

PUBLIC UTILITIES COMMISSION

505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298



July 25, 2023

Advice Letter 6635-E-A/E-B/E-C

Sidney Bob Dietz II
Director, Regulatory Relations
Pacific Gas and Electric Company
77 Beale Street
San Francisco, California 94177
E-mail: PGETariffs@pge.com

SUBJECT: Modifications to Electric Tariff Rule 21 to Incorporate IEEE 1547.1-2020 Test Procedures into Testing Regime for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E 5036

Dear Mr. Dietz:

Pacific Gas and Electric Company Advice Letter 6635-E-A/E-B/E-C is effective as of August 29, 2023.

Sincerely,

A handwritten signature in black ink that reads "Leuwam Tesfai".

Leuwam Tesfai
Deputy Executive Director for Energy and Climate Policy/
Director, Energy Division
California Public Utilities Commission

May 4, 2023

Advice 6635-E-C

(Pacific Gas and Electric Company ID U 39 E)

Public Utilities Commission of the State of California

Subject: Third Supplemental - Modifications to Electric Tariff Rule 21 to Incorporate IEEE 1547.1-2020 Test Procedures into Testing Regime for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E-5036

Purpose

Pacific Gas and Electric Company (PG&E) hereby submits this supplemental Tier 2 advice letter to propose additional modifications to PG&E's Electric Rule 21 (Rule 21) in furtherance of transitioning from UL1741SA to UL1741SB requirements and aligning with IEEE¹ 1547-2018 and IEEE 1547.1-2020 standards for inverter-based Generating Facilities, pursuant to California Public Utilities Commission (CPUC, or Commission) Resolutions E-5000 and E-5036.

This third supplemental advice letter supplements the original AL 6635-E and previous supplemental ALs 6635-E-A and 6635-E-B in part, proposing further revisions to Rule 21 to better align with IEEE 1547, and also to make minor corrections of typographical errors and various formatting adjustments.

This advice letter also updates the transition schedule previously proposed in PG&E's AL 6635-E, per the letter from CPUC Executive Director Rachel Peterson dated March 28, 2023 granting Southern California Edison Company (SCE)'s, PG&E's, and San Diego Gas & Electric Company (SDG&E) (collectively, "the Joint Utilities") request for extension to the requirements in Resolution E-5000 Ordering Paragraph (OP) 7.

The revised tariff sheets are listed on Attachment A and are attached hereto.

Background

PG&E submitted AL 6093-E on February 22, 2021 in compliance with Resolution E-5000 Ordering Paragraphs (OP) 6, 7, and 8, proposing tariff changes to incorporate the IEEE 1547-2018 Standards into its Electric Rule 21 tariff, *Generating Facility Interconnections*. Included in these proposed tariff changes were updates to Table

¹ Institute of Electrical and Electronics Engineers (IEEE)

Hh-4 and Figure Hh-1 to reflect the voltage values that aligned with IEEE 1547-2018, 97.0% and 103.0%, respectively.

PG&E submitted AL 6635-E² on July 1, 2022, in compliance with CPUC Resolutions E-5000³ and E-5036⁴ to incorporate into Rule 21 a transition plan from UL1741SA inverter requirements to new the UL1741SB requirements.

PG&E's AL 6635-E originally proposed a transition schedule from UL1741SA to UL1741SB certification standards for inverters, whereby the date for full transition to UL1741SB would be March 29, 2023. On March 16, 2023, SCE, on behalf of itself, PG&E, and SDG&E, respectfully requested approval of a five-month extension to the requirements in OP 7 of Resolution E-5000 that "[e]ighteen months after the publication of a nationally recognized test procedure containing [Phase 3, Function 1, Monitor Key Data], PG&E, SCE, and SDG&E shall require that the function be tested according to the prescribed procedures." CPUC Executive Director Rachel Peterson granted that request via letter on March 28, 2023, moving the deadline for full transition to UL1741SB from March 29, 2023 to August 29, 2023.

PG&E later submitted AL 6635-E-A on July 20, 2022 and AL 6635-E-B on February 24, 2023 to revise Rule 21 to further align with the other Joint Utilities' language and to make minor corrections.

CALSSA Protest

On March 16, 2023, CALSSA submitted a protest of PG&E's AL 6635-E-B (Protest), raising two issues regarding Volt/Var set points and storage ramp rate requirements.

PG&E submitted a reply to CALSSA's protest on March 23, 2023, agreeing to make the requested changes in a supplemental advice letter.

This Supplemental Advice Letter 6635-E-C

As discussed in PG&E's March 23, 2023 Reply to CALSSA's protest, PG&E proposes to revise Rule 21 as follows as noted below to further align with IEEE 1547-2018, and also to revise the proposed schedule to transition from UL1741SA to UL1741SB in accordance with the CPUC Executive Director's letter.

² PG&E Advice Letter [6635-E](#), *Modifications to Electric Tariff Rule 21 to Incorporate IEEE 1547.1-2020 Test Procedures into Testing Regime for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E5036*, submitted July 1, 2022

³ Resolution [E-5000](#) - *Resolution E-5000. Clarifies smart inverter communications requirements in response to the Petition of the California Solar & Storage Association for Modification of Resolution E-4832 and Resolutions E-4898.*

⁴ Resolution [E-5036](#) - *Resolution E-5036. Clarifies the testing requirements for smart inverter Phase 2 communications and corrects a typographical error in Resolution E-5000.*

Proposed Tariff Changes

Volt/Var Set Points

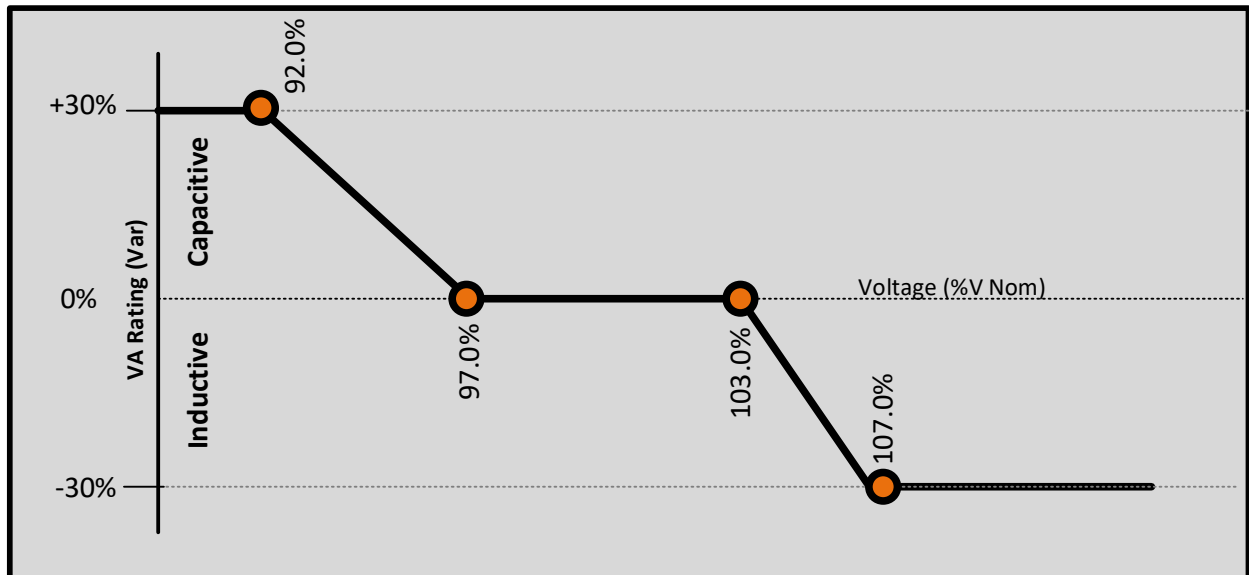
Section Hh.2.j will be revised as follows:

Table Hh-4 labeled “Voltage and Reactive Default Settings” will be revised as shown below to align with the agreed SWIG requirements:

Table Hh-4: Voltage and Reactive Default Settings

Voltage Setpoint	Voltage Value	Reactive Setpoint	Reactive Value	Operation
V1	92.0%	Q1	30%	Reactive Power Injection
V2	96.7% 97.0%	Q2	0	Unity Power Factor
V3	103.3% 103.0%	Q3	0	Unity Power Factor
V4	107.0%	Q4	30%	Reactive Power Absorption

Figure Hh-1 will be replaced with the diagram below to align with IEEE 1547-2018 requirements:



Also, Section P.2.j will be revised as follows:

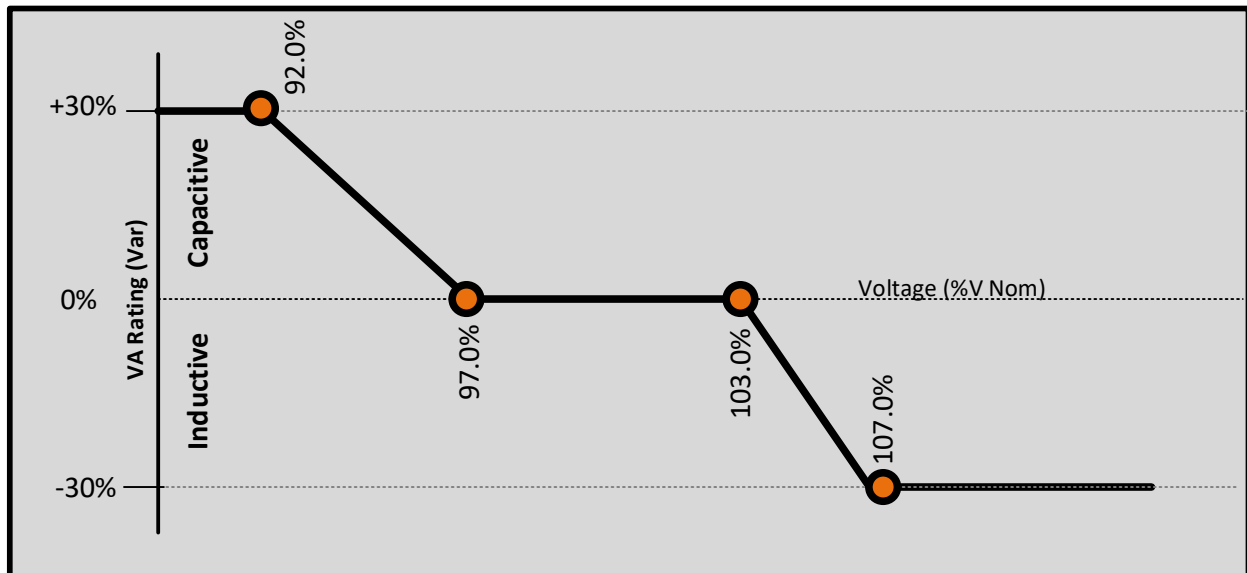
Table P-4 labeled “Voltage and Reactive Default Settings” will be revised as follows, to

- Align with the agreed SWIG requirements; and
- Correct a typographical error. PG&E noted there appear to be two different tables labeled “Table P-4” in Rule 21. For clarity, PG&E proposes to correct the numbering by relabeling the following table as “Table P-3.”

Table P-43: Voltage and Reactive Default Settings

Voltage Setpoint	Voltage Value	Reactive Setpoint	Reactive Value	Operation
V1	92.0%	Q1	30%	Reactive Power Injection
V2	96.7% 97.0%	Q2	0	Unity Power Factor
V3	103.3% 103.0%	Q3	0	Unity Power Factor
V4	107.0%	Q4	30%	Reactive Power Absorption

Figure P-1 will be replaced with the diagram below to align with IEEE 1547-2018 requirements:



Storage Ramp Rate Requirement

Table P-4 in Section P.2.o labeled “Default Activation States” will be revised as follows, to address CALSSA’s concern raised in their Protest.

- P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont’d)
 - 2. Prevention of Interference (Cont’d)
 - o. Default Activation States

Table P-4: Default Activation States

Function	State
Anti-islanding	Activated
Low/High Voltage Ride Through	Activated
Low/High Frequency Ride Through	Activated
Dynamic Volt/Var operations	Activated
Enter Service Ramp Control	Activated
Storage Inverter Normal Operation Ramp Control	Activated Deactivated*
Fixed power factor	Deactivated
Reconnect by “soft-start” methods	Activated
Frequency/Watt	Activated
Volt/Watt	Activated
Constant Reactive Power Mode	Deactivated
Set Active Power Function Mode(Optional)	Activated under mutual agreement
Dynamic Reactive Power Support Mode (Optional)	Activated under mutual agreement

* May be activated under mutual agreement. For projects where the SB storage inverter Ramp Control is activated by mutual agreement, the inverter will be tested per SA 11 normal ramp rate tests. The testing must be done by a NRTL or, if available, in accordance with PG&E’s interconnection handbook(s).

Rule 21 Section P.2.s will be revised as follows:

- P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)
2. Prevention of Interference (Cont'd)
- s. Storage Inverter Normal Operation Ramp Control Requirements

Smart Inverters used for energy storage applications ~~shall~~ **may optionally** include ramp-up rate control. The default value shall be 100% of maximum current output per second or slower if required by Applicant. Other ramp-up control settings can be used, when required, as mutually agreed by the Distribution Provider and the Applicant.

Formatting Changes and Edits to Support Corrected Table Numbering

As discussed above, PG&E updated the numbering for “Table P-4: Voltage and Reactive Default Settings” from “Table P-4” to “Table P-3.” Accordingly, PG&E is updating Section P.2.j as follows:

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

2. Prevention of Interference (Cont'd)
- j. Dynamic Volt/Var Operations

The Smart Inverter shall be capable of supporting dynamic reactive power compensation (dynamic Volt/Var operation) within the following constraints:

- The Smart Inverter shall be able to consume reactive power in response to an increase in line voltage, and produce reactive power in response to a decrease in line voltage as indicated in Table P-43.

Dynamic Volt/Var Operations Default Settings

Table P-43 and Figure P-1 depict the default setting, which should be applied for all inverter size. Specific volt/var settings may be required for larger generating facilities (such as 100 kW or greater) or for specific areas with the Distribution System as determined by the Distribution Provider.

Lastly, PG&E made some formatting changes to Sections P.6 and P.7 of our Rule 21 tariff.

Revised Proposed Transition Schedule

In accordance with the CPUC Executive Director's letter granting the Joint Utilities' request for an extension to the requirements in Resolution E-5000 Ordering Paragraph (OP) 7, PG&E proposes the following revised transition schedule:

- I. **August 1, 2022, to ~~March~~ August 28, 2023, –**
During this transition period Applicants can use either of the two options below:
 - A. Use existing Rule 21 requirements in Rule 21 Section Hh for inverters that comply with the following requirements:
 1. UL1741 and UL1741SA
 2. Attestation for Smart Inverter Phase 2 Communication requirements and Attestation for Smart Inverter Phase 3 requirements as established in Resolution E-5000 and as modified in Resolution E-5036
 - B. Use requirements as specified in Section P for Smart inverters that comply with the following requirements:
 1. UL1741 and UL174SB
 2. Attestation for Smart Inverter Phase 2 Communication requirements as established in Resolution E-5000 and as modified in Resolution E-5036⁵
- II. **April 1-August 29, 2023 -**
Following the transition period, full transition to UL1741 and 1741SB
 - A. Replace in its entirety the language in Rule 21 Section Hh with the language in Section P
 - B. Retire Section P
 - C. Use requirements as specified in Section Hh for Smart Inverters that comply with the following requirements:
 1. UL1741 and UL174SB
 2. Attestation for Smart Inverter Phase 2 Communication requirements as established in Resolution E-5000 and as modified in Resolution E-5036

No cost information is required for this advice letter.

⁵ Inverter manufacturers must continue to provide the information for CSIP certification or compatibility with a CSIP-compliant gateway as testing under UL1741SB does not account for this communication testing.

This advice letter will not increase any rate or charge, cause the withdrawal of service, or conflict with any other schedule or rule.

Protests

Pursuant to GO 96-B, General Rule 7.5.1., PG&E request to maintain the original protest and comment period designated in Advice Letter 6635-E and not reopen the protest period.

Effective Date

Pursuant to General Order (GO) 96-B, Rule 5.2, this advice letter is submitted with a Tier 2 designation. PG&E requests that this Tier 2 advice submittal become effective on regular notice on August 1, 2022, which was the proposed start date of the first phase of the proposed transition schedule described in Advice Letters 6635-E and 6635-E-A.

Notice

In accordance with General Order 96-B, Section IV, a copy of this advice letter is being sent electronically to parties shown on the attached list and the parties on the service list for R.17-07-007, R. 11-09-011. 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 Bob Dietz II
Director, Regulatory Relations

Attachments:

Attachment A: Tariff Sheets
Attachment B: Redline Tariff Revisions

cc: Service List R.17-07-007, R.11-09-011



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 (ID U39 E)

Utility type:

- ELC GAS WATER
 PLC HEAT

Contact Person: Kimberly Loo

Phone #: (415)973-4587

E-mail: PGETariffs@pge.com

E-mail Disposition Notice to: KELM@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) #: 6635-E-C

Tier Designation: 2

Subject of AL: Third Supplemental: Modifications to Electric Tariff Rule 21 to Incorporate IEEE 1547.1-2020 Test Procedures into Testing Regime for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E 5036

Keywords (choose from CPUC listing): Compliance, Rule 21

AL Type: Monthly Quarterly Annual One-Time Other:

If AL submitted in compliance with a Commission order, indicate relevant Decision/Resolution #: Resolutions E-5000 and E-5036

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:

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: 8/1/22

No. of tariff sheets: 11

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: See Attachment 1

Service affected and changes proposed¹: N/A

Pending advice letters that revise the same tariff sheets: 6635-E-A, 6635-E-B

¹Discuss in AL if more space is needed.

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

California Public Utilities Commission
Energy Division Tariff Unit Email:
EDTariffUnit@cpuc.ca.gov

Contact Name: Sidnev Bob Dietz II. c/o Megan Lawson
Title: Director, Regulatory Relations
Utility/Entity Name: Pacific Gas and Electric Company

Telephone (xxx) xxx-xxxx:
Facsimile (xxx) xxx-xxxx:
Email: PGETariffs@pge.com

Contact Name:
Title:
Utility/Entity Name:

Telephone (xxx) xxx-xxxx:
Facsimile (xxx) xxx-xxxx:
Email:

CPUC
Energy Division Tariff Unit
505 Van Ness Avenue
San Francisco, CA 94102

Clear Form

Cal P.U.C. Sheet No.	Title of Sheet	Cancelling Cal P.U.C. Sheet No.
55881-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 206	54305-E
55882-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 297	
55883-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 298	
55884-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 302	
55885-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 304	
55886-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 311	
55887-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 312	
55888-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 313	
55889-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 314	
55890-E	ELECTRIC TABLE OF CONTENTS Sheet 1	55879-E
55891-E	ELECTRIC TABLE OF CONTENTS Sheet 20	55537-E



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)

2. PREVENTION OF INTERFERENCE (Cont'd.)

j. Dynamic Volt/VAR Operations (Cont'd.)

Dynamic Volt/Var Operations Default Settings

Table Hh-4 and Figure Hh-1 depict the default settings, which should be applied for all inverter sizes. Specific volt/var settings may be required for larger Generating Facilities (such as 100 kw or greater), or for specific areas with the Distribution Systems as determined by the Distribution Provider.

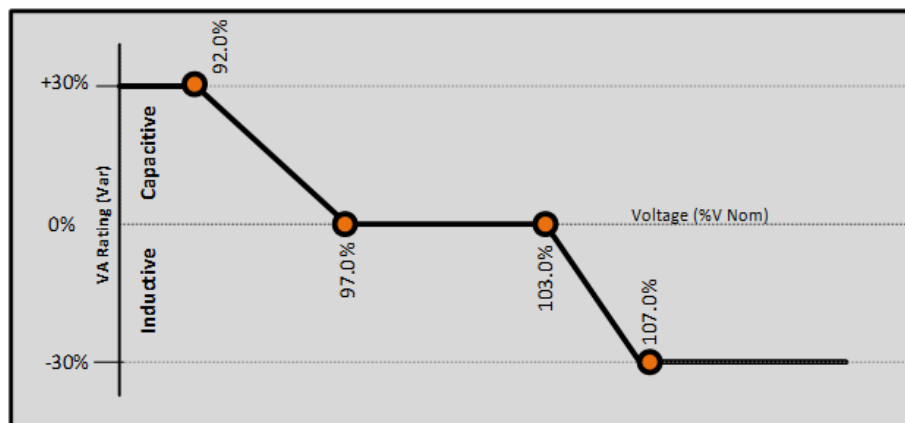
Default Open Loop Response Time for volt/var operation should be five (5) seconds.

Table Hh-4: Voltage and Reactive Default Settings

Voltage Setpoint	Voltage Value	Reactive Setpoint	Reactive Value	Operation
V1	92.0%	Q1	30%	Reactive Power Injection
V2	97.0%	Q2	0	Unity Power Factor
V3	103.0%	Q3	0	Unity Power Factor
V4	107.0%	Q4	30%	Reactive Power Absorption

(T)
(T)

Figure Hh-1: Voltage and Reactive Default Settings



(T)

(Continued)



**ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS**

Sheet 297

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(N)

2. Prevention of Interference (Cont'd)

g. Harmonics

When the Smart Inverter is serving balanced linear loads, harmonic current injection into Distribution Provider's Distribution or Transmission System at the PCC shall not exceed the limits stated in IEEE 1547-2018, 7.3. The harmonic current injections shall be exclusive of any harmonic currents due to harmonic voltage distortion present in Distribution Provider's Distribution or Transmission System without the Smart Inverter connected. The harmonic distortion of a Smart Inverter shall be evaluated using the same criteria as for the Host Loads.

h. Direct Current Injection

Smart Inverter should not inject direct current greater than 0.5% of rated output current into Distribution Provider's Distribution or Transmission System.

i. Smart Inverter Reactive Power Requirements

Smart Inverter Reactive Power capabilities shall comply with IEEE 1547-2018, Section 5.2 Category B requirement.

j. Dynamic Volt/Var Operations

The Smart Inverter shall be capable of supporting dynamic reactive power compensation (dynamic Volt/Var operation) within the following constraints:

- The Smart Inverter shall be able to consume reactive power in response to an increase in line voltage, and produce reactive power in response to a decrease in line voltage as indicated in Table P-3.

(N)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(N)

2. Prevention of Interference (Cont'd)

Dynamic Volt/Var Operations Default Settings

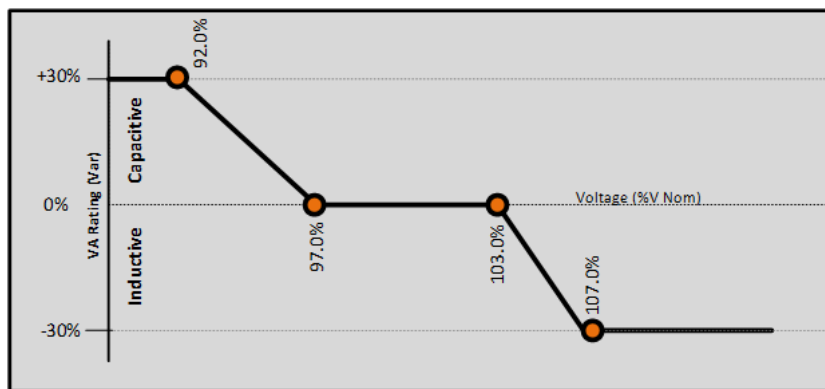
Table P-3 and Figure P-1 depict the default setting, which should be applied for all inverter size. Specific volt/var settings may be required for larger generating facilities (such as 100 kW or greater) or for specific areas with the Distribution System as determined by the Distribution Provider.

Default Open Loop Response Time for volt/var operation setting should be five (5) seconds.

Table P-3: Voltage and Reactive Default Settings

Voltage Setpoint	Voltage Value	Reactive Setpoint	Reactive Value	Operation
V1	92.0%	Q1	30%	Reactive Power Injection
V2	97.0%	Q2	0	Unity Power Factor
V3	103.0%	Q3	0	Unity Power Factor
V4	107.0%	Q4	30%	Reactive Power Absorption

Figure P-1: Voltage and Reactive Default Settings



(N)

(Continued)



**ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS**

Sheet 302

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(N)

2. Prevention of Interference (Cont'd)

o. Default Activation States

Unless otherwise provided by Distribution Provider, pursuant to Distribution Provider's Distribution Generation Interconnection Handbook, the default settings will be as follows:

Table P-4: Default Activation States

Function	State
Anti-islanding	Activated
Low/High Voltage Ride Through	Activated
Low/High Frequency Ride Through	Activated
Dynamic Volt/Var operations	Activated
Enter Service Ramp Control	Activated
Storage Inverter Normal Operation Ramp Control	Deactivated*
Fixed power factor	Deactivated
Reconnect by "soft-start" methods	Activated
Frequency/Watt	Activated
Volt/Watt	Activated
Constant Reactive Power Mode	Deactivated
Set Active Power Function Mode(Optional)	Activated under mutual agreement
Dynamic Reactive Power Support Mode (Optional)	Activated under mutual agreement

These default activation states may be modified by mutual agreement between Distribution Provider and Producer.

* May be activated under mutual agreement. For projects where the SB storage inverter Ramp Control is activated by mutual agreement, the inverter will be tested per SA 11 normal ramp rate tests. The testing must be done by a NRTL or, if available, in accordance with PG&E's interconnection handbook(s).

(N)

(Continued)



**ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS**

Sheet 304

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(N)

2. Prevention of Interference (Cont'd)

s. Storage Inverter Normal Operation Ramp Control Requirements

Smart Inverters used for energy storage applications may optionally include ramp-up rate control. The default value shall be 100% of maximum current output per second or slower if required by Applicant. Other ramp-up control settings can be used, when required, as mutually agreed by the Distribution Provider and the Applicant.

t. Ride-through of Consecutive Voltage Disturbances

Ride-through of consecutive voltage disturbances shall be in accordance with IEEE 1547-2018, 6.4.2.5.

u. Restore output without dynamic voltage support

Restore output without dynamic voltage support shall be in accordance with IEEE 1547-2018, 6.4.2.7.1.

v. Transition between performance operating regions:

Transition between performance operating regions should be in accordance with IEEE 1547-2018, 6.4.2.7.3.

w. Constant Reactive Power Mode

When in this mode, the Smart Inverter shall maintain a constant reactive power. The target reactive power level and mode (injection or absorption) shall be specified by the Distribution Provider and shall be within the same range specified in IEEE 1547-2018 section 5.3.5. The reactive power settings are allowed to be adjusted locally and/or remotely as specified by the Distribution Provider. The maximum Smart Inverter response time to maintain constant reactive power shall be 10 seconds or less.

(N)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 311

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(N)

6. Scheduling Capability Requirements

a. Generating Facilities which incorporate Smart Inverters shall incorporate scheduling capabilities with minimum scheduling memory capability of at least 24 events. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date. Each event is composed of modifications to each, selected group of, or all of the following Smart Inverter function:

- i) Modifications to the voltage and reactive set-points of the Dynamic volt/var function.
- ii) Modifications to the reactive power set-points for the fixed power factor function.
- iii) Modifications to the voltage and watt-reduction level set-points for the volt/watt function.

b. The Generating Facility's scheduling capability requirement herein shall be met by one or more of the following options:

- i) Scheduling capability requirements may be implemented at the GW/EMS. The GW/EMS shall communicate the necessary commands to the Smart Inverters within 10 minutes, or by mutual agreement, from when the GW/EMS receives the scheduling information.
- ii) Scheduling capability requirements may be implemented at the DER within the Generating Facility.
- iii) Scheduling capability requirements may be stored at an aggregator not co-located within the Generating Facility. The aggregator shall communicate the necessary commands to the Smart Inverter within 15 minutes of the aggregator receiving the scheduling information.
- iv) Other options may be utilized by mutual agreement between the Applicant and Distribution Provider

(N)

(Continued)



**ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS**

Sheet 312

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(N)

6. Scheduling Capability Requirements (Cont'd)

- c. The selected scheduling control system shall store the schedules and shall send operational commands to the Smart Inverters as required by the schedule received from the Distribution Provider. The Smart Inverter shall respond by changing its mode of operation as commanded at the schedule start time with no unreasonable delay.
- d. Each scheduled mode of operation shall include and start-time and duration The Smart Inverter should return to its default settings at the end of the duration time or shall enter a new operational mode as directed by the scheduling control system.

7. Monitoring and Telemetry Requirements

- a. The Smart Inverter shall have the capability to communicate its performance information per IEEE 1547-2018, 10.5 Table 29, unless otherwise provided by PG&E, pursuant to its Distribution Generation Interconnection Handbook:
 - i) Smart Inverter production or consumption of active power (watts).
 - ii) Smart Inverter consumption or production of reactive power (vars)
 - iii) Phase measured at the AC terminals of the Smart Inverter (volts)
 - iv) Frequency measured at the AC terminals of the Smart Inverter (Hz)
 - v) Connection Status
 - vi) Alarm Status
- b. When the Generating Facility includes energy-storage with Smart Inverters, the following monitoring and telemetry capability is required:

The Smart Inverter shall be capable of communicating the operational state of charge as a percent of energy storage capacity.

(N)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 313

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(N)

7. Monitoring and Telemetry Requirements (Cont'd)

c. Operational State as In-Service or not In-service communication capability requirements. The Smart Inverter shall be capable of communicating when the Smart Inverter is capable of providing electric services as follows:

i) In-Service

An operational state which indicates that the Smart Inverter is connected to the electric system and operating as determined locally by the Generating Facility operator or by a scheduling control system as outlined in section P.6

ii) Not In-Service

An operating state which indicates that the Smart Inverter is not capable of connecting to the electric system and not capable of providing any type of electrical support as required locally or as commanded by a scheduling control system as outlined in section P.6

d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows:

i) When the Generating Facility includes only Smart Inverters, the production or consumption of active and reactive power shall be communicated as an aggregate of all Smart Inverters within the Generating Facility.

ii) When a Generating Facility includes Smart Inverters and other technologies such as synchronous or induction generation systems, the Generating Facility shall communicate the following:

a) The production or consumption of active and reactive power shall be communicated in aggregate of all Smart Inverters within the Generating Facility.

b) The production or consumption of active and reactive power shall be communicated in aggregate of all the other technologies within the Generating Facility.

(N)

(Continued)



**ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS**

Sheet 314

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(N)

7. Monitoring and Telemetry Requirements (Cont'd)

d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows (Cont'd):

- i) When the Generating Facility with Smart Inverters includes one or multiple energy storage systems. The available operational energy should be communicated as an aggregate of all the energy storage systems.
- ii) Nameplate information shall be available through a local Generating Facility Interface as required in IEEE 1547-2018, 10.3 and must include the information as required in IEEE 1547-2018, Table 28.
- iii) Configuration information shall be available through a Local Generating Facility Interface as required in IEEE 1547-2018, 10.4. This information represents the present capacity and ability of the Generating Facility. When a configuration update changes the Generating Facility nameplate information, it may require a study depending on the change.

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(Continued)



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Sheet 1

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(Continued)

Advice 6635-E-C
Decision

Issued by
Meredith Allen
Vice President, Regulatory Affairs

Submitted
Effective
Resolution

May 4, 2023
E-5000 and E-5036



ELECTRIC TABLE OF CONTENTS

Sheet 20

Table with columns: RULE, TITLE OF SHEET, CAL P.U.C. SHEET NO. Includes entries for Rule 21 (Generating Facility Interconnections), Rule 22 (Direct Access Service), Rule 22.1 (Direct Access Service Switching Exemption Rules), Rule 23 (Standby Service), and Rule 23.2 (Community Choice Aggregation Open Season).





(Continued)

Attachment B

Redline Tariff Revisions

These redline revisions only include modified sheets that have language changes in this advice letter (AL 6635-E-C). Where Electric Rule 21 has been revised, the affected sheets are included in Attachment A.

In this advice letter and accordance to CPUC General Order 96B, Section 9.5.3, PG&E has implemented the use of the “(P)” symbol to signify material subject to change under a pending advice letter. The redlines in Attachment 2 are color coded to the specific advice letter. The color coding is as follows:

Redline Text Color	Advice Letter	Subject	Comments
	6635-E	Modifications to Electric Tariff Rule 21 to Incorporate IEEE 1547.1-2020 Test Procedures into Testing Regime for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E 5036	This advice letter is superseded by Advice 6635-E-A and Advice 6635-E-B. The redline changes remain in blue, so the additional supplemental changes can be identified compared to Advice 6635-E revisions.
	6635-E-A	Supplemental: Modifications to Electric Tariff Rule 21 to Incorporate IEEE 1547.1-2020 Test Procedures into Testing Regime for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E 5036	In this advice letter, revisions are made pursuant to Resolutions E-5000 and E-5036.
	6635-E-B	Second Supplemental: Modifications to Electric Tariff Rule 21 to Incorporate IEEE 1547.1-2020 Test Procedures into Testing Regime for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E 5036	In this advice letter, revisions are made pursuant to Resolutions E-5000 and E-5036. This supplemental further aligns with the other IOUs and makes minor corrections.
	6635-E-C	Third Supplemental: Modifications to Electric Tariff Rule 21 to Incorporate IEEE 1547.1-2020 Test Procedures into Testing Regime for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E 5036	In this advice letter, revisions are made pursuant to Resolutions E-5000 and E-5036. This supplemental better aligns with IEEE 1547 and supersedes some revisions made in 6635-E-A and 6635-E-B.



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)

2. PREVENTION OF INTERFERENCE (Cont'd.)

j. Dynamic Volt/VAR Operations (Cont'd.)

Dynamic Volt/Var Operations Default Settings

Table Hh-4 and Figure Hh-1 depict the default settings, which should be applied for all inverter sizes. Specific volt/var settings may be required for larger Generating Facilities (such as 100 kw or greater), or for specific areas with the Distribution Systems as determined by the Distribution Provider.

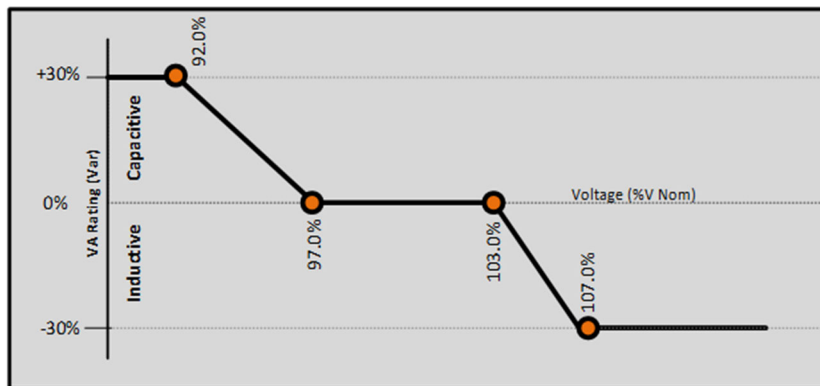
Default Open Loop Response Time for volt/var operation should be five (5) seconds.

Table Hh-4: Voltage and Reactive Default Settings

Voltage Setpoint	Voltage Value	Reactive Setpoint	Reactive Value	Operation
V1	92.0%	Q1	30%	Reactive Power Injection
V2	96.7% 97.0%	Q2	0	Unity Power Factor
V3	103.3% 103.0%	Q3	0	Unity Power Factor
V4	107.0%	Q4	30%	Reactive Power Absorption

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(T)

Figure Hh-1: Voltage and Reactive Default Settings



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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 257

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(P)

2. Prevention of Interference (Cont'd)

g. Harmonics

When the Smart Inverter is serving balanced linear loads, harmonic current injection into Distribution Provider's Distribution or Transmission System at the PCC shall not exceed the limits stated in IEEE 1547-2018, 7.3. The harmonic current injections shall be exclusive of any harmonic currents due to harmonic voltage distortion present in Distribution Provider's Distribution or Transmission System without the Smart Inverter connected. The harmonic distortion of a Smart Inverter shall be evaluated using the same criteria as for the Host Loads.

h. Direct Current Injection

Smart Inverter should not inject direct current greater than 0.5% of rated output current into Distribution Provider's Distribution or Transmission System.

i. Smart Inverter Reactive Power Requirements

Smart Inverter Reactive Power capabilities shall comply with IEEE 1547-2018, Section 5.2 Category B requirement.

j. Dynamic Volt/Var Operations

The Smart Inverter shall be capable of supporting dynamic reactive power compensation (dynamic Volt/Var operation) within the following constraints:

- The Smart Inverter shall be able to consume reactive power in response to an increase in line voltage, and produce reactive power in response to a decrease in line voltage as indicated in Table P-43.

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(P)

2. Prevention of Interference (Cont'd)

Dynamic Volt/Var Operations **Default Settings**

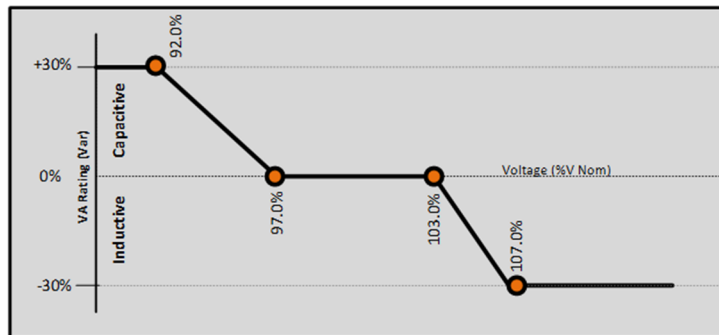
Table P-43 and Figure P-1 depict the default setting, which should be applied for all inverter size. Specific volt/var settings may be required for larger generating facilities (such as 100 kW or greater) or for specific areas with the Distribution System as determined by the Distribution Provider.

Default Open Loop Response Time for volt/var operation setting should be five (5) seconds.

Table P-34: Voltage and Reactive Default Settings

Voltage Setpoint	Voltage Value	Reactive Setpoint	Reactive Value	Operation
V1	92.0%	Q1	30%	Reactive Power Injection
V2	96.7% 97.0%	Q2	0	Unity Power Factor
V3	103.3% 103.0%	Q3	0	Unity Power Factor
V4	107.0%	Q4	30%	Reactive Power Absorption

Figure P-1: Voltage and Reactive Default Settings



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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(P)

2. Prevention of Interference (Cont'd)

o. Default Activation States

Unless otherwise provided by Distribution Provider, pursuant to Distribution Provider's Distribution Generation Interconnection Handbook, the default settings will be as follows:

Table P-4: Default Activation States

<u>Function</u>	<u>State</u>
<u>Anti-islanding</u>	<u>Activated</u>
<u>Low/High Voltage Ride Through</u>	<u>Activated</u>
<u>Low/High Frequency Ride Through</u>	<u>Activated</u>
<u>Dynamic Volt/Var operations</u>	<u>Activated</u>
<u>Enter Service Ramp Control</u>	<u>Activated</u>
<u>Storage Inverter Normal Operation Ramp Control</u>	<u>Activated</u> <u>Deactivated*</u>
<u>Fixed power factor</u>	<u>Deactivated</u>
<u>Reconnect by "soft-start" methods</u>	<u>Activated</u>
<u>Frequency/Watt</u>	<u>Activated</u>
<u>Volt/Watt</u>	<u>Activated</u>
<u>Constant Reactive Power Mode</u>	<u>Deactivated</u>
<u>Set Active Power Function Mode(Optional)</u>	<u>Activated under mutual agreement</u>
<u>Dynamic Reactive Power Support Mode (Optional)</u>	<u>Activated under mutual agreement</u>

These default activation states may be modified by mutual agreement between Distribution Provider and Producer.

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* May be activated under mutual agreement. For projects where the SB storage inverter Ramp Control is activated by mutual agreement, the inverter will be tested per SA 11 normal ramp rate tests. The testing must be done by a NRTL or, if available, in accordance with PG&E's interconnection handbook(s).

(N)

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(P)

2. Prevention of Interference (Cont'd)

s. Storage Inverter Normal Operation Ramp Control Requirements

Smart Inverters used for energy storage applications shall may optionally include ramp-up rate control. The default value shall be 100% of maximum current output per second or slower if required by Applicant. Other ramp-up control settings can be used, when required, as mutually agreed by the Distribution Provider and the Applicant.

t. Ride-through of ~~Consecutive~~ Conservative Voltage Disturbances

Ride-through of consecutive voltage disturbances shall be in accordance with IEEE 1547-2018, 6.4.2.5.

u. Restore output without dynamic voltage support

Restore output without dynamic voltage support shall be in accordance with IEEE 1547-2018, 6.4.2.57.1.

v. Transition between performance operating regions:

Transition between performance operating regions should be in accordance with IEEE 1547-2018, 6.4.2.7.3.

w. Constant Reactive Power Mode

When in this mode, the Smart Inverter shall maintain a constant reactive power. The target reactive power level and mode (injection or absorption) shall be specified by the Distribution Provider and shall be within the same range specified in IEEE 1547-2018 section 5.3.5. The reactive power settings are allowed to be adjusted locally and/or remotely as specified by the Distribution Provider. The maximum Smart Inverter response time to maintain constant reactive power shall be 10 seconds or less.

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 257

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(P)

6. Scheduling Capability Requirements

a. Generating Facilities which incorporate Smart Inverters shall incorporate scheduling capabilities with minimum scheduling memory capability of at least 24 events. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date. Each event is composed of modifications to each, selected group of, or all of the following Smart Inverter function:

- i) Modifications to the voltage and reactive set-points of the Dynamic volt/var function.
- ii) Modifications to the reactive power set-points for the fixed power factor function.
- iii) Modifications to the voltage and watt-reduction level set-points for the volt/watt function.

b. The Generating Facility's scheduling capability requirement herein shall be met by one or more of the following options:

- i) Scheduling capability requirements may be implemented at the GW/EMS. The GW/EMS shall communicate the necessary commands to the Smart Inverters within 10 minutes, or by mutual agreement, from when the GW/EMS receives the scheduling information.
- ii) Scheduling capability requirements may be implemented at the DER within the Generating Facility.
- iii) Scheduling capability requirements may be stored at an aggregator not co-located within the Generating Facility. The aggregator shall communicate the necessary commands to the Smart Inverter within 15 minutes of the aggregator receiving the scheduling information.

iv) Other options may be utilized by mutual agreement between the Applicant and Distribution Provider

(P)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(P)

6. Scheduling Capability Requirements (Cont'd)

- c. The selected scheduling control system shall store the schedules and shall send operational commands to the Smart Inverters as required by the schedule received from the Distribution Provider. The Smart Inverter shall respond by changing its mode of operation as commanded at the schedule start time with no unreasonable delay.
- d. Each scheduled mode of operation shall include and start-time and duration The Smart Inverter should return to its default settings at the end of the duration time or shall enter a new operational mode as directed by the scheduling control system.

7. Monitoring and Telemetry Requirements

- a. The Smart Inverter shall have the capability to communicate its performance information per IEEE 1547-2018, 10.5 Table 29, unless otherwise provided by PG&E, pursuant to its Distribution Generation Interconnection Handbook:
 - i) Smart Inverter production or consumption of active power (watts).
 - ii) Smart Inverter consumption or production of reactive power (vars)
 - iii) Phase measured at the AC terminals of the Smart Inverter (volts)
 - iv) Frequency measured at the AC terminals of the Smart Inverter (Hz)
 - v) Connection Status
 - vi) Alarm Status
- b. When the Generating Facility includes energy-storage with Smart Inverters, the following monitoring and telemetry capability is required:

The Smart Inverter shall be capable of communicating the operational state of charge as a percent of energy storage capacity.

(P)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(P)

7. Monitoring and Telemetry Requirements (Cont'd)

c. Operational State as In-Service or not In-service communication capability requirements. The Smart Inverter shall be capable of communicating when the Smart Inverter is capable of providing electric services as follows:

i) In-Service

An operational state which indicates that the Smart Inverter is connected to the electric system and operating as determined locally by the Generating Facility operator or by a scheduling control system as outlined in section P.6

ii) Not In-Service

An operating state which indicates that the Smart Inverter is not capable of connecting to the electric system and not capable of providing any type of electrical support as required locally or as commanded by a scheduling control system as outlined in section P.6

d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows:

i) When the Generating Facility includes only Smart Inverters, the production or consumption of active and reactive power shall be communicated as an aggregate of all Smart Inverters within the Generating Facility.

ii) When a Generating Facility includes Smart Inverters and other technologies such as synchronous or induction generation systems, the Generating Facility shall communicate the following:

a) The production or consumption of active and reactive power shall be communicated in aggregate of all Smart Inverters within the Generating Facility.

b) The production or consumption of active and reactive power shall be communicated in aggregate of all the other technologies within the Generating Facility.

(P)

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 257

P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(P)

7. Monitoring and Telemetry Requirements (Cont'd)

d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows (Cont'd):

iii) When the Generating Facility with Smart Inverters includes one or multiple energy storage systems. The available operational energy should be communicated as an aggregate of all the energy storage systems.

iv) Nameplate information shall be available through a local Generating Facility Interface as required in IEEE 1547-2018, 10.3 and must include the information as required in IEEE 1547-2018, Table 28.

v) Configuration information shall be available through a Local Generating Facility Interface as required in IEEE 1547-2018, 10.4. This information represents the present capacity and ability of the Generating Facility. When a configuration update changes the Generating Facility nameplate information, it may require a study depending on the change.

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Advice 5988-E-A
Decision D.20-09-035

Issued by
Robert S. Kenney
Vice President, Regulatory Affairs

Submitted May 19, 2021
Effective May 19, 2021
Resolution

**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.
Braun Blaising Smith Wynne, P.C.
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
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
Downey Brand LLP
Dish Wireless L.L.C.

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

GenOn Energy, Inc.
Green Power Institute
Hanna & Morton
ICF

iCommLaw
International Power Technology
Intertie

Intestate Gas Services, Inc.

Johnston, Kevin
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
McClintock IP
McKenzie & Associates

Modesto Irrigation District
NLine Energy, Inc.
NRG Solar

OnGrid Solar
Pacific Gas and Electric Company
Peninsula Clean Energy

Pioneer Community Energy

Public Advocates Office

Redwood Coast Energy Authority
Regulatory & Cogeneration Service, Inc.

Resource Innovations

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
Stoel Rives LLP

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