STATE OF CALIFORNIA
GAVIN NEWSOM, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE

January 19, 2022

Advice Letter 6212-E and 6212-E-A

Sidney Dietz
Director, State Regulatory Operations
Pacific Gas and Electric Company
77 Beale St., Mail Code B13U
P.O. Box 770000
San Francisco, CA 94177

SUBJECT: Disposition of PG&E 6212 E and 6212-E-A Improved ICA Data Validation Plan

Dear Mr. Dietz,

The Energy Division approves Advice Letter 6212-E and 6212-E-A, PG&E's Improved Data Validation Plans, with an effective date of May 28, 2021. Energy Division has determined that PG&E's AL 6212-E and 6212-E-A comply with the Administrative Law Judge's Ruling on the Joint Parties' Motion for an Order Requiring Refinements to the Integration Capacity Analysis (the Ruling) in the Distribution Resource Plan (DRP) proceeding, R.14-08-013, issued on January 27, 2021.

The protests of the Interstate Renewable Energy Council (IREC) and the Public Advocates Office (Cal Advocates) have either been addressed by PG&E or are dismissed by Energy Division, as discussed in Attachment 1.

Sincerely,

Simon Baker
Interim Deputy Executive Director for Energy and Climate Policy/
Interim Director, Energy Division
California Public Utilities Commission

cc: PGETariffs@pge.com
Richard Khoe, Rachel Gallegos, Chloe Lukins, Public Advocates Office
Yochanan Zakai, Interstate Renewable Energy Council, Inc
Service lists for R.21-06-017

Attachment 1: Background, Protests and Discussion

Background

On January 27, 2021, the Administrative Law Judge in R.14-08-013 issued a Ruling on the Joint Parties' Motion for an Order Requiring Refinements to the Integration Capacity Analysis (ICA). The Ruling ordered the IOUs to:

- Retain an independent technical expert (ITE) to review ICA data validation plans and review the IOU's data validation efforts.
- Submit improved ICA data validation plans and file them as a Tier 1 Advice Letter.
- Document the results of the IOUs data validation efforts to date, deficiencies discovered, or efficiencies realized in ICA implementation, and plans for ICA improvements in the Improved Data Validation Plans.
- Address how each utility's ICA could or could not address the objectives of the interconnection use case which has the goal of supporting the streamlining of Rule 21 interconnection.[1]

On May 28, 2021, PG&E filed Advice Letter 6212-E with its Improved Integration Capacity Analysis Data Validation Plan. IREC and Cal Advocates submitted protests to PG&E's AL 6212-E on June 17, 2021. On June 24, 2021, PG&E filed a response to both protests. On June 25, 2021, the Independent Technical Expert, Quanta Technology submitted a report (ITE Report) reviewing PG&E's data validation plan to Energy Division. On August 25, 2021, PG&E filed supplemental Advice Letter 6212-E-A to address the Independent Technical Expert (ITE) Report and recommendations.

Discussion of IREC's and Cal Advocates' Protests, PG&E's Reply, and Energy Division Disposition

We address the parties' protests and the PG&E's reply in the discussion below.

<u>Issue 1</u>: Request for Supplemental Advice Letter with ITE Report and Additional Time to Reply

IREC and Cal Advocates' protests requested PG&E share the ITE Report on the PG&E's data validation plan with stakeholders and asked for an additional time to respond to PG&E's Advice Letter after submission of the report. PG&E replied that the CPUC should not delay the approval of the IOUs' improved data validation plan advice letters and introduce a new step for comments on the ITE Report from stakeholders.[2]

Energy Division found it beneficial for transparency to direct PG&E to send the ITE Report to the DRP service list and to issue a supplemental advice letter to address recommendations of the ITE Report. After PG&E issued its supplemental advice letter, Energy Division re-opened the protest period, and no additional protests were received. As such, Energy Division finds that this issue has been resolved.

<u>Issue 2:</u> Future Deficiencies with ICA Data may not be Detected because PG&E's Improved Data Validations did not Include Specific Timelines or Plans to Address Load ICA Problems.

[1] ICA Refinement Ruling at 6.
[2] PG&E Reply to Protest of Advice Letter 6212-E at 2.

IREC's protest to 6212-E charges that PG&E's failure to identify errors with load ICA or develop a plan with timelines to correct errors is evidence that the data validation plans may be insufficient in detecting new issues.[3] PG&E's reply did not explain why there were no load ICA deficiencies discovered, nor did they explain why a specific plan to address load ICA issues was not included in the improved data validation plan. However, the ITE Report states that despite the assessment being focused on generation ICA, many of the findings and recommendations can be applied to load ICA.[4] PG&E's supplemental Advice Letter notes that it has already adopted the ITE Report recommendations and will continue to adopt recommendations made. The supplemental Advice Letter also included a timeline to implement the data validation plan improvements. The implementation of the ITE recommendations and other improvements by PG&E will help to detect future ICA issues. Furthermore, PG&E is required to develop a detailed load ICA workplan to address data issues and file it with the CPUC in February 2022. Energy Division and stakeholders will continue to review PG&E's data validation plans and efforts in Rulemaking 21-06-017. Therefore, Energy Division finds that Issue 2 is addressed.

Issue 3: IREC's Request for Clarifications on PG&E's Approach to Load Profile Updates

IREC's protest requested that PG&E provide clarification in a supplemental Advice Letter to clarify the maximum time between load profile updates today, and any plans to reduce this lag."[5] IREC also requested that PG&E file a supplemental Advice Letter to offer further clarification on performance targets for the PG&E's ICA and Data Validation Task.[6] IREC suggests that SCE's plan to reduce its lag time between updates from 12 months to 2-months is something PG&E should consider replicating.[7]

PG&E responded that historical load profiles are "updated once annually."[8] PG&E's response did not outline any plans to reduce any lag in load profile updates, however PG&E did commit to reviewing its approach to reducing lag time between updates. The ITE Report does not make any recommendations that suggest PG&E should change its timeline in updating load profiles. Load profile updates can be further examined in R.21-06-017. Energy Division finds that PG&E is not required to address load profile updates with specificity at this time, and therefore dismisses this protest.

Issue 4: IREC's Request for Clarifications on PG&E's Approach to Performance Targets on Data Validation Tasks

With regards to performance targets, PG&E's Reply says the fact that SCE has proposed performance targets in its Advice Letter is not sufficient justification to require PG&E to supplement its Advice Letter. PG&E's response is insufficient. The ITE Report includes recommendations for PG&E to establish both performance targets and metrics for ICA results. The ITE Report recommends that PG&E should identify ICA business owners that are responsible for establishing metrics to ensure that the ICA process is functioning as designed and that the results are of sufficient quality.[9] The ITE recommended that to ensure that there is long-term, ongoing improvement in the ICA results, each IOU should have an identified business owner solely responsible for those results. One of business owner's responsibilities should include establishing performance targets and metrics for ICA results.

[3] Id.
[4] Quanta Technology, PG&E ICA Data Validation Plan Assessment at 1.
[5] IREC Protest to 6212-E at 5.
[6] Id at 3.
[7] IREC Protest to 6212-E at 5.
[8] PGE Response at 3.
[9] Quanta Technology, PG&E ICA Data Validation Plan Assessment at 2.

PG&E's supplemental Advice Letter acknowledges seven recommendations of the ITE Report that PG&E plans to implement. However, PG&E did not fully acknowledge the ITE Report's specific recommendations for establishing performance targets and metrics for ICA results. Energy Division strongly suggests PG&E follow the ITE's recommendation for establishing performance targets and metrics described on pages 2-3 of the ITE Report. This issue is addressed, and no supplemental AL is required.

Pacific Gas and Electric Company

Sidney Dietz
Director
Regulatory Relations

Pacific Gas and Electric Company
77 Beale St., Mail Code B13U
P.O. Box 770000
San Francisco, CA 94177

Fax: 415-973-3582

May 28, 2021

Advice 6212-E
(Pacific Gas and Electric Company U 39 E)

Public Utilities Commission of the State of California

Subject: **PG&E Improved ICA Data Validation Plan**

Purpose

Pacific Gas and Electric Company (PG&E) submits this advice letter pursuant to the January 27, 2021, Administrative Law Judge's (ALJ) Ruling on the Joint Parties' Motion for an Order Requiring Refinements to the Integration Capacity Analysis. ALJ Robert M. Mason directs Investor Owned Utilities (IOUs) develop their improved ICA Data Validation Plans and file them in a Tier 1 Advice Letter.

PG&E's ICA Data Validation Plan documenting the results of the data validation efforts, deficiencies discovered, or efficiencies realized in ICA implementation and plans for ICA implementation including information on whether or not objectives of the interconnection use case supporting the streamlining of Rule 21 interconnection is included as Attachment 1.

Background

Decision (D.) 17-09-026 approved the Integration Capacity Analysis (ICA) to address the primary interconnection use case which includes 1) transparent display of ICA maps to aid third party Distributed Energy Resource (DER) developers in identifying interconnection locations where their projects are less likely to trigger costly distribution upgrades; and 2) providing ICA data that is sufficiently robust to be relied upon to streamline the Rule 21 interconnection of DERs. While the actual streamlining of Rule 21 occurs in the Rulemaking (R.) 17-07-007, this proceeding is responsible for the methodological development of the ICA and the publication of the ICA data and maps to support the streamlining of Rule 21.

The Commission ordered the IOUs to update their publicly posted ICA data monthly. On October 9, 2020, California Solar & Storage Association, Interstate Renewable Energy Council, Inc., and California Energy Storage Alliance (hereinafter Joint Parties) filed their Motion for an Order Requiring Refinements to the Integration Capacity Analysis (Motion), in which Joint Parties asked the Commission to order the IOUs to refine the ICA in order

to “avoid the undetected presence of problems with ICA results in the future” by issuing 13 orders.

On October 26, 2020, California Public Utilities Commission (Cal Advocates) filed its Response which supported the Motion. On November 5, 2020, Joint Parties filed their Reply in support of their Motion. On November 5, 2020, PG&E filed its Reply to Cal Advocates’ Response.

The Ruling grouped Parties’ 13 requests into three categories: 1) ICA Data Validation Refinements, 2) Continuing Improvements to the DRP Data Portals, and 3) Compliance issues. The Ruling further stated that while the IOUs have shown that they are currently in compliance with current data validation plan requirements and are proactively engaged in improving the ICA and willing to work with stakeholders to improve their ICA, this Ruling believes that the best way to improve the reliability of the ICA data for the core use case of streamlining Rule 21 interconnection is through independent validation to establish confidence in the reliability of the ICA data.

Attachment

In compliance with D.17-09-029, PG&E has attached the following:

Attachment 1: PG&E ICA Data Validation Plan

The submittal would not increase any current rate or charge, cause the withdrawal of service, or conflict with any rate schedule or rule.

Protests

*****Due to the COVID-19 pandemic, PG&E is currently unable to receive protests or comments to this advice letter via U.S. mail or fax. Please submit protests or comments to this advice letter to EDTariffUnit@cpuc.ca.gov and PGETariffs@pge.com*****

Anyone wishing to protest this submittal may do so by letter sent via U.S. mail, facsimile or E-mail, no later than **June 17**, **2021,** which is 20 days after the date of this submittal. Protests must be submitted to:

CPUC Energy Division
ED Tariff Unit
505 Van Ness Avenue, 4th Floor
San Francisco, California 94102

Facsimile: (415) 703-2200
E-mail: EDTariffUnit@cpuc.ca.gov

Copies of protests also should be mailed to the attention of the Director, Energy Division, Room 4004, at the address shown above.

The protest shall also be sent to PG&E either via E-mail or U.S. mail (and by facsimile, if possible) at the address shown below on the same date it is mailed or delivered to the Commission:

Sidney Dietz
Director, Regulatory Relations
c/o Megan Lawson
Pacific Gas and Electric Company
77 Beale Street, Mail Code B13U
P.O. Box 770000
San Francisco, California 94177

Facsimile: (415) 973-3582
E-mail: PGETariffs@pge.com

Any person (including individuals, groups, or organizations) may protest or respond to an advice letter (General Order 96-B, Section 7.4). The protest shall contain the following information: specification of the advice letter protested; grounds for the protest; supporting factual information or legal argument; name, telephone number, postal address, and (where appropriate) e-mail address of the protestant; and statement that the protest was sent to the utility no later than the day on which the protest was submitted to the reviewing Industry Division (General Order 96-B, Section 3.11).

Effective Date

PG&E requests that this **Tier 1** advice submittal become effective upon date of submittal, which is **May 28, 2021.**

Notice

In accordance with General Order 96-B, Section IV, a copy of this advice letter is being sent electronically and via U.S. mail to parties shown on the attached list. Address changes to the General Order 96-B service list should be directed to PG&E at email address PGETariffs@pge.com. For changes to any other service list, please contact the Commission's Process Office at (415) 703-2021 or at Process_Office@cpuc.ca.gov. Send all electronic approvals to PGETariffs@pge.com. Advice letter submittals can also be accessed electronically at: http://www.pge.com/tariffs/.

/S/
Sidney Dietz
Director, Regulatory Relations

Attachments

cc: Service List R.14-08-013

California Public Utilities Commission

ADVICE LETTER SUMMARY

ENERGY UTILITY

MUST BE COMPLETED BY UTILITY (Attach additional pages as needed)

Company name/CPUC Utility No.: Pacific Gas and Electric Company (U 39 E)

Utility type:
☑ ELC ☐ GAS ☐ WATER
☐ PLC ☐ HEAT

Contact Person: Stuart Rubio
Phone #: (415) 973-4587
E-mail: PGETariffs@pge.com
E-mail Disposition Notice to: SHR8@pge.com

EXPLANATION OF UTILITY TYPE
ELC = Electric GAS = Gas WATER = Water
PLC = Pipeline HEAT = Heat

(Date Submitted / Received Stamp by CPUC)

Advice Letter (AL) #: 6212-E

Tier Designation: 1

Subject of AL: PG&E Improved ICA Data Validation Plan

Keywords (choose from CPUC listing): Compliance

AL Type: ☐ Monthly ☐ Quarterly ☐ Annual ☑ One-Time ☐ Other:

If AL submitted in compliance with a Commission order, indicate relevant Decision/Resolution #: D.17-09-026

Does AL replace a withdrawn or rejected AL? If so, identify the prior AL: No

Summarize differences between the AL and the prior withdrawn or rejected AL: N/A

Confidential treatment requested? ☐ Yes ☑ No

If yes, specification of confidential information:
Confidential information will be made available to appropriate parties who execute a nondisclosure agreement. Name and contact information to request nondisclosure agreement/ access to confidential information:

Resolution required? ☐ Yes ☑ No

Requested effective date: 5/28/21

No. of tariff sheets: N/A

Estimated system annual revenue effect (%): N/A

Estimated system average rate effect (%): N/A

When rates are affected by AL, include attachment in AL showing average rate effects on customer classes (residential, small commercial, large C/I, agricultural, lighting).

Tariff schedules affected: N/A

Service affected and changes proposed[1]: N/A

Pending advice letters that revise the same tariff sheets: N/A

[1]Discuss in AL if more space is needed.

Clear Form

Protests and all other correspondence regarding this AL are due no later than 20 days after the date of this submittal, unless otherwise authorized by the Commission, and shall be sent to:

CPUC, Energy Division
Attention: Tariff Unit
505 Van Ness Avenue
San Francisco, CA 94102
Email: EDTariffUnit@cpuc.ca.gov

Name: Sidney Dietz, c/o Megan Lawson
Title: Director, Regulatory Relations
Utility Name: Pacific Gas and Electric Company
Address: 77 Beale Street, Mail Code B13U
City: San Francisco, CA 94177
State: California Zip: 94177
Telephone (xxx) xxx-xxxx: (415)973-2093
Facsimile (xxx) xxx-xxxx: (415)973-3582
Email: PGETariffs@pge.com

Name:
Title:
Utility Name:
Address:
City:
State: District of Columbia Zip:
Telephone (xxx) xxx-xxxx:
Facsimile (xxx) xxx-xxxx:
Email:

Clear Form

Advice 6212-E
May 28, 2021

Attachment 1

PG&E ICA Data Validation Plan

Contents

Integration Capacity Analysis (ICA) Process and Data Validation Plan

Executive Summary

Integration Capacity Analysis (ICA) is an automated analysis to determine how much load and generation the distribution system can host without making any modifications. The primary method for PG&E to manage ICA data quality control is through GridUnity's Grid Model Management (GMM). The GMM software is a platform that provides processes for managing circuit quality, via automation, dashboards, and manage-by-exception features that offer PG&E the ability to address data issues before systematically initiating ICA for each circuit. GMM with ICA is hosted in the GridUnity AWS cloud – engineers and administrators can register and use the system using only a browser.

Methodology

The flow of data from queued generation, LoadSEER, PG&E Electric Distribution GIS Application (EDGIS), and CYME is shown in Fig. 1. Thermal, voltage, protection, and reverse power flow will be checked in different stages of the process after each power flow run. PG&E's current distribution system modeling approach does not allow for some analyses to be performed within ICA stage. For example, limits on banks are performed within post-processing. The limits for node, line section, and feeders are applied within CYME. The entire process will be repeated for 576 hours (see Fig. 2), that represents 24 hours, 12 months, and maximum (90th percentile) and minimum (10th percentile) load.

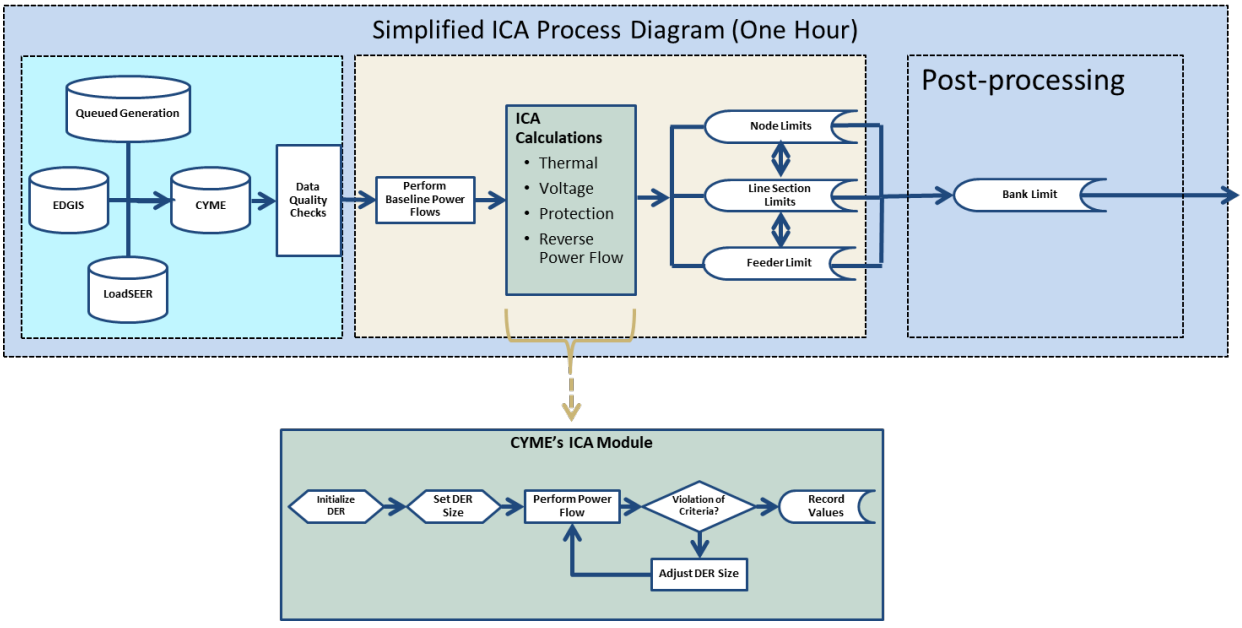

Figure 1: The ICA data flow process for 1 hour

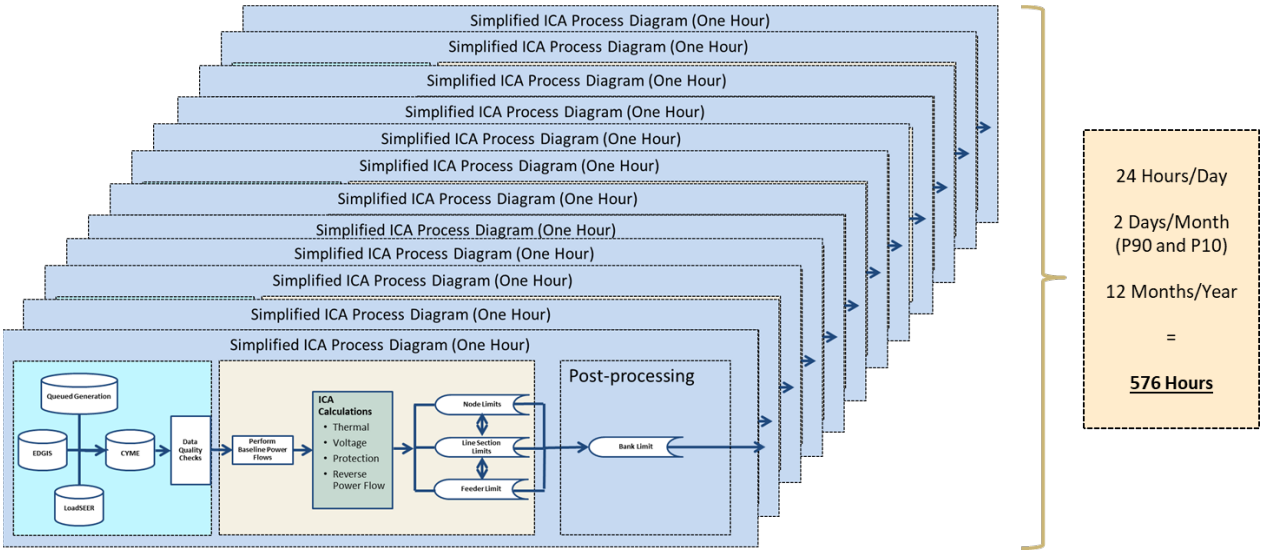

Figure 2: The ICA process runs for 576 intervals

ICA calculations are performed with CYME. For uniform load ICA, the calculations check for loading, voltage variation, and steady-state voltage violations and runs for all 576 hours. For generation ICA, loading, voltage variation, steady-state voltage, breaker/recloser reverse power flow, and protection are checked. This also runs for all 576 hours.

PG&E's current platform consists of 23 AWS servers with 18 cores (3GHz) processors each, that perform iterative ICA calculations. The platform is supporting ICA calculation of approximately 15% of PG&E circuits, on average, each month.

ICA Process, Monthly Updates, and Data Quality Checks

The ICA results on the public data portal are updated every month based on recent network models, load information, queued generation information, and device settings. The process for monthly network refresh and publication is shown in Fig. 3.

The most recent network models from CYME database, queued generation, and load data will be imported the 1st business day of each month (study cycle). The "network refresh" and "study trigger" process will be then initiated. The "network refresh" is the process of importing new load data, queued generation, network models, device settings, etc. from different databases to GMM for the new study cycle. The "study trigger" is the process that identifies which circuits need to be rerun based on the set thresholds on network topology changes, generation changes, load changes, device setting changes, etc.

The circuits that meet the triggering criteria due to network topology, device settings, load, and generation changes will start running. In the "Exception Review" stage most of data quality checks will be performed. If data quality issues exist for a specific circuit, the ICA process for that circuit will fail. Engineers will review the failed circuits and correct the models and data and rerun the circuits for successful completion. The publication process in GMM will be executed on the last business day of the month. The results will be post-processed to check for quality and the publishable public data will be

extracted. The final data will be published within the first 7 business day of the following month. The flow of data for publication is depicted in Fig. 4.

There are multiple processing routines within GMM; however, they can be summarized into five main stages (see Fig. 5). The stages are described in the next section. The circuit can fail in any of the stages based on data quality and power flow checks. Some of the checks are designed to capture pre-existing conditions in early stages of the process. Grid Model Management platform enables a more streamlined approach to identifying potential false positives and potential false negatives in ICA process to validate the results.

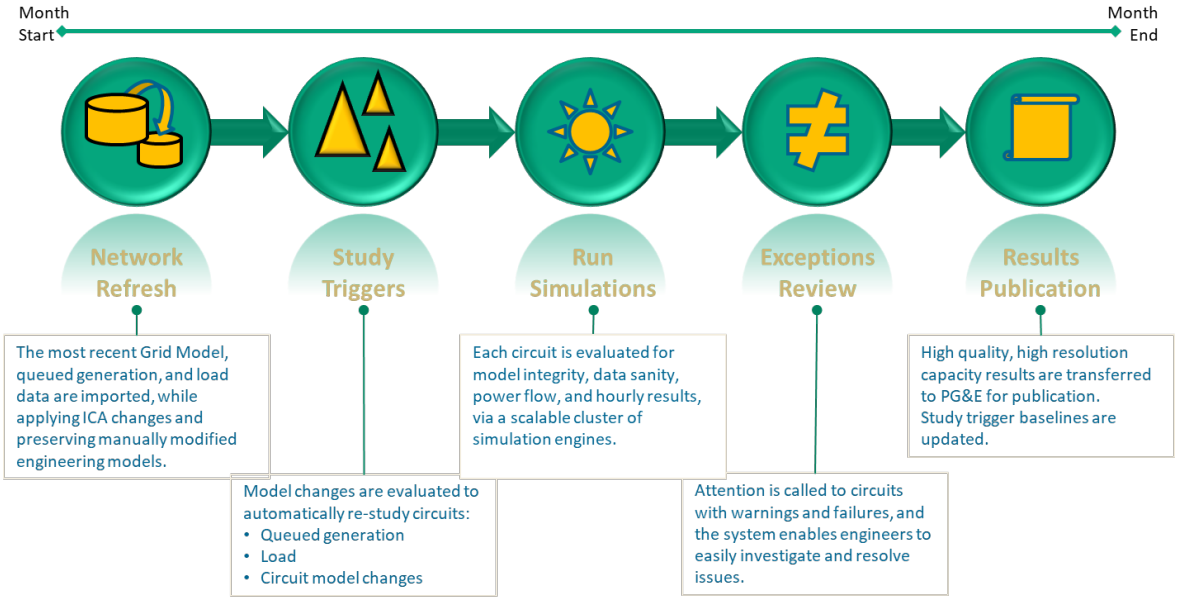

Figure 3: Monthly ICA publication process implemented in GMM

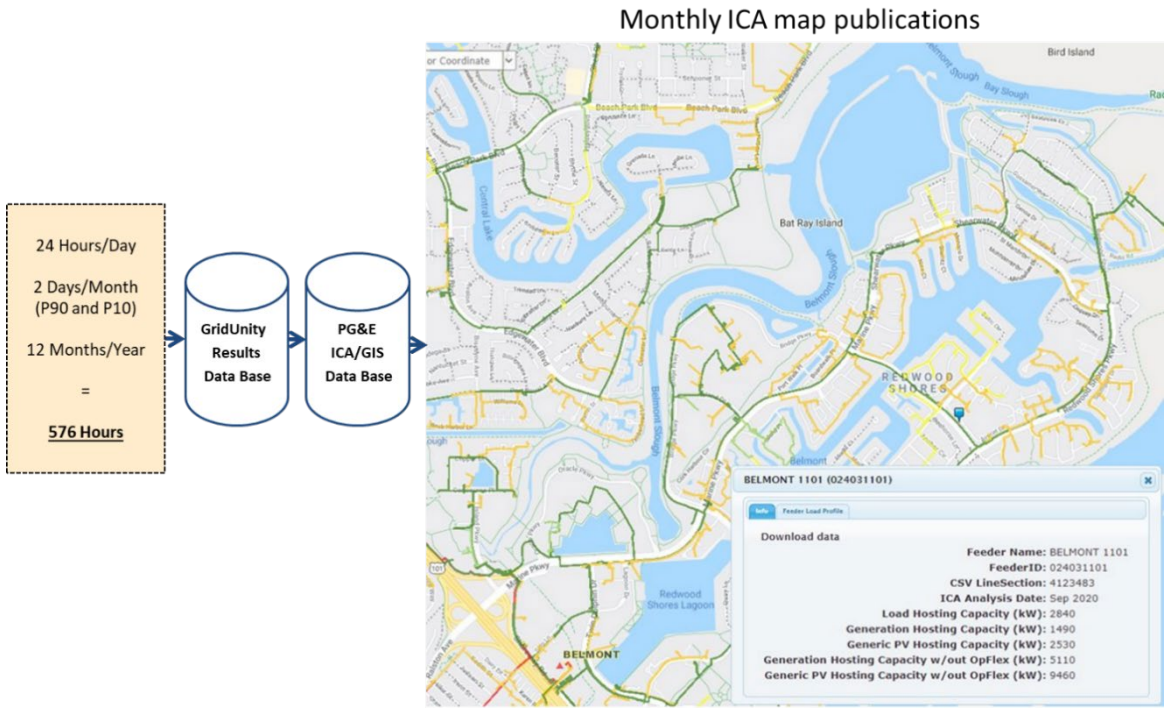

Figure 4: Flow of data for publication to the public maps

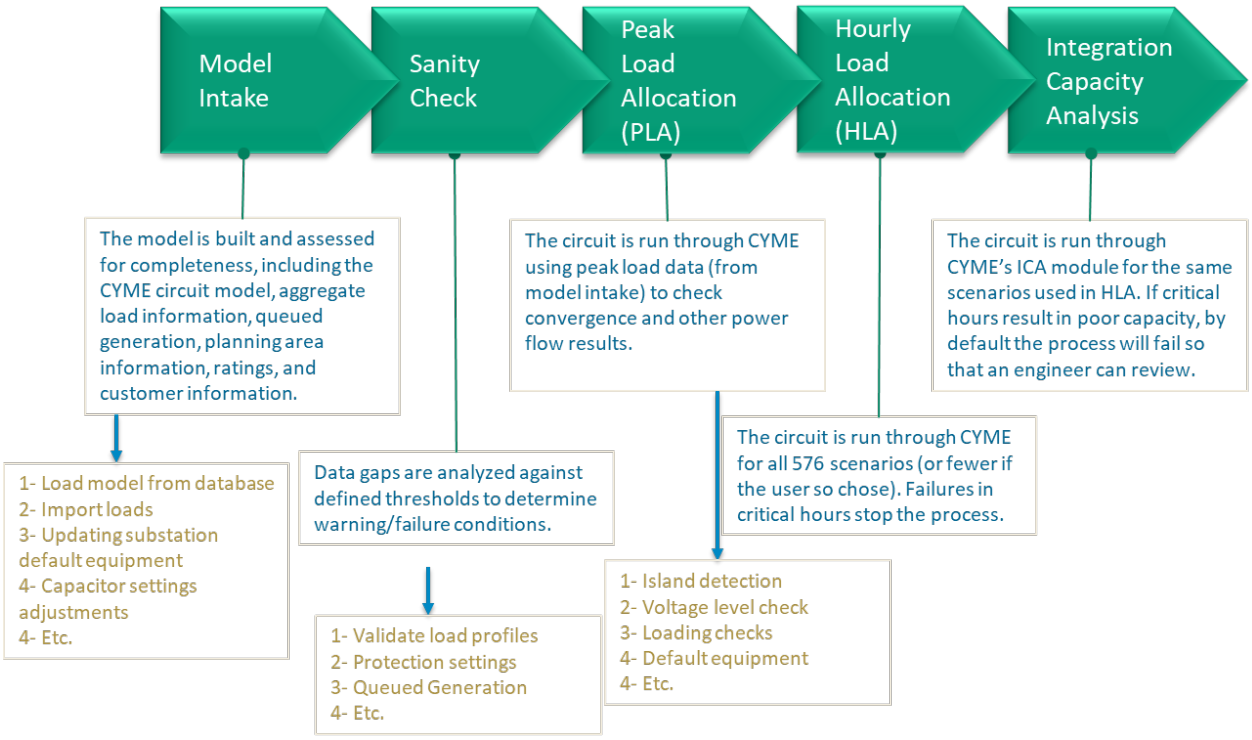

Figure 5: GMM steps: Data ingestion (Model Intake), data quality checks (Sanity Check, PLA, HLA), and ICA calculations.

Model Intake

This stage ingests PG&E's distribution model and automatically performs routine model-handling updates to prepare a circuit specifically for ICA. In this stage following steps are performed:

1- Update Substation Data for Equipment with Default Settings:

The substation equipment with default setting, e.g switches, breakers, cables, regulators, and Potential Transformers (PTs) need to be updated so that not to limit ICA results. This can be performed for ICA as bank capability limits are checked in post-processing.

2- Modeling Substation Regulator and Load Tap Changer (LTC) Output

PG&E's current implementation of ICA involves a concept called "LTC Slider". Bank-level loading is used to develop settings that output 122 V at minimum loading and 126 V at maximum loading. At each hour, the base-case loading level is used to specify what the output voltage is for that hour. This voltage is then used for circuit-level analysis. For most circuits, this voltage is set by changing the source voltage.

3- Modeling Circuit Capability

In this step, a switch is added on the first line section, that has a rating equivalent to the circuit capability. This allows circuit capabilities to be evaluated within the CYME application rather than through post processing.

4- Modeling Line Regulators

To improve power-flow convergence, the open-delta regulators are changed to closed-delta in this stage by adding a third regulator.

5- Modeling Auto-boosters

All auto-boosters will be bypassed.

6- Modeling Capacitors

In this stage, capacitor settings are adjusted to account for summer and winter settings. Temperature controlled capacitors are modified as ICA does not currently model ambient temperature.

7- Modeling Reclosers

In load flow, consistent with planning guidelines, reclosers will have a planning limit of 83% (1/1.2) of the phase minimum-to-trip settings.

8- Modeling Existing and Queued Generation

GMM connects pending interconnection applications at the proposed location in each circuit model.

9- Modeling Loads

PG&E imports bank and feeder load profiles from LoadSEER API. Individual customer AMI profiles are brought directly into the CYME model using CYME's dynamic data plugin (DDP).

Sanity Check

This stage performs situation-based model corrections, automating existing manual processes, and flagging to engineers any corrections that cannot be addressed through the process. After model intake is complete, various sanity checks will be performed on the model to confirm it can proceed to Load Allocation (see Table 1).

Table 1 - Sanity Checks

Name	Functionality
Validate Customer Matching	Checks the existence of load data for customers.
Validate Pre-Existing Overload	Checks pre-existing bank or feeder overload.
Validate Queued Generation	Checks if node ID in the queued generation match node ID in the model.
Protection Settings	Checks the validity of protective device Settings.

Peak Load Allocation (PLA)

Peak Load Allocation checks for modeling errors identified after a peak load flow is performed. The ICA platform checks for the modeling errors in this stage. Table 2 describes the checks performed in this stage.

Hourly Load Allocation (HLA)

Hourly Load Allocation performs time- and power flow-dependent steps for all 576 hours. The ICA platform checks for the modeling errors for all hours in this stage. Table 2 describes the checks performed in this stage.

Table 2 - Checks Performed in Peak Load Allocation and Hourly Load Allocation

Name	Perform check in?		Functionality
	Peak	Hourly	
Island Detection	Yes	No	Identifies circuit sections which are not connected to the rest of the circuit.
Voltage Level Check	Yes	Yes	Checks for over-voltage or under-voltage higher/lower than a certain threshold
Voltage Base Check	Yes	No	Compares voltage base with PG&E valid voltage levels.
Loading Check	Yes	Yes	Checks for device overload.
Equipment with Default Settings	Yes	No	Checks if transformers, reactors, protective devices, capacitors, or line-sections are not default.
Short Circuit Check	Yes	No	Checks the validity of short circuit duty for all the nodes.
Minimum Fault Check	Yes	No	Checks if the minimum fault analysis is performed successfully and the fault summary report is valid.
Circuit kvar Check	Yes	No	Logs feeder kvar at peak and minimum feeder loading.
Aggregate Load kW Check	Yes	Yes	Checks the discrepancy between aggregate load profile to CYME circuit level loading.

Process Status

The circuit can obtain different status when processing through different stages. There are five major process status as follows:

1- **"Completed"** indicates that the circuit has successfully passed the stage.
2- **"Failed"** indicates that a problem occurred that was serious enough to stop the workflow from processing any further.
3- **"Completed with Error"** is a warning and is a status that indicates an engineer should review the circuit workflow results, but it is less urgent than failures.
4- **"Stopped"** is used when a user chooses to stop a circuit before it gets to certain stage (e.g., stop before running ICA.)
5- An **"In Progress"** circuit indicates an actively running workflow.

As shown in Fig. 5, data will be checked in each stage for different conditions. For each condition a status will be generated. The statuses roll up – e.g., if any action fails, the stage will be failed, as will the overall circuit status. This is also true for "Completed with Errors". The worst status wins – if one action fails and another completes with errors, the stage will be Failed.

Failed Circuits and Engineering Intervention

Throughout the planned process, circuits may fail in different stages due to data quality issues. Within a stage, multiple actions might fail but the process will continue to finish the stage, such that the engineer can see the range of issues to be addressed within that stage. The failure will appear with a description and a remediation message. Distribution engineers will be assigned to failed circuits to review the issue and provide recommendations on how to resolve any data quality issues from the source (see Fig. 6). For example, this may include, but not limited to, finding appropriate data for any equipment with default settings from single-line diagrams or equipment nameplate, or correction of information in EDGIS. Following are the steps that an engineer may take to address the issue:

- Review failure on "circuit details" page in GMM,
- Download the models for different scenarios,
- Work on CYME models on local computer and find out the issue,
- Correct the CYME model,
- Upload the self-contained file into GMM,
- Rerun the workflow,
- Resolve the identified issue at the source, e.g. send a mapping request to correct information in EDGIS.

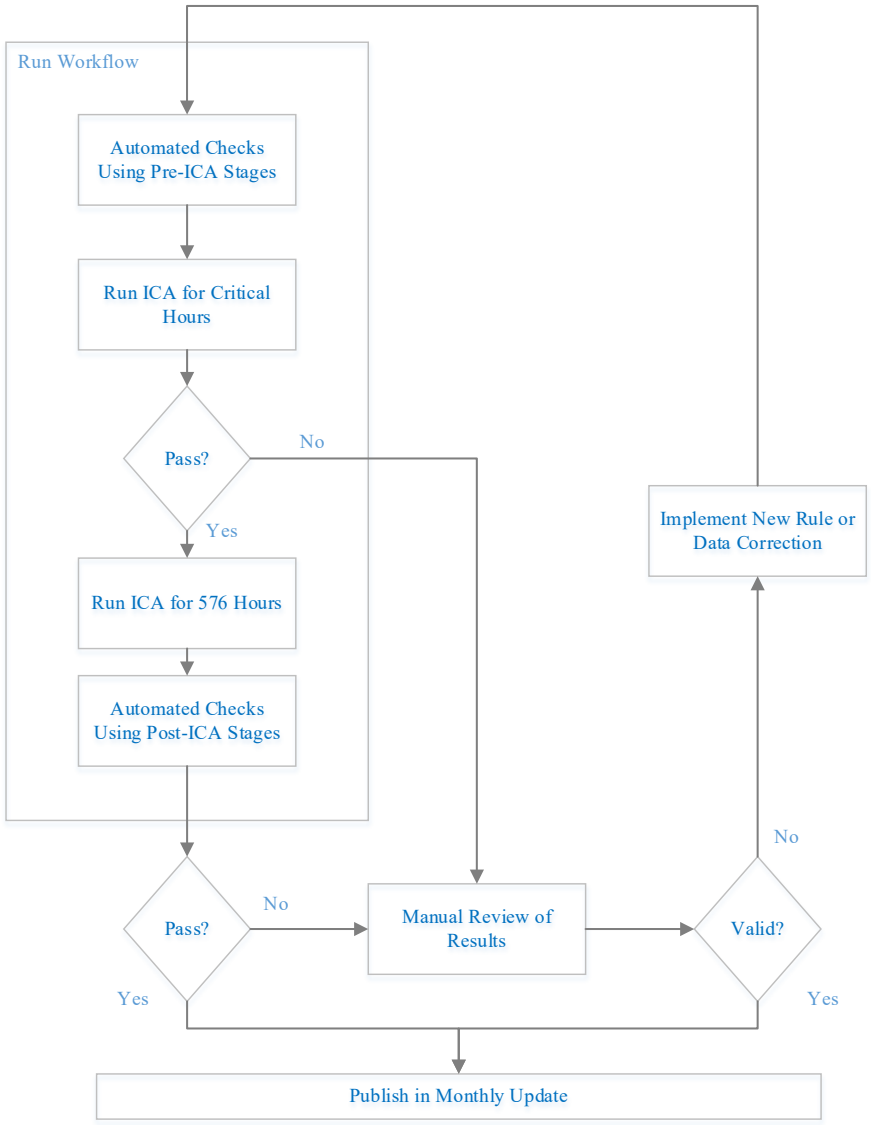

Figure 6: Process flow, data quality checks, and engineering intervention

Quality Control Efficiency Via a Smaller Set of Data

To reduce the computational effort for circuits that have major data quality problem, ICA workflows will be performed for a smaller set of hours in ICA stage, referred to as "critical hours." Developing the quality checks around a smaller set of hours allows for a shorter development cycle where data corrections, new rules, and new processes can be quickly tested by running only a fraction of the 576 hours that are ultimately required for publication. This also allows an engineer to test their fixes quickly and stop in ICA if a circuit needs to be reviewed.

Critical hours are defined as:

- Summer peak, summer minimum, winter peak, winter minimum (where winter months include January, February, March, November, and December).
- Summer daytime peak, summer daytime minimum, winter daytime peak, winter daytime minimum (where daytime starts at 10 AM and ends at 4 PM).

The process will not differentiate between “High Load” and ”Low Load”. Therefore, if hour 08_20 is identified as a peak hour, both “High Load” and “Low Load” scenarios will be studied. In that case, the circuit profile will have 16 critical hours. However, in some cases, daytime peak and all-day peak might coincide. As a result, the number of critical hours will be reduced accordingly.

In the planned process, after the critical hours workflows are performed, results are automatically checked for zero ICA values. This check is performed on all line section ICA values for critical hours. If more than 50% of Gen or Load ICA results are zeros, the check will fail. In this case, engineering review is required. If a change is implemented by the assigned engineer, the workflow will be repeated for the circuit. If the check for zero ICA values passes, a workflow will be automatically performed on all 576 power-flow runs.

For all the critical hours if both generation and load ICA results are available, the feeder is publishable. For a circuit to be publishable all configurations must have complete runs for all critical hours. If a feeder is publishable, the CSV file is generated with the available results.

If “critical hours” are not available (due to power-flow divergence), the circuit will fail. Therefore, at this stage, engineering review is required.

Post-processing Before Publication on the Public Map

This section summarizes the steps PG&E takes to validate ICA data extracted from NMM calculations to the public map. It outlines the data flow from Grid Unity to PG&E and consequently promoting the data to the public map.

Grid Unity to PG&E Secure Data Transfer

In this stage, GridUnity shares AWS and ESFT links for PG&E to download the ICA data to the PG&E network drive.

ICA SQL Database Data Import, Post-Processing, and Data Validation

PG&E Data Analysts (IT) import data from GU to SQL server, create database back up on PG&E network drive, and work with Database Administrator (DBA) to create new database. In this stage the Data Analysts perform data correction on GridUnity batch. Following major steps are taken:

- Check hours runs count (576 intervals)
- Compare records count in different tables
- Check for duplicate records in final output map
- Check for duplicate records in network section table
- Check for numeric data for threshold limits for (thermal, voltage, protection, safety)
- Check for Null nodes in final output map

- Validate analysis date on final output map
- Check substation data information for valid values
- Check redact flags for substation information
- Take back up of key publication tables, delete rows in the original database tables for which new results are available, and insert new results
- Check bank numbers on some of the feeders
- After main dataset is validated and completed, delete records from original table
- PG&E ICA Product Manager validates CSV data using Python scripts confirming all information is within acceptable range for publication and redaction flags are properly set.

Data Transfer from ICA SQL Database to ICA GIS Oracle Database

PG&E ICA Product Manager sends notice to GIS Application Engineer to refresh the "test map" with new data. GIS Application Engineer extracts distribution line data from EDGIS using ETL (extract, transform, load) scripts. GIS Application Engineer combines EDGIS and ICA to test map using a python script. GIS Application Engineer sends notice to PG&E ICA Product Manager to validate the test map.

Publication on the Test Map and Validation

PG&E ICA Product Manager validates data on test map in terms of ICA current and historical data pop-up display, coloring, redaction, feeder-level data display and coloring, and basic map features. PG&E ICA Product Manager creates and updates validation spreadsheet for tracking progress, including results from Python script, database counts, and feeder redaction comparison results from DIDF redaction lists.

Publication on the Public Map and Validation

PG&E ICA Product Manager sends notice to GIS Application Engineer to refresh production (public) map with new data and extract data to zipped Geodatabase (GDB) file for upload to the map. PG&E ICA Product Manager asks PG&E Data Analyst to upload GDB to ESFT, which automatically pushes to the public site. PG&E ICA Product Manager validates CSVs by downloading multiple files and ensuring that the file date matched the file from GridUnity and the values are appropriate for those displayed on the map. PG&E ICA Product Manager validates spatial data download works and verifies date and file size. PG&E ICA Product Manager validates data on production map. PG&E ICA Product Manager checks both refreshed and previous cycle ICA pop-up data, color coding, and redacted circuits. In addition, the PG&E ICA Product Manager checks feeder level data display features and color coding, and the functionality of the basic map features.

ICA Ownership

To ensure that there is long-term improvement in the ICA results, PG&E has assigned a Business Owner (BO) responsible for ICA activities and results. The BO manages the finance, contracts, internal and external meetings, collaborates with all parties, and insures proper documentation and communications. The BO collaborates with all internal and external stakeholders according to the RACI chart of Table 3.

Table 3. PG&E ICA RACI Chart

Task	PG&E			GridUnity		
	BO	**Eng./PM**	**IT**	**PM**	**IT**	**Eng.**
Manage resources for data validation	R, A	R	C	C	N/A	I
Establish long-term strategy to maintain output data quality	R, A	R	C	C, I	N/A	N/A
Establish performance targets and metrics for ICA results	R, A	R	C	C	N/A	N/A
Support data extracts	A	N/A	R	I	I	N/A
Import data into GU System	I	N/A	N/A	A	R	N/A
Support GMM/ICA platform issues (potential software defects)	I	C	I	A	R	R
Maintain NMM/ICA platform (upgrades)	I	I	I	A	R	C
Provide Operational Reviews	I	I	I	R, A	C	C
Initiate model refresh	R, A	I	N/A	I	N/A	N/A
Create publication batches	R, A	I, C	N/A	I	N/A	N/A
Address circuit failures and warnings (Team of ~20 distribution engineers)	I	R, A	N/A	N/A	N/A	N/A
Circuit warnings related to platform issues	I	I	N/A	A	R	C
Model Exchange	N/A	R, A	N/A	N/A	N/A	N/A
Maintain Data Lists	R, A	I	N/A	N/A	N/A	N/A
Bulk Run Circuits	R, I	R, I	N/A	I	N/A	N/A
Monitor the platform	I	N/A	I	A	R	C
Review circuit exceptions	I	R	I	I, C	N/A	N/A
Report system issues	R, A	R	N/A	I, C	I	I
Address system issues and circuit exceptions	I	I	N/A	A	R	R
Retrieve publication data from ESFT site	A	N/A	R	I	C	N/A

Publication on map and validation	I	R, A	R	N/A	N/A	N/A
Data validation and post-processing	A	R	R	C	N/A	N/A
Finance, contracts, deliverables, data requests, workshops, milestones, documentation	A, R	R	N/A	N/A	N/A	N/A
Tracking of identified needs for improvements through implementation	A, R	R	N/A	C	I	I
Regular spot-checking ICA results	A	R	R	C	N/A	C

PG&E distribution engineers meet weekly to discuss their findings and establish the best approaches to address data issues. GridUnity (GU) and PG&E hold weekly status updates every week, where IT engineers, senior distribution engineers, and BO meet with GU project managers and engineers to discuss issues, project milestones, modifications, and status. The highlights discussed in the distribution engineering weekly meetings will be shared with GU team and resolutions will be communicated to the engineering team accordingly.

Results of PG&E Data Validation Efforts to Date

PG&E has an ongoing effort to improve the quality of its system data. Fig. 7 compares the distribution of the published results for ICA uniform load for the entire network in PG&E service territory, which demonstrates continuous improvements of the results due to reduction of data quality issues.

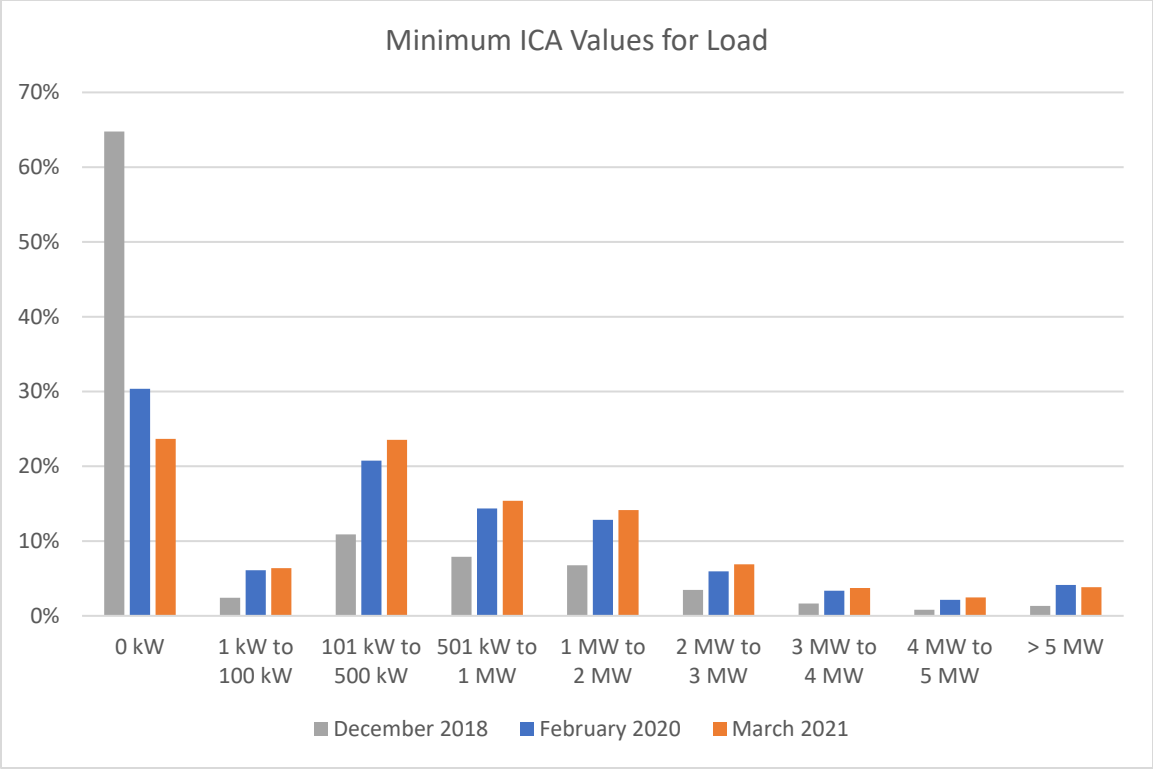

Figure 7: Distribution of Uniform Load ICA Results, demonstrating continuous improvement of the PG&E ICA data quality

Improvements Realized in ICA Implementation

Potential reasons for the increase in hosting capacity shown in Fig. 7 are: (1) using GridUnity's Grid Model Management (GMM) for PG&E's ICA, (2) enhancements to CYME's ICA algorithm, (3) updates to PG&E's Electric Distribution GIS (EDGIS) where possible (4) Improvements to load data:

Improvements to GridUnity's Grid Model Management (GMM)

Examples of how GMM has been used include but are not limited to:

- Equipment Modification – PG&E has identified system-wide rules for GMM to execute to prepare a model for the specific use case of ICA. For example, modifying substation equipment to account for equipment with default settings limiting ICA.
- Settings Modification – Modifying capacitor settings in summer and winter months.
- Misplaced loads/generation or incorrect load/generation information
- Failure and Warning Triggers – Establishing failure and warning triggers before the computationally-intensive ICA calculations are executed, for situations such as:
    - Equipment with default settings
    - Loading violations
    - Voltage violations
- Enhanced Convergence Strategies – PG&E has developed different levels of load flow settings to implement when a solution set is not complete. The first iteration of this strategy involves modifying the way regulators and capacitors are operated when a solution does not complete.

- Different Types of ICA Runs – GMM allows PG&E to run ICA for only a select number of hours (single hours and critical hours) without having to perform a full 576-hour run. This has allowed PG&E to test and perform quality control more quickly.

Improvements to CYME's ICA Algorithm

PG&E has been working with CYME to identify enhancements to the ICA algorithm, some of which have been deployed in the CYME version currently used by GMM. These enhancements include:

- Pre-Existing Loading Conditions (Critical Path Thermal Loading) - One of the more exciting updates is the inclusion of a new ICA setting related to thermal loading. The new setting allows for the thermal loading review of only the critical path back to the source for loading violations. Previously, adding load or generation on one node might cause an unrelated device to go from 101% of its planned loading limit to 101.001% of its planned loading limit. Without the new ICA setting, an unrelated device's loading changing from 101% to 101.001% resulted in an ICA thermal limit of 0 kW. Now CYME's ICA algorithm has the option to only review the critical path back to the source for thermal loading.
- Pre-Existing Voltage and Loading Conditions – CYME has implemented some improvements to the handling of pre-existing voltage and loading conditions.
- Limiters – Improved identification of ICA limiters, allowing for PG&E to perform a more thorough quality control.
- Convergence – Improved handling of circuits that have convergence challenges.
- Capacitor Convergence – In some cases, load flow was converging too quickly and capacitors were not reaching their steady-state position. This has been updated in the latest version of CYME.
- During the ICA data cleanup and validation process, PG&E has found some CYME gateway issues that affect the ICA data. PG&E has taken this opportunity to fine tune the CYME gateway and make changes where they were appropriate. However, PG&E has also found unique equipment throughout the PG&E system that could not be handled by updating the CYME gateway logic. In those cases, PG&E has created a unique SQL script that runs after each successful gateway extraction. This SQL script adjusts the properties of these unique equipment scenarios and eliminates the need to have a manual intervention each month.

Improvements to EDGIS Updates

As a part of the QC effort, PG&E has been looking to identify system-level updates to PG&E's Electric Distribution GIS (EDGIS). These updates include but are not limited to:

- Voltage Boosters – Updating the status of fixed voltage boosters, improving the quality of ICA voltage limits.
- Elbows – Updating the rating on some elbows, improving the quality of ICA thermal limits.
- Recloser Line Sections – Updating the rating of some recloser line sections, improving the quality of ICA thermal limits.
- Capacitor and Voltage Regulator Settings – Updating the settings on some capacitors and voltage regulators, as well as updating the conversion process from EDGIS to CYME.
- Parallel overhead lines – Updating the equivalent impedance information to increase the power-flow calculation speed and convergence.

Improvements to Load Data

As a part of QC effort, PG&E has been looking to identify possible data quality issues in load data:

- The load data in certain service areas may be affected by outages or Public Safety Power Shutoff (PSPS) events. This results in zero or low load consumption readings from metering data for the period of PSPS event. The load forecasting software should filter this data in advance, to assign correct loading information to different customers. PG&E took steps to remove these data points from the circuit load profile to prevent false ICA values.
- Some special loads existed in PG&E service territory GIS data with special billing requirements, that were not historically modelled in EDGIS. To accommodate those loads in CYME models, PG&E engineers had created a method to manually enter the information in EDGIS database. After integrating these loads into LoadSEER DDP, the load information was mapped again in EDGIS. Therefore, this caused double counting of specific loads in PG&E models. This issue has been identified and corrected.
- PG&E currently uses SCADA data with EDPI software to validate the loading information for ICA.

ICA - Rule 21 Interconnection Support

There is an ongoing effort to validate the ICA results comparing the ICA values with Rule 21, Screen M for screening of new interconnection application. There has not been a conflict reported to date. The PG&E ICA platform can support the streamlining of the Rule 21 interconnection process.

Long-Term Plans for ICA Improvements

PG&E will continue to perform quality control on ICA results and anticipates future opportunities to leverage GridUnity's GMM, enhancements to CYME's ICA algorithms, and updates to PG&E's EDGIS. In cases where changes are required in the process to avoid some unknown future issue, the process will be modified accordingly. If PG&E identifies a need in the future for a new check or data handling step in PLA, HLA, ICA, etc, they could be added to the process. The following are long-term options to improve ICA process:

1- Migration from EDGIS to Powerbase for device settings. Powerbase takes the actual settings file for devices directly from the field personnel for Breakers, Line Reclosers, Regulators, and Capacitors settings at the time of installation. The software has multiple file management capabilities, e.g. who created the file, which field personnel installed it, which hardware and software version are at the device. Therefore, it eliminates manual errors. The CYME gateway will receive the data directly from Powerbase and prepare CYME models automatically based on that information. Also, Powerbase saves all the previous settings. Therefore, engineers will have access to historical settings, when any changes happen, and who made the changes. This ensures that ICA platform will have the most updated and accurate device setting data.

2- More frequent updates (Daily instead of Monthly) to "queued generation" information that GMM platform digests. This will result in more reliable ICA data.

3- More frequent updates (Weekly instead of Monthly) to CYME model imports that GMM platform digests. This will result in more reliable ICA data.

4- PG&E plans to perform system-wide statistical analysis on ICA to identify potential issues that may exist. This includes but is not limited to breaking down the hosting capacity results shown for example in Fig. 7 to different buckets based on the limiting factors (steady-state voltage, thermal, voltage variation, and safety) to identify the most liming factors and investigate the root cause if an issue is identified.

Appendix

The diagram shown in Fig. 8 demonstrates the current organizational structure to manage ICA related workstreams and the ICA ownership.

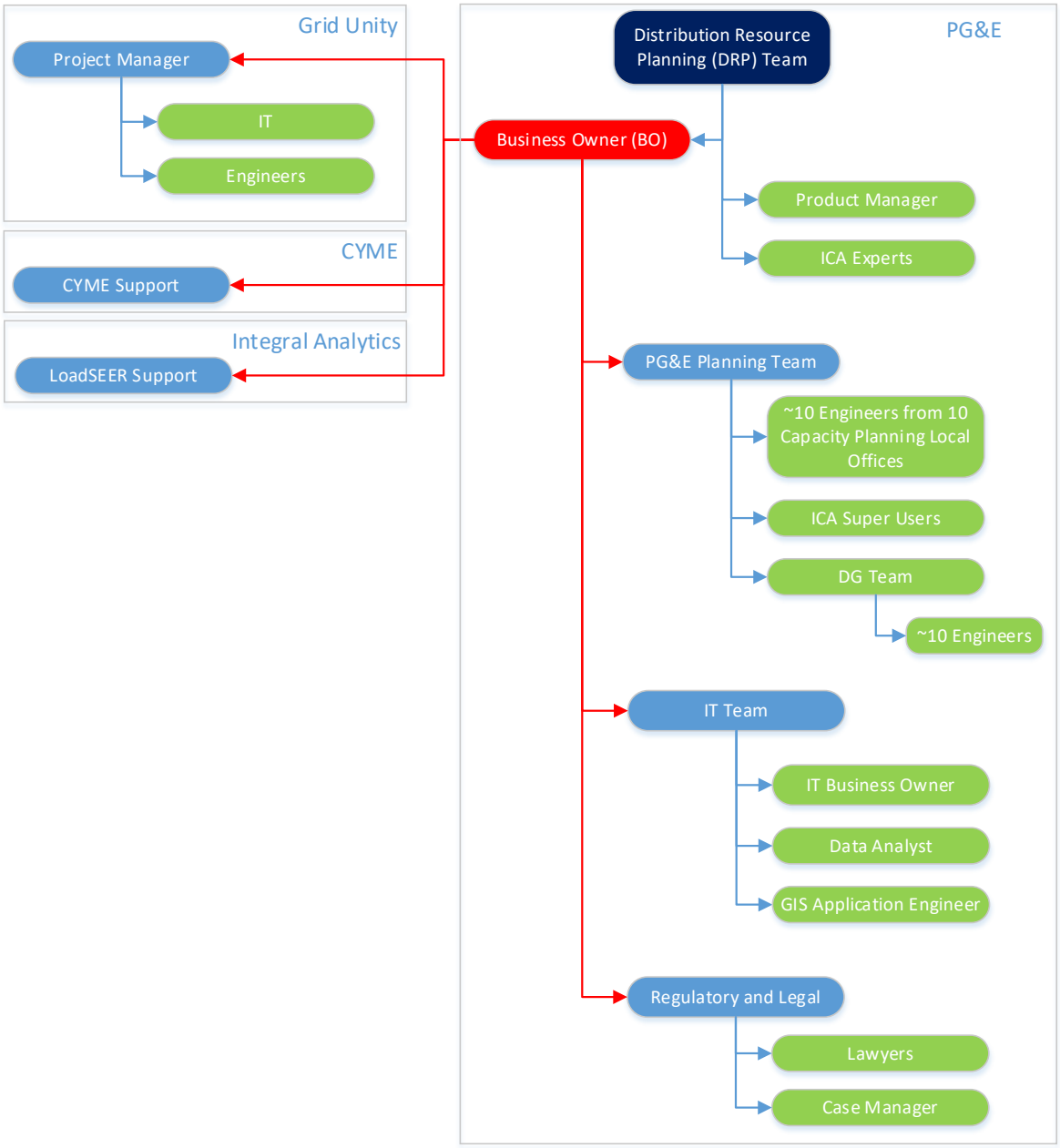

Figure 8: Integration Capacity Analysis involves teams from different departments and organizations

PG&E Gas and Electric
Advice Submittal List
General Order 96-B, Section IV

AT&T
Albion Power Company

Alta Power Group, LLC
Anderson & Poole

Atlas ReFuel
BART

Barkovich & Yap, Inc.
California Cotton Ginners & Growers Assn
California Energy Commission

California Hub for Energy Efficiency Financing

California Alternative Energy and Advanced Transportation Financing Authority
California Public Utilities Commission
Calpine

Cameron-Daniel, P.C.
Casner, Steve
Cenergy Power
Center for Biological Diversity

Chevron Pipeline and Power
City of Palo Alto

City of San Jose
Clean Power Research
Coast Economic Consulting
Commercial Energy
Crossborder Energy
Crown Road Energy, LLC
Davis Wright Tremaine LLP
Day Carter Murphy

Dept of General Services
Don Pickett & Associates, Inc.
Douglass & Liddell

East Bay Community Energy Ellison Schneider & Harris LLP Energy Management Service
Engineers and Scientists of California

GenOn Energy, Inc.
Goodin, MacBride, Squeri, Schlotz & Ritchie
Green Power Institute
Hanna & Morton
ICF
IGS Energy
International Power Technology
Intestate Gas Services, Inc.
Kelly Group
Ken Bohn Consulting
Keyes & Fox LLP
Leviton Manufacturing Co., Inc.

Los Angeles County Integrated Waste Management Task Force
MRW & Associates
Manatt Phelps Phillips
Marin Energy Authority
McKenzie & Associates

Modesto Irrigation District
NLine Energy, Inc.
NRG Solar

Office of Ratepayer Advocates
OnGrid Solar
Pacific Gas and Electric Company
Peninsula Clean Energy

Pioneer Community Energy

Redwood Coast Energy Authority
Regulatory & Cogeneration Service, Inc.
SCD Energy Solutions
San Diego Gas & Electric Company

SPURR
San Francisco Water Power and Sewer
Sempra Utilities

Sierra Telephone Company, Inc.
Southern California Edison Company
Southern California Gas Company
Spark Energy
Sun Light & Power
Sunshine Design
Tecogen, Inc.
TerraVerde Renewable Partners
Tiger Natural Gas, Inc.

TransCanada
Utility Cost Management
Utility Power Solutions
Water and Energy Consulting Wellhead Electric Company
Western Manufactured Housing Communities Association (WMA)
Yep Energy