FILED
02/28/22
04:59 PM
R2106017

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE

STATE OF CALIFORNIA

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

SOUTHERN CALIFORNIA EDISON COMPANY'S (U 338-E) 2022 LOAD INTEGRATION CAPACITY ANALYSIS REPORT

WILLIAM W. YU

Attorney for
SOUTHERN CALIFORNIA EDISON COMPANY

2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770
Telephone: (626) 302-1634
E-mail: William.W.Yu@sce.com

Dated: **February 28, 2022**

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE

STATE OF CALIFORNIA

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

SOUTHERN CALIFORNIA EDISON COMPANY'S (U 338-E) 2022 LOAD INTEGRATION CAPACITY ANALYSIS REPORT

I. INTRODUCTION

Pursuant to the California Public Utilities Commission's (Commission or CPUC) Ordering Paragraph (OP) 1 of the *Administrative Law Judge's Ruling Ordering Refinements to Load Integration Capacity Analysis* issued September 9, 2021 (Ruling), Southern California Edison Company (SCE) hereby submits this report providing a review and discussion on whether alignment of the Load Integration Capacity Analysis (ICA) and the Grid Needs Assessment (GNA) assumptions and methodologies could improve Load ICA results. SCE also discusses in this report its implementation of the refinements to the Load ICA modeling practices and reporting that were adopted by the Ruling, including SCE's work plan and cost estimate for developing the modeling enhancement.

SCE's report recommends further aligning forecast and input data across GNA and Load ICA but concludes that the analyses in the GNA and Load ICA serve different purposes and, therefore, necessitates maintaining differences in assumptions and methodologies. SCE finds that the input data to the calculations for the GNA and Load ICA, such as the forecast and equipment ratings used, can be more aligned to maintain consistency with both calculations. Nevertheless, the objectives served by the GNA and Load ICA are different, in that the GNA calculates when a demand *forecast* exceeds existing equipment ratings and requires system upgrades, whereas Load ICA calculates the available capacity on the system at present up to the point of requiring mitigation.

In the sections below, SCE provides: 1) an overview of the Load ICA and GNA methodology and assumptions and discusses whether alignment across the two assessments could improve Load ICA (Section II); 2) a description of its data validation methods to track and support accurate Load Integration Capacity results (Section II.II.D); and 3) the required activities to implement the modeling changes discussed in the Ruling (Section III).

II. LOAD ICA AND GNA METHODOLOGIES, ASSUMPTIONS, AND ALIGNMENT

Both Load ICA and GNA (the capacity service portion) evaluate the distribution system with respect to its ability to serve load, but differ with regards to the objectives and the approach used in that:

- Load ICA values represent the incremental capacity that is available on the distribution system within equipment ratings, through iterative power flow calculations. Existing Load ICA calculation is based on the existing system configuration, while the future Load ICA, which would incorporate the refinements proposed by the Ruling, will be calculated based on planned system configuration with forecasted load and distributed energy resources (DER) and all the proposed planned investments in the coming year.
- The GNA is an output of the distribution planning process (DPP). The DPP evaluates future system deficiencies given forecasted load and DER levels and proposes planned investments to mitigate the identified grid needs. GNA data represents grid needs after engineers have maximized utilization of existing equipment but does not account for planning investments proposed on the associated circuit/substation. Therefore, GNA

would indicate where planned investments are required to continue to operate the system safely and reliably.

The future Load ICA (incorporating the modeling enhancements as required by the Ruling) will evaluate the incremental capacity available after all the planned investments from the DPP are assumed to be installed and for which capacity increases are accounted. Even after incorporating the modeling enhancements, Load ICA's purpose necessitates carrying out a separate and different study beyond the annual DPP and GNA. Changing their methodologies to align with each other, without altering each study's purpose, is not possible. Instead, the data that feeds into both calculations could be made consistent to the extent possible so that calculation results are based on the same assumptions.

A. Load ICA

1. Methodology

The Load ICA is performed by iteratively increasing a simulated amount of load (*i.e.,* power demand) at each three-phase node[1] until a criteria limit is exceeded for each simulated hour[2]. The Load ICA produces results for each of the following three criteria: thermal, voltage variation, and voltage steady state:

- **Thermal Criteria**: Cable, conductor, and equipment ratings establish the thermal limits for load ICA. In cases where the Load ICA results exceed circuit ratings, the Load ICA results will be reduced to the circuit or substation transformer bank rating.
- **Voltage Variation Criteria:** Amount of load which can be installed without causing a voltage variation greater than 3%.

---

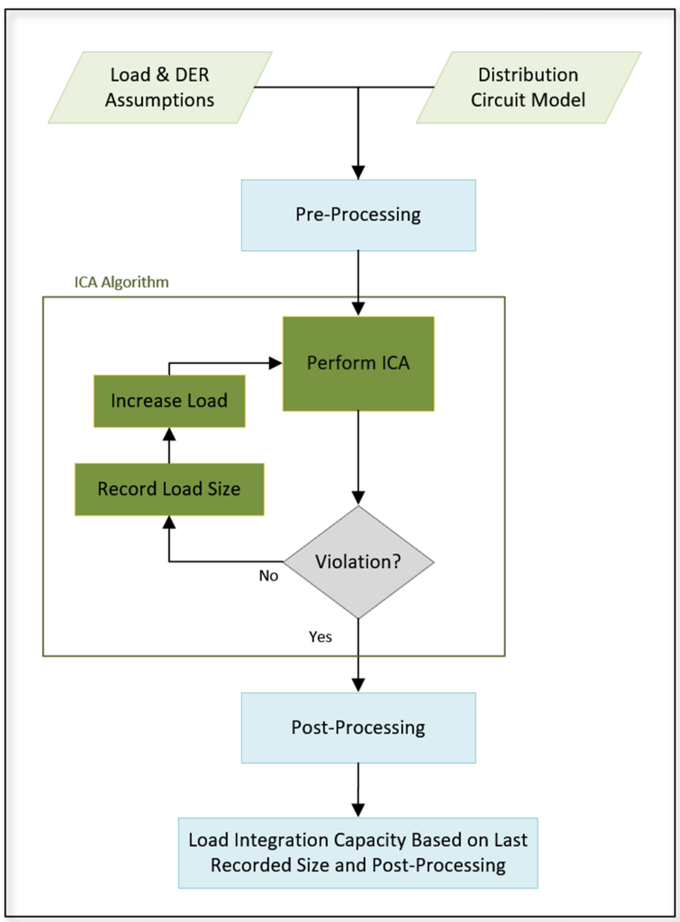
1 Nodes are based off circuit topology and interconnection points to model equipment.

2 The methodological directives were defined in OP 5 of the Decision on Track 1 Demonstration Projects A (Integration Capacity Analysis) and B (Locational Net Benefits Analysis) (D. 17-09-026) issued October 6, 2017.

- **Voltage Steady State Criteria:** Amount of load which can be installed without causing primary voltage to result in a deviation from Rule 2 limits at the customer premise. Rule 2 customer service voltage limits are 5% of the nominal voltage. Pursuant to the Ruling, the Voltage Steady State Criteria is from 118V[3] to 126 V on a 120 V base to account for allowable secondary voltage drop.

The maximum amount of uniform load that did not exceed any criteria limit is recorded as the Load ICA result for that node, hour, and criteria. The iterative process then moves to the next three-phase node and repeats the process until the analysis is completed for all three-phase nodes. This process is illustrated in **Figure 1**.

FIGURE 1. ITERATIVE LOAD ICA METHODOLOGY



3 The Ruling increased the lower bound of Rule 2 from 114 V to 118 V.

2. Assumptions

Current Load ICA is calculated using the following assumptions about distribution circuit models, circuit load profiles, DER profiles, and Advanced Metering Infrastructure (AMI) profiles for voltage analysis:

- **Distribution Circuit Models**: Models represent the normal and current configuration of distribution circuits.
- **Circuit Load Profiles**: The 576-hour circuit load profiles (12 months * 24 hours for monthly maximum and monthly minimum loading conditions) are utilized in the Load ICA.
- **DER Profiles**: Metered data is used wherever available, otherwise estimated or normalized regional photovoltaic (PV) output profiles are used to model the output of PV systems. Energy storage DER performance is modeled with representative profiles while all other non-PV DER profiles are modeled at 100% nameplate unless telemetry for a specific generation project is available.
- **AMI Profiles for Voltage Analysis:** The AMI profiles represent an aggregation of the customer demand to the associated structure. The 576-hour AMI profiles are composed of a typical maximum (90th percentile) profile and a typical minimum (10th percentile) profile.

B. GNA

1. Methodology

The GNA report presents the identified distribution and subtransmission needs, based on forecasted load and DER planning assumptions, that fall under one or more of the following distribution services: capacity, voltage/reactive power support, reliability (back-tie), and resiliency (microgrid). GNA data represents grid needs after engineers have maximized utilization of existing equipment and therefore require planned investments to continue to operate the system safely and reliably.

The GNA report is an output of the annual DPP. SCE's major DPP activities[4] include:

- **Historical Profile Review**: After a region's annual peak demand is believed to be recorded, engineers review the recorded demand profiles of each distribution circuit and distribution substation and remove anomalies. SCE then uses the cleansed profiles to determine the starting demand for each circuit and substation to develop a final forecast.
- **Load and DER Disaggregation**: SCE adds the disaggregated California Energy Commission's Integrated Energy Policy Report (IEPR) system level forecast to the starting demand to develop the 10-year forecast for all distribution circuits which is then aggregated to the substation level. In some instances, SCE also incorporates additional load growth that may not have been fully reflected in the IEPR forecast.
- **Identify Electric System Needs**: Engineers perform technical studies to determine whether the forecasted net demand can be accommodated by existing electric facilities, under normal and emergency conditions.
- **Develop Projects Solving Electric System Needs:** When the technical studies indicate forecasted net demand exceeds equipment ratings, engineers develop alternative solutions to solve the identified needs and evaluate these solutions to select the most cost-effective alternative that meets long-term system needs. SCE first seeks to maximize the utilization of existing assets through no cost solutions or load transfers before developing projects that require installing new, or modifying existing, infrastructure.

The GNA report is compiled after the DPP activities above are concluded. The GNA report represent the grid needs after no cost solutions are identified.

---

4 Future software tool advancement and regulatory requirements may impact this process.

2. Assumptions

The GNA is based on the following DPP assumptions about distribution circuit models, circuit and substation load profiles, DER profiles, and voltage profiles:

- **Distribution Circuit Models:** Forecasted distribution circuit models are not yet utilized for systematic load flows in the DPP. Models representing the normal and planned configuration of distribution circuits are studied as the need for more detailed analyses arise.
- **Circuit and Substation Load Profiles:** SCE's DPP is currently in the process of evolving from a single-point-in-time analysis to time series analysis as the software capabilities gradually roll out. The single point of system peak condition is developed from 8760-hour net demand forecast profile.
- **DER Profiles:** Normalized PV output profiles are multiplied by each PV generator's nameplate rating to create a profile for each PV generator. Energy storage DER profiles are modeled with a representative shape while all other non-PV DER profiles are modeled at 100% nameplate for every hour unless there is telemetry for a specific generation project.
- **Voltage Profiles:** System-wide voltage profiles are not currently considered as part of the DPP.

C. Discussion of whether the alignment of Load ICA and GNA assumptions and methodologies could improve ICA results

Alignment of the methodologies and assumptions between Load ICA and GNA will not improve Load ICA. The two studies serve different purposes, and must utilize different assumptions and methodologies, such as iterative power flow simulations to identify the available local capacity for the Load ICA versus a standalone analysis to identify capacity and other criteria violations on the entire circuit for the GNA, to calculate their expected outputs. Instead, the data that feeds into each calculation should be consistent such as, known load growth projects, equipment ratings, and load/DER forecasts/profiles so that calculation results can be based on the same underlying input data.

The difference observed between the GNA and the current iteration of the Load ICA is mainly due to the different methodologies deployed by each process, in addition to the base case differences (i.e., the current Load ICA results are calculated based on existing system topology and estimated historical loading while the GNA is developed based on forecasted system loading at the circuit head). SCE's DPP currently identifies voltage violations in the system primarily based on customer feedback. SCE has not yet performed system wide power flow simulations in the planning process to identify voltage violations as the software capabilities have not become fully available. These software related constraints also only allow SCE to evaluate feeder deficiencies at the circuit breaker instead of at individual feeder line segments.

Even when the software capabilities that enable SCE's DPP to perform circuit segment level and time series analyses are fully deployed, and future iteration of the Load ICA incorporates the planned system upgrades, methodologies should not be fully aligned. The GNA presents expected grid needs based on forecasted load and DER growth. Grid needs are identified after existing equipment capacity is maximized (e.g., no cost load transfer) but before specific planned investments are in place. Conversely, Load ICA with the requested modeling change from the Ruling will evaluate the available capacity on a given segment of a distribution circuit with forecasted load and DER growth, planned network reconfiguration, and after the proposed planned investments that will be in service in the coming year are in place. The Load ICA will start when the DPP is completed and planned investments are identified, then iteratively evaluate the amount of the load at a given node until any criteria limit is reached. Load ICA is an extra study beyond the annual DPP and should only be performed once annually to represent the output of the annual DPP, since the DPP is an annual study that remains static until it updated for the following cycle. However, outputs of both the GNA and the Load ICA should be based on the same input data and circuit/equipment models, which provides consistency regardless of which output is being analyzed.

D. Load ICA Data Validation Methods

Since the filing of the Joint IOU Uniform Load ICA narrative in March of 2021, SCE maintains the position the data validation methods outlined in Advice Letter 4508-E[5] and Advice Letter 4508-E-A[6] are still adequate data validation methods to improve Load ICA accuracy. SCE will continue to evaluate these and improve upon them as the need arises.

III. WORKPLAN TO IMPLEMENT MODELING CHANGES

A. Modeling Changes

The Ruling requires the utilities to perform the following modeling changes:

1. Model load ICA with all queued load projects and planned, known, near-term distribution system project
2. Model load ICA to include distribution system upgrades with an approved construction schedule and an in-service date within one year;
3. Model load ICA to consider forecasted DER growth;
4. Model load ICA to consider planned network reconfiguration
5. Model load ICA with load forecast for the next year.

SCE's proposal for how the requirements should be implemented is found on **Table 1**.

TABLE 1: LOAD ICA REFINEMENTS AND SCE'S PROPOSED IMPLEMENTATION

Load ICA Refinements	SCE Implementation
Model load ICA with all queued load projects and planned, known, near-term distribution system project	Models and profiles used for load ICA must include all incremental load and distribution projects for the first year of the forecast horizon.[7]

5 Advice Letter 4508-E.

6 Advice Letter 4508-E-A.

7 As discussed above, SCE proposes Load ICA to be updated annually, to align with the publication of the GNA. All five modeling enhancement requirements would be reflected in the annual Load ICA updates.

Load ICA Refinements	SCE Implementation
Model load ICA to include distribution system upgrades with an approved construction schedule and an in-service date within one year	Models and profiles used for load ICA must include all planned system upgrades for the first year of the forecast horizon.
Model load ICA to consider forecasted DER growth	Models and profiles used for load ICA must include forecasted DER growth for the first year of the forecast horizon.
Model load ICA to consider planned network reconfiguration	Models and profiles used for load ICA must reflect all planned system reconfiguration (i.e., permanent transfers) for the first year of the forecast horizon.
Model load ICA with load forecast for the next year	Profiles (circuit load, structure load, etc.) used in load ICA must reflect the first year of the most recent, approved planning cycle, converted to 576 format.

To enable the functionality in support of these five Load ICA refinements, SCE must make foundational technology and business process changes, as the systems that support the DPP and the Load ICA must be integrated. With the integration of these systems, underlying support processes must also be adapted.

The workplan described below accounts for time required to perform detailed business process and design discussions. For example, if we model the temporal operationalization of a known load project that is projected to be in-service on Month 10 of the first forecasted year, then published values from Month 1 to Month 9 of the published Load ICA would be invalid as the known load project would effectively use the available capacity on Month 10. This highlights the need to explore the development of separate models from those used in the current ICA process and, potentially, the DPP, to account for the temporal nature of future projects and forecasted values, as well as other challenges, such as the changes required to maintain two vast datasets. The workplan accounts for these changes and the underlying decision-making required to enable the five modeling enhancements.

Other challenges the engineering teams must address include:

- Translation of 8760-models to 576-models: current technology accommodates the time-series modeling of projects on an 8760 basis (e.g., hourly information for a year). ICA uses 576 models and profiles, which are specific to California's ICA implementation. Transforming 8760 data to 576 will require technology changes;
- Computing (e.g., hardware and software) requirements: ICA is a computing-resource demanding task. Given the addition of complexity (i.e., additional data and modeling considerations), ICA runtime performance will be compromised. As SCE identifies these issues, additional enhancements to hardware (e.g., servers) and/or software (e.g., CYME Power Flow Engine) may be required, introducing risk to the ICA processes;
- Business processes to maintain Generation ICA, Load ICA, and Distribution Planning Processes consistent: As further enhancements are made to the models currently being used by the overall ICA processes, maintenance processes need to be designed, developed, and implement to ensure data consistency across all three studies;
- Integration into existing development activities: The Load ICA refinements impact systems that are also used for other business processes. In some cases, these same systems are undergoing changes/development. Integrating the identified scope of work with those projects may result delays to the implementation.; and
- Project team(s): new project teams may need to be created to support new/incremental systems, datasets, and business processes, as needed.

B. <u>Workplan</u>

SCE reviewed the following considerations, assumptions, and dependencies in developing the implementation work plan:

1) Detailed estimates and schedules will be developed after the business requirements and system architecture design are finalized. This work plan is based on high-level business requirements, and although work has started on the development of detailed business requirements, the finalized business requirements can depend on any feedback from this

report and whether any incremental requirements are added to the scope of work (e.g., High DER OIR scope).

2) A project team must be assembled (e.g., subject matter experts made available) to complete the analysis, design, development, testing, deployment, and maintenance activities of the new modeling changes to Load ICA.

   a. Due to emergence of requirements and timing of deployment, strategic decision on technology (e.g., hardware, architecture, business processes) are still pending, and may impact implementation timelines

      i. Due to processing and data requirements, architectural decisions still pending on acquisition of new infrastructure. Work plan assumes current architecture and infrastructure will suffice.

3) Although a traditional representation of a work plan is provided (e.g., *waterfall* model), SCE may opt to use a different implementation methodology. If such change occurs, illustrated durations and milestones could change, but the overall completion date of the project is not expected to change.

   a. At this time, specific dates within the work plan are provided for reference only and should only be used as a high-level estimate for the durations of the planned activities, and not be interpreted as definitive.

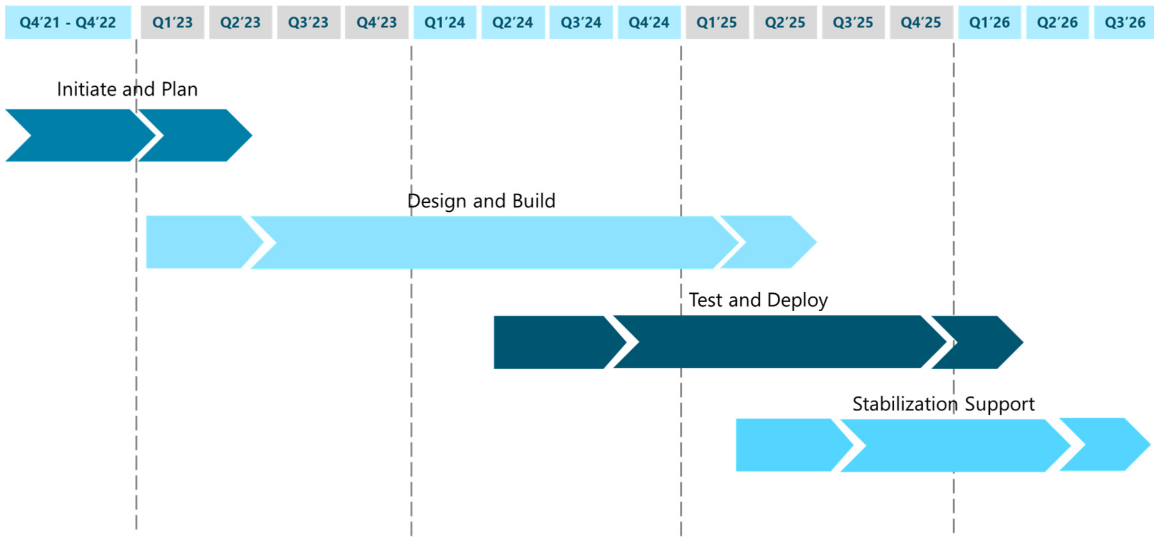
4) As an enterprise solution, this workplan still needs to be integrated with other enterprise software development timelines. This integration can change intra-workplan dates.

   a. Vendor changes could impact implementation(s) (e.g., CYME)

5) Any incremental scope will impact implementation timeframes.

Figure 2 summarizes the high-level work plan given these key considerations, assumptions, and dependencies:

FIGURE 2. LOAD ICA MODELING ENHANCEMENTS ILLUSTRATIVE TIMELINE



Based on preliminary evaluations of existing datasets, systems, and required functionality, the *Go-Live* date of the modeling changes to the Load ICA is estimated to occur approximately five to six years from the issuance of the ruling. For reference, as preliminary analysis activities started in Q4 2021, the new modeling changes could be deployed and available by Q3 2026, at the earliest; these timelines will be further defined as part of the initiate and plan activities. Description of the activities in the work plan are:

- **Initiate & Plan:** Develop detailed business and functional requirements based on CPUC mandates. SCE's cross-functional project team will collaborate to finalize these requirements. Upon finalizing business requirements, including functional and non-functional requirements, the SCE project team will undertake design activities involving system architecture. The system architecture will determine the way the required functionality and data will be developed and implemented. Typical system architecture activities include data modeling, system integration, and hardware & software evaluations.
- **Design & Build**: Once the system design is complete, development tasks including installation of required hardware and software environments, creation of new data

structures in databases, building of data and system interfaces, and identification of new procedures to support on-going maintenance of the system(s) will commence.

- **Test & Deploy:** End-to-end testing supports adequate processing times and response from the installed applications using performance benchmarking and verifies that no unexpected impacts to existing applications occurred. In addition, end-to-end testing assesses whether these tools are effective in a "real-world" scenario. This supports a satisfactory user experience but also tests underlying manual processes. Once successful testing phases are complete, the SCE project team will coordinate tasks required to "push" the new applications, systems, and interfaces to the production environment(s).
- **Stabilization Support**: Once deployed, the SCE project team will continue the performance evaluation of the Load ICA modeling refinements and associated technologies in its production environment. During this period, the SCE project team will also transition required on-going activities to SCE teams in support of maintenance/refresh tasks.

1. Milestones

SCE identified the following milestones as part of the Load ICA refinements workplan in **Table 2**:

TABLE 2: LIST OF MILESTONES DENOTED IN A T_0 + MONTHS NOTATION*

Start (Estimated Date)	#	Milestone
T_0 (Oct. 2021)	1	Project start
(Nov. 2022)	2	Annual ICA workshop
T_0 + 27 months (Jan. 2024)	3	Successfully create As-Planned connectivity model and profiles for a selected subset of circuits with Load Growth and DERs. Analyze impact on ICA.
(Nov. 2023)	4	Annual ICA workshop
T_0 + 42 months (April 2025)	5	Successfully create As-Planned connectivity model and profiles with approved mitigations for entire system. Analyze impact on ICA.

Start (Estimated Date)	#	Milestone
(Nov. 2024)	6	Annual ICA workshop
T_0 + 50 months (Dec. 2025)	7	Successfully create end-to-end integration across impacted systems that meet Milestone #2. Analyze impact on ICA.
(Nov. 2025)	8	Annual ICA workshop
T_0 + 57 months (July 2026)	9	Integrate CYME with all solutions for system-wide implementation. Analyze final ICA results.

*T_0 is the start date of the project and *Months* is the duration of activities leading up to the milestone

These milestones are subject to change based on the information gained through the analysis, design, and development activities. Any additional requirements or modifications not captured by the start of the project will likely result in changes to the work plan and may affect SCE's ability to deliver the designed solution in this timeframe.

2. Related Planned work

Currently, SCE is enhancing other aspects of the same tools that will need updates to meet the requirements established by the five modeling enhancements. Some of this new functionality may be used for the Load ICA modeling refinements, although still to be determined. These possible dependencies, also present other challenges, such as the need for processes and technology to synchronize data refresh and refresh frequency across different applications. SCE will identify opportunities to consolidate requirements, functionality, and efforts across other projects during the *Initiate & Plan* phase of the project.

3. Estimated Cost

Based on the current analysis, SCE's high-level preliminary cost estimate for the development and deployment of the five modeling enhancements to be in the $14 million -$16 million range. These estimates will be further developed as part of the detailed design and are subject to change based on detailed requirements and architecture finalization.

Respectfully submitted,

WILLIAM W. YU

/s/ William W. Yu

By: William W. Yu

Attorney for
SOUTHERN CALIFORNIA EDISON COMPANY

2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770
Telephone: (626) 302-1634
E-mail: William.W.Yu@sce.com

Dated: **February 28, 2022**