

Application No.: A.23-05-010
Exhibit No.: SCE-02 Vol. 03
Witnesses: M. Al-Ahmar
D. Bernaudo



(U 338-E)

2025 General Rate Case

Meter Activities

Before the

Public Utilities Commission of the State of California

Rosemead, California
May 12, 2023

SCE-02 Vol. 03: Meter Activities

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I.

INTRODUCTION

A. Content and Organization of Volume

This volume presents Southern California Edison's (SCE's) forecasts for (1) the Meter Activities Business Planning Element (BPE), and (2) Advanced Metering Infrastructure (AMI) 2.0 pre-deployment costs.

Chapter II includes analyses for the Meter Activities BPE of: (1) O&M and capital funding authorized in the 2021 General Rate Case (GRC) compared to recorded amounts in 2021; (2) the 2025 O&M Test Year forecast; and (3) the 2023 – 2028 capital expenditures forecast. Chapter III addresses AMI 2.0 planning costs, including the need for AMI 2.0, SCE's 2023-2024 O&M forecast for planning activities (provided as contextual information as SCE is not seeking recovery of these expenses in this GRC Application), and SCE's 2023-2028 capital expenditures forecast for planning activities.

B. Summary of O&M and Capital Request

For Meter Activities, SCE forecasts \$45.653 million in O&M expenses in Test Year 2025. This includes \$19.053 million for Meter Engineering, Field Meter Maintenance, and Field Meter Testing; \$5.708 million for Field Meter Reading; \$10.647 million for Meter Installations, Removals and Relocations; \$7.438 million for Customer Installation & Energy Theft; and \$2.806 million for Meter System Maintenance Design. SCE also forecasts \$202.670 million in capital expenditures for 2023-2028 for Meter Activities. This includes \$196.841 million for Meter Engineering and \$5.825 million for Meter System Maintenance Design.

As for AMI 2.0 planning work, SCE forecasts \$53.201 million in capital expenditures for 2023-2028.

SCE's total request for the Distribution Grid Business Planning Group (BPG) is presented in Figure I-1 and Figure I-2 below.

Figure I-1
Distribution Grid SCE 02 Vol 03 2025 O&M Forecast
(Total Company Constant \$000)

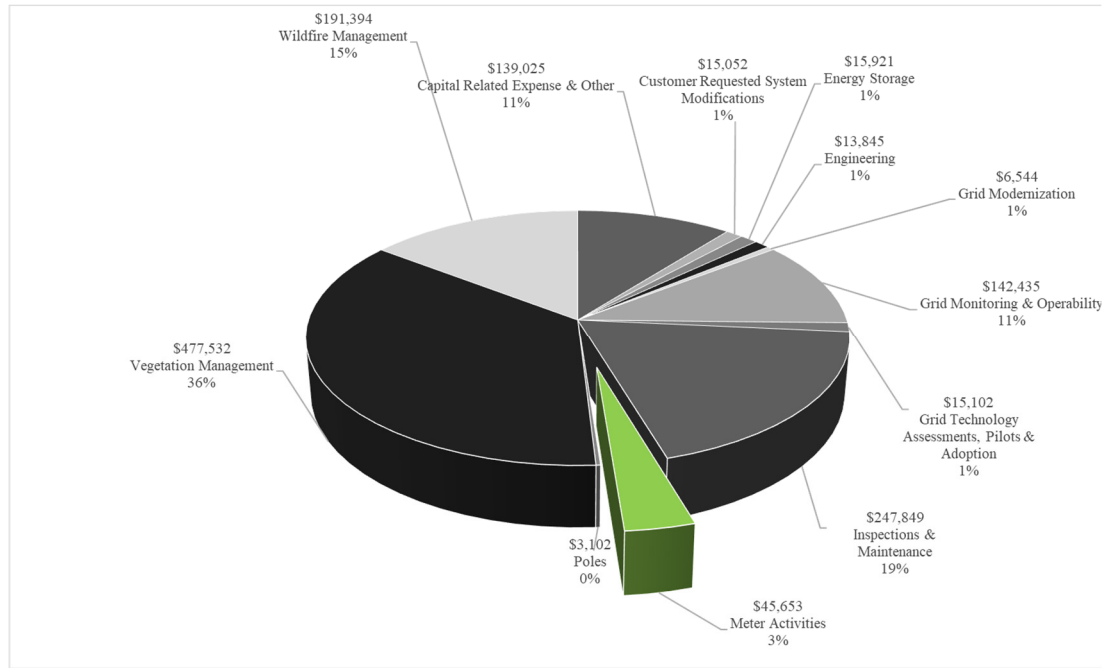
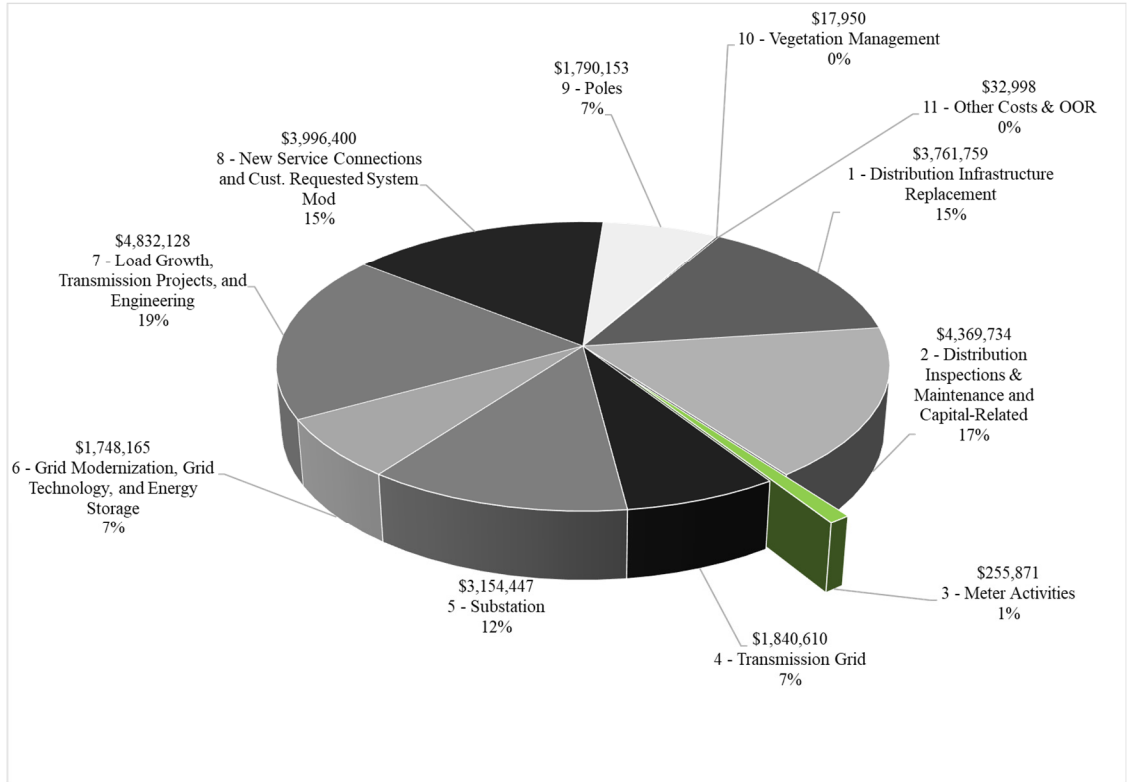


Figure I-2
Distribution Grid SCE 02 Vol 03 Capital Forecast 2023-2028
(Total Company Nominal \$000)



II.

METER ACTIVITIES

A. Overview

The Meter Activities BPE includes the activities associated with the life span of a customer's meter. The O&M activities include (1) Meter Engineering, Field Meter Maintenance, and Field Meter Testing; (2) Field Meter Reading; (3) Installations, Removals and Relocations; (4) Customer Installation & Energy Theft; and (5) Meter System Maintenance and Design. The capital activities include (1) Meter Engineering; and (2) Meter System Maintenance Design. The work done in these activities is required for the safety and reliability of the meter system, guards against the issues caused by technology obsolescence, allows customers to receive timely billing, makes sure that all customers pay their fair share for the electricity they use, and protects against the safety issues caused by energy theft. The O&M activities requested in this chapter are shown in Table II-1 and the capital activities requested in this chapter are shown in Table II-2.

Table II-1
Meter Activities O&M Activities
Recorded (2018-2022) / Forecast (2023-2025)
(Constant 2022 \$000)

	Recorded					Forecast		
	2018	2019	2020	2021	2022	2023	2024	2025
Field Meter Reading	\$6,835	\$4,845	\$5,137	\$5,499	\$5,317	\$5,466	\$5,531	\$5,708
Meter System Maintenance Design	\$2,833	\$3,046	\$3,333	\$3,371	\$2,846	\$2,477	\$2,480	\$2,806
Customer Installation and Energy Theft	\$5,116	\$6,671	\$7,595	\$6,817	\$7,160	\$7,381	\$7,332	\$7,438
Meter Engineering, Field Meter Maintenance, and Field Meter Testing	\$17,647	\$17,372	\$18,379	\$16,289	\$16,074	\$17,731	\$18,356	\$19,053
Installations, Removals and Relocations	\$9,467	\$10,992	\$9,979	\$8,549	\$11,362	\$10,670	\$10,706	\$10,647
Totals	\$41,899	\$42,926	\$44,423	\$40,525	\$42,759	\$43,725	\$44,405	\$45,653

Table II-2
Meter Activities Capital Activities
Recorded (2018-2022) / Forecast (2023-2028)
(Nominal \$000)

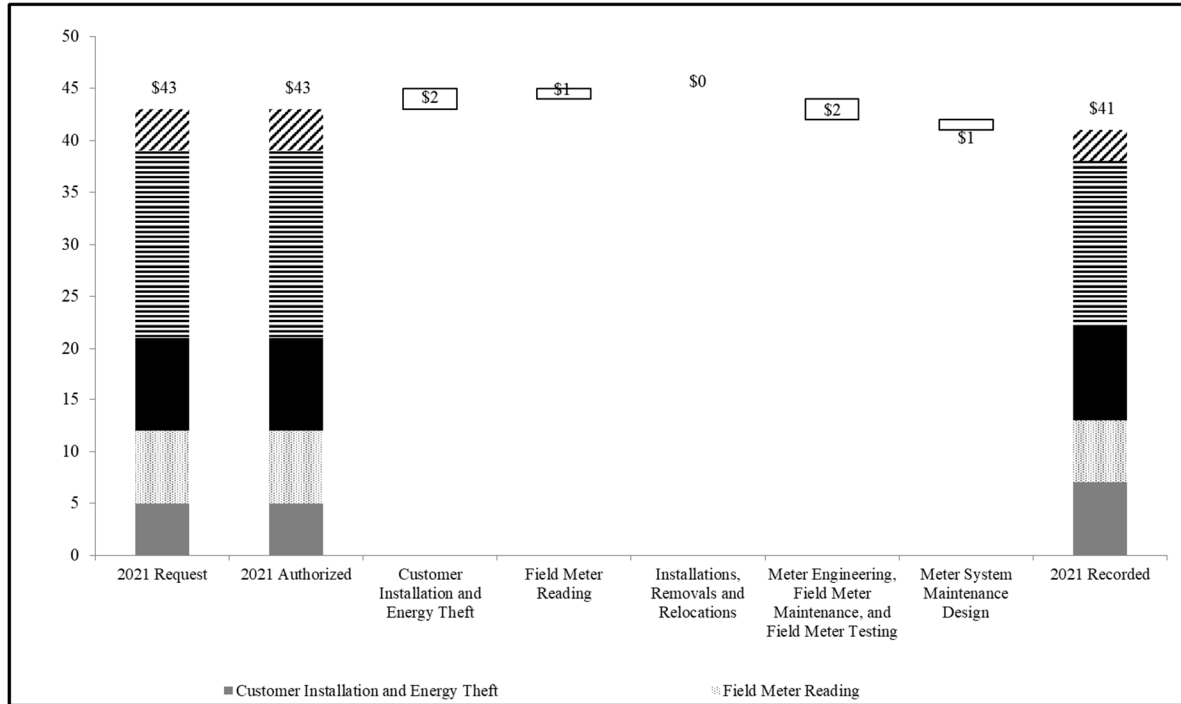
	Recorded					Forecast					
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Meter System Maintenance Design	\$228	\$288	\$788	\$384	\$374	\$904	\$936	\$965	\$987	\$1,007	\$1,026
Meter Engineering	\$13,061	\$24,270	\$50,436	\$26,248	\$35,437	\$29,247	\$33,703	\$34,431	\$34,855	\$33,950	\$30,656
Totals	\$13,290	\$24,558	\$51,224	\$26,632	\$35,810	\$30,152	\$34,639	\$35,397	\$35,843	\$34,957	\$31,683

B. 2021 Decision

1. Comparison of Authorized 2021 to Recorded

The 2021 GRC Decision requires SCE to compare the 2021 authorized amounts to the recorded amounts. The 2021 final decision authorized \$42.479 million for Meter Activities O&M. This compares to \$40.525 million total recorded for 2021, which is \$1.954 million lower than authorized. The lower recorded amount is primarily due to a decrease in meter reading activities due to a reduced need for manual meter reading as a result of continuing improvement in the SCE network's ability to collect data from meters. There was also a decrease in Customer Installation and Energy Theft and in Meter Engineering, Field Meter Maintenance, and Field Meter Testing due to a system freeze related to the new customer service system implementation.

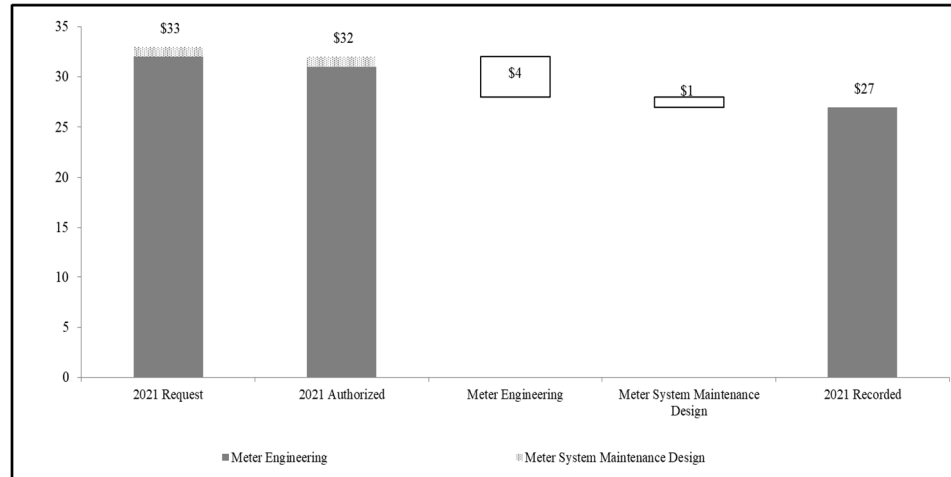
Figure II-3
2021 GRC Requested and Authorized O&M Expenses
Compared to Recorded for Meter Activities¹
(Total Company Constant 2022 \$Millions)



The 2021 GRC final decision also authorized \$32.340 million for Meter Activities capital expenditures in 2021. This compares to \$26.632 million total recorded for 2021, which is \$5.708 million under authorized. This lower recorded amount is primarily due to SCE having to defer planned projects due to supply chain constraints caused by both the COVID-19 pandemic and a worldwide microchip shortage. For example, SCE had planned in 2021 to replace approximately 6,000 Real Time Energy Metering (RTEM) meters that have obsolete radio technology. However, SCE was unable to replace any of these meters due to the microchip shortage. Similarly, SCE had planned to begin replacing legacy electromechanical meters in Catalina with over-the-air meters in 2020 but was not able to begin this project until the fourth quarter of 2021. In both instances, SCE was unable to acquire the necessary meters to timely begin and complete these projects due to the supply chain constraints. This is discussed more in section II.C below.

¹ WP SCE-07, Vol. 01, Authorized vs. Recorded.

Figure II-4
2021 GRC Requested and Authorized Capital Expenses
Compared to Recorded for Meter Activities²
(Total Company 2022 \$Millions)

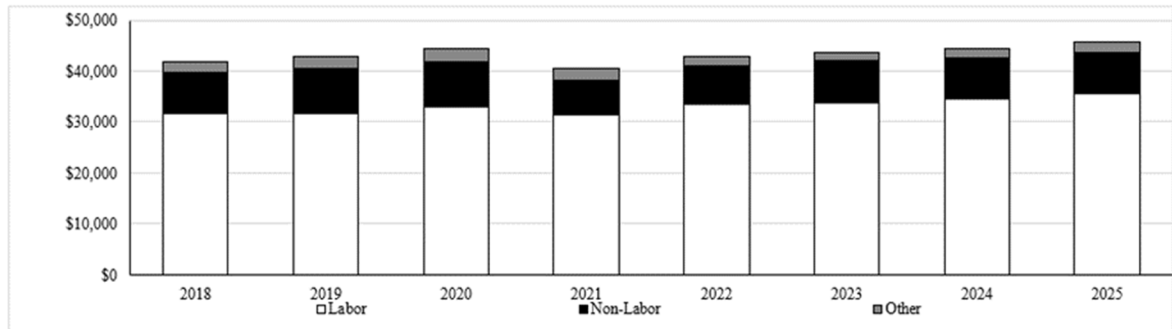


C. O&M Forecast – Meter Activities

The recorded historical and forecast O&M expenses for all Meter Activities are shown below in Figure II-5 and discussed in the following sections.

² WP SCE-07, Vol. 01, Authorized vs. Recorded.

Figure II-5
Meter Activities
Recorded 2018-2022 / Forecast 2023-2028³
(Constant 2022 \$000)



	Recorded					Forecast		
	2018	2019	2020	2021	2022	2023	2024	2025
Labor	\$31,811	\$31,645	\$32,915	\$31,513	\$33,509	\$33,829	\$34,539	\$35,674
Non-Labor	\$7,941	\$8,756	\$8,794	\$6,556	\$7,424	\$8,177	\$8,144	\$8,078
Other	\$2,147	\$2,525	\$2,714	\$2,457	\$1,826	\$1,719	\$1,722	\$1,901
Total Expenses	\$41,899	\$42,926	\$44,423	\$40,525	\$42,759	\$43,725	\$44,405	\$45,653
Ratio of Labor to Total	76%	74%	74%	78%	78%	77%	78%	78%

1. Meter Engineering, Field Meter Maintenance, and Field Meter Testing

a) Work Description and Need

The Meter Engineering, Field Meter Maintenance, and Field Meter Testing activity includes SCE's Meter Engineering, Meter Shop, Field Meter Maintenance, and Field Meter Testing operations.

Meter Engineering manages metering strategy, meter technical specification and selection, routine meter deployment support, and the reliability and quality of all metering products used on the SCE system. Engineering activities are primarily driven by customer growth, customer metering load requirements, meter failure and communication issues, introduction of new meter technology, and customer participation in time-of-use programs. Specially trained meter technicians perform complex metering jobs, which are jobs that require additional equipment or special installation or maintenance instructions indicating what steps the meter technician needs to take in order to complete the job. This

³ WP SCE-02, Vol. 03 pp. 1-6 – O&M Detail for Meter Engineering, Field Meter Maintenance, & Field Meter Testing.

1 work is normally performed for large commercial customers, although the residential sector also
2 requires this support for solar and electric vehicle charging metering requests. In addition, SCE's
3 metering engineers work with manufacturers to evaluate new metering products to meet SCE customer
4 needs. This group also analyzes trouble reports generated by SCE's Reliability Operations Center and
5 Advanced Metering Operations group to determine the root cause of an issue, identify equipment needed
6 for replacement, and provide replacement information to field meter technicians who perform the
7 replacement.

8 The Meter Shop tests meters received from suppliers, ensures they are set up
9 correctly in SCE's system with security keys, and manages the warranties and maintenance on meters
10 returned by SCE field service personnel. Security keys allow the decryption of meter information sent
11 back and forth from meter system and backhaul system. Meter Shop personnel also conduct root cause
12 analysis of field meter failures to maintain the safety, reliability, and data integrity of the meters in the
13 field. The Meter Shop also works with manufacturers on resolving meter product and quality issues.

14 Field Meter Maintenance and Field Meter Testing are activities performed to
15 verify installations are completed properly by confirming the service voltage and wiring are correct.
16 These activities are performed by meter technicians in SCE's Electrical Metering Services (EMS).
17 Appropriate measurements such as visual inspections, voltage/current measurements, continuity checks,
18 mechanical checks, and inspections confirm the service is being metered correctly, which is necessary
19 for accurate billing. Meter technicians also perform non-test work to the meter and panel, including
20 service wiring, interval read verifications, installation of relay equipment, communication checks, and
21 site assessments to determine if radio coverage is available prior to installing radio communication
22 meters. EMS supports SCE's metering systems by administering required meter testing and maintenance
23 programs. EMS also installs meters and associated metering equipment for complex metering
24 installations, including meter installations requiring specialized metering, current and or potential
25 transformers, as well as additional communication components (antenna, radio, etc.). The largest volume
26 of work is for meter-accuracy testing.

27 Meter-accuracy testing includes the following:

28 *Random sample and routine tests.* SCE's random sample and routine test function
29 consists of four testing programs: (1) annual testing of meters with annual usage of two million kWh or
30 more; (2) biennial testing of meters with annual usage between 720,000 kWh and two million kWh; (3)

1 random sample testing of non-residential meters with annual usage less than 720,000 kWh; and (4)
2 random sample testing of residential meters.

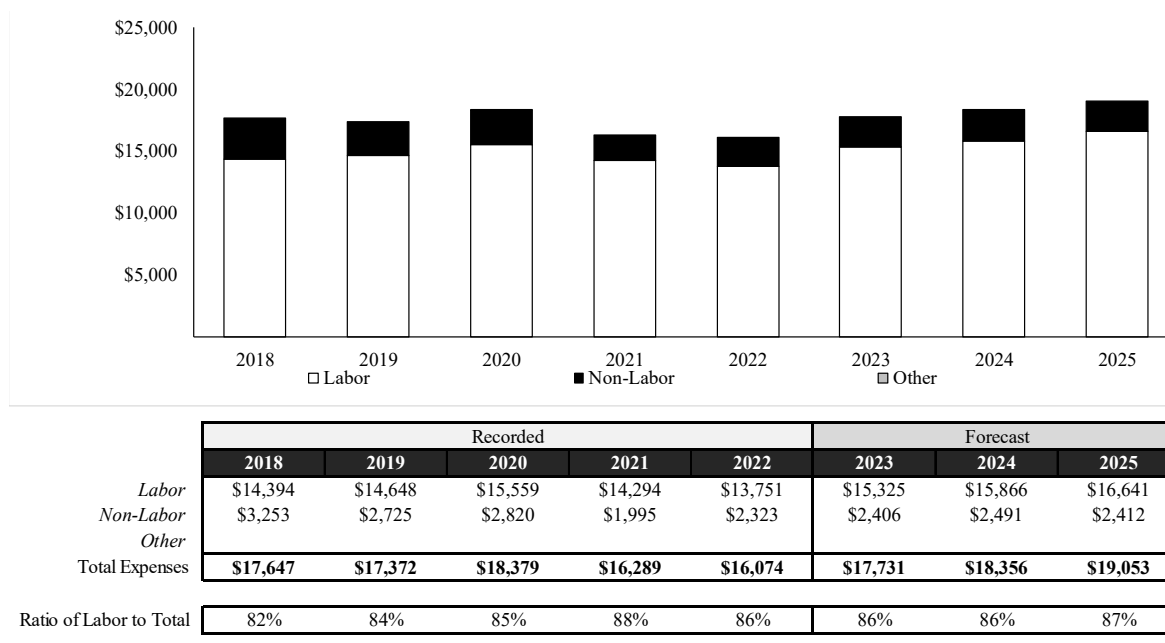
3 *Request tests.* Request tests come from customers, field personnel, and billing
4 representatives. Customers may question the accuracy of their meter and request a test. A meter test may
5 also be requested by the Commission, generally in response to a billing inquiry. Finally, field personnel
6 can observe conditions in the field, such as meter damage, which require a meter test to determine if the
7 meter is registering usage accurately or if it needs repair. When meter accuracy is found to be outside of
8 established tolerance limits, billing representatives are provided with test results, which they use to
9 calculate and issue bill corrections if necessary.

10 *Installation tests.* Installation tests consist of meter installation tests in the field
11 for new services to facilitate safe and accurate installation and for all complex metering services
12 following meter replacement. Field installation tests are necessary to identify potential service wiring
13 problem conditions or meter programming errors that could result in unsafe conditions or inaccurate
14 billing.

15 **b) Scope and Forecast Analysis**

16 The recorded and forecast O&M expenses for Meter Engineering, Field Meter
17 Maintenance, and Field Meter Testing are shown in Figure II-6.

Figure II-6
Meter Engineering, Field Meter Maintenance, & Field Meter Testing O&M
Expenses^{4,5}
Recorded 2018-2022/Forecast 2023-2025
(Constant 2022 \$000)



(1) Historical Variance Analysis

Recorded labor costs remained relatively static between 2018 and 2022. As for non-labor costs, the recorded costs decreased in 2019 from 2018 due to a reduction in lodging and meal expenses for employees working out of their areas to meet resource demands across the SCE territory. Non-labor costs then remained relatively flat in 2020 before decreasing again in 2021 due to a reduction in material costs. In 2022, non-labor costs remained close to the 2021 level.

(2) Forecast

SCE forecasts \$19.053 million for Meter Engineering, Field Metering Maintenance, and Field Meter Testing for Test Year 2025. This forecast is predominantly based on the 2022 last year recorded amount of \$16.074 million. However, SCE added an upward adjustment of

⁴ WP SCE-02, Vol. 03, pp. 1-6 – O&M Detail for Meter Engineering, Field Meter Maintenance, & Field Meter Testing.

⁵ The forecast incorporates accounting adjustments to reflect certain changes made to SCE’s employee compensation program. See Exhibit SCE-06, Vol. 04.

\$2.979 million to account for increased Field Meter Maintenance and Meter Engineering anticipated in the Test Year due to the aging meter population. As the meter population ages, SCE is experiencing increasing meter failures, which results in increased Field Meter Maintenance and Meter Engineering work. SCE experienced a 3% increase in Field Meter Maintenance and Meter Engineering in 2022 and, as the meter population continues to age, expects an annual increase of 5% in 2023, 10% in 2024, and another 10% in 2025, which is the basis of the 2025 forecast adjustment. This forecast methodology of last year recorded plus an adjustment is reasonable because although SCE plans to continue performing the activities described in Field Meter Testing at near current levels, an upwards adjustment is necessary for Field Meter Maintenance and Meter Engineering to reflect the increasing level of work required each year as the meter population continues to age and we experience additional meter failures. This forecast will provide SCE with the funding necessary to continue to perform the work needed to ensure our meters are installed safely and accurately, and to maintain the reliability and quality of the metering system.

2. Field Meter Reading

a) Work Description and Need for Activity

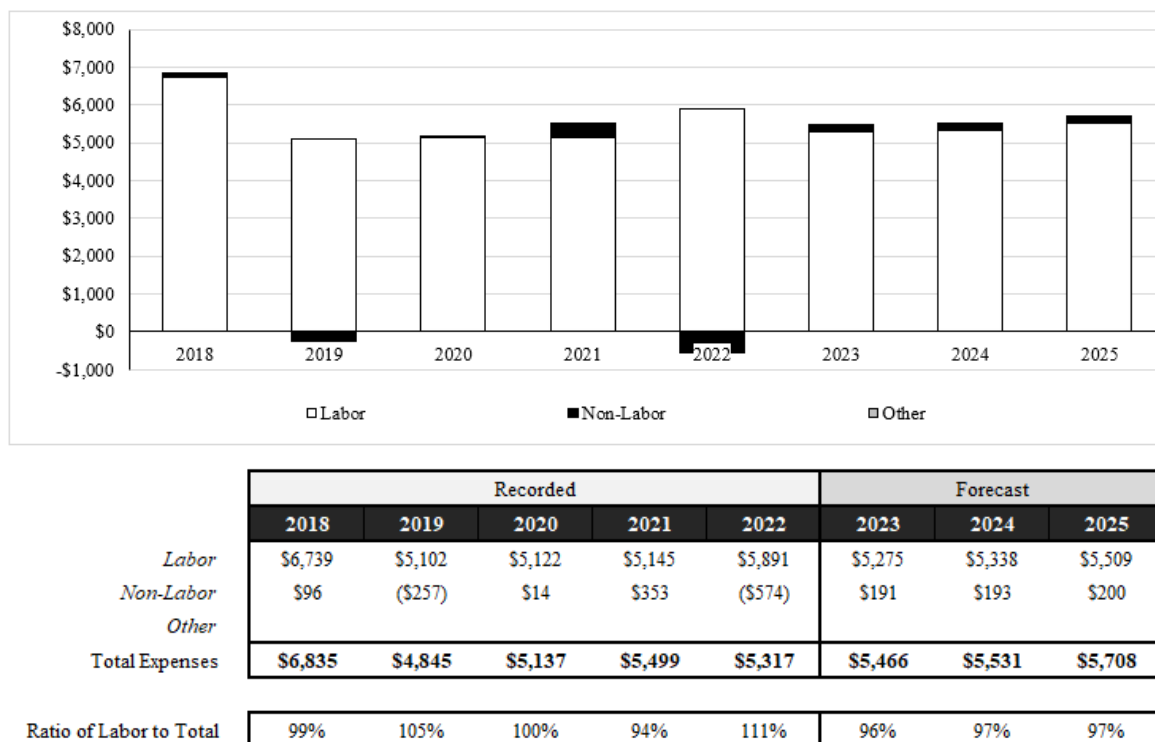
This activity includes Manual Meter Reading and Real-Time Energy Metering. Although over 99 percent of SCE's meters are read automatically, SCE needs to manually read meters that are located in areas where connectivity to the Edison SmartConnect (ESC) communications system is difficult or impractical. SCE also manually reads meters for customers that elected service under SCE's SmartConnect Opt-Out tariff (Schedule ESC-OO). Manual meter reading and data collection is performed by SCE's Field Service Representatives (FSRs).

Real-Time Energy Meters (RTEM) are deployed on the SCE system for large commercial and industrial accounts. Fifteen-minute interval-usage data is automatically collected and stored daily, and day-after usage data is provided to these customers through the internet.

b) Scope and Forecast Analysis

The recorded and forecast O&M expenses for Field Meter Reading are shown below in Figure II-7.

Figure II-7
Field Meter Reading O&M Expenses^{6,7}
Recorded 2018-2022/Forecast 2023-2025
(Constant 2022 \$000)



(1) Historical Variance Analysis

Labor costs decreased in 2019 due to (1) a reduced need for manual meter reading as a result of continuing improvement in the SCE network's ability to collect data from meters, and (2) Radio Frequency (RF) mitigation efforts to reduce hard-to-access meter locations. Labor costs then continued to stay below 2018 levels through 2022 as further improvement in the network's ability to collect data from meters drove more reductions in the need for manual meter reading. As for the non-labor costs, the variance in this activity between 2018 and 2022 was largely due to the timing of credits received from customer payments for installation of generation meter adapters (GMA). In addition, part

⁶ WP SCE-02, Vol. 03, pp. 7-12 – O&M Detail for Field Meter Reading.

⁷ The forecast incorporates accounting adjustments to reflect certain changes made to SCE's employee compensation program. See SCE-06, Vol. 04.

1 of the decrease in 2019 is attributable to a reduction in contractor work that was no longer needed to
2 support this activity.

3 **(2) Forecast**

4 SCE forecasts \$5.708 million for Field Meter Reading, which is \$0.391
5 million higher than the 2022 last year recorded amount of \$5.317 million. SCE started with the last
6 recorded year for forecasting the Test Year Field Meter Reading expenses because SCE forecasts this
7 necessary work to continue at the 2022 level and does not foresee any changes to the volume or type of
8 work over the GRC period. SCE then made an upwards adjustment to account for SCE's expectation
9 that there will be fewer GMA credits received in the Test Year. Last year recorded plus this adjustment
10 will provide SCE with the funding necessary to continue to perform the Field Meter Reading activity.

11 **3. Installations, Removals, and Relocations**

12 **a) Work Description and Need**

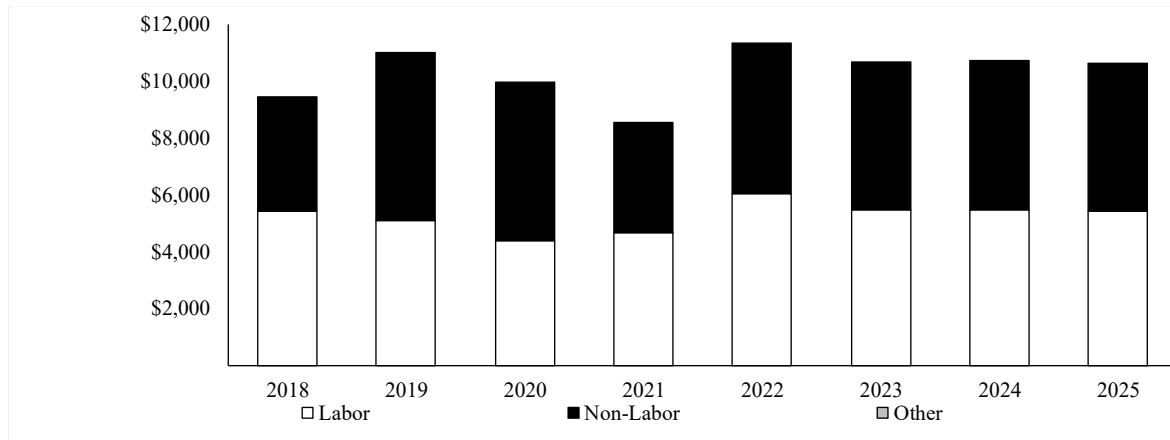
13 This activity includes the work done for the installation, replacement, and
14 relocation of customer meters. Installation, replacement, and relocation work includes setting meters for
15 new customers, relocating meters at customers' requests, and replacing broken meters.⁸ The volume of
16 customer requests and the use of contract labor varies and is difficult to forecast. Both SCE and
17 contractor crews perform the work depending on each service center's volume of meter-related work.
18 Labor costs associated with this work category include SCE crew and field personnel labor for
19 installing, removing, and relocating meters. Non-Labor costs include contractor costs, transportation,
20 and other allocated charges.

21 **b) Scope and Forecast Analysis**

22 The recorded and forecast O&M expenses for Meter Installations, Removals, and
23 Relocations are shown in Figure II-8:

⁸ This activity does not include the Customer Installation work described in Section 4.

Figure II-8
Installations, Removals, and Relocations O&M Expenses^{2,10}
Recorded 2018-2022/Forecast 2023-2025
(Constant 2022 \$000)



	Recorded					Forecast		
	2018	2019	2020	2021	2022	2023	2024	2025
Labor	\$5,424	\$5,110	\$4,366	\$4,680	\$6,028	\$5,456	\$5,491	\$5,430
Non-Labor	\$4,044	\$5,882	\$5,613	\$3,869	\$5,335	\$5,214	\$5,215	\$5,217
Other								
Total Expenses	\$9,467	\$10,992	\$9,979	\$8,549	\$11,362	\$10,670	\$10,706	\$10,647
Ratio of Labor to Total	57%	46%	44%	55%	53%	51%	51%	51%

(1) Historical Variance Analysis

From 2018-2020, labor costs decreased. Much of this decrease is attributable to a slight reduction in new meter installations (meter growth). Labor then increased in 2021 and more significantly in 2022 because of an increase in meter replacements. Non-labor increased from 2018 to 2019 due to an increased use of contractors to perform meter installations. Non-labor costs then decreased between 2020 and 2021 due to a reduction in new meter installations requiring less contractor work. In 2022, there was an increase in installations due to work deferred from 2021 due to COVID-19 impacts. The COVID-19 pandemic also contributed to the variability in meter installations and replacements throughout this five-year period due to a reduction in the availability of both meters and building materials due to supply chain issues caused by the pandemic.

² WP SCE-02, Vol. 03, pp. 13-18 – O&M Detail for Installations, Removals, and Relocations.

¹⁰ The forecast incorporates accounting adjustments to reflect certain changes made to SCE's employee compensation program. See SCE-06, Vol. 04.

1 **(2) Forecast**

2 SCE forecasts \$10.647 million for Installations, Removals, and
3 Relocations in Test Year 2025, which is \$0.715 million lower than the 2022 last year recorded amount
4 of \$11.362 million. The 2022 recorded amount was higher than is typical because work deferred from
5 2021 due to COVID impacts pushed some meter replacements that would normally have been done in
6 2021 into 2022. Therefore, to derive the 2025 Test Year forecast, SCE started with the 2022 recorded
7 labor and non-labor amounts of \$6.028 million and \$5.335 million and then made downward
8 adjustments of \$0.572 million and \$0.121 million, respectively, to account for the fact that SCE expects
9 the work level in 2023-2025 to be slightly lower than in 2022 as COVID impacts are diminishing.

10 **4. Customer Installation & Energy Theft**

11 **a) Work Description and Need**

12 This activity includes the work done for meter installations driven by customer
13 requests and the work done to identify and rectify energy theft.

14 **(1) Customer Installation**

15 The Customer Installation activity is different from both the Move-Ins
16 activity described in SCE-03, V.01 and the installations described in Section II.C.3 above. Customer
17 Installation includes work to respond to requests or problems customers have with their billing or
18 electrical service. This includes billing inquiries, complaints about noisy meters, removal of lock rings
19 for remodels, and reports of damaged meters. In addition to customer-initiated orders and orders
20 initiated by SCE's Customer Service organization, automated exception review processing programs in
21 the Meter Data Management System (MDMS) generate electronic orders to the field requiring meter
22 inspections and meter pick-up reads. These are generally complex issues that require the involvement of
23 field personnel and equipment.

24 **(2) Energy Theft**

25 This activity includes work required to collect revenues lost through
26 energy theft or billing exceptions caused by irregularities in meter registration. This revenue-assurance
27 function identifies customers who potentially benefit from energy usage at the expense of other
28 customers, identifies and corrects situations in which a customer has been billed incorrectly, and
29 addresses potential safety issues caused by these situations.

30 Since completing Edison SmartConnect (ESC) meter deployment in 2012,
31 SCE does not visually inspect all its metering installations on a monthly basis, as previously occurred

1 when meters were manually read. As a result, SCE's Energy Theft program is leveraging smart meter
2 technology (e.g., alarms, flags, exceptions, etc.) and using the annual survey program to identify energy
3 theft and public safety conditions. These are explained further below.

4 (a) **Smart Meter Technology**

5 SCE uses machine learning on ESC meter data to detect various
6 unauthorized intrusions into the metering system and communicate tamper flags that initiate a field
7 investigation. In addition, the program uses billing exception data in conjunction with tamper events to
8 generate field investigation orders.

9 (b) **Annual Survey Program**

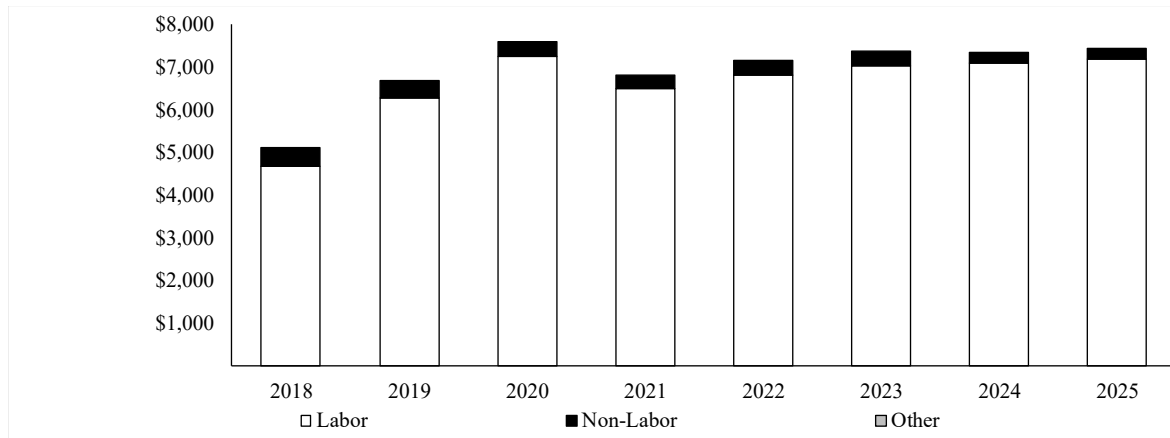
10 The Commission has mandated an annual survey of 0.5 percent of
11 installed ESC meters in order to mitigate the absence of meter readers, who were trained to identify
12 potential meter irregularities as part of the monthly manual meter reading process.¹¹ The annual survey
13 allows SCE to physically look for signs of energy theft in a random sample of the meter population.

14 b) **Scope and Forecast Analysis**

15 The recorded and forecast O&M expenses for Customer Installation and Energy
16 Theft are shown in. Figure II-9.

¹¹ ESC Phase III deployment Decision (D.08-09-039), Section 8, p. 17, and Section 10.1.2, p. 35.

Figure II-9
Customer Installation & Energy Theft O&M Expenses^{12,13}
Recorded 2018-2022/Forecast 2023-2025
(Constant 2022 \$000)



	Recorded					Forecast		
	2018	2019	2020	2021	2022	2023	2024	2025
Labor	\$4,669	\$6,266	\$7,250	\$6,483	\$6,823	\$7,027	\$7,098	\$7,201
Non-Labor	\$447	\$405	\$345	\$334	\$337	\$354	\$234	\$238
Other								
Total Expenses	\$5,116	\$6,671	\$7,595	\$6,817	\$7,160	\$7,381	\$7,332	\$7,438
Ratio of Labor to Total	91%	94%	95%	95%	95%	95%	97%	97%

(1) Historical Variance Analysis

As our SmartConnect Meter Population ages, SCE is experiencing increased work volumes of pick-up reads and meter exceptions from failed meters. This contributed to the increase in recorded labor costs from 2018 to 2020. In addition, in 2020, costs increased due to the development of new COVID-19 practices for field work. Because personnel had to work out of vehicles instead of the office during this time, new work practices had to be developed for distributing work, resolving issues, and working within COVID-19 health and safety guidelines. A decrease in costs was then experienced in 2021 due to the system freeze instituted during the transition to SCE's new customer service and billing system as part of the Customer Service Re-Platform project (CSRP). This system freeze resulted in reduced billing exceptions. Costs then increased in 2022 due to the backlog in billing

¹² WP SCE-02, Vol. 03, pp. 19-24 – O&M Detail for Customer Installation & Energy Theft.

¹³ The forecast incorporates accounting adjustments to reflect certain changes made to SCE's employee compensation program. See SCE-06, Vol. 04.

1 exceptions that resulted from the CSRP system freeze in 2021. From 2018 to 2022, non-labor costs
2 stayed relatively static, with just minor variances year-to-year

3 **(2) Forecast**

4 SCE forecasts \$7.438 million for Customer Installation & Energy Theft in
5 Test Year 2025, which is \$0.278 million higher than the 2022 last year recorded amount of \$7.160
6 million.- To derive this forecast, SCE started with the last recorded year. SCE then made two
7 adjustments. First, SCE made an upward adjustment of \$0.454 million to account for the increased work
8 expected in the Test Year. As discussed above, SCE is experiencing increasing work volumes of pick-up
9 reads and meter exceptions from failed meters. This trend will continue in this GRC period as SCE's
10 meter population continues to age. SCE then made a downward adjustment of \$0.176 million to account
11 for improvements in field meter processes.

12 **5. Meter System Maintenance and Design**

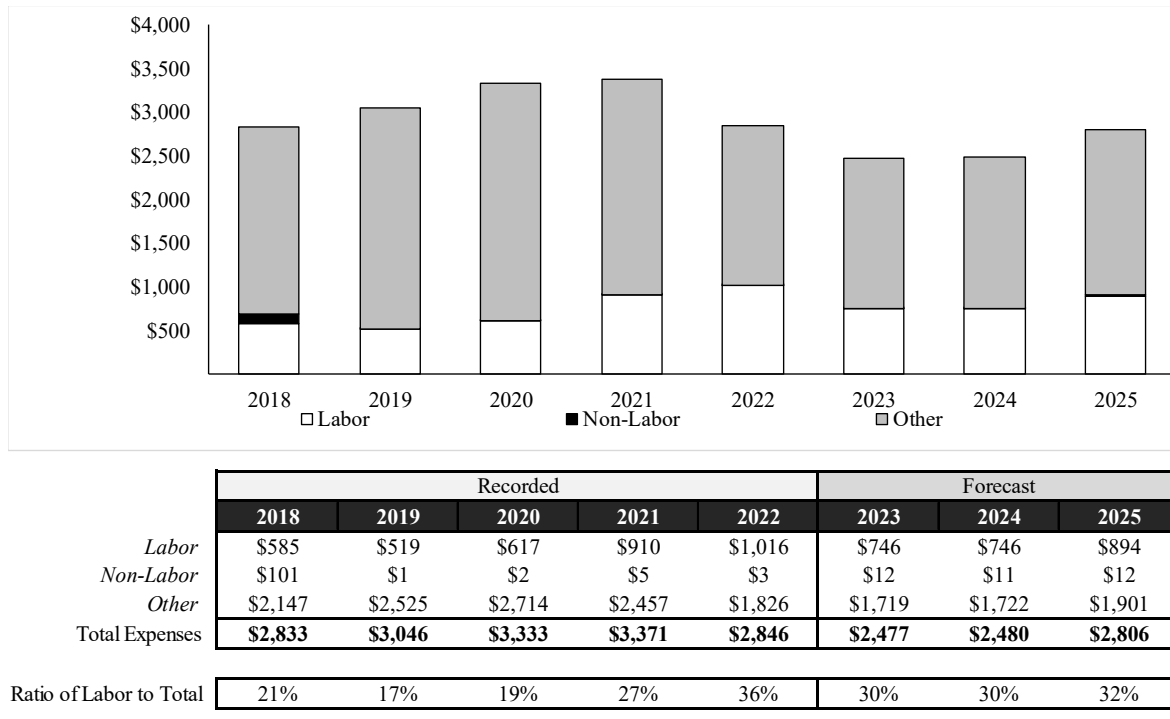
13 **a) Work Description and Need**

14 As described in Section II.C.2, SCE reads over 99 percent of its meters through
15 wireless communications using advanced meters. Advanced meters communicate customer consumption
16 data using a wireless mesh network, which uses cellular frequencies. Advanced Metering Operations
17 (AMO) analyzes meter and communication data to identify failed devices, issue repair orders, optimize
18 communication performance, update firmware, and mitigate system problems. These monitoring
19 activities help ensure customer usage data is accurate and processed for use by other SCE operational
20 units.

21 **b) Scope and Forecast Analysis**

22 The recorded and forecast O&M expenses for Meter System Maintenance Design
23 are shown below in Figure II-10.

Figure II-10
Meter System Maintenance Design^{14,15}
Recorded 2018-2022/Forecast 2023-2025
(Constant 2022 \$000)



(1) Historical Variance Analysis

Labor costs decreased from 2018 to 2019 due to resources shifting to a capital-related project to transition 3G cell relays to 4G in support of the cell relay replacement project. Labor costs then increased from 2019 to 2022 due to the increased support needed for SCE's meter system, including due to 4G complexity, increased security requirements, and the replacement of the Customer Service billing platform which required operational support. The significant decline in non-labor from 2018 to 2019 was due to an organizational restructure that required the Meter System Maintenance and Design team to move to a new office within the IT Grid Services organization. This was a one-time occurrence in 2018, so costs declined and stayed relatively steady from 2019 – 2022. Other expense, which comprises the costs to lease cellular bandwidth for meter data transmission

¹⁴ WP SCE-02, Vol. 03, pp. 25-30 – O&M Detail for Meter System Maintenance Design.

¹⁵ The forecast incorporates accounting adjustments to reflect certain changes made to SCE's employee compensation program. See SCE-06, Vol. 04.

(similar to cell phone bills), generally rose between 2018 and 2021 as additional cellular bandwidth services were needed during the migration from 3G cellular bandwidth to 4G/LTE cellular bandwidth. Once that effort wrapped up in 2021, these costs started to decline, which resulted in the decreased costs seen in 2022.

(2) Forecast

SCE forecasts \$2.806 million for Meter System Maintenance and Design in the Test Year, which is approximately the same as the 2022 last year recorded amount. Last year recorded is the appropriate basis for forecasting the Test Year O&M for Meter System Maintenance and Design as SCE expects this necessary work to continue at the 2022 level.

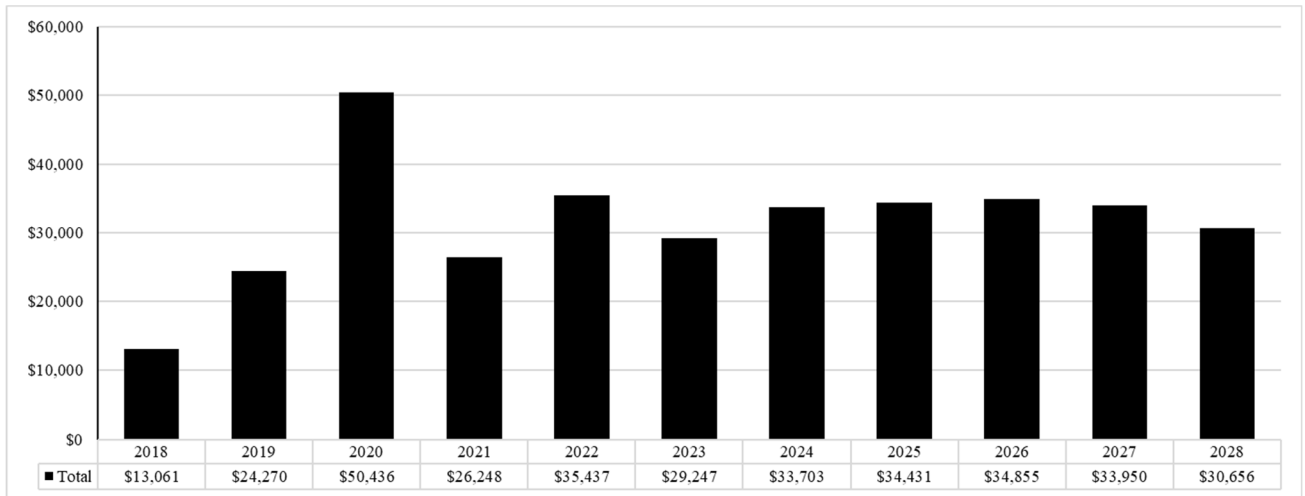
D. Capital Expenditures – Meter Activities

SCE forecasts \$202.670 million in capital expenditures for 2023-2028 for Meter Activities. This includes \$196.842 million for Meter Engineering and \$5.826 million for Meter System Maintenance Design.

1. Meter Engineering

The recorded and forecast capital expenditures for Meter Engineering are shown in Figure II-11.

Figure II-11
Meter Engineering Capital Expenditures Summary^{16,17}
Multiple WBS Elements¹⁸
Recorded 2018-2022/Forecast 2023-2028
(Total Company – Nominal \$000)



a) Program Description and Need

This program includes the meters needed to meet forecast customer growth, replace defective or damaged meters outside of their warranty period, and address meter technology changes for all of SCE’s residential, commercial, industrial, and agricultural customers, excluding Advanced Metering Infrastructure obsolescence which is being addressed by AMI 2.0 as discussed in Chapter III below. Metering Engineering develops the meter volume forecasts for meters such as the ESC meters, the RTEM meters, and the legacy non-communicating electromechanical meters. The following sections describe the different types of meters and describe how meter volume estimates were developed. The main drivers of work are comprised of the following activities: (1) Routine Meter Work, and (2) Non-Routine Meter-Related Projects.

¹⁶ WP SCE-02, Vol. 03, pp. 31-35 – Capital Detail by WBS Element for Meter Engineering.

¹⁷ The forecast incorporates accounting adjustments to reflect certain changes made to SCE’s employee compensation program. *See* SCE-06, Vol. 04.

¹⁸ WBS Elements: CET-ET-MS-SCR-452799, CET-ET-MSCE-744000, CET-ET-MSRB-452701.

1 **(1) Routine Meter Work**

2 **(a) Growth Meters**

3 The ESC meter is the standard meter that is used to serve new
4 customers with demands under 200 kW. The only exceptions are for those customers with demand in
5 excess of 200 kW (which requires an RTEM meter as described below) or customers who opt out of
6 ESC metering. For those opt-out customers, SCE will provide legacy electromechanical non-
7 communicating meters.

8 **(b) Replacement Meters**

9 Replacement meters are used to replace damaged meters for
10 customers with demands under 200 kW. Replacement meters for these customers are ESC meters,
11 except for those customers who have opted out of ESC metering. In those instances, SCE will provide a
12 legacy electromechanical non-communicating meter as the replacement meter.

13 **(c) RTEM Replacement**

14 SCE's largest customers with demands in excess of 200 kW
15 typically require more complex metering systems that are beyond the scope and capability of the ESC
16 program. RTEM meters are Interval Data Recorder (IDR) meters that are needed to accommodate the
17 most complex rates and billing options. SCE uses RTEM replacement meters to replace or install RTEM
18 meters for customers with demands greater than 200 kW.

19 **(2) Non-Routine Meter-Related Projects**

20 **(a) Cell Relay Maintenance Program**

21 During 2019–2022, SCE replaced all cell relays due to 3G
22 obsolescence and the transition over to LTE to improve the use of its over-the-air-metering-system. Cell
23 relays work in conjunction with smart meters to collect interval data from customer meters and relay that
24 data back to the Network Management System (NMS). One cell relay device can transmit data on
25 average with 500 smart meters. Factors impacting the product lifecycle of a cell relay include the
26 availability of product support by the cell relay vendor and the risk of technological obsolescence.

27 Although SCE has finished this replacement of all cell relays,
28 additional cell relay replacements and new installations continue to be needed for growth, stabilization,
29 and repairs in order to properly maintain our Metering System.

1 **(b) Infrastructure Replacement Program – RTEM meters**

2 As discussed above, SCE’s largest customers with demands in
3 excess of 200 kW typically require more complex metering systems that are beyond the scope of the
4 ESC program. Non-routine work includes our meter infrastructure replacement program of 12,000 of
5 our RTEM meters that have obsolete radio technology. Their existing radio technology is expected to
6 become obsolete and no longer supported by the end of 2024. Although SCE planned to complete this
7 replacement of the obsolete RTEM meters last GRC cycle, SCE was unable to do so due to supply chain
8 issues caused by the COVID-19 pandemic and a worldwide microchip shortage that required SCE to
9 defer this work due to the lack of product availability. This work is now scheduled to be completed from
10 2024 to 2027.

11 **(c) Catalina Meter Replacement Program**

12 The Catalina Meter Replacement program will convert legacy
13 electromechanical meters to over-the-air meters. This program began in the fourth quarter of 2021 and is
14 expected to be completed by year end 2024. This program will replace the 2,600 legacy
15 electromechanical meters on Catalina Island with over-the-air meters. Although SCE planned to
16 complete the Catalina Meter Replacement Program in the last GRC cycle, SCE was unable to do so due
17 to supply chain issues caused by the COVID-19 pandemic and a worldwide microchip shortage that
18 required SCE to defer this work due to the lack of product availability.

19 The over-the-air meters will help address safety risks, remove the
20 need for employees to deal with remote island conditions to read the meters, and provide time-of-use
21 capabilities. Employees who currently have to read meters that are located in rugged terrain or in hard-
22 to-access locations face a safety risk; reading the meters over the air will remove that risk. Further, over-
23 the-air meters will provide Catalina customers access to time-of-use rates and remote service switch for
24 remote connect and disconnect capabilities.

25 **(d) Complex Meter Replacement Program**

26 SCE has identified the need to replace nearly 5,000 complex
27 meters that are currently deployed throughout our service area on 480-volt commercial accounts and
28 have been identified as a reliability and potential safety risk. While SCE had previously planned to begin
29 this replacement in 2020, SCE was unable to begin this program due to supply chain issues caused by
30 the COVID-19 pandemic and a worldwide microchip shortage that required SCE to defer this work due

to the lack of product availability. SCE now intends to begin this program in 2023 and complete it in 2026.

(e) **Broadband Global Access Network Device Installation**

A Broadband Global Access Network (BGAN) device provides communication of customer billing, meter event, and performance data through a satellite signal in remote areas where cellular communication service is unavailable. This allows the communication of data for one or multiple meters in remote areas to SCE's billing and data services systems.

b) **Basis for Capital Expenditure Forecast**

SCE developed its forecast for Meter Engineering by aggregating the individual forecasts for (1) Routine Work and (2) Non-Routine Work. These individual cost forecasts are shown in Table II-3 and discussed in more detail in the following sections.

Table II-3
Meter Engineering Capital Expenditures
Forecast 2023-2028
(Total Company - Nominal \$000)

Line	Description	2025 GRC Forecast					
		2023	2024	2025	2026	2027	2028
1	Routine Work	\$ 27,349	\$ 27,339	\$ 27,667	\$ 27,716	\$ 27,636	\$ 27,942
2	Non-Routine Work	\$ 1,898	\$ 6,364	\$ 6,764	\$ 7,139	\$ 6,314	\$ 2,714
3	Total	\$ 29,247	\$ 33,703	\$ 34,431	\$ 34,855	\$ 33,950	\$ 30,656

(1) **Routine Meter Work**

The routine meter replacement forecast shown in Table II-3 is based on the three-year average from 2020-2022 plus escalation to 2023-2028 dollar amounts.¹⁹ This three-year average captures growth and replacements, and reflects the significant increase in replacements that SCE has been experiencing since 2020 as our Metering System continues to age.

While SCE also considered using a five-year average from 2018 to 2022 for developing the Test Year forecast, SCE rejected this methodology because 2018 and 2019 do not reflect the increased costs SCE has been incurring since 2020 due to the increase in meter replacements caused by our aging meter population. Prior to 2020, SCE meter replacement volumes had been

¹⁹ 2020 spend was \$27.4 million, 2021 spend was \$19.2 million, and 2022 spend was \$34.4 million, resulting in a three-year average of \$27 million (nominal).

relatively static over the past five years, but since 2020 SCE has experienced a significant increase due to our aging meter population. Because our meter population continues to age, that increase will continue into the Test Year. For that reason, it is not appropriate to include 2018 and 2019 in the average used to develop SCE's Test Year forecast.

(2) Non-Routine Meter-Related Projects

***Table II-4
Meter Engineering Non-Routine Work Capital Expenditures
Forecast 2023-2028
(Total Company - Nominal \$000)***

Line	Description	2023		2024		2025		2026		2027		2028	
		Volume	Cost	Volume	Cost	Volume	Cost	Volume	Cost	Volume	Cost	Volume	Cost
1	Cell Relay Maint program	500	\$ 1,300	500	\$ 1,300	750	\$ 1,950	1,000	\$ 2,600	1,000	\$ 2,600	1,000	\$ 2,600
2	RTEM Replacements Program			3,000	\$ 3,600	3,000	\$ 3,600	3,000	\$ 3,600	3,000	\$ 3,600		
3	Replacement Program	479	\$ 209	1,921	\$ 800								
4	Complex Meter Replacement	500	\$ 275	1,000	\$ 550	2,000	\$ 1,100	1,500	\$ 825				
5	ESC Communication Equipment (BGAN)	6	\$ 114	6	\$ 114	6	\$ 114	6	\$ 114	6	\$ 114	6	\$ 114
6	Totals	1,485	\$ 1,898	6,427	\$ 6,364	5,756	\$ 6,764	5,506	\$ 7,139	4,006	\$ 6,314	1,006	\$ 2,714

Non-Routine Meter-Related Projects are based on forecast unit volumes and unit costs. The forecast volumes of work and forecast costs (combined labor and material) are provided in Table II-4. As mentioned above in II.D.1.a)(1)(b) , SCE has a need to maintain its SmartConnect system by addressing the challenges created by the obsolescence of our existing metering system. To do so, SCE must (1) maintain cell relays, (2) replace RTEM meters, (3) continue to roll out over-the-air meters in Catalina, (4) replace complex meters, and (5) maintain BGAN devices.

The Cell Relay Maintenance Program is forecast to cost \$12.350 million from 2023-2028, based on a volume of 500 units in each of 2023 and 2024, 750 units in 2025, and 1,000 units in each of 2026-2028.²⁰ The RTEM replacement program is forecast to cost \$14.400 million to replace 12,000 RTEMs that will be obsolete by the end of 2027. The program is anticipated to span four years, beginning in 2024 and ending in 2027. The Catalina Meter Replacement Program is forecast to cost \$1.009 million from 2023-2024 to replace 2,400 legacy electromechanical meters with over-the-air

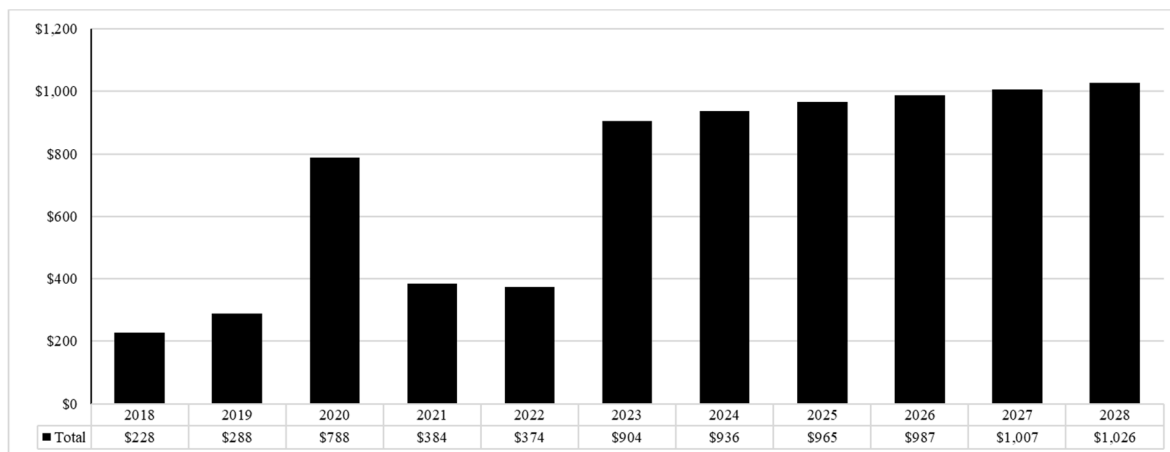
²⁰ Historically, SCE has replaced approximately 840 cell relays per year. Because SCE recently finished replacing all cell relays due to 3G obsolescence, SCE expects annual cell relay replacements under the Cell Relay Maintenance Program to ramp up over time to approximately 1,000 per year based on the new asset lifecycle.

meters. This program began in the fourth quarter of 2021 and is anticipated to end in 2024. The Complex Meter Replacement Program is forecast to cost \$2.750 million to replace 5,000 meters that have been identified as a safety risk to SCE employees and customer-owned property. It is anticipated to begin in 2023 and complete in 2026. Finally, SCE forecasts the installation and maintenance of BGAN from 2023 to 2028, at a cost of \$0.684 million.

2. Meter System Maintenance Design

The recorded and forecast capital expenditures for Meter System Maintenance Design are shown in Figure II-12 below.

Figure II-12
Meter System Maintenance Design Capital Expenditures Summary^{21,22}
CIT-00-OP-NS-000010
Recorded 2018-2022 / Forecast 2023-2028
(Total Company – Nominal \$000)



a) Work Description and Need

As discussed in II.D.1.a, SCE's largest customers with demands in excess of 200 kW typically require more complex metering systems that are beyond the scope of the ESC program. Whereas the costs for RTEM meters themselves are captured in II.D.1.c, this section includes the costs of the infrastructure that supports the network that those meters use. The RTEM meters communicate using a network separate from the ESC program to meet the requirements for customers with 200 kW of

²¹ WP SCE-02, Vol. 03, pp. 36-37 – Capital Detail by WBS Element for Meter System Maintenance Design.

²² The forecast incorporates accounting adjustments to reflect certain changes made to SCE's employee compensation program. See SCE-06, Vol. 04.

1 demand or greater. This program supports the networking, engineering, and infrastructure for new meter
2 deployment and resolving network performance issues. As new meters are added, the network designs
3 change and are built out to ensure communication to the new meter locations. These changes include
4 additional infrastructure, including network repeaters, and additional take-out points to meet latency and
5 bandwidth requirements.²³

6 **b) Basis for Capital Expenditure Forecast**

7 The forecast is the estimated amount required to support the infrastructure for the
8 new meters being added to the network, refresh existing network infrastructure, and change network
9 designs as network assets deployed in the field reach end of life or fail. From 2023 to 2028, the forecast
10 is itemized and based on an annual forecast of net new 650 devices to be added to the network or that
11 require additional network infrastructure due to infrastructure failure or performance issues.
12 Additionally, several existing network packet router nodes are reaching end of life and require
13 replacement to maintain communication to the entire population of RTEM meters. Therefore, this
14 estimate also includes replacing existing 125 nodes annually from 2023 to 2028, as the network is used
15 to remediate additional locations where SmartConnect meters will not work and to support the complex
16 meter replacement program.

²³ A take-out point is the router that provides the communication pathway for end-point meters.

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III.

ADVANCED METERING INFRASTRUCTURE

A. Overview

The purpose of this testimony is to provide SCE's base-level planning cost forecasts for designing, procuring, and implementing the next generation of smart meters (a program known as "Advanced Metering Infrastructure" or "AMI" 2.0). SCE's smart meters help advance our operational capabilities for customer service and grid management by, among other things, providing automation capabilities (e.g., automated on/off switch), enabling field efficiencies (e.g., automated meter reading), and transforming SCE's distribution network into an intelligent, integrated network-enabled monitoring and control system (e.g., real-time system monitoring). They have also facilitated the State's decarbonization and energy affordability objectives by enabling the Commission-supported transition to time-of-use (TOU) rates (e.g., via interval usage data). However, the current AMI system is nearing the end of its useful life in 2028, and existing AMI 1.0 meters are failing at an increasing rate, leading to increased meter replacement demands and costs. As a result, SCE needs to begin proactively replacing its meter fleet and associated infrastructure in this GRC cycle to avoid widespread failure, continue to provide customers adequate billing services, and avoid additional operational costs. At the same time, replacing the current AMI system as it reaches obsolescence enables SCE to put in place new AMI technology that can provide customer benefits in areas such as decarbonization, customer choice, grid resiliency and reliability, and DER integration.

AMI consists of several elements, including meters, communications network, data repository, and back-office systems/integration that support the overall meter-to-cash process. With increasing reliance on granular real time data to operate the grid, derive customer insights for asset management, provide targeted demand management, and help customers make informed choices on energy management, enhanced AMI capabilities will be even more indispensable.

As described below, SCE's proposal in this GRC is for base-level planning for the next generation of AMI deployment. This base level of planning from 2023 through 2027, which includes capability definition, technology evaluation, and field testing, is necessary to select the appropriate hardware and software technologies and enable systemwide installation of devices, systems, and processes starting in 2027 or 2028. This proposed approach is similar to the blueprint for SCE's original AMI approach that was approved by the Commission in D.08-09-039. Specifically, this base-level planning phase aligns with the planning phases of SCE's previous AMI 1.0 implementation ("Phase 1"

and “Phase 2”), which took place between 2005 and 2008. SCE is not seeking recovery for the costs of the broader, system-wide AMI deployment in this GRC. Instead, SCE intends to submit a separate subsequent application to the Commission for appropriate review and approval of those costs.

1. Regulatory Background

a) Edison SmartConnect (AMI 1.0)

SCE’s first generation of AMI smart meters, which was known as Edison SmartConnect™ (SmartConnect or AMI 1.0), was a comprehensive effort that included deploying meters and communications network, and updating the associated back-office systems, customer programs and services, and customer service operations. Beginning more than fifteen years ago, the Commission evaluated and approved SCE’s SmartConnect business case and cost recovery proposal in three phases: Phase 1 – Concept Definition, Engineering Design, and System Requirements (2005),²⁴ Phase 2 – Pre-Deployment Funding to Develop Final AMI Proposal (2007),²⁵ and Phase 3 – Full Deployment (2008).²⁶

First, in 2005, the Commission authorized \$12 million for SCE to perform due diligence to define the meter and system requirements for AMI 1.0 based on the corresponding benefits (i.e., systems engineering). Activities performed in this phase included developing the AMI technical and system requirements, conducting technology demonstrations to validate functionality, performing AMI concept feasibility analysis, developing reference architecture, and conducting a market assessment. The Phase 1 decision also authorized SCE to record its approved costs to the AMI Balancing Account (AMIBA). SCE completed Phase 1 work in 2006

Second, in 2007, the Commission authorized \$45.2 million for pre-deployment activities, including procuring technologies, selecting the deployment contractor, and performing a cost-benefit analysis. In its decision, the Commission stated that “[t]he funding of these activities will further the development of the details of SCE’s final AMI proposal, provide information to develop or refine the associated cost-benefit analysis, and assist parties and the Commission in analyzing SCE’s final AMI deployment business case.”²⁷ SCE was authorized to perform work in the following areas: AMI product management, information technology, business process and organizational readiness, field

²⁴ D.05-12-001.

²⁵ D.07-07-042.

²⁶ D.08-09-039.

²⁷ D.07-07-042.

1 deployment, customer tariffs and programs, systems integration, and program management and
2 organization. This Phase 2 decision also authorized SCE to continue to record its approved costs to the
3 AMIBA. SCE completed Phase 2 work in 2008.

4 Finally, in 2008, the Commission authorized \$1,633 million for SCE's full AMI
5 deployment activities.²⁸ Among other things, this Phase 3 decision approved the deployment of SCE's
6 proposed meters and infrastructure (e.g., back-office systems, communications network, and deployment
7 of approximately 5 million smart meters). The Phase 3 decision also authorized SCE to establish and
8 record its approved costs to the Edison SmartConnect Balancing Account (ESCBA). In December 2012,
9 SCE completed Phase 3. The SmartConnect program was among the first AMI programs in North
10 America to provide two-way remote reading and remote connect and disconnect capabilities at a large
11 scale and received national recognition.²⁹

12 **2. A New Comprehensive and Integrated AMI Solution is Needed Because SCE's**
13 **Existing AMI System is Experiencing Increasing Failures and Approaching**
14 **Technology Obsolescence**

15 AMI 1.0 meters were deployed from 2009 to 2012. By 2028, approximately 80% of
16 SCE's AMI 1.0 meters will have been installed in the field for more than fifteen years, and by the time
17 AMI 2.0 deployment is complete some will have been installed for more than 20 years. Although SCE
18 originally assumed a twenty-year life expectancy, SCE now expects a fifteen-year service life. A fifteen-
19 year service life is consistent with the higher failure rates and trends seen with smart meters across the
20 industry.³⁰ More importantly, as discussed in the following paragraphs, a fifteen-year service life aligns
21 with the increasing failure rate and technology obsolescence that SCE is experiencing with its own smart
22 meters.

23 As SCE's meter fleet has aged, SCE has been experiencing an increase in failures year-
24 over-year. For example, by 2019, the meter failure rate was approximately 0.7% or approximately
25 36,000 meters per year. In 2021, that failure rate jumped to approximately 1.2%, or 68,000 of SCE's
26 smart meters. In 2022, the failure rate jumped again up to 1.5%, or approximately 80,000 meters. This

²⁸ D.08-09-039 approved a Settlement Agreement with the Division of Ratepayer Advocates (DRA) (now known as "Cal Advocates") and stipulations with The Utility Reform Network (TURN).

²⁹ SCE's Edison SmartConnect Program received multiple industry awards, including awards from Electric Power Research Institute (EPRI) and the U.S. Department of Energy.

³⁰ For example, SDG&E and CenterPoint both replaced their AMI meters after fifteen years in service.

1 failure rate is expected to continue to increase exponentially as the meters get closer to the end of their
2 service lives. This increasing failure rate impacts SCE's ability to provide its customers reliable, timely
3 and accurate billing and results in higher manual billing costs, and increased costs for personnel to
4 troubleshoot and replace failed meters.³¹ As the failure rate increases, mass meter failure becomes more
5 likely. SCE must replace its AMI 1.0 meters before mass meter failure occurs because SCE would not
6 be able to meet meter replacement demand of that magnitude.

7 The AMI 1.0-meter population is also experiencing technology obsolescence. As meter
8 vendors advance to new meter hardware, there will be limited ability to upgrade SCE's meter
9 population. This is because when meter vendors advance to new iterations of meter hardware versions,
10 they often stop supporting enhancement efforts for older versions of the meters. As a result, the older
11 meter hardware version is no longer upgradable to support new software versions available for the
12 newer version of the meter hardware, leading to outdated meters. Currently, the majority of SCE's meter
13 population is at risk of technology obsolescence as SCE's current AMI vendor has announced software
14 upgrades will no longer be available for this population of meters. As a result, vendor support for these
15 meters will be limited going forward, and costs will increase.

16 Given the increasing meter failures, the risk of meter obsolescence,³² and inability to
17 update the associated and necessary software, it is imperative that SCE begins the replacement process
18 for its meter fleet and associated infrastructure to provide customers adequate billing services and avoid
19 additional operational costs. Planned pre-deployment activities will allow SCE to develop and test a
20 meter prototype, test capabilities that can benefit customers in areas such as decarbonization, customer
21 choice, grid reliability and resilience, DER integration, and prepare for this systemwide deployment.

22 **3. Necessary AMI System Replacement to Address Equipment Failure and**
23 **Obsolescence Provides a Unique Opportunity to Incorporate Capabilities That Will**
24 **Further Benefit Customers and Support State Decarbonization Policies**

25 Since SCE is planning to spend significant resources on replacement of the existing AMI
26 system, it is prudent for SCE to build in capabilities that will be required during the life span of the new
27 metering infrastructure. The next generation of AMI must not only be able to provide the capabilities the
28 current infrastructure supports and address the known failure modes of the current assets and lessons

³¹ Meter Activities Historical Variance Analysis II.C.4.b)(1).

³² Meter Activities II.C.1.b)(2), II.C.4.b), II.C.5.a) for additional information on meter replacement supply issues.

1 learned from the previous deployment, but also incorporate technology improvements that will help SCE
2 and its customers realize the State’s and the Commission’s goals of decarbonization, climate change
3 resilience, and transition to a clean energy economy. These new capabilities will be essential to provide
4 customers and grid operators the information and intelligence necessary to more effectively and
5 efficiently manage load, DERs, and utility infrastructure for safety, reliability, resilience, and
6 affordability. Not incorporating these capabilities during the next AMI system replacement would be a
7 lost opportunity that will require costly retrofits or replacements later. SCE is actively benchmarking
8 with other utilities who have implemented next generation smart meters along with vendors to inform
9 robust definition of capabilities necessary and to drive technology availability for large-scale
10 implementation. AMI 2.0 will contribute to advancements in capabilities in the following areas, and
11 SCE plans to test the following types of capabilities during pre-deployment activities:

12 **Grid resiliency and reliability.** Distributed intelligence, edge computing, and low
13 latency communication networks are needed for expanded situational awareness, enhanced grid safety,
14 and improved utility response for troubleshooting and addressing grid-related issues and outages. This
15 information will also enhance SCE’s predictive analytics capabilities for risk-informed asset
16 management capabilities. SCE expects to evaluate several functionalities including volt-var
17 optimization, real-time power quality monitoring, transformer load modeling, feeder phase balancing,
18 grid health monitoring, outage restoration, EV grid load balance, customer appliance health monitoring,
19 and detection of things like EVs, vegetation growth, wires down, arcs, broken neutrals, and faults.

20 **Enhanced customer energy management tools.** To enable active premise surgical load
21 shedding, and real-time and dynamic energy data for demand response for decarbonization, reliability
22 and resilience, enhanced energy management is needed for home device level energy consumption,
23 targeting specific loads, and offering incentives to reduce or shift loads via smart meter and smart phone
24 “App” Integrations. During the pre-deployment period, SCE expects to evaluate appliance level load
25 disaggregation, AMI meter interface with third-party internet of things (IoT) appliances and energy
26 equipment, and personalized energy management plan.

27 **Enable renewable adoption.** Real-time customer engagement solutions, edge
28 computing, and demand response will be critical to enable the speed and scale of decarbonization
29 envisioned by the State. Customers need accurate, timely and actionable information (e.g., real-time
30 pricing, energy management insights, usage alerts, energy efficiency) to manage their electric energy

consumption and control their home energy devices to optimize energy usage based on their needs, which can help reduce and shift energy usage and even lower their energy bills.

DER integration. Behind-the-meter DER monitoring, energy measurement and control capability, DER data aggregation, and integration to the Distributed Energy Resources Management System (DERMS) will help provide customers with the ability to manage the demand on DERs, enabling them to make better decisions on when to use, store and sell energy. SCE expects to evaluate energy measurement and control on customer side generation, isolation capability during grid outages to provide backup power through customer generation sources, and peer-to-peer trading.

Enhanced analytics capabilities. Capabilities such as low latency communication, high compute power, onboard sensors, high resolution waveform capture, edge analytics inside the meter (distributed intelligence), and advanced techniques (artificial intelligence (AI), machine learning (ML) algorithms, etc.) are needed to support analytics-based decision making. These types of capabilities will help improve the customer experience and support enhanced personalization and engagement, grid management and planning, systems control and outage management. SCE expects to evaluate TOU/peak alerts, excess usage identification, fault detection, non-intrusive load monitoring, disaggregated usage and behavioral insights, home energy reports, home automations, energy efficiency, HVAC maintenance, load forecasting, asset performance management, connectivity model of electrical networks, DER integration, EV detection, demand side flexibility and forecasting power demand and generation.

4. SCE's Phased Approach

SCE forecasts \$5.016 million in O&M expenses in 2023 and 2024 and \$53.201 million in capital expenditures from 2023-2027 for pre-deployment base-level planning costs for AMI 2.0. As shown in Table III-5 and Table III-6, these costs are for three pre-deployment stages: Market Assessment, Proof of Concept Demonstration, and Field Testing. The activities, deliverables, and forecast costs for these three stages are described below. SCE is seeking review and recovery for the base-level planning capital expenditures in this GRC. As for the base-level planning O&M, SCE will be filing a motion seeking authority to establish a memorandum account for tracking these costs for future review and recovery.

Table III-5
AMI Pre-Deployment O&M Activities
Forecast (2023-2025)
(Constant 2022 \$000)

O&M Forecast	2023	2024	2025
Market Assessment	\$4,432		
Proof of Concept		\$585	
Total O&M	\$4,432	\$585	

Table III-6
AMI Pre-Deployment Capital Activities³³
Forecast 2023-2028
(Total Company - Nominal \$000)

Capital Forecast	2023	2024	2025	2026	2027	2028
Proof of Concept		\$12,552	\$8,368			
Field Test		\$3,497	\$4,103	\$12,284	\$12,397	
Total Capital		\$16,049	\$12,471	\$12,284	\$12,397	

Building upon much of the foundational work that will be completed in these pre-deployment activities, SCE then plans to file a standalone application in 2025 with a comprehensive plan (including technology solutions, vendor partners, back and front office integration, and customer programs and benefits) for a successful full deployment of an AMI 2.0 solution that will address the issue of increasingly failing meters and technology obsolescence of the current AMI solution and enable many of the necessary future capabilities and benefits discussed above. This standalone application will include SCE's proposals for review and recovery of the forecast costs for AMI 2.0 deployment.³⁴ These forecast costs will include the costs to deploy the new AMI 2.0 solution across SCE's system, including costs related to acquisition of meters and communications network; installation of meters and communications network; implementation and operation of back-office systems; customer tariffs, programs and services; customer service operations; and program management informed by the pre-

³³ WP SCE-02, Vol. 03, pp. 38-40 – Meter Activities Customer GridEdge (AMI 2.0) Capital Summary.

³⁴ SCE's "standalone" application is intended to be analogous to A.07-07-026 (Southern California Edison Company's (U 338-E) Application for Approval of Advanced Metering Infrastructure Deployment Activities and Cost Recovery Mechanism, or the Edison SmartConnect Phase 3 Application).

deployment activities discussed above, including preliminary learnings, evaluation of options, pre-planning work, and investigation and finalization of intended use cases and overall functionality needed. Until full deployment of an AMI 2.0 solution, SCE will continue its current efforts to mitigate the risks associated with meter failures and system obsolescence.

Figure III-13 below shows a conceptual timeline for SCE’s AMI 2.0 pre-deployment and deployment activities.

Figure III-13
AMI Pre-Deployment and Deployment Phase
High-Level Projected Timeline

Phase	Stage	Date
Pre-Deployment	Market Assessment	2023
	Proof of Concept Demonstration	2024 to 2025
	Field Testing	2025 to 2027
Deployment Phase		2027 to TBD

B. 2021 Decision

1. Comparison of Authorized 2021 to Recorded

The 2021 GRC Decision requires SCE to compare the 2021 authorized amounts to the recorded amounts.- Advanced Metering Infrastructure 2.0 is a new activity in this GRC so there were no authorized or recorded costs in 2021.

C. O&M and Capital Expenditures Forecasts - Pre-Deployment

1. Market Assessment

a) Work Description and Need for Activity

As AMI technology has matured over the last two decades, a variety of AMI solutions have become commercially available globally with varying degrees of interoperable,³⁵ interchangeable,³⁶ and modular solutions. Within North America, most of the commercially available AMI solutions are proprietary, single-vendor-sourced AMI systems and solutions that are locked in with a single vendor to provide a complete end-to-end solution. Outside of North America, however, and

³⁵ Interoperable meter can connect and communicate across multiple systems and share data through compatible data formats and protocols.

³⁶ Interchangeable meters have components or network modules that can be interchanged or swapped providing the ability to mix and match the best technology components of different vendors.

specifically in Europe and Asia, utilities have made a concerted effort to develop interoperable and interchangeable AMI solutions that promote multi-vendor, modular, and plug-and-play ecosystems for the AMI infrastructure. As SCE shifts towards a digitized, decarbonized, and decentralized grid, interoperable and interchangeable solutions and ecosystems will be key to managing a resilient, sustainable, affordable and secure grid. Additionally, next generation AMI solutions like this can provide personalized and real-time customer engagement solutions that will enable customer choice and help them make intelligent energy consumption decisions.

A global market assessment and benchmarking effort is thus necessary as this will allow SCE to comprehensively understand the current state of AMI technology maturity, which will enable SCE to pick the best technology solution for customers and enable SCE to develop more reliable cost estimates. This effort will allow SCE to identify vendors who are willing to participate and collaborate with SCE and each other in developing next generation AMI solutions, similar to what is currently being developed in non-North American markets. A comprehensive market assessment will help SCE identify the meter vendors who are interested in providing meter hardware and software platforms that can be integrated with SCE's communications network. The expected deliverable from this effort will be a market assessment report that evaluates (1) AMI technology maturity and its capabilities towards meeting the emerging use cases discussed above, (2) back/front office technology implementation strategy, and (3) various customer program/education aspects. This work will occur in 2023.

The AMI 2.0 Market Assessment will lead to the development of the AMI 2.0 roadmap, which will consist of planning and evaluation work to support the overall program. This roadmap will address AMI 1.0 lessons learned regarding hardware failures, obsolescence, and interoperability, enable advanced use cases (e.g., real-time customer data access, smart grid integration, and waveform signature analysis³⁷), and identify internal system impacts, dependencies (e.g., IT, customer service), and organizational change management requirements. This roadmap will further summarize the capabilities to be enabled, as well as provide a preliminary summary of deployment costs, benefits, and schedule. SCE expects this work to also occur in 2023.

³⁷ Waveform signature analysis offers real time power quality monitoring and provides immediate, actionable information incorporating advanced data capabilities and analytical techniques.

b) **Basis for O&M Forecast**

Table III-7
AMI 2.0 Market Assessment O&M³⁸
Forecast 2023 - 2025
(Total Company - Constant 2022 \$000)

O&M Forecast	Cost Element	2023	2024	2025
Contract Resources	NL	\$1,700		
Technical Resources	L	\$2,732		
Total O&M		\$4,432		

As shown in Table III-7, SCE forecasts \$4.432 million in O&M for the Market Assessment stage of the AMI 2.0 pre-deployment activities, which includes the costs for both in-house technical resources as well as external vendor support. As this O&M is forecast to be incurred prior to 2025, SCE is not seeking review and cost recovery for these costs in this GRC. SCE will be filing a motion seeking authority to establish a memorandum account for tracking these costs for future review and recovery, and, assuming that relief is granted, will record its actually incurred costs in that account once established.

2. Proof-of-Concept Demonstration

a) **Work Description and Need for Activity**

Building off the Market Assessment and Roadmap, SCE will work with multiple industry partners, including meter manufacturers, communications device manufacturers, and system integrators, to develop an AMI 2.0 Proof of Concept and perform lab testing to prove out the meter and meter systems technology. A key objective of this effort will be to develop an open standards hardware and software platform that provides interoperability and interchangeability that will support modular multi-vendor solutions on a cost-effective basis prior to implementing a full system. Interoperability is the ability of a metering device to connect and communicate across multiple systems and share data through compatible data formats and protocols. This is necessary as data exchange between different applications, databases and IT systems is necessary to provide low-cost data access to all the appropriate stakeholders. Interchangeability is the option to swap meter components or network modules within the metering devices to provide the ability to mix and match the best technology components of different

³⁸ WP SCE-02, Vol. 03, pp. 41-42 – Advanced Metering Infrastructure Market Assessment O&M Detail.

1 vendors. This is important because it will allow multiple meter vendors to allow for supplier diversity
2 and preventing single vendor lock in. In addition, emerging solutions, such as meter adaptor devices
3 which provide cost-effective electrical isolation to support PSPS, and customer generation & EV
4 measurement to enhance visibility of actual generation at the customer site, will enable development and
5 implementation of the modular solutions based on customer needs.

6 Prototype development and testing will allow SCE to develop and test multiple
7 iterations of prototype AMI meters to ensure that the technology solution ultimately chosen for
8 deployment meets the needs of SCE and its customers, can be implemented successfully from a
9 technical perspective, and is feasible from a financial perspective. Prototype development will be
10 focused in the gap areas within the industry where readily available commercial solutions are not
11 available. From 2024 to 2025, SCE will develop metering and communications equipment hardware that
12 encompasses edge computing, low latency, distributed intelligence, DER enablement, cloud solutions,
13 enhanced cybersecurity, and real-time demand response. To do this, SCE anticipates selecting four
14 different meter vendors and three different communication vendors that meet SCE's business and
15 technical requirements. Ultimately, this prototype development will result in the building of
16 approximately 500 meters that can be used for safety, compliance, and functional testing. Evaluation
17 will be conducted in the lab environment to validate unit, integration, system, communication, and cyber
18 security functionality of the prototype devices. SCE will test both internally and externally. Internal
19 testing will focus on new product capabilities, while external testing will focus on cyber penetration,
20 safety testing, and compliance testing.

21 This stage also includes labor for development of technical requirements, a
22 business requirements document (BRD), and high-level architecture for building the AMI system.
23 Development of technical requirements includes conducting feasibility testing and working with vendors
24 to develop and build prototype devices to conduct lab testing, cyber testing, and meter farm testing. In
25 addition, SCE will build technical specifications for the replacement of AMI 1.0 and integration with the
26 back-office system. During the Proof-of-Concept Demonstration stage, SCE will also conduct a vendor
27 selection process through a competitive request for proposal (RFP) for the Field Testing stage. SCE will
28 also develop specific use cases and develop a plan for field testing these specific use cases. Based on the
29 initial technical requirement and prototype development work, SCE will develop a BRD based on use
30 cases, functional specifications, and technical specifications. SCE will further develop high-level
31 architecture to integrate the new AMI 2.0 meters into the back-office systems.

1 Finally, along with the hardware development and testing, the Proof-of-Concept
2 Demonstration stage also includes customized software development for interface development of a
3 universal data collection engine for multiple vendors.

4 b) **Basis for O&M Forecast**

Table III-8
AMI 2.0 Proof-of-Concept Stage O&M³⁹
(Constant 2022 \$000)

Cost Category	Cost Element	2023	2024	2025
Contract Resources	NL		\$282	
Technical Resources	L		\$302	
Total			\$585	

5 SCE forecasts \$0.585 million in O&M expenses in 2024 for development of an
6 AMI 2.0 deployment plan during the Proof-of-Concept stage. This forecast, which is based on similar
7 costs incurred for AMI 1.0, consists of both SCE labor and contract labor since SCE does not have all of
8 the necessary technical expertise for this work in house. As this O&M is forecast to be incurred prior to
9 2025, SCE is not seeking review and cost recovery for these costs in this GRC. SCE will be filing a
10 motion seeking authority to establish a memorandum account for tracking these costs for future review
11 and recovery, and, assuming that relief is granted, will record its actually incurred costs in that account
12 once established.

³⁹ WP SCE-02, Vol. 03, pp. 43-44 – Advanced Metering Infrastructure Proof of Concept O&M Detail.

c) **Basis for Capital Expenditures Forecast**

Table III-9
AMI 2.0 Proof-of-Concept Capital Expenditures^{40,41}
(Total Company – Nominal \$000)

Cost Category	2023	2024	2025	2026	2027	2028
Proof of Concept Equipment		\$188	\$125			
Proof of Concept Lab Test Equipment		\$360	\$240			
External Lab Contract (Labor)		\$1,050	\$700			
IT Backoffice Systems		\$380	\$253			
Labor (SCE)		\$7,218	\$4,812			
Labor (Contract)		\$3,357	\$2,238			
Total		\$12,552	\$8,368			

As shown in Table III-9, SCE forecasts \$20.920 million in capital expenditures from 2024-2025 for the Proof-of-Concept stage. This forecast is based on the volume of meters and supporting equipment necessary for adequate testing, historical costs for meter and meter related equipment, as well as vendor estimates for prototype testing and hosted software solutions. Specifically, this forecast encompasses four categories: equipment, testing, software, and labor.

SCE's forecast of \$0.313 million for equipment includes the cost of 500 meters, 50 backhaul routers, and 20 form 43S panels.

- SCE estimates needing 500 meters for the Proof-of-Concept Demonstration to allow a sufficient number of meters for functional testing, hardware testing, system testing, and external lab testing. SCE will test both residential and commercial/industrial (C&I) meters as they will require different functionality. SCE plans to test approximately 300 residential meters⁴² with a forecasted cost of \$125 per meter (the current average cost for an AMI 1.0 residential meter) and approximately 200 C&I meters⁴³ at an estimated cost of

⁴⁰ WP SCE-02, Vol. 03, pp. 45-46 – Advanced Metering Infrastructure Proof-of-Concept Capital Detail.

⁴¹ The forecast incorporates accounting adjustments to reflect certain changes made to SCE's employee compensation program. See SCE-06, Vol. 04.

⁴² SCE estimates 300 residential meters will be required for various testing scenarios, including hardware, software evaluation, cyber, wireless, IT system, integration, etc.

⁴³ SCE estimates 200 C&I meters will be required for various testing scenarios, including hardware, software evaluation, cyber, wireless, IT system, integration, etc.

1 \$300 per meter (the current average cost for an AMI 1.0 C&I meter).⁴⁴ The
2 cost per meter used for this forecast is a conservative estimate given that the
3 next generation of AMI meters will have added functionalities and capabilities
4 compared to the AMI 1.0 meters (e.g., allow for increased customer
5 engagement, improved real-time energy monitoring functionality), which will
6 likely make these AMI 2.0 meters more expensive than a standard AMI 1.0
7 meter.

- 8 • SCE estimates needing 50 backhaul routers⁴⁵ which will provide the
9 communications path from meters in the field to IT back-office systems that
10 collect meter data. For these, SCE estimates a unit cost of \$3,850 per router
11 based on past purchase orders, totaling \$0.193 million. This estimate is
12 consistent with the current cost of pole-mounted routers used in the current
13 AMI solution.
- 14 • Finally, SCE forecasts needing 20 form 43S panels which are a new type of
15 customer panel and socket that enables DER integration at the customer
16 premise, providing additional measurement and control capabilities. SCE
17 estimates a unit cost of \$1,000 per panel for the 20 form 43S panels, totaling
18 \$20,000. The unit cost is based on the historical cost of similar regular form
19 2S panels, which cost between \$600 - \$1,000 per panel. The form 43S panels
20 have additional secure connections and wiring, so the estimated cost is higher
21 than the form 2S.

22 SCE's forecast of \$2.350 million for testing includes \$0.600 million for prototype
23 hardware testing equipment and \$1.750 million to engage external labs for proof-of-concept hardware
24 testing. The testing equipment needed includes meter testing boards, spectrum analyzers, RF
25 interference testing tools, laptops, DER solar and battery simulation lab set up, and in home load control
26 devices. SCE's estimate to conduct external lab testing for cybersecurity penetration, safety and

⁴⁴ A residential meter is a single-phase meter, while a C&I meter is a polyphase meter that requires additional components within the meter making it more expensive than a residential AMI meter.

⁴⁵ SCE estimates 50 backhaul routers will be required for various testing scenarios and also for stakeholders needing samples to conduct testing and IT integration activities.

1 compliance is estimated to be \$1.750 million and is based on past contracts with external lab vendors for
2 similar types of prior engagements.

3 SCE's forecast of \$0.633 million for software accounts for the anticipated one-
4 time software fee for hosted solutions from multiple vendors, as well as the backhaul costs for wireless
5 service fees. Each supplier that participates in the Proof-of-Concept stage will be providing hosted
6 services for their back-office software solution. The hosted functions include data collection services to
7 collect meter data from the meters and analysis functions to evaluate and demonstrate the supplier's
8 ability to meet SCE's business use cases. Backhaul costs for wireless services fees are required
9 communication services needed to communicate from meters in the field to IT back-office systems. This
10 estimate is based on discussions with, and proposals received from, meter vendors.

11 Finally, SCE's forecast of \$17.624 million for technical labor accounts for the
12 SCE and contractor technical labor needed to support the proof-of-concept phase. Contract resources are
13 necessary for specific technical skills and expertise in the emerging AMI 2.0 space to successfully
14 develop proof of concept devices. Based on similar proof of concept development efforts and projects
15 planning activities in the past, SCE anticipates needing the following resources:

- 16 • 17 engineer and IT specialist resources for 18 months to plan, develop
17 technical requirements, conduct feasibility analyses, and work with vendors to
18 develop 500 prototype devices. These resources will also be responsible for
19 conducting evaluation testing on the prototype devices from different
20 suppliers
- 21 • Five project resources (business advisors, project managers, and one project
22 analyst) for 12 months to build technical specifications for the replacement of
23 the existing SmartConnect Meters and additions/replacements needed for the
24 related IT back-office system, align AMI 2.0 requirements with other business
25 requirements, develop the business case to conduct RFPs for field testing, and
26 to plan for lab and field testing, operations, and deployment strategy
- 27 • Three technical resources (an advisor, technical specialist and a technical
28 writer) for 12 months to build the business requirements document based on
29 use cases and functional specifications

- Nine engineer and IT specialist resources for nine months to build the conceptual and logical architecture documentation for the system⁴⁶

For a more detailed breakdown of SCE's forecast for the Proof-of-Concept stage, please see the Proof-of-Concept workpaper.⁴⁷

3. Field Testing

a) Work Description and Need

The Field Testing stage will begin in mid-2024 and continue through 2027. The objectives of Field Testing will be to ensure that systemwide deployment will (1) be cost effective consistent with business needs and project objectives, (2) have multiple vendor and communications options to ensure product availability and flexibility, (3) use technology that has been tested and validated, and (4) implement a solution that is scalable and will remain viable, practical, and cost effective even if the technology evolves. While SCE will perform extensive lab testing prior to field testing, lab evaluations are limited to a small representative sample of devices and the lab environment cannot fully replicate the field environment. In order to mitigate the risks inherent in a systemwide deployment that will involve millions of devices, field testing is essential to enable SCE to test a large enough sample of devices under real operating conditions in the field prior to systemwide deployment.

As part of this field testing, various use cases for the AMI 2.0 meters will need to be tested with a meaningful sample size in the field. These use cases will be tested with metering and communications solutions from multiple vendors with a focus on flexible, interoperable, and standards-based solutions that can be integrated into standard data collection systems. For AMI 1.0, SCE performed field testing with 5,000 meters, a 0.1% representative sample size of the SCE meter population. Given the additional functionality and capabilities of AMI 2.0 meters and expected increase in use cases, SCE will need to field test a larger sample of approximately 0.2% or 10,000 meters for AMI 2.0. Vendor identification and AMI use case definition are ongoing. However, SCE expects to test four vendors and more than 25 use cases. Field testing 10,000 meters will allow approximately 100

⁴⁶ This is incremental to the work being performed by the 17 engineer and IT specialist resources described in the first bullet point. Building the conceptual and logical architecture documentation for the system is an industry standard approach to systems engineering and ensures all suppliers and solution providers have clear direction on their deliverables as well as the integration points across the solution. With any substantial technology investment that interacts with customers, grid management, billing, IT operations, and cybersecurity, a conceptual design that documents how the system meets the business requirements and delivers on the use cases to meet the customer and business needs is required.

⁴⁷ WP SCE-02, Vol. 03 – Advanced Metering Infrastructure Proof of Concept Capital Forecast workpaper.

1 meters per use case per vendor. This estimate of 100 meters per use case is based on historical
2 experience and best practices based on experiences from AMI 1.0 field testing. In addition to installing
3 AMI 2.0 meters for field testing, we also plan to install up to 300 router devices to provide backhaul
4 communication support for the AMI 2.0 network being field tested. SCE will also implement a program
5 management office to measure progress towards selecting an AMI 2.0 solution and help ensure SCE
6 meets critical milestones and achieves required business capabilities.

7 Specifically, SCE anticipates field testing the use case categories described below.
8 Each category contains multiple potential individual use cases. The final set of use cases for field testing
9 will be prioritized and selected to appropriately balance the need to provide customer benefits with
10 implementation timelines, complexities, and costs, while having the flexibility to add future capabilities
11 in a modular fashion.

- 12 • **Residential customer energy management:** This could include testing real-
13 time energy usage insights, real-time pricing notifications, budget billing,
14 usage alerts, real time energy data for demand response, in-home device level
15 disaggregation, peer-to-peer trading, load reduction or load shift incentives
16 using energy data.
- 17 • **DER integration:** This could include evaluating behind-the-meter customer
18 energy generation monitoring and control capabilities, DER scheduling,
19 battery/EV to grid energy demand balancing, customer generation isolation to
20 support PSPS events, capacity planning, DER data aggregation, and dynamic
21 load forecasting.
- 22 • **Energy efficiency:** This could include testing in-home appliance monitoring
23 and control capabilities with enhanced demand response and home automation
24 using the AMI 2.0 meter's edge analytics capabilities. In addition, SCE plans
25 to provide customers with compatible smart thermostats, switches for pool
26 pumps and other appliances that will interface with the AMI 2.0 device to test
27 enhanced energy efficiency and demand response use cases.
- 28 • **Customer safety:** This could include evaluating use cases such as detecting
29 customer-side panel wiring issues, in-home appliance health monitoring, and
30 improved customer outage notifications.

- **Street light metering sensors:** This could include testing street light meter sensor integration capabilities within AMI 2.0 communication backhaul, upstream systems, and back-office billing capabilities.
- **Grid resiliency and reliability:** This could include use cases focused on safety and situational awareness (e.g., detection of arcs, faults, wire down events, and vegetation growth), as well as those focused on things like transformer load management, real-time power quality monitoring, Volt Var optimization, grid load balance, phase balancing and mapping, distributed intelligence capabilities to improve speed and accuracy of response, troubleshooting efforts, modernization of distribution systems, dynamic load planning and balancing.

Once Field Testing is complete, SCE will evaluate results, make modifications to metering devices based on test results (if necessary), and retest revised devices to ensure successful deployment. Once the device design has passed testing, SCE will evaluate field test results against the business requirements and technical specifications established. Finally, SCE will make recommendations for selecting meter vendors for full-scale deployment.

b) Basis for Capital Expenditures Forecast

Table III-10
AMI 2.0 Field Testing Capital Expenditures^{48,49}
Forecast 2023-2028
(Total Company – Nominal \$000)

Cost Category	2023	2024	2025	2026	2027	2028
Field Testing Equipment		\$1,166	\$1,166	\$1,166	\$1,166	
IT Backoffice Systems		\$2,331	\$2,937	\$2,983	\$3,096	
Device Installation and Training Labor				\$1,238	\$1,238	
Technical Labor Cost (SCE)				\$4,178	\$4,178	
Technical Labor Cost (Contract)				\$2,719	\$2,719	
Total		\$3,497	\$4,103	\$12,284	\$12,397	

Table III-10 Table III-10 highlights SCE's forecast of \$32.281 million in capital expenditures from 2023-2028 for the Field Testing stage. This forecast is based on historical costs for

⁴⁸ WP SCE-02, Vol. 03, pp. 47-48 – Advanced Metering Infrastructure Field Testing.

⁴⁹ The forecast incorporates accounting adjustments to reflect certain changes made to SCE's employee compensation program. See SCE-06, Vol. 04.

1 meters, meter-related equipment, and meter installation labor, as well as estimated costs for IT software
2 to integrate the new metering devices into the SCE upstream systems, which will allow SCE to enable
3 emerging use cases and to perform the billing function of the meter successfully during Field Testing.
4 Specifically, this forecast encompasses four categories: equipment, IT Back Office Systems, device
5 installation and training, and technical labor. SCE's forecasts for each of these categories is discussed in
6 the following sub-sections. For a more detailed breakdown of SCE's forecast for the Field Testing stage,
7 please see the Field Testing workpaper.⁵⁰

8 (1) **Equipment**

9 SCE plans to spend \$4.663 million on Field Testing equipment consisting
10 of 10,000 meters, 300 routers, 300 Form 43S panels, and panel retrofits and appliances needed for use
11 case testing as follows:

- 12 • **Meters.** As discussed for the Proof of Concept forecast above, SCE
13 estimates the average unit cost of each AMI 2.0 meter will be \$125 for
14 residential meters and \$300 for C&I meters,⁵¹ resulting in a total cost
15 for 10,000 meters for Field Testing of \$2 million.
- 16 • **Backhaul routers.** SCE estimates a unit cost of \$3,850 per backhaul
17 router based on past purchase orders, which is consistent with the
18 current cost of pole-mounted routers used in the current AMI solution.
19 This results in a total cost for 300 backhaul routers for Field Testing of
20 \$1.35 million.
- 21 • **Form 43S panels.** In order to evaluate behind the meter customer
22 energy generation monitoring and control capabilities, SCE will need
23 to upgrade existing meter panels that exist at the customer premise to
24 accommodate the new form 43S meter type. SCE estimates needing
25 300 Form 43S panels at an estimated unit cost of \$1,000 per panel with
26 additional cost of \$1,500 per unit for residential form 43S panel
27 upgrade installation cost. This unit cost is based on historical average

⁵⁰ WP SCE-02, Vol. 03, pp. 47-48 – Advanced Metering Infrastructure Field Testing.

⁵¹ The basis for the estimated AMI 2.0 meter cost is explained in section III.C.2.c).

1 panel costs used for panel upgrades. The estimated total costs for the
2 panels are \$750,000.

- 3 • **Energy Efficiency Appliances.** To test energy efficiency use cases,
4 SCE plans to provide 500 customers with a bundle of energy
5 efficiency appliances that will interact with the AMI 2.0 meters,
6 including compatible smart thermostats, switches for pool pumps, heat
7 pumps, and EV chargers at a total estimated cost of \$1,000 per
8 appliance bundle, totaling \$500,000. This unit cost was derived based
9 on the average price of a smart home device estimated at
10 approximately \$250. SCE anticipates providing 4 energy efficiency
11 devices to each customer to be tested.
- 12 • **Retrofitted Customer Panels.** In order to test customer safety use
13 cases, SCE will retrofit 200 customer panels to allow for enhanced
14 safety use cases such as detecting customer side panel wiring issues, in
15 home appliance health monitoring, and improved customer outage
16 notifications. SCE estimates a unit cost of \$500 for these retrofits,
17 resulting in a total cost of \$100,000. This unit cost is based on a typical
18 panel upgrade which includes panel upgrade equipment and the
19 installation cost.

20 (2) **IT Backoffice Systems**

21 The forecasted IT Backoffice Systems costs required to support Field
22 Testing is \$11.347 million for 2024-2027. The capital forecast was developed using SCE's internal cost
23 estimation model. This model utilizes industry best practices and SCE subject matter expertise to
24 estimate project cost components. This forecast encompasses costs for consultants, managed service
25 providers, software and vendors, and hardware for developing specific business outcomes required by
26 Field Testing. These costs fall into five categories: integration, cloud enterprise computing costs,
27 cybersecurity services, professional services, and software licensing.

28 Integration costs include the work required to interconnect existing
29 systems to the Field Testing systems under evaluation. SCE plans to spend \$6.075 million on integration
30 for nine interfaces to three vendor solutions for a total of 27 interfaces at an average interface cost of
31 \$0.225 million. Cost estimates were derived from an assessment of the interface complexity,

1 functionality, reliability objectives, and cybersecurity requirements. Existing systems include electric
2 usage data processing and billing, grid management, meter operations, network operations, customer
3 programs and services, customer portal, and asset management to new meter data collection systems and
4 new analytical systems.

5 Cloud enterprise computing costs include the necessary computing,
6 storage, security, and networking services to conduct a successful field test with 10,000 meters to
7 evaluate multiple suppliers and their associated data collection and analysis software. SCE plans to
8 spend \$1.522 million on cloud enterprise computing. Forecast costs were derived from recent supplier
9 Request for Information (RFI) submittals.

10 Cybersecurity services costs include the work to inspect and perform
11 penetration testing on each new component of the system, which is necessary prior to starting testing in
12 the field. SCE estimates spending \$0.575 million for cybersecurity services. This forecast was developed
13 using SCE's internal cost estimation model, which is discussed above. Testing will be performed for all
14 four suppliers.

15 Professional services costs consist of IT back-office design,
16 implementation, and testing services from four meter vendors. SCE expects to spend \$2.025 million on
17 professional services during this stage, which is derived from meter vendor RFI submittals.

18 Software licensing costs are for the licensed software of meter vendors (or
19 other solution providers) which is required to run the system and perform data collection, configuration
20 management, firmware upgrades, and advanced analytics. SCE expects to spend \$1.2 million on
21 software licensing costs for Field Testing. This software licensing cost forecast was developed using
22 SCE's internal cost estimation model.

23 **(3) Device Installation and Training Labor**

24 In order to install and troubleshoot 10,000 AMI 2.0 devices, 300 backhaul
25 routers, and 300 Form 43S panels for Field Testing, SCE forecasts approximately \$2.475 million in
26 labor costs. The installation cost for each meter is forecast to be \$200, resulting in a total cost of \$2
27 million for meter installation. The installation cost for each router is forecast to be \$1,000, resulting in a
28 total cost of \$300,00 for router installation. The installation cost for each streetlight meter is estimated to
29 be \$50, resulting in a total cost of \$75,000 for streetlight meter installation. These costs are all based on
30 the current installation cost that SCE incurs today to install a single meter, router, or streetlight meter.
31 Finally, SCE will need to provide training to the meter technicians and troublemen who will install this

1 equipment for testing. SCE estimates that this training will cost \$100,000, which is based on the
2 resources needed to developing training material, set up training workshops, and to coordinate and
3 conduct training workshops.

4 **(4) Technical labor costs**

5 Finally, SCE will need both SCE and contractor technical labor to support
6 field testing as SCE does not have the technical skills and expertise in the emerging AMI 2.0 space to
7 successfully field test the new devices on its own. Based on recent activities related to similar projects
8 and a staff planning and forecasting analysis, SCE anticipates needing 24 resources for 24 months to
9 plan, execute, and validate field testing of over 25 use cases in the areas of customer engagement, grid
10 resiliency and decarbonization and to manage the RFP process to identify vendors who will support the
11 full AMI 2.0 deployment. These resources will include engineers to test and evaluate the new meter
12 technology, evaluate the use cases, and evaluate meter devices and performance; IT specialists to
13 manage processes and integration of three IT systems during field testing and to conduct the RFPs for
14 the back-office software, meter technology, and system integration for full deployment (i.e., develop the
15 evaluation criteria, identify vendors to participate in the RFP, initiate and conduct the RFP, analyze and
16 review RFP responses, and make final vendor selections); a project manager to manage the project
17 planning and schedule, senior managers to oversee grid technology, business requirements, and the
18 progress of field testing; and a project analyst to support analytical and reporting requirements. In total,
19 SCE anticipates that the capital expenditures for the technical labor supporting Field Testing will total
20 \$13.799 million.