

PUBLIC UTILITIES COMMISSION

505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298



May 8, 2018

Advice Letter 5210-E

Erik Jacobson
Director, Regulatory Relations
Pacific Gas and Electric Company
77 Beale Street, Mail Code B13U
P.O. Box 770000
San Francisco, CA 94177

SUBJECT: Modifications to Electric Rule 21 to Incorporate Reactive Power Priority Settings for Smart Inverters

Dear Mr. Jacobson:

Advice Letter 5210-E is effective as of April 26, 2018 per Resolution E-4920 Ordering Paragraphs.

Sincerely,

A handwritten signature in cursive script that reads "Edward Randolph".

Edward Randolph
Director, Energy Division

December 29, 2017

Advice 5210-E

(Pacific Gas and Electric Company ID U 39 E)

Public Utilities Commission of the State of California

**Subject: Modifications to Electric Rule 21 to Incorporate Reactive Power
Priority Settings for Smart Inverters**

Purpose

The purpose of this advice letter (AL) is to make modifications to Pacific Gas and Electric Company's (PG&E) Electric Tariff Rule 21 (Rule 21) to incorporate reactive power priority settings for smart inverters pursuant to the December 22, 2014, Decision (D.) 14-12-035¹ in Rulemaking (R.) 11-09-011.²

Background

The California Public Utilities Commission (Commission or CPUC) initiated R.11-09-011 on September 22, 2011, to review, and if necessary, revise Rule 21 and related tariffs governing generation and storage facilities interconnecting with PG&E's electric distribution system. Certain generating facilities, such as solar and storage, incorporate inverters to convert their direct current (DC) output to the voltage and frequency of PG&E's alternating current (AC) distribution system.

In 2013, the Smart Inverter Working Group (SIWG) was formed to set policy for a new generation of inverters, referred to as "smart inverters." The development of smart inverters with advanced functionality was an important strategy to mitigate the impact of high penetrations of distributed energy resources (DER) and is a primary focus for the SIWG. Among the new functionality developed was the ability to mitigate high distribution line voltage by changing the reactive (i.e. "Var") component of the output of

¹ Decision 14-12-035, "Interim Decision Adopting Revisions to Electric Rule 21 for Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company to Require 'Smart' Inverters." Date of Issuance December 22, 2014.

<http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M143/K827/143827879.PDF>

² Order Instituting Rulemaking on the Commission's Own Motion to improve distribution level interconnection rules and regulations for certain classes of electric generators and electric storage resources.

the Smart Inverter. This capability is referred to as the “Volt/Var” function. The importance of Volt/Var is that it has the potential to reduce DER grid integration costs.

In early 2014, the SIWG “Phase 1” Report³ laid the groundwork for the utilization of the Volt/Var function⁴, among other items. In December 2014, D.14-12-035 was issued ordering the IOUs⁵ to submit tariff revisions to incorporate the SIWG’s recommendations through advice letter filings.

On January 20, 2015, PG&E submitted AL 4565-E⁶; approval of this AL was received on April 8, 2015. This AL builds on this earlier submittal.

PG&E submits this advice letter to incorporate the “**reactive** power priority” feature into Rule 21. Reactive power priority requires smart inverters to (1) provide reactive power if voltage is low or (2) absorb reactive power if voltage is high. With high penetrations of exporting inverter-based DERs, the voltage of the distribution grid can be pushed out of the normal operating range. The reactive power priority feature can mitigate this risk to the distribution system. Adopting the reactive power priority requirement for smart inverters will help address this concern.

This issue was still under discussion in the SIWG when PG&E submitted AL 5107-E on July 26, 2017 to update Rule 21 to facilitate the Phase 1 smart inverter deployment on September 8, 2017.⁷ On July 27, 2017, the Energy Division (ED) issued a Staff Proposal⁸ soliciting informal stakeholder comments to help bring closure on the reactive power priority issue. The IOUs continued work with the ED and stakeholders leading up to this AL.

In early October 2017, on a joint IOU call with the ED, the ED requested that the IOUs prepare advice letters to implement reactive power priority requirements. In subsequent discussions, the IOUs committed to submitting the AL by December 29, 2017. One important item discussed with the ED is the effective date for this proposal. This AL

³ “Phase 1” of the SIWG covered recommendations to the technical design and operating revisions to Rule 21 for DERs utilizing inverter-based technologies. It should be noted, that there are other SIWG “Phases” that are beyond the scope of this Advice Letter.

⁴ The fourth “Phase 1” proposal involved revisions to Rule 21 for “Dynamic Volt-Var Operation: Revise Electric Tariff Rule 21, Sections H.2.a, H.2.b, H.2.i and R21 table H.1 to reflect proposed new dynamic volt/var operations requirements.”

⁵ The IOUs, or investor owned utilities, consists of Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company.

⁶ AL 4565-E, “Revisions to Electric Tariff Rule 21 in Compliance with Decision 14-12-035” can be found at: http://www.pge.com/nots/rates/tariffs/tm2/pdf/ELEC_4565-E.pdf

⁷ AL 5107-E, “Modifications to PG&E’s Electric Rule 21 Tariff and Interconnection Agreements and Forms to Incorporate Smart Inverter Phase 1 Modifications,” effective July 29, 2017. https://www.pge.com/tariffs/assets/pdf/adviceletter/ELEC_5107-E.pdf

⁸ “Staff Proposal On Reactive Power Priority Setting Of Smart Inverters” issued by the CPUCs Energy Division, Grid Planning And Reliability Section on July 27, 2017. <http://cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442454143>

requests an effective date three months following approval of this AL. This advice letter is submitted as a Tier 2, consistent with the procedure followed in AL 5107-E.

Tariff Changes

- 1) Proposed Rule 21 Changes to Section Hh,2.i and j. (Added text in bold; removed text in strikeout):

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS

2. PREVENTION OF INTERFERENCE

i. **Fixed** Power Factor

Producer shall provide adequate reactive power compensation on site to maintain the Smart Inverter power factor near unity at rated output or a Distribution Provider specified power factor in accordance with the following requirements:

- (i) Default Power Factor setting: Absorbing reactive power at 0.95 lagging power factor.
- (ii) Aggregate generating facility is greater than 15 kW: 1.0 +/- 0.15 (0.85 Lagging to 0.85 Leading) down to 20% rated power **irrespective of Real Power Production** ~~based on available reactive power.~~
- (iii) Aggregate generating facility is less than or equal to 15 kW: 1.0 +/- 0.10 (0.90 Lagging to 0.90 Leading) down to 20% rated power **irrespective of Real Power Production** ~~based on available reactive power.~~

j. Dynamic Volt/VAR Operations

The Smart Inverter shall be capable of operating dynamically within a power factor range of +/- 0.85 PF for larger (>15 kW) systems, down to 20% of rated active power, and +/- 0.9 PF for smaller systems (≤ 15 kW), down to 20% of rated active power, **irrespective of Real Power Production** ~~based on available reactive power.~~ This dynamic Volt/VAR capability shall be able to be activated or deactivated in accordance with Distribution Provider requirements.

The Distribution Provider may permit or require the Smart Inverter systems to operate in larger power factor ranges, including in 4-

quadrant operations for storage systems with the implementation of additional anti-islanding protection as determined by the Distribution Provider.

The Smart Inverter shall be capable of providing 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.
- The reactive power provided shall be **per the range irrespective of real power production** ~~based on available reactive power~~, but the maximum reactive power provided to the system shall be as directed by the Distribution Provider.
- **Reduction of real power production is allowed to meet the required reactive power ranges.**

Protests

Anyone wishing to protest this filing may do so by letter sent via U.S. mail, facsimile or E-mail, no later than January 18, 2018, which is 20 days after the date of this filing. 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:

Erik Jacobson
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 2 advice filing become effective three months after its approval.

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 and the parties on the service lists for R.11-09-011 and R.17-07-007. 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 filings can also be accessed electronically at: <http://www.pge.com/tariffs/>.

_____/S/

Erik Jacobson
Director, Regulatory Relations

Attachments

cc: Service Lists R.11-09-011 and R.17-07-007

CALIFORNIA PUBLIC UTILITIES COMMISSION

ADVICE LETTER FILING 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
 PLC HEAT WATER

Contact Person: Kingsley Cheng

Phone #: (415) 973-5265

E-mail: k2c0@pge.com and PGETariffs@pge.com

EXPLANATION OF UTILITY TYPE

ELC = Electric GAS = Gas
PLC = Pipeline HEAT = Heat WATER = Water

(Date Filed/ Received Stamp by CPUC)

Advice Letter (AL) #: **5210-E**

Tier: 2

Subject of AL: **Modifications to Electric Rule 21 to Incorporate Reactive Power Priority Settings for Smart Inverters**

Keywords (choose from CPUC listing): Compliance, Rules

AL filing type: Monthly Quarterly Annual One-Time Other _____

If AL filed in compliance with a Commission order, indicate relevant Decision/Resolution #: N/A

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: _____

Is AL requesting confidential treatment? If so, what information is the utility seeking confidential treatment for: No

Confidential information will be made available to those who have executed a nondisclosure agreement: N/A

Name(s) and contact information of the person(s) who will provide the nondisclosure agreement and access to the confidential information: _____

Resolution Required? Yes No

Requested effective date: **Three Months After Commission Approval**

No. of tariff sheets: **5**

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: **Electric Rule 21**

Service affected and changes proposed: N/A

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

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

California Public Utilities Commission
Energy Division
EDTariffUnit
505 Van Ness Ave., 4th Flr.
San Francisco, CA 94102
E-mail: EDTariffUnit@cpuc.ca.gov

Pacific Gas and Electric Company
Attn: Erik Jacobson
Director, Regulatory Relations
c/o Megan Lawson
77 Beale Street, Mail Code B13U
P.O. Box 770000
San Francisco, CA 94177
E-mail: PGETariffs@pge.com

Cal P.U.C. Sheet No.	Title of Sheet	Cancelling Cal P.U.C. Sheet No.
41724-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 10	40754-E
41725-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 191	40763-E
41726-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 192	40764-E
41727-E	ELECTRIC TABLE OF CONTENTS Sheet 1	41721-E
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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 10

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

Sheet 191

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

2. PREVENTION OF INTERFERENCE (Cont'd.)

g. Harmonics (Cont'd.)

Table Hh.3

Maximum harmonic current distortion in percent of current (I) [1,2]

Individual harmonic order, h (odd harmonics) [3]	h<11	11≤h<17	17≤h<23	23≤h<35	35≤h	Total demand distortion
Max Distortion (%)	4.0	2.0	1.5	0.6	0.3	5.0

[1] – IEEE1547-4.3.3

[2] – I = the greater of the maximum Host Load current average demand over 15 or 30 minutes without the GF, or the GF rated current capacity (transformed to the PCC when a transformer exists between the GF and the PCC).

[3] – Even harmonics are limited to 25% of the odd harmonic limits above.

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. Fixed Power Factor

(T)

Producer shall provide adequate reactive power compensation on site to maintain the Smart Inverter power factor near unity at rated output or a Distribution Provider specified power factor in accordance with the following requirements:

(i) Default Power Factor setting: Absorbing reactive power at 0.95 lagging power factor.

(ii) Aggregate generating facility is greater than 15 kW: 1.0 +/- 0.15 (0.85 Lagging to 0.85 Leading) down to 20% rated power irrespective of Real Power Production.

(T)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 192

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

2. PREVENTION OF INTERFERENCE (Cont'd.)

i. Fixed Power Factor (Cont'd.) (T)

(iii) Aggregate generating facility is less than or equal to 15 kW: 1.0 +/- 0.10 (0.90 Lagging to 0.90 Leading) down to 20% rated power irrespective of Real Power Production. (T)

j. Dynamic Volt/VAR Operations

The Smart Inverter shall be capable of operating dynamically within a power factor range of +/- 0.85 PF for larger (>15 kW) systems, down to 20% of rated active power, and +/- 0.9 PF for smaller systems (≤15 kW), down to 20% of rated active power, irrespective of Real Power Production. This dynamic Volt/VAR capability shall be able to be activated or deactivated in accordance with Distribution Provider requirements. (T)
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The Distribution Provider may permit or require the Smart Inverter systems to operate in larger power factor ranges, including in 4-quadrant operations for storage systems with the implementation of additional anti-islanding protection as determined by the Distribution Provider.

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

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(N)

(Continued)



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Advice 5210-E
Decision

Issued by
Robert S. Kenney
Vice President, Regulatory Affairs

Date Filed December 29, 2017
Effective _____
Resolution _____

Advice 5210-E
December 29, 2017

Attachment 2

Redline of Changes to Electric Rule 21



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 10

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Advice
Decision

Issued by
Robert S. Kenney
Vice President, Regulatory Affairs

Date Filed	_____
Effective	_____
Resolution	_____



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

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

2. PREVENTION OF INTERFERENCE (Cont'd.)

i. Fixed Power Factor (Cont'd.)

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(Continued)

Advice
Decision

Issued by
Robert S. Kenney
Vice President, Regulatory Affairs

Date Filed	_____
Effective	_____
Resolution	_____

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

AT&T	Don Pickett & Associates, Inc.	OnGrid Solar
Albion Power Company	Douglass & Liddell	Pacific Gas and Electric Company
Alcantar & Kahl LLP	Downey & Brand	Praxair
Anderson & Poole	Ellison Schneider & Harris LLP	Regulatory & Cogeneration Service, Inc.
Atlas ReFuel	Evaluation + Strategy for Social Innovation	SCD Energy Solutions
BART	G. A. Krause & Assoc.	SCE
Barkovich & Yap, Inc.	GenOn Energy Inc.	SDG&E and SoCalGas
Bartle Wells Associates	GenOn Energy, Inc.	SPURR
Braun Blaising McLaughlin & Smith, P.C.	Goodin, MacBride, Squeri, Schlotz & Ritchie	San Francisco Water Power and Sewer
Braun Blaising McLaughlin, P.C.	Green Charge Networks	Seattle City Light
CPUC	Green Power Institute	Sempra Energy (Socal Gas)
California Cotton Ginners & Growers Assn	Hanna & Morton	Sempra Utilities
California Energy Commission	ICF	SoCalGas
California Public Utilities Commission	International Power Technology	Southern California Edison Company
California State Association of Counties	Intestate Gas Services, Inc.	Southern California Gas Company (SoCalGas)
Calpine	Kelly Group	Spark Energy
Casner, Steve	Ken Bohn Consulting	Sun Light & Power
Cenergy Power	Leviton Manufacturing Co., Inc.	Sunshine Design
Center for Biological Diversity	Linde	Tecogen, Inc.
City of Palo Alto	Los Angeles County Integrated Waste Management Task Force	TerraVerde Renewable Partners
City of San Jose	Los Angeles Dept of Water & Power	TerraVerde Renewable Partners, LLC
Clean Power	MRW & Associates	Tiger Natural Gas, Inc.
Clean Power Research	Manatt Phelps Phillips	TransCanada
Coast Economic Consulting	Marin Energy Authority	Troutman Sanders LLP
Commercial Energy	McKenna Long & Aldridge LLP	Utility Cost Management
Cool Earth Solar, Inc.	McKenzie & Associates	Utility Power Solutions
County of Tehama - Department of Public Works	Modesto Irrigation District	Utility Specialists
Crossborder Energy	Morgan Stanley	Verizon
Crown Road Energy, LLC	NLine Energy, Inc.	Water and Energy Consulting
Davis Wright Tremaine LLP	NRG Solar	Wellhead Electric Company
Day Carter Murphy	Nexant, Inc.	Western Manufactured Housing Communities Association (WMA)
Defense Energy Support Center	ORA	YEP Energy
Dept of General Services	Office of Ratepayer Advocates	Yelp Energy
	Office of Ratepayer Advocates, Electricity Planning and Policy B	