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Electrification Impacts Study Research Plan

Prepared for:

California Public Utilities Commission, Energy Division

Proceeding R.21-06-017 (Order Instituting Rulemaking to Modernize the Electric Grid for a High Distributed Energy Resources Future)

Submitted by:

Kevala, Inc.
55 Francisco Street Suite 350
San Francisco, CA 94133

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Executive Summary

Successfully achieving California's electrification and decarbonization goals depends on an electricity grid that can support diverse electrification technologies and maintain the affordability of the grid for California's families and businesses. However, the scope and scale of potential electric grid impacts and associated costs necessary to support California's ambitious electrification goals, are not currently well-understood.

Existing electric distribution planning processes may be insufficient to timely select and deploy traditional distribution infrastructure and Distributed Energy Resource (DER) solutions to meet grid needs. Existing planning processes may require more information and precision to minimize utility customer costs or to identify barriers and opportunities to equitably distribute costs.

The California Public Utilities Commission's (CPUC) current electric utility Distribution Planning Process' (DPP) Grid Needs Assessment (GNA) evaluates necessary grid investments based on a single forecast scenario selected from the latest, adopted version of the California Energy Commission's (CEC) Integrated Energy Policy Report (IEPR)[1]. This biennial statewide demand forecast focuses on an econometric forecast of what is likely to occur rather than forecasting loads based on policy goals.

It is increasingly acknowledged that the number of electric vehicles (EV) needed to meet state policy goals for transportation electrification is higher than what is currently reflected in IEPR forecasts[2]. Moreover, electrification of transportation and buildings will not occur homogenously across a utility's service territory. For example, highly localized medium-duty and heavy-duty (MD/HD) electric vehicles and public fast-charging stations supporting California's electrification goals will likely represent significant growth in certain areas. Identifying these locations and the distribution circuits that support them early on can enable informed decision-making about grid requirements.

As awareness of the importance of achieving high electrification targets to meet state climate policy goals increases, so do questions about the electric grid's readiness to support higher electricity loads. For example, what would be the consequences if future electrification is higher than is reflected in current forecasts? Where and when would any such consequences manifest? What are the most cost-effective means of mitigating those consequences? How can grid

[1] As an example, the investor-owned utilities' (IOU) 2022 GNA were based on the 2020 IEPR. The 2023 GNAs are expected to be based on the 2021 IEPR. Since the IOUs require approximately one year to prepare the GNA, the process must begin before a more recent IEPR version has been adopted.

[2] The CEC has embarked on a new long-term demand scenarios development and assessment project, including the development of two High Electrification Scenarios (a policy/compliance scenario and a mitigation scenario) based on datasets from the adopted 2021 IEPR. The demand scenarios are described as "long-term" because building decarbonization and transportation electrification scenarios will be developed out to 2050. See Final 2021 IEPR, Volume IV, Chapter 4: https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2021-integrated-energy-policy-report.

modernization and investment costs and benefits be more equitably allocated to ratepayers? And is there a risk of overinvestment if electrification impacts are less than projected?

In its Order Instituting Rulemaking R.21-06-017[3] the CPUC has recognized the need to understand a range of possible outcomes to successfully prepare and manage the grid, and that a high-electrification future may require different planning approaches. To this end, the CPUC has specified the following questions to be addressed in Track 1, Phase 1 of the proceeding:

- Should the Utilities' DPPs be modified to address policy-based issues such as forecasting scenarios for increased electrification, improved data sharing, electric vehicle adoption, adoption of real-time rates and related flexible load management technologies, and equity?
- Should policy-forecasting scenarios for higher electrification be used for determining potential grid investments needed to address electrification?[4]

To inform these policy questions, the CPUC contracted with Verdant Associates and Kevala, Inc. (Kevala) to estimate the scope of new electric grid infrastructure required under a range of electrification scenarios and examine distribution planning methodologies. These goals will be achieved by implementing this Electrification Impacts Study Research Plan (Research Plan), which is designed to:

- Enable the identification of grid enhancements and changes necessary to support California's stated transportation and building electrification policy goals by 2035.[5]
- Consider alternatives for evaluating distribution capacity expansion and deferral options (i.e., non-wires alternatives and DER-based alternatives) into the utilities' DPP.
- Explore increasing the granularity of technology adoption models in high electrification scenarios to inform the development of mitigation strategies which will seek to optimize grid planning, maximize the equity and reliability benefits, and minimize the costs of high electrification

[3] Proceeding R.21-06-017, opened with an *Order Instituting Rulemaking to Modernize the Electric Grid for a High Distributed Energy Resources Future*, issued on July 7, 2021.

[4] Assigned Commissioner's Scoping Memo and Ruling in R.21-06-017, November 15, 2021.

[5] Executive Order N-79-20 (September 23, 2020) sets the following goal: "100 percent of in-state sales of new passenger cars and trucks will be zero-emission by 2035. It shall be a further goal of the State that 100 percent of medium- and heavy-duty vehicles in the State be zero-emission by 2045 for all operations where feasible and by 2035 for drayage trucks. It shall be further a goal of the State to transition to 100 percent zero-emission off-road vehicles and equipment by 2035 where feasible."

- Improve clarity and transparency of electrification scenario inputs, methodologies, and outputs across state energy planning agency processes.

Furthermore, as the state implements its ambitious electrification and decarbonization goals, policy-based projected load growth could change the grid in many ways. The distribution system impacts of California's future accelerated transportation and building electrification may not materialize based purely on historical or allocated trends. This Research Plan describes an approach to a distribution planning process that can examine various grid scenarios in the most geographically and temporally granular way possible. The methodology is designed to optimize the integration of DERs within the distribution grid efficiently and cost effectively and, specifically, to examine the challenges identified by proceeding R.21-06-017:

- Can CPUC-jurisdictional, premise-specific meter information be used to develop circuit-specific forecasts based on an expectation of the levels of electrification necessary to meet the state's policy goals?
- How can premise and circuit-specific grid integration analysis be incorporated into the distribution and sub-transmission grid infrastructure planning processes that are within the CPUC's jurisdiction?
- Can the current distribution planning approach and processes evolve to be sustainable, engage stakeholders, consider both deferral and capacity additions, and result in meaningful and cost-effective grid investments?
- How can the CPUC enable deeper consideration of equity-oriented distribution planning factors with forecasts based on real-time geographic and socio-economic analyses?
- Can the current lag time between system-wide planning for generation and transmission, and distributed energy resource procurement, be meaningfully shortened in order to prepare the electric grid to support electrification initiatives?

This document describes the three-part Electrification Impacts Study Research Plan in support of Rulemaking R.21-06-017.

The Research Plan starts with **Part 1 (Bottom-Up Load Forecasting and System-Level Electrification Impacts Cost Estimates)**, which will focus on developing and providing an hourly, premise-specific net-load high DER and electrification forecast adoption for the 2025, 2030, and 2035 time horizons. These hourly, premise-specific net-load adoption forecasts will serve as the backbone to understanding the impacts of electrification on distribution planning and grid infrastructure needs. Part 1 will also provide initial distribution capacity expansion and system-

level cost estimates for each of the time horizons aggregated at the IOU service territory level to provide insights into transmission planning investments.

Multiple scenarios will be compared, including a base case scenario (2021 IEPR Mid-Energy Demand) and a series of higher electrification scenarios. By comparing multiple scenarios, the CPUC could arrive at several potential findings to inform near-term DPP policy:

- Low Impact: Grid impacts from higher electrification in the short term are not significant and do not justify deviating from current planning practices.
- High Impact: Grid impacts from higher electrification are very impactful and justify more aggressive grid build out and/or mitigation strategies.
- Mixed Impact: Grid impacts are mostly manageable, but certain long-lead-time critical distribution and transmission infrastructure projects are needed and justifiable as "least regrets."

In **Part 2 (Electrification Impacts Staff Proposal)**, Kevala, with CPUC Energy Division staff and the full CPUC consulting team[6] will support an Electrification Impacts Staff Proposal leveraging any insights from the disaggregated load adoption scenarios developed in Part 1, to provide recommendations on improving the DPP process. The objective will be to enable a range of utility electrification scenario grid needs and other opportunities for non-traditional upgrades to mitigate grid impacts.

Part 3 (Electrification Grid Integration Report) of the study will focus on updating the disaggregated load and adoption scenarios developed in Part 1, and creating a more robust framework for estimating utility-specific grid investment and assessing programmatic enhancements and their costs. Various scenarios with high DER will be considered, namely transportation and building electrification forecasts, grid integration technologies such as advanced DER controls and load management, and the implications of managed DER growth.

It is important to note that this Electrification Impacts Study and the proceeding R.21-06.017 do not seek to set policy on the overall number of DERs nor to increase or decrease the desired level of DERs. The focus is on preparing the grid to accommodate what is expected to be a high DER future and to capture as much value as possible from DERs while mitigating unintended negative impacts. Regardless of the Study's ultimate findings, the CPUC and its stakeholders will gain much needed analytic insight into how to prepare the grid for high electrification. Under any planning scenario, the CPUC can improve the DPP to better prepare for high electrification, reduce

[6] The consulting team is composed of Verdant Associates, LLC along with Gridworks, Xanthus Consulting, and Kevala.

ratepayer costs, and maximize DER value to the grid. Options may include different combinations of traditional infrastructure, new DERs, optimal siting of TE loads, and flexible load technologies and strategies.

The timely execution of the three parts of the Electrification Impacts Study Research Plan will be dependent on the timely availability of the data required to perform the research as described in Appendix 2: Input Data and Utility Data Request of this document. Throughout the implementation of the Research Plan, Kevala through the CPUC and CEC will coordinate with stakeholders working on initiatives such as Integrated Resource Planning, demand forecasting for DERs, IEPR stakeholder processes, and electrification planning to share and coordinate on scenarios, data inputs, and assumptions. As stakeholder engagement is an important element of this Research Plan, workshops and opportunities for stakeholder comments are planned at several junctures in the schedule, as shown in the detailed timeline provided in the Project Management and Stakeholder Input section of this document. Responses to specific stakeholder comments on the Draft Research Plan are provided in Appendix 3: Responses to Public Comments.

Background

The California Public Utilities Commission's (CPUC) Rulemaking R.21-06-017 focuses on preparing the grid to accommodate what is expected to be a high Distributed Energy Resource (DER) future. In line with statements made in the Order Instituting Rulemaking (OIR),[7] this Electrification Impacts Study intends to support CPUC decision making for preparing the grid to accommodate what is expected to be a high DER future and capturing as much value as possible from DERs while mitigating unintended negative grid impacts. The study does not intend to establish policy regarding increasing or decreasing the desired level of DER deployment, but rather focus on proposing new methods and tools, consistent with the DER Action Plan 2.0, to "align the CPUC's vision and actions to maximize ratepayer and societal value of an anticipated high-DER future."[8]

The OIR states that DER growth is expected to continue to increase in California, especially due to policies and programs driving transportation electrification and associated DERs (i.e., electric vehicles (EVs) and electric vehicle supply equipment (EVSE)). By 2025, EVSE infrastructure in the United States is forecasted to result in more annual DER capacity additions than solar.[9] In California, state-specific transportation electrification and climate goals are expected to result in millions of EVs and EVSE DERs by 2030.[10] Executive Order N-79-20 sets a target for 100 percent of new cars and passenger trucks sold in California to be zero emission by 2035. In addition, state legislation, CPUC proceedings, and local building reach codes are expected to further drive building and mobility electrification. For example, Senate Bill (SB) 1477 and Assembly Bill (AB) 3232, designed to reduce greenhouse gas emissions from buildings and support local electrification laws, are likely to further drive DER penetration and electrification.

The CPUC recognizes that successfully achieving California's electrification and decarbonization goals depends on an electricity grid that can support diverse electrification technologies at scale and maintain the affordability of those technologies and electric rates for California's families and businesses. This Research Plan is designed to inform and support several scoping questions for

[7] Order Instituting Rulemaking to Modernize the Electric Grid for a High Distributed Energy Resources Future, July 2, 2021 (R.21-06-017), at pp. 7-10.

[8] Draft CPUC DER Action Plan 2.0, July 23, 2021, at p. 3.

[9] *United States Distributed Energy Resources Outlook: DER Installations and Forecasts 2016-2025E*. Wood Mackenzie, July 2020. Reported in *What the Coming Wave of Distributed Energy Resources Means for the US Grid*. Greentech Media, June 18, 2020. Also from the Wood Mackenzie executive summary for their July 2020 outlook report.

[10] The California Air Resources Board is currently refining its EV forecast for 2030 and will be incorporated into the CEC's future demand forecasts.

the CPUC's Order Instituting Rulemaking R.21-06-0171. Specific issues and questions raised in R.21-06-017 to be addressed through this Research Plan include:

- How should the Distribution Planning Process (DPP)/Distribution Investment Deferral Framework (DIDF) processes improve to support widespread electrification?
- What improvements to the Grid Needs Assessment (GNA) load forecasting can be made to identify the grid investments that are needed to support electrification?
- What coordination is needed between the CPUC, the California Energy Commission (CEC), and the California Independent System Operator (CAISO) to improve the use of transportation and building electrification forecast data for distribution planning purposes?
- How should DPP/DIDF processes be coordinated with other CPUC processes, policies, and proceedings to adequately and efficiently plan for distribution grid upgrades triggered by transportation and building electrification and to reduce, defer, or avoid grid upgrades where feasible?
- How can the tools, processes and analytical framework developed through this Study support the Updated Goals and Objectives identified in the Environmental and Social Justice (ESJ) Action Plan 2.0? For example, Goal #2 strives to "Increase investment in clean energy resources to benefit ESJ communities, especially to improve local air quality and public health".[11] The premise-level analyses envisioned in this study anticipates enabling more granular, ESJ-informed analysis of clean energy technologies and programs.

The CPUC expanded on these guiding questions in the following scoping questions in the "Assigned Commissioner's Scoping Memo and Ruling," in R.21-06-017 dated November 15, 2021:

- **Track 1, Phase 1**
  - Scoping Question 1: Should the Utilities' DPPs be modified to address policy-based issues such as forecasting scenarios for increased electrification, improved data sharing, electric vehicle adoption, adoption of real-time rates and related flexible load management technologies, and equity? Should policy forecasting scenarios for higher electrification be used for determining potential grid investments needed to address electrification?
  - Scoping Question 2: How should Utilities' GNA and Distribution Deferral Opportunities Report (DDOR) be coordinated with the draft Transportation Electrification Framework and/or any existing or future Utility transportation

[11] CPUC Environmental & Social Justice Action Plan 2.0 - Draft for Public Comment issued October 26, 2021

electrification planning efforts stemming from the transportation electrification proceeding (R.18-12-006) and any successor proceeding?

- Scoping Question 3: How can the GNA and DDOR reports better reflect the types of Transportation Electrification investments identified in the draft Transportation Electrification Framework and the legislative directives from AB 841 (Ting, 2020)?

- **Track 1, Phase 2**
  - Scoping Question 1: Should Utilities better integrate DERs into their standard annual DPP? If so, in what ways should the Utility DPPs improve with respect to planning for DERs (e.g., capturing additional value from these resources and optimizing resource siting)? How should Utility ownership of DERs be considered in these changes to DPP?
  - Scoping Question 2: Should the DIDF be modified to better capture DER value and optimize DER siting? Improvements may include better aligning the DIDF with Utility DPPs, implementing key insights from the Standard Offer Contract pilot and Participation Pilots adopted in Decision (D.) 21-02-006, and considering additional pilots, as well as evaluating how can DERs provide resource adequacy services when not being used for deferral.
  - Scoping Question 3: Leveraging the analysis identified in Track 1, Phase 1, are there ways in which utility distribution planning representatives could better engage with local and tribal governments, environmental and social justice communities, and local developers to ensure new planned loads and developments are factored into Utility DPPs and local concerns regarding distribution planning are adequately addressed?

These scoping questions indicate a need to review existing electric distribution planning processes to ensure they are sufficient for timely selecting and deploying traditional distribution infrastructure and DER solutions to grid needs with the precision needed to minimize utility customer costs or with the information necessary to identify barriers and opportunities to equitably distribute costs.

Further, the scope and scale of potential electric distribution grid impacts and associated costs necessary to support California's ambitious electrification goals are not currently well-understood. The CPUC's current electric utility DPP Grid Needs Assessment evaluates necessary grid investments based on a single forecast scenario tied to the CEC's latest, adopted IEPR forecast. This biennial statewide forecast has, to date, focused on an econometric forecast of what is reasonably likely to occur rather than forecasting loads based on policy outcomes.

This Research Plan examines whether and how premise-level, policy-based forecasting can be integrated into California's grid planning processes by applying 1) locational electric grid analytics to both present and anticipated electric grid conditions, and 2) a capacity planning lens to

distribution planning as well as the deferral framework currently in place. The Research Plan is designed to optimize the integration of DERs within the distribution grid efficiently and cost effectively, and specifically to examine the following questions:

- Can CPUC-jurisdictional, premise-specific meter information be used to develop circuit-specific forecasts based on an expectation of the levels of electrification necessary to meet the state's policy goals?
- How can premise and circuit-specific grid integration analysis be incorporated into the distribution and sub-transmission grid infrastructure planning processes that are within the CPUC's jurisdiction?
- Can the current distribution planning approach and processes evolve to be sustainable, engage stakeholders, consider both deferral and capacity additions, and result in meaningful and cost-effective grid investments?
- How can the CPUC enable deeper consideration of equity-oriented distribution planning factors with forecasts based on real-time geographic and socio-economic analyses?
- Can the current lag time between system-wide planning for generation and transmission, and distributed energy resource procurement, be meaningfully shortened to prepare the electric grid to support electrification initiatives?

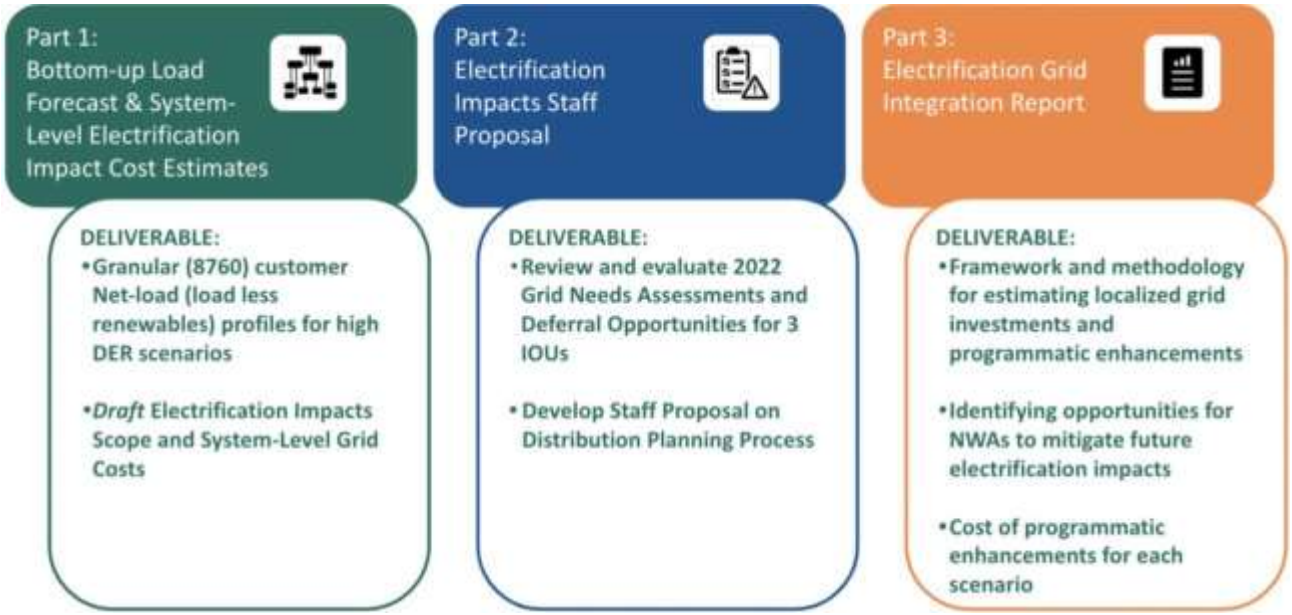
The Electrification Impacts Study is intended to provide the foundation for an improved framework for distribution planners to evaluate grid needs, and value grid solutions based on the hyper-granular location of future electrification needs.[12] Because the distribution system impacts of California's future accelerated transportation and building electrification may not materialize based purely on historical or allocated trends, the Research Plan explores how the unique effect of electrification on each utility circuit can be identified, based on myriad factors specific to that circuit. This Research Plan is designed to investigate these anticipated future changes in the most geographically and temporally granular way available. It is not, however, intended to put forward a separate Grid Needs Assessment from those that are developed by the IOUs, or recommend specific technologies or infrastructure projects. Moreover, the Electrification Impacts Study is not a cost-benefit study.

[12] The Integrated Capacity Analysis (ICA), which is the hosting capacity set of tools and methods used by the California IOUs to determine where the grid can accommodate additional DERs without triggering costly grid upgrades, is one example of a tool that reflects current but not future grid needs. The ICA reflects monthly grid updates, latest geographic information system information, and queued DERS; it does not reflect the future grid conditions planned in the utilities' GNAs, DDORs, and grid modernization plans that are all part of the DPP process.

Electrification Impacts Study Approach

This section describes the three-part Electrification Impacts Study Research Plan, including its goals, approach, and timeline to support proceeding R.21-06-017. The Electrification Impacts Study will be separated into three distinct parts as illustrated in Figure 1, and further described in the following subsections.

Figure 1: The Electrification Impacts Study parts and deliverables



As the sum of the three parts outlined above, this Electrification Impacts Study Research Plan is designed to enable identification of distribution and transmission grid enhancements and changes necessary to support the transportation and building electrification policy goals for 2035 specified in Executive Order N-79-20. The Research Plan is designed to inform a framework that can integrate distribution capacity expansion and deferral options into utility DPPs to assess lowest cost and maximum benefit options. The outcomes of the Electrification Impacts Study could be potentially used to update those processes as anticipated in several of the scoping questions identified in R.21-06-017.

Part 1: Bottom-Up Load Adoption Model & System-Level Electrification Impacts Cost Estimates

Part 1 of this Research Plan starts by estimating the scope and scale of electrification impacts (system level) using a highly granular premise-level technology adoption analysis. End-user technology advancements, climate change weather events, and pandemic-driven customer adaptations are all changing customer electricity consumption behavior in novel and unexpected

ways.[13] To investigate how these changes and their grid impacts are captured in current distribution grid models, Kevala will use high resolution (premise-level) modeling approaches to project, simulate, and hyper-granularly locate demand-side modifier estimates such as EVs, photovoltaic (PV) systems, and electric vehicle charging infrastructure. This approach contrasts with the current "top-down" disaggregation approach which starts with a system-level forecast and allocates down to distribution circuits using proportional and/or probabilistic models that estimate loads for a designated geographic area.

Part 1:
Objective 1 – Estimate the scope and scale of electrification impacts (system level) by leveraging CPUC-jurisdictional, time series and premise-specific information to develop circuit-specific forecasts based on an expectation of the levels of electrification necessary to meet the state's policy goals.

Objective 2 - Enable premise and circuit-specific grid integration analysis within the context of the distribution and sub-transmission grid infrastructure

In Part 1, Kevala will examine and deliver:

- Annual hourly 8760 net-load customer-level profiles for "High DER" transportation and beneficial electrification scenarios for the 2025, 2030, and 2035 time horizons
- Initial distribution capacity expansion and system-level cost estimates for each of the time horizon scenarios aggregated at the IOU service territory level to provide insights into transmission planning investments

Part 1 will focus on providing an hourly premise-specific net-load scenario with high DER and electrification predictions for the 2025, 2030, and 2035 time horizons. The 2025, 2030 and 2035 time horizons were selected because 2025 captures the current distribution planning cycle (five years through approximately 2025); 2030 (a mid-range year) will capture the expected timeframe when DERs and the distribution system will be the predominant resources for meeting grid needs (2030); and 2035 (an outer year) is the timeframe by when transmission solutions could be assumed to be capable of addressing grid needs.

The Part 1 report is intended to align with and help support the planning activities of the CPUC and its stakeholders in the summer of 2022, potentially including the 2022 Distributed Forecasting Working Group (DFWG), the CEC's High Electrification Scenario development, and IOU planning for 2023 GNA and DDOR filings and beyond. Outer-year scenario calibrations may enable utility and stakeholders to plan for and assess long-lead time project options that may be necessary to

[13] "Despite more people staying at home, U.S. residential energy use fell 4% in 2020," May 17, 2021, available at: https://www.eia.gov/todayinenergy/detail.php?id=47976

support policy goals. They may also enable multiple GNA and DDOR scenarios to be considered in future years of the DPP process. Further, customer-level profiles that reflect Kevala's Assessor Platform analysis of geo-spatial (e.g., circuit-specific) and public socio-economic factors should enable the CPUC and its stakeholders to develop additional insights into quantifying appropriate equity as well as resiliency metrics. These insights could be applicable to future distribution planning processes, and could support the incorporation of equity considerations into distribution and transmission planning.

Inputs and Assumptions

Kevala will largely rely on the inputs and assumptions contributed by the IOUs to the CEC's 2021 Integration Energy Policy Report (IEPR) for system-level load and demand-side modifiers that will inform the load and DER inputs of the Electrification Impacts Study, along with additional IOU and other state agency data. The data requested from the IOUs in support of this study is massive; over 20 million premise-specific data fields, covering over 10,000 distribution circuits are expected to be examined. The specific data requested is described in detail in Appendix 2: Input Data and Utility Data Request.[14] The additional data and assumptions relied upon for this study are being gathered and incorporated and will be documented and shared in the Part 1 report to the extent it is available. For example, Kevala understands the importance of integrating medium and heavy-duty electric vehicle deployment data to the extent available into its policy outcome-based scenarios. Kevala seeks to incorporate all available data related to MDV and HDVs into its Part 1 analysis, particularly policy goals established by the state for those resources and to refine assumptions and data as appropriate in Part 3.

The first, or "base" scenario to which Kevala will calibrate its premise-level demand is the IEPR coincident peak "Mid-Mid", or "likely" scenario through 2035.[15] This involves calibrating to both the baseline load forecast and the individual demand modifier forecasts.

In addition to the IEPR scenario, Kevala developed demand and adoption scenarios designed to reflect different combinations of demand/adoption modifier variables related to achieving the electrification policy targets set in Executive Order N-79-20 as well as an interagency electric

[14] Local emissions data are not included in the Part 1 analysis for this Research Plan, nor will local emissions equity metrics be explored in Part 1. Subsequent refinements to the Part 1 analysis could, with stakeholder engagement, incorporate local emissions data as available in Part 3 or subsequent elements of this research.

[15] The IEPR "Mid-Mid" scenario includes mid-level adoption scenarios for energy efficiency and building and transportation electrification. Energy efficiency and fuel substitution (building electrification) aligns to the adopted CPUC goals for proceeding R.13-11-005. "Mid-Mid" refers to Scenario 3 when referring to Additional Achievable Energy Efficiency (AAEE) or Additional Achievable Fuel Switching (AAFS) load modifiers applied to the "mid" baseline forecast.

infrastructure planning scenario to 2035 developed by the CEC in coordination with California Air Resources Board (CARB), CAISO, and CPUC to plan for electrification policy compliance and resultant grid impacts.[16]

The scenarios in Table 1 below show the inputs associated with each demand modifier for each of the calibration scenarios selected for Demand and DER Growth forecast. The IEPR Mid-Mid case was selected as the calibration targets for the load and most DERs. Transportation Electrification and Behind-the-Meter (BTM) Tariffs are the only demand modifiers that reflect different assumptions. This approach is designed to isolate the impact of initial key factors likely to impact the distribution grid and to maintain consistency with the 2021 IEPR base case to the greatest extent possible. Building electrification, energy efficiency, and other demand modifiers will be further considered for Part 3.

[16] After several months of discussion in late 2021 and early 2022 among CEC, CARB, CAISO, and CPUC staff, an Interagency Working Group was formed to develop the specifications of a demand scenario that places a greater emphasis on electrification than is embedded within the CEC's adopted 2021 IEPR mid-mid managed demand forecast. The purpose of this Interagency High Electrification Scenario is for the CAISO and CPUC to consider its results for study purposes in their respective planning processes. Final details about this scenario will be presented in the Part 1 Electrification Impacts Study or earlier if finalized for release by the CEC and joint agencies.

Table 1: Part 1 Demand/Adoption Scenarios

Scenario	(1) Base Case IEPR 2021	(2) High Electrification + Existing BTM Tariffs	(3) Accelerated High Electrification + Existing BTM Tariffs	(4) High Electrification + Modified BTM Tariffs	(5) Accelerated High Electrification & Modified BTM Tariffs
Input Name	**Demand Forecast/DER Growth Forecast Calibration Target**				
Load (demand forecast)[17]	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid
Energy Efficiency (DER growth forecast)[18]	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid
Building Electrification (DER growth forecast)[19]	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid
PV (DER growth forecast)[20]	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid
Energy Storage (DER growth forecast)	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid
TOU Escalation	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid	IEPR 2021 Mid

[17] Base forecast includes demand response expectations that are already incorporated into IOU forecasts. As a result, separate modeling of demand response will not be done in Part 1 as it is expected to be de minimis in the overall forecast. This assumption can be validated in Part 3.

[18] For purposes of energy efficiency, the IEPR 2021 Mid-Mid Scenario utilizes Additional Achievable Energy Efficiency (AAEE) Scenario 3.

[19] For purposes of building electrification, the IEPR 2021 Mid-Mid Scenario utilizes Additional Achievable Fuel Switching (AAFS) Scenario 3.

[20] While Solar PV and Energy Storage growth forecasts are listed here as using IEPR 2021 Mid-Mid assumptions, these growth forecasts will necessarily change with any modification in BTM tariffs, which is listed as a separate demand modifier for purposes of the Part 1 Study.

Scenario	(1) Base Case IEPR 2021	(2) High Electrification + Existing BTM Tariffs	(3) Accelerated High Electrification + Existing BTM Tariffs	(4) High Electrification + Modified BTM Tariffs	(5) Accelerated High Electrification & Modified BTM Tariffs
Input Name	**Demand Forecast/DER Growth Forecast Calibration Target**				
Transportation Electrification (DER growth forecast)	IEPR 2021 Mid (3.7M light-duty ZEVs by 2030)[21]	Interagency Scenario[22]	IEPR 2021 Bookend Scenario (7.8M light-duty ZEVs by 2030) [23]	Interagency Scenario	IEPR 2021 Bookend Scenario (7.8M light-duty ZEVs by 2030)
Behind-the-Meter Tariffs	Existing BTM Tariffs[24]	Existing BTM Tariffs	Existing BTM Tariffs	Modified BTM Tariffs[25]	Modified BTM Tariffs

The bottom-up, disaggregated load modeling approach discussed below will explore ways of reconciling these various electrification goals and projections, in order to understand and efficiently plan for their impacts on the distribution grid.

Bottom-Up Net-Load Forecasting

Kevala will leverage its Assessor Platform to develop a bottom-up net-load adoption model for the Electrification Impacts Study. The Assessor Platform supports full premise-specific modeling using Advanced Metering Infrastructure (AMI) and customer billing rate data (e.g., time-of-use rates billing details) as inputs to produce complete monthly bills in support of econometric modeling of DER adoption.

[21] The 2021 IEPR demand forecast shows an increase in light-duty ZEVs to more than 3.7 million in 2030 for the mid-case and more than 5.5 million for the high-case (Volume IV at p. 65). Medium- and heavy-duty assumptions as well as battery electric vehicles (BEV) versus plug-in hybrid electric vehicle (PHEV) assumptions are under development in coordination with the CEC and CARB and will be identified in the Part 1 Study.

[22] Interagency Scenario number of assumed ZEVs is currently under development between the CEC and CARB and is generally assumed to be approximately 5 million California ZEVs by 2030.

[23] The 2021 IEPR demand forecast shows an increase in light-duty Zero-Emission Vehicles (ZEV)s to 7.7 million and 7.8 million, respectively, for the aggressive and bookend cases (Volume IV at p. 66).

[24] Existing BTM tariff assumptions based on Net Energy Metering 2.0 Tariff.

[25] Modified BTM tariff assumptions based on the December 13, 2021, Proposed Decision for proceeding R.20-08-020, titled, *Decision Revising Net Energy Metering Tariff and Subtariffs,* available at: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M430/K903/430903088.PDF. At this time, the Proposed Decision has not been adopted and no alternate has been proposed.

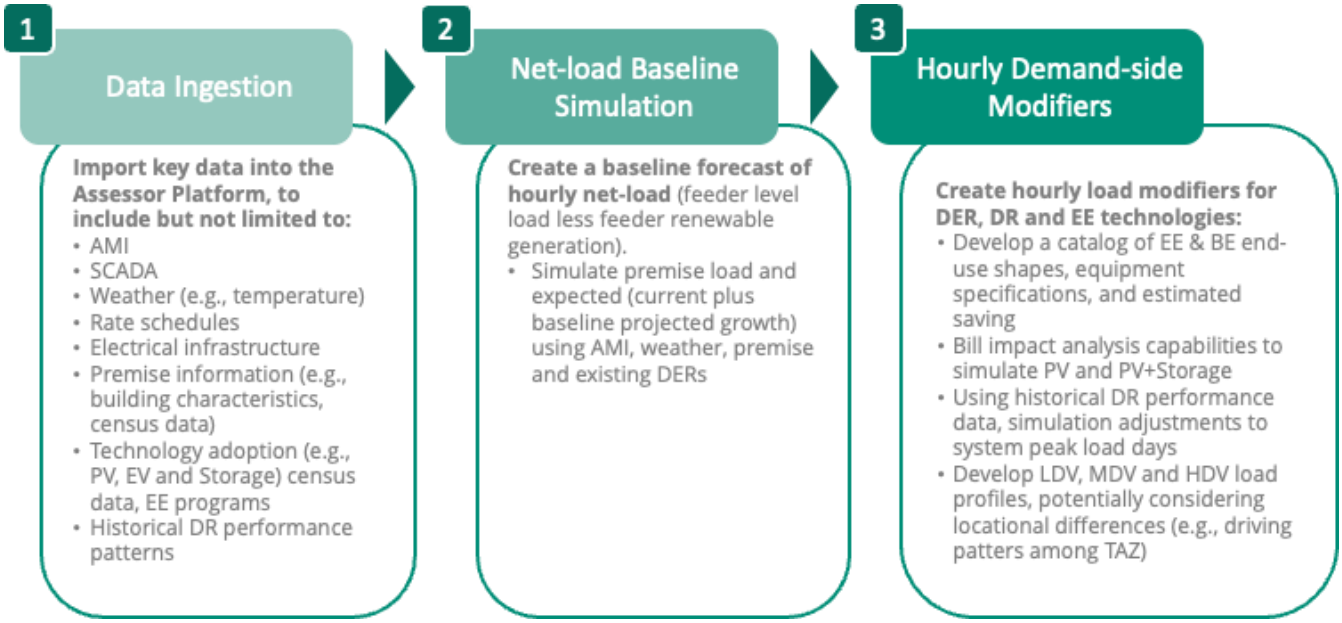
Top-down: System level forecast that is allocated down to distribution circuits using proportional and/or probabilistic models that estimate loads and DER for a designated geographic area ("allocation method").

Bottom-up: Econometric adoption models to forecast premise-level loads and DER that are aggregated up to the circuit level and/or transmission system level.

Kevala's bottom-up approach starts with a premise-level baseline demand estimate of how much power and energy will be needed, when it will be needed, and where it will be needed. The estimate will be created from AMI data. If AMI data for some customers or planning areas is not available, Kevala can also simulate demand that is based on attributes of the customer's build-environment that is available in the Assessor Platform.

The next step is to estimate the adoption and propensity models of new loads and technologies and DERs (e.g., solar, storage, electrification of appliances and EV adoption) and add the new loads to the base demand to create a net-demand scenario. Kevala identifies where customers are economically advantaged to adopt DERs and then the likelihood of adoption based on other factors (e.g., rent versus own, multi-unit dwelling versus single occupant, etc.) as well as technology cost curves, program and incentive features, etc. Kevala then applies a probability distribution for each technology type's adoption. The Assessor Platform also simulates the behavior of the demand-side modifiers, resulting in a simulated net-load that reflects the behavior of demand modifiers. The main steps, taken in the bottom-up net-load adoption model, are described below in Figure 2.

Figure 2: Bottom-up premise-specific net-load model for the Electrification Impacts Study



Kevala recognizes that rate design, rate levels, and customer program eligibility and parameters are important assumptions in developing demand modifier projections. For Part 1 of this Research Plan, Kevala will rely on existing pricing signals and customer program parameters in place at the time of the Part 1 analysis to develop demand-side modifier profiles. For example, Kevala will not create new rate designs or peak periods to apply to the future forecast years identified; rather, currently applicable rate design policies and program requirements will be applied.

The timely development of the Part 1 disaggregated load adoption outlined in this section of the Research Plan is dependent on the availability of the data required to perform the research as described in the data request section (see Appendix 2: Input Data and Utility Data Request). In the event there is a data delay, Kevala will work with the CPUC, other data stakeholders, and providers to revise research deliverables and timing as appropriate.

Reconciling System-Level Forecasts and Impacts on Transmission Planning

Load and DER can be forecasted using a system-focused, top-down DER adoption approach; a parcel-level, bottom-up DER adoption approach; or a hybrid of both. Load and DER growth methods are described as follows:

- The top-down approach takes system-level forecast predictions and growth parameters and applies those projections to the feeder or substation level.
- The bottom-up approach uses DER adoption and propensity models, likely payback period and bill savings, and expected growth or known local development to forecast changes to load, electrification DER adoption, and load and generation behavior.

- The hybrid approach uses the previously described bottom-up approach and scales it to match system-level forecast predictions.[26]

In this Research Plan Kevala will use the bottom-up and hybrid methods illustrated in Figure 3 below. Kevala's Assessor Platform will provide the bottom-up case illustrated in the center which then will be scaled to match the IEPR's coincident peak system-level forecast using the hybrid approach described above, as well as other high electrification policy-driven scenarios.

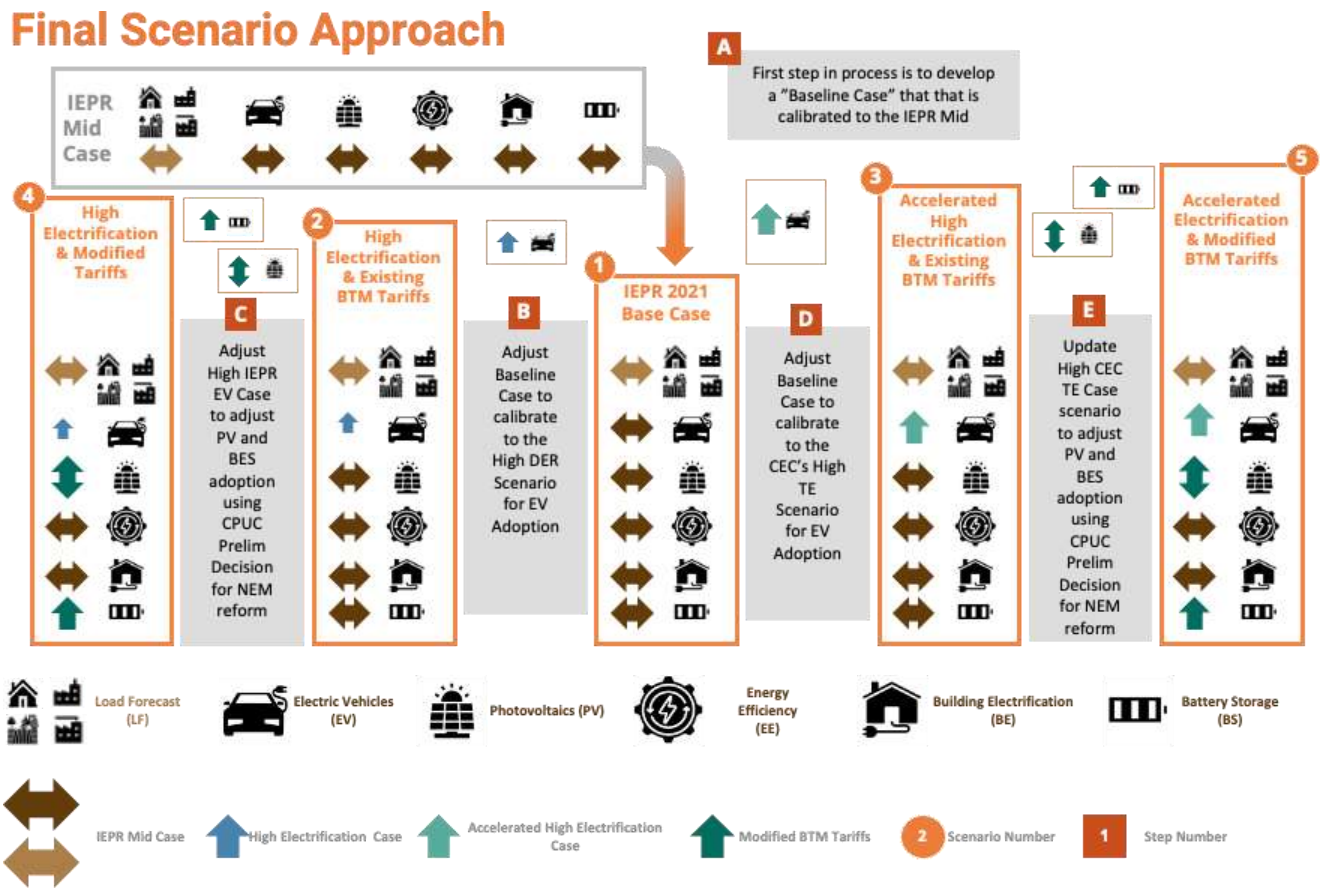
Kevala will coordinate with stakeholders, the CEC, and the utilities to facilitate information exchange files to inform upcoming DPP activities. The nature and format of data to be provided to utilities and stakeholders will be determined during the stakeholder processes planned for the review of the Part 1 Study. Information exchange could be in several formats depending on stakeholder use and could inform system-level forecasts and circuit power-flow input data in the distribution power flow software format used by the utilities.

Electrification Scope and System-Level Grid Costs

The hourly profile net-load adoption scenarios for 2025, 2023, and 2035 will be aggregated to the feeder level to provide an initial distribution capacity expansion estimate for each of the time horizon scenarios and aggregated by cost category at the IOU service territory level to provide initial insights into transmission planning investments for the high electrification scenario.

[26] Utility GNA filings and DDOR reports take a similar approach, scaling their distribution analysis to match identified system-level forecasts.

Figure 3: Proposed steps in the bottom-up load net-load adoption model to scale to system-level forecasts such as the 2021 IEPR and high or low policy-driven cases



Part 2 Electrification Impacts Staff Proposal

As part of the Staff Proposal development process, Kevala will review the 2022 GNA/DDOR filings. This will include a comparison of the inputs and assumptions used by the IOUs and a description of how Part 1 of the Study will be used to inform the projected infrastructure requirements for high electrification scenarios. This review, together with Part 1 of the Study, is intended to yield insights into potential additional specific infrastructure requirements to enable a high DER and electrification future, potential improvements to GNA/DDOR filing documentation and data, and utility DPPs.

Part 2:

Objective 1 - Support the evolution of the current distribution planning approach to one that is sustainable, engages stakeholders, considers both deferral and capacity additions, and results in meaningful and cost-effective grid investments.

Objective 2 - Enable deeper consideration of equity-oriented distribution planning factors with forecasts based on real-time geographic and socio-economic analyses.

Kevala, with CPUC Energy Division Staff and other firms on the CPUC consulting team, will develop the CPUC Staff Proposal informing the Track 1, Phase 1 proposed decision on near-term DPP and GNA/DDOR improvements. The following objectives are expected to inform potential Staff Proposal recommendations:

- Evaluate the impact of policy-driven electrification forecasts (e.g., bottom-up high DER scenarios).
- Make reasonable assumptions about EVs, EV supply equipment, Vehicle Grid Integration (VGI), Time-of-Use (TOU) rates, real-time rates, and flexible load management technologies such that these DER technologies are cost-effectively integrated into the utilities' DPPs.
- Improve utilities' GNA/DDOR documentation and data, to possibly include a comparison to the Electrification Impacts Study's bottom-up planning framework.
- Evaluate the potential need for specific, long-lead-time infrastructure requirements to enable High DER and electrification.
- Mitigate near-term and medium-term impacts based on various demand scenarios (e.g., 2021 IEPR-calibrated case, various high electrification scenarios).
- Improve utility DPPs to reduce data processing and regulatory filing preparation time.
- Develop methods for identifying locations of existing and future light-duty (LD) and MD/HD EVs and other DER generation and loads.
- Continue to explore the bottom-up approach while comparing it to existing IOU top-down/hybrid DPP approaches
- Ongoing CPUC DPP data collection from the IOUs and provide stakeholder access to data.
- Increase/ensure equity in distribution system investment decision making.

This Electrification Impacts Staff Proposal will address the question of how the DPP/DIDF processes should improve to support widespread electrification and will be submitted into the record of proceeding R.21-06-017.

Part 3 Electrification Grid Integration Report

In Part 3 of the Electrification Impacts Study, Kevala will provide an Electrification Grid Integration Report in coordination with other consultant workstreams by April 2023. The Electrification Grid Integration Report will build on the disaggregated load forecasting scenarios developed in Part 1 to develop and implement a framework for estimating specific, highly granular grid investment and/or programmatic enhancements and their costs under various scenarios for transportation

and building electrification. In coordination with the 2023 DPP process, Kevala will revise the bottom-up load scenarios and the assumptions and inputs from Part 1 as necessary to reflect stakeholder input. For example, specific assumptions about vehicle-to-grid (V2G) policy and/or incentive programs can be discussed with stakeholders and incorporated into the Part 3 Report as appropriate. Similarly, Kevala, along with stakeholders can explore incorporating mapped Disadvantaged Community (DAC) areas, and/or appropriate local emissions data sources into the Assessor Platform. Such additional data could be incorporated to support visualization and analysis of the equity impact(s) of electrification from an economic or public health perspective on DACs, as well as potentially identify opportunities to avoid or mitigate such impacts. As with the Part 1 analysis to be conducted under this Research Plan, the intent of the Electrification Grid Integration Report is not to set policy or recommend specific DERs, but to provide insights into the potential impacts of policy and technology alternatives in supporting efficient distribution planning.

Part 3:
Objective 1 - Leverage CPUC-jurisdictional, real-time premise-specific information to develop circuit-specific forecasts based on an expectation of the levels of electrification necessary to meet the state's policy goals.

Objective 2 - Enable premise and circuit-specific grid integration analysis within the context of the distribution and sub-transmission grid infrastructure that is within the CPUC's jurisdiction.

Objective 3 - Support the evolution of the current distribution planning approach to one that is sustainable, engages stakeholders, considers both deferral and capacity additions, and results in meaningful and cost-effective grid investments.

Objective 4 - Enable deeper consideration of equity-oriented distribution planning factors with forecasts based on real-time geographic and socio-economic analyses.

Objective 5 - Shorten the current lag time between system-wide planning for generation and transmission.

Kevala will coordinate with the IOUs on distribution planning and operating constraints, as well as on each IOUs unit cost of specific equipment (equipment cost catalog) to calculate costs of traditional grid upgrades that would support a high electrification scenario. The data required to successfully complete a grid integration analysis will include the data requested in Appendix 2: Input Data and Utility Data Request and other data identified as necessary. Kevala will also describe how the Part 1 Study will be used (and revised as needed) to inform the Part 3 Electrification Grid Integration Report.

Electrification Grid Impacts and Upgrades Costs

Kevala will develop a sampling method to perform a distribution system grid impact analysis. The analysis will include the costs of traditional infrastructure upgrades in a high electrification scenario. Kevala will develop a framework to study how the distribution grid can support the load changes and DERs required for each high DER scenario without overloading and with appropriate voltage management. Kevala will estimate the cost of any upgrades needed to achieve these ends. These analyses will be accomplished using distribution power flow modeling and bottom-up engineering cost assessment methods. Existing, applicable rate structures will be incorporated into this analysis, but custom scenarios with VGI or other assumptions may be explored as well.

The electrification grid impact and upgrade costs analysis will consider the overall distribution system impact and cost of changes in load and DERs in an analysis over the following three time periods:

- Between 2021 and 2025
- Between 2025 and 2030
- Between 2030 and 2035

Kevala will leverage the distribution system electric models from the IOUs and will attach the loads and DERs corresponding to each of the High DER scenarios. The data required to perform the electrical engineering modeling are described in Appendix 2: Input Data and Utility Data Request. Kevala will then conduct detailed engineering power flow simulations to identify challenges. This power flow analysis will be used to identify the suite of upgrades, if any, required to manage distribution system constraints. Finally, the detailed corresponding costs for these infrastructure upgrades will be estimated and summarized for consideration in future integrated distribution planning processes.

Capacity Expansion, Deferral Opportunities, and Business Models

By leveraging the engineering models prepared for the electrification grid impacts work previously described, Kevala will propose a method to assess distribution capacity expansion needs and identify opportunities for non-wires alternatives (NWA), deferral, and flexible load management technologies. The assessment will inform the value of coordinating transportation electrification, DERs, and load management in a high DER future. It is intended to provide the CPUC and stakeholders a framework to ensure that EVs, EVSE, VGI, real-time rates, and flexible load management technologies are integrated into utility DPPs such that they are available to cost effectively reduce, defer, or avoid distribution system upgrades and provide grid services. It is not, however, intended to recommend specific DER technology or solution procurements.

Project Management and Stakeholder Input

The Research Plan accounts for internal and external project management activities to ensure that the research scope outlined in previous sections of this document are performed according to the timeline proposed. This includes anticipating the need to support cross-proceeding and interagency coordination activities and disseminating each study findings to stakeholders via the R.21-06-017 service lists and at workshops. Kevala will review Research Plan inputs, methodologies, and outputs in the workshop(s) associated with each of the three Parts of the Research Plan.

The Draft Research Plan was distributed by the CPUC's Energy Division to the R.21-06-017 service list on December 6, 2021. Energy Division and Kevala presented an overview of the Draft Research Plan at a publicly noticed workshop via WebEx on December 7, 2021.

Parties were further invited to submit informal comments to Energy Division on the Draft Research Plan by December 21, 2021. Twelve sets of informal comments across 23 stakeholders were submitted by: 350 Bay Area, the CAISO, Center for Sustainable Energy, Environmental Defense Fund, Green Power Institute, Joint CCAs (Silicon Valley Clean Energy Authority, Peninsula Clean Energy Authority, Marin Clean Energy, San Jose Clean Energy Authority, Sonoma Clean Power Authority, and Central Coast Community Energy), Joint Parties (Sierra Club, California Alliance for Community Energy, Wild Tree Foundation, Vote Solar, Center for Biological Diversity, 350 Bay Area, and the Climate Center), Pacific Gas & Electric and Southern California Edison (jointly), Public Advocates Office, San Diego Gas & Electric, Tesla, and the Utility Consumers' Action Network. Consistent themes across the comments included study goals, scope, methodology and data sets to be used; interagency coordination; and the relationship of Research Plan results to equity planning, other statewide planning processes, and selection of specific DER technologies. Clarifications to the Draft Research Plan in response to comments have been incorporated, as appropriate, into this Research Plan. A detailed summary of the informal comments submitted together with the Researchers' responses to them is attached to this Final Research Plan as Appendix 3: Responses to Public Comments.

Kevala welcomes parties' questions and input into the value of premise-level electrification demand and adoption scenarios. The challenges noted by some of the parties have been identified in the proceeding and will be addressed through the Study objective of providing proof-of-concept for a policy-oriented, bottom-up methodology. As noted in this Research Plan, the Study will also account for the potential value of premise-level disaggregation methods. This approach is intended to capture electrification impacts that are not uniform across all distribution circuits, particularly in transportation electrification. There is consensus that uncertainty and net demand variability are growing issues with increasing renewable penetration, extreme weather

events, and uncertainty at the distribution level. The premise-level approach outlined in this Research Plan is intended to capture unique circuit impacts that are necessary to address and are not completely accounted for in existing planning approaches.

Kevala will provide Research Plan inputs, methodologies, and outputs in the published reports and at workshop(s) associated with each of the three Parts of this Research Plan. Inputs and assumptions will distinguish between received utility measured data, and simulated scenario data in order to ensure visibility into the premise-level adoption modeling that will be developed in this Research Plan.[27] Data and other scenario assumption refinements to Part 1 of this Research Plan are anticipated to be incorporated into Part 3 of this Research Plan and the project team welcomes stakeholder input on those refinements.

Figure 4 and Figure 5 below outline the broad timeline of the Electrification Impacts Study components described in this Research Plan and its interactions with the DPP annual milestones and dependencies, as well as the key procedural milestones identified in the Scoping Memo in R.21-06-017.

Appendix 1: Acronyms and Definitions contains updated acronyms and definitions related to this Research Plan. Current data requests submitted by Energy Division to Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas and Electric in support of this Research Plan can be found in Appendix 2: Input Data and Utility Data Request.

[27] Kevala recognizes that the level of specific data access may vary across different stakeholders and will comply with all CPUC requirements and documentation necessary for sharing detailed data inputs with specific stakeholders.

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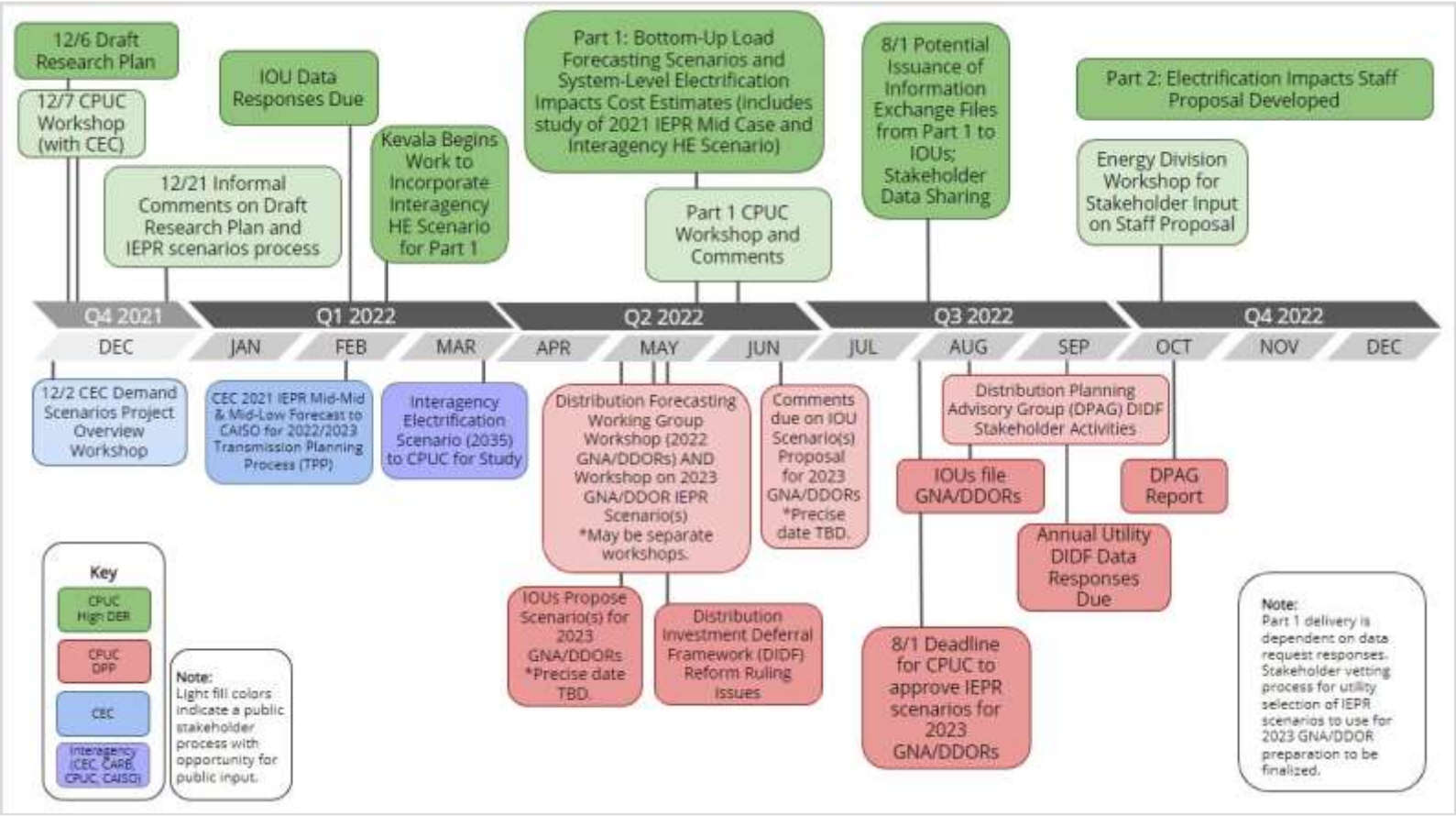
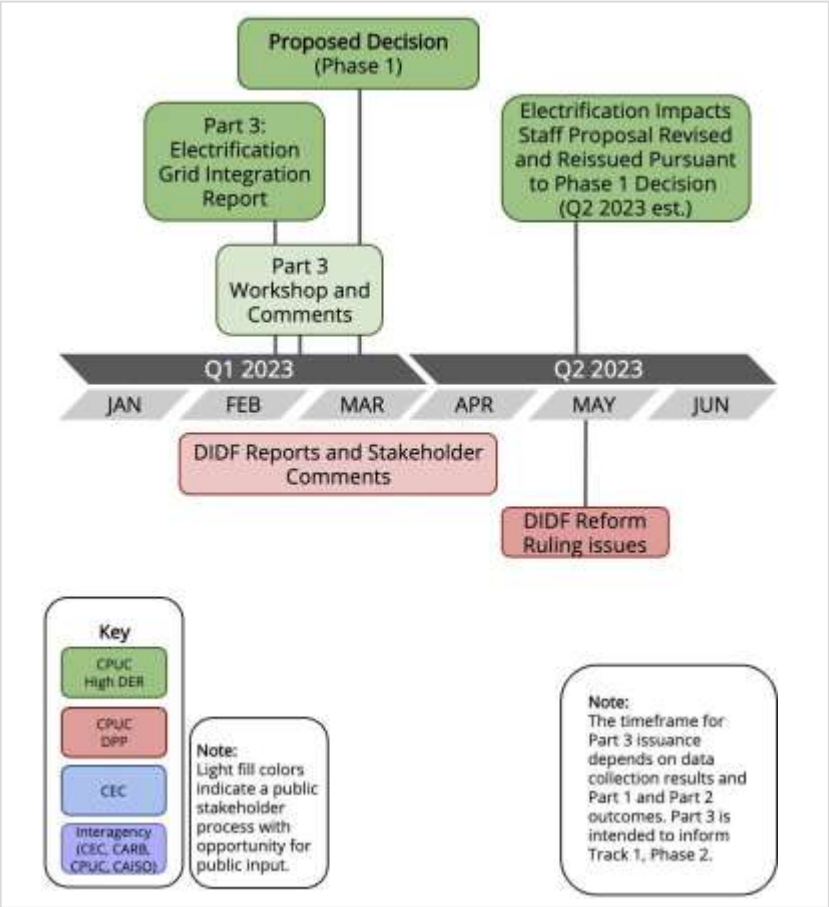
Figure 4. Research Plan Schedule for December 2021 through December 2022[28]



[28] D.18-02-004 requires that IEPR datasets be used by the utilities to prepare their GNA/DDORs (Ordering Paragraph 1). The May 11, 2020, Ruling for proceeding R.14-08-013 (Attachment A, Reform #3) establishes that the CPUC Energy Division approves the IEPR datasets used by the utilities to prepare their GNA/DDORs and that the utilities each use the same IEPR datasets.

Figure 5. Research Plan Schedule for January 2023 through June 2023



Appendix 1: Acronyms and Definitions

Acronyms

AMI: Advanced Metering Infrastructure

CARB: California Air Resource Board

CAISO: California Independent System Operator

CEC: California Energy Commission

CPUC: California Public Utilities Commission

DER: Distributed Energy Resources

DIDF: Distribution Investment Deferral Framework

DR: Demand Response

DDOR: Distribution Deferral Opportunities Report

DPP: Distribution Planning Process

EV: Electric Vehicle

EVSE: Electric Vehicle Service Equipment

GNA: Grid Needs Assessment

HDV: Heavy-Duty Vehicle

IEPR: Integrated Energy Policy Report

IRP: Integrated Resource Plan

LDV: Light-Duty vehicle

MDV: Medium-Duty Vehicle

OIR: Order Instituting Rulemaking

TOU: Time-of-Use Rates

V2G: Vehicle to Grid

VGI: Vehicle Grid Integration

Definitions

Adoption model: A model that predicts the consumer's likelihood to adopt a new technology. The model considers multiple variables that can reliably predict the consumer's ability and willingness to adopt a new technology such as the characteristics of early adopters, factors that drive market potential, and historical adoption rates.

Advanced Metering Infrastructure (AMI): A time-series energy consumption data measurement and collection system that includes advanced meters/smart meters at the customer site, communication networks between the customer and utility, and data collection and management systems that make the information available to the utility, customer, and authorized third party vendors.

Bottom-up Adoption: A bottom-up method simulates load and DER based on adoption models while considering the characteristics of early adopters, factors that drive market potential, and adoption rates that are applied to the remaining potential customers. The adoption is predicted at a granular level (i.e., at the customer premise level).

California Independent System Operator (CAISO): CAISO is the electric grid operator for California's electrical transmission system.

Demand Forecast: The existing 10-year time horizon that the CPUC and CAISO use to make commitments for new generating resource development or new transmission lines.

Demand Scenarios: A set of longer-term projections to inform thinking about the implications of trying to achieve long-term goals. Includes consideration of "accelerated" electrification scenarios that may be needed to achieve state policy goals.

Distributed Energy Resources (DER): Includes distributed renewable generation resources, energy efficiency measures, energy storage devices, electric vehicles, time varying and dynamic rates, flexible load management technologies, and demand response technologies. Most DERs are connected to the distribution grid behind the customer's electric meter, and some are connected in front of the customer's electric meter.

Demand Response (DR): Refers to any change in net electricity demand made by the customer in response to an economic or grid signal to reduce, increase, or shift net demand relative to what the net demand level would have been in the absence of the signal. The change could be temporary or recurring.

Electric Vehicle Service Equipment (EVSE): The equipment that interconnects the electricity grid at a site to an EV. Sometimes used more broadly to mean "charging station," whether AC or DC, but not including other behind-the-meter charging-related infrastructure.

Grid Integration, or Grid Integration Analysis: The practice of developing efficient ways to deliver variable renewable energy to the grid. Robust integration methods look at how to maximize the cost-effectiveness of incorporating variable renewable energy into the power system while maintaining or increasing stability and reliability.

Information-Exchange Files: Kevala will coordinate with stakeholders, the CEC, and the utilities to facilitate information exchange to inform upcoming DPP activities. The nature and format of data to be provided to the utilities and stakeholders will be determined during the stakeholder processes planned for review of the Part 1 Study. Information exchange could be in several formats depending on stakeholder use and could inform system-level forecasts and circuit power-flow input data in the distribution power flow software format used by the utilities.

Integrated Energy Policy Report (IEPR): California Senate Bill 1389 requires the California Energy Commission to conduct assessments and forecasts of all aspects of energy industry supply, production, transportation, delivery and distribution, demand, and prices. The California Energy Commission adopts an IEPR every two years and an update every other year. The energy and DER forecasts produced in the IEPR are used in the California utilities' Distribution Planning Process.

Integrated Resource Plan (IRP): A procurement plan used by utilities that details what resources are to be procured and how they will be procured to comply with California's climate and energy policies, adequately balance safety, reliability, and cost, while meeting the State's environmental goals described in SB 350 and SB 100.

Non-wires alternatives: An electricity grid investment or project that uses non-traditional transmission and distribution solutions, such as DERs and load management technologies, to defer or replace the need for specific equipment upgrades, such as transmission lines or transformers.

Order Instituting Rulemaking (OIR): Rulemaking proceeding opened by the California Public Utilities Commission to consider the creation or revision of rules, general orders, or guidelines affecting more than one utility or a broad sector of the industry. Comments, proposals, and/or testimony are submitted by parties to the OIR in written form; oral arguments or presentations are sometimes allowed.

Premise Level: In the context of utility meter and billing data, a premise is typically defined as a building or a single location that provides a particular service (such as electric or gas service) or is used for a particular purpose. A premise normally has several attributes associated with it, including, but not limited to, a service address (or an address ID or electric service location ID), longitude / latitude of the address, a master meter indicator and / or a multi-unit dwelling indicator.

Time-of-Use (TOU) Rate: A rate plan with rates that vary according to the time of day, season, and day type (weekday or weekend/holiday). Time-of-use rates can encourage the efficient use of the system and can reduce the overall costs for both the utility and customers.

Top-down allocation: A method for providing a transmission system-level aggregate load and DER forecast that disaggregates the load and DER forecast to distribution circuits based on utility data for the circuit (e.g., load, energy, or number of customers) or statistical propensity models.

Vehicle-Grid Integration (VGI): A framework for utilizing the flexible charging and discharging capabilities of plug-in electric vehicles as grid assets.

Appendix 2: Input Data and Utility Data Request

To perform the Electrification Impacts Study, Kevala will use multiple sources of data including:

- Publicly available data sources that are already in or will be added to Kevala's Assessor platform
- Data requested (and currently in the process of being received) from the IOUs
- Additional state planning data used by the CPUC and CEC and accessed through the CPUC-CEC interagency agreement on data sharing, as necessary

Data Request 1, 2 and 3 tables below describe the datasets that Kevala has requested from the IOUs and has coordinated with the CPUC and CEC.

Supplemental data requests may be required if there are updates to the current data request items and/or additional categories of data are identified as needed for any Electrification Impacts Study components.

Data Request 1

Category	Data Description	Preferred Format
Data Type: Geospatial/Relational		
Grid	Circuit GIS data that maps substations and feeder routes that includes phase count information and object ID. Includes both location and association/relational for circuit: ● Circuit GIS data and equipment rating info: ○ Lat/long location of: substations, transformers within substations, feeder paths (start and end of segments), service transformers ○ Transformer size (voltage and capacity) ○ Object IDs for each component ○ Upstream component object ID ● Transformer GIS data for primary/substation transformers and secondary/service transformers (if not covered under "A" above): ○ Service transformers, service transformer ID, service transformer location, voltage and capacity rating ○ Service points, service point ID, service point location, meter ID(s) (if different than the service point ID), service transformer ID associated with service point	GIS file e.g., shapefile or geodatabase
Data Type: Electrical Models		
Grid	Power flow network models for all circuits or distribution service territory, which includes feeder routes, equipment location, ratings of grid components, and settings of protection and regulation equipment. Power flow models must include circuit models and all settings and input data necessary to run the scenarios used in the GNA report	CYME or Synergi for distribution circuits and PSLF for sub transmission
Scenarios	All load customer class, and load and DER time-series profiles for all DRP scenarios	text file or csv

Category	Data Description	Preferred Format
Data Type: Load and rates		
Load	All historical available AMI data in hourly (8760) or 15 min intervals (kW, kWh) with GMT timestamps. If timestamps are local time include the UTC offset in each timestamp. This data should include an identifier in each record which allows each reading to be related to the meter GIS data.	.csv
Load and DER	Loadshape catalog per customer class and adjustments for EV, PV, EE, and DR	text file or csv
Load	LBNL Load shapes for EVs (LD, MD and HD).	text file or csv
Load and DER	New load growth and DER projects identified for determining grid needs	text file or csv
Rates	Billing rate schedule and DER rate schedule per customer	text file or csv
Data Type: Costs		
Costs	Complete catalog of equipment installed costs used for the 2022 GNA/DDOR (such as conductors, service transformers, substation transformers, capacitors, voltage regulators, LTCs, etc.).;	table or text file
Costs	Most recent cost of service study with backup work papers	text file or csv

Category	Data Description	Preferred Format
Data Type: Methods		
Constraints	All voltage, thermal and protection and any other constraints applied to hosting capacity or limiting factors on operating the distribution system	table or text file
Assumptions	Any assumptions used on operation or equipment setting changes in high DER scenarios used in the DRP	table or text file
Assumptions	All bus-bar-level disaggregation assumptions/method to per circuit 8760 forecast of load and DER growth, including transmission served load, losses and distribution served load	table or text file
	All adoption propensity assumptions to distribute load, EE, EV, DR and DER forecast within the circuits	table or text file
	All other assumptions and methods used in the current DRP, ICA and LNBA analysis not described in the "constraints" data category	table or text file
Data type: Requirements		
Requirements	All standard cyber security requirements that must be met by the CPUC's contractor in order to receive any of the data referenced in this data request directly from the utility	table or text file; actual agreements or documentation, as applicable
Requirements	All standard utility confidentiality and/or non-disclosure agreement requirements that must be agreed to by the CPUC's contractor in order to receive any of the data referenced in this data request directly from the utility	table or text file; actual agreements or documentation, as applicable

Data Request 2

Category	Data Description	Preferred Format
Data Type: Additional EV - if available:		
EV	Charging station details: • Address, location (lat/lon) • Date service began • Number of EVSEs, by month • Power ratings of EVSEs • Access policy • Dates of any upgrades and what equipment was upgraded • Service point identifier to link station to corresponding load data (AMI) • Service point rate schedule and monthly subscription levels, if applicable	.csv/.xlsx
EV	Public and workplace charger counts by type (e.g., L2, DCFC) used in IEPR forecast; by year; by IEPR scenario; highest geographic resolution available	.csv/.xlsx
EV	LDV, MDV and HDV counts by type (e.g., BEV vs PHEV) used in IEPR forecasts; by year; by IEPR scenario; by zip code	.csv/.xlsx
EV	Battery pack price ($/kWh) assumed in IEPR forecasts; by year; by IEPR scenario	.csv/.xlsx
EV	CA DMV vehicle registration data, ideally at the address-level, if not by zip code. Data for all powertrains (BEV, PHEV, FCEV, ICE [petrol, diesel]), all duties / classes	.csv/.xlsx

Category	Data Description	Preferred Format
Data Type: Program		
Demand Response*	Existing DR projects/programs as reported by IOUs: • Customer location or corresponding customer ID from AMI (linkage to customer premise) • DR program type (e.g., critical peak pricing, pay for performance) • Program incentive • Targeted response if applicable • Observed response if applicable • Bill credits/charges related to DR • CAISO Resource ID, where applicable • CAISO Resource ID mapping to the aggregated load ID, where applicable • Historical event start and end times and dates as well as targeted geographic area • If procured from an aggregator, provide data on the nature of that procurement including listing of address specific aggregator	.csv/.xlsx
** Data initially identified as being available from CAISO and CPUC, but after further investigation it was determined that these data are managed and captured by each IOU. Further, this request expands beyond market integrated DR and includes load modifying DR programs such as critical peak pricing.*		
Data Type: Geospatial/Relational		
SCADA	Substation SCADA data: • Current • Peak kW • GIS lat/lon location	.csv/.xlsx
SCADA	Feeder head SCADA data: • Current • Peak kW • GIS lat/lon location	.csv/.xlsx

Category	Data Description	Preferred Format
Data Type: Times Series		
SCADA	Available SCADA time series data for each transformer bank and feeder (timeframe must match AMI data as this data is used to calibrate aggregation of customer loads) Data request 001 (12/3/2021) includes access to the asset framework to show the relationship of the equipment. This timeseries data requested must match the specifications of that asset framework data. For the time series data, please provide a 5-minute time stamp when possible. Data fields requested include the following steady-state time series: • 3 phase voltage (kV) • 3 phase current (amps) • Single phase voltage (kV) • Single phase current (amps) • Phase angle • Power factor • Real power (kW) • Reactive power (kVar) • Apparent power (kVA) • Energy (kWh) • Corresponding breaker equipment status (i.e., open or close)	.csv/.xlsx

Data Request 3

Category	Data Description	Preferred Format
Data Type: Load and DER Forecast and other Program Data		

IEPR Load and Demand Side modifier forecasts	**2021 IEPR Load and demand side modifier forecasts by the following dimensions:**
	• 2021 IEPR Scenarios:
	  ○ Low
	  ○ Mid
	  ○ High
	  ○ Aggressive
	  ○ Bookend
	• Energy/ DER Granularity:
	  ○ by IOU
	  ○ by customer class (Residential vs non-Residential)
	• Geographic Granularity (as available):
	  ○ CAISO
	  ○ TAC
	  ○ IOU
	  ○ Bus-bar
	  ○ Other
		.csv/.xlsx

Category	Data Description	Preferred Format
Data Type: Load and DER Forecast and other Program Data		
2021 IEPR ZEV Adoption Forecasts	**CEC 2021 IEPR ZEV Adoption Forecasts, by the following dimensions:** ● 2021 IEPR Scenarios: ○ Low ○ Mid ○ High ○ Aggressive ○ Bookend ● Vehicle Granularity ○ Duty (LD, MD, HD) ○ Class ([LD] car, SUV/crossover, van, truck; [MD/HD] bus, van, straight truck, semi tractor, passenger) ○ Powertrain (BEV, PHEV, HEV, FCEV, ICE) ● Geographic Granularity ○ CAISO ○ TAC ○ IOU ○ Bus-bar ○ Other (i.e., CEC planning areas, county, etc.)	.csv/.xlsx

Category	Data Description	Preferred Format
Data Type: Load and DER Forecast and other Program Data		

2021 IEPR ZEV EVSE / Port Forecasts	**CEC 2021 IEPR ZEV EVSE / Port Forecasts, by the following dimensions:**
	• 2021 IEPR Scenarios:
	  ○ Low
	  ○ Mid
	  ○ High
	  ○ Aggressive
	  ○ Bookend
	• EVSE Granularity
	  ○ Use case (i.e., SUD, SUD shared, MUD, Workplace, Public, Cooridor, etc.)
	  ○ Charger Capacity-level (i.e., L1, L2, DCFC)
	  ○ Historical Charger Capacity-level (i.e., DCFC in 2022 = 50 kW; DCFC in 2035 = 100 kW)
	• Geographic Granularity
	  ○ CAISO
	  ○ TAC
	  ○ IOU
	  ○ Bus-bar
	  ○ Other (i.e., CEC planning areas, county, etc.)
		.csv/.xlsx

Category	Data Description	Preferred Format
Data Type: Load and DER Forecast and other Program Data		
2021 IEPR ZEV Load Impact / Energy Demand Forecasts	**CEC 2021 IEPR ZEV Load Impact / Energy Demand, by the following dimensions:** ● 2021 IEPR Scenarios: ○ Low ○ Mid ○ High ○ Aggressive ○ Bookend ● Energy / Demand Granularity ○ Energy and Demand, by use case, 8760 hourly load profile (i.e., SUD, SUD shared, MUD, Workplace, Public, Corridor, etc.) ● Geographic Granularity ○ CAISO ○ TAC ○ IOU ○ Bus-bar ○ Other (i.e., CEC planning areas, county, etc.)	.csv/.xlsx

Category	Data Description	Preferred Format
Data Type: Load and DER Forecast and other Program Data		
2021 JASC HEIAWG ZEV Adoption Forecasts	**2021 JASC HEIAWG ZEV Adoption Forecasts, by the following dimensions:** ● 2021 JASC HEIAWG final ZEV adoption scenario ● Vehicle Granularity ○ Duty (LD, MD, HD) ○ Class ([LD] car, SUV/crossover, van, truck; [MD/HD] bus, van, straight truck, semi tractor, passenger) ○ Powertrain (BEV, PHEV, HEV, FCEV, ICE) ● Geographic Granularity ○ CAISO ○ TAC ○ IOU ○ Bus-bar ○ Other (i.e., CEC planning areas, county, etc.)	.csv/.xlsx
2021 JASC HEIAWG ZEV EVSE / Port Forecasts	**2021 JASC HEIAWG ZEV EVSE / Port Forecasts, by the following dimensions:** ● 2021 JASC HEIAWG final ZEV adoption scenario ● EVSE Granularity ○ Use case (i.e., SUD, SUD shared, MUD, Workplace, Public, Corridor, etc.) ○ Charger Capacity-level (i.e., L1, L2, DCFC) ○ Historical Charger Capacity-level (i.e., DCFC in 2022 = 50 kW; DCFC in 2035 = 100 kW) ● Geographic Granularity ○ CAISO ○ TAC ○ IOU ○ Bus-bar ○ Other (i.e., CEC planning areas, county, etc.)	.csv/.xlsx

Category	Data Description	Preferred Format
Data Type: Load and DER Forecast and other Program Data		

2021 JASC HEIAWG ZEV Load Impact / Energy Demand Forecasts	**2021 JASC HEIAWG ZEV Load Impact / Energy Demand, by the following dimensions:**
	• 2021 JASC HEIAWG final ZEV adoption scenario
	• Energy / Demand Granularity
	  ○ Energy and Demand, by use case, 8760 hourly load profile (i.e., SUD, SUD shared, MUD, Workplace, Public, Corridor, etc.)
	• Geographic Granularity
	  ○ CAISO
	  ○ TAC
	  ○ IOU
	  ○ Bus-bar
	  ○ Other (i.e., CEC planning areas, county, etc.)
		.csv/.xlsx

Category	Data Description	Preferred Format
Data Type: Load and DER Forecast and other Program Data		
CARB 2020 MSS ZEV Adoption Forecasts	**CARB 2020 MSS ZEV Adoption Forecasts, by the following dimensions:** ● CARB 2020 MSS ZEV adoption forecast (or most current and appropriate adoption forecast) ○ Light-duty ○ Medium-duty/ Heavy-duty ● Vehicle Granularity ○ Duty (i.e., LD, MD, HD) ○ Class (i.e., [LD] car, SUV/crossover, van, truck; [MD/HD] bus, van, straight truck, semi tractor, passenger) ○ Powertrain (i.e., BEV, PHEV, HEV, FCEV, ICE) ● Geographic Granularity ○ CAISO ○ TAC ○ IOU ○ Bus-bar ○ Other (i.e., CEC planning areas, air district, county, etc.)	.csv/.xlsx

Category	Data Description	Preferred Format
Data Type: Load and DER Forecast and other Program Data		

2021 IEPR High Electrification Building Electrification (Fuel Substitution) Forecast	**CEC 2021 IEPR FS Load Impact / Energy Demand, by the following dimensions:**
	• 2021 IEPR Scenarios:
	  ○ High Electrification - Policy/Compliance
	  ○ High Electrification - Mitigation
	• Energy / Demand Granularity
	  ○ Energy and Demand, by sector and end use (heating, water heating, etc.)
	  ○ Energy and Demand, by 8760
	• Geographic Granularity
	  ○ CAISO
	  ○ TAC
	  ○ IOU
	  ○ Bus-bar
	  ○ Other
		.csv/.xlsx

2018-2020 IOU EE Program Participation and Billing Database	Energy efficiency program participation data and associated billing data of program participants and non-participants.	.csv/.xlsx
TAC to Service Territory Factors	All 2021 IEPR data is at the TAC level. Kevala is seeking the data at the IOU Service Territory level only. Having this data at the most granular level - sector, climate zone or zip code. Otherwise, the factors by IOU will work, too.	.csv/.xlsx
2019 RASS Survey Participation Data	RASS participant survey data and billing ID.	.csv/.xlsx

Appendix 3: Responses to Public Comments

The following stakeholders provided feedback and comments on the research plan.

- 350 Bay Area
- California Independent System Operator
- Center for Sustainable Energy
- Environmental Defense Fund
- Green Power Institute
- Joint CCAs (Silicon Valley Clean Energy Authority, Peninsula Clean Energy Authority, Marin Clean Energy, San Jose Clean Energy Authority, Sonoma Clean Power Authority, and Central Coast Community Energy)
- Joint Parties (Sierra Club, California Alliance for Community Energy, Wild Tree Foundation, Vote Solar, Center for Biological Diversity, 350 Bay Area, and the Climate Center)
- Pacific Gas & Electric and Southern California Edison (jointly)
- Public Advocates Office
- San Diego Gas & Electric
- Tesla
- Utility Consumers' Action Network

The table below contains a summary of the comments / feedback received and the response and steps taken to address them.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
1	350 Bay Area	Study goals & scope	Research plan should clearly state how Kevala's model evaluates alternatives, cost and benefits, DER response to rate and policy signals, optimization functionality, and tradeoffs.	The Part 1 Study is intended to provide a framework for updating the evaluation of requirements and potential costs of options necessary to support the additional grid electrification required to meet California policy goals. This Study is not intended to put forward a separate Grid Needs Assessment from those that are developed by the IOUs or recommend specific technologies or infrastructure options. Moreover, the Research Plan is not a cost-benefit study.
2	350 Bay Area	Methodology Datasets	Research plan should have sufficient details on methodologies utilized and capability of modeling approach. Also clarify how Kevala will address circuit flexibility for reconfiguration in circuit level forecasts and how historical DR performance data will be applicable. In mitigation scenario, prioritize mitigation of electrification of infrastructure costs. 350 Bay Area would like the analysis to include an evaluation of 3 opportunities to use DERs to achieve these savings.	Kevala will review Research Plan inputs, methodologies, and outputs in the workshop(s) associated with each of the three Parts of the Research Plan. Kevala agrees with 350 Bay Area that circuit capacity and flexibility, and historical demand response performance data, are important factors in this analysis; these factors have been requested in the utility data requests and will be incorporated into each Part of the Research Plan.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
3	350 Bay Area	Study goals & scope Equity	Mitigation and analysis should also focus on resilience, economic, and equity goals. More specifically: economic/equity impacts on customers experiencing major disruptive events, resiliency, grid planning and investment, coordination across public entities, and environmental and social justice.	The load forecast described in the Research Plan anticipates integrating utility 8760 AMI data with geo-spatial (e.g., circuit-specific) and public socio-economic data to create premise-specific forecasts. Kevala agrees that resiliency, economic, and equity factors are important factors to identify in grid planning to support electrification. Kevala expects that the premise-level forecast developed in Part 1 of the Research Plan will enable parties to develop additional insights into quantifying appropriate equity and resiliency metrics that could be applicable to future distribution planning processes.
4	350 Bay Area	Study goals & scope Role of DERs	The Research Plan should evaluate the impacts of policy and tariff alternatives on DERs to understand different utilization scenarios. Focus is not necessarily on the impacts of DERs or to set policy, but how they might be influenced by policies adopted by CPUC.	The Part 1 Study is intended to provide a framework for updating the evaluation of requirements and potential costs of options necessary to support the additional grid electrification required to meet California policy goals. The Study is not intended to put forward a separate Grid Needs Assessment from those that are developed by the IOUs or recommend specific technologies or infrastructure options. Moreover, the Research Plan is not a cost-benefit study.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
5	350 Bay Area	Study goals & scope Role of DERs	Modeled scenarios can include several features as baseline, but the alternatives should focus on resources with a high degree of flexibility and dispatchability that can respond to policy incentives and signals, with the goal of reducing the need for investment in grid infrastructure and cost to ratepayers while achieving emissions, resilience, and equity goals.	The Part 1 Study is intended to provide a framework for updating the evaluation of requirements and potential costs of options necessary to support the additional grid electrification required to meet California policy goals. This Study is not intended to put forward a separate Grid Needs Assessment from those that are developed by the IOUs or recommend specific technologies or infrastructure options. Moreover, the Research Plan is not a cost-benefit study.
6	CAISO	Interagency relationship	CAISO, CEC, CARB, and CPUC should continue to collaborate and consistently use the same information, referring to "single forecast set"	The premise-level forecast described in this Research Plan is based on coordinated common inputs used by the CEC in the Integrated Energy Policy Report. As noted in the draft Research Plan, Kevala intends to create a scenario that calibrates the premise-level forecast to the CEC's 2021 IEPR, and the additional policy outcome-based scenarios described in the Research Plan. The CPUC and Kevala are closely coordinating Research Plan underlying data inputs with the IEPR. All data requests underlying this Research Plan are provided as an attachment to this Research Plan.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
7	CAISO	Definitions	CAISO clarifies difference between "forecast" and "scenarios." There is a single forecast from CEC and demand scenarios within the forecast, which do not include legislative/'what if' scenarios. Emphasizes importance of using scenarios and forecasts clearly and aligning forecast/scenario approach among agencies and T&D planning to avoid bad investments.	Kevala will collaborate with state agencies to ensure consistency of terms used and data sources. Kevala acknowledges the CAISO's noting of the difference between "forecasts" and "scenarios." The draft Research Plan will be updated to align these definitions with the 2021 IEPR.
8	CAISO	Methodology	CAISO seeks clarity on how bottom-up methodology will roll circuit-level forecasts to feeder and bus-bar level. CAISO wants Kevala to align with the IOU IEPR approach and roll up to a coincident peak. CAISO also expresses the need to be coordinated on data-sharing to ensure Kevala approach is aligned with all agencies.	The Study intends to map the forecast to coincident peak used by the CEC in the IEPR. Kevala will clarify this in the net load forecasting description in Part 1 of the Research Plan.
9	SDG&E	Forecast, relationship to other planning processes	Clarify which system-level forecast Kevala will use. Agrees generally with the need for Research Plan approach to high electrification planning. SDG&E will provide feedback on which long-term forecast is used. There should be no delay to the 2023 planning cycle beginning Aug 2022.	Kevala will identify which IEPR and policy-driven forecast targets will be used in the studies and will present the assumptions and drivers of the bottom-up net-load scenarios in the Part 1 Study and at the Part 1 Workshop. The CPUC and Kevala are closely coordinating the Research Plan' underlying data inputs with the IEPR and agencies (CARB, CAISO, CEC).

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
10	SDG&E	Forecast, relationship to other planning processes	DPP and Rule 15 and 16 are effective for short-term needs. SDG&E believes the Electrification Impacts Study (EIS) will not be useful for short-term, and that the existing DPP approach meets customer needs, and the IOU methodology of disaggregating CEC load forecast efficiently targets T&D locational upgrades. SDG&E does not want EIS results to be binding for IOUs. Refers to SDG&E V2G pilots, DR deferral programs, ability to meet EV needs.	The Electrification Impacts Study will inform proposed improvements to the short-term and long-term distribution planning process based on the findings and expected grid impacts of the bottom-up high DER net-load scenarios. The Research Plan is not intended to propose specific grid solutions or recommend specific technologies or infrastructure investments.
11	SDG&E	Forecast, relationship to other planning processes	Kevala study results should be used in long-term planning and CAISO TPP. SDG&E believes policy-based load forecast will be useful for long-term transmission and substation planning, especially for TE. It could be used in CEC IEPR, and then IOUs could recommend which forecast to use in DPP 2023 planning cycle. SDG&E states that the EIS forecast should be used for CAISO TPP and not just informational. CEC should encourage use for CAISO decision-making.	The Electrification Impacts Study will inform proposed improvements to the short-term and long-term distribution planning process based on the findings and expected grid impacts of the bottom-up high DER net-load scenarios. The Research Plan is not intended to propose specific grid solutions or recommend specific technologies or infrastructure investments. The CAISO TPP process is for transmission planning, and SDG&E should consider directing their comments to CAISO. Note that the timeline in Figure 4 of the Research Plan shows the JASC HE Scenario being provided to the CAISO in approximately June 2022.
12	SDG&E	Forecast, relationship to other planning processes	Regarding medium-term planning: SDG&E believes CEC forecasts could be useful for "medium-term" to 2030. SDG&E questions the need for ”low-electrification” scenario or how DPP improvements would lead to fewer regulatory filings.	The calibration scenarios have been developed and identified in the Final Research Plan (See Table 1 in Part 1: Bottom-Up Load Adoption Model & System-Level Electrification Impacts Cost Estimates). How the DPP might change is currently an open question that the Research Plan Parts can help inform.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
13	Center for Sustainable Energy (CSE)	Datasets	CSE recommends error-checking Assessor datasets for building characteristics, identifying forecast versus imported data.	Kevala will review Study Research Plan inputs, methodologies, and outputs in the published reports and at workshop(s) associated with each of the three Parts of the Research Plan. Kevala agrees it is important to distinguish between measured data (existing and received) and forecast data in order to ensure visibility into the premise-level forecasts that will be developed in this Research Plan, and will make those distinctions clearly in the reports associated with each Part of this Research Plan. Kevala notes that data and other forecast assumption refinements to Part 1 of this Research Plan are anticipated to be incorporated into Part 3 of this Research Plan and welcome stakeholder input on those refinements.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
14	Center for Sustainable Energy (CSE)	Equity	CSE requests definition for "equity" in distribution planning with input from stakeholders.	The load forecast described in the Research Plan anticipates integrating utility 8760 AMI data with geo-spatial (e.g., circuit-specific) and public socio-economic data to create premise-specific forecasts. Kevala agrees that resiliency, economic, and equity factors are important factors to identify in grid planning to support electrification. Kevala expects that the premise-level forecast developed in Part 1 of the Study will enable parties to develop additional insights into appropriate equity and resiliency metrics that could be applicable to future distribution planning processes. CPUC and Verdant Associates are also evaluating equity in a separate proceeding, which Kevala believes is intended to provide an in-depth evaluation of the role of equity in key planning processes.
15	Center for Sustainable Energy (CSE)	Datasets	CSE recommends additional datasets to the EV analysis: ● NREL 2021 Q1 alternative fueling station report ● Executive Order on ZEVs	Kevala appreciates specific suggested additional datasets. Kevala has incorporated the suggested data sets into the evaluation. Kevala is documenting all of the datasets that will be used for this study, including utility-sourced data, data sets relied upon by other state agencies in electric grid planning and policy-making, and appropriate public data.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
16	Center for Sustainable Energy (CSE)	Definitions	CSE requests Research Plan reflect methodology-related definitions that were discussed in workshop, including: ● "Premise-specific" ● "Acceleration scenarios" ● "Grid integration analysis"	The Research Plan will be updated to specify these definitions.
17	Joint CCAs	Methodology	Joint CCAs express support for aggressive electrification and the bottom-up approach to achieving California's electrification goals.	To clarify, this Electrification Impacts Study and the High DER Proceeding do not seek to set policy on the overall number of DERs nor do they seek to increase or decrease the desired level of DERs. The focus is on preparing the grid to accommodate what is expected to be a high DER future and to capture as much value as possible from DERs as well as mitigate unintended negative impacts.
18	Joint CCAs	Study goals & scope	Joint CCAs express strong support for "mitigation" scenarios to handle "skyrocketing" T&D costs, and recommend discussion of additional programs and standards beyond what is included in the Study to achieve decarbonization.	To clarify, this Electrification Impacts Study and the High DER Proceeding do not seek to set policy on the overall number of DERs nor do they seek to increase or decrease the desired level of DERs. The focus is on preparing the grid to accommodate what is expected to be a high DER future and to capture as much value as possible from DERs as well as mitigate unintended negative impacts.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
19	Joint CCAs	Data transparency	Joint CCAs request stakeholder access to the Study's premise and circuit data, methodologies, and assumptions under a Non Disclosure Agreement (NDA).	While Kevala cannot comment on the level of data access appropriate for stakeholders or the process for sharing data, all Study assumptions and description of methodologies will be documented and reviewed with all parties at one or more future workshops. Kevala looks forward to future engagement during these workshops to ensure confidence and clarity in the approach.
20	Joint CCAs	Stakeholder engagement	Joint CCAs request the ability to comment, at minimum, on IOU requests and IEPR scenarios.	Demand and adoption scenarios are described in Table 1 in Part 1: Bottom-Up Load Adoption Model & System-Level Electrification Impacts Cost Estimates and will be further refined with stakeholder input for Part 3 of the Research Plan.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
21	Green Power Institute (GPI)	Methodology	Approach to premise-level modeling: GPI questions the need for grid-wide premise-level modeling and whether selective premise-level models and a sampling approach are sufficient for some DER or electrification trends. • ICA in the DRP involved circuit clustering and extrapolation initially - not deemed sufficient for near-term use of ICA but GPI view that it is useful for long-term. GPI suggests testing accuracy of IOU top-down approach to identify where premise-level methods are most useful. • GPI request for funding transparency of studies. • GPI suggests addition of quantitative analysis of equity impact in environmental and health impact costs of grid scenarios (2030, 2035, 2050) (Section IV of comments describes proposed methodology)	Kevala welcomes discussion of the value of bottom-up and premise-level evaluation. The challenges noted by GPI are important and have been identified in the proceeding and will be addressed through the Study objective of providing proof-of-concept for a policy-oriented, premise-level, bottom-up methodology. As noted in the Research Plan, the Study will also account for the potential value of premise-level disaggregation methods. This approach is intended to capture electrification impacts that are not uniform across all distribution circuits, particularly in transportation electrification. There is consensus that uncertainty and net demand variability are growing issues with increasing renewable penetration, extreme weather events, and DERs at the distribution level. The premise-level approach outlined in this Research Plan is intended to capture unique circuit impacts that may not be completely accounted for in existing planning approaches. As GPI notes, this approach is extremely time and resource intensive and its immediate application to 2022 GNA/DDOR processes will be limited by necessity as stakeholders understand the methodology. The contract value to complete the work to support the CPUC in the High DER proceeding is identified in CPUC's publicly-issued RFP for this work.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
22	Green Power Institute (GPI)	Methodology	Electrification grid integration report: GPI wants to know more about how power flow analysis works and its usefulness for identifying upgrades. Suggests addition of distribution system expansion pathway and deployment plan for forecast years. Suggests inclusion of TotalView Energy Platform.	Kevala appreciates the opportunity to explain power flow analysis further as well as additional methodology assumptions. Kevala has reached out to GPI directly for a longer discussion of these topics beyond written responses to informal comments.
23	Green Power Institute (GPI)	Methodology	Suggested addition of TotalView software (and other "free or publicly available" software) packages for "hourly electricity grid interaction and allows quantification of a comprehensive picture of economic as well as lifecycle environmental and health impacts, going well beyond GHG emissions tracking and including particulate matter, human toxicity, land transformation, marine toxicity, water depletion, etc.".	Kevala thanks GPI for its recommendation of additional software for this analysis and have discussed their detailed suggestions directly with GPI. The Study analysis described is planned to be built entirely within the Kevala Network Assessor environment. Integration of other "software packages" and capabilities cannot be incorporated into near-term analyses described in this Research Plan. However, Kevala is open to discussing ways of enhancing its analysis over the three Parts of this Research Plan that are consistent with meeting its deliverable requirements.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
24	Green Power Institute (GPI)	Interagency relationship Planning processes	IOU disaggregation in IEPR: GPI recommends IOU top-down load disaggregation for mid- and high- DER IEPR forecast in 2023 GNA/DDOR prior to bottom-up analysis. Recommends that IOUs and CEC determine how IEPR would be reconciled with local load considerations and how known/projected load above CEC forecast will be included.	Kevala welcomes discussion of the value of bottom-up and premise-level evaluation. The challenges noted by GPI have been identified in the proceeding and will be addressed through the Study objective of providing proof-of-concept for a policy-oriented, bottom-up methodology. As noted in the Research Plan, the Study will also account for the potential value of premise-level disaggregation methods. This approach is intended to capture electrification impacts that are not uniform across all distribution circuits, particularly in transportation electrification. There is consensus that uncertainty and net demand variability are growing issues with increasing renewable penetration, extreme weather events, and uncertainty at the distribution level. The premise-level approach outlined in this Research Plan is intended to capture unique circuit impacts that are necessary to address and not completely accounted for in existing planning approaches.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
25	Environmental Defense Fund (EDF)	Methodology Datasets	EDF suggests use of local emissions outcome data as a success metric. Emphasizes importance of quantifying and planning medium and heavy-duty ZEV deployment based on transit corridors and planning along routes.	Part 1 of the Study does not intend to include local emissions data or to recommend specific success metrics, but Kevala acknowledges EDF's comments and will explore incorporating local emissions in future parts of the Study. Kevala understands the importance of integrating medium and heavy-duty electric vehicle deployment into its policy outcome-based forecasts and seeks to incorporate all available data related to MDV and HDVs.
26	Environmental Defense Fund (EDF)	Study assumptions	EDF emphasizes that the need for expanded distribution buildout is an unfounded assumption, and minimizing infrastructure investments should be a major goal of "high electrification future." EDF also expresses concerns that Distributed Generation (DG) solar + storage benefits, EV battery capabilities as a grid resource were not fully reflected in 7 Dec workshop.	Kevala emphasizes that this Research Plan is intended to provide a framework for the evaluation of requirements and potential costs of options necessary to support the additional grid electrification required to meet California policy goals. This Research Plan is not intended to assess grid sensitivities or recommend specific technologies, infrastructure options, future policy, or rate changes. Moreover, the Research Plan is not a cost-benefit study. This Research Plan is not intended to put forward a separate Grid Needs Assessment from those that are developed by the IOUs or recommend specific technologies or infrastructure options.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
27	Environmental Defense Fund (EDF)	Methodology Datasets	Predictive methodology outlined in 7 Dec workshop is only applicable to LDV due to policy changes for the future. EDF believes that Parts 2 and 3 of the Study will be incorrect if the existing Part 1 MDV and HDV assumptions are used, as this points to less predictability and higher fast charging needs for MDV/HDV. EDF suggests a joint modeling assumptions workshop.	All Study methodologies and data sources will be documented for stakeholders. Kevala welcomes feedback and questions during upcoming workshops to discuss the modeling approach. Specifically, the results of the disaggregated load forecast will be reviewed with stakeholders during a workshop scheduled for the beginning of Q2 2022. Kevala understands the importance of integrating medium and heavy-duty electric vehicle deployment into its policy outcome based forecasts and seeks to incorporate all available data related to MDV and HDVs, particularly policy goals established by the state for those resources.
28	Environmental Defense Fund (EDF)	Study goals & scope Proceeding	EDF seeks clarity on which model outputs will be used at what point for decision-making in the Rulemaking.	As described in the Draft Research Plan, the Part 2 Staff Proposal of this Study will begin to consider whether and how to incorporate the Part 1 analysis into the R.21-06-017.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
29	Public Advocates Office	Study goals & scope	Public Advocates Office recommends a clearer statement of goals in the Research Plan, specifically regarding whether it is only intending to address better load forecasting and identification of grid needs, or whether it will consider all aspects of the distribution planning process.	Kevala appreciates the opportunity to clarify the problem statement(s) as articulated in the Electrification Impacts Study Research Plan. Successfully achieving California's electrification and decarbonization goals depends on an electricity grid that can support diverse electrification technologies and maintain the affordability of those technologies for California's families and businesses. The scope and scale of potential electric grid impacts and associated costs necessary to support California's ambitious electrification goals are not well understood. Existing electric distribution planning processes may be insufficient to timely identify and deploy traditional distribution infrastructure and Distributed Energy Resources (DERs) with the precision needed to minimize costs for utility customers. Alternative planning methodologies may be needed for a high penetration DER future.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
30	Public Advocates Office	Interagency relationship Planning processes	Public Advocates Office (PAO) explains that DIDF may not consider non-wires alternatives and wires solutions on a level playing field, resulting in suboptimal procurement processes. PAO recommends that DIDF outcome assessment occur concurrently with the Kevala Study, either by Kevala or another consultant. Energy Division should consider DIDF reforms and impact of this proceeding, including a survey of IOUs' and DER providers' experiences.	DIDF reform will be a focus of the Staff Proposal planned for 2024 in Track 1, Phase 2. For potential items to be addressed in the 2022 Staff Proposal described in the Research Plan, see the Part 2 Electrification Impacts Staff Proposal description of the Research Plan.
31	Joint Parties	Equity	Joint Parties suggest review of which regulatory mechanisms, policies, socio-economic factors either hinder or encourage equitable DER growth be included in the Electrification Impacts Study.	The load forecast described in the Research Plan anticipates integrating utility 8760 AMI data with geospatial (e.g., circuit-specific) and public socio-economic data to create premise-specific forecasts. Kevala agrees that resiliency, economic, and equity factors are important factors to identify in grid planning to support electrification. Kevala expects that the premise-level forecast developed in Part 1 of the Research Plan will enable parties to develop additional insights into appropriate equity and resiliency metrics that could be applicable to future distribution planning processes. Kevala anticipates incorporating Assessor Platform data visualizations reflecting equity considerations into the Part 3, Electrification Grid Integration Report of this Research Plan. Review of specific regulatory mechanisms and policies' impact on equitable DER growth is not anticipated in Part 1 of this Research Plan.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
32	Joint Parties	Equity	Include statement of equity goals in high DER future: Joint Parties propose CPUC and stakeholder identification of gaps that contribute to inequitable DER distribution. Recommend that if cost-effectiveness is evaluated then Total Resource Cost (TRC) test should be used; provides critique Avoided Cost Calculator (ACC) and suggests including energy security in benefits of DER.	Kevala emphasizes that this Research Plan is intended to provide a framework for the evaluation of requirements and potential costs of options necessary to support the additional grid electrification required to meet California policy goals. While Part 1 will lay the foundation for that analysis, Parts 2 and 3 of this Research Plan will provide further opportunities to incorporate targeted equity-oriented data into the analysis for policy consideration and metric development. This Research Plan is not intended to assess grid sensitivities or recommend specific technologies, infrastructure options, future policy or rate changes. The ACC is part of the Integrated Distributed Energy Resources proceeding (R.14-10-003).
33	Tesla	Distribution planning Datasets	T&D capacity expansion is necessary for charging needs, especially fast charging: Tesla is unclear on whether the Research Plan includes public charging infrastructure, whether the Assessor Platform includes standalone (non-BTM) charging. Tesla seeks clarity on how DC fast & public charging needs will be addressed in the proceeding.	The purpose of this Research Plan is to identify the differences, if any, in evaluating distribution grid needs for a policy-driven outcome that is based on premise-level forecasts. As Tesla notes, identifying T&D capacity requirements will be a key output of this evaluation approach. Kevala seeks to incorporate public charging, workplace charging, and BTM charging into its Part 1 Reports of this Research Plan and refine assumptions and data as appropriate in the Part 3 Electrification Grid Integration Report.

#	Commenter	Topic Covered	Summary of comment, feedback or change requested	Electrification Impacts Study Research Plan Researcher's Response
34	Tesla	Datasets	MDV and HDV needs to be included for full electrification impact analysis: Tesla cites CARB Rule that will result in 100,000 MDV and HDV ZEV by 2030	Kevala understands the importance of integrating medium and heavy-duty electric vehicle deployment into its policy outcome-based forecasts and seeks to incorporate all available data related to MDV and HDVs, particularly policy goals established by the state for those resources.
35	Tesla	Distribution planning	DIDF and capacity upgrade needs: Tesla urges the Commission to not delay capacity expansion in order to address problems with DIDF participation (for example, inability to dually participate in other DER programs) to meet EV needs.	Kevala does not anticipate making specific capacity and/or technology recommendations as part of this Research Plan. DIDF reform will be a focus of the Staff Proposal planned for 2024 in Track 1, Phase 2. For potential items to be addressed in the 2022 Staff Proposal described in the Research Plan, see the description of Part 2 of the Research Plan.

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36	Tesla	Distribution planning Proceeding scope	Tesla expresses support for evaluating 'specific long-lead time infrastructure": Rural travel corridors will need long-lead-time investments like land acquisition efforts and recommends Staff Proposal examine shortening timelines where possible.	Kevala does not anticipate making specific capacity and/or technology recommendations as part of this Research Plan. As noted in the draft Research Plan, Part 2 of this Research Plan anticipates developing a staff proposal in 3Q 2022 that will identify potential distribution planning process changes through which utilities and stakeholders can recommend specific solutions. Approaches to identifying and evaluating long-lead-time projects in the 2023 and 2024 GNA/DDOR filings is related to Track 1, Phase 1, Scoping Question 1, which states, "Should the Utilities' DPPs be modified to address policy-based issues such as forecasting scenarios for increased electrification ..." Should policy-forecasting scenarios for higher electrification be used for determining potential grid investments needed to address electrification?"

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37	SCE, PG&E	Datasets, assumptions, bottom-up framework, grid investment needs and locations, relationship to other planning processes, data confidentiality	Data confidentiality: IOUs wish for Kevala to address how confidentiality will be maintained, managed, protected; cybersecurity protocols in place to prevent data leakage.	Kevala acknowledges the comments from PG&E and SCE on data confidentiality and agrees that data security is of the utmost importance. Kevala's Assessor Platform has built in security to protect Critical Energy Infrastructure Information, customers' Personally Identifiable Information (PII) and sensitive market information (if applicable). The Assessor Platform's security framework ensures that each data element and each analytical capability can be separately entitled for individual users within and across organizations.
38	SCE, PG&E	Datasets, assumptions, bottom-up framework, grid investment needs and locations, relationship to other planning processes, data confidentiality	PG&E and SCE expect to "review, vet, and provide feedback" on CEC key assumptions in demand scenario analysis before finalization of assumptions in early 2022. IOUs seek clarity on purpose of each upcoming comment period.	Stakeholder feedback on the CEC's High Electrification Scenario analysis is outside the scope of this Research Plan. See the timeline in Figure 4 in the Project Management and Stakeholder Input section of the Research Plan for the currently understood timing of that CEC High Electrification Scenario Analysis. The schedule in the Research Plan envisions multiple touch points across all stakeholders throughout the engagement process.

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39	SCE, PG&E	Datasets, assumptions, bottom-up framework, grid investment needs and locations, relationship to other planning processes, data confidentiality	Bottom-up framework: IOUs suggest quantifying difference between existing modeling and bottom-up approach to identify where premise-level or above granularity is necessary. IOUs hope that Kevala modeling can improve disaggregation of system level EV forecast to feeder/transformer level.	Kevala welcomes the suggestion of a quantified comparison of the Study results with current disaggregation approaches. That comparison will be incorporated into Part 2 of the Research Plan. Part 1 of the Research Plan will build a forecast up from the premise-level and identify gaps, if any, to the utilities' current disaggregation methods. Those differences can be quantified in Part 2.
40	SCE, PG&E	Datasets, assumptions, bottom-up framework, grid investment needs and locations, relationship to other planning processes, data confidentiality	Future demand-side technology: PG&E, SCE suggest that impact study results be generated with and without future tech to include uncertainty. Suggest EIS include high level recommendations on usefulness of technology to reduce electrification demand.	This Research Plan is not intended to evaluate specific technologies' ability to meet grid needs. The benefit of calibrating to multiple high-electrification scenarios as proposed in the Research Plan is to capture the range of uncertainty about technologies and behaviors.

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41	SCE, PG&E	Datasets, assumptions, bottom-up framework, grid investment needs and locations, relationship to other planning processes, data confidentiality	PG&E, SCE suggest categorizing grid investment needs, especially EV upgrades not in defined GNA /DDOR project categories - IOUs say this is main benefit of comparing EIS to DDOR but that EIS/DDOR comparison will not be useful for comparing individual investments.	Kevala clarifies that the Study does not intend to provide a grid needs assessment or substitute for the GNA process. Kevala recognizes that the utilities have additional factors to consider in their GNA/DDOR filings. In Part 2 of this Research Plan, Kevala will explore opportunities, if any, of incorporating Part 1 of the Research Plan into the utility planning processes. Kevala looks forward to discussion on integrating solutions at the Energy Division workshop for stakeholder input to the Staff Proposal in Q4 2022.
42	SCE, PG&E	Datasets, assumptions, bottom-up framework, grid investment needs and locations, relationship to other planning processes, data confidentiality	Usefulness of granular, locational grid investment identification: IOUs state that grouping investments by category to understand grid impact is more useful. Suggest that EIS recommendations for investments be directional only.	Grid investments will be categorized in Part 1 of the study for the high-level cost impact assessment.

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43	SCE, PG&E	Datasets, assumptions, bottom-up framework, grid investment needs and locations, relationship to other planning processes, data confidentiality	DPP preparation time: EIS can provide insight to data that can be removed from IOU regulatory filings.	The Electrification Impacts Study can potentially provide insights to data that can be removed from IOU regulatory filings.
44	SCE, PG&E	Datasets, assumptions, bottom-up framework, grid investment needs and locations, relationship to other planning processes, data confidentiality	IEPR scenario and IOU planning: Emphasize importance of beginning planning in August. Express concerns over timing of CEC project results.	Kevala understands that the CEC is part of a joint-agency Working Group recently formed to develop a policy-based, high electrification scenario. Kevala intends to closely coordinate with the CEC and joint agencies across datasets and analysis timelines as appropriate and allowed, consistent with interagency agreements.

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45	Utility Consumers' Action Network (UCAN)	Study goals & scope	T&D cost increases harm ratepayers: grid capacity upgrades over course of proceeding will diminish flexibility opportunities. UCAN suggests CPUC & consultants consider 'open questions' (p.3-4) on harm of infrastructure overinvestment on consumers and local flexibility markets. UCAN suggests using dynamic rate pilots as point of consideration these questions (referred above): PG&E and SCE pilots approved 2 Dec 2021	Kevala acknowledges that the rate design and rate level changes being considered in other proceedings have the potential to affect electrification impact across IOUs. The real-time rates proceeding identified in the DER Action Plan 2.0, and existing dynamic rates pilots are examples. This Research Plan will not recommend specific technologies, programs, policies, and rate designs but can potentially assist policy-maker decisions in identifying specific technologies, rates, policy, or program decisions that could be impactful in facilitating equitable electrification.
46	Utility Consumers' Action Network (UCAN)	Datasets	Timely access to utility data: UCAN emphasizes that time is of the essence and that CPUC should ensure timely data access.	Kevala is working actively through its prime contractor and Commission staff to identify necessary data requirements from utilities in compliance with all contractual requirements.
47	Utility Consumers' Action Network (UCAN)	Datasets	UCAN recommends use of additional data for accurate customer bill modeling: service account with each meter, monthly peak demand (kW) to account for 5-minute interval demand charges, CARE participation, meter designations and baseline zones, supplier designation, and service level voltage. UCAN recommends IOUs disclose data processing methods for already-disclosed AMI data to ensure malfunctioning meters are addressed	Kevala has incorporated suggestions for additional data parameters into its data requests (updated data requests are included as an attachment to the Final Research Plan) to complete Part 1 of this Research Plan, and anticipates updating and adding to future data requests as Energy Division and stakeholders identify additional data requirements for Parts 2 and 3. As data is provided by the IOUs, Kevala is working actively with each of them to identify and document unique data processing actions taken.

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(End of Attachment 2)