 21-12
Workpaper Table 21-13: Distributed Energy Resource Management System Forecast Details	WP 21-13

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Supplemental Workpapers	
Workpaper Table 21-14: Grid Modernization Classification Table	WP 21-14
Workpaper Table 21-15: Grid Modernization Cost Table	WP 21-16
Workpaper Table 21-16: Location of (D.) 18-03-023 In GRC Filing	WP 21-17
Project Summaries	
Project Summary - Advanced Distribution Management System	WP 21-18
Project Summary - Distributed Energy Resource Management System	WP 21-31
Project Summary - Distribution Engineering Planning Tools	WP 21-35
Project Summary - Distribution Deferral Non-Procurement Costs	WP 21-43
Project Summary - Community Microgrid Enablement Program	WP 21-48
Project Summary - Electric Emerging Technology Program	WP 21-52
Project Summary - Elkhorn Battery Energy Storage System	WP 21-55
Project Summary - IGP IT Infrastructure	WP 21-58
Index Template	WP 21-64

Workpaper Table 21-1
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 21
Integrated Grid Platform and Grid Modernization Plan
Expenses by Major Work Category
(Thousands of Nominal Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference (A)
1	AB	Misc Expense			484	2,003	3,320	3,926	4,135	10,015	WP 21-3, (1)
2	AT	Research & Development	20,423	18,907	14,651	8,004	14,609	16,158	16,653	17,174	WP 21-3
3	HG	Elec Trans Ops Engr & Tech		453	3,374	3,010	5,154	5,424	2,287	15,541	WP 21-3
4	IG	Manage Var Bal Acct Processes		71	149	236	686	4,013	5,596	3,026	WP 21-3
5	JV	Maintain IT Apps & Infra			1,404	524	1,429	1,345	2,500	3,309	WP 21-3
6	**Total**		**20,423**	**19,431**	**20,062**	**13,778**	**25,198**	**30,867**	**31,171**	**49,065**	

(1) MWC AB excludes 2022-23 costs related to Elkhorn Battery Energy Storage System that are confidential. Refer to confidential Exhibit-4, Appendix A

Workpaper Table 21-2
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 21
Integrated Grid Platform and Grid Modernization Plan
Expenses by Major Work Category
(Thousands of Base Year Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference
1	AB	Misc Expense			502	2,008	3,320	3,892	3,992	9,444	(1)
2	AT	Research & Development	21,987	20,209	15,091	8,075	14,609	15,967	16,006	16,040	
3	HG	Elec Trans Ops Engr & Tech		475	3,472	2,975	5,154	5,430	2,237	14,837	
4	IG	Manage Var Bal Acct Processes		78	154	240	686	3,987	5,394	2,800	
5	JV	Maintain IT Apps & Infra			1,432	522	1,429	1,335	2,417	3,113	
6	**Total**		**21,987**	**20,762**	**20,651**	**13,820**	**25,198**	**30,611**	**30,046**	**46,234**	

(1) MWC AB excludes 2022-23 costs related to Elkhorn Battery Energy Storage System that are confidential. Refer to confidential Exhibit-4, Appendix A

Table 21-3
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 21, Integrated Grid Platform and Grid Modernization
Recorded Expense Walk by Major Work Category
(Thousands of Nominal Dollars)

Ln. No.	Year	Amount	MWC AB	MWC AT	MWC HG	MWC IG	MWC JV	Detailed Description/Explanation	Reference
1	**2016**	**20,423**	**0**	**20,423**	**0**	**0**	**0**		
2			0						
3				(1,516)				Costs decreased because some EPIC 2 projects originally scheduled to close in 2017 were delayed into 2018 or 2019.	WP 21-5 Line 26
4					453			Costs increased due to planning activities in advance of ADMS vendor selection.	WP 21-5 Line 11
5						71		Costs increased due to the initiation of the DIDF program.	WP 21-5 Line 35
6							0		
7	**2017**	**19,431**	**0**	**18,907**	**453**	**71**	**0**		
8			484					Costs increased due to the initiation of Integration Capacity Analysis-related Planning Tools development.	WP 21-5 Line 31
9				(4,256)				Costs decreased because 11 out of 12 EPIC 3 project initially forecasted to start in 2018 were delayed into later years due to a delay in receiving Commission decision D.18-10-052	WP 21-5 Line 26
10					2,921			Costs increased due to the initiation of the ADMS project, including ADMS vendor selection, System Integrator (SI) selection, and the beginning of the project's Plan/Analyze phase.	WP 21-5 Line 11
11						79		Costs increased due to the ramp-up of activities associated with the DIDF program.	WP 21-5 Line 35
12							1,404	Costs increased due to the initiation of IGP IT Infrastructure work.	WP 21-5 Line 20
13	**2018**	**20,062**	**484**	**14,651**	**3,374**	**149**	**1,404**		
14			1,519					Costs increased due to running of Integration Capacity Analysis using previously developed tools over a partial year and increased requirements related to DDOR and GNA analysis.	WP 21-5 Line 31
15				(6,647)				Costs decreased because EPIC 2 projects were largely finished by 2019 and EPIC 3 projects were slower to ramp up after the delay in receiving Commission decision D.18-10-052	WP 21-5 Line 26
16					(364)			Costs decreased slightly as vendor selection ended and the ADMS project moved to more capital-intensive activities.	WP 21-5 Line 11
17						87		Costs increased due to the ramp-up of activities associated with the DIDF program.	WP 21-5 Line 35
18							(880)	Overall costs decreased as a decline in work activities associated with IGP Cybersecurity, Data Center and Control Center Infrastructure Preparation, and SCADA Network Reliability Improvements offset increases associated with Distribution Engineering Planning Tools and FAN.	WP 21-5 Line 20
19	**2019**	**13,778**	**2,003**	**8,004**	**3,010**	**236**	**524**		
20			1,316					Costs increased due to running of Integration Capacity Analysis using previously developed tools over a full year and increased requirements related to DDOR and GNA analysis per DIDF Improvements Ruling.	WP 21-5 Line 31
21				6,604				Costs increased due to nine EPIC3 projects initiating and ramping spend.	WP 21-5 Line 26
22					2,144			Costs increased due to an increase in ADMS project activities, including the completion of the Plan/Analyze phase, the beginning of the project Design phase, and the beginning of data cleanup activities.	WP 21-5 Line 11
23						450		Costs increased due to the initiation of the CMEP program. DIDF costs increased but were partially offset by a one-time credit associated with a contracts deposit. Costs associated with the Avoided Cost Calculator also increased.	WP 21-5 Line 35
24							905	Costs increased as work activity increased in all sub-areas of the IGP IT Infrastructure project.	WP 21-5 Line 20
25	**2020**	**25,198**	**3,320**	**14,609**	**5,154**	**686**	**1,429**		

Table 21-4
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 21, Integrated Grid Platform and Grid Modernization
Forecast Expense Walk by Major Work Category
(Thousands of Nominal Dollars)

Ln. No.	Year	Amount	MWC AB	MWC AT	MWC HG	MWC IG	MWC JV	Detailed Description/Explanation	Reference
1	**2020**	**25,198**	**3,320**	**14,609**	**5,154**	**686**	**1,429**		
2			606					Costs will increase due to increased requirements related to DDOR and GNA analysis per DIDF Improvements Ruling.	WP 21-5 Line 31
3				1,550				Costs will increase due to six EPIC3 Wave 2 projects expected to be initiated in 2021	WP 21-5 Line 26
4					270			No significant change.	WP 21-5 Line 11
5						3,327		Costs will increase due to an increase in CMEP program activitity during the program's first year of operation. Costs for DRP administration also increased due to requirements associated with the DIDF Improvement Ruling.	WP 21-5 Line 35
6							(84)	Overall costs will decrease slightly as declines in work activities associated with IGP Cybersecurity, SCADA Network Reliability Improvements, and Distribution Engineering Planning Tools will offset increases in activity associated with FAN, Substation Converge Compute Platform, and Data Center and Control Center Infrastructure Preparation	WP 21-5 Line 20
7	**2021**	**30,867**	**3,926**	**16,158**	**5,424**	**4,013**	**1,345**		
8			209					Costs will increase primarily due to escalation.	WP 21-5 Line 31
9				494				Costs will increase primarily due to escalation.	WP 21-5 Line 26
10					(3,138)			Per note in WP 21-5, Note No. (1), the value displayed here does not reflect actual expected spend in 2022. Costs will increase due to an increase in ADMS project activities, including the completion of Release 1 Testing, the beginning of Release 1 Cutover on a division-by-division basis, the completion of the Release 2 Plan/Analyze phase, the beginning of Release 2 Design/Build/Test activities, the Build of the Release 2 Network Model expansion, the beginning of Release 3 Design, and an increase in data cleanup activities including the Secondary Mesh project.	WP 21-5 Line 11
11						1,583		Costs will increase due to the ramp-up of activities associated with DER Pilots.	WP 21-5 Line 35
12							1,155	Overall costs will increase as increases in work activities associated with FAN, SCADA Network Reliability, and Substation Converge Compute Platform will offset declines in work activity associated with Distribution Engineering Planning Tools and Data Center and Control Center Infrastructure Preparation	WP 21-5 Line 20
13	**2022**	**31,171**	**4,135**	**16,653**	**2,287**	**5,596**	**2,500**		
14			5,880					Costs will increase due to the transfer of CMEP work from MWC IG to MWC AB. CMEP costs are expected to increase over the previous year due an anticipated increase in microgrid development activity following the Commission's expected 2022 approval of the Microgrid Incentive Program. .	WP 21-5 Line 31
15				521				Costs will increase primarily due to escalation.	WP 21-5 Line 26
16					13,255			Per note in WP 21-5, Note No. (1), the value displayed here does not reflect actual expected spend in 2022. Costs will increase due to an increase in expense-intensive project activities including training, change management, and field collection of Phase ID data.	WP 21-5 Line 11
17						(2,571)		Overall costs will decrease as the transfer of CMEP work from MWC IG to MWC AB will more than offset an increase in DRP Non-Procurement costs due to increased DRP DIDF and DER Pilots program activities.	WP 21-5 Line 35
18							809	Costs will increase due to an increase in work activities associated with Enhanced Planning Tools.	WP 21-5 Line 20
19	**2023**	**49,065**	**10,015**	**17,174**	**15,541**	**3,026**	**3,309**		

Workpaper Table 21-5
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 21, Integrated Grid Platform and Grid Modernization Plan
Integrated Grid Platform and Grid Modernization Plan - Expense Summary
(Thousands of Dollars)

Line No.														Notes	Reference
1	**MWC HG - Operations Engineering and Technology**	**MAT**	**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**2024 Forecast**	**2025 Forecast**	**2026 Forecast**		
2	**Advanced Distribution Management System**	**HGC**													
3	ADMS Release 1 (SCADA)	**HGC**	$ -	$ 453	$ 1,944	$ 2,730	$ 4,557	$ 2,283	$ 2,146	$ 2,067	$ -	$ -	$ -		WP 21-18
4	ADMS Release 2 (OMS)	**HGC**	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,693	$ 4,399	$ 2,679	$ -	$ -		WP 21-18
5	ADMS Release 3 (Advanced Apps)	**HGC**	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,527	$ 1,652	$ 401	$ -	$ -		WP 21-18
6	ADMS Asset Data	**HGC**	$ -	$ -	$ 618	$ 163	$ 427	$ 1,641	$ 1,490	$ 4,897	$ 5,031	$ -	$ -		WP 21-18
7	ADMS Cybersecurity	**HGC**	$ -	$ -	$ -	$ -	$ -	$ 1,000	$ -	$ 1,859	$ 1,573	$ -	$ -		WP 21-18
8	ADMS PMO	**HGC**	$ -	$ -	$ 812	$ 117	$ 171	$ 500	$ 529	$ 547	$ 562	$ -	$ -		WP 21-18
9	Forecast Adjustment	**HGC**	$ -	$ -	$ -	$ -	$ -	$ -	$ (10,099)	$ -	$ -	$ -	$ -	(1)	Ex.-4, Ch. 2; WP 21-18
10	**Distributed Energy Resource Management System**	**HGC**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 119	$ 502	$ 2,644	$ 3,480		WP 21-31
11		**MWC HG Total**	**$ -**	**$ 453**	**$ 3,374**	**$ 3,010**	**$ 5,154**	**$ 5,424**	**$ 2,287**	**$ 15,541**	**$ 10,748**	**$ 2,644**	**$ 3,480**		
12	**MWC JV - Information Technology Expense**	**MAT**	**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**					
13	**Distribution Engineering Planning Tools (Non-DRP Driven)**	**JVA**	$ -	$ -	$ 106	$ 197	$ 298	$ 215	$ 200	$ 1,009					WP 21-35
14	**IGP IT Infrastructure**	**JVA**													
15	Field Area Network	**JVA**	$ -	$ -	$ 121	$ 156	$ 241	$ 400	$ 1,000	$ 1,000					WP 21-58
16	SCADA Network Reliability Improvements	**JVA**	$ -	$ -	$ 211	$ 46	$ 437	$ 340	$ 900	$ 900					WP 21-58
17	Substation Converge Compute Platform	**JVA**	$ -	$ -	$ -	$ -	$ -	$ 160	$ 400	$ 400					WP 21-58
18	Data Center and Control Center Infrastructure Preparation	**JVA**	$ -	$ -	$ 246	$ 58	$ 61	$ 230	$ -	$ -					WP 21-58
19	**IGP Cybersecurity**	**JVA**	$ -	$ -	$ 720	$ 66	$ 392	$ -	$ -	$ -				(2)	
20		**MWC JV Total**	**$ -**	**$ -**	**$ 1,404**	**$ 524**	**$ 1,429**	**$ 1,345**	**$ 2,500**	**$ 3,309**					
21	**MWC AT - Research and Development**	**MAT**	**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**					
22	EPIC Program	**AT#**	$ 20,423	$ 18,907	$ 14,651	$ 8,004	$ 14,609	$ 16,158	$ 16,653	$ -					WP 21-52
23	Electric Emerging Technology Program - Administration	**AT#**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,717					WP 21-52
24	Electric Emerging Technology Program - Projects	**AT#**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,453					WP 21-52
25	Electric Emerging Technology Program - Partnerships	**AT#**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,004					WP 21-52
26		**MWC AT Total**	**$ 20,423**	**$ 18,907**	**$ 14,651**	**$ 8,004**	**$ 14,609**	**$ 16,158**	**$ 16,653**	**$ 17,174**					
27	**MWC AB - Misc. Expense**	**MAT**	**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**					
28	**Distribution Engineering Planning Tools (DRP Driven)**	**AB#**	$ -	$ -	$ 484	$ 2,003	$ 3,320	$ 3,926	$ 4,135	$ 4,565					WP 21-35
29	**Elkhorn Battery Energy Storage System**	**AB#**	$ -	$ -	$ -	$ -	$ -	$ -	***Confidential***					(3)	WP 21-55
30	**Community Microgrid Enablement Program**	**AB#**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,450					WP 21-48
31		**MWC AB Total**	**$ -**	**$ -**	**$ 484**	**$ 2,003**	**$ 3,320**	**$ 3,926**	**$ 4,135**	**$ 10,015**					
32	**MWC IG**	**MAT**	**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**					
33	**Community Microgrid Enablement Program**	**IG#**	$ -	$ -	$ -	$ -	$ 391	$ 3,088	$ 3,177	$ -					WP 21-48
34	**Distribution Deferral Non-Procurement Costs**	**IG#**	$ -	$ 71	$ 149	$ 236	$ 296	$ 926	$ 2,419	$ 3,026					WP 21-43
35		**MWC IG Total**	**$ -**	**$ 71**	**$ 149**	**$ 236**	**$ 686**	**$ 4,013**	**$ 5,596**	**$ 3,026**					
36															
37		**Expense Total**	**$ 20,423**	**$ 19,431**	**$ 20,062**	**$ 13,778**	**$ 25,198**	**$ 30,867**	**$ 31,171**	**$ 49,065**					

Assumptions and Notes

(1) Additional expenses are forecasted for ADMS in 2022 that were not included in the GRC forecast due to the forecast prioritization process, described further in Chapter 2. PG&E intends to identify funding for this work through efficiencies elsewhere in the Electric Operations portfolio.

(2) These costs encompass the IT-related portions of the work

(3) Refer to confidential Exhibit-4, Appendix A

Workpaper Table 21-6
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 21
Integrated Grid Platform and Grid Modernization Plan
Capital Expenditures by Major Work Category
(Thousands of Nominal Dollars)

			Capital Expenditures												
No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Note	Reference
1	21	Misc Capital	-	-	1,114	2,116	395	2,882	3,083	2,237	1,852	1,902	-		
2	2F	Build IT Apps & Infra	-	-	12,077	16,759	26,724	19,540	17,900	20,369	19,086	19,695	17,000		
3	3M	Install/Repl Var Bal Acct	10,151	(5)	-	-	-	-	-	-	-	-	-		
4	3R	Energy Storage Capital	-	-	-	15,460	86,080	*Confidential*		4,092	12,954	-	-	(1) (2)	
5	63	E T&D Control System/ Facility	-	-	5,048	12,209	44,373	81,885	126,880	109,049	68,042	20,565	26,438		
6	82	TO-EGI/WRO/SI	-	-	11	67	41	121	-	-	-	-	-		
7		**Grand Total**	**10,151**	**(5)**	**18,250**	**46,610**	**157,613**	**104,428**	**147,863**	**135,747**	**101,935**	**42,163**	**43,438**		
8	3R	Errata Adjustment								(4,092)	(12,954)			(1)	
9		**Grand Total**	**10,151**	**(5)**	**18,250**	**46,610**	**157,613**	**104,428**	**147,863**	**131,655**	**88,981**	**42,163**	**43,438**		WP 21-10, WP 21-11

(1) Line 9, 2022-2024 Forecast values vary from the values listed in the Results of Operations (RO) Model due to errata. These amounts do not align to the RO Model provided to the Public Advocates Office at the time of filing. The RO will be updated to incorporate these errata with the Joint Comparison Exhibit submittal.
(2) MWC 3R excludes 2021-22 costs related to Elkhorn Battery Energy Storage System that are confidential. Refer to confidential Exhibit-4, Appendix A

Workpaper Table 21-7
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 21
Grid Modernization
Forecast Capital Expenditures Summary
(Thousands of Nominal Dollars)

		Capital Expenditures							
Line No.	Description	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	Projects > $3 Million*	178,624	101,757	147,600	135,476	100,557	41,063	43,438	WP 21-8, (1)
2	Other Work	5,806	2,671	264	271	1,378	1,100	-	WP 21-9, (1)
3	**Total**	**184,430**	**104,428**	**147,863**	**135,747**	**101,935**	**42,163**	**43,438**	

4 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

(1) Excludes MWC 3R 2021-22 costs related to Elkhorn Battery Energy Storage System that are confidential. Refer to confidential Exhibit-4, Appendix A

Workpaper Table 21-8
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 21
Integrated Grid Platform and Grid Modernization Plan
Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million*
(Thousands of Nominal Dollars)

Line No.	Planning Order	Description	MWC	Operative Date	CWIP 2020 Recorded Adjusted	Capital Expenditures 2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Subtotal	Reference
	MWC - 21	**Misc Capital**											
1	5530791	Dist Resources Planning Tools MA	21		319	2,882	3,083	2,237	1,852	1,902	-	12,276	
2	**Total**				**319**	**2,882**	**3,083**	**2,237**	**1,852**	**1,902**	**-**	**12,276**	WP 21-12
	MWC - 2F	**Build IT Apps & Infra**											
3	5779168	IGP Communication-FAN	2F	Dec-2021	19,564	-	-	-	-	-	-	19,564	
4	5779169	IGP Communication-SCADA	2F	Dec-2021	6,543	-	-	-	-	-	-	6,543	
5	5794602	IGP Enhanced Planning Tools (C)	2F	Dec-2020	-	1,050	1,000	3,469	1,886	1,995	-	9,400	
6	5794665	IGP-Field Area Network (C)	2F	Dec-2020	-	8,340	8,340	8,340	-	-	-	25,020	
7	5794666	IGP-Field Area Network Ph2 (C)	2F	Dec-2020	-	-	-	-	8,600	8,900	9,100	26,600	
8	5794667	IGP-SCADA Ntwk Rel Improv (C)	2F	Dec-2020	-	7,250	7,250	7,250	-	-	-	21,750	
9	5794668	IGP-SCADA Ntwk Rel Improv Ph2 (C)	2F	Dec-2020	-	-	-	-	7,500	7,700	7,900	23,100	
10	5794669	IGP-Substation Conv Compute Pltfm (C)	2F	Dec-2020	-	600	1,310	1,310	-	-	-	3,220	
11	**Total**				**26,107**	**17,240**	**17,900**	**20,369**	**17,986**	**18,595**	**17,000**	**135,197**	WP 21-12
	MWC - 3R	**Energy Storage Capital**											
12	5785091	ELKHORN: Install Energy Storage System	3R	Jul-2021	100,617	***Confidential***		-	-	-	-	100,617	(1)
13	5795610	SYSPLAN Energy Storage 3RC	3R	Dec-2020	-			4,092	12,954	-	-	17,046	(1)
14	**Total**				**100,617**	**-**	**-**	**4,092**	**12,954**	**-**	**-**	**117,663**	WP 21-12
	MWC - 63	**E T&D Control System/ Facility**											
15	5528219	ADMS R1 - CAP	63		48,487	53,795	49,973	33,996	27,731	-	-	213,982	
16	5544409	ADMS R3 - CAP	63		-	-	16,359	26,760	8,866	-	-	(1)	
17	5544413	DERMS - CAP	63		-	-	-	975	4,005	20,565	26,438	51,983	
18	5779239	ADMS Asset Data - CAP	63	Dec-2024	1,375	1,615	1,851	2,371	561	-	-	7,772	
19	5791859	ADMS R2 - CAP	63	Dec-2024	402	20,012	58,433	39,207	23,875	-	-	141,930	
20	5792400	ADMS CyberSecurity - CAP	63	Dec-2024	1,317	6,213	-	5,470	2,726	-	-	15,726	
21	**Total**				**51,581**	**81,635**	**126,616**	**108,778**	**67,764**	**20,565**	**26,438**	**483,378**	WP 21-12
22		**Grand Total**			**178,624**	**101,757**	**147,600**	**135,476**	**100,557**	**41,063**	**43,438**	**748,514**	

23 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

(1) MWC 3R excludes 2021-22 costs related to Elkhorn Battery Energy Storage System that are confidential. Refer to confidential Exhibit-4, Appendix A

Workpaper Table 21-9
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 21
Integrated Grid Platform and Grid Modernization Plan
Recorded and Forecast Capital Expenditures Details - Other Work*
(Thousands of Nominal Dollars)

			Capital Expenditures											
Line No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	2F	Build IT Apps & Infra	-	-	3,271	3,290	5,183	2,300	-	-	1,100	1,100	-	WP 21-12
2	3M	Install/Repl Var Bal Acct	10,151	(5)	-	-	-	-	-	-	-	-	-	WP 21-12
3	3R	Energy Storage Capital	-	-	-	245	697	-	-	-	-	-	-	WP 21-12, (1)
4	63	E T&D Control System/ Facility	-	-	160	74	-	250	264	271	278	-	-	WP 21-12
5	82	TO-EGI/WRO/SI	-	-	11	67	41	121	-	-	-	-	-	WP 21-12
6	**Grand Total**		**10,151**	**(5)**	**3,442**	**3,677**	**5,921**	**2,671**	**264**	**271**	**1,378**	**1,100**	**-**	

7 * Excludes projects greater than $3M

(1) MWC 3R excludes 2021-22 costs related to Elkhorn Battery Energy Storage System that are confidential. Refer to confidential Exhibit-4, Appendix A

Table 21-10
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 21, Integrated Grid Platform and Grid Modernization
Recorded Capital Walk by Major Work Category
(Thousands of Nominal Dollars)

Ln. No.	Year	Amount	MWC 2F	MWC 3M	MWC 3R	MWC 21	MWC 63	MWC 82	Detailed Description/Explanation	Reference
1	**2016**	**10,151**	**0**	**10,151**	**0**	**0**	**0**	**0**		
2				(10,156)					Costs decreased due to the conclusion of the Smart Grid Pilot projects.	WP 21-12 Line 25
3	**2017**	**(5)**	**0**	**(5)**	**0**	**0**	**0**	**0**		
4			12,077						Costs increased due to the initiation of IGP IT Infrastructure work.	WP 21-12 Line 19
5				5						WP 21-12 Line 25
6						1,114			Costs increased due to the initiation of Planning Tools Development for the DRP.	WP 21-12 Line 22
7							5,048		Costs increased due to the initiation of the ADMS project, including ADMS vendor selection, System Integrator (SI) selection, and the beginning of the project's Plan/Analyze phase.	WP 21-12 Line 10
8								11	Costs increased due to the beginning of inter-tie work associated with the Elkhorn BESS project.	WP 21-12 Line 31
9	**2018**	**18,250**	**12,077**	**0**	**0**	**1,114**	**5,048**	**11**		
10			4,681						Overall costs increased as increases in work activity associated with Distribution Engineering Planning Tools, FAN, and SCADA Network Reliability offset declines in work associated with IGP Cybersecurity and Data Center and Control Center Infrastructure Preparation.	WP 21-12 Line 19
11					15,460				Costs increased due to an initial milestone payment to the Elkhorn Bess EPC vendor.	WP 21-12 Line 28
12						1,001			Costs increased due development of the DRP data portal and tool development related to Integration Capacity Analysis.	WP 21-12 Line 22
13							7,161		Costs increased due to an increase in ADMS project activities, including the completion of the Plan/Analyze phase, the beginning of the project Design phase, and the beginning of data cleanup activities.	WP 21-12 Line 10
14								56	Costs increased due to an increase in inter-tie work associated with the Elkhorn BESS project.	WP 21-12 Line 31
15	**2019**	**46,610**	**16,759**	**0**	**15,460**	**2,116**	**12,209**	**67**		
16			9,965						Overall costs increased as increases in work activity associated with FAN, SCADA Reliability Improvements, Data Center and Control Center Infrastructure Preparation, and IGP Cybersecurity offset a decline in work activity associated with Distribution Engineering Planning Tools.	WP 21-12 Line 19
17					70,620				Costs increased due to a higher second milestone payment to the Elkhorn BESS EPC vendor.	WP 21-12 Line 28
18						(1,721)			Costs decreased due to completion of most tool development work during the previous year.	WP 21-12 Line 22
19							32,165		Costs increased due to an increase in ADMS project activities, including the completion of the project Design phase, the beginning of the Network Model Build, the beginning of the Application Build, and an increase in data cleanup activities.	WP 21-12 Line 10
20								(26)	Costs decreased due to a decrease in inter-tie work associated with the Elkhorn BESS project.	WP 21-12 Line 31
21	**2020**	**157,613**	**26,724**	**0**	**86,080**	**395**	**44,373**	**41**		

Table 21-11
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 21, Integrated Grid Platform and Grid Modernization
Forecast Capital Walk by Major Work Category
(Thousands of Nominal Dollars)

Ln. No.	Year	Amount	MWC 2F	MWC 3R	MWC 21	MWC 63	MWC 82	Detailed Description/Explanation	Reference
1	**2020**	**157,613**	**26,724**	**86,080**	**395**	**44,373**	**41**		
2			(7,184)					Overall costs will decrease as a decline in work activity associated with FAN, SCADA Reliability Improvements, and IGP Cybersecurity will offset an increase in work activity associated with Substation Converge Compute Platform.	WP 21-12 Line 19
3				(86,080)				The 2021 cost estimate for the Elkhorn BESS project is confidential. Please refer to Exhbit-4, Appendix A.	WP 21-12 Line 28
4					2,487			Costs will increase due to initiation of DRP-related projects related to the CYME and LoadSEER application	WP 21-12 Line 22
5						37,511		Costs will increase due to an increase in ADMS project activities, including the completion of the Application and Network Model builds, the beginning of Release 1 Testing, the selection of a SCADA Point-to-Point vendor and the beginning of Point-to-Point Testing, and the beginning of the Release 2 Plan/Analyze phase.	WP 21-12 Line 10
6							80	Costs will increase due to an increase in inter-tie work associated with the Elkhorn BESS.	WP 21-12 Line 31
7	**2021**	**104,428**	**19,540**	**0**	**2,882**	**81,885**	**121**		
8			(1,640)					Overall costs will decrease as a decline in work activity associated with Data Center and Control Center Infrastructure Preparation and Enhanced Planning Tools will offset an increase in work activity associated with the Substation Converge Compute Platform.	WP 21-12 Line 19
9				0				The 2022 cost estimate for the Elkhorn BESS project is confidential. Please refer to Exhbit-4, Appendix A.	WP 21-12 Line 28
10					201			Costs will increase primarily due to escalation.	WP 21-12 Line 22
11						44,995		Costs will increase due to an increase in ADMS project activities, including the completion of Release 1 Testing, the beginning of Release 1 Cutover on a division-by-division basis, the completion of the Release 2 Plan/Analyze phase, the beginning of Release 2 Design/Build/Test activities, the Build of the Release 2 Network Model expansion, and the beginning of Release 3 Design.	WP 21-12 Line 10
12							(121)	Costs will decrease because the inter-tie work associated with the Elkhorn BESS was completed in the previous year.	WP 21-12 Line 31
13	**2022**	**147,863**	**17,900**	**0**	**3,083**	**126,880**	**0**		
14			2,469					Costs will increase due to an increase in work activity associated with Distribution Engineering Planning Tools.	WP 21-12 Line 19
15				0				Costs will decrease because the milestone payment to the Elkhorn BESS EPC vendor in 2022 will be the final one.	WP 21-12 Line 28
16					(847)			Costs will decrease due to an expected decrease in internal labor for tools development.	WP 21-12 Line 22
17						(17,831)		Costs will decrease due to a decrease in ADMS project activities, including completion of Release 1 Testing, the Release 2 Plan/Analyze phase, and the Release 2 Network Model build during the previous year.	WP 21-12 Line 10
18	**2023**	**131,655**	**20,369**	**0**	**2,237**	**109,049**	**0**		
19			(1,283)					Costs will decrease due to a decline in work activity associated with Distribution Engineering Planning Tools.	WP 21-12 Line 19
20					(384)			Costs will decrease due to an expected decrease in internal labor for tools development.	WP 21-12 Line 22
21						(41,007)		Costs will decrease due to a decrease in ADMS project activities, including completion of Release 3 Design during the previous year, and a reduction in pace of Release 1 cutover and Release 2 Design/Build/Test activities.	WP 21-12 Line 10
22	**2024**	**88,981**	**19,086**	**0**	**1,852**	**68,042**	**0**		
23			609					Costs will increase primarily due to escalation.	WP 21-12 Line 19
24					50			No significant change.	WP 21-12 Line 22
25						(47,477)		Costs will decrease due to the conclusion of the ADMS project.	WP 21-12 Line 10
26	**2025**	**42,163**	**19,695**	**0**	**1,902**	**20,565**	**0**		
27			(2,695)					Costs will decrease due to the conclusion of the Distribution Engineering Planning Tools project.	WP 21-12 Line 19
28					(1,902)			Costs will decrease because project work is expected to complete in 2025.	WP 21-12 Line 22
29						5,873		Costs will increase due to an increase in Design/Build/Test activities for the DERMS project.	WP 21-12 Line 10
30	**2026**	**43,438**	**17,000**	**0**	**0**	**26,438**	**0**		

Workpaper Table 21-12
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 21, Integrated Grid Platform and Grid Modernization Plan
Integrated Grid Platform and Grid Modernization Plan - Capital Summary
(Thousands of Dollars)

Line No.			2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Notes	Reference
1	**MWC 63 - Electric Distribution Operations Technology**	**MAT**													
2	**Advanced Distribution Management System (ADMS)**	**63C**													WP 21-18
3	ADMS Release 1 (SCADA)	**63C**	$ -	$ -	$ 2,969	$ 10,873	$ 41,365	$ 53,795	$ 49,973	$ 33,996	$ 27,731	$ -	$ -		WP 21-18
4	ADMS Release 2 (OMS)	**63C**	$ -	$ -	$ -	$ -	$ 402	$ 20,012	$ 58,433	$ 39,207	$ 23,875	$ -	$ -		WP 21-18
5	ADMS Release 3 (Advanced Apps)	**63C**	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,359	$ 26,760	$ 8,866	$ -	$ -		WP 21-18
6	ADMS Asset Data	**63C**	$ -	$ -	$ 1,919	$ 1,261	$ 1,290	$ 1,615	$ 1,851	$ 2,371	$ 561	$ -	$ -		WP 21-18
7	ADMS Cybersecurity	**63C**	$ -	$ -	$ -	$ -	$ 1,317	$ 6,213	$ -	$ 5,470	$ 2,726	$ -	$ -		WP 21-18
8	ADMS PMO	**63C**	$ -	$ -	$ 160	$ 74	$ -	$ 250	$ 264	$ 271	$ 278	$ -	$ -		WP 21-18
9	**Distributed Energy Resource Management System (DERMS)**	**63C**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 975	$ 4,005	$ 20,565	$ 26,438		WP 21-31
10		**MWC 63 Total**	**$ -**	**$ -**	**$ 5,048**	**$ 12,209**	**$ 44,373**	**$ 81,885**	**$ 126,880**	**$ 109,049**	**$ 68,042**	**$ 20,565**	**$ 26,438**		
11	**MWC 2F - Information Technology Capital**		**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**2024 Forecast**	**2025 Forecast**	**2026 Forecast**		
12	**Distribution Engineering Planning Tools (Non-DRP Driven)**	**2FA**	$ -	$ -	$ 880	$ 1,897	$ 1,180	$ 1,050	$ 1,000	$ 3,469	$ 1,886	$ 1,995	$ -		WP 21-35
13	**IGP IT Infrastructure**	**2FA**													
14	Field Area Network	**2FA**	$ -	$ -	$ 5,586	$ 9,371	$ 12,183	$ 8,340	$ 8,340	$ 8,340	$ 8,600	$ 8,900	$ 9,100		WP 21-58
15	SCADA Network Reliability Improvements	**2FA**	$ -	$ -	$ 3,220	$ 4,098	$ 9,367	$ 7,250	$ 7,250	$ 7,250	$ 7,500	$ 7,700	$ 7,900		WP 21-58
16	Substation Converge Compute Platform	**2FA**	$ -	$ -	$ -	$ -	$ -	$ 600	$ 1,310	$ 1,310	$ 1,100	$ 1,100	$ -		WP 21-58
17	Data Center and Control Center Infrastructure Preparation	**2FA**	$ -	$ -	$ 824	$ 361	$ 2,443	$ 2,300	$ -	$ -	$ -	$ -	$ -		WP 21-58
18	**IGP Cybersecurity**	**2FA**	$ -	$ -	$ 1,567	$ 1,033	$ 1,551	$ -	$ -	$ -	$ -	$ -	$ -	(1)	
19		**MWC 2F Total**	**$ -**	**$ -**	**$ 12,077**	**$ 16,759**	**$ 26,724**	**$ 19,540**	**$ 17,900**	**$ 20,369**	**$ 19,086**	**$ 19,695**	**$ 17,000**		
20	**MWC 21 - Misc. Capital**	**MAT**	**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**2024 Forecast**	**2025 Forecast**	**2026 Forecast**		
21	**Distribution Engineering Planning Tools (DRP-Driven)**	**21A**	$ -	$ -	$ 1,114	$ 2,116	$ 395	$ 2,882	$ 3,083	$ 2,237	$ 1,852	$ 1,902	$ -		21-35
22		**MWC 21 Total**	**$ -**	**$ -**	**$ 1,114**	**$ 2,116**	**$ 395**	**$ 2,882**	**$ 3,083**	**$ 2,237**	**$ 1,852**	**$ 1,902**	**$ -**		
23	**MWC 3M - Install/Repl Var Bal Acct**	**MAT**	**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**2024 Forecast**	**2025 Forecast**	**2026 Forecast**		
24	**Smart Grid Pilot Program**	**3M#**	$ 10,151	$ (5)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	(2)	
25		**MWC 3M Total**	**$ 10,151**	**$ (5)**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**		
26	**MWC 3R - Energy Storage Capital**	**MAT**	**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**2024 Forecast**	**2025 Forecast**	**2026 Forecast**		
27	**Elkhorn Battery Energy Storage System**	**3RC**	$ -	$ -	$ -	$ 15,460	$ 86,080	*Confidential*		$ -	$ -	$ -	$ -	(3)	WP 21-55
28		**MWC 3R Total**	**$ -**	**$ -**	**$ -**	**$ 15,460**	**$ 86,080**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**		
29	**MWC 82 - TO-EGI/WRO/SI**	**MAT**	**2016 Recorded**	**2017 Recorded**	**2018 Recorded**	**2019 Recorded**	**2020 Recorded**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**2024 Forecast**	**2025 Forecast**	**2026 Forecast**		
30	**Elkhorn Battery Energy Storage System (Gen-Tie)**	**82Y**	$ -	$ -	$ 11	$ 67	$ 41	$ 121	$ -	$ -	$ -	$ -	$ -		WP 21-55
31		**MWC 82 Total**	**$ -**	**$ -**	**$ 11**	**$ 67**	**$ 41**	**$ 121**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**		
32		**Capital Total**	**$ 10,151**	**$ (5)**	**$ 18,250**	**$ 46,610**	**$ 157,613**	**$ 104,428**	**$ 147,863**	**$ 131,655**	**$ 88,981**	**$ 42,163**	**$ 43,438**		

Assumptions and Notes

(1) These costs encompass the IT-related portions of the work forecasted in the 2020 GRC as the "IGP Cybersecurity Project". A.18-12-009, Exhibit (PG&E-7), Chapter 9.
(2) Costs are pursuant to the four Smart Grid Deployment Pilot Projects authorized by the Commission in D. 13-030-032 and summarized in PG&E Advice Letter 4990-E.
(3) Refer to confidential Exhibit-4, Appendix A.

Workpaper Table 21-13
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 21, Integrated Grid Platform and Grid Modernization Plan
Distributed Energy Resource Management System (DERMS) Forecast Details

Line No.		Project Phase	Vendor Selection, Plan, Analyze		Design, Build, Cutover			
2	**Cost Element**		**2023**	**2024**	**2025**	**2026**	**Total**	**Assumptions/Notes**
3	Software License (ADMS/DERMS Integration)		$ -	$ 660,000	$ -	$ -	$ 660,000	Based on vendor quote
4	Annual Maintenance Fee on ADMS/DERMS Integration Software		$ -	$ -	$ 132,000	$ 132,000	$ 264,000	Based on vendor quote
5	New DERMS (License)		$ -	$ -	$ 2,000,000	$ 2,200,000	$ 4,200,000	Based on vendor quote and PG&E SME judgement
6	Software Custom Development		$ -	$ -	$ -	$ 1,944,000	$ 1,944,000	Assumption of 40% of software cost (Line3+Line5) based on PG&E SME judgement
7	Software Vendor Implementation Services		$ -	$ -	$ 1,904,000	$ 1,904,000	$ 3,808,000	Based on vendor quote
8	Environment Cost		$ -	$ -	$ 1,500,000	$ 500,000	$ 2,000,000	Based on PG&E SME judgement
9	*Internal Resource FTE*		1.00	3.50	7.00	7.00		Based on PG&E SME judgement
10	*Internal Resource rate*		$ 150	$ 150	$ 150	$ 150		Based on PG&E SME judgement
11	Internal resources		$ 312,000	$ 1,092,000	$ 2,184,000	$ 2,184,000	$ 5,772,000	
12	*External Resource FTE*		0.50	1.00	7.00	10.50		Based on PG&E SME judgement
13	*External Resource rate*		$ 250	$ 250	$ 250	$ 250		Based on PG&E SME judgement
14	External resources		$ 273,000	$ 546,000	$ 3,822,000	$ 5,733,000	$ 7,239,680	Based on PG&E SME judgement
15	AFUDC		$ 38,042	$ 149,437	$ 750,566	$ 949,230	$ 1,887,275	AFUDC of 7.35% based on PG&E Standard FIN-3804S assuming average time of 2 years before capital operative date
16	**Best Case Total Cost (Unescalated)**		**$ 623,042**	**$ 2,447,437**	**$ 12,292,566**	**$ 15,546,230**	**$ 30,909,275**	
17	Capital (Best Case, Unescalated)		$ 555,621	$ 2,182,592	$ 10,962,351	$ 13,863,926	$ 27,564,490	
18	Expense (Best Case, Unescalated)		$ 67,421	$ 264,845	$ 1,330,216	$ 1,682,304	$ 3,344,786	Assumes approximately 11.5% total project expense ratio on Best Case forecast excluding AFUDC
19	Capital cumulative escalation multiplier		5.37%	8.22%	11.14%	14.14%		WP Table 2-17
20	Expense cumulative escalation multiplier		6.28%	9.61%	13.04%	16.58%		WP Table 2-17
21	**Best Case Total Cost (Escalated)**		**$ 657,114**	**$ 2,652,184**	**$ 13,686,867**	**$ 17,785,118**	**$ 34,781,283**	
22	Capital (Best Case, Escalated)		$ 585,459	$ 2,361,897	$ 12,183,228	$ 15,823,967	$ 30,954,550	
23	Expense (Best Case, Esclated)		$ 71,655	$ 290,287	$ 1,503,639	$ 1,961,151	$ 3,826,733	
24	**Expected Value of AACE Class 5 Estimate Uncertainty**		$ 459,980	$ 1,856,529	$ 9,580,807	$ 12,449,583	$ 24,346,898	The expected value of the estimate uncertainty is 70% for AACE Class 5 estimates. Based on PG&E's Project Cost Management Standard (PM-1015S) requiring an AACE Class 5 estimate for "projects in the early concept and planning phase."
25	**Expected Case Total Cost**		**$ 1,117,094**	**$ 4,508,712**	**$ 23,267,674**	**$ 30,234,701**	**$ 59,128,182**	=Line21+Line24
26	**GRC Forecast**		**$ 1,094,111**	**$ 4,507,207**	**$ 23,209,199**	**$ 29,917,827**	**$ 58,728,344**	Reflects identification of work efficiencies within Line 25 forecast
27	Capital Forecast		$ 974,877	$ 4,005,016	$ 20,565,333	$ 26,438,166	$ 51,983,392	
28	Expense Forecast		$ 119,234	$ 502,191	$ 2,643,866	$ 3,479,661	$ 6,744,952	

Workpaper Table 21-14
Pacific Gas and Electric Company
Exhibit (PGE-4), Chapter 21, Integrated Grid Platform and Grid Modernization Plan
Grid Modernization Classification Table

A. Technology Category	B. Use Cases	C. Function	D. System wide or Local Deployment	E. Distribution System Management Activities and Responsibilities	F. System/ Integration Challenges Addressed	G. Relevant DERs	H. Applicable Grid Mod Technologies Related to DER Integration	I. Utility GRC Application Volume and Category
1. Grid Connectivity Model	High DER Adoption (HDA), Safety and Reliability (S&R), Grid and DER Services (GDS)	Circuit modeling, Data Used for Forecasting and DER Value and Solution Analysis	System wide	Distribution Planning, Grid Operations, Market Operations	Items 1 - 8 of list of challenges	EV, DG, ES, EE, DR	Base data layer for ICA, Load and DER forecasting, state estimation, ArcGIS, EDGIS	*Base Mapping Activities* (Exhibit 4, Chapter 20, MWC GE) *GIS Technical Enhancements (Exhibit 4, Chapter 20, MWC 21/GE)* *Advanced Distribution Management System* (Exhibit 4, Chapter 21, MWC 63/HG)
2. Grid Management Systems (GMS)	HDA, GDS, S&R	All functions in the definitions, except for DER Value and Solutions Analysis	System wide	Distribution Grid Operations	All items	PEV, DG, ES, DR	Distributed Energy Resource Management System (DERMS), Advanced Distribution Management System (ADMS), Demand Response Management System (DRMS), DER Head-End, and VVO.	*Advanced Distribution Management System* (Exhibit 4, Chapter 21, MWC 63/HG) *Distributed Energy Resource Management System* (Exhibit 4, Chapter 21, MWC 63/HG)
3. Long and Short-term Planning Tools	HDA, S&R, GDS	DER Forecasting, DER Valuation Solution Analysis, Circuit Modeling	System wide	Distribution Planning	Thermal, Operational Limitations	EE, DR, EV, DG, ES	Integrated Load and DER forecasting, solution analysis for capacity/reliability, LoadSEER, Power flow modeling and analysis of distribution feeders (CYME) System Modeling Toolset (SMT); Long-Term Planning Tools (LTPT;) Integration Capacity Analysis (ICA), Locational Net Benefit Analysis Tool (LNBA)	*Distribution Engineering Planning Tools* (Exhibit 4, Chapter 21, MWC 2F,21/JV,AB) *Advanced Distribution Management System* (Exhibit 4, Chapter 21, MWC 63/HG) *Distributed Energy Resource Management System* (Exhibit 4, Chapter 21, MWC 63/HG)
4. Data Sharing Portals	HDA, S&R, GDS	DER Valuation, Solution Analysis, Circuit Modeling	System wide	Distribution Planning	Sustained voltage violations, thermal, protection	EE, DR, EV, DG, ES	Data Sharing Portal (web interface) to publish Distribution Resources Plan data; Distribution Resource Plan External Portal (DRPEP)	*Distribution Engineering Planning Tools* (Exhibit 4, Chapter 21, MWC 21/AB)
5. Grid Analytics Application	HDA, S&R, GDS	Circuit/System Modeling	System wide	Distribution Planning Grid Operations	Sustained voltage violations, thermal, protection, asset management	EV, DG, ES, DR	Asset management, sensing and measurement (data), improves quality of asset data to improve distribution planning inputs and operational decisions	*Distribution Engineering Planning Tools* (Exhibit 4, Chapter 21, MWC 2F,21/JV,AB) *Advanced Distribution Management System* (Exhibit 4, Chapter 21, MWC 63/HG) *Distributed Energy Resource Management System* (Exhibit 4, Chapter 21, MWC 63/HG)
6. Interconnection Processing Tool	HDA, S&R, GDS	Application Assessment and Processing	System wide	Service Planning and Customer Engagement	Indirect impact on sustain voltage violations, thermal, protection interconnection process)	EV, DG, ES	Customer facing application to support streamlining the interconnection process, improve distribution planning, Integration Capacity Analysis (ICA)	*Billing & Rates* (Exhibit 4, Chapter 20, MWC 2FJV)
7. Adaptive Protection System	S&R, HDA, GDS	Sensing & Measurement, Data & Device Communications, Control & Feedback Systems, Reliability Management	Local & System wide	Grid Operations	Protection	All	This is typically incorporated as part of the Common Substation Platform (CSP) at the substation level. In the future, it may be incorporated into ADMS. (Capability in GMS for SCE)	*Advanced Distribution Management System* (Exhibit 4, Chapter 21, MWC 63/HG) *Distribution Automation Recloser SCADA Installations* (Exhibit 4, Chapter 13, MWC 49) *Automation and Protection* (Exhibit 4, Chapter 4.3, MWC 49) *Replace Substation SCADA* (Exhibit 4, Chapter 16, MWC 09) *Although funding for implementation of an Adaptive Protective System is not requested in this GRC filing, funding for enabling foundational technologies is requested in the programs noted above.
8. Substation Automation and Common Substation Platform (CSP)	HDA, S&R, GDS	Sensing & Measurement, Data & Device Communications, Control & Feedback Systems, Reliability Management, Cybersecurity	Local & System Wide	Distribution Planning, Grid Operations, Market Operations	Items 1 - 10 of list of challenges	EV, DG, ES	SCADA, coordinated distribution device control with DERs, protection, cybersecurity	*IGP IT Infrastructure* (Exhibit 4, Chapter 21, MWC 2F/JV)
9. Volt/Var Optimization	HDA, S&R, GDS	Sensing & Measurement, Data & Device, Communications Control & Feedback Systems	Local	Distribution Planning, Grid Operations, Market Operations	Voltage fluctuation, sustained voltage violations, Low (Secondary) Voltage Controllers, Conservation Voltage Reduction	EV, DG, ES, DR	Substation Load Tap Changers, Voltage Regulators, Automated programmable capacitor controls, integration with DMS and EMS, future integration with smart inverters	*Advanced Distribution Management System* (Exhibit 4, Chapter 21, MWC 63/HG) *Enable Distributed Generation Dist Line* (Exhibit 4, Chapter 17, MWC 06) *Power Factor Management* (Exhibit 4, Chapter 17, MWC 06) *Although funding for implementation of VVO is not requested in this GRC filing, funding for enabling foundational technologies is requested in the chapters noted above.
10. Fault Location, Isolation and Service Restoration (FLISR)	HDA, S&R, GDS	Sensing & Measurement, Data & Device Communications, Control & Feedback Systems, Reliability Management	Local	Distribution Planning, Grid Operations, Market Operations	Thermal, Operational Limitations, Fault Location & Service Restoration, Cybersecurity	EV, DG, ES, DR	Remote Intelligent Switches, Augmented Remote Control Switches, Automatic Reclosers, RCS retrofits	*FLISR Restoration* (Exhibit 4, Chapter 13, MWC 49) *Advanced Distribution Management System* (Exhibit 4, Chapter 21, MWC 63/HG)
11. Remote Fault Indicators	S&R, HDA, GDS	Sensing & Measurement, Data & Device Comms.	Local	Distribution Planning, Grid Operations, Market Operations	Thermal, Operational Limitations, Cybersecurity	EV, DG, ES	Wireless bidirectional fault indicators, providing real time power flow characteristics	*Distribution Grid Sensors (Exhibit 4, Chapter 4.3, MWC 49)*

Workpaper Table 21-14
Pacific Gas and Electric Company
Exhibit (PGE-4), Chapter 21, Integrated Grid Platform and Grid Modernization Plan
Grid Modernization Classification Table

A. Technology Category	B. Use Cases	C. Function	D. System wide or Local Deployment	E. Distribution System Management Activities and Responsibilities	F. System/ Integration Challenges Addressed	G. Relevant DERs	H. Applicable Grid Mod Technologies Related to DER Integration	I. Utility GRC Application Volume and Category
12. Field Area Network	S&R, HDA, GDS	Sensing and Measurement, Data & Device Communications, Cybersecurity	Large Local Areas, eventually system wide	Distribution Planning, Grid Operations, Market Operations	Items 1 - 10 of list of challenges	EV, DG, ES	Wireless radios, Routers	*IGP IT Infrastructure* (Exhibit 4, Chapter 21, MWC 2F/JV)
13. Wide Area Network	S&R, HDA, GDS	Sensing and Measurement, Data & Device Communications, Cybersecurity	Large Local Areas, eventually system wide	Distribution Planning, Grid Operations, Market Operations	Items 1 - 10 of list of challenges	EV, DG, ES	Fiber optic and IP connectivity	*PG&E's WAN investments are contained within the "Core Network Infrastructure and Operations" program forecast in Exhibit 7, Chapter 8. The investments described within this program are only partially related to WAN and Grid Modernization.
14. Grid Sensors	HDA, S&R, GDS	Sensing & Measurement, Data & Device Comms.	Local	Distribution Planning, Grid Operations, Market Operations	Thermal, Operational Limitations, Fault Location & Service Restoration, Cybersecurity	EV, DG, ES	Typically, incorporated with other devices/systems such as SCADA reclosers, and FLISR schemes. Telemetry included with the RFIs, RCS retrofits and RISs. This could also include Phasor Measurement Units (PMUs)	*Distribution Grid Sensors* (Exhibit 4, Chapter 4.3, MWC 49) *Distribution Automation Recloser SCADA Installations* (Exhibit 4, Chapter 13, MWC 49) *Automation and Protection* (Exhibit 4, Chapter 4.3, MWC 49) *FuseSavers* (Exhibit 4, Chapter 13, MWC 49) *Single Phase Reclosers* (Exhibit 4, Chapter 4.3, MWC 49) *Sectionalizing Devices* (Exhibit 4, Chapter 4.3, MWC 49) *Install Substation SCADA* (Exhibit 4, Chapter 16, MWC 09) *Replace Substation SCADA* (Exhibit 4, Chapter 16, MWC 09) *Enable Distributed Generation Dist Line* (Exhibit 4, Chapter 17, MWC 06) *Power Factor Management* (Exhibit 4, Chapter 17, MWC 06)
15. Remote Controlled Switches	HDA, S&R	Control & Feedback Systems	Local	Distribution Planning, Grid Operations,	Operational Limitations	All	Typically, incorporated with other devices/systems such as SCADA reclosers, and FLISR schemes.	*FLISR Restoration* (Exhibit 4, Chapter 13, MWC 49) *Distribution Automation Recloser SCADA Installations* (Exhibit 4, Chapter 13, MWC 49) *Automation and Protection (Exhibit 4, Chapter 4.3, MWC 49)* *FuseSavers* (Exhibit 4, Chapter 13, MWC 49) *Single Phase Reclosers* (Exhibit 4, Chapter 4.3, MWC 49) *Sectionalizing Devices* (Exhibit 4, Chapter 4.3, MWC 49) *Install Substation SCADA* (Exhibit 4, Chapter 16, MWC 09) *Replace Substation SCADA* (Exhibit 4, Chapter 16, MWC 09)
16. DER Hosting Capacity Reinforcement	HDA, GDS, S&R	Control & Feedback Systems	Local	Grid Operations	Thermal	All	Installing new manual switches, upgrading sections of cable/ conductor, extending feeder lines to create new ties	*Although many capacity projects described in Exhibit-4, Chapter 17 come with ancillary benefits related to DER hosting capacity, none are being pursued primarily for reasons related to DER hosting capacity.
17. Relay Replacement	HDA, S&R	Control & Feedback Systems	Local	System Planning, Grid Operations	Protection	All	Upgrading legacy protection relays on as-needed basis	*Replace Substation Protective Relays* (Exhibit 4, Chapter 16, MWC 09)
18. Utility-Owned Storage	HDA, S&R	Sensing & Measurement, Control & Feedback, Reliability Management	Local	System Planning and Grid Operations	Voltage Violations, Thermal, Operational Limitations, DER Aggregation Impacts	DR, EV, DG, ES	Energy storage systems installed on the distribution systems to buffer DER output and load (PEV)	*Renz Energy Storage Project* (Exhibit 4, Chapter 17, MWC 06/46) *Elkhorn Battery Energy Storage System* (Exhibit 4, Chapter 21, MWC 3R/82/AB)
19. Microgrid Interfaces	HDA, S&R	Sensing & Measurement, Control & Feedback, Reliability Management	Local	System Planning and Grid Operations	Voltage Violations, Thermal, Operational Limitations, DER Aggregation Impacts	DR, EV, DG, ES	"Trayer" switches and other hardware and software which allow DER powered microgrids to operate in islanded mode	*Community Microgrid Enablement Program* (Exhibit 4, Chapter 21, MWC IG) *Temporary Distribution Microgrids* (Exhibit 4, Chapter 4.3, MWC 49) *Remote Grid* (Exhibit 4, Chapter 4.3, MWC AB/KAT)

Workpaper Table 21-15
Pacific Gas and Electric Company
Exhibit (PGE-4), Chapter 21, Integrated Grid Platform and Grid Modernization Plan
Grid Modernization Cost Table

Line No.	GRC Subprogram Name	GRC Exhibit & Chapter	Workpaper Reference	Related Grid Modernization Technology Categories	MAT	Cost Type	2020	2021	2022	2023	2024	2025	2026
1	Distribution Grid Sensors	Ex.4, Ch. 4.3	WP 4-118	Remote Fault Indicators Grid Sensors	49I	Capital	$ 2,272	$ 12,369	$ 23,036	$ 22,653	$ 21,711	$ 22,696	$ 24,405
2	Remote Grid	Ex.4, Ch. 4.3	WP 4-111	Microgrid Interfaces	08W	Capital				$ 8,500	$ 18,200	$ 25,400	$ 28,800
3					AB#	Expense		$ 1,382	$ 1,423	$ 1,464			
4					KAP	Expense			$ 617	$ 953			
5	Temporary Distribution Microgrids	Ex.4, Ch. 4.3	WP 4-115	Microgrid Interfaces	49M	Capital	$ 13,718	$ 16,448	$ 13,559				
6	Sectionalizing Devices	Ex.4, Ch. 4.3	WP 4-107	Grid Sensors Remote Controlled Switches	49H	Capital	$ 69,441	$ 42,890	$ 20,919	$ 11,933	$ 12,255	$ 12,586	$ 12,926
7	Automation and Protection	Ex.4, Ch. 4.3	WP 4-93	Grid Sensors Remote Controlled Switches Adaptive Protection System	49A	Capital	$ 1,456	$ 6,990					
8	Single Phase Reclosers	Ex.4, Ch. 4.3	WP 4-104	Grid Sensors Remote Controlled Switches	49T	Capital		$ 2,305	$ 2,764	$ 2,940	$ 3,087	$ 3,241	$ 3,403
9	Distribution Automation Recloser SCADA Installations	Ex.4, Ch. 13	WP 13-35	Grid Sensors Remote Controlled Switches Adaptive Protection System	49A	Capital	$ 17		$ 6,203	$ 1,841	$ 1,891	$ 2,057	$ 2,112
10	FuseSavers	Ex.4, Ch. 13	WP 13-14	Grid Sensors Remote Controlled Switches	49T	Capital		$ 1,110	$ 808	$ 1,393	$ 1,363	$ 1,329	$ 1,290
11	FLISR Restoration	Ex.4, Ch. 13	WP 13-14	FLISR	49S	Capital	$ 3,915	$ 2,353	$ 2,453	$ 3,721	$ 3,938	$ 4,147	**$ 4,341**
12	Replace Substation Protective Relays	Ex.4, Ch. 16	WP 16-12	Relay Replacement	09E	Capital	$ 5,018	$ 2,603	$ 2,540	$ 2,908	$ 3,714	$ 3,100	$ 3,430
13	Install Substation SCADA	Ex.4, Ch. 16	WP 16-19	Grid Sensors Remote Controlled Switches	09D	Capital	$ 14,307	$ 6,841	$ 6,329	$ 470	$ 3	$ 3,301	$ 3,040
14	Replace Substation SCADA	Ex.4, Ch. 16	WP 16-20	Grid Sensors Remote Controlled Switches Adaptive Protection System	09B	Capital	$ 11,417	$ 10,292	$ 12,228	$ 18,210	$ 18,465	$ 16,426	$ 16,944
15	Enable Distributed Generation Dist Line	Ex.4, Ch. 17	WP 17-39	Grid Sensors Volt-Var Optimization	06P	Capital	$ 930		$ 742	$ 1,344	$ 1,594	$ 1,731	$ 1,842
16	Power Factor Management	Ex.4, Ch. 17	WP 17-42	Grid Sensors Volt-Var Optimization	06K	Capital	$ 43		$ 618	$ 1,119	$ 1,326	$ 1,440	$ 1,535
17	Renz Energy Storage Project	Ex.4, Ch. 17	WP 17-52	Utility-Owned Storage	46A	Capital	$ 696	$ 26,287	$ 154				
18					10W	Capital	$ 41	$ 1,116					
19	Billing and Rates	Ex.4, Ch. 20	WP 20-38	Interconnection Processing Tool	2F	Capital	$ 5,046	$ 4,719	$ 7,264	$ 5,347	$ 6,403	$ 6,055	$ 6,514
20					JV	Expense	$ 69	$ 44	$ 100	$ 100			
21	Base Mapping Activities	Ex.4, Ch. 20	WP 20-7	Grid Connectivity Model	GE	Expense	$ 1,430	$ 1,640	$ 1,640	$ 391			
22	GIS Technical Enhancements	Ex.4, Ch. 20	WP 20-19	Grid Connectivity Model	21	Capital			$ 349	$ 395	$ 445	$ 502	$ 566
23					GE	Expense	$ 711	$ 900	$ 900	$ 6,765			
24	Community Microgrid Enablement Program	Ex.4, Ch. 21	WP 21-48	Microgrid Interfaces	IG#	Expense	$ 391	$ 3,088	$ 3,177				
25					AB#	Expense				$ 5,450			
26	Advanced Distribution Management System (ADMS)	Ex.4, Ch. 21	WP 21-18	Grid Management Systems Long and Short-term Planning Tools Grid Connectivity Model Grid Analytics Application Adaptive Protection System Volt-Var Optimzation FLISR	63C	Capital	$ 44,373	$ 81,885	$ 126,880	$ 108,074	$ 64,037		
27					HGC	Expense	$ 5,154	$ 5,424	$ 2,287	$ 15,422			
28	Distributed Energy Resource Management System (DERMS)	Ex.4, Ch. 21	WP 21-31	Grid Management Systems Long and Short-term Planning Tools Grid Analytics Application	63C	Capital				$ 975	$ 4,005	$ 20,565	$ 26,438
29					HGC	Expense				$ 119			
30	Elkhorn Battery Energy Storage System	Ex.4, Ch. 21	WP 21-55	Utility-Owned Storage	3RC	Capital	$ 86,080	***CONF (Ex.4, Appendix A)***					
31					82Y	Capital	$ 41	$ 121					
32					AB#	Expense			***CONF (Ex.4, Appendix A)***				
33	Distribution Engineering Planning Tools	Ex.4, Ch. 21	WP 21-35	Long and Short-term Planning Tools Data Sharing Portals Grid Analytics Application	21A	Capital	$ 395	$ 2,882	$ 3,083	$ 2,237	$ 1,852	$ 1,902	
34					2FA	Capital	$ 1,180	$ 1,050	$ 1,000	$ 3,469	$ 1,886	$ 1,995	
35					AB#	Expense	$ 3,320	$ 3,926	$ 4,135	$ 4,565			
36					JVA	Expense	$ 298	$ 215	$ 200	$ 1,009			
37	IGP IT Infrastructure	Ex.4, Ch. 21	WP 21-58	Field Area Network Substation Automation and Common Substation Platform	2FA	Capital	$ 25,544	$ 18,490	$ 16,900	$ 16,900	$ 17,200	$ 17,700	$ 17,000
38					JVA	Expense	$ 739	$ 1,130	$ 2,300	$ 2,300			
39	**Capital Total**						$ 285,930	$ 240,751	$ 247,829	$ 214,429	$ 183,376	$ 146,174	$ 154,587
40	**Expense Total**						$ 12,112	$ 17,748	$ 16,778	$ 38,538	$ -	$ -	$ -

Workpaper Table 21-16
Pacific Gas and Electric Company
Exhibit (PGE-4), Chapter 21, Integrated Grid Platform and Grid Modernization Plan
Location of (D.) 18-03-023, Appendix A Requirements in PG&E's GRC Filing

Line No.	Section, Grid Modernization Submission Requirements (Appendix A)	Question	Where response is located
1	Grid Modernization Plan Overview, 1.a.i.	High level status of grid modernization upgrades initiated and completed to date	Attachment A1 (Ex 4, Ch 21)
2	Grid Modernization Plan Overview, 1.a.ii.	Additional spending requirements necessary to complete the grid modernization objectives, within and beyond the current GRC cycle	For "Within the cycle" requirements, see: -Ex.4, Ch 21 Testimony & Workpapers -Grid Modernization Cost Table (WP 21-15) For "Beyond the cycle" requirements, see: -10 Year Grid Modernization Vision (Ex 4, Ch 21, Attachment A), Section C
3	Grid Modernization Plan Overview, 1.a.iii.	A high level but complete status of DER related research, development and demonstration (RD&D) projects planned, in process, proposed and/or approved.	Attachment A2 (Ex 4, Ch 21)
4	Grid Modernization Plan Overview, 1.b.i.	Are there foundational planning and communications technologies that are critical for distribution system planning for DER integration that have not been installed?	Ex.4, Ch 21 Testimony and Workpapers Attachment A1 (Ex 4, Ch 21)
5	Grid Modernization Plan Overview, 1.b.ii.	And does the investment in these foundational technologies together with the capabilities they enable outweigh the "traditional" solution to provide the needed capability?	Ex.4, Ch 21 Testimony and Workpapers Ex.4, Ch 17 Testimony, Section B.1.a
6	Grid Modernization Plan Overview, 1.c.i.	For each type of DER, what types of integration challenges are anticipated occur?	10 Year Grid Modernization Vision (Ex 4, Ch 21, Attachment A), Section D.11
7	Grid Modernization Plan Overview, 1.c.ii.	What type of distribution system upgrades are critical to mitigate each of these challenges?	Grid Modernization Classification Table (WP 21-14), Column F
8	Grid Modernization Plan Overview, 1.c.iii.	How, and to what degree, does the Grid Modernization Plan enable two-way flows of electricity?	10 Year Grid Modernization Vision (Ex 4, Ch 21, Attachment A), Section D.11 ADMS Project Summary Workpaper (WP 21-18) DERMS Project Summary Workpaper (WP 21-31) Enable Distributed Generation Dist Line Project Summary Workpaper (WP 17-39)
9	Grid Modernization Plan Overview, 1.d.i.	DERs that can serve as an alternative to meet each type of challenge	Ex.4, Ch 17 Testimony, Section B.1.a DRP Non-Procurement Costs Project Summary Workpaper (WP 21-43) 10 Year Grid Modernization Vision (Ex 4, Ch 21, Attachment A), Section E.4
10	Grid Modernization Plan Overview, 1.d.ii.	What additional technology upgrades, if any, are needed to enable DERs to provide grid services. Role of existing and customer technologies in achieving objectives:	Grid Modernization Classification Table (WP 21-14), Columns B & C ADMS Project Summary Workpaper (WP 21-18) DERMS Project Summary Workpaper (WP 21-31) IGP IT Enablement Project Summary Workpaper (WP 21-58)
11	Grid Modernization Plan Overview, 1.e.i.	Explain how the grid modernization proposal leverages existing AMI infrastructure, third party communication networks, and smart inverters to support grid modernization objectives	Attachment A1 (Ex 4, Ch 21)
12	Grid Modernization Plan Overview, 2.a.	Narrative discussion of proposed grid modernization programs and program drivers for this GRC cycle, with examples	Ex.4, Ch 21 Testimony and Workpapers
13	Grid Modernization Plan Overview, 2.b.	Cost summary of Grid Modernization Plan: List of total amount requested	Grid Modernization Cost Table (WP 21-15) Ex.4, Ch 21 Testimony and Workpapers
14	Grid Modernization Plan Overview, 2.c.	Attach classification table	Grid Modernization Classification Table (WP 21-14)
15	Grid Modernization Program Requirements, 1.a.	Proposed itemized costs for proposed program	Project Summary Workpapers (Ex 4, Ch 21) Cost Summary Workpapers (WP 21-5, WP 21-12) Grid Modernization Cost Table (WP 21-15)
16	Grid Modernization Program Requirements, 1.b.	If proposed budget for 3 year GRC period covers a portion of the overall cost of the proposed program, please provide the total program costs, including expenditures already incurred and remaining costs	Project Summary Workpapers (Ex 4, Ch 21) Cost Summary Workpapers (WP 21-5, WP 21-12) Grid Modernization Cost Table (WP 21-15) 10 Year Grid Modernization Vision (Ex 4, Ch 21, Attachment A), Section C
17	Grid Modernization Program Requirements, 2.a.	The full list of investments (projects) proposed, Technology capabilities:, System integration challenges the technology supports, Grid services the technology enables, Supporting technologies: Which other investments are necessary to also beinstalled in order to enable the proposed investment	Project Summary Workpapers (Ex 4, Ch 21) Grid Modernization Classification Table (WP 21-14), Column F
18	Grid Modernization Program Requirements, 2.b.	Maturity of proposed technology: Discussion of the technological development of the proposed investment, and if emerging, what type of technology it is replacing	Project Summary Workpapers, Supplemental Questions Table (Ex 4, Ch 21)
19	Grid Modernization Program Requirements, 2.c.	Expected useful life of equipment	Project Summary Workpapers, Supplemental Questions Table (Ex 4, Ch 21)
20	Grid Modernization Program Requirements, 2.d.	Equipment capacities, ratings, and other specifications	Project Summary Workpapers, Supplemental Questions Table (Ex 4, Ch 21)
21	Grid Modernization Program Requirements, 3.a.	Investment Drivers: Identify what primary grid need is driving each grid modernization request and how the proposed investment meets that need	Project Summary Workpapers (Ex 4, Ch 21) Grid Modernization Classification Table (WP 21-14), Column F
22	Grid Modernization Program Requirements, 3.b.	Attribution to DER integration: Percentage of costs directly attributable to DER integration vs. safety and reliability	Project Summary Workpapers, Supplemental Questions Table (Ex 4, Ch 21)
23	Grid Modernization Program Requirements, 3.c.	Which DERs does the proposed technology integrate	Grid Modernization Classification Table (WP 21-14), Column G Project Summary Workpapers, Supplemental Questions Table (Ex 4,Ch 21)
24	Grid Modernization Program Requirements, 3.d.	Investment alternatives, including existing equipment and DERs	Project Summary Workpapers (Ex 4, Ch 21)
25	Grid Modernization Program Requirements, 4.a.	List itemized cost and description of O&M expenses to maintain, repair and update grid modernization systems.	Grid Modernization Expense Summary Workpaper (WP 21-5) Project Summary Workpapers (Ex 4, Ch 21)
26	Grid Modernization Program Requirements, 5.a.	Description of the status of the current equipment installed	Attachment A1 (Ex 4, Ch 21) Project Summary Workpapers (Ex 4, Ch 21)
27	Grid Modernization Program Requirements, 5.b.	List of any project requests authorized in the previous GRC that were not completed	Ex.4, Ch 21 Testimony, Section E
28	Grid Modernization Program Requirements, 6.a.	Proposed method for assessment of cost reasonableness	Ex.4, Ch 21 Testimony, Section D Project Summary Workpapers (Ex 4, Ch 21)
29	Grid Modernization Program Requirements, 6.b.	Result of cost reasonableness assessment	Project Summary Workpapers (Ex 4, Ch 21)
30	Grid Modernization Program Requirements, 7.a.	Description of need: Explanation of the basis for determining scale and location of the investment need	Grid Modernization Classification Table (WP 21-14), Column D Project Summary Workpapers, Supplemental Questions Table (Ex 4, Ch 21)
31	Grid Modernization Program Requirements, 7.b.	Deployment Plan: Implementation schedule for projects, or discussion of determination of when distribution upgrades need to be deployed	Project Summary Workpapers (Ex 4, Ch 21) 10 Year Grid Modernization Vision (Ex 4, Ch 21, Attachment A)

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – ADVANCED DISTRIBUTION MANAGEMENT SYSTEM

Project Title: Advanced Distribution Management System
Major Work Categories: 63/HG
Planning Order Numbers: 5528219, 5544409, 5779239, 5782639, 5791859, 5792400, 5043829, 5054389, 5054609, 5058549, 5259132, 5260118, 5044950
Project Start Date: 2018
Project Completion Date: 2024
Operative Date (only applies to Capital): Various

I. Project Description

This project will continue PG&E's multiyear implementation of an Advanced Distribution Management System (ADMS), integrating several mission critical Distribution Operator applications currently spread across multiple platforms. The ADMS will become the core distribution operations technology tool that enables the visibility, control, forecasting, and analysis of a more dynamic grid.

When fully deployed, the ADMS platform will bring the capabilities of today's Distribution Supervisory, Control and Data Acquisition (D-SCADA), Distribution Management System (DMS), and Outage Management System (OMS) into a single platform. These applications are described below.

D-SCADA: PG&Es D-SCADA system gathers, processes, and displays system-wide operating data to Distribution Operators at control centers. Operators use the system to remotely control and/or operate devices on the distribution network. The D-SCADA system consists of distributed IT network system and server hardware (the SCADA "platform") and a growing number of SCADA-enabled field devices which send and receive real time data over the network.

DMS: DMS is a system that utilities use to maintain an As-Operated model of the electric distribution grid that can run advanced applications that analyze and control the grid. Examples of these advanced applications include Fault Location, Isolation and Service Restoration (FLISR), Volt/Var Optimization (VVO), Restoration Switching Analysis, Switch Planning and Execution.

OMS: OMS is a network model-based system that utilities use to identify electrical outage locations and assist in the restoration of power. This system also provides utility customers with updated outage information and is the source for reliability reporting. The accuracy of OMS's outage identification is dependent on its network model reflecting the actual as-switched state of the distribution system at any given time.

Integrating SCADA, DMS, and OMS into a single, more robust platform will reduce the potential for operator error, facilitate cybersecurity measures, enable PG&E to run a new suite of advanced applications that enhance current capabilities associated with safety, reliability, and affordability, and respond to future needs associated with the growth of Distributed Energy Resources (DERs) and complexity from growing wildfire risk.

In today's Distribution Control Centers, Operators use multiple, unintegrated applications (SCADA, and DMS/OMS[1]) that use different databases and display information on different screens. In order to coordinate the operation of the applications the Operator must read data from one system and input into one or more

[1] PG&E's DMS and OMS are presently integrated.

other systems. For example, today when a circuit breaker automatically opens, the SCADA system will alert the Operator, who then must query the SCADA system, and use a different computer screen and user interface to update the As-Operated model in the DMS to note that the circuit breaker is now open. In another example, when a device is operated as part of planned or unplanned switching, the operator needs to tag[2] the device both in the SCADA and DMS applications, referencing the switch log associated with the device being operated. Since these systems are not integrated and must rely on Operators to manually keep the data in them in sync, Operator error may lead to one system being out of sync and not reflecting current grid conditions. Inconsistent information between SCADA and DMS may impact decision-making and limits the ability to provide situational intelligence and automation. An integrated ADMS will eliminate these inefficiencies, unlocking value for customers and PG&E.

The ADMS project is divided into six main categories of work, which are discussed in more detail below.[3]

1. ADMS Release 1 (SCADA)
2. ADMS Release 2 (OMS)
3. ADMS Release 3 (Advanced Applications)
4. ADMS Asset Data Enhancement
5. ADMS Cybersecurity
6. ADMS Project Management Office (PMO)

1. ADMS Release 1 (SCADA)

The primary scope of ADMS Release 1 is to replace PG&E's legacy RT-SCADA system with a modern, cybersecure SCADA system integrated with PG&E's network model. Scope for ADMS Release 1 also includes replacing PG&E's legacy Yukon Feeder Automation (YFA) FLISR software with a native ADMS FLISR product, developing ADMS functionality to support PG&E wildfire risk mitigation efforts such as reclose blocking, implementing the Operator Training Simulator (OTS) in ADMS to assist with new Operator training, and implementing the WebDMD product to enable field visibility to information in ADMS.

Key activities supporting ADMS Release 1 include:

- Design and build of integrations between ADMS and databases such as GIS, Powerbase, Landbase, ABB DMS/OMS, Weather, and PI.
- Design and build of the network model in ADMS, resulting in digital representations of all PG&E feeders and substations with SCADA signals mapped to devices.
- Point-to-point testing to verify the accuracy of the SCADA signal mapping.
- Design of the product's look-and-feel, including configuration settings, symbology and SCADA displays.
- Comprehensive testing of the final product to ensure all design requirements are met.

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[2] Tagging consists of adding text description and selecting fields that describe why a device is in an abnormal state. The tag can link the abnormal state to planned switching or an unplanned outage.

[3] The program also tracks costs associated with these work categories. See section IV of this document for further detail on program cost.

- Business process design, user and support team training, and change management.

2. ADMS Release 2 (OMS)

Over the years PG&E has developed a highly custom-built ecosystem of outage management applications that is costly to maintain and challenging to integrate. The primary scope of ADMS Release 2 is to replace PG&E's current outage management applications with OMS functionality in ADMS including outage planning, calculation of outage location and extent, crew dispatch, customer outage notification, switch log generation, and reliability reporting in a single vendor-supported product. Examples of legacy PG&E outage management applications that are targeted for replacement by ADMS include the Application for Work, (AFW) Planned Outage Planner (POP), Integrated Logging and Information System (ILIS), Outage Management Tool (OMT), Outage Dispatch Tool (ODT), Trace Component List (TCL), Circuits in Abnormal Condition (CIAC), Outage Replay and Outage Notification applications.

Release 2 also includes development of Public Safety Power Shutoff (PSPS) planning functionality in ADMS, including the ability to automatically generate PSPS de-energization plans based on weather polygons superimposed on the as-switched network model.

Work during ADMS Release 2 will include Design, Build, and Test activities, an extension to the Network Model to include customer connectivity, and extensive training and change management for the large number of internal users of OMS features.

3. ADMS Release 3 (Advanced Applications)

The scope of ADMS Release 3 is to enable Advanced Applications within the ADMS platform. The most foundational of these advanced applications is Load Flow/State Estimation, which provides the ability to model real-time power flows at any location on the distribution grid using a combination of SCADA telemetry, physical properties of network features stored in GIS and CYME, device settings stored in PowerBase, and the as-switched state of the grid as maintained in ADMS. Another foundational advanced application is Load Forecasting, which predicts future power flows at all points on the distribution grid. The combination of Load Flow/State Estimation and Load Forecasting enables many additional advanced applications including:

- Identification of real-time and predicted future thermal, voltage, or protection constraints, enhancing safety and situational awareness.
- Automated switching recommendations for planned outages, unplanned outages, or constraint mitigation, improving operational efficiency and reducing risk of human error.
- Fully automated FLISR schemes, allowing faster and more flexible service restoration than PG&E's current "rule-based" FLISR.
- Automated adjustment of voltage and power factor regulation device settings (Volt-Var Optimization), enabling energy savings, peak load reduction, and reduced Rule 2 violations.
- Automated adjustment of protective device settings (Adaptive Protection), enhancing safety and customer reliability.
- Dispatch of DER in response to grid constraints via the Distributed Energy Resource Management (DERMS) platform.

Work during ADMS Release 3 will include Design and Build phases but will particularly emphasize testing to ensure the accuracy of power flow calculations and automated recommendations, as well as training to ensure users proficiency with the newly available tools.

4. ADMS Asset Data Enhancement

The goal of this workstream is to execute on data enhancement initiatives that will improve the quality of ADMS power flow solutions and/or facilitate the build or maintenance of the ADMS network model. This workstream was forecasted in the 2020 GRC as a standalone project called "Distribution Asset Data Improvement"[4], but is included within the broader ADMS forecast for this GRC in order to bring all ADMS-related forecast into a single location.

A key initiative under this workstream is improving the quality of PG&E's Phase ID data, an essential input into ADMS power flow calculations and advanced applications. PG&E has executed on the Phase ID project described in the 2020 GRC and is now integrating phasing data derived from the algorithm originally prototyped in the EPIC 2.14 project into GIS. The forecast in this GRC includes funding for additional work related to Phase ID data enhancement, including O&M and improvement of the Phase ID algorithm, purchase of new Phase ID tools for field crews to use during construction, and funding for targeted field collection of Phase ID data in the event that algorithm-derived phasing data quality for some circuits is determined to be insufficient for calculating load flows during the Testing phase of ADMS Release 3.

The scope of the ADMS Asset Data Enhancement workstream also includes implementation of GIS data model enhancements required for the ADMS network model build, development of data update scripts to improve data quality in attributes required by ADMS, build of new QA-QC rules in PG&E's ArcFM software to enforce consistent data entry in key ADMS attributes, and a project to improve the quality of PG&E's Secondary Mesh data required for the Release 2 network model expansion. PG&E determined the "Substation Data Architecture and Specifications" project described in the 2020 GRC was not required following a decision to maintain substations in ADMS, not GIS.

5. ADMS Cybersecurity

This workstream's goal is to enact an industry leading cybersecurity design supporting the new ADMS that will mitigate security risks, implement advance security protection controls, enhance detection and response to counter an advancing threat landscape against the electric distribution grid. This workstream represents the ADMS portion of the "IGP Cybersecurity Project" work forecasted in Ex.-7, Ch.9 of the 2020 GRC, now included within the broader ADMS forecast to bring all ADMS-related forecast into a single location.[5] The project will extend PG&E's security architecture implementation model to support ADMS and provide a highly-dependable, defense-in-depth security implementation model that avoids a single point of failure. More specifically, the work will involve deploying next generation firewall at the Distribution Control Centers (DCCs), implementing enhanced identity and access management solutions, implementing advanced threat monitoring for operational technology,

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[4] A.18-12-009, Exhibit (PG&E-4), p. 19-19.

[5] The "IGP Cybersecurity Project" from Ex.-7, Ch.9 of the 2020 GRC also included scope related to IT Infrastructure. Forecast for this component of the work is located in WP 21-5, Line 20 and WP 21-12, Line 18.

including the ability for PG&E's Security Operations Center to monitor threats at the DCCs, and extension of PG&E's vulnerability management platform and incident response forensic tools to the DCCs.

6. ADMS Project Management Office (PMO)

The scope of the ADMS PMO workstream is to develop processes, plans and tools for the program management of the ADMS program. Specific tasks handled by the ADMS PMO include schedule management, resource planning, onboarding, risk management, document review, deliverable management, and reporting.

II. Project Schedule

The table below outlines the timing of key ADMS program activities and milestones:

2018	• Conducted a competitive solicitation for an ADMS vendor and selected a vendor. • Conducted a competitive solicitation for a Systems Integrator (SI) partner and selected an SI. • The Plan/Analyze phase for Release 1 began.
2019	• The Plan/Analyze phase for Release 1 completed. • The Design phase for Release 1 began. • Planning of data enhancement work needed for ADMS began.
2020	• The Design phase for Release 1 concluded. • Build of the Release 1 Network Model began. • Data enhancement work supporting the Release 1 Network Model build occurred. • Release 1 Application Build began.
2021	• Build of the Release 1 Network Model will be completed. • Release 1 Application Build will be completed. • Release 1 Testing will begin. • A competitive solicitation for a SCADA Point-to-Point testing vendor will be held and Point-to-Point testing will begin. • A competitive solicitation for a Release 2 and 3 SI will be held and Plan/Analyze phase of ADMS Release 2 and Release 3 will begin. • Phase ID data from the algorithm will begin to be integrated into GIS; other data enhancement activities supporting Network Model build and maintenance will occur.
2022	• Software Testing of ADMS Release 1 will conclude. • Cutover of Release 1 on a division-by-division basis will begin as Point-to-Point testing is completed. • Plan/Analyze of Releases 2 will be completed and iterative Design/Build/Test activities will begin. • Build of the Release 2 Network Model Extension will occur, including associated data enhancement activities such as the Secondary Mesh project. • Iterative Design/Build/Test of Release 3 Advanced Applications will begin on an application-by-application basis.
2023-2024	• Cutover of Release 1 on a division-by-division basis will continue as Point-to-Point testing is completed.

	• Testing of ADMS Release 2 functionality will conclude and cutover will occur after Release 1 functionality has been deployed to all divisions. • Release 3 functionality will be deployed on an application-by-application basis when testing is completed. • PG&E will begin targeted field collection of Phase ID data as needed to support accurate load flow. Newly acquired field phasing tools will also enable collection of Phase ID data during construction.

The schedule described above may change depending on project resource availability and implementation plans developed during the Design phases.

III. Justification

The distribution grid operating environment is becoming increasingly complex.

- California is increasingly exposed to extreme weather conditions brought on by climate change, evidenced by the wildfires of recent years. Control center operators need the best available situational awareness and response capabilities in order to operate in this new normal of extreme weather.
- The electric grid is under constant cyber threat. To provide safe and reliable energy to our customers, PG&E must continue evolving and improving our resilience to cyber security threats to the grid.
- There is an increasing number of DERs on the grid. As described in Section D.11 of Attachment A to Chapter 21, DERs can create operational challenges at high volume and penetration levels.

In addition to improving PG&E's ability to operate amid this growing complexity, there are three primary justifications for ADMS:

1) **PG&E's D-SCADA application needs to be replaced.** PG&E's existing D-SCADA application is nearing its end of life, is not equipped with modern best-in-class cybersecurity functionality, cannot be integrated with other distribution control applications, and cannot support the data volume and advanced applications required for future grid conditions, including an increase in field devices and DER penetration. Similarly, the current hardware supporting the SCADA system does not have sufficient processing or storage capacity to address the increasing complexity of the grid, or to support advanced control applications that will be available if the platform is upgraded.

2) **PG&E's distribution grid operational technology should be an integrated platform.** The work performed by control center operators needs to evolve and move away from unnecessary manual labor. Today, control center operators use multiple applications concurrently, often manually transferring information between these systems, which is a source of human error, creates duplicative work, and limits technology's ability to automate and drive efficiencies. Implementing an ADMS platform with common data of the As-Operated grid state and real-time SCADA states will avoid these issues, allow control center operators to perform higher value add activities, and enable more safety, reliability, and affordability benefits.

   Implementation of a single ADMS platform drives efficiencies in how the platform will be maintained and improved upon in the future. Compared with integrating across multiple applications, having a single integrated platform delivers the following benefits:

- Advanced Applications can be run that utilize data shared across the platform. Existing applications require one-off integrations that are costly and challenging to maintain at scale.
- Training and change management is simpler with one vendor than with multiple vendors.
- Supporting and maintaining a single platform is less costly than doing so for multiple integrated applications provided by different vendors.

3) **PG&E's distribution grid operational technology must be positioned for the future to accommodate future DER growth.** PG&E's existing operating technology is not well-suited to operate the grid as customer adoption of DERs continues. PG&E's SCADA and DMS systems were not designed with the grid operating conditions caused by high volume and penetration of DERs in mind, nor were they designed to efficiently integrate with other systems envisioned to enable to DERs to provide distribution services, such as System DERMS[6] and/or Demand Response Management System (DRMS[7]).

IV. Cost

The cost of the ADMS program is summarized in the table below. Description of the scope of work associated with each cost category are location in Section I of this document.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

		Recorded					Forecast						
Project Component	**MAT**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**Total**
Capital													
ADMS Release 1 (SCADA)	63C		$ -	$ 2,969	$ 10,873	$ 41,365	$ 53,795	$ 49,973	$ 33,996	$ 27,731			**$ 220,702**
ADMS Release 2 (OMS)	63C		$ -	$ -	$ -	$ 402	$ 20,012	$ 58,433	$ 39,207	$ 23,875			**$ 141,930**
ADMS Release 3 (Advanced Apps)	63C		$ -	$ -	$ -	$ -	$ -	$ 16,359	$ 26,760	$ 8,866			**$ 51,985**
ADMS Asset Data	63C		$ -	$ 1,919	$ 1,261	$ 1,290	$ 1,615	$ 1,851	$ 2,371	$ 561			**$ 10,866**
ADMS Cybersecurity	63C		$ -	$ -	$ -	$ 1,317	$ 6,213	$ -	$ 5,470	$ 2,726			**$ 15,726**
ADMS PMO	63C		$ -	$ 160	$ 74	$ -	$ 250	$ 264	$ 271	$ 278			**$ 1,297**
Expense													
ADMS Release 1 (SCADA)	HGC		$ 453	$ 1,944	$ 2,730	$ 4,557	$ 2,283	$ 2,146	$ 2,067	$ -			**$ 16,180**
ADMS Release 2 (OMS)	HGC		$ -	$ -	$ -	$ -	$ -	$ 6,693	$ 4,399	$ 2,679			**$ 13,771**
ADMS Release 3 (Advanced Apps)	HGC		$ -	$ -	$ -	$ -	$ -	$ 1,527	$ 1,652	$ 401			**$ 3,580**
ADMS Asset Data	HGC, HG#		$ -	$ 618	$ 163	$ 427	$ 1,641	$ 1,490	$ 4,897	$ 5,031			**$ 14,267**
ADMS Cybersecurity	HGC		$ -	$ -	$ -	$ -	$ 1,000	$ -	$ 1,859	$ 1,573			**$ 4,433**
ADMS PMO	HGC		$ -	$ 812	$ 117	$ 171	$ 500	$ 529	$ 547	$ 562			**$ 3,238**
Forecast Adjustment	HGC							$ (10,099)					**$ (10,099)**
Total Project Capital Forecast			$ -	$ 5,048	$ 12,209	$ 44,373	$ 81,885	$ 126,880	$ 108,074	$ 64,037			**$ 442,506**
Total Project Expense Forecast (-Adjustment)			$ 453	$ 3,374	$ 3,010	$ 5,154	$ 5,424	$ 12,386	$ 15,422	$ 10,246			**$ 55,469**
Total Project Forecast (-Adjustment)			$ 453	$ 8,422	$ 15,219	$ 49,528	$ 87,309	$ 139,266	$ 123,496	$ 74,283			**$ 497,975**

Additional Cost Information

[6] DERMS can be defined as a software platform that can manage a variety of both aggregated and individual DERs to support various objective functions related to grid support, customer value, or market participation.

[7] DRMS is the IT system that processes enrollments, registration to the California Independent System Operator (CAISO), management of aggregated resources, dispatch events of PG&E's Demand Response events and retail settlements.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – ADVANCED DISTRIBUTION MANAGEMENT SYSTEM

Forecasts for the "Release 1 (SCADA)", "ADMS Asset Data", "ADMS Cybersecurity", and "ADMS PMO" subcomponents of the ADMS project are the result of a detailed bottoms-up forecasting exercise by PG&E subject matter experts, informed by insights on project cost gained through implementation to-date. PG&E utilized an Association for the Advancement of Cost Engineering (AACE) Class 2 estimate for these subcomponents of the ADMS forecast due to the use of deterministic estimating methods and the presence of detailed engineering designs and resource/contracting plans. The forecast for the "Release 2 (OMS)" and "Release 3 (Advanced Apps)" portions of the ADMS project was developed by PG&E subject matter experts in consultation with both the ADMS software vendor and a third-party Systems Integrator with extensive experience implementing ADMS projects in North America. PG&E utilized an AACE Class 3 estimate for these subcomponents of the ADMS forecast due to the presence of a detailed scope of work and estimation method that was more deterministic than probabilistic.

Note that due to the GRC forecast prioritization process described further in Exhibit 4, Chapter 2, PG&E's current expense forecast for ADMS for 2022 is $10.1 million higher than the amount included in the final GRC forecast. PG&E intends to identify funding for this work through efficiencies elsewhere in the Electric Operations portfolio.

The ADMS cost estimates presented here supersede, and are higher than, the cost estimates for ADMS that were presented in the 2020 GRC. The higher program cost estimates are partly the result of including the "ADMS Asset Data" and "ADMS Cybersecurity" within the ADMS program forecast in this GRC.[8] However, the estimates also increased as a result of a bottoms-up program reforecasting exercise that benefitted from cost insights gained through several years of program implementation experience; the cost estimates in the 2020 GRC, by contrast, were made prior to initiation of significant program activities. One key driver of the cost estimate increase in this GRC was a recognition that PG&E's OMS replacement cost (Release 2) would be higher than at comparable utilities due to the highly complex and customized nature of PG&E's legacy OMS applications. Other drivers of the cost increase include finalized contract amounts after detailed scope of work planning, increased internal labor requirements, and increased hardware and software license costs due to the final technical infrastructure design. Despite the cost increase, PG&E's current total project cost estimate for ADMS remains within the High Case forecast created at the initiation of the project.

V. Benefits

This section highlights a non-exhaustive selection of ADMS benefits including those related to safety, situational awareness, training, compliance, operational efficiency, and DER awareness.

Safety

- **Address the known cyber security vulnerabilities of the existing D-SCADA application:** Replacing D-SCADA with an integrated ADMS will address known cyber security vulnerabilities. This improves the security of the grid and thus public safety by making it more challenging for bad actors to interfere with grid operations and prevent the delivery of power to customers.

Situational Awareness

[8] In the 2020 GRC, the Asset Data subcomponent of the ADMS project was forecasted as the "Distribution Asset Data Improvement" program (A.18-12-009, Exhibit (PG&E-4), p. 19-19; additionally, the Cybersecurity subcomponent of the ADMS project was forecasted within the "IGP Cybersecurity Project" (A.18-12-009, Exhibit (PG&E-4), WP 9-79).

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- **Provide visibility to masked loads[9]:** ADMS will have the ability to estimate the behind the meter load served by DERs, showing operators the total load consumed. This load estimation, coupled with some real-time telemetry of DERs, can provide operators with estimates that provide actionable information to perform restoration in the event of an outage on a circuit with a high penetration of DERs.
    - **Today:** The only real-time visibility that operators and engineers have to DERs is to large units (>1MW) with telemetry per interconnection requirements. Operators have no visibility into masked loads of smaller-capacity DERs. During an outage, inverter-based generation trips offline. With subsequent restoration, operators may encounter cold load pickup issues that delay restoration.
    - **Future:** ADMS provides estimates of the masked load served by DERs. This information will be used by operators to forecast the load that will be picked up from “back feed” sources during restoration. Restoration switching will be planned so that line sections will not be overloaded during restoration and protective devices on the “back feed” circuit won’t trip.

- **Intelligent Alarm Processing**: Intelligent Alarm Processing is a capability of ADMS that automatically filters and prioritizes alarms for operators, making the operator more efficient when assessing and addressing grid issues. This is especially important when storms create above average outage and alarm volume, and operators can be inundated with alarms. Suppression of redundant alarms improves overall situational awareness and reduces operator workload. Today’s SCADA alarm display only has basic intelligence that filters alarms based on “priority” and cannot eliminate duplicate alarms.
    - **Today:** Operators have one continuous flow of alarms; alarms do not "roll up" to an event alarm.
    - **Future:** Can have an "inbox" like format of alarms, can have decluttering capabilities, can separate alarms into different screens.

- **Promote greater awareness across PG&E of real-time grid status:** ADMS vendors have developed read-only ADMS viewer capabilities that allow sharing information contained in the ADMS with wider audiences across utilities. In Release 2, PG&E plans on implementing a “thin client” application which provides the set of ADMS features to run on mobile devices (tablet or laptop) in various operating systems (iOS, Windows). This allows for more PG&E personnel to have access to a subset of ADMS features such as electronic switching records, allowing for better awareness of actual grid conditions across PG&E.
    - **Today:** DMS can only be accessed via the DMS application on a laptop or desktop computer. The DMS application requires more memory (RAM) than PG&E standard laptops offer, so people running DMS on laptops require enhanced laptops.
    - **Future:** Information in ADMS can be accessed via a “thin client” application, which aligns with PG&E’s mobile computing strategy of equipping field resources with tablets. Field personnel will

[9] “Load Masking” describes a situation in which the lack of generation output visibility prevents system operators and engineers from determining the real system load conditions which can inhibit the ability to plan and operate the distribution system. This is discussed in the CPUC Interconnection Rulemaking (R.17-07-007) Working Group One Final Report, issued March 15, 2018.

be able to use their standard issue technology to access some ADMS functionality and look at the same big picture status of the grid as the control center operator.

Operational Efficiency

- **Switching Planning and Execution:** ADMS enables switching submittal, planning, and execution to be a process contained within one application, driving substantial efficiency. ADMS provides the ability for efficient scheduling with "clash checking"[10] as well as fast development of switch logs, with fully embedded intelligence to verify the switch log's impact, in both real time and study mode.
    - **Today:** Control center personnel manually evaluate the ability to perform planned outages in close electrical proximity. Switching logs are then manually written and checked. Field personnel use paper copy switch logs, which must be either printed and picked up in an office or written by hand while dictated by a control center operator over the phone.
    - **Future:** Some, but not all, of the planned outage "clash checking" can be automated or partially automated. Larger and more complex projects (e.g., test programs) will still require manual input to plan outages and develop switching logs.

- **PSPS Planning and Execution:** ADMS can significantly improve the efficiency of PG&E's PSPS operations through improved situational awareness and faster switch plan generation.
    - **Today:** The "PSPS Toolset," which includes PSPS Viewer and the PSPS Situational Intelligence Platform (PSIP), generates PSPS de-energization plans based on weather polygons, but because this tool is based on the as-built network model, significant manual work is required to reconcile these plans with the as-switched network state. Additionally, Operators spend substantial time writing PSPS switching plans by hand and field crews have limited visibility into the as-switched network state during PSPS events.
    - **Future:** ADMS can automatically generate PSPS de-energization plans based on weather polygons superimposed on the as-switched network model and Operators will no longer need to write switch logs by hand. These improvements will save substantial time in the generation of PSPS switching plans, allowing PG&E to be more responsive to last-minute changes in PSPS scope due to changing weather conditions or grid topology. Better field visibility into the as-switched network model will also improve situational awareness during PSPS and accelerate restoration times.

- **Better load forecasting driving better grid operations:** ADMS has a load forecasting engine that develops "operational time horizon" (i.e., 24 hr., 7 day) load forecasts.
    - **Today:** Load forecasts are determined by manually analyzing peak loading over the past 30 days and applying judgment on how the peak conditions should be applied to the switching being evaluated. Some load forecasts are conservative, which can result in slower restoration during outages (i.e., reduced reliability), or an increase in switching steps for planned switching (i.e., reduced operational efficiency).

[10] *Clash checking* refers to the ability of ADMS to determine if an incremental clearance can be taken based on the present or planned future state. ADMS evaluates this based on the pre-clearance topology, and the capability of the grid to be in abnormal configuration during the switching for take-out switching, during the clearance, and go-back switching when the clearance is no longer needed.

  - **Future:** ADMS-produced load forecasts allow for more consistent and time series capable simulation capabilities critical to assessing switching options on a more complex and constrained system.

- **FLISR expansion and maintenance:** FLISR is an advanced application that is part of the ADMS platform. ADMS FLISR will know the topology and capacity of the grid, and the forecasted load. Therefore, ADMS FLISR requires less configuration than PG&E's existing FLISR, which must be manually configured by an engineer and FLISR application specialist. With an ADMS FLISR, it will take less time to create new FLISR schemes[11] and maintain existing schemes.
  - **Today:** FLISR schemes are manually studied by a PG&E engineer, who determines allowable automatic restoration actions based on system topology, capacity, and forecasted loads. These automatic restoration actions are configured in the FLISR application by an application specialist.
  - **Future:** ADMS will partially automate the process for creating new FLISR schemes and maintaining existing schemes when there are material changes to topology, capacity, or load.

- **Reduce utility line losses:** ADMS's optimal power flow capabilities can control SCADA-enabled capacitors to minimize line losses while maintaining power factor and voltage compliance. Reducing line losses lowers greenhouse gas emissions and reduces PG&E's energy procurement costs, which in turn reduces the cost to customers.

- **Drive Conservation Voltage Reduction:** ADMS's optimal power flow capabilities can control SCADA-enabled substation transformer load tap changers (LTCs), line voltage regulators, and capacitors to drive Conservation Voltage Reduction (CVR). CVR is a well-understood physical effect that reduces the energy consumed by customers' devices. This lowers greenhouse gas emissions and reduces PG&E's energy procurement costs, which in turn reduces the cost to customers.

Training

- **Operator Training Simulator:** ADMS has a training simulator that can effectively train existing and new operators. The simulator allows the creation of real-life complex training scenarios that include SCADA-related events and operations, switching management, and outage management events (e.g., customer calls, SmartMeter outage notifications, hazards, damage, etc.). The simulator can simulate the behavior of protection and DERs. For example, the simulator could simulate the cold load pickup challenges on circuits with high PV penetration.
  - **Today:** Training simulations are performed with DMS only, with no SCADA capabilities (SCADA interaction is done via voice).
  - **Future:** Interactive training simulations better mimic the operating environment, making operator training more effective and efficient.

Compliance

[11] SCADA-enabled substation and field devices (i.e., circuit breakers, line reclosers, switches) must be installed and commissioned for new FLISR schemes to be enabled.

- Power Factor Compliance with CAISO Tariff: ADMS can automate the control of SCADA-enabled capacitors, improving power factor compliance at the T-D interface with applicable CAISO tariffs.
    - **Today:** Planning engineers periodically analyze settings for capacitor controllers, evaluating peak load and minimum load conditions, setting capacitor controller settings for voltage and power factor compliance during these edge cases. Few capacitors on PG&E's system are SCADA-enabled, so settings updates are performed by field personnel.
    - **Future:** With continued additional investment in device controller SCADA upgrades, online Volt Var Optimization (VVO) can maintain compliance with voltage and power factor requirements under planned and abnormal system configuration with minimal intervention since the topology of the system is always known to the ADMS.

DER Aware

- **Automation applications are built to consider the impact of DERs and Microgrids:** This creates value where PG&E experiences higher penetration of DERs in the future.
    - **Today:** Existing tools have very little information on DERs and are not built with high-DER penetration in mind.
      Future: A platform built anticipating high DER penetration, with data on DER location and capabilities. ADMS is built to monitor microgrids to ensure the safe operation of disconnection and reconnection of microgrids.

VI. Alternatives Considered

During Q4 2020, PG&E considered the option of delaying the start of Release 2 (OMS) for a period of one-to-two years to in response to concerns over competing budget pressure and internal resource availability. Ultimately, PG&E leadership rejected this option and approved the required budget and resources, citing the importance of continuing the ongoing momentum and success from Release 1, maintaining the planned retirement schedule for PG&E's legacy OMS applications, and minimizing the period of time where legacy OMS applications will need to exist in parallel with the Release 1 ADMS system.

VII. Grid Modernization Supplemental Questions

Attribution to DER integration vs safety and reliability	Of the three key justifications for implementing an ADMS, two are mostly attributed to safety and reliability, and one is mostly attributed to DER integration. **Safety & Reliability:** • Replaces the existing D-SCADA • Delivers an integrated platform (in the ADMS) that delivers safety, reliability, and operational efficiency benefits in how PG&E operates the grid today **DER Integration** • Positions PG&E for the future by implementing a platform that is designed for future DER growth The specific attribution percentages of project cost to safety, reliability, and DER integration are not feasible to produce given the interrelated nature of the investment.
DERs the proposed technology integrates	This proposed technology will support integration of all DERs except energy efficiency.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – ADVANCED DISTRIBUTION MANAGEMENT SYSTEM

Integration Challenges the technology supports	ADMS addresses two specific challenges, understanding DER impact on load, and enabling the connection to other platforms or applications that enable DERs to provide services. • **Load:** ADMS will provide insight into how DERs impact loading and voltage, allowing operators to make decisions informed with DERs input. • **Connection to other and future platforms:** ADMS vendors are presently designing their systems to be integrated to DERMS and DRMS-like systems. The vendor landscape understands that this is a likely future requirement, and to compete for new business must design their systems to meet future needs.
Grid services the technology enables	ADMS will not by itself enable any DER grid services. However, ADMS will provide the foundational situational awareness and load flow data for a future DERMS to provide grid services.
Maturity of the proposed technology	Mature. U.S. utilities outside California have deployed ADMS.
Expected useful life of equipment	>10 years
Equipment capacities, ratings and other specifications	N/A
Additional Information for locational investments	ADMS is a systemwide application. Some advanced applications will be enabled across the entire system, some will be specific to circuits based on, for example, high DER penetration or reliability considerations.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTED ENERGY RESOURCE MANAGEMENT SYSTEM

Project Title: Distributed Energy Resource Management System
Major Work Categories: 63/HG
Planning Order Numbers: 5544413, 5058550
Project Start Date: 2023
Project Completion Date: 2026
Operative Date (only applies to Capital): 2026

Project Description

This project will implement a Distributed Energy Resource Management System (DERMS) to complement the foundational technology improvements and grid management tools built by the Advanced Distribution Management System (ADMS) program. The DERMS will allow PG&E to manage the added operational and programmatic complexity of ever-growing Distributed Energy Resources (DERs) and DER Programs on the PG&E grid. PG&E will build a DERMS platform to deliver the following capabilities:

- Monitoring, dispatch, and program management of DER systems – DERMS will be a secure platform that enables the monitoring and dispatch of both front-of-the-meter (FTM), behind-the-meter (BTM), and aggregated DER assets with rules based on program types.
- Full integration with ADMS – DERMS will seamlessly integrate with the ADMS, building on the integrated network model and grid modeling capabilities provided by the core ADMS product.
- DER advanced situational awareness for normal and abnormal conditions – DERMS will provide additional DER visibility beyond what is typically included by an ADMS such as DER status, flexibility, availability, forecasted flexibility, and program insights. Moreover, while the ADMS is generally focused on larger or aggregated DERs, the DERMS will have the ability to manage and provide visibility to smaller DERs at larger numbers.
- DER constraint management for interconnection and abnormal conditions – DERMS will manage constraints on DERs including a limited generation profile, and other more dynamic constraints under abnormal conditions. DERMS will also help manage DER impacts at the Transmission and Distribution interface including coordination of wholesale market participants on the Distribution system and enable more dynamic hosting and load serving capacity.
- Operation of DER-based deferral solutions - Examples of such solutions include projects participating in the Distribution Investment Deferral Framework (DIDF) and other alternatives to conventional infrastructure investments. As the number of these projects expand, platform-based controls and processes will increase the efficiency to manage the dispatch, mitigations, and settlements of these systems.
- Enable DER-based resilience solutions - DER-based resilience solutions such as third party and PG&E-operated microgrids are projected to grow as microgrids are increasingly leveraged for both resilience and PSPS impact mitigation. A platform-based approach will help ensure proper management and operation of these systems and enable higher participation of DER assets.

Justification

The impact of DERs and the management of DER programs are becoming increasingly complex. While investments in ADMS are creating a system that is DER-aware, additional functionality supplied by a DERMS is required to manage the DERs and related DER programs, especially at scale.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTED ENERGY RESOURCE MANAGEMENT SYSTEM

California is a leader in the growth of DERs including solar, battery storage, electric vehicles, and demand response. This progress is driven by a confluence of technology advancements, consumer preferences, and complementary legislative and regulatory actions in the state. Moreover, wildfire risks have also accelerated the proliferation of resilience focused DER solutions in California.

While DERs help achieve California's clean energy and resilience objectives, they can potentially create new challenges including capacity constraints, power quality issues, and adverse impacts on protection systems due to bi-directional flow. In addition to the electrical complexities, there are programmatic and policy requirements that also need to be managed as the rules and regulations around DERs in PG&E's service territory continue to evolve. Within the past few years there have been multiple regulatory efforts around DER programs within different tracks including IDER, DIDF, DER Tariff Pilots, Microgrid OIR, Vehicle-to-Grid (V2G), Rule 21, etc. A DERMS will aid in managing and providing value for the DERs within the multiple DER-centric programs that continue to evolve as the technology and processes mature.

As described in the Project Description, the DERMS platform addresses these operational and programmatic challenges while leveraging existing investments through the following capabilities:

- Monitoring, dispatch, and program management of DER systems
- Full integration with ADMS
- DER advanced situational awareness for normal and abnormal conditions
- DER constraint management for interconnection and abnormal conditions
- Operation of DER based deferral solutions
- Enable DER-based resilience solutions

A DERMS is required to help PG&E achieve its vision of a future electric grid as a secure, reliable, and affordable platform that enables continued gains for clean energy and California's economic interests in a way that provides maximum flexibility and value for customers.

Cost

Cost forecasts for both the capital and expense components of the project are shown in the table below.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

		Recorded					Forecast						
Project Component	**MAT**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**Total**
Capital													
DERMS - CAP	63C								$ 975	$ 4,005	$ 20,565	$ 26,438	***$ 51,983***
Expense													
DERMS - EXP	HGC								$ 119	$ 502	$ 2,644	$ 3,480	***$ 6,745***
Total Project Forecast									***$ 1,094***	***$ 4,507***	***$ 23,209***	***$ 29,918***	***$ 58,728***

Additional Cost Information:
This estimate includes costs for license fees, an annual subscription fee for a DERMS provider, implementation services, custom development, environment build cost, internal labor, external systems integration, hardware, and software.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTED ENERGY RESOURCE MANAGEMENT SYSTEM

The DERMS program forecast was created by subject matter experts at PG&E in consultation with a third-party Systems Integrator using the assumptions outlined in Workpaper WP 21-13. PG&E used an AACE Class 5 estimate because the project is in the early concept and planning phases.

Benefits

Benefit Areas	Project Benefits
Advanced Situational Awareness	This project builds on the capabilities of a DER-aware ADMS to enhance DER related situational awareness to include smaller DERs at larger scales as well as DER program specific data and capabilities.
Operational Efficiency	A DERMS platform will leverage ADMS investments and provide a single application to manage multiple DER types, DER programs, and DER locations
Reliability and Resilience	DERMS provides a platform to create value from DERs to help solve reliability and resilience challenges facing the grid including constraint management, DER grid services, and microgrid integration.
Compliance	PG&E seeks to deploy a DERMS that can quickly and flexibly accommodate evolving CPUC requirements such as DIDF, potential DER tariffs, evolving interconnection requirements, etc.
Customer Satisfaction	A DERMS platform will provide a method to not only enable value from customer DERs, but to mitigate the potential negative effects on customers from DERs at high grid penetrations.

Alternatives Considered

PG&E considered the following three alternatives related to DERMS:

Alternative 1 – Maintaining the status quo (not recommended): This alternative is not recommended for PG&E because it provides no path to integrate and manage the growing number of DERs and DER programs at a platform scale. In past GRCs, PG&E did not advocate for a platform DERMS based on the need to focus on foundational technologies like ADMS and relied on deploying as-needed spot solutions as PG&E waited for more maturity in the market. In addition, there was an insufficient number of DERs requiring advanced controls to warrant a platform level investment. However, now with ADMS being deployed, increasing regulatory and policy pressures, and advances in DER growth and technology, PG&E feels the status quo will result in increased costs through multiple disjointed spot solutions, inefficient handling of the added complexity of DERs, and potential operational risks from reduced integration with existing operational platforms like ADMS.

Alternative 2 – Implement a DERMS platform and integrate it with ADMS (as proposed in this project summary): Implementing a DERMS platform and integrating it with ADMS is PG&E's preferred alternative because it:

1. Leverages the foundational investments made in a DER-aware ADMS
2. Provides a platform that can be scaled to multiple DER types, DER programs, and DER locations

3. Provides a system to enable value for customers while managing the complexities of operating the grid with high DER penetrations
4. Positions PG&E for the future by implementing a system that can evolve with the changing technological and regulatory environments

Alternative 3 – Implement a standalone DERMS platform (not recommended): This alternative is not recommended for PG&E because it does not leverage the foundational investments and operational integrations made in a DER-aware ADMS. This would create added costs, complexities, and inefficiencies including:

- Not capitalizing on the current ADMS investment
- Potential higher cost of ownership in managing multiple duplicative models, systems, and integrations
- Limiting the visibility and integration with the grid operations
- Providing a more complex user experience for grid operators

Grid Modernization Supplemental Questions

Attribution to DER integration vs safety and reliability	DERMS is directly related to DER integration, however the use of DERMS can also help improve the safety and reliability of the PG&E system in relation to DERs through improved situational awareness and management of DER services.
DERs the proposed technology integrates	DERMS will work with front-of-the-meter, behind-the-meter, and aggregated DERs of various types that may be members of a variety of DER programs.
Integration Challenges the technology supports	DERMS directly addresses issues related to integrating more DERs into the grid, including both management of added complexity on the electrical system as well as the management of programs that help provide value for PG&E customers.
Grid services the technology enables	DERMS will be the platform that enables DER grid services of various types. Grid services that DERs provide will continue to evolve with time, but near-term services include managing distribution constraints, distribution investment deferral, resilience services, and wholesale products.
Maturity of the proposed technology	Different capabilities within the DERMS system have varying levels of maturity, but in general, a comprehensive utility DERMS is still a relatively nascent technology.
Expected useful life of equipment	There will be a continued need for this technology for the foreseeable future and the specific capabilities will continue to evolve as technology and policies advance. DERMS will need to evolve as systems, integrations, and programs change.
Equipment capacities, ratings and other specifications	N/A
Additional Information for locational investments	N/A

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTION ENGINEERING PLANNING TOOLS

Project Title: Distribution Engineering Planning Tools
Major Work Categories: 21/AB (DRP-Driven Tools); 2F/JV (Non-DRP-Driven Tools)
Planning Order Numbers: 5779166, 5794602, 5056892, 5260112, 5530791, 5260875
Project Start Date: 2018
Project Completion Date: 2025
Operative Date (only applies to Capital): Various by project

Project Description

Distribution planning is becoming increasingly complex and a variety of new sources of data need to be integrated to support accurate system modeling. Advanced planning tools are the foundation for well-planned grid infrastructure improvements because they allow PG&E to evaluate a wider variety of scenarios and conditions created by an increasingly dynamic and distributed electric grid. The advanced capabilities required include the ability to forecast load under a variety of scenarios and the ability to perform time-series analysis of the distribution system (i.e. conditions at many different times of day or year, or in varying weather conditions) to forecast long-term and near-term planning deficiencies and constraints. Also, by transitioning from studying a single point in time to scenario-based and time-series analyses, automating existing analyses and processes is also required to manage the growing complexities in distribution planning analysis.

PG&E currently uses several distribution planning tools and databases, four of which— Electric Distribution PI (EDPI) Historian, Geographic Information System (GIS), LoadSEER, and CYMDIST Distribution Analysis (CYME)—are relevant here.

- EDPI Historian is the historic SCADA measurement archive system.
- GIS serves as PG&E's master database for geospatial data, electric system connectivity information, and asset information.
- LoadSEER is a load forecasting application made by Integral Analytics that analyzes geospatial, SCADA, SmartMeter™, customer billing, historical and forecast weather, and power flow data to produce an econometric load blueprint that serves as the core forecasting product for a utility. LoadSEER produces a much more detailed and accurate picture of customer load than a simple estimate based on kWh consumption. It also uses analytics that allow for modeling of load for various customer types (e.g., commercial, industrial, and agricultural) and under many different circumstances (e.g., varying weather conditions, different times of day, and different economic assumptions of future growth).
- CYME is a distribution power flow modeling application used for engineering planning studies and simulating the behavior of the electric distribution network under different operating conditions and scenarios. CYME includes several built-in functions required for distribution network planning, operations, and corresponding analysis.

Previous work proposed in the 2020 GRC had four components: 1) enable CYME integration with LoadSEER and EDPI Historian; 2) set up CYME to be able to run time series analysis; 3) enable CYME to incorporate network phasing information from GIS when it becomes available; and 4) replace the existing custom GIS-based database used to manage distribution line equipment settings with a new database built upon the commercial software product PowerBase. An update on these four components is included below:

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTION ENGINEERING PLANNING TOOLS

- CYME/LoadSEER and EDPI Integration: PG&E has worked with Integral Analytics and CYME to develop the Dynamic Data Plugin (DDP) interface between the CYME and LoadSEER applications. This allows for the transfer of EDPI and AMI data directly into the power flow models in the CYME application.
- Enable CYME Time Series Analysis: PG&E plans to begin this project in 2021.
- Incorporate Phasing Information: PG&E is planning on testing the ability to transfer phasing information from GIS to CYME once the underlying data is available within GIS.
- PowerBase Equipment Settings Database: PowerBase is on schedule to be completed in 2021. Engineers will be able to update equipment settings within the PowerBase application and transfer these settings into the CYME application.

Work forecast in the 2023 GRC builds upon current and past planning tools development and can be broken down into two categories—planning tool development driven by Distribution Resource Plan (DRP)[1] compliance, which is tracked in MWCs 21/AB, and non-DRP-related distribution planning tool enhancements, which are tracked in MWCs 2F/JV.

Planning Tool Development Driven by DRP Compliance:
Multiple tracks within the DRP have required the creation and use of new tools (e.g., Integration Capacity Analysis (ICA[2], LNBA[3], DRP Data Portal[4]). The DRP also required the ongoing analysis and publication of distribution data via the Grids Needs Assessment (GNA) and Distribution Deferral Opportunity Report DDOR[5] annual reports.

Work related to the on-going management of initial requirements and initial improvement rulings within the DRP can be categorized in three areas.

- ICA – The objective of ICA is to simulate the ability of individual distribution line sections to accommodate additional DERs without potentially causing issues that would impact customer reliability and power quality. PG&E has worked with a third-party vendor to operationalize ICA and incorporate intelligent quality control into the ICA process. The Rule 21 Interconnection Process has adopted the use of ICA.[6] On select circuits monthly, ICA is performed, results are validated as-needed, circuit models are updated as-needed, and results are published.

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[1] R.14-08-013

[2] D.17-09-026

[3] D.17-09-026

[4] D.18-02-004

[5] D.18-02-004

[6] R.17-07-007

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTION ENGINEERING PLANNING TOOLS

- DIDF – The annual Distribution Investment Deferral Framework (DIDF) includes the publication of the GNA and DDOR, hosting of Distribution Planning Advisory Group (DPAG) meetings, and coordination with an Independent Professional Engineer (IPE) and Independent Evaluator (IE).

  The objective of the GNA is to provide transparency into the assumptions and results of the distribution planning process that yield the Candidate Deferral Opportunities shortlist, propose grid modernization investments, and proactive hosting capacity upgrades proposed to accommodate forecast DER growth. PG&E's GNA presents data available regarding PG&E's projected distribution grid needs over a five-year planning horizon.

  The objective of the DDOR is to utilize the GNA to identify PG&E's candidate distribution deferral opportunities shortlist. In addition, other objectives of the DDOR are to provide transparency into the assumptions and results of the distribution resources planning process that yield the DDOR candidate shortlist and provide the associated DER attributes required to meet these opportunities.

- DRP Data Portal – The DRP Data Portal is an externally-facing, map-based portal that provides information about PG&E's distribution network, including ICA, GNA, and DDOR results.[7]

The scale of the data and analysis within the DRP requires specific and customized tools to process and ensure data quality and accuracy. GNA and DDOR requirements from the DRP require PG&E to make upgrades to existing planning tools, including the CYME application and the LoadSEER application. The new functionalities delivered by this project will include:

- Scenario Planning - Studying distribution system impacts across various forecast and planning scenarios. This is a significant enhancement to the current process that requires a separate database with manual exclusion of all capacity projects before creating the GNA and DDOR reports.
- Load Forecasting Enhancements – Forecasting load more granularly, at the line section level, and performing short-term load forecasts for DER dispatch associated with DIDF contracts.
- Tools Integration – Eliminating manual processes by automating the integration of various distribution planning tools for publication of data as required by the DRP.
- Report Process Management – Automating the process and creation of DIDF reports.

Non-DRP-Related Distribution Planning Tool Enhancements:
This project includes three additional enhancements to the CYME application and study process driven by business needs unrelated to the DRP.

- CYME Substation Modeling and Analysis – This project will further model the substation within CYME, including but not limited to transmission protective devices at the interface between transmission and distribution, transformer banks, substation buses, and distribution breakers. Adding new substation components into the CYME model will allow for additional analyses to be performed within the CYME application. The current process requires engineers to do some of the substation-level analyses outside of CYME, either in separate protection analysis tools, spreadsheets, or on paper. Further incorporating

[7] PG&E AL 5295-E, May 16, 2017

the substation model into distribution planning software allows engineers to further study within CYME bank and feeder level upgrades, bank and feeder loss studies, substation elements of the distribution protection studies, and bank and feeder capability ratings.

- Distribution Time-Series Analysis Phase 2 - This project will build upon the successful implementation of the CYME Time-Series Load Flow Analysis project and further automate the distribution planning process. This project will extend the existing time-series analysis to assist with Voltage Regulator and Capacitor optimization and Risk Prioritization. Additionally, this project will investigate the use of the Advanced Project Manager (APM), results from the time-series analysis, and the technoeconomic analysis module to generate standardized and templated project authorization documentation.

- Distribution Planning Automation - The Distribution Planning Automation project will develop a manage-by-exception analysis process within CYME for capacity planning study deficiencies. Circuit analyses will be initiated and reviewed at the dashboard level, allowing engineers to focus their review on circuits with forecasted deficiencies. Distribution planning tools will also be further integrated with two-way information flow.

Justification

Planning Tool Development Driven by DRP compliance is recorded in the Distribution Resources Plan Tools Memorandum Account (DRPTMA). The DRPTMA is a requirement arising from Decision 17-09-026 (Decision on Track 1 Demonstration Projects A (Integration Capacity Analysis) and B (Locational Net Benefits Analysis), in the Distribution Resources Plan (DRP) proceeding. Advice letter 5255-E, effective as of February 8, 2018, created a new sub-account in DRPTMA for costs associated with the Grid Needs Assessment (GNA), Distribution Deferral Opportunity Report (DDOR) and DRP Data Access Portal which is mandated by Decision (D.) 18-02-004 (Decision on Track 3 Issues: DER Growth Scenarios and the Distribution Investment Deferral Framework). The DRPTMA does not have a CPUC-authorized budget, instead the costs have been placed in the memorandum account and are subject to reasonableness review in this GRC. To date, many DRP compliance requirements have been met via manual processes. Experience and expanding requirements have proven that this will be unsustainable in future years. The planning tool enhancements driven by DRP compliance build upon this experience, expanding tool capabilities and eliminating manual processes.

Non-DRP-related distribution planning tool enhancements are driven by the increasing complexities brought on by time-series analyses.

Both DRP and non-DRP related items are justified by three main objectives: a) eliminating manual analysis and processes through automation, b) minimizing manual application integration, and c) managing analysis complexities.

- Scenario planning will eliminate the manual process used to date for DRP compliance. Rather than creating separate system snapshots, with and without grid upgrades, a single snapshot can be created with multiple scenarios.
- The LoadSEER and CYME applications will be further integrated, minimizing the need to enter and transfer duplicative information manually.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTION ENGINEERING PLANNING TOOLS

- Report process management will automate and streamline the report generating process of DIDF, eliminating the manual management of a large and complex dataset.
- CYME Substation Modeling and Analysis will eliminate the need to perform protection studies within multiple applications and further enable the ability to automate work via scripting.
- Distribution Time-Series Analysis Phase 2 will minimize the complexities and automate the analysis associated with developing device settings and device placement for multiple time points. Other manual processes may also be eliminated through technoeconomic analysis modules.
- Distribution Planning Automation will address all three objectives. Planning studies will be automated, allowing engineers to only focus their attention where needed in the manage-by-exception process. The CYME and LoadSEER applications will be further integrated in the automation process. The automation will also manage the large and complex dataset created when studying multiple time points. For example, as electrification load increases, including load from electric vehicle (EV) charging infrastructure, more circuits will require a study of their winter peaks.
- The ICA, LNBA, DIDF, and DRP Data Portal Requirements require upfront implementation costs, as well as ongoing updates/maintenance costs associated with ongoing regulatory requirements.

In addition to the project justifications above, load forecasting enhancements will be made to improve and further enhance the annual capacity planning and DIDF processes.

Cost

The total cost of the Distribution Engineering Planning Tools project is summarized in the table below. DRP-related planning tool development work is tracked in MWCs 21/AB, while non-DRP-related work is tracked in MWCs 2F/JV.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

		Recorded					Forecast						
Project Component	**MAT**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**Total**
Capital													
DRP-Driven Planning Tools	21A	$ -	$ -	$ 1,114	$ 2,116	$ 395	$ 2,882	$ 3,083	$ 2,237	$ 1,852	$ 1,902	$ -	**$ 15,582**
Non-DRP Driven Planning Tools	2FA	$ -	$ -	$ 880	$ 1,897	$ 1,180	$ 1,050	$ 1,000	$ 3,469	$ 1,886	$ 1,995	$ -	**$ 13,356**
Expense													
DRP-Driven Planning Tools	AB#	$ -	$ -	$ 484	$ 2,003	$ 3,320	$ 3,926	$ 4,135	$ 4,565	$ -	$ -	$ -	**$ 18,432**
Non-DRP Driven Planning Tools	JV#	$ -	$ -	$ 106	$ 197	$ 298	$ 215	$ 200	$ 1,009	$ -	$ -	$ -	**$ 2,025**
Total Capital Forecast			$ -	$ 1,994	$ 4,012	$ 1,575	$ 3,932	$ 4,083	$ 5,706	$ 3,738	$ 3,897	$ -	**$ 28,938**
Total Expense Forecast			$ -	$ 590	$ 2,200	$ 3,618	$ 4,141	$ 4,335	$ 5,574	$ -	$ -	$ -	**$ 20,457**

Additional Cost Information:
PG&E used the IT Project/Program Estimating Tool (PET) to document estimate assumptions and generate labor and non-labor cost forecasts for most aspects of the non-DRP-related planning tool development work, although a subcomponent of the forecast related to the Distribution Line Settings project was created using a Job Estimate. To calculate labor costs, the PET captures labor hours by activity and resource type, multiplies that by standard labor rates, and adds in standard overhead factors. To calculate non-labor costs, the PET captures contract costs by type (such as software licenses or third-party services), material costs by unit quantity and unit price, and standard overheads such as materials burden and AFUDC. Other factors, such as

escalation and capital/expense ratios, are calculated based on standard rates and accounting guidance. See Exhibit (PG&E-7), Chapter 8 for additional information regarding the PET.

Forecasts for DRP-related tool development were created by PG&E subject matter experts using a combination of vendor quotations and PG&E internal labor costs. The capital and expense costs associated with DRP-related tools and non-DRP related tools are attributed and tracked by separate order numbers. Accordingly, there are specific vendor contracts, product managers, and engineers working on the specific tools that track their incremental costs to the order numbers associated with the tools. Examples of PG&E internal labor expense costs include the labor required to create and review GNA and DDOR reports and maintain ICA results. Expense costs also include ICA processing to update results monthly. ICA Processing requires significant computational and storage resources. The solution is hosted on AWS cloud platform. Cloud hosting costs are categorized as expense.

No capital cost forecast was included for 2026 because Distribution Engineering Planning Tool development work is expected to be completed by 2025.

Benefits

Benefit Area	Project Benefits
Public Safety	• Proactive review of multiple time points on a recurring basis will eliminate the number of real-time issues identified.
Reliability	• Integrating applications and/or reducing the number of applications used for a single analysis reduces errors associated with entering and reviewing data in multiple applications. • Incorporating the substation model in CYME will allow automation and optimization of substation coordination analysis, resulting in reduced electric outage impacts.
Risk and Compliance	• Enable components of the DRP focused on the annual DIDF process. • Reviewing multiple time points and scenarios will provide additional data that can improve the RIBA process.
Affordability	• Automate analyses, eliminating manual tasks and reducing costs. • Reviewing multiple time points and scenarios will provide additional data that will further allow PG&E to prioritize and rank projects.

Alternatives Considered

1. Status quo: This alternative, which does not update the LoadSEER or CYME applications is not feasible to meet all requirements. PG&E does not recommend this alternative because it does not enable requirements within the DRP and it does not support integrations and automations that enable the proactive review of bidirectional power flows.
2. Pursue planning tool development driven by DRP compliance, but do not pursue planning tool development not driven by DRP compliance. This is not recommended as the automation capabilities developed in the planning tools not driven by DRP compliance will enable the recurring analysis and

review of multiple time points when performing planning studies. Without these enhancements, reviewing multiple time points would be too labor intensive.

3. Pursue planning tool development not driven by DRP compliance, but do not pursue planning tool development driven by DRP compliance. This is not recommended as it could impact the quality and timeliness of DIDF reporting and other DRP requirements.

Grid Modernization Supplemental Questions

Attribution to DER integration vs safety and reliability	The investment drivers associated with enhanced planning tools include: • Supporting targeted distribution deferral with DERs. • Accommodating autonomous DER growth that has socialized interconnection costs. • Ensuring system safety; meets outcomes of Safety Model Assessment Proceeding (SMAP) and Risk Assessment Mitigation Phase (RAMP). • Maintaining reliability while expanding DER. The specific attribution percentages of project cost to safety, reliability, and DER integration are not feasible to produce given the interrelated nature of the investment.
DERs the proposed technology integrates	This proposed technology integrates all types of DERs including energy efficiency, demand response, energy storage, electric vehicles and photovoltaics. The load models developed for forecasting and integration in the modeling tools have capabilities to incorporate demand response and storage adoption behaviors as well.
Integration Challenges the technology supports	Awareness of DERs in long term planning and forecasting provides the ability to model reverse power impacts from DERs as part of load flow and short circuit analysis. This analysis is needed to study historical events and future system impacts resulting from bi-directional system power flow. These impacts can include thermal capacity constraints, system voltage compliance, protection coordination, and fault detection. Additionally, a time series power flow analysis is needed to understand system constraints as a result of non-simultaneous load and generation profiles. DER impacts are studied up front as part of the interconnection process. Long term planning impacts are studied in detail during the annual planning process. This improved modeling approach will assist in both aspects. Incorporating

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTION ENGINEERING PLANNING TOOLS

	DER models and various DER scenarios such as loss of largest generators on the system will be used to ensure system stability and constraint adherence.
Grid services the technology enables	By providing the ability for modeling time-series bi-directional power flow, system constraints can be assessed and optimized to provide increased access of DERs to provide grid services.
Maturity of the proposed technology	The technology and solutions to be deployed as part of planning tools investment is driving the industry towards the future. Therefore, the specific solutions are less mature than traditional utility platforms. This technology is replacing traditional means of performing distribution modeling with more efficient and enhanced capabilities new to the distribution planning analysis space.
Expected useful life of equipment	The expected useful life of the IT infrastructure and software solutions for planning tools is primarily dictated by software lifecycle and future technologies and solutions introduced into the market. While the new capabilities should support planning for a number of years, the software and processes for DER planning, analysis and integration are still relatively nascent and may undergo further enhancements in the future.
Equipment capacities, ratings and other specifications	N/A
Additional Information for locational investments	N/A

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTION DEFERRAL NON-PROCUREMENT COSTS

Project Title: Distribution Deferral Non-Procurement Costs
Major Work Categories: IG
Planning Order Numbers: 5042188, 5046189
Project Start Date: 2018
Project Completion Date: TBD (Beyond 2026)
Operative Date (only applies to Capital): N/A

Project Description

PG&E is responsible for providing deferral of distribution services via the Distribution Resource Plan (DRP) (R.14-08-013), as well as Incentive Pilots via the Distributed Energy Resources Distribution Deferral Account DERDDA (R.14-10-003). Through the DRP, PG&E has developed the Distribution Investment Deferral Framework (DIDF) to procure, through third party vendors, distribution deferral services to replace or defer traditional wire-based projects in the Company's project planning pipeline.

This scope of work included under this project is recovery of non-procurement costs associated with the provision of distribution deferral services. Distribution deferral procurement costs are not included in this GRC application because no actual distribution deferral procurement costs have been paid as of December 31, 2020.

This project also includes costs for updates to the Avoided Costs Calculator (ACC) as recorded in the Avoided Cost Calculator Update Memorandum Account (ACCUMA).

Justification

PG&E administers the DIDF to select the best candidates for potential deferral of distribution services. The culmination of this process is procurement of distribution deferral services via a Request for Offer (RFO) from third parties. Per Commission direction (D.16-12-036 and D.18-02-004[1]), non-procurement costs associated with these contracts are to be recovered in the GRC. PG&E has followed the specific CPUC compliance requirements of the Distribution Resource Plan (DRP) (R.14-08-013) and the Distributed Energy Resources Distribution Deferral Account (DERDDA), formerly the Integrated Distributed Energy Resources Account (IDERA), to track non-procurement costs. These non-procurement costs encompass both the DERDDA incentive pilots as well as the DRP Distribution Investment Deferral Framework (DIDF) Projects. PG&E filed Tier 2 Advice Letter filings[2] that provided a forecast of the expected non-procurement costs for RFO solicitations run to date.

[1] D.16-12-036, OP 21

[2] AL 5096-E, AL 5531, AL 5435, AL 5707, AL 5688, AL 6002-E

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTION DEFERRAL NON-PROCUREMENT COSTS

On June 15, 2016, the Commission issued D.16-06-007, Decision to Update Portions of the Commission's Current Cost-Effectiveness Framework. In the decision, the Commission required utilities to pay for work performed by contractors to update the Avoided Cost Calculator on an annual basis.[3]

Unspent funds from the calculator update may be used to supplement technical assistance funds, and vice versa, within an overall cap of $500,000 for the first three years. Beginning in Fiscal Year 2019-20, the authorization will be $100,000 per year on a going forward basis until or unless the Integrated Distributed Energy Resources proceeding (R. 14-10-003) or a successor proceeding determines that updates to the Avoided Cost calculator are no longer needed.

On May 21, 2019, the Commission issued D.19-05-019 which authorized the previously allocated funds in D.16-06-007, which had not yet been used due to contracting difficulties, to be used for implementation of ACC updates, as well as additional cost-effectiveness work and research studies beginning in fiscal year 2018-2019. The decision authorized utilities to seek recovery of costs booked to the Avoided Cost Calculator Update Memorandum Account (ACCUMA). The timing of including amounts recorded in the ACC memorandum account in rates will be determined through a GRC. Upon approval, the amounts recorded in the account will be transferred to the DRAM for recovery in rates through the Annual Electric True-up (AET) process.

Cost

Cost for the program are shown in the table below. There is no capital component to the program; all costs are expense.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

		Recorded					Forecast		
Project Component	**MAT**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Expense									
DRP DIDF Non-Procurement Costs	IG#	$ -	$ 71	$ 149	$ 232	$ 26	$ 881	$ 2,375	$ 2,981
ACCUMA	IG#	$ -	$ -	$ -	$ 5	$ 270	$ 45	$ 45	$ 45
Total Project Forecast		***$ -***	***$ 71***	***$ 149***	***$ 236***	***$ 296***	***$ 926***	***$ 2,419***	***$ 3,026***

Additional Cost Information

Actuals

As of December 31, 2020, PG&E has recorded $478k in the Distribution Investment Deferral Framework Administrative Costs Memorandum subaccount, all of which ($478k) is consistent with the forecast administrative costs approved in PG&E Advice Letters AL 5096-E, AL 5531, AL 5435, AL 5707, AL 5688, AL 6002-E. The amounts increase annually as the number of candidate deferral opportunities solicited increase, with the exception of 2020 in which a one-time credit from a forfeited counterparty offset the majority of the cost. The forecasted amounts increase starting in 2021 due to the increased sourcing requirements, including the launching of the DER tariff pilots as specified by D.21-02-006, and the managing and dispatch of DER contracts as they come on-line.

[3] D.16-06-007, OP 8

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTION DEFERRAL NON-PROCUREMENT COSTS

PG&E filed Tier 2 Advice Letters[4] that provided a forecast of non-procurement costs for RFO solicitations run to-date. The costs approved in these advice letter filings are pre-approved for recording and recovery and are reviewed by the Commission in PG&E's GRC. Any administrative costs exceeding the forecast approved in the advice letter are subject to a reasonableness review. However, actual non-procurement costs less than the pre-approved amounts and thus are not subject to a reasonableness review. The reason the actuals are less than the pre-approved amounts is because the DER contracts have not progressed.

Advice Letter Approvals

Program	IDER/ DIDF DER projects	DIDF Advice Letter	Closeout Advice Letter	Reference Advice Letter Appendix/Attachment
IDER	**Gonzales**	AL5531-E	AL5531-E	AL 5531 - Attachment E
2018 DIDF	**Huron**	AL 5435	AL 5707	AL 5707 - Attachment F
	New Lammers	AL 5435	N/A	AL 5435 - Attachment C
	Sant Nella	AL 5435	AL 5707	AL 5707 - Attachment F
2019 DIDF	**Alpaugh/Corcoran**	AL 5688	N/A	AL 5688 - Attachment D
	Calflax	AL5688	N/A	AL 5688 - Attachment D
	Sant Nella	AL5688	N/A	AL 5688 - Attachment D
	FMC	AL 5688	N/A	AL 5688 - Attachment D
2020 DIDF	**Willow Pass Bank 1**	AL 6002	N/A	AL 6002 - Attachment C
	San Miguel Bank 2	AL 6002	N/A	AL 6002 - Attachment C
	Calistoga Bank 1	AL 6002	N/A	AL 6002 - Attachment C
	Ripon 1705	AL 6002	N/A	AL 6002 - Attachment C
	Blackwell Bank 1	AL 6002	N/A	AL 6002 - Attachment C
	Zamora 1108	AL 6002	N/A	AL 6002 - Attachment C
	Greenbrae Bank 2	AL 6002	N/A	AL 6002 - Attachment C

Additionally, PG&E is allowed to seek recovery for contingency plan spending to date, per Order 51 of the 2020 DIDF Improvements Ruling, itemized by DIDF RFO Project. In PG&E's 2020 DDOR[5], PG&E reported on the contingency spending for the most recent DIDF solicitations. As of August 1, 2020, the contingency spend on Candidate Deferral Opportunities that PG&E received authorization to solicit was as follows:

- New Lammers Feeder: $1,690.54
- Huron Bank 1: $551,590.80
- Santa Nella: $345,143.66
- Calflax: $46,558.88
- Corcoran: $232.72

[4] AL 5096-E, AL 5531, AL 5435, AL 5707, AL 5688, AL 6002-E

[5] PG&E's 2020 DDOR, p. 27

- FMC: $0

However, PG&E is not seeking recovery of these costs as contingency costs in this GRC filing, because these projects were not successfully deferred and so PG&E is proceeding with these Planned Investments. Therefore, these costs are included as Capital in the Capacity Chapter of the GRC[6].

The costs for the ACCUMA are PG&E's allocation of costs as specified in D.16-06-007 and D.19-05-019.

Forecast

The forecasted non-procurement costs are incremental costs as required for administering the CPUC required DER distribution deferral programs, including the annual DIDF RFO requirements (D.16-12-036 and D.18-02-004) and the DER Tariff Pilots (D.21-02-006). The forecast is the product of PG&E SME judgement regarding the labor required to complete the work. The forecasted costs for the ACCUMA are based on D.16-06-007 and D.19-05-019.

Benefits

The non-procurement costs under this forecast will cover program activities including but not limited to:

- The solicitation process (including RFOs and DER Tariff Pilot solicitations)
- Ability to dispatch DERs for deferral service
- Development & administration of contracts
- Ongoing testing, validation of deployed DERs
- Marketing and Outreach, including website creation and maintenance for the Partnership Pilot
- Ongoing project and contract management costs
- Contingency planning costs, developed in conjunction with PG&E's Distribution Planning group, to ensure continued operation of the grid
- Updates to the Avoided Cost Calculator

Alternatives Considered

PG&E did not consider alternatives as this is mandated work.

Grid Modernization Supplemental Questions

Attribution to DER integration vs safety and reliability	The investment drivers associated with DER deferral includes: • Development & administration of DER contracts • Ongoing testing, validation and deployment of DERs • Ongoing project and contract management costs • Contingency planning costs to ensure continued operation of the grid The specific attribution percentages of project cost to safety, reliability, and DER integration are not feasible to produce given the interrelated nature of the investment.

[6] Ex. 4, Ch. 17.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – DISTRIBUTION DEFERRAL NON-PROCUREMENT COSTS

DERs the proposed technology integrates	The proposed DER deferral opportunities provide the potential for integration of all types of DERs including energy efficiency, demand response, energy storage, electric vehicles and photovoltaics.
Integration Challenges the technology supports	The proposed DER deferral opportunities support the integration challenges of contingency planning and ongoing testing, validation of deployed DERs
Grid services the technology enables	The investment drivers associated with DER deferral enables: • Dispatch of deployed DERs for deferral service • Ongoing testing, validation of deployed DERs • Contingency planning costs, developed in conjunction with PG&E's Distribution Planning group, to ensure continued operation of the grid
Maturity of the proposed technology	N/A
Expected useful life of equipment	N/A
Equipment capacities, ratings and other specifications	N/A
Additional Information for locational investments	Distribution Deferrals by DERs can occur anywhere across the PG&E Service Territory. Selection of specific locations are based upon the annual DIDF process, with feedback from the external Distribution Planning Advisor Group (DPAG).

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – COMMUNITY MICROGRID ENABLEMENT PROGRAM

Project Title: Community Microgrid Enablement Program (CMEP)
Major Work Categories: IG, AB
Planning Order Numbers: 5059130, 5053212, 5053989
Project Start Date: 2020
Project Completion Date: n/a (2026 or beyond)
Operative Date (only applies to Capital): n/a

Project Description

PG&E proposed the CMEP in Track 1 of the Microgrid OIR[1] as part of PG&E's plan to address Public Safety Power Shutoff (PSPS) mitigation and support energy resilience for our customers and communities. The program helps communities design permanent, multi-customer microgrids by providing incremental technical and financial support on a prioritized basis for qualifying projects in areas with the greatest resilience needs. The program also provides the tariffs and agreements necessary to define the operating relationships among the parties.

The program helps communities overcome the technical, financial, legal, and regulatory challenges inherent in deploying novel microgrid technology deployments. While CMEP provides tools and information for all forms of resilience solutions, the focus of the program is on facilitating the development of complex, front-of-the-meter, multi-customer microgrids.

The CMEP consists of four elements:

- Web-Based Tools and Information – PG&E's Community Resilience website (www.pge.com/resilience) provides comprehensive self-service information on customer-sited and community microgrid implementations, including a Resilience Planning Guide, and a Community Microgrid Technical Best Practices Guide. Additionally, the site includes resources for interconnection planning, grid maps and tools, and financial resources.
- Enhanced Utility Technical Support – PG&E has dedicated staff to provide technical support for eligible CMEP projects. The support is structured in three stages, each with distinct objectives, and serves to facilitate the development of a project from initial concept exploration, through solution assessment, and finally, for certain types of resilience solutions, through project completion.
- Pro Forma Tariff and Agreements – Multi-customer community microgrids are complex, and involve novel technical, financial, and operational considerations amongst multiple parties. In order to surmount these challenges and facilitate the development of multi-customer microgrids, PG&E has developed a pro forma Community Microgrid Enablement Tariff, which defines the eligibility and development of community microgrids, as well as their relationship to existing tariffs. PG&E has also developed a Microgrid Operating Agreement, which defines the roles and responsibilities in the development and operation of a community microgrid.
- Cost Offsets – CMEP will offset the cost of certain PG&E equipment necessary to enable the safe islanding of an eligible community microgrid, up to a cap of $3 million per project. This may include

[1] R. 19-09-009

equipment such as isolation devices, PG&E's microgrid controller, and equipment to ensure that the microgrid is safe to operate. The cost offsets do not cover the cost of distributed generation or energy storage.

CMEP also provides prioritized support and dedicated funding to help meet the resilience needs of disadvantaged and vulnerable communities. PG&E will prioritize projects located in Disadvantaged Communities as defined by CalEnviroScreen, tribal lands, zip codes with more than 50% of residents enrolled or eligible for the California Alternate Rates for Energy (CARE) program, and zip codes identified as "Rural". PG&E has created a separate funding allocation specifically for the use of these disadvantaged and vulnerable communities.

Finally, PG&E also prioritizes projects that are most urgent for public health, safety, and the public interest. This prioritization is made through an assessment of the urgency of the risks facing the community, the timeliness/executability of the solution, and the impact to communities.

In track 1 of the Microgrid OIR, the CPUC approved CMEP through 2022.[2] In Track 2 of the Microgrid OIR, the CPUC directed the three investor-owned utilities (IOUs) to develop jointly with stakeholders a Microgrid Incentive Program (MIP).[3] At the time of this writing, that program has been neither designed nor approved; however, the Decision noted an intention to harmonize the two programs.[4] In this GRC, PG&E seeks to continue the CMEP beyond 2022, with the exception of the capital expenditure/cost offsets component of the program, which PG&E expects to be included with the MIP in a manner that is consistent across the three IOUs.

Justification

The program is justified because communities are increasingly exploring energy resilience solutions to keep critical facilities and community resources energized during a grid outage. The demand for such resilience solutions in the face of extreme weather, Public Safety Power Shutoffs, wildfires, and other hazards is growing dramatically.

One of several tools that can provide such energy resilience is a microgrid. Other tools include customer-sited distributed generation and storage, and other grid-based solutions. Helping local and tribal governments determine the appropriate resilience solution for their specific needs is one of the key objectives of CMEP.

Cost

Forecasted costs for this program are shown in the table below. In accordance with D.20-06-017, Ordering Paragraph 16, PG&E intends to recover costs for CMEP capital and expense through 2022 via a reasonableness review application after such costs have been recorded in the Microgrids Memorandum Account.

Major Project Spending Estimates

[2] D.20-06-017

[3] D.21-01-018

[4] D.21-01-018, p.62

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – COMMUNITY MICROGRID ENABLEMENT PROGRAM

(Thousands of Nominal Dollars)

Project Component	MAT	Recorded					Forecast		
		2016	2017	2018	2019	2020	2021	2022	2023
Expense									
CMEP Program Expense (2020-2022)	IG#					$ 391	$ 3,088	$ 3,177	
CMEP Program Expense (2023 onwards)	AB#								$ 5,450
Total Project Forecast						***$ 391***	***$ 3,088***	***$ 3,177***	***$ 5,450***

Additional Cost Information

2021
With the approval of the CMEP Implementation Plan in March 2021, PG&E forecasts a significant ramp up in labor costs, as it builds out the Enhanced Technical Support elements of the program and implements outreach to disadvantaged and vulnerable communities.

2022
The forecast increase over 2021 is primarily due to escalation.

2023
With the expected approval in 2022 of the Microgrid Incentive Program directed by the CPUC in D.21-01-018, PG&E forecasts a significant increase in interest in community microgrids. The Microgrid Incentive Program provides a cap of $15 million per project and includes a broad range of eligible cost elements. As such, the program is expected to drive significantly more interest in community microgrids than the CMEP, which offers cost offsets only for those distribution upgrades necessary to enable the safe islanding of a community microgrid up to a cap of $3 million.

Benefits
With strong interest in community microgrids driven by increasing desire for energy resilience in the face of wildfires, extreme weather, and PSPS events, PG&E sees an important ongoing role for the Tools and Information and Enhanced Technical Support elements of CMEP. Beyond merely cost offsets, CMEP provides important support to guide the development of a community microgrid from concept through implementation. This type of support will be more necessary than ever once the Microgrid Incentive Program is fully defined and approved.

Alternatives Considered
PG&E considered not requesting an extension of the CMEP expenses beyond 2022 and including those costs as part of the MIP. However, the processes PG&E has developed and will continue to develop as part of CMEP are unique to PG&E's systems and organizational structures and are not therefore easily adapted to a common framework across the three IOUs. PG&E believes it is most appropriate to keep the 3-stage, 11-step process which is at the core of CMEP's Enhanced Technical Support, as well as the accompanying web-based tools and resources, and tariff and agreements, continuing beyond 2022 in order to support the nascent and rapidly growing interest in community microgrids and other resilience solutions.

PG&E also considered including the capital expenditure / cost offset portion of the program in CMEP beyond 2022. However, D.21-01-018 is clear in its direction that the 3 IOUs ensure their customers have access to

one-time matching funds payment to offset some portion of the utility infrastructure upgrade costs associated with implementing the islanding function of a microgrid. Since the 3 IOUs will be jointly putting forward a plan for MIP later this year, PG&E believes those costs are best included as part of the MIP proposal.

Grid Modernization Supplemental Questions

Attribution to DER integration vs safety and reliability	This program supports DER integration by providing technical support and resources to ensure the operational safety and stability of the community microgrid during islanded operations and in blue-sky mode.
DERs the proposed technology integrates	Community microgrids may incorporate multiple types of DERs, driven by the community's objectives for the microgrid. They may include controllable (e.g., fuel cell and reciprocating engine), limited or non-controllable (e.g., wind and solar PV) and back-up (e.g., diesel gensets) generation plus energy storage. They may also include EV chargers and enabling technologies.
Integration Challenges the technology supports	Microgrids may help encourage or incentivize additional DER adoption by providing additional reliability and resilience to customers.
Grid services the technology enables	Microgrids can have a positive impact on reliability by keeping customers energized during upstream grid outages. This impact will be most notable toward the end of long distribution lines that traverse rough terrain, have heavy vegetation coverage, and suffer from winter storm impacts or PSPS.
Maturity of the proposed technology	While behind the meter single customer microgrids have been in existence for many years, the practical implementation of multi-customer microgrids is relatively new with few notable examples. The technology itself, largely speaking, is not the new aspect; it is the application of new policy and operational approaches that are new.
Expected useful life of equipment	N/A
Equipment capacities, ratings and other specifications	N/A
Additional Information for locational investments	The CMEP requires eligible microgrids to serve customers that have been either impacted by a previous PSPS, are within a Tier 2 or Tier 3 High Fire Threat District or are in the top 1% of worst performing circuits for reliability.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – ELECTRIC EMERGING TECHNOLOGY PROGRAM

Project Title: Electric Emerging Technology Program
Major Work Categories: AT
Planning Order Numbers: 5259321, 5273046, 5273047
Project Start Date: 2023
Project Completion Date: n/a (2026 or beyond)
Operative Date (only applies to Capital): n/a

Project Description

The Electric Emerging Technology Program will identify, develop and demonstrate emerging but unproven technologies to provide benefits to PG&E's electric customers and advance California energy policy objectives. This program will allow PG&E to continue its invaluable work in the Technology Demonstration and Deployment (TD&D) area of the Electric Program Investment Charge (EPIC) program in the event that the Utilities are not authorized in the EPIC successor program rulemaking (R.19-10-005) to continue as EPIC administrators beyond the current EPIC 3 cycle. Current EPIC work will end by 2022, and PG&E's role in demonstrating emerging technologies will remain critical going forward, particularly in support of PG&E and the state's high-priority wildfire risk mitigation and clean energy goals. In the event that the IOUs are authorized in R.19-10-005 to continue administering their respective EPIC programs at the current funding levels, PG&E will withdraw this program from consideration in the 2023 GRC.

The program will be comprised of three primary components:

- **Emerging Technology Projects** – Through these projects, PG&E will develop and demonstrate pre-commercial technologies or strategies at a scale sufficiently large and in conditions sufficiently reflective of anticipated actual operating environments to enable appraisal of their operational and performance characteristics and financial risks. Candidate projects and initiatives will be evaluated based on their expected furtherance of safety, reliability, resiliency, customer affordability and renewable energy integration.
- **External Innovation Partnerships** – This area will cover a range of external partnerships and initiatives, including external innovation challenges, industry technology and vendor landscaping, participation in emerging technology consortia, and targeted partnerships with academia and national labs. Maintaining these types of targeted partnerships and initiatives will be critical to not only keeping PG&E appraised of technology trends and promising opportunities, but also enabling PG&E to influence other resources and sources of funding towards addressing the needs of California and PG&E's customers.
- **Emerging Technology Program Administration** – This area will create a central Program Management Office (PMO) to administer the portfolio of emerging technology projects and external innovation partnerships. This PMO would be similar in structure to the centralized governance and enabling services in place for the current EPIC program. The current EPIC program caps administrative expenses at 10 percent of overall program spend, and PG&E would similarly cap the expenditures for this Electric Emerging Technology Program.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – ELECTRIC EMERGING TECHNOLOGY PROGRAM

Justification

In recent years, California has experienced strong storm and wind events, highly variable precipitation patterns, as well as an unprecedented expansion of high-fire threat areas. This has resulted in an increased frequency of damaging wildfires. To meet both this challenge and the challenges presented by California's ambitious climate goals, the electric grid needs to be hardened and made more flexible and adaptable to changing conditions and DERs. Many grid and wildfire mitigation technologies are at the cusp of changing how the utility traditionally operates. Demonstrations are needed to test and evaluate emerging technologies for performance, systems compatibility, and use case fit before making significant investments.

Cost

The cost of the Electric Emerging Technology Program is shown in year 2023 in the table below. As with the current EPIC program, there is no capital component to the program and all costs are expense.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

		Recorded					Forecast		
Project Component	**MAT**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Expense									
EPIC Program	AT#	$ 20,423	$ 18,907	$ 14,651	$ 8,004	$ 14,609	$ 16,158	$ 16,653	$ -
Electric Emerging Technology Program - Administration	AT#	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,717
Electric Emerging Technology Program - Projects	AT#	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,453
Electric Emerging Technology Program - Partnerships	AT#	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,004
Total Project Forecast		**$ 20,423**	**$ 18,907**	**$ 14,651**	**$ 8,004**	**$ 14,609**	**$ 16,158**	**$ 16,653**	**$ 17,174**

Additional Cost Information:
The forecast for the Electric Emerging Technology Program was primarily derived from historic spending for the EPIC program. The future program is intended to be funded at the same level as PG&E's historical EPIC funding allotment. Please refer to D.18-01-008 for discussion of how PG&E's funding allocation for the EPIC program was determined.

Benefits

Projects selected for inclusion in the Electric Emerging Technology Program may have benefits related to DER Integration, Safety, Reliability, Resiliency Affordability, and more. As with the current EPIC program, all projects will start with a comprehensive business plan that clearly identifies the goals of the project, metrics that will be collected and how the project would be deemed successful at the inception. At the time of project closure, qualitative and quantitative benefits will be calculated for the project itself or projected if it is to be implemented systemwide.

Alternatives Considered

1. ***If PG&E's direct EPIC program administration role is maintained, do not pursue Electric Emerging Technology Program (Recommended).*** In the event that the IOUs are authorized in R.19-10-005 to continue administering their respective EPIC programs at the current funding levels, PG&E will withdraw this program from consideration in the 2023 GRC.
2. ***If PG&E's EPIC program administration role is not maintained, pursue Electric Emerging Technology Program at lower funding level than previous EPIC program allotment (Not Recommended).*** Funding for the Electric Emerging Technology Program will be required at levels

commensurate with the previous EPIC program to allow funding for technology demonstration work sufficient to meet the scale of the challenges to the California grid posed by wildfire and DER integration.

Grid Modernization Supplemental Questions

Attribution to DER integration vs safety and reliability	Allocation of projects in the portfolio would be decided by a committee of Directors based on projected emerging technology needs.
DERs the proposed technology integrates	This proposed technology will support integration of all DERs except purely demand response and purely energy efficiency.
Integration Challenges the technology supports	Various. Projects aim to identify the potential integration challenges before they are adopted in mass.
Grid services the technology enables	Various
Maturity of the proposed technology	The technologies within this program are by definition pre-commercial emerging technologies.
Expected useful life of equipment	N/A
Equipment capacities, ratings and other specifications	N/A
Additional Information for locational investments	N/A

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – ELKHORN BATTERY ENERGY STORAGE SYSTEM

Project Title: Elkhorn Battery Energy Storage System
Major Work Categories: 3R, 82, AB
Planning Order Numbers: 5791879, 5785091, 5785562, 5790240, 5795610, 5781023, 5794899, 5057136
Project Start Date: 2018
Project Completion Date: 2022
Operative Date (only applies to Capital): Various

Project Description

PG&E received approval by the CPUC's Resolution E-4949 to design, permit, construct, and maintain a lithium-ion Battery Energy Storage System (BESS) that will deliver 182.5 megawatts (MW) at the point of interconnection at the Moss Landing Substation in Monterey County. The project is forecasted to be released to operations in July 2021 with an early 2022 forecasted project completion date. The Elkhorn BESS will be owned and operated by PG&E.

Justification

The Elkhorn BESS will enhance reliability by addressing capacity deficiencies as a result of local load growth and will participate in the California Independent System Operator (CAISO) markets, providing energy and ancillary services - such as serving as an operating reserve that can quickly be dispatched to ensure there is sufficient generation to meet load -- to the CAISO-controlled grid.

On January 12, 2018, the Commission issued E-4909, which ordered PG&E to hold one or more competitive solicitations for energy storage and/or preferred resources to address the South Bay – Moss Landing and Pease local sub-area capacity deficiencies and to manage voltage issues in the Bogue sub-area.5 Furthermore, E-4909 outlined requirements for the solicitation, including evaluation criteria and other considerations that should be applied in the selection of projects from the solicitation.

Per Resolution E-4949, PG&E was authorized to record the revenue requirement based on actual costs up to the adopted cost forecast associated with the project once the project achieved commercial operation to the New System Generation Balancing Account (NSGBA). The resolution directed costs to be forecasted in the GRC, but transferred to the NSGBA for recovery through the New System Generation Charge (NSGC) and recovered in rates via the CAM for the full useful life of the project using the net capacity cost calculation.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – ELKHORN BATTERY ENERGY STORAGE SYSTEM

Cost

The costs for the Elkhorn Battery Energy Storage Project are summarized in the table below.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

Project Component	MAT	Recorded					Forecast					
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Capital												
Elkhorn BESS (Capital)	3RC				$15,460	$86,080	***Confidential***					
Elkhorn BESS (Gen-Tie)	82Y			$ 11	$ 67	$ 41	$ 121					
Expense												
Elkhorn BESS (Expense)	AB#							***Confidential***				

Additional Cost Information:
The Elkhorn Battery Energy Storage project's associated capital and operations and maintenance (O&M) costs include the following components: (1) the Turnkey Engineering, Procurement and Construction (EPC) Agreement with Tesla for the construction of the battery energy storage system (BESS); (2) PG&E's costs associated with the medium-voltage (MV) to high-voltage (HV) interconnection and related work; (3) PG&E's costs for permitting, engineering, project management, communications/ metering-related activities, and project-related Allowance for Funds Used During Construction (AFUDC); (4) the 20-year LTPMA with Tesla to cover the BESS maintenance and performance guarantees; and (5) PG&E's ongoing maintenance work to support the LTPMA and ensure effective ongoing operations of the Moss Landing Project, including the MV and HV equipment.

The costs for the Elkhorn BESS in MAT 3RC and AB# are confidential in the years 2021-2023. Please refer to confidential Ex.4, Appendix A for this cost information.

Benefits

The Elkhorn BESS will address capacity deficiencies and provide energy and ancillary services to the CAISO market.

Alternatives Considered

PG&E is no longer considering alternatives to this project because the project has been approved.

Grid Modernization Supplemental Questions

Attribution to DER integration vs safety and reliability	Project benefits are mostly related to reliability, but the project will also help integrate DER into the bulk power system.
DERs the proposed technology integrates	All
Integration Challenges the technology supports	The project will help integrate DER into the bulk power system by serving as a dispatchable, carbon-free resource to help meet the ramp in evening net load on the CAISO grid that is caused in part by decreasing power generation from DER.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROJECT SUMMARY – ELKHORN BATTERY ENERGY STORAGE SYSTEM

Grid services the technology enables	The project will serve as a capacity resource, while also providing energy and ancillary services to the CAISO market.
Maturity of the proposed technology	Mature. Grid-scale batteries are becoming increasingly common.
Expected useful life of equipment	20 years
Equipment capacities, ratings and other specifications	The Elkhorn BESS is a 182.5MW lithium-ion battery storage system.
Additional Information for locational investments	The Elkhorn BESS is located at the Moss Landing Substation in Monterey County.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROGRAM SUMMARY – IGP IT INFRASTRUCTURE

Program Title: IGP IT Infrastructure
Major Work Categories: 2F, JV
Planning Order Numbers: 5057331, 5057332, 5260114, 5057333, 5057334, 5260115, 5057335, 5057336, 5057330, 5260116, 5260117, 5779168, 5791698, 5794665, 5794666, 5779169, 5794667, 5794668, 5794669, 5794670, 5779170, 5779171, 5779172, 5794664
Program Start Date: January 2018
Program Completion Date: Ongoing
Operative Date (only applies to Capital): Operative as Installed

Program Description and Justification

The Integrated Grid Platform (IGP) IT Infrastructure program will modernize the IT communications network and computing infrastructure necessary to transmit and process data from PG&E's grid control systems and an increasing number of connected devices and sensors on the grid. This will provide a reliable, resilient foundation to support grid modernization objectives as well as the scalability necessary to enable future evolution in grid technologies and services. This program will deliver foundational capabilities that span from PG&E data centers and control centers to substations and field data collection points. It will improve situational awareness for IT teams supporting grid operations, improve the reliability of existing SCADA data collection networks, and deliver communications network capacity sufficient to enable advanced security capabilities, automation growth, and other capabilities necessary to support Distributed Energy Resources (DER). Furthermore, it will upgrade the communications networks and facilitate the installation of the new Advanced Distribution Management System (ADMS) at the three PG&E Distribution Control Centers (DCCs). PG&E will apply IT architecture best-practices utilizing standardized technologies to improve operational efficiency and reduce technical debt from legacy systems.

The IGP IT Infrastructure program is an ongoing program that will evolve over time to meet the broader needs of PG&E's Grid Modernization efforts. This program currently includes the following workstreams:

Field Area Network (FAN):

This workstream continues ongoing efforts to deploy a multi-purpose wireless FAN. The FAN is a modular, meshed communications system that provides connectivity for many PG&E field locations and devices, including distribution automation devices, DERs, and substations. Components of the FAN include wireless radio/router "nodes" that offer robust cybersecurity and the bandwidth/latency needed to support current and future distribution automation assets. These FAN radios leverage modern Internet Protocol (IP)-based technology and support the latest industry protocol standards. The wireless mesh offers higher reliability than legacy point-to-multipoint radio systems as the mesh can maintain communications during many radio failure conditions. The FAN is highly scalable and engineered to meet the growing demands of distribution automation, DER integration, and other Grid Modernization requirements. Other capabilities enabled by FAN include Fault Location Isolation and Service Restoration (FLISR), disabling of recloser functionality in High Fire Threat areas, and Microgrid communications. Enhanced communications monitoring is also an integral component of FAN, offering greatly improved troubleshooting and resilience over legacy radio communications systems.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROGRAM SUMMARY – IGP IT INFRASTRUCTURE

This workstream will install FAN gateways and mesh nodes at key locations across PG&E's service area. FAN gateways will be installed at key PG&E substations, service centers, and offices that are well-positioned to connect to PG&E field devices via the FAN mesh. These gateways connect the FAN mesh to PG&E's broader communication network and act as the points where data will pass between FAN meshes and the traditional wired Operational Data Network (ODN). FAN mesh nodes will be installed on distribution poles and transmission structures to extend the coverage of the mesh network to areas where connectivity is required. FAN mesh radios will also be installed next to field devices (e.g., switches, reclosers, capacitor banks, PG&E-owned DERs) to allow the information from these devices to be conveyed over the FAN mesh. PG&E will monitor mesh performance in the Company's 24x7 Network Operation Center. Each mesh will be capable of supporting hundreds of field devices. Over the first phase of this program (ending in 2023), PG&E plans to complete deployment of 140-160 meshes and 4,500-4,800 FAN devices. From 2024 to 2026, PG&E plans to scale the FAN by deploying an additional 2,000-3,000 FAN devices and supporting infrastructure.

The FAN workstream is a component of the "Multi-Faceted Mitigations" mitigation program for the Company's IT Asset Failure risk, which is discussed in Exhibit (PG&E-7), Chapter 8.

SCADA Network Reliability Improvements:

This workstream continues ongoing efforts to improve the reliability of PG&E's electric Supervisory Control and Data Acquisition (SCADA) network that carries data between SCADA devices and PG&E control centers. Between 2017 and 2020, PG&E experienced more than 2,300 network failures impacting electric SCADA communications for varying lengths of time. PG&E's legacy SCADA network is based on a 30+ year-old architecture that was not designed to support the increasing demand being placed on it. To enable the SCADA network reliability necessary to support grid modernization objectives, this workstream investigates SCADA performance on a device by device basis to identify components and systems contributing to the high failure rate. Based on that information, PG&E then implements improvements to SCADA designs, which include:

- Elimination of Alternating Current (AC) powered components, utilizing battery-backed Direct Current (DC) wherever feasible
- Removal of obsolete equipment such as modems and voice frequency data bridges
- Removal or replacement of high failure rate equipment and unreliable leased third-party circuits
- Installation of back-up communication paths to critical sites and devices to improve resiliency

There are many technologies that can be deployed to accomplish these goals. PG&E will deploy the most cost-effective solution that meets the site's or device's communications requirements (e.g., bandwidth, latency, jitter, etc.). Example communications migrations are:

- Migrating to private communications and radio infrastructure (such as Microwave and FAN)
- Upgrading legacy SCADA radios to next generation equipment
- Redesigning leased third-party circuits to maximize reliability and eliminate aged technologies (such as modems, AC powered equipment, copper cables and High Voltage Protection equipment)
- Migrating to IP-based lease services from third-party providers
- Adding secondary communications circuits to highly critical equipment to eliminate single points of failure for SCADA communications.

The SCADA Network Reliability workstream is a component of the "Multi-Faceted Mitigations" mitigation program for the Company's IT Asset Failure risk, which is discussed in Exhibit (PG&E-7), Chapter 8.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROGRAM SUMMARY – IGP IT INFRASTRUCTURE

Substation Converged Compute Platform:

This workstream continues ongoing efforts to modernize the computing infrastructure at electric substations. As PG&E has deployed more automation and control capabilities, IT needs at electric substations have evolved. These needs include expanded IT cybersecurity and physical security capabilities. At the core of these capabilities is foundational IT infrastructure that enables the devices in the substation to perform their functions. This infrastructure is largely made up of servers, network, and cybersecurity components. As PG&E's use of automation devices has grown, the demand for compute capabilities at remote field sites (such as substations) has increased, proliferating the deployment of individual infrastructure components to support that demand. In addition, the introduction and increased physical security monitoring at substations has also created a demand for more computing services, requiring more servers at the substations. PG&E will need to be able to cost-effectively scale the substation infrastructure to meet demand as it continues to increase, especially to enable future DER participation, visibility and control.

To accomplish this, the Substation Converged Compute Platform workstream will design a scalable, modern, "cloud-like" platform consisting of converged compute, storage, networking, and security infrastructure components needed to support the various applications and services required at the substation. PG&E will then deploy this converged infrastructure at several pilot substations. This new design will streamline the deployment of individual infrastructure components and simplify operational support requirements by leveraging modern technologies similar to those used in PG&E data centers but adapted to the unique conditions of the substations. This design will then become the standard for future deployments of computing infrastructure at PG&E substations.

Data Center & Control Center Infrastructure Preparation:

PG&E's legacy RT SCADA platform was built on a distributed set of servers that collect field and substation device data. These servers were housed at 16 locations across PG&E territory. The new ADMS platform, which replaces RT SCADA, uses a centralized architecture and is co-located across PG&E's three DCCs for performance and resiliency purposes. To provided adequate capacity and reliability for a centralized ADMS, this workstream continues efforts to enhance the communications networks at the three DCCs to support an expanded IT footprint; installs capacity on existing fiber optic circuits between the DCCs, PG&E data centers, and key substations to support increased data traffic; and provides alternate communications routes to improve resiliency and reduce down-time resulting from potential network asset failures. The Data Center & Control Center Infrastructure Preparation workstream is a component of the "Multi-Faceted Mitigations" mitigation program for the Company's IT Asset Failure risk, which is discussed in Exhibit (PG&E-7), Chapter 8.

Cost

PG&E used the IT Project/Program Estimating Tool (PET) to document estimate assumptions and generate labor and non-labor cost forecasts for this program. To calculate labor costs, the PET captures labor hours by activity and resource type, multiplies that by standard labor rates, and adds standard overhead factors. To calculate non-labor costs, the PET captures contract costs by type (such as software licenses or third-party services), material costs by unit quantity and unit price, and standard overheads such as materials burden and AFUDC. Other factors, such as escalation and capital/expense ratios, are calculated based on standard rates and accounting guidance. See Exhibit (PG&E-7), Chapter 8 for additional information regarding the PET. PG&E can provide the specific PET outputs produced for this program upon request.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROGRAM SUMMARY – IGP IT INFRASTRUCTURE

Program Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE (MWC JV)													
FAN	$0	$0	$121	$156	$241	$400	$1,000	$1,000	$850	$900	$900	$5,569	
SCADA Network Reliability Improv.	$0	$0	$211	$46	$437	$340	$900	$900	$700	$750	$800	$5,084	
Substation Conv. Compute Platform	$0	$0	$0	$0	$0	$160	$400	$400	$350	$350	$0	$1,660	
Data Ctr./Ctrl. Ctr. Infra.	$0	$0	$246	$58	$61	$230	$0	$0	$0	$0	$0	$595	
Expense Total	**$0**	**$0**	**$578**	**$261**	**$739**	**$1,130**	**$2,300**	**$2,300**	**$1,900**	**$2,000**	**$1,700**	**$12,907**	
CAPITAL (MWC 2F)													
FAN	$0	$0	$5,586	$9,371	$12,183	$8,340	$8,340	$8,340	$8,600	$8,900	$9,100	$78,760	
SCADA Network Reliability Improv.	$0	$0	$3,220	$4,098	$9,367	$7,250	$7,250	$7,250	$7,500	$7,700	$7,900	$61,535	
Substation Conv. Compute Platform	$0	$0	$0	$0	$0	$600	$1,310	$1,310	$1,100	$1,100	$0	$5,420	
Data Ctr./Ctrl. Ctr. Infra.	$0	$0	$824	$361	$2,443	$2,300	$0	$0	$0	$0	$0	$5,928	
Capital Total	**$0**	**$0**	**$9,630**	**$13,829**	**$23,993**	**$18,490**	**$16,900**	**$16,900**	**$17,200**	**$17,700**	**$17,000**	**$151,642**	

Benefits

Benefit Areas	Program Benefits
Reliability	The FAN workstream provides high bandwidth, and highly resilient connections to field devices on poles and other structures where other communications technologies are not viable. The SCADA Network Reliability Improvements workstream ensures that connections from substations and field sites to back-end servers have back-up communication channels (where deemed necessary), back-up power systems, and monitoring of all communications infrastructure. At PG&E control centers, resiliency improvements help ensure high availability of SCADA servers, network equipment, and power systems that support control center operations.
Operational Efficiency	Improved resiliency in SCADA communications naturally leads to improved operational efficiency by ensuring that SCADA communication to field devices is delivered more reliably and consistently. This improved communications reliability ensures that the electric system is reconfigured more reliably by FLISR schemes during outages, reducing customer down time and manual dispatch of technicians. Standardizing computing infrastructure at substations using a converged infrastructure architecture also makes adding capacity more efficient and simplifies maintenance.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 21, INTEGRATED GRID PLATFORM AND GRID MODERNIZATION PLAN
PROGRAM SUMMARY – IGP IT INFRASTRUCTURE

Grid Modernization Supplemental Questions

Attribution to DER integration vs safety and reliability	The infrastructure investments are foundational in nature, and as such, they both support the safe and reliable operations of the distribution grid and provide capabilities necessary to enable DER integration when needed.
What DERs does the proposed technology integrate	The proposed infrastructure has the capability to support DERs that require SCADA controls and telemetry. Infrastructure for smaller DERs will be informed by TD&D, including EPIC Project 2.26, EPIC Project 2.03A, EPIC Project 2.02 DERMS and Rule 21 OIR. PG&E is also evaluating the communication infrastructure used by DER aggregators for secure and reliable integration into PG&E's grid operations.
Integration Challenges the technology supports	This investment supports improving DER visibility and control.
Grid services the technology enables	N/A
Maturity of the proposed technology	PG&E's communication infrastructure primarily uses IP-based and Radio Frequency (RF)-based technologies that support the latest industry standards. These technologies are mature and widely used in the telecommunications industry. PG&E's computing infrastructure also leverages standard technology that is widely used in the IT industry. PG&E continues to evaluate and incorporate industry best practices wherever feasible.
Expected useful life of equipment	1. Communications Networks: 5-20 years depending on type of equipment 2. Servers: 5 years
Equipment capacities, ratings and other specifications	The FAN can support: • > 50,000 devices via modular scalability • < 50 ms field device to field device • < 100 ms field device to control center • > 1 Mbps bandwidth to a field device • > 3 Mbps bandwidth to substation/powerhouse Next generation SCADA network radios can support: • 15-60 Kbps throughput with adaptive modulation • 256-bit encryption and certificate management • Over the Air Programming (OTAP)

	• IP functionality (virtual ports and VLAN operation) • Integration with contemporary network element managers (for remote monitoring and management) via SNMP • RADIUS and TACACS+ user authentication Capacities, ratings, and specifications for supporting network infrastructure vary by location and equipment type. Network equipment is selected to meet location-specific requirements.
Additional Information for locational investments	Telecommunication infrastructure is prioritized based on ongoing evaluation of network coverage, network reliability metrics, and coordinated planning with asset deployment programs. The type of technology deployed often depends on geographic terrain, third-party wireless network coverage, and the local availability of other third-party network services.

Alternatives Considered

PG&E considers a variety of well-suited and supported communications technologies to provide the required communications services from the SCADA field devices and substations back to the centrally located head-end applications. PG&E typically selects and deploys the most cost-effective communications technology that meets the communications requirements of the device. PG&E uses a combination of both PG&E-owned network assets and leased third-party services and evaluates alternatives on a site-by site basis. Some key alternatives include:

1. Installation of private, PG&E-owned, microwave or fiber optic communications
2. Installation of private, PG&E-owned radio systems (FAN or point-to-multipoint radio systems)
3. Installation of leased, third-party-owned IP communications services (telephone or cable company land-line services)
4. Installation of leased, third-party-owned satellite communications
5. Installation of leased, third-party-owned cellular communications

It is the deployment of this blend of technologies that provides added resiliency to the system when applied correctly. Within the same geography, these choices allow for diverse modalities (e.g., radio frequency and land lines), vendors, and costs. In remote areas of PG&E's service territory, choices can be limited, and PG&E typically applies the most reliable communications technology option available.

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
Index Template

Testimony ___ Workpapers _X_ SOQ ___

Exhibit Number: _4_ Chapter Number: _21_

Chapter Title: Integrated Grid Platform and Grid Modernization Plan_

Witness Name: Quinn Nakayama_

Page No.	Line No.	Item	As Filed	As Corrected
Errata as of November 5, 2021				
WP 21-22	N/A	Key ADMS Program Activities and Milestones, Year 2022	• Testing of ADMS Release 1 will conclude.	• Software Testing of ADMS Release 1 will conclude.
WP 21-39	N/A	Additional Cost Information	PG&E used the IT Project/Program Estimating Tool (PET) to document estimate assumptions and generate labor and non-labor cost forecasts for non-DRP-related planning tool development work.	PG&E used the IT Project/Program Estimating Tool (PET) to document estimate assumptions and generate labor and non-labor cost forecasts for most aspects of the non-DRP-related planning tool development work, although a subcomponent of the forecast related to the Distribution Line Settings project was created using a Job Estimate.

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES

TABLE OF CONTENTS

Subject	Page No.
Expense Workpapers	
Workpaper Table 22-1: Expenses by Major Work Category - Nominal Dollars	WP 22-1
Workpaper Table 22-2: Expenses by Major Work Category - Base Year Dollars	WP 22-2
Workpaper Table 22-3: Major Work Category AB - Recorded Walk	WP 22-3
Workpaper Table 22-4: Major Work Category AB - Forecast Walk	WP 22-4
Workpaper Table 22-5: Major Work Category IS - Recorded Walk	WP 22-5
Workpaper Table 22-6: Major Work Category IS - Forecast Walk	WP 22-6
Workpaper Table 22-7: Major Work Category OM - Recorded Walk	WP 22-7
Workpaper Table 22-8: Major Work Category OM - Forecast Walk	WP 22-8
Workpaper Table 22-9: Major Work Category OS - Recorded Walk	WP 22-9
Workpaper Table 22-10: Major Work Category OS - Forecast Walk	WP 22-10
Workpaper Table 22-11: Expense Summary by Category	WP 22-11
Workpaper Table 22-12: MWC AB Forecast Details	WP 22-12
Workpaper Table 22-13: MWC OM/OS Forecast Details	WP 22-13
Workpaper Table 22-14: MWC OM/OS 2020 FRMMA Allocation Detail	WP 22-14

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES

TABLE OF CONTENTS
(CONTINUED)

Subject	Page No.
Capital Workpapers	
Workpaper Table 22-15: Capital Expenditures by Major Work Category	WP 22-15
Workpaper Table 22-16: Forecast Capital Expenditures Summary	WP 22-16
Workpaper Table 22-17: Recorded CWIP and Forecast Capital Expenditures Details - Planning Orders Over $3 Million	WP 22-17
Workpaper Table 22-18: Recorded and Forecast Capital Expenditures Details - Other Work	WP 22-18
Workpaper Table 22-19: Major Work Category 05 - Recorded Walk	WP 22-19
Workpaper Table 22-20: Major Work Category 05 - Forecast Walk	WP 22-20
Workpaper Table 22-21: Major Work Category 21 - Forecast Walk	WP 22-21
Workpaper Table 22-22: Capital Summary by Category	WP 22-22
Project Summary – Applied Technology Services (ATS) Lab Safety and Reliability Upgrades	WP 22-23
Project Summary - Applied Technology Services (ATS) Capital Lab Project	WP 22-26
Project Summary - Federal Land Authorization	WP 22-29
Project Summary - Regulatory Compliance and Quality Assurance	WP 22-31

Workpaper Table 22-1
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 22
Electric Distribution Support Activities
Expenses by Major Work Category
(Thousands of Nominal Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference (A)
1	AB	Misc Expense	20,000	13,429	19,118	16,151	47,137	6,365	9,155	49,510	WP 22-3, WP 22-4
2	IS	Streetlight Support		1,056	853	165	709	862	864	1,641	WP 22-5, WP 22-6
3	OM	Operational Management	17,068	18,408	5,274	12,407	(4,204)	14,401	14,422	19,513	WP 22-7, WP 22-8
4	OS	Operational Support	11,695	(212)	20,345	7,571	55,555	45,894	45,961	60,931	WP 22-9, WP 22-10
5	**Total**		**48,763**	**32,681**	**45,591**	**36,294**	**99,196**	**67,522**	**70,401**	**131,594**	

Workpaper Table 22-2
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 22
Electric Distribution Support Activities
Expenses by Major Work Category
(Thousands of Base Year Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast
1	AB	Misc Expense	21,160	14,075	19,487	15,600	47,137	6,380	8,930	47,339
2	IS	Streetlight Support		1,106	859	163	709	868	847	1,572
3	OM	Operational Management	18,856	19,922	5,292	12,552	(4,204)	14,064	13,645	17,871
4	OS	Operational Support	12,108	(1,144)	20,593	7,201	55,555	44,798	43,443	55,741
5	**Total**		**52,124**	**33,959**	**46,231**	**35,515**	**99,196**	**66,110**	**66,865**	**122,523**

Workpaper Table 22-3
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #22, Electric Distribution Support Activities
Major Work Category AB - Recorded Walk
MWC AB - Misc Expense
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded/Adjusted**	**$20,000**			
2		Distribution Support	($6,265)		Decrease mainly due to completion of Pole Loading Recalculations, reduction in Engineering Rotational Development Program, and reduction in Contract/Consulting spend.	WP 22-11 Line 1
3		ATS	($101)		Minor variation consistent with recorded historical.	WP 22-11 Line 2
4		Interdepartmental Energy Usage	($126)		Minor variation consistent with recorded historical.	WP 22-11 Line 6
5		Public Awareness Outreach	($79)		Minor variation consistent with recorded historical.	WP 22-11 Line 8
6		**Net Change**	**($6,571)**			
7	**2017**	**Recorded/Adjusted**	**$13,429**			
8		Distribution Support	$5,684		Increase in headcount to support Affordability.	WP 22-11 Line 1
9		ATS	($107)		Minor variation consistent with recorded historical.	WP 22-11 Line 2
10		Interdepartment Energy Usage	$113		Minor variation consistent with recorded historical.	WP 22-11 Line 6
11		Public Awareness Outreach	($1)		Minor variation consistent with recorded historical.	WP 22-11 Line 8
12		**Net Change**	**$5,689**			
13	**2018**	**Recorded/Adjusted**	**$19,118**			
14		Distribution Support	($4,381)		Decrease in headcount to support Affordability.	WP 22-11 Line 1
15		ATS	($3)		Minor variation consistent with recorded historical.	WP 22-11 Line 2
16		Federal Land Authorization	$1,292		Execution of final Operations and Maintenance Plan and 21 consolidated Master permits and Easements.	WP 22-11 Line 5
17		Interdepartmental Energy Usage	($455)		Minor variation consistent with recorded historical.	WP 22-11 Line 6
18		Regulatory Compliance and Quality Assurance	$515		Minor variation consistent with recorded historical.	WP 22-11 Line 7
19		Public Awareness Outreach	$66		Minor variation consistent with recorded historical.	WP 22-11 Line 8
20		**Net Change**	**($2,967)**			
21	**2019**	**Recorded/Adjusted**	**$16,151**			
22		Distribution Support	$17,240		Increase in contract/consulting,	WP 22-11 Line 1
23		ATS	$2,545		Special projects related to wildfire risk and mitigation/system hardening, higher levels of new/failed product testing and calibration of measuring and test equipment, lab maintenance.	WP 22-11 Line 2
24		Federal Land Authorization	$3,531		Executed work as part of the Operations and Maintenance Plan	WP 22-11 Line 5
25		Interdepartmental Energy Usage	$261		Minor variation consistent with recorded historical.	WP 22-11 Line 6
26		Regulatory Compliance and Quality Assurance	$7,221		Initial formation of group.	WP 22-11 Line 7
27		Public Awareness Outreach	$188		Minor variation consistent with recorded historical.	WP 22-11 Line 8
28		**Net Change**	**$30,985**			
29	**2020**	**Recorded/Adjusted**	**$47,137**			

[1] All Standard Rate Standard Cost Variance aligns with MWC AB in current cost model.
[2] Standard Cost Variance is "underclear" if standard rates are set in a way which results in Costs Out less than Costs In.
[3] Standard Cost Variance is "overclear" if standard rates are set in a way which results in Costs Out greater than Costs In.

Workpaper Table 22-4
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #22, Electric Distribution Support Activities
Major Work Category AB - Forecast Walk
MWC AB - Misc Expense
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded**	**$47,137**			
2		Distribution Support	($3,411)		Reduction in contracts/consulting.	WP 22-11 Line 1
3		ATS	($1,207)		Fewer special projects.	WP 22-11 Line 2
4		Federal Land Authorization	($475)		Minor variation consistent with recorded historical.	WP 22-11 Line 5
5		Interdepartmental Energy Usage	($2)		Minor variation consistent with recorded historical.	WP 22-11 Line 6
6		Regulatory Compliance and Quality Assurance	$8,370		Expansion of group/roles	WP 22-11 Line 7
7		Public Awareness Outreach	$167		Minor variation consistent with recorded historical.	WP 22-11 Line 8
8		Affordability	($44,214)		Affordability consists of known and unknown cost savings opportunities across the Electric Distribution portfolio. For 2023, cost savings opportunities have been embedded into the individual MWC forecasts.	WP 22-11 Line 9
9		**Net Change**	**($40,772)**			
10	**2021**	**Forecast**	**$6,365**			
11		Distribution Support	($5,830)		Reduction in cancelled orders forecast	WP 22-11 Line 1
12		ATS	$98		No significant change.	WP 22-11 Line 2
13		Additional Asset Data Capture	$1,269		Additional costs for risk mitigation program. Mitigation activities to update improve EO risk models.	WP 22-11 Line 3
14		Improved Distribution Risk Model	$1,473		Additional costs for risk mitigation program. Mitigation activities to update improve EO risk models.	WP 22-11 Line 4
15		Federal Land Authorization	($174)		No significant change.	WP 22-11 Line 5
16		Interdepartmental Energy Usage	$83		No significant change.	WP 22-11 Line 6
17		Regulatory Compliance and Quality Assurance	$493		No significant change.	WP 22-11 Line 7
18		Public Awareness Outreach	$17		No significant change.	WP 22-11 Line 8
19		Affordability	$5,361		Affordability consists of known and unknown cost savings opportunities across the Electric Distribution portfolio. For 2023, cost savings opportunities have been embedded into the individual MWC forecasts.	WP 22-11 Line 9
20		**Net Change**	**$2,790**			
21	**2022**	**Forecast**	**$9,155**			
22		Distribution Support	$1,436		Increase in contracts/consulting.	WP 22-11 Line 1
23		ATS	$92		No significant change.	WP 22-11 Line 2
24		Additional Asset Data Capture	$27		No significant change.	WP 22-11 Line 3
25		Improved Distribution Risk Model	$40		No significant change.	WP 22-11 Line 4
26		Federal Land Authorization	($720)		No significant change.	WP 22-11 Line 5
27		Interdepartmental Energy Usage	$87		No significant change.	WP 22-11 Line 6
28		Regulatory Compliance and Quality Assurance	$520		No significant change.	WP 22-11 Line 7
29		Public Awareness Outreach	$18		No significant change.	WP 22-11 Line 8
30		Affordability	$38,853		Affordability consists of known and unknown cost savings opportunities across the Electric Distribution portfolio. For 2023, cost savings opportunities have been embedded into the individual MWC forecasts.	WP 22-11 Line 9
31		**Net Change**	**$40,355**			
32	**2023**	**Forecast**	**$49,510**			

[1] All Standard Rate Standard Cost Variance aligns with MWC AB in current cost model. "Overclear" if standard rates are set in a way which results in Costs Out greater than Costs In.

Workpaper Table 22-5
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #22, Electric Distribution Support Activities
Major Work Category IS - Recorded Walk
MWC IS - Streetlights[1]
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded**	**$0**			
2		Streetlights	$1,056		Increased costs for consulting services.	WP 22-11 Line 11
3		**Net Change**	**$1,056**			
4	**2017**	**Recorded**	**$1,056**			
5		Streetlights	($203)		Slight reduction in work compared to previous year.	WP 22-11 Line 11
6		**Net Change**	**($203)**			
7	**2018**	**Recorded**	**$853**			
8		Streetlights	($689)		Slowed the pace of audits.	WP 22-11 Line 11
9		**Net Change**				
10	**2019**	**Recorded**	**$165**			
11		Streetlights	$544		Initiated large areas of work.	WP 22-11 Line 11
12		**Net Change**				
13	**2020**	**Recorded Adjusted**	**$709**			

Workpaper Table 22-6
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #22, Electric Distribution Support Activities
Major Work Category IS - Forecast Walk
MWC IS - Streetlights[1]
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded**	**$709**			
2		Streetlights	$154		Initiated additional areas of work.	WP 22-11 Line 11
3		**Net Change**	**$154**			
4	**2021**	**Forecast**	**$862**			
5		Streetlights	$1		No significant change	WP 22-11 Line 11
6		**Net Change**	**$1**			
7	**2022**	**Forecast**	**$864**			
8		Streetlights	$777		Work may include high population areas.	WP 22-11 Line 11
9		**Net Change**	**$777**			
10	**2023**	**Forecast**	**$1,641**			

Workpaper Table 22-7
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #22, Electric Distribution Support Activities
Major Work Category OM - Recorded Walk
MWC OM - Operational Management
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded/Adjusted**	**$17,068**			
2		Overhead Allocation (OM)[1]	($1,997)		Overall credit larger based on outcome of OM/OS study.	WP 22-11 Line 12
3		Operational Management (OM) PCC Costs[2]	$3,337		Driven by shift of FTEs between Type D (OM) and Type G (OS) cost centers.	WP 22-11 Line 13
4		**Net Change**	**$1,340**			
5	**2017**	**Recorded/Adjusted**	**$18,408**			
6		Overhead Allocation (OM)[1]	$6,011		Credit lower as result of lower PCC costs.	WP 22-11 Line 12
7		Operational Management (OM) PCC Costs[2]	($19,145)		Driven by PCC consolidation and lower resulting headcount in Type D (OM) cost centers.	WP 22-11 Line 13
8		**Net Change**	**($13,134)**			
9	**2018**	**Recorded/Adjusted**	**$5,274**			
10		Overhead Allocation (OM)[1]	$9,821		Driven by shift of applied credit between OM/OS.	WP 22-11 Line 12
11		Operational Management (OM) PCC Costs[2]	($2,688)		Driven by shift of FTEs between Type D (OM) and Type G (OS) cost centers.	WP 22-11 Line 13
12		**Net Change**	**$7,133**			
13	**2019**	**Recorded/Adjusted**	**$12,407**			
14		Overhead Allocation (OM)[1]	($21,707)		Driven by shift of applied credit between OM/OS.	WP 22-11 Line 12
15		Operational Management (OM) PCC Costs[2]	$5,096		Driven by escalation, headcount growth associated with wildfire response and mitigation work, and result of OM/OS study.	WP 22-11 Line 13
16		**Net Change**	**($16,611)**			
17	**2020**	**Recorded/Adjusted**	**($4,204)**			

[1] Overhead Allocation represents the portion of total OM/OS Expense costs applied to Non-Expense (Capital and Balancing Account) orders in each month. It is applied as an overhead on internal labor charges in these orders.
[2] Operational Management and Support PCC Costs represents the gross cost to supervise, support or manage PG&E personnel who charge their time directly to orders. Costs include salary and employee related costs for leadership and support staff in the management and support provider cost centers (PCC's).

Workpaper Table 22-8
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #22, Electric Distribution Support Activities
Major Work Category OM - Forecast Walk
MWC OM - Operational Management
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded**	**($4,204)**			
2		Overhead Allocation (OM)[1]	$16,137		Credit lower as result of lower overall Distribution PCC costs.	WP 22-11 Line 12
3		Operational Management (OM) PCC Costs[2]	$2,468		Driven by labor escalation and updated OM/OS study (Distribution vs Tranmission factors).	WP 22-11 Line 13
4		**Net Change**	**$18,605**			
5	**2021**	**Forecast**	**$14,401**			
6		Overhead Allocation (OM)[1]	($38)		No significant change.	WP 22-11 Line 12
7		Operational Management (OM) PCC Costs[2]	$59		No significant change.	WP 22-11 Line 13
8		**Net Change**	**$21**			
9	**2022**	**Forecast**	**$14,422**			
10		Overhead Allocation (OM)[1]	$2,000		Reduced credit due to end of FRMMA; offset by esclation.	WP 22-11 Line 12
11		Operational Management (OM) PCC Costs[2]	$3,090		Driven by escalation only and changes to recording of Officer Compensation.	WP 22-11 Line 13
12		**Net Change**	**$5,091**			
13	**2023**	**Forecast**	**$19,513**			

[1] Overhead Allocation represents the portion of total OM/OS Expense costs applied to Non-Expense (Capital and Balancing Account) orders in each month. It is applied as an overhead on internal labor charges in these orders.
[2] Operational Management and Support PCC Costs represents the gross cost to supervise, support or manage PG&E personnel who charge their time directly to orders. Costs include salary and employee related costs for leadership and support staff in the management and support provider cost centers (PCC's).

Workpaper Table 22-9
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #22, Electric Distribution Support Activities
Major Work Category OS - Recorded Walk
MWC OS - Operational Support
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded/Adjusted**	**$11,695**			
2		Overhead Allocation (OS)[1]	($6,618)		Overall credit larger based on target of OM/OS study.	WP 22-11 Line 15
3		Operational Support (OS) PCC Costs[2]	($5,289)		Driven by shift of FTEs between Type D (OM) and Type G (OS) cost centers.	WP 22-11 Line 16
4		**Net Change**	**($11,907)**			
5	**2017**	**Recorded/Adjusted**	**($212)**			
6		Overhead Allocation (OS)[1]	($1,664)		Credit larger as result of higher PCC costs.	WP 22-11 Line 15
7		Operational Support (OS) PCC Costs[2]	$22,222		Driven by escalation, heacount growth and result of OM/OS study.	WP 22-11 Line 16
8		**Net Change**	**$20,557**			
9	**2018**	**Recorded/Adjusted**	**$20,345**			
10		Overhead Allocation (OS)[1]	**($26,274)**		Overall credit larger based on outcome of OM/OS study, shift of applied credit between OM/OS.	WP 22-11 Line 15
11		Operational Support (OS) PCC Costs[2]	**$13,499**		Driven by escalation, headcount growth associated with wildfire response and mitigation work, and result of OM/OS study.	WP 22-11 Line 16
12		**Net Change**	**($12,775)**			
13	**2019**	**Recorded/Adjusted**	**$7,571**			
14		Overhead Allocation (OS)[1]	$14,554		Driven by shift of applied credit between OM/OS.	WP 22-11 Line 15
15		Operational Support (OS) PCC Costs[2]	$33,430		Driven by escalation, headcount growth associated with wildfire response and mitigation work, and result of OM/OS study.	WP 22-11 Line 16
16		**Net Change**	**$47,984**			
17	**2020**	**Recorded/Adjusted**	**$55,555**			

[1] Overhead Allocation represents the portion of total OM/OS Expense costs applied to Non-Expense (Capital and Balancing Account) orders in each month. It is applied as an overhead on internal labor charges in these orders.
[2] Operational Management and Support PCC Costs represents the gross cost to supervise, support or manage PG&E personnel who charge their time directly to orders. Costs include salary and employee related costs for leadership and support staff in the management and support provider cost centers (PCC's).

Workpaper Table 22-10
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #22, Electric Distribution Support Activities
Major Work Category OS - Forecast Walk
MWC OS - Operational Support
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded**	**$55,555**			
2		Overhead Allocation (OS)[1]	$42,308		Credit lower as result of lower overall Distribution PCC costs.	WP 22-11 Line 15
3		Operational Support (OS) PCC Costs[2]	($51,969)		Driven by updated Distribution versus Transmission factors as result of 2021 OM/OS study (net shift to TO rate case).	WP 22-11 Line 16
4		**Net Change**	**($9,661)**			
5	**2021**	**Forecast**	**$45,894**			
6		Overhead Allocation (OS)	($129)		No significant change.	WP 22-11 Line 15
7		Operational Support (OS) PCC Costs	$196		No significant change.	WP 22-11 Line 16
8		**Net Change**	**$67**			
9	**2022**	**Forecast**	**$45,961**			
10		Overhead Allocation (OS)	$6,740		Reduced credit due to end of FRMMA; offset by esclation.	WP 22-11 Line 15
11		Operational Support (OS) PCC Costs	$8,230		Driven by escalation only.	WP 22-11 Line 16
12		**Net Change**	**$14,970**			
13	**2023**	**Forecast**	**$60,931**			

[1] Overhead Allocation represents the portion of total OM/OS Expense costs applied to Non-Expense (Capital and Balancing Account) orders in each month. It is applied as an overhead on internal labor charges in these orders.
[2] Operational Management and Support PCC Costs represents the gross cost to supervise, support or manage PG&E personnel who charge their time directly to orders. Costs include salary and employee related costs for leadership and support staff in the management and support provider cost centers (PCC's).

Workpaper Table 22-11
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 22, Electric Distribution Support Activities
Expense Summary by Category
(Thousands of Nominal Dollars)

Line No.		2016 Actual	2017 Actual	2018 Actual	2019 Actual	2020 Actual	2021 Forecast	2022 Forecast	2023 Forecast	Notes	Reference
1	Distribution Support	$ 14,793	$ 8,528	$ 14,212	$ 9,831	$ 27,071	$ 23,660	$ 17,830	$ 19,266		WP 22-12
2	ATS	$ 2,072	$ 1,971	$ 1,865	$ 1,862	$ 4,406	$ 3,199	$ 3,297	$ 3,389	(1)	WP 22-12
3	Additional Asset Data Capture	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,269	$ 1,297	(2)	WP 3-27
4	Improved Distribution Risk Model	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,473	$ 1,513	(3)	WP 3-28
5	Federal Land Authorization	$ -	$ -	$ -	$ 1,292	$ 4,823	$ 4,348	$ 4,174	$ 3,454		WP 22-28
6	Interdepartmental Energy Usage	$ 2,910	$ 2,784	$ 2,896	$ 2,441	$ 2,702	$ 2,700	$ 2,783	$ 2,870	(4)	
7	Regulatory Compliance and Quality Assurance	$ -	$ -	$ -	$ 515	$ 7,736	$ 16,106	$ 16,599	$ 17,119		WP 22-30
8	Public Awareness Outreach	$ 225	$ 146	$ 145	$ 211	$ 399	$ 566	$ 583	$ 602	(5)	
9	Affordability	$ -	$ -	$ -	$ -	$ -	$ (44,214)	$ (38,853)	$ -	(6)	
10	**MWC AB Total**	**$ 20,000**	**$ 13,429**	**$ 19,118**	**$ 16,151**	**$ 47,137**	**$ 6,365**	**$ 9,155**	**$ 49,510**		
11	**Streetlights (MWC IS) Total**	**$ -**	**$ 1,056**	**$ 853**	**$ 165**	**$ 709**	**$ 862**	**$ 864**	**$ 1,641**	(7)	
12	Overhead Allocation (OM)	$ (34,414)	$ (36,411)	$ (30,400)	$ (20,579)	$ (42,286)	$ (26,149)	$ (26,187)	$ (24,187)	(8)	WP 22-13
13	Operational Management (OM) PCC Costs	$ 51,482	$ 54,819	$ 35,674	$ 32,986	$ 38,082	$ 40,550	$ 40,609	$ 43,699	(9)	WP 22-13
14	**MWC OM Total**	**$ 17,068**	**$ 18,408**	**$ 5,274**	**$ 12,407**	**$ (4,204)**	**$ 14,401**	**$ 14,422**	**$ 19,513**		
15	Overhead Allocation (OS)	$ (110,571)	$ (117,189)	$ (118,853)	$ (145,126)	$ (130,573)	$ (88,265)	$ (88,393)	$ (81,653)	(8)	WP 22-13
16	Operational Support (OS) PCC Costs	$ 122,265	$ 116,977	$ 139,198	$ 152,697	$ 186,127	$ 134,158	$ 134,354	$ 142,584	(9)	WP 22-13
17	**MWC OS Total**	**$ 11,695**	**$ (212)**	**$ 20,345**	**$ 7,571**	**$ 55,555**	**$ 45,894**	**$ 45,961**	**$ 60,931**		
18	**Expense Total**	**$ 48,763**	**$ 32,681**	**$ 45,591**	**$ 36,294**	**$ 99,196**	**$ 67,522**	**$ 70,401**	**$ 131,594**		

Notes

(1) ATS costs include the Electric & Magnetic Field (EMF) Program and ATS Distribution Support (i.e. Dielectric Truck Testing, Instrument Calibration and Repair, and Failure Analysis and Incident Investigation). Forecast based on multi-year historical demand and expected future needs.
(2) This is a new program in 2022.
(3) This is a new program in 2022.
(4) Interdepartmental Energy Usage costs is the cost of electricity (or natural gas) used at various PG&E facilities. Forecast based on historical levels of spend.
(5) Public Awareness Outeach Program started in 2016 and includes costs associated with public outreach and messaging to mitigate the Distribution Overhead Conductor Primary risk.
(6) Affordability consists of known and unknown cost savings opportunities across the Electric Distribution portfolio. For 2023, cost savings opportunities have been embedded into the individual MWC forecasts.
(7) MWC IS - Streetlight Support (costs associated with billing for streetlights, including field inventory audits and streetlight ownership verification) higher forecast due to the increase in those areas that have had substantial growth and where past inventories have not been completed
(8) "Overhead Allocation" represents the portion of total OM/OS Expense costs applied to Non-Expense (Capital and Balancing Account) orders in each month. It is applied as an overhead on internal labor charges in these orders. Forecast for Operational Management (OM) and Operational Support (OS) overhead allocation to non-expense orders is based on 2021 plan, plus escalation for 2022 and 2023, and adjusted for change in allocation of operations management and support costs to FRMMA effective 2023.
(9) "Operational Management and Support PCC Costs" represents the gross cost to supervise, support or manage PG&E personnel who charge their time directly to orders. Costs include salary and employee related costs for leadership and support staff in the management and support provider cost centers (PCC's). Forecast for Operational Management (OM) and Operational Support (OS) PCC forecast is based on 2021 plan, plus escalation for 2022 and 2023 and adjusted for changes in recording certain Officer Compensation.

Workpaper Table 22-12
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 22, Electric Distribution Support Activities
MWC AB Forecast Details
(Thousands of Nominal Dollars)

Line No.		2016 Recorded	2017 Recorded	2018 Recorded	2019 Recorded	2020 Recorded	2021 Forecast	2022 Forecast	2023 Forecast	Assumptions
1	**MWC AB - Distribution Support**									
2	FAA Compliance	$ 1,350	$ 1,264	$ 66	$ -	$ -	$ 1,029	$ -	$ -	(1)
3	Industry Dues & Easement Costs	$ 783	$ 785	$ 852	$ 757	$ 1,020	$ 835	$ 859	$ 885	(2)
4	Misc Recurring	$ 7,231	$ 3,674	$ 4,273	$ 197	$ 9,805	$ 11,554	$ 8,438	$ 7,908	(3)
5	Misc. Contract & Consulting	$ 9,230	$ 4,480	$ 7,410	$ 7,965	$ 17,390	$ 10,270	$ 8,532	$ 10,473	(4)
6	Standard Cost Variance	$ (3,802)	$ (1,675)	$ 1,610	$ 912	$ (1,144)	$ (28)			(5)
7	**Total Distribution Support**	**$ 14,793**	**$ 8,528**	**$ 14,212**	**$ 9,831**	**$ 27,071**	**$ 23,660**	**$ 17,830**	**$ 19,266**	
8	**MWC AB - ATS**									
9	ATS Support	$ 1,199	$ 1,334	$ 1,183	$ 1,582	$ 4,154	$ 2,521	$ 2,598	$ 2,671	(6)
10	ATS EMF Program	$ 849	$ 637	$ 682	$ 280	$ 253	$ 678	$ 699	$ 719	(7)
11	ATS Climate Change Study	$ 24	$ -	$ -	$ -	$ -	$ -			(8)
12	**Total ATS**	**$ 2,072**	**$ 1,971**	**$ 1,865**	**$ 1,862**	**$ 4,406**	**$ 3,199**	**$ 3,297**	**$ 3,389**	

Forecast Assumptions and Details

(1) Work represents the Federal Authorization Adminstration (FAA) filings needed for poles/towers. For 2019 - 2020, these costs will be included in the construction programs.

(2) PG&E is a member of Edison Electric Institute (EEI) which is an association of U.S. shareholder owned electric companies and provides industry data, strategic business intelligence, conferences and forums, and other products and services.

(3) Forecast based on historical spend.

(4) Forecast based on expected contract & consulting costs.

(5) Standard Rate Standard Cost Variance is not forecasted as rates will be adjusted throughout the year to minimize impact.

(6) ATS Support Services for Electric Distribution ensure compliance with regulations and the safe and reliable operation of PG&E's assets. The types of services include Dielectric Truck Testing, Instrument Calibration and Repair, and Failure Analysis and Incident Investigations. The ATS Support Services forecast based on multi-year historical demand, as well as forecasted growth in mission-critical support activities for wildfire, Measuring and Test Equipment and lab maintenance.

(7) The Electric Magnetic Field (EMF) Program addresses customer and employee concerns about EMF as directed by the CPUC. Cost forecast is based on historical spending for labor, contract and materials in support of the EMF program including the cost of the Electric Power Research Institute's (EPRI) EMF Research Program. PG&E did not participate with the EPRI programs in 2019 and 2020 but will resume participation in 2021.

(8) The ATS Climate Change program is responsible for investigating potential climate change risks to PG&E systems and infrastructure and to consult with responsible operating departments to begin developing specific plans to adapt to and mitigate climate change risks as appropriate. In 2017, responsibility for the Climate Change program was transferred to the Corporate Sustainability department.

Workpaper Table 22-13
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 22, Electric Distribution Support Activities
MWC OM/OS Forecast Details
(Thousands of Nominal Dollars)

Summary: MWCs OM and OS - Operational Management and Support forecasts are based on 2021 budget, adjusted for escalation, changes to recording of certain Officer Compensation and incorporation of FRMMA-related management and support costs into the 2023 GRC.

Line	MWC	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast
1	OM/OS - Operational Management and Support	$ 51,351	$ 60,295	$ 60,383	$ 80,443

2021 Forecast Detail

	Description	Value	Note
3	Gross PCC budget (salary and employee related costs) for OM/OS PCC's ["Debit"]	$ 272,701	(1)
4	OM/OS employees (annual full time equivalent)	1693	(2)
5	Overhead allocation to Capital & Balancing Accounts ["Credit"]	$ (186,430)	(3),(6)
6	Net Expense	$ 86,271	Line 3 + Line 5
7	Expense %	31.64%	Line 6 / Line 3
8			
9	Electric Tranmission portion	$ 25,976	(4)
10	Electric Distribution %	69.89%	1 - (Line 9 / Line 6)
11	**Net OM/OS expense budget for ED**	**$ 60,295**	Line 6 - Line 9

2021 to 2023 Forecast Walk

	Description	2021	2022	2023	Note
13	**Base OM/OS expense budget for ED**	**$ 60,295**	**$ 60,295**	**$ 60,295**	
14	Changes to recording of Officer Compensation consistent with SB 901	-	-	$ 567	(5)
15	FRMMA-related management and support costs (non-GRC 2021-2022)	-	-	$ 14,828	(6)
16	Adjusted Base	$ 60,295	$ 60,295	$ 75,690	Lines 13+14+15
17	Cumulative Escalation Rate (applied to Debit and Credit)	-	0.15%	6.28%	(7)
18	Escalation Amount	-	$ 88	$ 4,753	Line 16 * Line 17
19	**Total OM/OS Forecast**	**$ 60,295**	**$ 60,383**	**$ 80,443**	Line 16 + Line 18

(1) Based on total 2021 planned PCC costs for Type D and Type G PCC's. "Operational Management and Support PCC Costs" represents the Gross cost to supervise, support or manage PG&E personnel who charge their time directly to orders. Cost include salary and employee related costs for leadership and support staff in the management and support provider cost centers.

(2) Total Type D+G PCC's 2021 plan headcount (annual average / full time equivalent)

(3) Overhead allocation amount based on 2021 plan; result of 2021 OM/OS study. "Overhead Allocation" represents the portion of total OM/OS Expense costs applied to Non-Expense (Capital and Balancing Account) orders in each month. It is applied as an overhead on internal labor charges in these orders.

(4) Distribution vs Transmission amounts based on 2021 plan; result of 2021 OM/OS study

(5) In its 2020 GRC, PG&E excluded the costs of all utility and corporation officers from its forecast. In the 2023 GRC, pursuant to CPUC Resolution E-4963 (Dec. 14, 2018), PG&E excluded from its 2023 forecast the salary and benefits of the utility's SEC Rule 240.3b-7 officers. PG&E has also voluntarily excluded from its 2023 forecast the cost of the PG&E Corporation's SEC Rule 240.3b-7 officers although not required by the Resolution. PG&E has adjusted the 2019 and 2020 recorded costs to include the non-SEC Rule 240.3b-7 officers compensation costs for trending purposed to reflect more accurately total 2020 costs (including shareholder-funded compensation) as compared to the 2023 forecast. See Exhibit (PG&E-8), Chapter 4 for further discussion of officer compensation costs.

(6) In 2021 and 2022 the portion of OM/OS costs associated with incremental wildfire mitigation activities recovered through the FRMMA are being recorded to the memorandum account. 2023 OM/OS forecast includes full management and support costs associated with work forecasted in the 2023 GRC, including work previously recorded to FRMMA. See WP 22-14 for more details.

(7) See Exhibit (PG&E-12), Chapter 4 for information regarding the escalation rates. Escalation for 2022 OM/OS is negligible and represents minor differences in assumptions used in internal investment plan vs final GRC escalation rates (forecast effectively held flat to 2021 plan due to budget constraints).

Workpaper Table 22-14
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 22, Electric Distribution Support Activities
MWC OM/OS 2020 FRMMA Allocation Detail
(Thousands of Nominal Dollars)

Summary: In years 2020 through 2022, a portion of Operational Management and Support (OM/OS) costs associated with the incremental wildfire mitigation activities recovered through the Fire Risk Mitigation Memorandum Account (FRMMA) are being recorded to the FRMMA. By contrast, PG&E's 2023 OM/OS forecast includes the full management and support costs associated with work forecasted in the 2023 GRC, including work previously recorded to FRMMA. As shown in the table below, for 2020, OM/OS costs were allocated to the FRMMA by multiplying (1) the incremental 2020 OM/OS costs above the GRC imputed authorized by (2) the ratio of spending on FRMMA activities relative to total forecasted distribution-related expense costs above the GRC imputed authorized. [Note that for the purposes of this calculation 2020 spending is based on a 2020 EOY forecast as of 12/1/2020 because that is the data that was available at the time the forecast was prepared.]

Step 1: Calculate incremental 2020 OM/OS spending versus GRC imputed 2020 authorized amount for OM/OS

Line	Step Description		Note
1	2020 OM/OS Imputed Authorized OM/OS	$ 29,522	(1)
2	2020 EOY Forecast OM/OS	$ 69,626	(2)
3	**Forecasted Incremental OM/OS**	**$ 40,104**	Line 2 - Line 1

Step 2: Calculate incremental 2020 non-OM/OS GRC expense versus imputed authorized

	MWC (Base GRC Expense unless otherwise noted)	Imputed Authorized	2020 EOY Forecast	Variance	Var % (of Total Var)	(2)
4	AB	$ 66,477	$ 48,894	$ (17,583)	-1.8%	
5	AR	$ -	$ 10,446	$ 10,446	1.0%	
6	BA	$ 21,344	$ 31,927	$ 10,583	1.1%	
7	BF	$ 33,084	$ 79,599	$ 46,514	4.7%	
8	BH	$ 57,276	$ 66,049	$ 8,773	0.9%	
9	BK	$ 1,662	$ 1,665	$ 3	0.0%	
10	DD	$ 20,381	$ 22,932	$ 2,551	0.3%	
11	DN	$ -	$ 2	$ 2	0.0%	
12	EV	$ 12,625	$ 11,616	$ (1,009)	-0.1%	
13	EW	$ 8,859	$ 14,450	$ 5,591	0.6%	
14	EY	$ -	$ 6,112	$ 6,112	0.6%	
15	EZ	$ -	$ 75	$ 75	0.0%	
16	FZ	$ 16,974	$ 16,000	$ (974)	-0.1%	
17	GA	$ 13,585	$ 25,766	$ 12,182	1.2%	
18	GC	$ 29,125	$ 43,506	$ 14,381	1.4%	
19	GE	$ 5,899	$ 7,307	$ 1,408	0.1%	
20	HG	$ 10,948	$ 7,295	$ (3,653)	-0.4%	
21	HN	$ 375,765	$ 656,164	$ 280,400	28.2%	(3)
22	HX	$ 2,048	$ 2,261	$ 212	0.0%	
23	HY	$ -	$ 1,416	$ 1,416	0.1%	
24	IF	$ 33,743	$ 33,322	$ (422)	0.0%	
25	IG	$ 418,428	$ 463,885	$ 45,457	4.6%	(3)
26	IH	$ -	$ 12,126	$ 12,126	1.2%	
27	IS	$ 1,088	$ 1,088	$ 0	0.0%	
28	IU	$ -	$ 1,497	$ 1,497	0.2%	
29	JV	$ 5,246	$ 0	$ (5,246)	-0.5%	
30	KA	$ 32,449	$ 40,117	$ 7,668	0.8%	
31	KB	$ 12,537	$ 11,882	$ (655)	-0.1%	
32	KC	$ 4,025	$ 4,413	$ 388	0.0%	
33	AB / IG (WMBA)	$ -	$ 187,178	$ 187,178	18.8%	(4)
34	AB / IG (FRMMA)	$ -	$ 202,776	$ 202,776	20.4%	(4)
35	BF (FRMMA)	$ -	$ 91,162	$ 91,162	9.2%	
36	BH (FRMMA)	$ -	$ 620	$ 620	0.1%	
37	GA (FRMMA)	$ -	$ 15,673	$ 15,673	1.6%	
38	GC (FRMMA)	$ -	$ 2,821	$ 2,821	0.3%	
39	KA (FRMMA)	$ -	$ 56,530	$ 56,530	5.7%	
40	**TOTAL**	**$ 1,183,567**	**$ 2,178,573**	**$ 995,006**	**100.0%**	Sum lines 4:39

Step 3: Subtotal incremental 2020 expense for non-OM/OS base GRC, WMBA, and FRMMA activities versus GRC imputed authorized for these activities, use those amounts to calculate the percentage of total incremental spending that is attributable to spending in the FRMMA.

	Subtotals	Imputed Authorized	2020 EOY Forecast	Variance	Var % (of Total Var)	
41						
42	GRC Base Expense + WMBA	$ 1,183,567	$ 1,808,991	$ 625,424	62.9%	Sum lines 4:33
43	FRMMA	$ -	$ 369,582	$ 369,582	37.1%	Sum lines 34:39
44	**TOTAL**	**$ 1,183,567**	**$ 2,178,573**	**$ 995,006**	**100.0%**	Line 42 + Line 43

Step 4: Apply that percentage to the incremental 2020 OM/OS spending calculated in Step 1 above to determine the portion of incremental OM/OS spending associated with the FRMMA.

	Description	Incremental OM/OS	Allocation %	Allocation	
45	GRC Base Expense + WMBA	$ 40,104	62.9%	$ 25,208	Line 42 % x Line 3
46	FRMMA		37.1%	$ 14,896	Line 43 % x Line 3

(1) 2020 imputed authorized amounts. See PG&E's response to Master Data Request CalAdvocates_MDR25-Q01, dated June 30, 2021, attachment CalAdvocates_MDR25-Q01Atch01, Electric Distribution 2016 Expense Comparison by MWC, Column F, lines 163 and 164.

(2) 2020 EOY forecast as of 12/1/2020 used for purposes of calculation

(3) Routine and Enhanced Vegetation Management imputed authorized unit cost increased by 49% to account for cost increases associated with SB247, which would otherwise drive an overallocation to Vegetation Management program of the incremental Management and Support costs. While volumetric program expansion drove incremental OM/OS costs associated with these programs, the unit price increases associated with SB247 were not a driver for increased Management and Support costs.

(4) Forecast of FRMMA versus WMBA costs in MWCs AB / IG was derived based on 2020 YTD actuals through November and forecast at the planning order level

Workpaper Table 22-15
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 22
Electric Distribution Support Activities
Capital Expenditures by Major Work Category
(Thousands of Nominal Dollars)

			Capital Expenditures											
No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	5	Tools & Equipment	9,335	5,778	7,209	7,532	6,711	5,203	9,167	6,901	7,079	7,263	7,455	WP 22-19, WP 22-20
2	21	Misc Capital	-	-	-	-	1,276	(23,542)	1,496	1,493	1,496	1,499	1,502	WP 22-21
3		**Grand Total**	**9,335**	**5,778**	**7,209**	**7,532**	**7,987**	**(18,340)**	**10,663**	**8,394**	**8,575**	**8,762**	**8,956**	

Workpaper Table 22-16
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 22
Electric Distribution Support Activities
Forecast Capital Expenditures Summary
(Thousands of Nominal Dollars)

		Capital Expenditures							
Line No.	Description	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	Projects > $3 Million*	4,976	3,764	10,663	8,394	8,575	8,762	8,956	WP 22-17
2	Other Work	-	(22,103)	-	-	-	-	-	WP 22-18
3	**Total**	**4,976**	**(18,340)**	**10,663**	**8,394**	**8,575**	**8,762**	**8,956**	

4 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 22-17
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 22
Electric Distribution Support Activities
Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million*
(Thousands of Nominal Dollars)

					CWIP	Capital Expenditures								
Line No.	Planning Order	Description	MWC	Operative Date	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Subtotal	Reference
	MWC - 05	**Tools & Equipment**											
1	5506659	ED Federal Land Authorizations	5		4,976	-	-	-	-	-	-	4,976	
2	5508179	E Dist ATS Capital Tools	5		-	920	934	941	954	968	983	5,700	
3	5508759	Emeryville Tools & Equipment	5		-	544	552	576	590	605	620	3,487	
4	5530899	SYSPLN - MWC 05 ATS Dome (ED)	5		-	2,300	2,397	-	-	-	-	4,696	
5	5543423	SYSPLAN ED 05A	5		-	-	5,285	5,384	5,535	5,690	5,852	27,746	
6	**Total**				**4,976**	**3,764**	**9,167**	**6,901**	**7,079**	**7,263**	**7,455**	**46,606**	WP 22-22
	MWC - 21	**Misc Capital**											
7	5543485	SYSPLAN ED 21	21		-	-	1,496	1,493	1,496	1,499	1,502	7,484	
8	**Total**				**-**	**-**	**1,496**	**1,493**	**1,496**	**1,499**	**1,502**	**7,484**	WP 22-22
9		**Grand Total**			**4,976**	**3,764**	**10,663**	**8,394**	**8,575**	**8,762**	**8,956**	**54,090**	

10 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 22-18
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 22
Electric Distribution Support Activities
Recorded and Forecast Capital Expenditures Details - Other Work*
(Thousands of Nominal Dollars)

			Capital Expenditures											
Line No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	5	Tools & Equipment	6,497	3,604	4,331	4,207	4,146	1,439	-	-	-	-	-	WP 22-22
2	21	Misc Capital	-	-	-	-	1,276	(23,542)	-	-	-	-	-	WP 22-22
3	**Grand Total**		**6,497**	**3,604**	**4,331**	**4,207**	**5,421**	**(22,103)**	**-**	**-**	**-**	**-**	**-**	

4 * Excludes projects greater than $3M

Workpaper Table 22-19
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter #22, Electric Distribution Support Activities
Major Work Category 05 - Recorded Walk
MWC 05 - Tools and Equipment
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2016**	**Recorded Adjusted**	**$9,335**			
2		General Tools	($2,809)		Decrease in purchase of Restoration and MPP tools.	WP 22-22 Line 1
3		ATS Tools	($1,322)		ATS spent less on tool purchases in 2017 due to higher than normal tool purchases in 2016.	WP 22-22 Line 2
4		Federal Land Authorization	$577		Costs to suport creation and negotiation of Operations and Maintenance Plan with Region 5 of US Forest Service	WP 22-22 Line 4
5		Material Overdraw	($2)		Minor variation consistent with recorded historical.	WP 22-22 Line 5
6		**Net Change**	**($3,556)**			
7	**2017**	**Recorded Adjusted**	**$5,778**			
8		General Tools	$1,146		Increase in purchase of Restoration tools and LBOR switches.	WP 22-22 Line 1
9		ATS Tools	$437		ATS tool purchases returned to normal levels.	WP 22-22 Line 2
10		Federal Land Authorization	($151)		Minor variation consistent with recorded historical.	WP 22-22 Line 4
11		Material Overdraw	($1)		Minor variation consistent with recorded historical.	WP 22-22 Line 5
12		**Net Change**	**$1,431**			
13	**2018**	**Recorded Adjusted**	**$7,209**			
14		General Tools	($372)		Minor variation consistent with recorded historical.	WP 22-22 Line 1
15		ATS Tools	($121)		Minor variation consistent with recorded historical.	WP 22-22 Line 2
16		Federal Land Authorization	$815		Execution of final Operations and Maintenance Plan and 21 consolidated Master permits and Easements.	WP 22-22 Line 4
17		Material Overdraw	$1		Minor variation consistent with recorded historical.	WP 22-22 Line 5
18		**Net Change**	**$323**			
19	**2019**	**Recorded Adjusted**	**$7,532**			
20		General Tools	($259)		Minor variation consistent with recorded historical.	WP 22-22 Line 1
21		ATS Tools	($69)		Minor variation consistent with recorded historical.	WP 22-22 Line 2
22		Federal Land Authorization	($493)		After plan execution, capital dollars no longer used for implementation, most road work and inventory, and compliance work.	WP 22-22 Line 4
23		Material Overdraw	$0		Minor variation consistent with recorded historical.	WP 22-22 Line 5
24		**Net Change**	**($821)**			
25	**2020**	**Recorded Adjusted**	**$6,711**			

Workpaper Table 22-20
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 22, Electric Distribution Support Activities
Major Work Category 05 - Forecast Walk
MWC 05 - Tools and Equipment
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$6,711**			
2		General Tools	($2,443)		Missed forecast for Distribution M&C and MPP tools.	WP 22-22 Line 1
3		ATS Tools	$63		Minor variation consistent with recorded historical.	WP 22-22 Line 2
4		ATS Capital Lab Project	$2,300		New project starting in 2021 to upgrade high-voltage dome.	WP 22-22 Line 3
5		Federal Land Authorization	($1,428)		PG&E is not forecasting capital expenditures for 2021-2026 for this area of work	WP 22-22 Line 4
6		**Net Change**	**($1,508)**			
7	**2021**	**Forecast**	**$5,203**			
8		General Tools	$3,854		Included forecast for Distribution M&C and MPP tools, addition of DLT tools.	WP 22-22 Line 1
9		ATS Tools	$14		No significant change.	WP 22-22 Line 2
10		ATS Capital Lab Project	$97		No significant change.	WP 22-22 Line 3
11		**Net Change**	**$3,965**			
12	**2022**	**Forecast**	**$9,167**			
13		General Tools	$124		No significant change.	WP 22-22 Line 1
14		ATS Tools	$7		No significant change.	WP 22-22 Line 2
15		ATS Capital Lab Project	($2,397)		Expecting to complete project in 2022. No 2023 forecast.	WP 22-22 Line 3
16		**Net Change**	**($2,266)**			
17	**2023**	**Forecast**	**$6,901**			
18		General Tools	$165		No significant change.	WP 22-22 Line 1
19		ATS Tools	$13		No significant change.	WP 22-22 Line 2
20		ATS Capital Lab Project	$0		No significant change.	WP 22-22 Line 3
21		**Net Change**	**$178**			
22	**2024**	**Forecast**	**$7,079**			
23		General Tools	$170		No significant change.	WP 22-22 Line 1
24		ATS Tools	$14		No significant change.	WP 22-22 Line 2
25		**Net Change**	$184			
26	**2025**	**Forecast**	**$7,263**			
27		General Tools	$177		No significant change.	WP 22-22 Line 1
28		ATS Tools	$15		No significant change.	WP 22-22 Line 2
29		**Net Change**	$192			
30	**2026**	**Forecast**	**$7,455**			

Workpaper Table 22-21
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit 4, Chapter 22, Electric Distribution Support Activities
Major Work Category 21 - Forecast Walk
MWC 21 - Misc Capital
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$1,276**			
2		ATS Lab Safety and Reliability Upgrades	$263		Forecasted to implement additional lab safety and reliability upgrades.	WP 22-22 Line 7
3		External Contract Estimating Holding	($81)		No significant change	WP 22-22 Line 8
4		Affordability	($25,000)		Affordability consists of known and unknown cost savings opportunities across the Electric Distribution portfolio. For 2022 - 2026, cost savings opportunities have been embedded into the individual MWC forecasts.	WP 22-22 Line 9
5		**Net Change**	**($24,818)**			
6	**2021**	**Forecast**	**($23,542)**			
7		ATS Lab Safety and Reliability Upgrades	$38		No significant change	WP 22-22 Line 7
8		Affordability	$25,000		No forecast reduction in 2022	WP 22-22 Line 9
9		**Net Change**	**$25,038**			
10	**2022**	**Forecast**	**$1,496**			
11		ATS Lab Safety and Reliability Upgrades	($3)		No significant change	WP 22-22 Line 7
12		**Net Change**	**($3)**			
13	**2023**	**Forecast**	**$1,493**			
14		ATS Lab Safety and Reliability Upgrades	$3		No significant change	WP 22-22 Line 7
15		**Net Change**	**$3**			
16	**2024**	**Forecast**	**$1,496**			
17		ATS Lab Safety and Reliability Upgrades	$3		No significant change	WP 22-22 Line 7
18		**Net Change**	**$3**			
19	**2025**	**Forecast**	**$1,499**			
20		ATS Lab Safety and Reliability Upgrades	$3		No significant change	WP 22-22 Line 7
21		**Net Change**	**$3**			
22	**2026**	**Forecast**	**$1,502**			

Workpaper Table 22-22
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 22, Electric Distribution Support Activities
Capital Summary by Category
(Thousands of Nominal Dollars)

Line No.		2016 Actual	2017 Actual	2018 Actual	2019 Actual	2020 Actual	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Notes	Reference
1	General Tools	$ 6,721	$ 3,911	$ 5,057	$ 4,685	$ 4,426	$ 1,983	$ 5,837	$ 5,960	$ 6,125	$ 6,295	$ 6,472	(1)	
2	ATS Tools	$ 1,933	$ 610	$ 1,048	$ 927	$ 857	$ 920	$ 934	$ 941	$ 954	$ 968	$ 983	(2)	
3	ATS Capital Lab Project	$ -	$ -	$ -	$ -	$ -	$ 2,300	$ 2,397	$ -	$ -	$ -	$ -		WP 22-25
4	Federal Land Authorization	$ 679	$ 1,256	$ 1,105	$ 1,921	$ 1,428	$ -	$ -	$ -	$ -	$ -	$ -	(3)	WP 22-28
5	Material Overdraw	$ 2	$ -	$ (1)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	(4)	
6	**MWC 05 Total**	**$ 9,335**	**$ 5,778**	**$ 7,209**	**$ 7,532**	**$ 6,711**	**$ 5,203**	**$ 9,167**	**$ 6,901**	**$ 7,079**	**$ 7,263**	**$ 7,455**		
7	ATS Lab Safety and Reliability Upgrades	$ -	$ -	$ -	$ -	$ 1,195	$ 1,458	$ 1,496	$ 1,493	$ 1,496	$ 1,499	$ 1,502	(5)	WP 22-23
8	External Contract Estimating Holding	$ -	$ -	$ -	$ -	$ 81	$ -	$ -	$ -	$ -	$ -	$ -	(6)	
9	Affordability	$ -	$ -	$ -	$ -	$ -	$ (25,000)	$ -	$ -	$ -	$ -	$ -	(7)	
10	**MWC 21 Total**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 1,276**	**$ (23,542)**	**$ 1,496**	**$ 1,493**	**$ 1,496**	**$ 1,499**	**$ 1,502**		
11	**Capital Total**	**$ 9,335**	**$ 5,778**	**$ 7,209**	**$ 7,532**	**$ 7,987**	**$ (18,340)**	**$ 10,663**	**$ 8,394**	**$ 8,575**	**$ 8,762**	**$ 8,956**		

Notes

(1) General Tools includes the costs of tools procured for Operations, Maintenance & Construction employees to perform distribution-related work. The forecast for 2020 to 2022 is based on the 2018 budget with minor adjustments.

(2) ATS Tools includes the cost of laboratory and testing equipment used for field work or at the ATS laboratories. The forecast for 2023 to 2026 is based on the expected need to replace obsolete equipment and to invest in new technology.

(3) Negotiation of the United States Forest Service Master Special Use Permit is complete. PG&E is not making a 2021-2026 capital forecast for work in this area.

(4) Material for capital projects are typically charged against the capital order for a specific project (e.g., cable is purchased for a cable replacement project and is charged to a capital order associated with MWC 56). Sometimes material is purchased for a project and goes unused (e.g. a sudden change in scope or an over estimate of the amount of material needed) which results in an overdraw of materials. Normally, the overdrawn material is credited back to the capital order that was initially used to purchase the material. However, sometimes a capital order is not available or applicable to incur the overdrawn material credit. In these cases, the material is credited back to an order in MWC 05.

(5) Ongoing facility and operating equipment upgrades at the ATS testing laboratories located at the San Ramon Technology Center.

(6) External Contract Estimating Holding is a holding order for capital projects that are typically cleared out by the end of the year and allocated to the correct capital projects. The amount in 2020 was the remaining at the end of the year and will be cleared out in 2021.

(7) Affordability consists of known and unknown cost savings opportunities across the Electric Distribution portfolio. For 2022 - 2026, cost savings opportunities have been embedded into the individual MWC forecasts.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES
PROJECT SUMMARY – APPLIED TECHNOLOGY SERVICES (ATS) LAB SAFETY & RELIABILITY UPGRADES

Project Title: Applied Technology Services (ATS) Lab Safety & Reliability Upgrades
Major Work Categories: 21
Planning Order Numbers: 5539560
Project Start Date: 1/1/2021
Project Completion Date: Ongoing
Operative Date (only applies to Capital): as each project is operational

Project Description

In order to stay up-to-date on aging equipment, evolving technologies, and testing techniques, PG&E needs to make ongoing facility and operating equipment upgrades at the ATS testing laboratories at the San Ramon Technology Center (SRTC). ATS has 10 technical work units providing a variety of engineering, failure analysis, and testing services. Work is performed in more than a dozen distinct laboratories that require periodic safety and reliability upgrades. Laboratory upgrades in the 2023-2026 timeframe will be prioritized based on the most pressing needs of the company and are expected be driven by increases in: failure analysis testing, new technology assessments, wildfire risk mitigation analysis and evaluation, asset risk reduction and asset integrity evaluations.

Justification

The SRTC campus was originally built in the early 1970's and covers about 13 acres. As the utility industry has evolved, this site has adapted to changing priorities and technologies. With increasing demand for the services provided by ATS, laboratories will need to be updated, sized appropriately and repurposed. Laboratories have unique requirements above and beyond standard buildings. This can include special climate control for temperature and humidity, safety equipment such as fume extractors, and other work specific equipment. Labs can also require special work surfaces/work benches, storage, lighting, and access control. Equipment and materials being tested or evaluated can be quite large requiring adequate storage space including outdoor areas or areas with added access security.

Cost

The total estimated cost for ongoing lab safety and reliability upgrades are approximately $1.5 million per year for the 2023-2025 time period. This project was first initiated in 2020 so there are no prior recorded costs. Of the alternatives considered, our proposal is to adopt Option 3 as explained below.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
CAPITAL												
Capital Total	N/A	N/A	N/A	N/A	1,195	1,458	1,496	1,493	1,496	1,499	1,502	8,637
TOTAL PROJECT COST	N/A	N/A	N/A	N/A	1,195	1,458	1,496	1,493	1,496	1,499	1,502	8,637

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES
PROJECT SUMMARY – APPLIED TECHNOLOGY SERVICES (ATS) LAB SAFETY & RELIABILITY UPGRADES

Benefits

- SRTC has testing capabilities that are not available elsewhere in the service territory. Other labs providing the same services are out-of-state or out of the country.
- In-house resources are lower cost than using external contractors with similar expertise.
- Engaging with ATS for services provides cost-effective resources, centrally located in the service territory and does not require formal contracts and negotiations.

Alternatives

- **Option 1 – Make no facility and operating equipment upgrades:** This option would not be feasible as we would risk having unplanned laboratory outages, operating with obsolete technology, and possibly operating without needed safety upgrades to protect our employees and facility.
- **Option 2 – Continue with ad-hoc requests in each rate case:** This option requires many years advance planning and is appropriate for the major projects with significant costs. But this option does not meet the needs of smaller laboratory projects that address the emergent needs of our internal utility business partners. This option would also make it difficult to adapt to rapidly changing technology.
- **Option 3 – Baseline funding for SRTC facility and operating equipment upgrades**: This option provides an efficient mechanism to fund smaller laboratory upgrades when they are needed due to safety, technology, and utility business drivers. Projects having the highest priority can be funded and implemented to support current utility priorities, new technology and to address laboratory safety.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES
PROJECT SUMMARY – APPLIED TECHNOLOGY SERVICES (ATS) CAPITAL LAB PROJECT

Project Title: Applied Technology Services (ATS) Capital Lab Project
Major Work Categories: 05
Planning Order Numbers: 5530899
Project Start Date: 1/1/2020
Project Completion Date: 12/31/2022
Operative Date (only applies to Capital): 12/31/2022

Project Description

This project proposes to replace the existing high voltage lab equipment and control room in PG&E's Applied Technology Services (ATS) High Voltage Dome Lab with modern state-of-the-art equipment that will increase the capabilities of the lab.

The ATS Dome Lab was designed and constructed in the early 1970's and became operational in 1974. The existing 44-year-old system is at the end of its operating life and is breaking down at an increasing rate. Spare parts are becoming difficult to find and manufacturers no longer support the equipment.

The test facility is capable of generating voltages up to 720 kV. The facility is unique; it is the last remaining high voltage lab of its kind in California and one of the few remaining high voltage test labs in the United States.

The ATS High Voltage Dome Lab is used for:

- Dielectric testing and certification of company and third party equipment, tools and vehicles, including:
    - ANSI Certification testing for PG&E and other utilities 500 kV "bare-hand" insulated boom trucks;
    - Development of new tools and work methods for improved safety and productivity.
- High voltage insulation and power factor testing of Substation Equipment.
- High voltage insulator contamination studies, with the resulting data used for Substation and Transmission insulator selection in high contamination areas to improve reliability.
- Incident re-creation for failure analysis.
- Testing new substation, power generation and transmission components before installation on PG&E's system. By testing new products and technologies in the High Voltage Lab, PG&E can determine impacts on the operating system and validate vendor's performance claims.
- Miscellaneous equipment and dielectric testing.
- High voltage demonstrations for internal and external groups to showcase research projects, lab capabilities and promote STEM education for college and high school students.

The High Voltage Dome Lab is a valuable resource not only for PG&E but other utilities in the Western United States.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES
PROJECT SUMMARY – APPLIED TECHNOLOGY SERVICES (ATS) CAPITAL LAB PROJECT

Justification

The proliferation of solar photovoltaic generators, electric vehicles and other distributed generation applications creates new challenges for PG&E. Power may flow in both directions on a large scale where previously the power flowed in only one direction. This may affect decision making regarding deployment of new high voltage substation and transmission equipment, integration of new equipment with legacy equipment and new infrastructure requirements and system operations, tools and procedures.

The modernization of the ATS High Voltage Dome Lab will allow PG&E to test new types of equipment, including transmission system and substation infrastructure improvements, which enable improved safety and reliability of the power grid. All significant new projects, equipment, systems, or tools added to the power grid must be tested and proven in the lab environment before field implementation. The ATS High Voltage Dome Lab project is a key contributor to the overall success of PG&E's plans for a modernized power grid.

Cost

The total estimated cost for a modern test system is approximately $4.6 million, spread over the 2021-2022 time period. Cost estimates are based on engineering estimates for the project scope.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast						
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
CAPITAL												
Capital Total	N/A	N/A	N/A	N/A	-	2,300	2,397	-	-	-	-	4,697
TOTAL PROJECT COST	N/A	N/A	N/A	N/A	-	2,300	2,397	-	-	-	-	4,697

Benefits

- Cost Reduction (reduce existing costs): No direct cost reduction has been identified.
- Cost Avoidance (offset new costs): The High Voltage Dome Lab will help PG&E avoid potential negative impacts to electric service reliability and operability by testing new unproven equipment in a controlled test environment before it is placed into service. The High Voltage Dome Lab can help PG&E avoid purchasing and installing equipment that may not work well on its system, and can also validate manufacturers' product claims. Testing can also help prove warranty claims for products that do fail allowing recoupment of funds from manufacturers. As of the time PG&E prepared its forecast, no specific cost avoidance opportunities have been identified.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES
PROJECT SUMMARY – APPLIED TECHNOLOGY SERVICES (ATS) CAPITAL LAB PROJECT

Alternatives Considered

- Alternative 1 – Use of spare transformers from Moss Landing: Three identical transformers from the Moss Landing Power Plant that were used to support a decommissioned research lab were evaluated for possible refurbishment. The transformers were inspected and tested and found to not be viable due to their age and condition. Repairs and restoration were not feasible. This would only have been a partial solution and would not upgrade or modernize the lab's capabilities.

- Alternative 2 – Repairs to existing transformers: The significant level of repairs needed for the current transformers approaches the cost of replacement with new equipment. In addition, repairing the transformers would only be a partial solution. The High Voltage Lab also includes other failing and outdated equipment (e.g. control console, wiring, cables, etc.) dating back to the 1920's, the 1950's and the early 1970's.

- Alternative 3 – Abandon the lab: PG&E would lose these unique testing capabilities. There are limited options for other labs to perform similar testing. These labs are outside of California and are not all independent (i.e. they belong to the manufacturers). There would be a cost to scrap the existing equipment.

- Alternative 4 – Buy and install new test system: This option maintains current testing capability and allows for the use of modern, computerized controls and software tools such as Labview. There would also be new testing capabilities including Power Factor and Partial Discharge. New equipment would be easier to maintain than the existing equipment and would be supported by the manufacturers.

- After consideration of the alternatives, PG&E recommends Alternative 4. Other alternatives either were not feasible or would not resolve the operating issues with the system. The unique testing capabilities of this lab are important to PG&E for high voltage testing of equipment, tools, materials and vehicles. The lab supports safety, compliance and reliability through testing, certification, incident recreation, failure analysis, new product acceptance and validation of manufacturers' claims.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES
PROJECT SUMMARY – FEDERAL LAND AUTHORIZATION

Project Title: Federal Land Authorization
Major Work Categories: MWC 05 / AB
Planning Order Numbers: 5506659 / 5048733
Project Start Date: 2005
Project Completion Date: 2049
Operative Date (only applies to Capital): 12/31/2020

Project Description

In 2019, PG&E executed a 30-year Master Special Use Permits and Easements (MPE) agreement with the Pacific West Region of the United States Forest Services, Region 5 (USFS). The MPE agreement renewed and consolidated approximately 465 expired land authorizations and consolidated the remaining land authorizations into twenty one permits and easements. The MPE also formalizes how PG&E is to interact with the USFS on routine operations and maintenance activities through a Master Operations and Maintenance Plan (MOMP). As a condition of the MPE, PG&E is obligated to perform some road improvements and cultural and biological compliance activities.

Justification

One of the successes of the renewal and consolidation effort was the creation of the MOMP, which describes how PG&E will conduct routine maintenance activities in compliance with the MPE during its 30 year duration. The MOMP reduces the amount of time staff spends processing and waiting for approval of routine operations and maintenance activities. It achieves consistency across the region for reviewing and approving activities and it put measures in place to ensure continued protection of environmental resources. It ensures that PG&E complies with USFS policies and standards, and other federal laws and regulations. Finally, it ensures that PG&E can adhere to state and federal laws, regulations, and standards to ensure safe and reliable operations of its power system. The MOMP outlines several reporting requirements related to weed occurrence data collection, biological resources, the Heritage Resources Management Plan and the Historic Properties Management Plan.

In order to comply with all requirements detailed in the USFS MPE and MOMP, budget allocation is required for reporting requirements associated with weed occurrence data collection and reporting, biological resources data collection and reporting, data collection and reporting requirements associated with the Heritage Resources Management Plan and the Historic Properties Management Plan. Funding is also required to support the permit administrator with forest and utility annual meeting preparation and data accumulation and presentation material. All costs are for internal and contract support. Costs were derived from interviews with subject matter experts who have worked on similar efforts that require annual reporting to agencies.

In addition to the above, funding is required to support obligations associated with the electric distribution and transmission access inventory which is a 5-year requirement (2019-2023) agreed to by PG&E in a letter dated September 14, 2018. In late 2020, PG&E completed a draft of the access inventory and provided it to the 11 National Forests for review and approval. PG&E will work with those forests throughout 2021 and 2022 to finalize the access inventory. In addition, PG&E has committed to conducting a condition assessment of the access roads used during the course of normal business operations. PG&E will assess and repair those facilities identified as Access in the Utility Access Network, using the MOMP as the implementing guidance for inspection and repair activities needed for these facilities. Focus will be on distribution system access, as the transmission system access is a well-established program within PG&E. PG&E will work with the USFS to identify and prioritize those access segments needing timely repairs and improvements to achieve Forest

Service Road Maintenance Level 2 standards as required by the USFS for incorporation into the MPE.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES
PROJECT SUMMARY – FEDERAL LAND AUTHORIZATION

Cost

The cost includes a cost recovery agreement (CRA) with USFS, internal resources cost, and external contractor costs. This work is mandatory as a condition for the approval of the MPE.

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast							
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Workpaper Reference
EXPENSE													
MWC AB PO 5048733				1,292	4,823	4,348	4,174	3,454				18,091	WP 22-11 Line 5
												-	
Expense Total	**-**	**-**	**-**	**1,292**	**4,823**	**4,348**	**4,174**	**3,454**	**-**	**-**	**-**	**18,091**	WP 22-11 Line 5
CAPITAL													
MWC 05 PO 5506659	679	1,256	1,105	1,921	1,428							6,389	WP 22-21 Line 4
Capital Total	**679**	**1,256**	**1,105**	**1,921**	**1,428**	**-**	**-**	**-**	**-**	**-**	**-**	**6,389**	WP 22-21 Line 4
TOTAL PROJECT COST	**679**	**1,256**	**1,105**	**3,213**	**6,251**	**4,348**	**4,174**	**3,454**	**-**	**-**	**-**	**24,480**	

Benefits

- Compliance of USFS Master Permits and Easements
- Prevent Notice of Violation
- Compliance with Access Roads Inventory Agreement dated September 14, 2018

Alternatives Considered

Non-compliance with Master Permits and Easements which will result in revocation of land authorizations which permit electric infrastructure within USFS lands.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES
PROJECT SUMMARY – REGULATORY COMPLIANCE & QUALITY ASSURANCE

Project Title: Regulatory Compliance & Quality Assurance
Major Work Categories: AB
Planning Order Numbers: Various
Project Start Date: 2019
Project Completion Date: Ongoing
Operative Date (only applies to Capital): N/A

Project Description

The Electric Regulatory Compliance & Quality Assurance organization was created in mid-2019 to promote, encourage and influence a strong and healthy compliance culture. This team serves as the liaison between the regulators and Electric Operations. These regulators broadly include the CPUC, Wildfire Safety Division, CAISO, NERC, WECC, CALFIRE, Federal Monitor and State Observer. The functional work groups within this organization are described below.

Electric Data Response Unit (EDRU)
The EDRU coordinates accurate and on-time responses to data requests sent to Electric Operations. Assists in the preparation of the response and ensures its accuracy through quality control checks and coordination with stakeholders. The EDRU receives and manages requests from all of EO's regulators.

Electric Corrective Action Program
The Electric Corrective Action Program runs the preferred tool to find and fix issues within Electric Operations. Additionally, the Program conducts cause evaluations to determine the cause of issues, identifies cognitive trends, and provides the findings to Electric Operations business owners so they can create mitigation plans to prevent recurrences.

Serious Injuries and Fatalities (SIF)
Investigates every serious injury and fatality incident involving electric operations workers. These investigations are completed within a goal of 30 days. The team is responsible for the incident intake, evaluation, corrective action identification, and corrective action implementation process.

Electric Incident Investigations
Investigates all electric incidents and fire ignitions, submits 20-day reports to the CPUC, responds to 20-day report and other data requests, performs Event Analysis Reports (EARs) that follow the 20-day reports, and maintains PG&E's ignition tracking database. In addition, this team leads the Intelligence & Investigations team of PSPS activations and analyzes damage data which is included in the 10-day report to the CPUC.

CPUC Compliance
Interprets new compliance requirements and identifies owners. Provides compliance guidance to Electric Operations and provides input on nonconformance and noncompliance matters. Coordinates pre-audits and shares findings with regulators. Responds to audit-related data requests. Responds to NOVs and audit findings.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES
PROJECT SUMMARY – REGULATORY COMPLIANCE & QUALITY ASSURANCE

Quality Management
Performs best practice quality management program which includes quality verification and quality assurance audits to determine whether Electric Operations' work is compliant with requirements and procedures.

Compliance, Governance & Reporting
Provides insights through reporting and facilitates Compliance forum and Self-Report forum to determine systemic safety issues. Supports the compliance portion of the EO Risk and Compliance Committee. Tracks and influences the EO Compliance Maturity Model efforts. Provides tools for EO employees to understand and meet compliance obligations.

Justification

The Regulatory Compliance & Quality Assurance team was created to support Electric Operations' implementation of the Plan, Do, Check, Act operating model. A core tenant of that model is that those who Check work should be separated from those who Do the work.

With the ongoing changes to the utility business, the number of regulatory proceedings and legislative initiatives is increasing. The work demands on this relatively new organization have continued to increase as these valued and critical partners to help Electric Operations find issues, implement mitigation plans, and understand new regulatory requirements. The demand on this work is evidenced by these results in 2020 and of which we expect to continue in future years:

- Responded to nearly 6,000 data requests in 2020. Approximately 75% of these were from the CPUC
- Completed 47 Event Analysis Reports – 194% increase over 2019
- Submitted 93 Electric Incident Reports – 16% increase over 2019
- Stood up a new process to support Wildfire OII Corrective Action #7/Root Cause Analyses, OII CA #14/Safety Audits and OII CA #15/Attestation for key regulatory safety filings
- Completed approximately 3,600 quality management work audits and completed numerous systemwide PAS 55/ISO 55001 assessments
- Conducted assessment of compliance data, improved quality of reporting
- Created a stand-alone Cause Evaluation group, allowing for expanded causal evaluations to support the Asset Failure team

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT 4 – ELECTRIC DISTRIBUTION, CHAPTER 22, ELECTRIC DISTRIBUTION SUPPORT ACTIVITIES
PROJECT SUMMARY – REGULATORY COMPLIANCE & QUALITY ASSURANCE

Cost

Major Project Spending Estimates
(Thousands of Nominal Dollars)

	Recorded					Forecast				
	2016	2017	2018	2019	2020	2021	2022	2023	Total	Workpaper Reference
EXPENSE										
MWC AB PO 5050542					1,181	1,547	1,594	1,644	5,967	
MWC AB PO 5050543				244	1,489	1,303	1,343	1,385	5,764	
MWC AB PO 5050544				84	3,146	8,831	9,101	9,386	30,549	
MWC AB PO 5050545				187	1,920	4,425	4,560	4,703	15,796	
									-	
Expense Total	**-**	**-**	**-**	**515**	**7,736**	**16,106**	**16,599**	**17,119**	**58,075**	**WP 22-11 Line 7**

Benefits

A centralized compliance, quality, governance and reporting, and CAP function in Electric Operations provides a consistent, systematic, and holistic view of procedure use and adherence and compliance. A robust Regulatory Compliance and Quality Assurance organization provides a layer of defense against risk and nonconformance. Electric Operations benefits from the insights provided by a single organization that manages compliance, quality, governance and reporting, and CAP.

Alternatives Considered

1. Decentralize the RC&QA functions
   a. Pros
      i. Each organization and department can tailor their efforts for their needs
   b. Cons
      i. Inconsistent approaches to quality, compliance, and CAP
      ii. Limited governance and siloed reporting insights

2. Status Quo: Maintain 2020 staffing levels
   a. Pros
      i. No change management
   b. Cons
      i. Reduced performance by the team as a layer of defense against risk and nonconformance
      ii. Less ability to produce quality audits, compliance guidance and analysis, governance and reporting information, cause evaluations, incident investigations, data responses, serious injury and fatality investigation, and CAP Management
      iii. Increased response time to data requests

PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE
EXHIBIT (PG&E-4) ELECTRIC DISTRIBUTION

WORKPAPERS SUPPORTING
CHAPTER 23, COMMUNITY REBUILD PROGRAM

TABLE OF CONTENTS

Subject	Page No.
Expense Workpapers	
Workpaper Table 23-1: Expenses by Major Work Category - Nominal Dollars	WP 23-1
Workpaper Table 23-2: Expenses by Major Work Category - Base Year Dollars	WP 23-2
Workpaper Table 23-3: Expenses by Major Work Category IF- Recorded Walk	WP 23-3
Workpaper Table 23-4: Expenses by Major Work Category IF - Forecast Walk	WP 23-4
Workpaper Table 23-5: Expenses by Major Work Category IF - Forecast Details	WP 23-5
Capital Workpapers	
Workpaper Table 23-6: Capital Expenditures by Major Work Category	WP 23-6
Workpaper Table 23-7: Forecast Capital Expenditures Summary	WP 23-7
Workpaper Table 23-8: Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million	WP 23-8
Workpaper Table 23-9: Recorded and Forecast Capital Expenditures Details - Other Work	WP 23-9
Workpaper Table 23-10: Major Work Category 95 - Recorded Walk	WP 23-10
Workpaper Table 23-11: Major Work Category 95 - Forecast Walk	WP 23-11
Workpaper Table 23-12: MWC 95 - Major Emergencies Forecast Details	WP 23-12
Workpaper Table 23-13: Total Costs by Workstream	WP 23-13
Workpaper Table 23-14: Forecasted Units by Workstream	WP 23-14
Project Summary - Community Rebuild Program	WP 23-15
Index Template	WP 23-25

Workpaper Table 23-1
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 23
Community Rebuild Program
Expenses by Major Work Category
(Thousands of Nominal Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	Reference (A)
1	IF	Community Rebuild Expense			123,477	233,292	29,194	12,071	15,138	13,781	WP 23-3, WP 23-4
2	**Total**				**123,477**	**233,292**	**29,194**	**12,071**	**15,138**	**13,781**	

Workpaper Table 23-2
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 23
Community Rebuild Program
Expenses by Major Work Category
(Thousands of Base Year Dollars)

Line No.	MWC	Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast
1	IF	Community Rebuild Expense			125,492	230,083	29,194	11,928	14,550	12,871
2	**Total**				**125,492**	**230,083**	**29,194**	**11,928**	**14,550**	**12,871**

Workpaper Table 23-3
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 23, Community Rebuild Program
Expense Walk by Major Work Category
MWC IF - Community Rebuild Expense
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2018**	**Recorded Adjusted**	**123,477**			
2		Electric Service Connections	44		For PG&E's electric service connections restored during the original Camp Fire restoration event, PG&E charged costs to the Major Emergency Program, not the Community Rebuild Program.	WP 23-5 Line 1
3		Construction Site Clearing	108,222		Camp Fire occurred in November 8, 2019. Large increase in vegetation management to make the area safe for first responders.	WP 23-5 Line 2
4		Community Rebuild Program Management Office (PMO)	1,549		PG&E had to stand up a PMO to provide oversight on the matrixed resources supporting the program and ensure project scope, schedule and financials are governed appropriately. PMO was created in February 2019 after PG&E went from emergency response/restore to long-term rebuild.	WP 23-5 Line 3
5		**Net Change**	**109,815**			
6	**2019**	**Recorded Adjusted**	**233,292**			
7		Electric Service Connections	156		PG&E received approval on Advice Letter 5744-E to provide customers temporary service for pedestal program. The expense costs for this include the cost of the pedestal material and labor to remove the pedestal at the time the permanent service is installed.	WP 23-5 Line 1
8		Construction Site Clearing	(207,904)		PG&E completed the required vegetation management work required to make the area safe for first responders and PG&E crews in 2019. Large decrease in 2020 due to change from emergency response/restoration to long-term rebuild.	WP 23-5 Line 2
9		Community Rebuild Program Management Office	3,650		PG&E identified the need to increase the size of the Program Management Office to ensure that the Program was managed successfully and provide the required oversight for a program of this size and scale.	WP 23-5 Line 3
10		**Net Change**	**(204,098)**			
11	**2020**	**Recorded Adjusted**	**29,194**			

Workpaper Table 23-4
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 23, Community Rebuild Program
Expense Walk by Major Work Category
MWC IF - Community Rebuild Expense
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$ 29,194**			
2		Electric Service Connections	204		PG&E expects an increase in temporary services for pedestal program to ensure that customers rebuilding have the power to rebuild their homes. PG&E completed a study with Harvard University to build a predictive model of return rate.	WP 23-5 Line 1
3		Construction Site Clearing	(15,089)		PG&E expects a decrease in vegetation management because future vegetation work required is for long-term electric facilities, no longer restoration.	WP 23-5 Line 2
4		Community Rebuild Program Management Office	(2,238)		PG&E expects to capitalize 95% of the Program Management Office and only 5% remain in expense.	WP 23-5 Line 3
5		**Net Change**	**(17,123)**			
6	**2021**	**Forecast**	**12,071**			
7		Electric Service Connections	(155)		No significant change	WP 23-5 Line 1
8		Construction Site Clearing	3,235		PG&E expects an increase in vegetation management as PG&E accelerates the completion of the electric underground mainline construction to be completed by the end of 2025.	WP 23-5 Line 2
9		Community Rebuild Program Management Office	(13)		No significant change	WP 23-5 Line 3
10		**Net Change**	**3,067**			
11	**2022**	**Forecast**	**15,138**			
12		Electric Service Connections	10		No significant change	WP 23-5 Line 1
13		Construction Site Clearing	(1,515)		PG&E expects a decrease in vegetation management as PG&E does not build as much electric overhead mainline construction that was not restored during the original restoration effort.	WP 23-5 Line 2
14		Community Rebuild Program Management Office	148		No significant change	WP 23-5 Line 3
15		**Net Change**	**(1,357)**			
16	**2023**	**Forecast**	**13,781**			

Workpaper Table 23-5
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 23, Community Rebuild Program
MWC IF - Community Rebuild Forecast Details
(Thousands of Nominal Dollars)

Line No.	Description	Recorded 2016	Recorded 2017	Recorded 2018	Recorded 2019	Recorded 2020	Forecast 2021	Forecast 2022	Forecast 2023	Assumptions	Reference
1	Electric Service Connections (Expense)	$0	$0	($44)	$0	$156	$360	$205	$215	1, 2, 3	WP 23-13, line 2
2	Construction Site Clearing	$0	$0	$123,521	$231,744	$23,840	$8,751	$11,986	$10,471	4, 5	WP 23-13, line 3
3	Community Rebuild Program Management Office (Expense)	$0	$0	$0	$1,549	$5,198	$2,960	$2,947	$3,095	6	WP 23-13, line 4
4	**Final Recorded and Forecast**	**$0**	**$0**	**$123,477**	**$233,292**	**$29,194**	**$12,071**	**$15,138**	**$13,781**		

Forecast Assumptions and Details

1) PG&E will be required to provide temporary power to customers that had service pre-Camp Fire if they submit a service application for temporary power.
2) PG&E will offer the rebuild customers a pedestal that was approved in AL 5744-E if they apply for temporary service.
3) PG&E will charge expense for the pedestal since it is customer-owned asset and will charge expense for the removal of the pedestal.
4) PG&E was required to cut down 85,708 trees during PG&E's restoration efforts to make the Camp Fire footprint safe for first responders and PG&E's crews.
5) In 2020 and beyond, constuction site clearing costs are associated with vegetation management work required to install PG&E's long-term infrastructure and rebuild activities.
6) The Camp Fire Footprint required a Program Management Office to manage the long-term rebuild effort. The PMO was established in February 2019.

Workpaper Table 23-6
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 23
Community Rebuild Program
Capital Expenditures by Major Work Category
(Thousands of Nominal Dollars)

			Capital Expenditures											
No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	95	Community Rebuild Capital	-	-	-	48,397	88,100	87,513	133,169	142,480	129,570	97,444	16,940	WP 23-10, WP 23-11
2		**Grand Total**	**-**	**-**	**-**	**48,397**	**88,100**	**87,513**	**133,169**	**142,480**	**129,570**	**97,444**	**16,940**	

Workpaper Table 23-7
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 23
Community Rebuild Program
Forecast Capital Expenditures Summary
(Thousands of Nominal Dollars)

		Capital Expenditures							
Line No.	Description	2020 CWIP	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	Projects > $3 Million*	20,501	119,347	133,169	142,480	129,570	97,444	16,940	WP 23-8
2	Other Work	(6)	(31,834)	-	-	-	-	-	WP 23-9
3	**Total**	**20,494**	**87,513**	**133,169**	**142,480**	**129,570**	**97,444**	**16,940**	

4 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 23-8
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 23
Community Rebuild Program
Recorded CWIP and Forecast Capital Expenditures Details - Projects Over $3 Million*
(Thousands of Nominal Dollars)

					CWIP	Capital Expenditures							
Line No.	Planning Order	Description	MWC	Operative Date	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Subtotal	Reference
	MWC - 95	**Community Rebuild Capital**											
1	5537319	Butte Rebuild Camp Fire-OH Tap Perm	95		-	7,807	-	-	-	-	-	7,807	
2	5537321	Butte Rebuild Camp Fire- UG	95		7,620	53,859	-	-	-	-	-	61,479	
3	5537322	Butte Rebuild Camp Fire-MHP	95		7,975	11,069	-	-	-	-	-	19,044	
4	5537749	Butte Rebuild Camp Fire- UG 95F Other	95		4,906	27,656	-	-	-	-	-	32,562	
5	5539162	Butte Rebuild Camp Fire- Pedestal Pilot	95		-	3,645	-	-	-	-	-	3,645	
6	5539259	Butte Rebuild Camp Fire-Srvc Cnnct Perm	95		-	15,311	-	-	-	-	-	15,311	
7	5543419	SYSPLAN CEMA 95F	95		-	-	133,169	-	-	-	-	133,169	
8	5544406	Major Emergency 95# Butte WLDFR-M014	95		-	-	-	142,480	129,570	97,444	16,940	386,434	
9	**Total**				**20,501**	**119,347**	**133,169**	**142,480**	**129,570**	**97,444**	**16,940**	**659,451**	WP 23-12
10		**Grand Total**			**20,501**	**119,347**	**133,169**	**142,480**	**129,570**	**97,444**	**16,940**	**659,451**	

11 * Planning orders where Construction Work in Progress (CWIP) Balance as of December 31, 2020 plus six years (2021-2026) of forecast.

Workpaper Table 23-9
Pacific Gas and Electric Company
2023 GRC
Exhibit (PG&E-4), Chapter 23
Community Rebuild Program
Recorded and Forecast Capital Expenditures Details - Other Work*
(Thousands of Nominal Dollars)

			Capital Expenditures											
Line No.	MWC	MWC Description	2016 Recorded Adjusted	2017 Recorded Adjusted	2018 Recorded Adjusted	2019 Recorded Adjusted	2020 Recorded Adjusted	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	Reference
1	95	Community Rebuild Capital	-	-	-	15,419	25,491	(31,834)	-	-	-	-	-	
2	**Grand Total**		**-**	**-**	**-**	**15,419**	**25,491**	**(31,834)**	**-**	**-**	**-**	**-**	**-**	WP 23-12

3 * Excludes projects greater than $3M

Workpaper Table 23-10
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 23, Community Rebuild Program
Capital Walk by Major Work Category
MWC 95 - Community Rebuild Capital
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2018**	**Recorded Adjusted**	**0**			
2		Electric Underground Mainline Construction	21,521		PG&E started to underground the electric underground mainline construction after making a public commitment to do so in May 2019.	WP 23-12 Line 1
3		Electric Overhead Mainline Construction	13,441		PG&E built electric overhead mainline construction to serve customers that required service prior to the completion of the electric underground mainline construction. In 2019, PG&E built 15.5 miles.	WP 23-12 Line 2
4		Electric Service Connections (Capital)	11,590		PG&E has an obligation to restore service to customers at PG&E's expense that had service pre-Camp Fire. In 2019, PG&E received 2,239 service applications from rebuild customers.	WP 23-12 Line 3
5		Remote Grids	225		PG&E identified 3 sites for remote grids to forgo the construction of traditional electric underground mainline or electric overhead mainline construction. These costs represent the cost to determine feasibility.	WP 23-12 Line 4
6		Electric Mobile Home Parks	1,619		PG&E has an obligation to restore Mobile Home Parks that had service pre-Camp Fire. PG&E has utilized the Rule 28 Mobile Home Park Program to manage the rebuild of the parks. The costs here are for parks that do not qualify for the Rule 28 Mobile Home Park program.	WP 23-12 Line 5
7		**Net Change**	**48,397**			
8	**2019**	**Recorded Adjusted**	**48,397**			
9		Electric Underground Mainline Construction	18,485		PG&E increased the rate of electric underground mainline construction. PG&E completed 0.2 miles in 2019 and 31.0 miles in 2020.	WP 23-12 Line 1
10		Electric Overhead Mainline Construction	3,516		PG&E continued to build electric overhead mainline construction to serve customers. PG&E built 19.3 miles in 2020, 3.8 miles more than in 2019.	WP 23-12 Line 2
11		Electric Service Connections (Capital)	6,945		PG&E continued to have an obligation to restore service to customers at PG&E's expense that had service pre-Camp Fire. In 2020, PG&E received 2,722 service applications from rebuild customers.	WP 23-12 Line 3
12		Remote Grids	(451)		PG&E wrote off all capital spend for the three remote grid sites because PG&E determined they were not cost-effective because they cost more than traditional electric overhead or underground mainline construction.	WP 23-12 Line 4
13		Electric Mobile Home Parks	5,925		PG&E continued to restore service at Mobile Home Parks. By the end of 2020, PG&E had restored 322 mobile home spaces.	WP 23-12 Line 5
14		Community Rebuild Program Management Office (Capital)	5,283		The PMO supports the management of the long-term rebuild effort, and was established in February 2019. Approval to capitalize PMO costs did not begin until 2020 and are embedded in the individual project costs beginning in 2022.	WP 23-12 Line 6
15		**Net Change**	**39,703**			
16	**2020**	**Recorded Adjusted**	**88,100**			

Workpaper Table 23-11
Pacific Gas and Electric Company
2023 General Rate Case
Exhibit (PG&E-4), Chapter 23, Community Rebuild Program
Capital Walk by Major Work Category
MWC 95 - Community Rebuild Capital
(Thousands of Nominal Dollars)

Ln. No.	Year	Program/Activity	Amount		Detailed Description/Assumptions	Reference
1	**2020**	**Recorded Adjusted**	**$ 88,100**			
2		Electric Underground Mainline Construction	2,908		PG&E expects to decrease the need to build as much electric overhead mainline construction due to creating mini- electric underground mainline construction projects to serve customers rather than building electric overhead mainline construction.	WP 23-12 Line 1
3		Electric Overhead Mainline Construction	(7,658)		PG&E forecasts 8 miles of electric overhead mainline construction in 2021 compared to the 19.3 miles construction in 2020. This is primarily due to PG&E building mini electric underground mainline construction to serve customers.	WP 23-12 Line 2
4		Electric Service Connections	3,195		PG&E hired Harvard University to build a predictive model of return rate of customers. In 2021, PG&E forecasts completing 1,914 electric service connections.	WP 23-12 Line 3
5		Remote Grids	225		PG&E wrote off all capital spend for the remote grids in 2020. PG&E has not identified other feasible remote grid sites. No plans for 2021. PG&E will continue to evaluate feasibility and will pursue if more cost effective than traditional electric underground or electric overhead mainline construction.	WP 23-12 Line 4
6		Electric Mobile Home Parks	3,525		PG&E will continue to rebuild mobile home parks in 2021 that were impacted by the Camp Fire based on the readiness of mobile home park owners. PG&E forecasts that 505 mobile home spaces will be completed.	WP 23-12 Line 5
7		Community Rebuild Program Management Office	(2,783)		The PMO costs for the Community Rebuild will be allocated to the individual orders that make up the Program. PG&E's Capital Accounting determine that PG&E could capitalize 95% of the costs for the PMO.	WP 23-12 Line 6
8		**Net Change**	**(587)**			
9	**2021**	**Forecast**	**87,513**			
10		Electric Underground Mainline Construction	51,998		PG&E will accelerate the electric underground mainline construction from 15.8 miles in 2020 to 22.94 miles in 2021. PG&E is targeting completion of all electric underground mainline construction by the end of 2025.	WP 23-12 Line 1
11		Electric Overhead Mainline Construction	(3,044)		PG&E forecasts that it will construct 4 miles of electric overhead mainline construction in 2022 compared to 8 miles forecasted in 2021.	WP 23-12 Line 2
12		Electric Service Connections	(1,408)		No significant change	WP 23-12 Line 3
13		Electric Mobile Home Parks	610		No significant change	WP 23-12 Line 5
14		Community Rebuild Program Management Office	(2,500)		Beginning in 2022, approved capital PMO costs are embedded in the individual project costs.	WP 23-12 Line 6
15		**Net Change**	**45,656**			
16	**2022**	**Forecast**	**133,169**			
17		Electric Underground Mainline Construction	19,428		PG&E will accelerate the electric underground mainline construction from 22.94 miles in 2022 to 26.47 miles in 2023. PG&E is targeting completion of all electric underground mainline construction by the end of 2025.	WP 23-12 Line 1
18		Electric Overhead Mainline Construction	(3,201)		PG&E forecasts that it will construct 2 miles of electric overhead mainline construction in 2023 compared to 4 miles in 2022.	WP 23-12 Line 2
19		Electric Service Connections	32		No significant change	WP 23-12 Line 3
20		Electric Mobile Home Parks	(6,948)		PG&E forecasts to complete 326 Mobile Home spaces in 2022, down from the 505 Mobile Home Spaces forecasted in 2021.	WP 23-12 Line 5
21		**Net Change**	**9,311**			
22	**2023**	**Forecast**	**142,480**			
23		Electric Underground Mainline Construction	(9,356)		PG&E will be completing the electric underground mainline construction in the Town of Paradise. The remaining scope will be 22.6 miles in 2024 (Decrease in units from 2023 of 26.47 miles).	WP 23-12 Line 1
24		Electric Overhead Mainline Construction	225		No significant change	WP 23-12 Line 2
25		Electric Service Connections	951		No significant change	WP 23-12 Line 3
26		Electric Mobile Home Parks	(4,731)		PG&E forecasts to be completed with all electric mobile home parks by the end of 2023 for customers that have submitted a service application.	WP 23-12 Line 5
27		**Net Change**	**(12,911)**			
28	**2024**	**Forecast**	**129,570**			
29		Electric Underground Mainline Construction	(27,822)		PG&E will be completing the electric underground mainline construction in the part of Magalia that PG&E publicly announced to replace underground. This mileage is limited to 14.8 miles (Decrease from the 22.6 miles forecast in 2024).	WP 23-12 Line 1
30		Electric Overhead Mainline Construction	363		No significant change	WP 23-12 Line 2
31		Electric Service Connections	(4,666)		PG&E forecasts to restore service to 876 electric service connections in 2025 compared to 1,482 forecasted in 2024. This is based on the Harvard University Study evaluating return rate of red-tagged customers.	WP 23-12 Line 3
32		**Net Change**	**(32,125)**			
33	**2025**	**Forecast**	**97,444**			
34		Electric Underground Mainline Construction	(77,163)		PG&E expects to complete the electric underground mainline construction by the end of 2025. Future capital costs are limited to: electric overhead mainline construction, electric service connections, remote grids, electric mobile home parks and Community Rebuild PMO.	WP 23-12 Line 1
35		Electric Overhead Mainline Construction	(1,970)		PG&E forecasts that it will construct 1 mile of electric overhead mainline construction in 2025 compared to 2 miles in 2024.	WP 23-12 Line 2
36		Electric Service Connections	(1,372)		No significant change	WP 23-12 Line 3
37		**Net Change**	**(80,504)**			
38	**2026**	**Forecast**	**16,940**			

Workpaper Table 23-12
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 23, Community Rebuild Program
MWC 95 - Community Rebuild Forecast Details
(Thousands of Nominal Dollars)

Line No.	Description	Recorded 2016	Recorded 2017	Recorded 2018	Recorded 2019	Recorded 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Assumptions	Reference
1	Electric Underground Mainline Construction	$0	$0	$0	$21,521	$40,006	$42,914	$94,912	$114,341	$104,985	$77,163	$0	1	WP 23-13, line 8
2	Electric Overhead Mainline Construction	$0	$0	$0	$13,441	$16,958	$9,300	$6,256	$3,055	$3,279	$3,642	$1,672	2	WP 23-13, line 9
3	Electric Service Connections (Capital)	$0	$0	$0	$11,590	$18,535	$21,730	$20,322	$20,354	$21,306	$16,639	$15,268	3, 4	WP 23-13, line 10
4	Remote Grids	$0	$0	$0	$225	-$225	$0	$0	$0	$0	$0	$0	5	WP 23-13, line 11
5	Electric Mobile Home Parks	$0	$0	$0	$1,619	$7,544	$11,069	$11,679	$4,731	$0	$0	$0	3, 4	WP 23-13, line 12
6	Community Rebuild Program Management Office (Capital)	$0	$0	$0	$0	$5,283	$2,500	$0	$0	$0	$0	$0	6	WP 23-13, line 13
7	**Final Recorded and Forecast**	**$0**	**$0**	**$0**	**$48,397**	**$88,100**	**$87,513**	**$133,169**	**$142,480**	**$129,570**	**$97,444**	**$16,940**		

Forecast Assumptions and Details

1) PG&E publicly committed in May 2019 to underground PG&E's electric distribution facilities in Paradise and parts of Magalia. PG&E expects to complete this effort by the end of 2025.
2) PG&E did not restore 100% of the electric overhead mainline that existed pre-Camp Fire during the original restoration because it was still working on a long-term plan to rebuild and only a limited number of customers needed power at the time of restoration.
3) For customers requiring service prior to the electric underground mainline being completed and in areas where PG&E did not restore the electric overhead mainline during the original restoration effort, PG&E has and will build temporary overhead facilities to serve customers.
4) PG&E is required to restore service to customers that had service pre-Camp Fire (both electric service connections and electric mobile home parks). PG&E conducted a study with Harvard University to determine the return rate of impacted customers based on an evaluation of other fire rebuild efforts, socio-economic factors, etc.
5) PG&E evaluated the potential to create remote grids rather than building traditional electric underground or overhead mainline construction. After feasibility, the proposed project was canceled. No further sites have been identified.
6) Community Rebuild Program Management Office supports the management of the long-term rebuild effort, and was established in February 2019. Approval to capitalize PMO costs was granted in 2020; these costs are embedded in the individual project costs beginning in 2022.

Workpaper Table 23-13
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 23, Community Rebuild Program
Total Costs by Workstream
(Thousands of Nominal Dollars)

Line No.	Exhibit (PG&E-4) Electric Operations	MAT/MWC	Recorded	Recorded	Recorded	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	
1	**Expense**		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**Reference**
2	Electric Service Connections	**IFF**	($44)	$0	$156	$360	$205	$215				WP 23-5, Line 1
3	Construction Site Clearing	**IFF**	$123,521	$231,744	$23,840	$8,751	$11,986	$10,471				WP 23-5, Line 2
4	Community Rebuild Program Management Office	**IFF**	$0	$1,549	$5,198	$2,960	$2,947	$3,095				WP 23-5, Line 3
5	**Total Expense**		**$123,477**	**$233,292**	**$29,194**	**$12,071**	**$15,138**	**$13,781**				
6	**Capital**		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
7	Electric Underground Construction Hardening Program	**08W**	$0	$16,818	$24,774	$41,534	$58,172	$71,245	$65,922	$48,830	$0	WP 4-27, Line 10
8	Electric Underground Mainline Construction	**95F**	$0	$21,521	$40,006	$42,914	$94,912	$114,341	$104,985	$77,163	$0	WP 23-12, Line 1
9	Electric Overhead Mainline Construction	**95F**	$0	$13,441	$16,958	$9,300	$6,256	$3,055	$3,279	$3,642	$1,672	WP 23-12, Line 2
10	Electric Service Connections	**95F**	$0	$11,590	$18,535	$21,730	$20,322	$20,354	$21,306	$16,639	$15,268	WP 23-12, Line 3
11	Remote Grids	**95F**	$0	$225	($225)	$0	$0	$0	$0	$0	$0	WP 23-12, Line 4
12	Electric Mobile Home Parks	**95F**	$0	$1,619	$7,544	$11,069	$11,679	$4,731	$0	$0	$0	WP 23-12, Line 5
13	Community Rebuild Program Management Office	**95F**	$0	$0	$5,283	$2,500	$0	$0	$0	$0	$0	WP 23-12, Line 6
14	**Total Capital**		$0	$65,214	$112,875	$129,047	$191,342	$213,726	$195,492	$146,275	$16,940	
15	**Exhibit (PG&E-4) Electric Operations - Total Costs**		**$123,477**	**$298,507**	**$142,069**	**$141,118**	**$206,480**	**$227,507**	**$195,492**	**$146,275**	**$16,940**	

	Exhibit (PG&E-3) Gas Operations		Recorded	Recorded	Recorded	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	
16	**Expense**		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
17	Gas Main Construction	**LX**	$0	$5,325	($4,016)	$0	$0	$0				
18	Gas Services	**LX, FIM**	$0	$71	$8,454	$0	$0	$0				
19	Community Rebuild Program Management Office	**LX**	$0	$1,355	$930	$1,500	$2,859	$2,912				Exhibit (PG&E-3), Chapter 13, WP 13-14, line 1
20	**Total Expense**		**$0**	**$6,752**	**$5,367**	**$1,500**	**$2,859**	**$2,912**				
21	**Capital**		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
22	Aldyl-A Gas Mainline Construction	**14D**	$0	$14,529	$27,284	$25,600	$24,722	$14,344	$10,977	$4,502	$0	WP 23-14, line 11 and Exhibit (PG&E-3), Chapter 4, WP 4-18, line 49
23	Gas Main Construction	**3QA**	$0	$0	$2,949	$0	$0	$0	$0	$0	$0	
24	Gas Services	**3QA, 50A**	$0	$756	$8,883	$27,294	$14,773	$15,043	$15,868	$10,515	$9,727	WP 23-14, line 13 and Exhibit (PG&E-3), Chapter 4, WP 4-18, line 79
25	Gas Mobile Home Parks	**3QA, 50B**	$0	$1,150	$5,981	$4,817	$9,414	$2,767	$0	$0	$0	WP 23-14, line 14 and Exhibit (PG&E-3), Chapter 4, WP 4-19, line 21
26	**Total Capital**		$0	$16,435	$45,097	$57,710	$48,909	$32,153	$26,845	$15,017	$9,727	
27	**Exhibit (PG&E-3) Gas Operations - Total Costs**		**$0**	**$23,187**	**$50,465**	**$59,210**	**$51,768**	**$35,065**	**$26,845**	**$15,017**	**$9,727**	

	Exhibit (PG&E-6) Customer Care		Recorded	Recorded	Recorded	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	
29	**Capital**		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
30	Nov 2018 Camp Fire-Electric Meters-CEMA	**3M**	$0	$26	$6	$248	$254	$0	$0	$0	$0	Exhibit (PG&E-6), Chapter 7; WP 7-10 lines 30, 37, 44, and WP 7-14, line 33
31	Nov 2018 Camp Fire-Gas Meters-CEMA	**3M**	$0	$47	$37	$254	$261	$0	$0	$0	$0	Exhibit (PG&E-6), Chapter 7; WP 7-10 lines 30, 37, 44, and WP 7-14, line 33
32	Nov 2018 Camp Fire-Gas Modules-CEMA	**3M**	$0	$0	$30	$0	$0	$0	$0	$0	$0	Exhibit (PG&E-6), Chapter 7; WP 7-10 lines 30, 37, 44, and WP 7-14, line 33
33	Butte Wildfire Rebuild - Electric Meters	**25**	$0	$0	$0	$0	$0	$261	$267	$162	$166	Exhibit (PG&E-6), Chapter 7; WP 7-10 lines 30, 37, 44, and WP 7-14, line 33
34	Butte Wildfire Rebuild-Gas Mtrs/Modules	**74**	$0	$0	$0	$0	$0	$268	$273	$166	$170	Exhibit (PG&E-6), Chapter 7; WP 7-10 lines 30, 37, 44, and WP 7-14, line 33
35	**Total Capital**		**$0**	**$74**	**$73**	**$502**	**$515**	**$529**	**$540**	**$328**	**$336**	
36	**Exhibit (PG&E-6) Customer Care - Total Costs**		**$0**	**$74**	**$73**	**$502**	**$515**	**$529**	**$540**	**$328**	**$336**	

37	**Total Expense (PG&E-3, PG&E-4, PG&E-6)**		**$123,477**	**$240,045**	**$34,562**	**$13,571**	**$17,997**	**$16,693**			
38	**Total Capital (PG&E-3, PG&E-4, PG&E-6)**		**$0**	**$81,723**	**$158,045**	**$187,259**	**$240,765**	**$246,408**	**$222,876**	**$161,620**	**$27,002**

Workpaper Table 23-14
Pacific Gas and Electric Company
Exhibit (PG&E-4), Chapter 23, Community Rebuild Program
Forecasted Units by Workstream
(Thousands of Nominal Dollars)

Line No.	Workstream	MAT Code	Capital vs. Expense	2023	2024	2025	2026	2023-2026 Total Forecasted Units	Reference
1	**Exhibit (PG&E-4) Electric Operations**								
2	Electric Underground Mainline Construction	95F	Capital	26.5	22.6	14.8	0	63.9 miles	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
3	Electric Underground Construction Hardening Program	08W	Capital	16.2	13.9	9.1	0	39.2 miles	WP 4-27, Line 8
4	Electric Overhead Main Line Construction	95F	Capital	2	2	2	1	7 miles	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
5	Electric Service Connections	95F/IFF	Capital and Expense	1482	1482	877	876	4,717 underground services	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
6	Electric Mobile Home Parks	95F	Capital	115	0	0	0	115 spaces	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
7	Construction Site Cleaning	IFF	Expense	27	21	14	30	92 miles (underground and overhead)	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
8	Community Rebuild Program Management Office	IFF	Expense	20	20	20	20	20 FTE	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
9	Remote Grids	95F	Capital	0	0	0	0	0 Remote Grids	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
10	**Exhibit (PG&E-3) Gas Operations**								
11	Aldyl-A Gas Mainline Construction	14D	Capital	4.7	3.5	1.4	0	9.6 miles	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
12	Gas Main Construction	3QA / LX	Capital and Expense	0	0	0	0	0 Miles	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
13	Gas Services	3QA /50A /FIM/LX	Capital and Expense	1482	1482	877	876	4,717 gas services	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
14	Gas Mobile Home Parks	3QA/50B	Capital	84	0	0	0	84 spaces	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
15	Community Rebuild Program Management Office	LX	Expense	20	20	20	20	20 FTE	PG&E-4, Chapter 23, Project Summary - Community Rebuild Program
16	**Exhibit (PG&E-6) Customer Care**								
17	Customer Care Meter Forecast	3M /25 /74	Capital	1482	1482	877	876	4,717 meters	PG&E-6, Chapter 7 Metering Services and Engineering; WP 7-10, 7-14

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 23, COMMUNITY REBUILD PROGRAM
PROJECT SUMMARY – COMMUNITY REBUILD PROGRAM

Project Title: Community Rebuild Program
Major Work Categories: 95, IF
Planning Order Numbers: Various
Project Start Date: 02/01/2019
Project Completion Date: 12/31/2026
Operative Date (only applies to Capital): Various

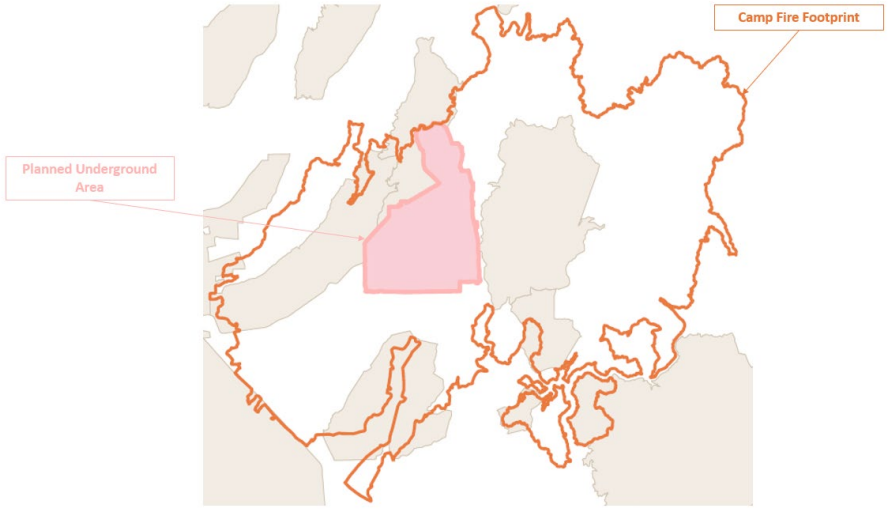
Project Description

The Community Rebuild Program ("The Program") was formed at PG&E after the 2018 Camp Fire to lead the long-term rebuild of PG&E's infrastructure, which devastated the Town of Paradise and surrounding areas in Butte County. The Camp Fire destroyed over 18,000 structures, including 13,400 premises.

PG&E weighed many factors in its decision on how to rebuild long-term including: reducing wildfire risk, improving egress routes for evacuation, aligning PG&E rebuild plans with the Town of Paradise urban design plan, and the opportunity to joint trench electric and gas facilities. PG&E publicly committed to undergrounding the Town of Paradise and in some surrounding areas like parts of Magalia in May 2019.

The entire project entails 207 miles of electric underground mainline construction, 58 miles of Aldyl-A Gas Main Line Construction joint-trenched with electric underground mainline construction, 62 miles of electric overhead main line construction, 13,686 electric service connections, and 1,293 mobile home park spaces. PG&E plans to complete all the underground mainline over a 5-10-year period.

Figure 1
The Camp Fire impacted ~430 miles of electric distribution ("Camp Fire Footprint"). Within this area, PG&E's public commitment includes undergrounding 207 miles ("Planned Underground Area").



PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 23, COMMUNITY REBUILD PROGRAM
PROJECT SUMMARY – COMMUNITY REBUILD PROGRAM

Justification / Benefits

The scope focuses on meeting PG&E's obligation to serve customers by restoring utility infrastructure to meet our public commitments (mandated), while exceeding PG&E's regulatory requirement to rebuild at the electric overhead hardened standard by moving assets underground (non-mandated).

The value proposition of the Program includes:

- Reducing wildfire risk and improving public safety: During the Camp Fire, many electric overhead mainline distribution poles fell into the streets and blocked access to the egress routes. The impacted area is in a Tier 2 (Elevated) and 3 (Extreme) fire risk area, with a very small area in Tier 1 (Normal). **Figure 2** shows an image of a fallen mainline distribution pole.

Figure 2

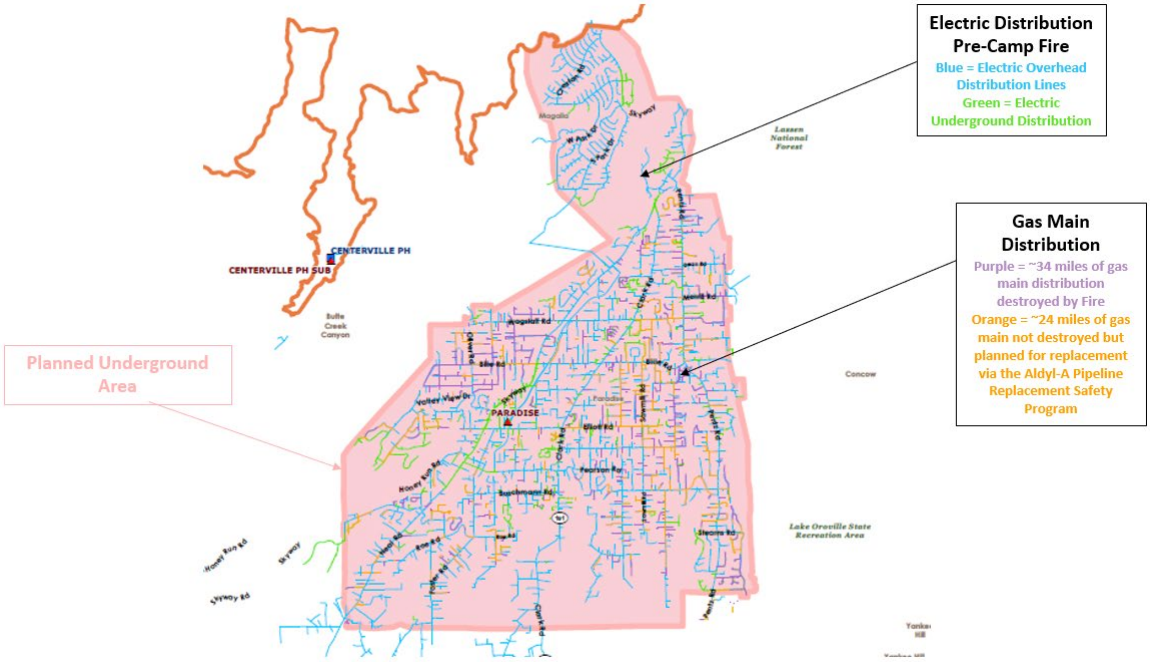


- Future avoided costs: Some distribution lines, such as Bucks Creek 1101, have required replacement due to wildfire damage multiple times in the last decade.

- Joint Trench Opportunities: Approximately 34 miles of gas main distribution was destroyed by the Camp Fire and PG&E has an obligation to restore the gas main to serve customers (Noted in purple in Figure 3). An additional 24 miles of gas main were not destroyed but were planned to be replaced via PG&E's Aldyl-A Gas Mainline Construction Replacement Safety Program (Noted in Orange in Figure 3). In these areas of Paradise, PG&E is taking advantage of the unique opportunity to joint trench the underground construction with gas and electric. Performing joint trench helps drive down the electric underground mainline costs and gas main distribution costs by sharing costs.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 23, COMMUNITY REBUILD PROGRAM
PROJECT SUMMARY – COMMUNITY REBUILD PROGRAM

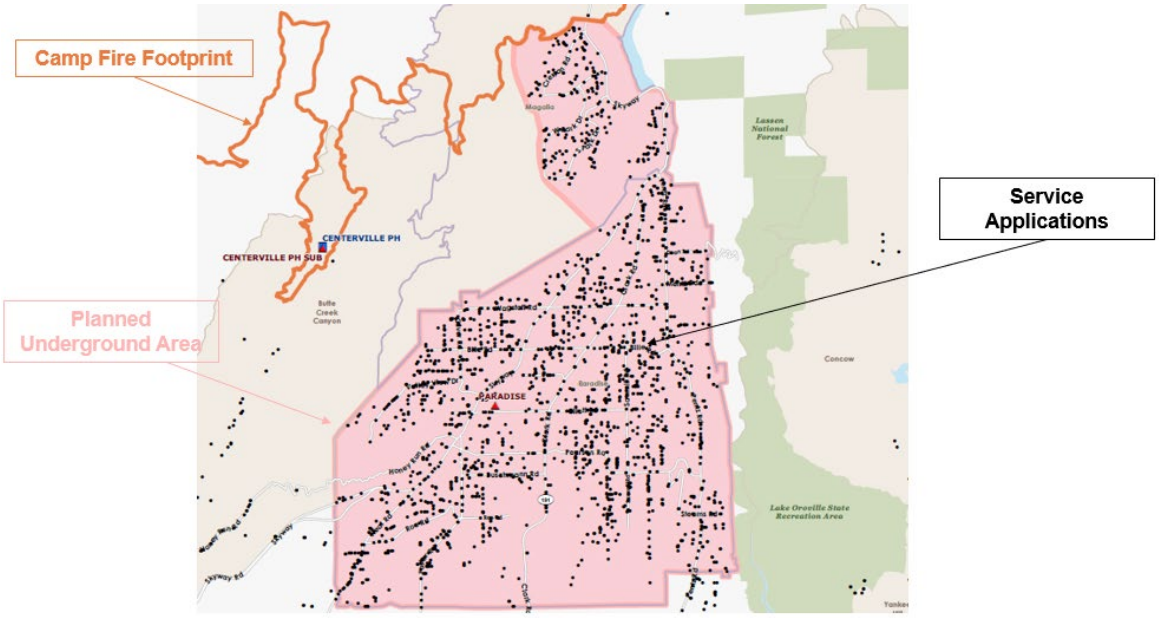
Figure 3



- City Planning and Economic Growth: The Town of Paradise ("Town") and Butte County have expressed strong desire for underground utilities to improve the safety egress paths, improve their Town design, follow a "dig-once" ordinance, and encourage economic growth and higher return rate of impacted customers by making it safer. PG&E is coordinating construction closely with the Town of Paradise to complete construction before they repave their Town arteries. As of 3/9/21, PG&E have received 5,519 service applications from impacted customers. **Figure 4** depicts the scattered pattern of customers applying for service (black dots).

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 23, COMMUNITY REBUILD PROGRAM
PROJECT SUMMARY – COMMUNITY REBUILD PROGRAM

Figure 4



- Public Safety Power Shutoffs (PSPS) Improvements: In 2020, this area of PG&E's service territory experienced five PSPS events spanning a total of 13 days. As the Program is executed over the next 5-10 years, it will further enable planned electric mainline underground distribution areas to remain energized during PSPS events.

The Program is part of both PG&E's 2020 approved Wildfire Mitigation Plan and 2021 filed Wildfire Mitigation Plan with annual targets to complete underground construction within the Camp Fire Footprint.

PG&E expanded the Emergency Consumer Protection Plan to support residential and non-residential customers affected by the Camp Fire and other disasters in Compliance with Decision (D.) 18-08-004 Advice Letter 4014-G/5378-E. A portion of the work in MAT 95F is a Wildfire risk mitigation (WLDFR-M014).

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 23, COMMUNITY REBUILD PROGRAM
PROJECT SUMMARY – COMMUNITY REBUILD PROGRAM

Cost

Major Project Spending Estimates

(Thousands of Nominal Dollars)

	Recorded					Forecast						
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
EXPENSE												
Various POs	N/A	N/A	123,477	233,292	29,194	12,071						398,034
PO 5056981							15,138					15,138
PO 5058182								13,781				13,781
Expense Total	**-**	**-**	**123,477**	**233,292**	**29,194**	**12,071**	**15,138**	**13,781**	**-**	**-**	**-**	**426,953**
CAPITAL												
Various POs				48,397	88,100	87,513						**224,010**
PO 5543419							133,169					133,169
PO 5544406								142,480	129,570	97,444	16,940	386,434
Capital Total			**-**	**48,397**	**88,100**	**87,513**	**133,169**	**142,480**	**129,570**	**97,444**	**16,940**	**743,613**
TOTAL PROJECT COST	**-**	**-**	**123,477**	**281,689**	**117,294**	**99,584**	**148,307**	**156,261**	**129,570**	**97,444**	**16,940**	**1,170,566**

The entire project entails 207 miles of electric underground mainline construction, 58 miles of Aldyl-A Gas Main Line Construction joint-trenched with electric underground mainline construction, 62 miles of electric overhead main line construction, 13,686 electric service connections, and 1,293 mobile home park spaces. PG&E plans to complete all the underground mainline over a 5-10-year period. **Table 1** outlines the forecasted units by year for 95F and IFF only.

Table 1

Workstream	2023	2024	2025	2026	Total
Electric Underground Mainline Construction (Miles)	26.5	22.6	14.8		63.9
Electric Overhead Main Line Construction (Miles)	2.0	2.0	2.0	1.0	7.0
Electric Mobile Home Park (Spaces)	115				115
Electric Service Connections (Premises)	1,482	1,482	877	876	4,717
Temporary Services for Pedestal Program (Premises)	264	264	264	264	1,056
Overhead Services	168	168	168	168	672
Construction Site Clearing (Miles)	27	21	14	30	92
Community Rebuild Program Management Office (Full Time Employees) (Electric)	20	20	20	20	80
Gas Services (Premises)	1,482	1,482	877	876	4,717
Gas Mobile Home Parks	84	0	0	0	84
Community Rebuild Program Management Office (Full Time Employees) (Gas)	20	20	20	20	80

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EXHIBIT (PG&E-4), CHAPTER 23, COMMUNITY REBUILD PROGRAM
PROJECT SUMMARY – COMMUNITY REBUILD PROGRAM

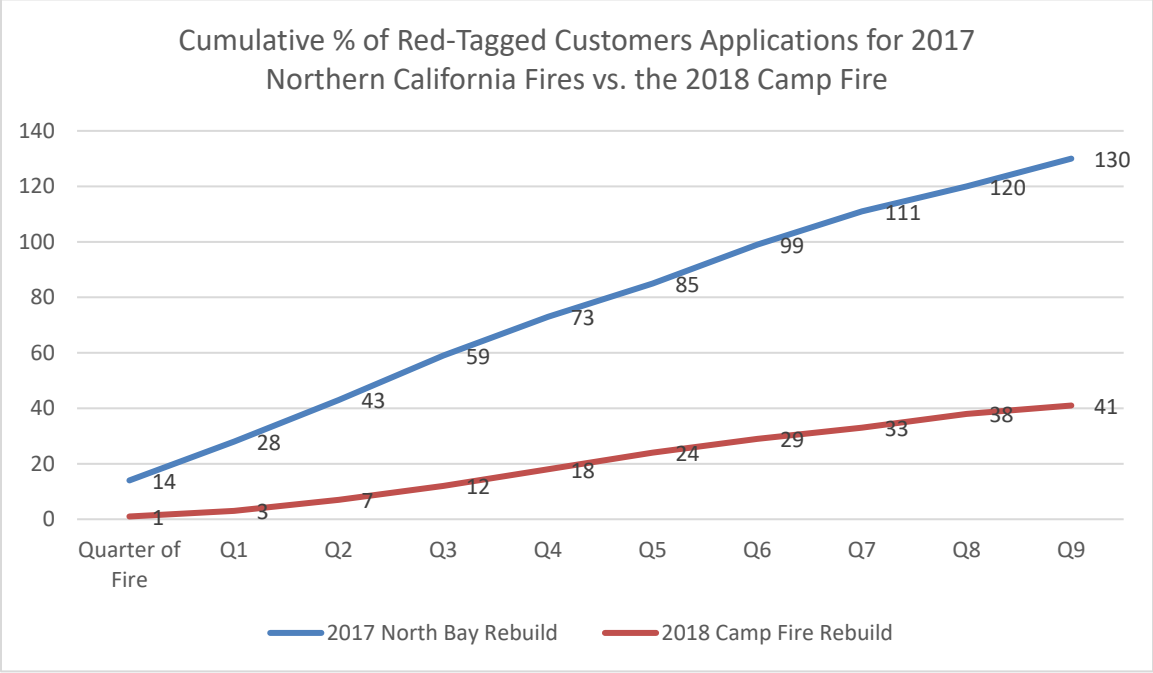
Additional Cost Information:

Primary Assumptions

- Expense
  - Expense costs are based on costs for material and labor costs.
  - The Temporary Service for Pedestal Program workstream W1 forecast is based on the cost of the pedestal material and the labor to remove the pedestal at the time the permanent service is installed. There is also a capital component based on the labor and material to install the permanent splice box to connect to the temporary pedestal.
  - The Construction Site Clearing workstream W2 forecast is based on unit cost per foot for construction site clearing during PG&E's initial emergency response effort to the 2018 Camp Fire, program performance in 2019 and 2020, and on factors specific to the Community Rebuild program.
  - The Community Rebuild PMO workstreams W3 and W4 consists primarily of Community Rebuild Program's PMO labor, or headcount needed for program oversight and support. 95 percent of headcount for the PMO is charged directly to major capital project costs for the underground construction on the Community Rebuild. The other 5 percent of the headcount for the Community Rebuild Program PMO is reflected in the expense forecast. This expense forecast is further split 50/50 between gas and electric to share support resources since both commodities are built in the program.
- Capital
  - PG&E used both a unit cost and project cost estimating methodologies to forecast the costs for the work described herein.
  - Electric Underground and Overhead MainLine Construction, and Electric and Gas Services
    - To develop an initial forecast for workstreams W5, W6, W8, W9, and W10 PG&E benchmarked the rebuild costs associated with the Coffey Park rebuild after the 2017 Northern California Wildfire Season due to similar construction factors such as joint trench construction, urban environment, and soil conditions. PG&E then adjusted the cost from the Coffey Park rebuild to account for factors specific to the Camp Fire footprint. The primary factors driving the adjustments were joint utility participation and resource availability. Workstreams W5, W6 and W8 forecasts were based on a cost/foot, and workstreams W9 and W10 were based on a cost per premise (typically property or account) from the Coffey Park rebuild. The units for underground mainline mileage were based on the miles of distribution that existed prior to the Camp Fire.
  - AldylA Gas Underground Construction, Service Meters, and Electric and Gas Mobile Home Parks
    - For workstream W7, PG&E used the replacement unit cost for AldylA Gas Mainline Construction described in Exhibit (PG&E-3) Chapter 4, WP 4-18.
    - For workstream W11 PG&E used the unit cost method for meters as described in the Metering Services and Engineering Chapter Exhibit (PG&E-6), WP 7-10 and 7-14. Annual units for residential and commercial services for the Community Rebuild Program are based on current demand trends and rebuild rates from other disasters, specifically including the 2017 and 2018 Northern California Wildfires.
    - For workstreams W12 and W13, PG&E evaluated the cost per space based on historical average cost for PG&E mobile home spaces for years 2016 – 2018 and adjustments based on factors specific to the Camp Fire footprint drivers, as described above. Units

for MHPs are forecasted based on current customer demand to rebuild MHPs; the majority of MHPs in the Community Rebuild scope have applied for participation.
  - There is no forecast for Remote Grid workstream W14 and therefore no estimating method.
- The Electric Underground Main Line Construction will be completed by the end of 2025. This scope will be aligned with the Town of Paradise's urban design plan that focuses on road widening efforts to improve egress routes. PG&E will prioritize the areas where PG&E was not able to restore natural gas during PG&E's original restoration response. Cost forecasted past 2025 will be for customer driven work as customers apply for service including: electric service connections, electric mobile home parks spaces, Community Rebuild Program Management Office, and construction site clearing costs.
- Customers will return to rebuild following the Camp Fire and PG&E will be required to serve them based on the customer need-by-date. PG&E modeled the return rate of customers by engaging Harvard University to build a predictive model. The model considered: other PG&E rebuild return rates (i.e. Carr Fire, North Bay), pre-Camp Fire PG&E services received, participation pre-Camp Fire in PG&E programs (i.e. energy efficiency, CARE, FERA), usage, socioeconomic factors and insurance differences. **Graph 1** compares cumulative application rates for the 2017 Northern California Fires (Red-Tagged Customers: 6,684 premises) vs. the Camp Fire (Red-Tagged Customers: 13,400) as a ratio of the total red-tagged impacted customers.

Graph 1



- Customers applying for service that they did not have pre-Camp Fire will be treated like a PG&E New Business Customer and those costs are not included in the forecast. For example, if a customer only had electric service pre-Camp Fire, but the customer now wants both electric and gas service, PG&E will pay for the electric service, but the customer will be responsible for the extension of gas service to serve their premise.

PACIFIC GAS AND ELECTRIC COMPANY
EXHIBIT (PG&E-4), CHAPTER 23, COMMUNITY REBUILD PROGRAM
PROJECT SUMMARY – COMMUNITY REBUILD PROGRAM

- Regardless if all 13,400 premises impacted by the Camp Fire rebuild, PG&E will be required to rebuild 100% of the infrastructure that existed pre-Camp Fire to serve the customers that do apply due to the scattered pattern of service applications as pictured in **Figure 4.**
- Rebuild customers will have the option to have temporary power to rebuild their homes prior to receiving permanent power from PG&E. As approved in the Advice Letter 6120-E, PG&E received approval for a pilot pedestal program to provide supplemental measure under PG&E's Emergency Consumer Protection Plan for eligible residential customers impacted by the Camp Fire. See **Figure 6** below for a diagram of the pedestal pilot and **Figure 7** for permanent power. By conducting the pilot program, PG&E expects to have positive average savings per customer for all areas PG&E chooses to implement this program.

Figure 6 – Pedestal for Temporary Power

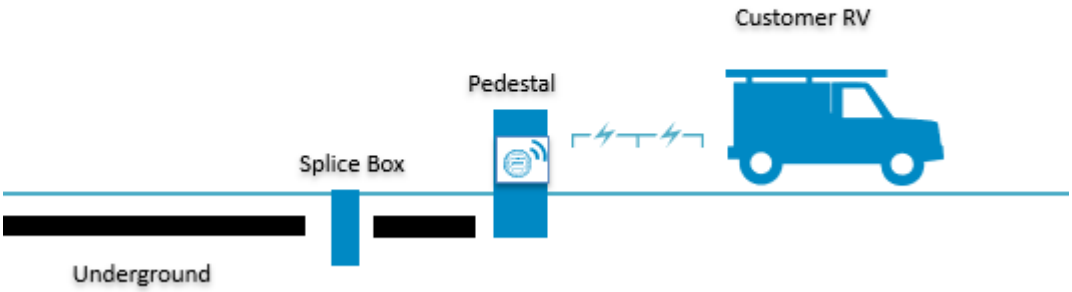
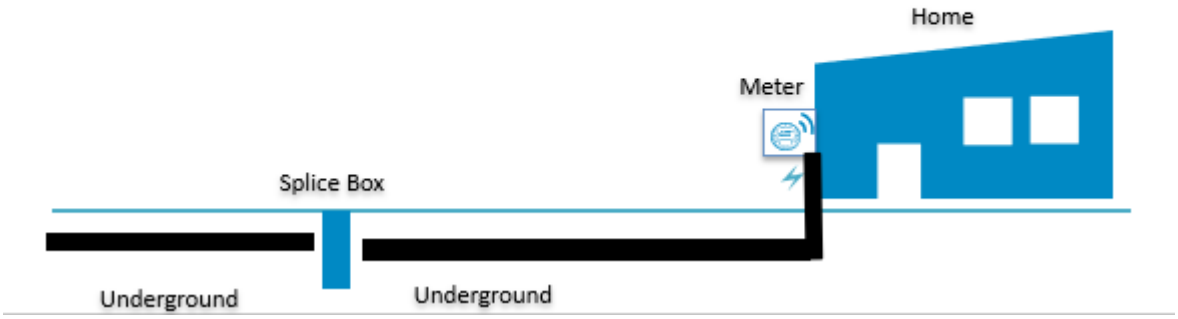


Figure 7 – Permanent Power



- PG&E's Community Rebuild and Resiliency (CRRP) Program Management Organization will be required for the duration of the rebuild to oversee all aspects of the rebuild including safety, operational/construction, financial and program controls, and customer and external engagement.
- Costs recovery for Butte Rebuild Expenditures for 2019-2020, excluding cost disallowed by the Wildfire Order Instituting Investigation (OII) disallowances in accordance with D.30-05-019.

Alternatives Considered

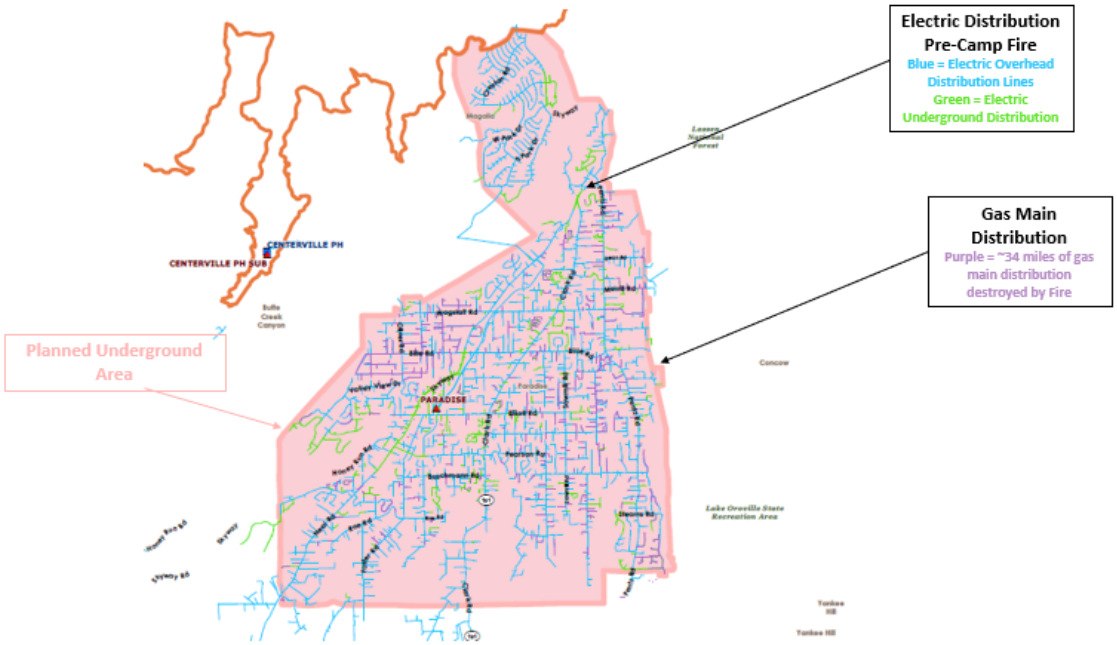
PG&E evaluated two other Rebuild Programs before making the public decision to underground the Town of Paradise and parts of Magalia in May 2019.

Alternative 1: Like-for-Like with Overhead Hardened Distribution Facilities
Alternative 1 focused on rebuilding like-for-like electric overhead main line construction that existed pre-Camp Fire, but to the hardened standard, while also rebuilding the approximately 34 miles of gas main destroyed by the Fire as depicted in **Figure 8**.

Alternative 1 was not selected because:

- Public Safety: The risk of PG&E's electric overhead main line construction poles impacting egress routes during any future potential emergency/evacuation would have remained if PG&E rebuilt like-for-like.
- Joint Trench Opportunities: As part of PG&E's obligation to restore service to customers that had service pre-Fire, PG&E would be required to restore the 34 miles of gas main distribution impacted by the Fire. PG&E would be forgoing the cost savings by joint-trench electric and gas facilities if it rebuilt electric overhead lines rather than undergrounding those lines.
- City Planning and Economic Growth: Rebuilding overhead facilities did not meet the Town's desire for unobstructed egress routes nor the town's urban design process. If PG&E had rebuilt electric overhead facilities, there would have been a high likelihood that we would have been required to relocate those facilities due to the Town of Paradise's road widening work and increased the work required by other budget.
- PSPS Impacts: There would have been a greater likelihood with electric overhead main line construction that the Town of Paradise and parts of the surrounding areas would have been in scope for future PSPS events if not placed underground.

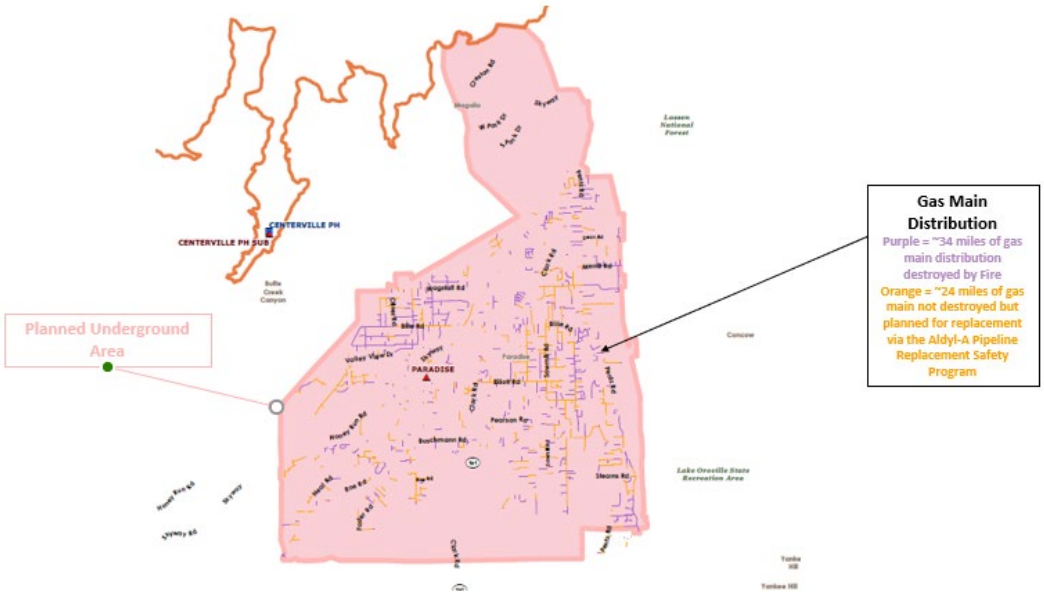
Figure 8



Alternative 2: Partial Electric Mainline Underground Distribution

Alternative 2 focused on undergrounding the electric distribution mainline only where PG&E could joint-trench with gas main distribution as depicted in **Figure 9**. The scope would have been 58 miles of joint trench electric mainline underground distribution and gas main distribution and 149 miles of electric overhead main line construction. Alternative 2 was not selected for the same reasons as Alternative 1. Alternative 2 only partially helped improve the risks associated with public safety, partially decreased the long-term O&M costs, did not align with the City Planning and economic growth plan, and PSPS impacts only partially mitigated.

Figure 9



PACIFIC GAS AND ELECTRIC COMPANY
2023 GENERAL RATE CASE

Testimony ___ Workpapers _X_ SOQ ___

Exhibit Number: _4_ Chapter Number: _23_

Chapter Title: _Community Rebuild Program_

Witness Name: _Marcela Fox_

Page No.	Line No.	Item	As Filed	As Corrected
Errata as of November 5, 2021				
WP 23-1	1	MWC description revised	E Dist Major Emergency	Community Rebuild Expense
WP 23-2	1	MWC description revised	E Dist Major Emergency	Community Rebuild Expense
WP 23-6	1	MWC description revised	E Dist Major Emergency	Community Rebuild Capital
WP 23-8	0	MWC description revised	E Dist Major Emergency	Community Rebuild Capital
WP 23-9	1	MWC description revised	E Dist Major Emergency	Community Rebuild Capital
WP 23-3 WP 23-4 WP 23-5 WP 23-10 WP 23-11 WP 23-12	Title	WP Titles, replaced "Major Emergency" with "Community Rebuild"	Major Emergency	Community Rebuild