

PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

ENERGY DIVISION

RESOLUTION E-4898

April 26, 2018

R E S O L U T I O N

Resolution E-4898. Approval, with Modifications, of Request for Modifications to Electric Rule 21 Tariff to Incorporate Smart Inverter Phase 3 Advanced Functions in Compliance with Decision 16-06-052.

PROPOSED OUTCOME:

- Approves, with modifications, Pacific Gas and Electric, Southern California Edison and San Diego Gas & Electric's proposed revisions to the Electric Rule 21 Tariff incorporating eight Smart Inverter Working Group Phase 3 advanced functionality recommendations.
- Modifies the effective dates of function capabilities, adjusts technical requirements of the eight functions, and modifies activation dates.
- Rejects the proposed revisions to the Electric Rule 21 Tariff communications requirements for smart inverters.

SAFETY CONSIDERATIONS:

- Implementation of smart inverter Phase 3 advanced functions could improve the safety and reliability of the distribution system and overall electric grid.

ESTIMATED COST:

- This Resolution is expected to reduce ratepayer costs associated with interconnecting distributed energy resources under the Electric Rule 21 Tariff by minimizing the impact of those resources on the distribution system.

By Advice Letters (ALs) 5129-E (Pacific Gas and Electric) and 3647-E (Southern California Edison), Filed on August 18, 2017, and 3106-E

(San Diego Gas & Electric), Filed on August 17, 2017, hereafter collectively the Advice Letters or ALs.

SUMMARY

Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E) request approval of modifications to Electric Rule 21 Tariff (Rule 21) that incorporate the Smart Inverter Working Group (SIWG) Phase 3 advanced functions recommendations. The recommendations are comprised of eight functions that can improve the performance of the distribution grid and the network as a whole. Subject to the modifications herein, this Resolution finds the proposed tariff revisions of Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric to be compliant with Decision (D.) 16-06-052.¹ This Resolution modifies the effective date of the function capability requirements, makes adjustments to the technical requirements of the eight functions, approves mandatory activation of two of the eight functions (Frequency Watt Mode and Volt Watt Mode), and rejects the proposed modifications to smart inverter communications requirements. This Resolution requires PG&E, SCE, and SDG&E to develop methodologies and file reports on frequency events, voltage excursions, and voltage complaint processes.

BACKGROUND

The Commission initiated Rulemaking (R.) 11-09-011 on September 22, 2011 to review and, if necessary, revise the rules and regulations governing the interconnection of generation and storage facilities to the electric distribution systems of the investor-owned utilities (IOUs). The IOUs' rules and regulations pertaining to the interconnection of generating facilities are set forth in the Electric Rule 21 Tariff. Generating resources interconnecting to the utility grid via

¹ Alternate Decision Instituting Cost Certainty, Granting Joint Motions to Approve Proposed Revisions to Electric Tariff Rule 21, and Providing Smart Inverter Development a Pathway Forward for Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company.

Rule 21 which produce direct current (DC) power require an inverter to convert the DC from the generating resource to the voltage and frequency of the alternating current (AC) distribution system. In early 2013, the Smart Inverter Working Group was formed by parties of R.11-09-011 to develop proposals to take advantage of the new, rapidly advancing technical capabilities of inverters. In March 2016, the SIWG completed its first set of recommendations for the Phase 3 advanced functions.^{2,3}

The Phase 3 advanced functions are summarized as follows:

- 1. Monitor Key Distributed Energy Resource (DER) Data:** The inverter takes measurements as it converts power. With the ability to communicate, the inverter can send this information, such as voltage and active and reactive power, to the utility.
- 2. DER Disconnect and Reconnect Command (Cease to Energize and Return to Service):** In certain situations, the utility may need to de-energize circuits to perform maintenance or repairs, or to prevent unsafe conditions during an emergency. With this function, the utility can send a command to the inverter to disconnect the DER from the local electrical system or prevent the DER from energizing the local system.
- 3. Limit Maximum Active Power Mode:** This function establishes an upper limit on active power that a DER or system of DERs can produce or use. By limiting active power, this function helps to prevent adverse voltage conditions on the distribution grid and other related issues, especially in high DER penetration areas.

² SIWG Phase 3 DER Functions: Recommendations to the CPUC for Rule 21, Phase 3 Function Key Requirements, and Additional Discussion Issues, Issued March 31, 2017.

³ The SIWG's Phase 1 and Phase 2 recommendations were incorporated into Rule 21 in April 2015 and April 2017.

4. **Set Active Power Mode:** Similar to the previous function, this function establishes the active power that a DER or a system of DERs can produce or use.
5. **Frequency Watt Mode:** As a system-wide parameter, frequency is affected by all devices connected to the electric power system. High frequency events are often a sign of too much power in the grid and vice versa. Frequency Watt Mode is one method for countering these events, which is accomplished by reducing power in response to rising frequency or vice versa.
6. **Volt Watt Mode:** As a general rule, the production of active power raises voltage. This relationship can be problematic when solar photovoltaic (PV) systems interconnect in large numbers on distribution circuits where utilities have not planned for voltage rise and where existing distribution equipment cannot lower voltage. Volt Watt Mode modifies active power from DERs based on predetermined voltage ranges to prevent the local voltage on the distribution circuit from rising/dropping outside of allowable levels. Voltage regulators are a common mitigation measure used on circuits with and without PV to ensure that voltage stays within acceptable levels all the way to the end of the circuit. As PV injects power to the grid at various points along a circuit, the complex interaction of ever-changing load and generation conditions can cause imbalances in voltage levels. These voltage excursions can be mitigated by the smart inverter's Volt Watt Mode raising or lowering voltage but that change in voltage reduces the amount of real power that is exported.
7. **Dynamic Reactive Support:** This function is similar to the Volt Var Function from Phase 1. However, instead of modifying reactive power in response to the steady-state voltage level, this function responds to the rate of change in voltage.
8. **Scheduling Power Values and Models:** This function enables scheduling of active and reactive power, as well as modification of settings of other functions.

On June 23, 2016, the Commission adopted Decision 16-06-052, which directed the IOUs to file proposed revisions to Rule 21 setting forth any agreed-upon

technical requirements, testing and certification processes, and effective dates for Phase 3 functions in Tier 3 Advice Letters no later than six months from the effective date of D.16-06-052 and in the absence of consensus, to file a work plan and an outline of next steps for tariff development.

On November 17, 2016, the Commission's Energy Division hosted a public workshop with the purpose of providing guidance to the IOUs on the Advice Letter filings. During the workshop, it was determined that the development of the Phase 3 advanced function recommendations was insufficient at the time for the IOUs to propose revisions to Rule 21 adopting these functions.

On December 20, 2016, the IOUs jointly filed Tier 1 AL 4983-E that provided a work plan and an outline of next steps for tariff development including a status update on the activities outlined in the work plan by March 30, 2017.

On March 31, 2017, the SIWG submitted final revisions to the Phase 3 recommendations. In addition, the IOUs filed the required status update on March 30, 2017. In accordance with the work plan, the IOUs each anticipated filing a Tier 3 Advice Letter in June 2017. The June 2017 filing date was contingent on additional stakeholder discussions; additionally, in AL 4983-E, the IOUs stated, "the filing date for the Tier 3 Advice Letters may be modified upon approval from the Commission's Energy Division, with support of SIWG members, if deemed appropriate to maintain synchronization with IEEE 1547 and still be within reason of attaining the goal of smart inverters reaching full functionality by 2020 as stated in the Commission's DER Action Plan."

On June 20, 2017, the IOUs jointly requested to extend the submittal date of the Tier 3 Advice Letters incorporating the Phase 3 advanced functions into Rule 21 to August 18, 2017. On June 27, 2017, Commission Executive Director Timothy Sullivan granted the IOUs' request for extension of the Advice Letters.

On August 17 (SDG&E) and August 18 (SCE and PG&E), 2017, the IOUs filed the Advice Letters to comply with D.16-06-052 proposing Rule 21 tariff revisions that set forth agreed-upon technical requirements, testing and certification processes, and effective dates for the smart inverter Phase 3 advanced functions. In addition, the Advice Letters proposed revisions to the smart inverters Phase 2 communications in the Rule 21 tariffs and mandatory activation for two of the eight Phase 3 advanced functions.

Pacific Gas and Electric, Southern California Edison, San Diego Gas & Electric
ALs 5129-E, 3647-E, & 3106-E / JK8

Pursuant to several parties' and the IOUs' request in protests and replies to protests, the Energy Division held a public workshop on the Advice Letters on October 25, 2017 at the Commission. The purpose of the workshop was to discuss and, if possible, resolve issues raised in protests to the Advice Letters. As discussed in the Discussion Section below, we find that several protested issues were resolved at the workshop.

NOTICE

Notice of ALs 5129-E, 3647-E, and 3106-E was made by publication in the Commission's Daily Calendar. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric state that a copy of the Advice Letters was mailed and distributed in accordance with Section 4 of General Order 96-B. The ALs were served to Service List R.11-09-011.

PROTESTS

Six groups of parties filed protests to the ALs on September 6 and 7, 2017: Clean Coalition, the Solar Energy Industries Association (SEIA), the California Solar Energy Industries Association (CALSEIA), Sunrun, SunSpec Alliance, and the Joint Stakeholders, which consists of Tesla, ABB, Outback Power Technologies, and Enphase Energy.

Clean Coalition's protest to San Diego Gas & Electric's AL 3106-E was filed on September 7, 2017 and was dated as September 6, 2017. The protest was deemed late. On September 8, 2017, Energy Division informed Clean Coalition and San Diego Gas & Electric that the protest would still be considered. All other protests were timely filed.

We address parties' protests in the Discussion Section below.

IOU REPLIES TO ADVICE LETTER PROTESTS

On September 13, 2017, SDG&E filed a timely reply to protests. On September 14, 2017, SCE and PG&E filed timely replies to protests.

We address the IOUs' replies along with parties' protests in the Discussion Section below.

DISCUSSION

We treat the protested issues and the parties' comments on the Draft Resolution, by issue, in the section below.

Issue 1: Whether the Advice Letters Are Compliant with D.16-06-052.Protests

Clean Coalition asserts that the proposed revisions included in the Advice Letters are beyond the scope of the Smart Inverter Working Group and that which was ordered by D.16-06-052.⁴ Clean Coalition argues that the scope of the Advice Letters should be limited to requiring certain capabilities for advanced inverters and not the mandatory activation of those capabilities. Clean Coalition recommends that the Commission not accept the Advice Letters at this time and instead refer the Advice Letters to the SIWG for expedited review and modification.

SEIA contends that the proposed revisions were not agreed upon by the SIWG and are not consistent with the expectations of D.16-06-052.⁵ Particularly, SEIA references Attachment E of D.16-06-052, which states, "these eight capabilities would only be enabled or permitted after contractual or market agreements are made." SEIA argues that the Advice Letter process was insufficient for making determinations on smart inverter compensation and that there are open proceedings working on the development of the compensation mechanisms, specifically the interconnection proceeding, Rulemaking (R.) 17-07-007,⁶ the Distributed Resources Plan (DRP) proceeding R.14-08-013,⁷ and the Integrated Distributed Energy Resources (IDER) proceeding R.14-10-003.⁸

⁴ Clean Coalition's Joint Protest to ALs.

⁵ SEIA's Joint Protest ALs.

⁶ Order Instituting Rulemaking to Consider Streamlining Interconnection of Distributed Energy Resource and Improvements to Rule 21.

⁷ Order Instituting Rulemaking Regarding Policies, Procedures and Rules for Development of Distribution Resources Plans Pursuant to Public Utilities Code Section 769.

⁸ Order Instituting Rulemaking to Create a Consistent Regulatory Framework for the Guidance, Planning and Evaluation of Integrated Distributed Energy Resources.

Sunrun claims that the Advice Letters do not meet the Commission's standards for approval because the relief the Advice Letters' request 1) is unjust and unreasonable, 2) would violate a Commission order, 3) is not authorized by statute or Commission order, 4) requires a formal evidentiary hearing and is inappropriate for an Advice Letter, and 5) is pending before the Commission in another formal proceeding.⁹ Sunrun recommends that the Commission 1) reject the Advice Letters, 2) require the IOUs to build more consensus within the SIWG and then submit new Advice Letters setting forth agreed-upon, advanced inverter capabilities installed in deactivated mode as a default, 3) consider whether any critical issues of fact regarding the degree of curtailment customers would face from Function 5, Frequency Watt Mode, and Function 6, Volt Watt Mode, should be within the scope of R.17-07-007, and 4) leave questions of compensation and the operational requirements needed to justify such compensation to their appropriate formal proceedings in which the issues are properly scoped.

Discussion

In response to parties' claim that the Advice Letters go beyond the scope ordered by D.16-06-052, we find that D.16-06-052 neither required nor prohibited the IOUs from proposing mandatory activation as part of the technical requirements. Particularly, SEIA's reference to Attachment E of D.16-06-052 is incorrect in that the statement, "these eight capabilities would only be enabled or permitted after contractual or market agreements are made,"¹⁰ was not a Commission directive. The statement in Attachment E was a reference to the SIWG's Phase 3 recommendations, which was not adopted in full by the Commission. The Commission directed the IOUs to use the recommendations to develop their tariff revisions. However, the recommendations themselves are not binding.

Ordering Paragraph 9 of D.16-06-052 ordered the IOUs to "file proposed revisions to Tariff Rule 21 setting forth any agreed-upon technical requirements, testing and certification processes, and effective dates for Phase 2 communication protocols and Phase 3 additional advanced inverter functions in separate Tier 3

⁹ Sunrun, Inc.'s Joint Protest to ALs.

¹⁰ Attachment E of Decision 16-06-052: History and Status of the Smart Inverter Working Group.

advice letters.”¹¹ D.16-06-052 also allowed the IOUs to file a work plan in the absence of consensus in lieu of a December 2016 Advice Letter filing. The filed work plan set a deadline of 6 months, which was subsequently extended to 8 months. During this time, the IOUs engaged with stakeholders weekly to develop tariff revisions and meet the Commission-approved timeline for adoption into Rule 21. Therefore, while several parties (Clean Coalition, SEIA, Sunrun) claimed that the proposed tariff revisions are not in compliance with Decision 16-06-052 and that the Advice Letters should be rejected pending further review by the Smart Inverter Working Group, the Commission finds that the Advice Letters represent the extensive collaboration completed to date by all parties and have been properly filed pursuant to Commission procedures. Furthermore, most of the revised modifications to Rule 21 represent agreed-upon technical requirements, testing and certification processes, and effective dates following the Commission Staff hosted workshop, as discussed. The remaining issues are discussed and decided via this Resolution.

In addition, the default activation of Functions 5 and 6 does not eliminate the potential for compensation for these functions as would be developed through other proceedings including the IDER and the interconnection proceeding, R.17-07-007¹². The Commission may consider the development of compensation mechanisms in open proceedings, and the study of these functions will assist in determining appropriate levels and mechanisms for compensation if

¹¹ D.16-06-052 OP 9: Pacific Gas and Electric Company, Southern California Edison Company and San Diego Gas & Electric Company shall file proposed revisions to Tariff Rule 21 setting forth any agreed-upon technical requirements, testing and certification processes, and effective dates for Phase 2 communications protocols and phase 3 additional advanced inverter functions in separate Tier 3 Advice Letters no later than six months from the effective date of this decision.

¹² Scoping Ruling of President Picker October 2, 2017 for R.17-07-007 includes in the scope of the Rule 21 Proceeding item 27) What should be the operational requirements of smart inverters? What rules and procedures should the Commission adopt for adjusting smart inverter functions via communication controls?; and item 28) How should the Commission coordinate with the Integrated Distributed Energy Resource proceeding to ensure operational requirements are aligned with any relevant valuation mechanisms?

compensation is found to be warranted. We reject SEIA's assertion that requiring activation of Functions 5 and 6 is a compensation question and therefore beyond the scope of these ALs. Activation of Functions 5 and 6 is a reasonable part of utilizing smart inverter functionality to benefit the grid and ratepayers.

Conclusion of Issue 1:

We find that the Advice Letters were filed properly in compliance with D.16-06-052. We reject Sunrun's assertion that the Advice Letters do not meet the Commission's standards for approval. The SIWG is a collaborative process that often yields significant stakeholder consensus that helps inform Commission decision making. The SIWG cannot always achieve 100% consensus, nor are the SIWG's deliberations binding upon the Commission. We consider the consensus and non-consensus view points, and make decisions on the merits of each issue.

Issue 2: The Effective Dates for the Implementation of the Phase 3 Function Capabilities.

Protests

CALSEIA recommends that the Commission should change the proposed effective date for Function 1, Monitor Key DER Data, to 12 months for design and certification instead of the IOU-proposal of 9 months.^{13,14} In addition, CALSEIA asserts that for all relevant functions, performance of the functions via aggregators must be allowed to avoid functionality that would be designed and may be later abandoned.

SunSpec Alliance recommends that the timing of all of the requirements be harmonized to coincide with the next release of the international standards, Institute of Electrical and Electronics Engineers (IEEE) 1547 and 1547.1, because the staggered implementation of the function capabilities will have a financial impact on inverter manufacturers and create unnecessary complexities.¹⁵

¹³ CALSEIA Protest of PG&E AL 5129-E and SCE AL 3547-E.

¹⁴ CALSEIA Protest of SDG&E 3106-E.

¹⁵ SunSpec Alliance Protest to ALs.

Sunrun expressed concerns that the accelerated timelines for meeting the new requirements would diminish the health and vibrancy of California's inverter market.

Workshop

At the October 25, 2017 workshop, stakeholders resolved these disputes and a consensus emerged on two dates for requiring the Phase 3 functions.

The capability of smart inverters to perform Functions 1, 5, 6, and 8 was determined to be the later of: 1) 12 months after the approval of Advice Letters PG&E 5129-E, SCE 3647-E, and SDG&E 3106-E or 2) 9 months after the release of the SunSpec Alliance communication protocol certification test standard or the release of another industry-recognized communication protocol certification test standard. This date was chosen to align with dates already approved for Phase 2 communication requirements.

For Functions 2, 3, 4, and 7, it was determined that the effective date should be the earlier of: 1) December 2019 or 2) 12 months after approval of the IEEE 1547.1 standard revision. This date was chosen to better align with IEEE standards, but to not delay beyond the Commission's goal in the DER Action Plan to have all smart inverter functionality fully operational by the end of 2019.

The net result of these two effective dates is to consolidate effective dates for Phase 2 and Phase 3 functions into two dates to minimize transitions for smart inverter manufacturers, customers, and utilities. These dates also align with development of operational requirements of smart inverters and rules and procedures for adjusting smart inverter functions via communication controls which is scoped into R.17-07-007 and scheduled for Commission Decision in Summer 2019.

Discussion

At the workshop, it was anticipated that this Resolution would be voted on at the December 14, 2017 Commission Meeting. However, due to modifications to the Resolution based on comments, this Resolution is now being considered for vote on at the April 26, 2018 Commission Meeting. To align with previous expectations and reduce the amount of dates that stakeholders would have to meet by aligning with other timelines, we modify the effective dates of Functions 1, 5, 6, and 8 to 9 months after the release of the SunSpec Alliance communication

protocol certification test standard or the release of another industry-recognized communication protocol certification test standard.¹⁶ These dates are reflected in Table 1. In addition, a modification, as addressed in Issue 7, is incorporated to allow for an appropriate timeline for Function 4 and Function 7. The final effective dates are in Table 2 of this Resolution after the Conclusion of Issue 7.

Table 1: Effective Dates Proposed in IOU ALs and Effective Dates Based on October 25, 2017 Workshop Consensus

Function	Effective Date Proposed in IOU ALs	Effective Date Based on Workshop Consensus
Function 1 Monitor Key DER Data	Later of: 1) March 2018 or 2) 9 months following SunSpec Alliance Communication Protocol Certification Test Standard.	9 months following SunSpec Alliance Communication Protocol Certification Test Standard.
Function 2 DER Disconnect and Reconnect Command (Cease to Energize and Return to Service)	12 months after IEEE 1547.1 standard revisions approval.	Earlier of: 1) December 2019 or 2) 12 months after approval of the IEEE 1547.1 standard revision.
Function 3 Limit Maximum Active Power Mode	12 months after IEEE 1547.1 standard revisions approval.	Earlier of: 1) December 2019 or 2) 12 months after approval of the IEEE 1547.1 standard revision.
Function 4 Set Active Power Mode	Optional Upon Mutual Agreement between Utility and Applicant.	Earlier of: 1) December 2019 or 2) 12 months after approval of the IEEE 1547.1 standard revision.
Function 5 Frequency Watt Mode	12 months from Commission approval of the Phase 3 Advice Letters.	9 months following SunSpec Alliance Communication Protocol Certification Test Standard.
Function 6 Volt Watt Mode	12 months from Commission approval of the Phase 3 Advice Letters.	9 months following SunSpec Alliance Communication Protocol Certification Test Standard.
Function 7 Dynamic Reactive Support	Optional Upon Mutual Agreement between Utility and Applicant.	Earlier of: 1) December 2019 or 2) 12 months after approval of the IEEE 1547.1 standard revision.

¹⁶ The deadline of 9 months after the release of a test standard is not affected by the effective date of this Resolution. The effective dates of Functions 2, 3, 4, and 7 are also not affected by the effective date of this Resolution.

Function	Effective Date Proposed in IOU ALs	Effective Date Based on Workshop Consensus
Function 8 Scheduling Power Values and Modes	Later of: 1) March 2018 or 2) 9 months following SunSpec Alliance Communication Protocol Certification Test Standard.	9 months following SunSpec Alliance Communication Protocol Certification Test Standard.

Conclusion of Issue 2:

The workshop consensus dates are reasonable but are modified slightly here to accommodate the timeframe of this adopted Resolution. The final effective dates are in Table 2 of this Resolution to incorporate the Conclusions of Issue 2 and Issue 7.

Issue 3: Differences Between the Proposed Modifications and the International Standards.

Protests

Several parties (Clean Coalition, SEIA, CALSEIA, the Joint Stakeholders) note variances in the proposed tariff revisions from the international standards, IEEE 1547 and IEEE 1547.1, and recommended modification to avoid direct conflict with the standard.^{17,18,19}

Workshop

Despite not coming to agreement about the activation of Function 6 and the inclusion of Function 8, the workshop participants reached consensus on technical requirements for Functions 1 and 8. Per the discussions from the October 25, 2017 workshop, the IOUs submitted modifications to the proposed tariff revisions to the Commission's Energy Division on November 3, 2017. These modifications incorporate the SIWG agreed-upon technical requirements and

¹⁷ The Joint Stakeholders' Protest to SDG&E AL 3106-E.

¹⁸ The Joint Stakeholders' Protest to SCE AL 3647-E.

¹⁹ The Joint Stakeholders' Protest to PG&E AL 5129-E.

address many of the stakeholder concerns regarding harmonizing with the international standard, IEEE 1547.²⁰

For Function 1, Monitor Key DER Data, the measurement of current is removed and energy storage capacity is represented by percentage of energy storage capacity and not available kWh.

For Function 6, Volt Watt Mode, the active power output is reduced at a rate of 25% instead of the IOU-proposed 50% of real power nameplate rating per one percent of nominal voltage and the active power output produced by the smart inverter is reduced to 0 watts when the measured voltage is greater than 110% instead of 108%. This setting represents a compromise from the original SIWG recommendation which was a stricter setting for mitigating overvoltage. It will result in less curtailment of DERs when they trigger over-voltage which is a concern of protesters.

For Function 8, Scheduling Power Values and Modes, modifications to the normal ramp up rate and reconnect ramp up rate set points were removed and clarification was added on when the smart inverter will respond to changing its mode of operations.

An additional modification to the technical requirement of Function 6 is addressed in Issue 6.

Conclusion of Issue 3:

We find that the updated technical requirements for Functions 1 and 8, detailed in Appendix A, reflect consensus of the Smart Inverter Working Group and October 2017 workshop, and these requirements should be adopted into Rule 21.

The IOUs shall make a supplemental compliance Advice Letter filing to incorporate the revisions in Appendix A to their Rule 21 tariffs.

We discuss outstanding protest issues with Functions 6 and 8 separately below.

²⁰ These revisions are detailed in Appendix A.

Issue 4: Adopting the Capabilities for Function 2, DER Disconnect and Reconnect Command, and Function 3, Limit Maximum Active Power ModeProtests

CALSEIA recommends that the Commission not require the capabilities of Function 2, DER Disconnect and Reconnect Command, and Function 3, Limit Maximum Active Power Mode, until the Commission approves operational rules. CALSEIA is concerned that without limitations, the IOUs will deploy the functions, which CALSEIA claims will result in curtailment, i.e. loss in active power, and consequently have a financial impact. Sunrun also has concerns with Functions 2 and 3 with regards to curtailment.

Workshop

At the October 25, 2017, stakeholders came to consensus on allowing the capabilities of Function 2 and Function 3. The IOUs' ALs require smart inverters to have the capability to perform these two functions and do not require the functions to be activated immediately. The interconnection proceeding, R.17-07-007, is scoped to develop operational rules for smart inverter functions by the summer of 2019.

Discussion

CALSEIA's rejection of these functions would stand in the way of the Commission's goal of achieving fully operational smart inverters by the end of 2019, because the Commission cannot develop operational rules for smart inverter functions that have not been adopted as required capabilities.

Conclusion of Issue 4:

We find no reason to back away from requiring these capabilities in smart inverters and reject CALSEIA's recommendation.

As discussed on Issue 2 on effective dates, the capability to perform these functions is required on the earlier of: 1) December 2019 or 2) 12 months after the IEEE 1547.1 standard revision is approved, which is after the date that R.17-07-007 plans to have a proposed decision on the operational requirements of smart inverters.

The IOUs shall incorporate Functions 2 and 3 as proposed when making the supplemental compliance Advice Letter filing.

Issue 5: Activation of Function 5, Frequency Watt Mode

Sub-issue: Stakeholder Request to Delay or Defer Function 5 Activation

Protests

Several parties (CALSEIA, Sunrun, the Joint Stakeholders) assert that Function 5 should only be a required capability and not have mandatory activation. The Joint Stakeholders claim that R.17-07-007 would be a more appropriate venue for determining activation of Function 5.

IOU Replies to Protests

The IOUs recommend that the Commission direct the Energy Division to host an in-person workshop to support further consensus development for the Rule 21 tariff revisions incorporating the Phase 3 advanced functions and discuss issues raised in the protests.

Workshop

As referenced previously, on October 25, 2017, the Energy Division held a workshop on the Phase 3 advanced functions. Activation of Function 5 was discussed.

Draft Resolution Outcome

The Draft Resolution found the IOUs' proposal for activation of Function 5 to be reasonable and approved. To address concerns, the IOUs were ordered to study the impacts of activation.

Comments on Draft Resolution

Stakeholders repeated their recommendation that the activation of Function 5 should be delayed or deferred to open proceedings. SEIA, Sunrun, and Tesla recommend further discussions and studies on the impacts of implementation, such as a pilot between the IOUs and a research institution.

Discussion

As is shown in following sections, we find that the activation of Function 5 does not require further discussion and study, as suggested by stakeholders. The impact is expected to be de minimis and benefits of Function 5 can be realized at this time.

In earlier SIWG work, Function 5 was once part of the Phase 1 autonomous functions, but was not included in Phase 1. We see Function 5 as having some of the same attributes of Phase 1 autonomous functions. Activation of Function 5 has benefits to the grid and to ratepayers.

Sub-issue: Need for Activation of Function 5

Comments on Draft Resolution

SEIA and Sunrun argue that the activation of the Function 5 is not necessary to ensure grid reliability and power quality and point to the Rule 21 and DRP proceedings for study, anticipation, and resolution of grid issues. SEIA and Tesla contend that activation is not the most efficient means to gather information on the functions.

Discussion

The benefits of Function 5 are apparent by the SIWG Phase 3 recommendations submitted to the CEC and CPUC in March 2017. Function 5, Frequency Watt Mode, will allow DERs to respond to frequency changes, which is of substantial importance as the grid displaces traditional inertia-providing fossil fuel generation with renewable technologies, many of which do not provide the same inertia.

The frequency throughout the Western Interconnection²¹ is effectively the same (60 Hz). Calling DERs to support frequency events (fundamentally a system-wide problem) has the potential to affect all constituents of the Western Interconnection, which has a population over 80 million. The significance of this situation is not lost on the Commission. In addition, the SIWG noted the

²¹ The Western Interconnection includes all or part of 14 western continental states of the U.S., parts of western Canada, and northern Mexico.

importance of regulating frequency autonomously in emergency situations, as this function does, because the response must be fast to be of benefit.

The ALs propose default settings for the Frequency Watt Mode function that will decrease real power production when frequency rises above 60.1 Hz and increase real power production when frequency drops below 59.9 Hz. The impact of this default setting for this function is that the smart inverters will provide more or less real power to help keep the entire grid within acceptable frequency ranges once a frequency excursion, a rare event, is already underway.

Since the IOUs proposed the ALs, the update to the international standard, IEEE 1547, was completed and approved. In the updated standard, the new dead band was defined as 60 Hz +/- 0.036 Hz, meaning that real power production is increased when frequency drops below 59.964 Hz and that real power production is decreased when frequency rises above 60.036 Hz. This setting aligns with the North American Electric Reliability Corporation's (NERC's) Standard BAL-003-1.²² This setting also aligns with the Federal Energy Regulatory Commission's (FERC's) Order 842.²³ We find it logical to align with this new standard as many of the stakeholders involved in the approval of the international standard are also participants in the SIWG and Commission proceedings. We order the IOUs to incorporate the updated IEEE 1547 settings.

The result of conforming California's Rule 21 interconnected smart inverters with this setting would be that only after generators participating in frequency response markets have already responded to a frequency event and the grid continues to experience significant fluctuation outside of acceptable frequency limits, then the grid's fleet of smart inverters can automatically respond to

²² The purpose of NERC Standard BAL-003-1 is to require sufficient frequency response from balancing authorities to maintain frequency within predefined bounds by arresting frequency deviations and supporting frequency until the frequency is restored to its scheduled value.

²³ FERC Order 842 requires newly interconnecting generating facilities to install, maintain, and operate a governor or equivalent with a maximum 5 percent droop and +/- 0.036 Hz dead band.

support grid stabilization. The default setting adopted here is for contingency and is not intended to be for grid services as is addressed in a section below.

Sub-issue: Impact of Activation of Function 5

Protests

Sunrun argues that the default activation of Function 5 for all prospective DERs creates curtailment risks that have not been studied.

Comments on Draft Resolution

CALSEIA and CESA argue that storage customers will primarily be impacted and these customers would lose on stored energy that they were counting to be available for other purposes. Sunrun contends that the impacts of activating the function in California are not well understood and CESA argues that the function could force customers to bear costs that would resolve problems occurring out of the state.

Sunrun and IREC argue that project financing will be affected. Sunrun states that the operations and maintenance (O&M) costs of storage resources could accelerate as these resources are forced to incur more cycles and performance is reduced.

IREC states that the IOUs could offer a means for customers to receive reimbursements for energy production losses that exceed an established "reasonable limit." IREC argues that there must be customer protection schemes in place before activation.

Discussion

We reject CALSEIA and CESA's notion that activation of Frequency Watt Mode should be prevented because customers would be counting on the stored energy for other purposes. In the event of a blackout, grid-connected DER customers would be unable to provide any services as they would be required to be deactivated until the grid issues are resolved.

Frequency events are uncommon and are generally on the order of magnitude of seconds to minutes if mitigated in a timely fashion.²⁴ Therefore, the impact from the use of Function 5 to individual DER systems is expected to be *de minimis*. However, the impact of these events, if left unmitigated, is potentially detrimental to all customers, DER and non-DER alike. Frequency disruptions can be caused by a large generator suddenly tripping offline, and such disruptions can cause a cascading blackout unless other generators (or smart inverters) instantly respond to support grid frequency.

We reiterate that the use of the function is only when the grid is experiencing system-wide disturbances. If DERs do not provide support at these times, it is likely that these disturbances will expand and not only will these DERs be affected, many other customers will be impacted as well. Thus, it is irrelevant whether the issue is in California or not; the issue affects California including the DER systems that stakeholders are particularly concerned about. In addition, we note that frequency events are short in duration, i.e. from seconds to minutes, and would not be expected to reach the 4-hour capacity of many storage systems today.²⁵ Thus, we reject the notion that these resources will incur significant impacts to performance.

Given the expected *de minimis* impact, we do not find that activation would impair project finance. The additional time that the grid is available due to activation of the function will benefit all grid-connected resources.

We find that the default setting in the updated IEEE 1547 already serves as a reasonable limit, because it is the limit to which balancing authorities are required to plan and operate the grid as illustrated in NERC Standard BAL-003-1. The smart inverters required to adopt the proposed default setting will only be activated when the frequency is outside NERC Standard BAL-003-1. The grid operator is already required to take actions to keep frequency within the

²⁴ Frequency was outside of the IOU proposed range of +/- 0.1 Hz about 0.009% of the time from 2011 to 2017.

²⁵ 1 minute of a 4 hour storage unit is 0.4% of the total capacity.

acceptable band, so this setting will only call up smart inverters to help in the rare instances when the grid experiences excursions outside the NERC standard.

Sub-issue: Whether Frequency Watt Mode Is Considered Frequency Response

Comments on Draft Resolution

CESA asserts that frequency response is not a distribution service and both the Federal Energy Regulatory Commission and the California Independent System Operator (CAISO) are considering rules on frequency response. CESA and IREC recommend the development of tariffs for grid services before activation.

Discussion

We reject stakeholders' assertion that activation should be prevented because the FERC and the CAISO are considering rules for grid-wide services. The default settings of Frequency Watt Mode are a requirement for grid stability on a prospective emergency basis. Ensuring grid stability as the grid shifts from thousands to millions of distributed generators will only become more essential in the future. In the past, a small number of large central station generators primarily provided frequency stability; however, in the future, a large range of technologies and resources will provide frequency response services. As we shift to that future, it is important that smart inverters are set to a default setting to respond to an extreme event that is not otherwise cured by the frequency regulation markets.

To be clear, the activation of Function 5 at this time as a default setting does not prevent the same DER customer from participating in frequency regulation markets as they develop since the market for these frequency response grid services would occur within the band of 59.964 Hz and 60.036 Hz.

Sub-issue: Whether Frequency Watt Mode Is Technically Feasible

Comments on Draft Resolution

CALSEIA questions whether activation of Function 5 is technically feasible.

Discussion

We reject the concern that the Frequency Watt Mode is not technically feasible at this time. The approval of the update to international standard IEEE 1547 signals

that there are no issues with this function and manufacturers will be able to provide this functionality within the timeframe determined in this Resolution.

Sub-issue: Whether Activation Violates the Public Utility Regulatory Policies Act of 1978

Comments on Draft Resolution

Sunrun states that curtailing DERs prevents customers from serving their own load, requiring them to buy power from the utility and violating the Public Utility Regulatory Policies Act of 1978 (PURPA).

Discussion

Sunrun is referring to the case where there is an over-frequency event and DER customers would have to decrease real power production to provide grid support. Similar to previous statements on under-frequency events, these events result in de minimis impacts to DER customers. From January 2017 to September 2017, there were no over-frequency events outside the frequency band proposed in the IOUs' ALs. We have also already addressed that the default settings of Frequency Watt Mode are for contingency for grid stability. Further, PURPA does not provide an unrestrained right to export all power produced. A utility may discontinue purchases from a facility that is contributing to a system emergency.

Additionally, there is no PURPA issue with activation of Function 5 for under-frequency events. Under-frequency events result in an increase of real power to the grid for minimal amounts of time so that the frequency of the grid can return to normal limits. This setting only affects the power when the inverter is capable of increasing real power production, and it does not prevent the DER customer from serving its own load.

Sub-issue: Whether to Require IOU Reporting on Impact of Function 5

Draft Resolution Outcome

The Draft Resolution ordered the IOUs to study the impacts of activation.

Comments on Draft Resolution

The IOUs request to remove the reporting requirement on the impacts of activating Function 5 from the Draft Resolution. The IOUs argue that they do not

have the ability to track or record impacts to DER for activating the function, and they are not privy to the data produced by the DER owner/operator which they claim is the only one that could calculate any curtailment. The IOUs further contend that even if DER owners/operators notified the utility, there is no straightforward way to verify the accuracy of the information.

Discussion

Given that frequency is a system-wide parameter, we see no need to track the impacts to all individual DERs as initially intended by the Draft Resolution. The impact is expected to be de minimis and reporting on all individual DERs would create unnecessary burden on all parties.

We will continue to monitor grid frequency going forward. Because frequency events are generally infrequent events, it is feasible for the IOUs to monitor the number of events per year and report to the Commission on their duration and *estimated impact* on DER customers. In addition, given that the IOUs have storage assets themselves and there are a collection of Commission-approved programs which support DERs, we find it feasible to monitor the impact of activating Function 5 on a set of DER customers and/or use IOU-operated resources as a proxy for determining impact. No later than 90 days after the effective date of this Resolution, the IOUs shall submit Tier 1 Advice Letters proposing a methodology for monitoring frequency events and estimating their likely impact on DER customers with Phase 3 compliant smart inverters. The IOUs shall also propose methods to measure impact on a set of DER customers as highlighted to be included in reporting. The Advice Letter will propose the data variables and data sources that can be reported.

To provide in-depth monitoring when activation of Function 5 begins, the IOUs shall file quarterly reports via Tier 1 Advice Letter utilizing the approved reporting methodology on frequency events for one full calendar year, i.e. four reports, starting three months after the mandatory activation of Function 5. Following this year, the IOUs shall file annual reports on frequency events via Tier 1 Advice Letter with a file date based on the anniversary of the activation of Function 5. No sooner than five years after the activation of Function 5, the IOUs may file proposals via Tier 2 Advice Letter on whether to continue or modify the reporting requirement.

Conclusion of Issue 5

Therefore, we approve the IOUs' request to have mandatory activation of Function 5 and adopt Function 5 into Rule 21. We order the IOUs to each file a Tier 1 Advice Letter on the methodology for monitoring of frequency events and estimating impact to DER customers no later than 90 days after the effective date of this Resolution. We also order quarterly and annual reporting via a Tier 1 Advice Letter based on the approved methodology following the mandatory activation of Function 5, as specified previously.

The IOUs shall incorporate Function 5 when making the supplemental compliance Advice Letter filing. The IOUs shall incorporate the default setting to be called upon based on IEEE 1547 settings for Function 5, Frequency Watt Mode.

Issue 6: Activation of Function 6, Volt Watt Mode

Activation of Volt Watt Mode was the most contested issue in protests to the ALs and comments to this Resolution. We discuss each aspect of the concerns below, and we aim to clarify the intent of the activation of the function and set up a fair method that will allow the function to serve its purpose of contributing to safety and reliability, while not being overly burdensome to all parties involved.

Sub-issue: Stakeholder Request to Delay or Defer Function 6Protests

Several parties (SEIA, CALSEIA, Sunrun, the Joint Stakeholders) assert that Function 6 should only be a required capability and not have mandatory activation of a default setting. The Joint Stakeholders claim that R.17-07-007 would be a more appropriate venue for determining activation of Function 6.

IOU Replies to Protests

The IOUs recommend that the Commission direct the Energy Division to host an in-person workshop to support further consensus development for the Rule 21 tariff revisions incorporating the Phase 3 advanced functions and discuss issues raised in the protests.

Workshop

As referenced previously, on October 25, 2017, the Energy Division held a workshop on the Phase 3 advanced functions. Activation of Function 6 was discussed.

Draft Resolution Outcome

The Draft Resolution found the IOUs' proposal for activation of Function 6 to be reasonable and approved. To address concerns, the IOUs were ordered to study the impacts of activation.

Comments on Draft Resolution

Similar to Function 5, Stakeholders recommend that the activation of Function 6 should be delayed or deferred an open proceeding. SEIA, Sunrun, and Tesla also recommend further discussions and studies on the impacts of implementation. CALSEIA recommends either that the activation of Volt Watt Mode be addressed in a separate resolution or that the activation date be extended by a few months and make it contingent on a later finding that the impacts will be minimal.

Discussion

Similar to Function 5, we find that the activation of Function 6 does not require further discussion and study, as suggested by stakeholders. The impact is expected to be de minimis and benefits of Function 6 can be realized at this time.

In earlier SIWG work, Function 6 was once part of the Phase 1 autonomous functions, but was not included in Phase 1. We see Function 6 as having some of the same attributes of Phase 1 autonomous functions. In fact, the autonomous functions included "voltage ride-through" that allow a smart inverter to stay connected to the grid during a period of grid disturbance. Activation of Function 6 with the proposed default setting will have similar benefits to the grid and to ratepayers as the already adopted autonomous functions.

Sub-issue: Need for Activation of Function 6

Comments on Draft Resolution

SEIA and Sunrun argue that the activation of the Function 6 is not necessary to ensure grid reliability and power quality and point to the Rule 21 and DRP proceedings for study, anticipation, and resolution of grid issues. SEIA and Tesla contend that activation is not the most efficient means to gather information on

the functions. SEIA and Sunrun argue that the Commission's use of the word "minimal" with respect to the rate of incurrence that the functions are utilized implies there is no justification for statewide basis. CALSEIA argues that the existing Volt Var function from Phase 1 likely addresses the potential impacts of DERs to increase voltage.

Several stakeholders (CALSEIA, SEIA, Sunrun, Tesla) refer to the Hawaii Public Utilities Commission decision that activation of Volt Watt Mode was not required in Hawaii based on a study conducted by the National Renewable Energy Laboratory (NREL) on the Hawaiian Electric Companies' (HECO's) grid.

Discussion

The benefits of Function 6 are apparent by the SIWG Phase 3 recommendations that indicate Function 6 has the potential to avoid or defer distribution upgrades. Volt Watt Mode will assist in places where high DER penetrations at the distribution level may drive feeder voltage too high. In the absence of this function being available with the default setting as proposed, the utility will have to delay interconnections, study potential voltage issues, and install equipment to mitigate voltage issues in order to maintain the utility's obligation to maintain voltage stability.

By requiring the default activation of this function at the proposed setting, the utility will be able to allow more customers to interconnect DERs, enable more streamlined Rule 21 interconnections, and ultimately facilitate higher penetrations of DER installations. The Volt Watt Mode function will allow more customers to interconnect DERs because it allows for greater grid safety with higher penetration levels of DERs. In the absence of the Volt Watt Mode, the utility must pre-emptively make investments to protect against voltage excursions conservatively, regardless of whether they are likely to occur. The Volt Watt Mode will allow more streamlined interconnections because it will allow some systems to interconnect in advance of system upgrades (or even without system upgrades) by protecting the system against rare events.

In the event the smart inverters are infrequently called upon to support voltage excursion events, then it will have been in the best interest of ratepayers and the DER customers to rely on the Volt Watt Mode function to mitigate against infrequent or unpredictable events. In the event that smart inverters are called upon regularly to solve voltage problems, then the utility is obligated to resolve

voltage issues pursuant to the IOUs' Electric Rule 2 Tariffs. These investments will likely be more costly than the use of the smart inverter functionality, but under existing regulations – all customers will pay for these distribution system upgrades and the utility will add the cost of those upgrades to rate base.

Also, voltage issues that can be mitigated with the Volt Watt Mode function setting can arise from one additional DER system being added to a circuit, or they can arise from the collective impact of many systems, or they can arise because of a change in the circuit's load or load shape. Due to the complexity of the cause of the voltage problem and the fact that these problems could arise at any time during the installation lifetime of a DER, the proactive activation of Function 6 will help avert or delay problems. If the activation of Function 6 is harmful to a particular system owner, it will only be because the voltage levels on the circuit are regularly outside acceptable Rule 2 limits.

It is extremely relevant to clarify that the IOUs are obligated to resolve voltage issues pursuant to the IOUs' Electric Rule 2 Tariffs. The Commission's activation of the Volt Watt Mode with a default setting is not intended to serve as permanent voltage regulation solution in lieu of active IOU management of voltage within Rule 2 limits.²⁶ Rather Volt Watt Mode is intended to solve real-time issues that have an impact on all customers, DER and non-DER, and are caused by DERs customers' participation on the grid, as they occur. As the penetration of DERs increases, it becomes more likely that a single system (or a collective of systems) interacting with load fluctuations may cause voltage levels to rise or fall outside of acceptable limits.

The Volt Watt Mode function will simply respond to these voltage events and keep the grid safe. The Volt Watt Mode function will facilitate higher penetration of DERs because it is the DERs interacting in a cumulative fashion (with ever-changing load conditions) that can cause system voltage excursions. A single additional system may be perceived as being "unsafe" once penetration

²⁶ The IOUs Electric Rule 2 Tariffs define the service voltages that the IOUs actively design and operate to deliver to customers. These service voltages are generally +/- 5% from 100% of nominal voltage at the Point of Common Coupling (PCC) and are established by the American National Standards Institute (ANSI), specifically ANSI C84.1-1995 Range A.

levels get close to minimum load; however, a large number of systems working pre-emptively together with Volt Watt Mode enabled can protect against this system condition.

The default setting of the Volt Watt Mode proposed by the IOUs, which is also in the recently updated international standard IEEE 1547, is 106% of nominal voltage, which is past the Rule 2 limit of 105% of nominal voltage. Thus, if activated with these settings, the usage of Volt Watt Mode occurs only after voltage has already exceeded acceptable limits.

Long-term resolution of voltage issues are expected to be ultimately mitigated by the least cost and optimal method, which may include either the installation of a distribution upgrade (such as a voltage regulator) or the continued utilization of the Volt Watt Mode, potentially at a narrower band and/or with compensation if determined in R. 17-07-007. When voltage issues arise, customers, DER and non-DER, can and should report these issues to the utility in order for both IOU and customers to be in compliance with Rule 2. Smart inverters will aid in locating these issues and notifying the utility in order to reach long-term resolution sooner.

The Volt Watt Mode function is especially important in some situations, such as areas with long and skinny conductors, where the existing Volt Var function from Phase 1 is not as effective in resolving voltage issues. Additionally, the Volt Watt Mode function can be very helpful if grid conditions emerge (such as through the loss of load on a circuit or changes to load shape on a circuit) that cause voltage instability, particularly far from existing voltage regulation devices.

We agree that grid reliability and power quality are studied in the Rule 21 and the DRP processes and find that the activation of Function 6 will assist in streamlining both processes.

With respect to stakeholders' reference to the Hawaii Public Utilities Commission, we do not find the discussions to be fully similar.

Some stakeholders refer to a study conducted by NREL on HECO's grid in regards to the potential impact on customers in California. We clarify that this study is not applicable to the possible impacts of activating the Volt Watt Mode

function in California. The assumption of the NREL study was that Volt Watt Mode would be the permanent solution for voltage issues as they arise. However, that is not the intent here. The use of the Volt Watt Mode function is to be to minimize impacts of voltage deviations. Long-term mitigation, if appropriate, is further discussed in the section below.

In addition, the same study found that enabling Volt Watt Mode will result in more total customers being able to interconnect PV systems and will result in removing high voltage as a barrier for interconnecting higher penetration levels of distributed PV. The study found that Volt Watt Mode enabled more PV generation than it curtailed. High voltage will become a more prominent issue as penetrations increase because each PV incrementally increases voltage under adverse grid conditions.

The comparison of California and Hawaii ignores the fact that there are critical differences between who pays for distribution upgrades in California versus who pays in Hawaii. In California, under current Rule 21 policy, Net Energy Metering (NEM) customers under 1 Megawatt (MW) pay an interconnection fee but do not pay for distribution system upgrades needed to maintain reliability (and protect against adverse events such as voltage excursions). These distribution costs are allocated to all ratepayers. In Hawaii, DER customers pay for these upgrades themselves. It makes sense that a DER customer in Hawaii may prefer to use the Volt Watt Mode function instead of paying for a large distribution upgrade even if it slightly reduces their real power output. However, in California, the DER customer does not pay for the distribution upgrades. Thus, it makes more sense to activate the feature on all future DER systems. In many and probably most cases, the impact on a DER customer will be de minimis - i.e. the function will be called upon extremely infrequently. If the impact on a customer is frequent and/or not de minimis, the California utilities are obligated to maintain Rule 2 limits and make the necessary distribution grid upgrades to maintain voltage levels.

Without activation of Volt Watt Mode, the costs of distribution upgrades that could be resolved with some minimal utilization of Volt Watt Mode will be borne by ratepayers. With the activation of Volt Watt Mode, only distribution upgrades that are truly needed due to persistent and severe circuit voltage conditions will be borne by ratepayers.

Sub-issue: Impact of Activation of Function 6Protests

Sunrun argues that the default activation of Function 6 for all prospective DER customers creates curtailment risks that have not been studied.

Comments on Draft Resolution

CALSEIA and IREC assert that activating Volt Watt Mode will have a devastating impact on a small percentage of customers. SEIA and Sunrun claim that customers, who may not be contributing to the problem, would not be able to plan for, control for, fix, or even be aware there are issues. Sunrun recommends that if the Commission decides to allow mandatory activation, an exemption can be created for low-impact DERs, such as non-export and under 10 kW systems.

Sunrun and IREC argue that project financing will be affected. IREC states that the IOUs could offer a means for customers to receive reimbursements for energy production losses that exceed an established “reasonable limit.” IREC argues that there must be customer protection schemes in place before activation. Sunrun argues that activation of Volt Watt Mode will particularly harm the financing of DERs for low and middle-income customers.

Discussion

The activation of Volt Watt Mode as a default in smart inverters is expected to have a small impact on a small number of DER customers. The IOUs provided Energy Division data to show that all three IOUs maintain voltage within the Rule 2 limits over 99% of the time throughout 2017. The data is attached in Appendix C. Since the Volt Watt Mode function will activate when voltage exceeds 106%, which is a full 1% of nominal voltage above the Rule 2 limits, the incidence of curtailment of real power is expected to be lower than 1%. PG&E and SDG&E estimated that approximately 0.1% of customers would experience more than 1% of curtailment of real power based on historic smart meter data. The PG&E data included the full dataset from PG&E meters and not just meters with existing solar. The estimation assumed a worst case scenario and that no mitigation would occur as is later discussed below on the voltage complaint process. Therefore, the activation of Volt Watt Mode is expected to have a de minimis impact.

The IOUs have the capability to monitor voltage through smart meter data and they report that they are actively examining these readings for voltages outside of Rule 2 limits. The IOUs' monitoring and response to this data will help to prevent voltage deviations above 106% of nominal voltage, thereby reducing the frequency with which the Volt Watt Mode is triggered and reducing the length of time that Volt Watt Mode is used when necessary.

In the event that customers, with or without DERs, experience voltage issues, these customers can and should report these issues to the utility. The Volt Watt Mode will assist in discovering these voltage issues and ensuring that they are not exacerbated. Reporting on the voltage complaint process, as is discussed later in this Discussion section, will assist with enforcing utility compliance with Rule 2 and ensuring voltage issues are resolved in a timely and appropriate manner.

The IOUs all have a voltage complaint process. If a customer experiences a voltage issue, they can contact utility customer support. The utilities each have an obligation to respond to the customer within a matter of days. Standard utility practice has been to resolve voltage deviations on the utility side of the meter within five business days, once the utility is aware of the issue and the voltage deviation can be resolved without significant infrastructure upgrades. We acknowledge that not all DER customers will be actively monitoring their generation. Therefore, we clarify that third parties, such as the developer or inverter manufacturer, may contact the utility on behalf of the DER customer.

In the case that utility engineering analysis uncovers that the voltage issue is caused by the customer, it is the customer's responsibility under Rule 2 to resolve the issue.²⁷ In this situation, the IOU works with the customer to help the customer adjust their settings if feasible or coordinate on the appropriate infrastructure upgrades. Volt Watt Mode helps these customers to stay in compliance with Rule 2. The alternative could be worse for the customer. If their

²⁷ The Rule 2 tariffs specify that the IOUs have the responsibility of delivering appropriate service voltages to customers and customers are responsible for not creating service interference to others including causing voltage to go outside of the Rule 2 ranges. If customers do cause interference, they are obligated to pursue corrective action to address it.

voltage rises above 110% of nominal voltage, then their system automatically trips off, which would have more of an impact on their power production than the small amount of curtailment from the use of Volt Watt Mode.

It is also likely that the Volt Watt Mode is the preferred option over potentially costly distribution upgrades that are dedicated to a single customer and paid for by that customer and may delay the DER customer from interconnecting with the grid before the distribution upgrade is installed. The Volt Watt Mode also prevents further impact to other customers resulting from the high voltage.²⁸

The activation of the Volt Watt Mode function and the utility voltage resolution process serve to both fix voltage issues as they arise and determine the appropriate responsibility for resolving the voltage issues. Thus, the activation of Volt Watt Mode is warranted and valuable.

In order to monitor that the IOUs are satisfying their Rule 2 obligations, we order the IOUs to monitor the frequency and amount of voltage excursions, in particular on circuits where smart inverters are being utilized that have the Volt Watt Mode function activated, and present findings to the Commission. The IOUs shall coordinate with the Smart Inverter Working Group to develop appropriate reporting methodologies to estimate the impact of activating Function 6 and to allow the Commission to examine and enforce utility compliance with Rule 2. We encourage stakeholders to provide their own data as well to compare with the IOU data and better inform the Commission. We order Commission Staff to monitor IOU compliance with Rule 2 and IOU response to DER or non-DER customer complaints about Rule 2 voltage violations. We expect smart inverter communication functions to facilitate the gathering and analysis of this data. After working with the SIWG, the IOUs shall file Advice Letters with proposed reporting methodologies via Tier 1 Advice Letter by October 1, 2018. The Advice Letter will include the data that will be provided and the source of the data that will be provided in the reporting. The IOUs shall

²⁸ The IOUs have Volt Var Optimization (VVO) programs and specifically those related to Conservation Voltage Reduction (CVR). The purpose of CVR programs is to operate voltages within the lower regions of the Rule 2 voltage ranges. Studies to date have shown that lower voltages generally result in lower electricity consumption.

also consider whether it is appropriate to report on customer-sourced data in the Advice Letters.

To provide in-depth monitoring when activation of Function 6 begins, the IOUs shall file quarterly reports via Tier 1 Advice Letter utilizing the approved reporting methodologies on voltage excursions for one full calendar year, i.e. four reports, starting three months after the mandatory activation of Function 6. Following this year, the IOUs shall file annual reports on voltage excursions via Tier 1 Advice Letter with a file date based on the anniversary of the activation of Function 6. No sooner than five years after the activation of Function 6, the IOUs may file proposals via Tier 2 Advice Letter on whether to continue or modify the reporting requirement.

If we find that the IOUs are not resolving voltage issues within a timely period that are on the utility side of the meter, and thus, the responsibility of the IOU, we may determine to deactivate the Volt Watt Mode at a later time. In order to do so, we order the IOUs to report on their voltage complaint resolution process. Specifically, we order the IOUs to report on how many voltage complaints were received with categories for both DER and non-DER customers, whether the complaint was from the customer or a third-party on behalf of the customer, the duration it took to resolve each complaint, whether the voltage issue was on the utility side or the customer side of the meter, the method for resolving the voltage issue, and the cost of the method for resolving the voltage issue.

Similar to the reporting on voltage excursions, the IOUs shall file quarterly reports via Tier 1 Advice Letter on the voltage complaint process for one full calendar year, i.e. four reports, starting three months after the mandatory activation of Function 6. Following this year, the IOUs shall file annual reports on the voltage complaint process via Tier 1 Advice Letter with a file date based on the anniversary of the activation of Function 6. No sooner than five years after the activation of Function 6, the IOUs may file proposals via Tier 2 Advice Letter on whether to continue or modify the reporting requirement.

By the time of the first quarterly Tier 1 Advice Letter the utilities shall update their websites with clearly identified and easy to find information explaining their respective voltage complaint processes, including steps of the customer and utility and how a customer can contact the utility regarding a voltage issue. This

section of utility website should explain how the utility determines if the cause of a voltage issue is attributable to the utility or the customer.

While stakeholders have indicated concerns about significant amounts of curtailment posed to an unknown minority of DER customers, we point to the Integration Capacity Analysis (ICA) tool developed in the DRP proceeding for identifying likely places where utilization of Volt Watt Mode would be prevalent. The ICA tool will determine the available hosting capacity of every circuit in the IOUs' service territories to accommodate DERs and includes the examination of voltage limitations. The ICA tool will help DER developers site projects in grid locations that are unlikely to trigger system upgrades including those to resolve voltage issues caused by DERs. The ICA tool is to be published publicly this summer, which is before when Volt Watt Mode would be activated.

Sunrun's recommendation that "low-impact" DERs be exempted is not persuasive. To date, California has installed over 6,000 megawatts of photovoltaic systems. Aggregated, these DERs have an impact. Furthermore, the exemption of some systems will only result in an impact shift to the customers without the exemption.

We reject the notion that project financing will be impaired. Volt Watt Mode involves situations that will be quickly fixed by the utility, resulting in de minimis impact to customers, or situations that are the responsibility of the DER customer. Customers should not be compensated for issues that they are solely responsible for resolving under Rule 2.

Finally, we disagree with the argument that Volt Watt Mode will particularly harm low and middle-income customers. Since we have found that Volt Watt Mode is expected to have a de minimis impact on all DER customers, there is no reason to expect there to be a significant impact particularly to these customers. There is no evidence presented that utility circuits susceptible to voltage excursions at various penetration levels of DERs are correlated to customer income levels.

Sub-issue: Whether Volt Watt Mode Is Considered a Grid ServiceComments on Draft Resolution

Sunrun draws attention to the fact that voltage support has been identified in other proceedings including the IDER proceeding. CESA and IREC recommend the development of tariffs for grid services before activation.

Discussion

Voltage support is one of the four identified grid services in the IDER proceeding that can be procured as “non-wires alternatives.” This Resolution addresses a different issue – reducing voltage that may be caused by DER customers that are obligated to resolve them under Rule 2 through the use of Function 6. The proposed default setting would result in an amount of curtailment that is too small to compensate for those that are not responsible under Rule 2. In the case that the customers are responsible, they are requesting compensation for an issue they are responsible to fix under Rule 2. Thus, the proposed default setting is not considered a grid service, but rather compliance with Rule 2 established for grid safety. Activation of Volt Watt Mode does not preclude the Commission establishing compensation for any grid services in the future, particularly customized settings that are for staying with Rule 2 limits, rather than response for when the utility circuit is already out of Rule 2 compliance.

Sub-issue: Whether Activation Violates the Public Utility Regulatory Policies Act of 1978Comments on Draft Resolution

Sunrun states that curtailing DERs prevents customers from serving their own load, requiring them to buy power from the utility and violating the Public Utility Regulatory Policies Act of 1978.

Discussion

We refute Sunrun’s claim that the function prevents customers from serving their own load. In its comments, Tesla states that when inverters discharge to cover onsite load, they do not directly cause voltage rise beyond the point of common coupling. The tariff language in Appendix B also allows for measurement at the point of common coupling. Thus, it is primarily when customers are discharging to the grid and not using their own generation that voltage issues arise and use of the functions is necessary.

In addition, there is no PURPA issue with activation of Function 6. PURPA does not provide an unrestrained right to export all power produced. A utility may discontinue purchases from a facility that is contributing to a system emergency. Further, Appendix B has been revised to address stakeholders' concern that activation of Function 6 could prevent customers from serving their own load.

Sub-issue: Whether to Require Reporting

Draft Resolution Outcome

The Draft Resolution ordered the IOUs to report on the impacts to DER customers from the activation of Function 6.

Comments on Draft Resolution

Sunrun states that it is not aware of any inverter models that can track curtailment posed by the activation of Volt Watt Mode.

The IOUs request to remove the reporting requirement on the impacts of activating Function 6 from the original Draft Resolution. The IOUs argue that they do not have the ability to track or record impacts to DER for activating the functions and is not privy to the data produced by the DER owner/operator which they claim is the only one that could calculate any curtailment. The IOUs further contend that even if DER owners/operators notified the utility, there is no straightforward way to verify the accuracy of the information.

Discussion

We have modified this requirement. We find the removal of reporting to be an inadequate outcome. Without reporting, the Commission could not determine whether the IOUs are fulfilling their obligation under Rule 2 and whether Function 6 should continue to remain activated. Thus, we reject the request to remove the reporting requirement.

Stakeholders indicate complications regarding the ability to measure the amount of reduced power production. The IOUs also comment that the IOUs are neither privy to nor are able to track and record reductions and would be reliant on self-reporting by the DERs. The evidence to date has shown that DER customer impact is not the appropriate reporting required but rather the amount of voltage deviations and the timing of resolving voltage issues.

We order the IOUs to work with the Smart Inverter Working Group to develop a reporting methodology to ensure that the appropriate voltage data is obtained. After working with the SIWG, the IOUs shall file Advice Letters with proposed reporting methodologies via Tier 1 Advice Letter by October 1, 2018. We also order the IOUs to file quarterly and annual reports via Tier 1 Advice Letter following the mandatory activation date of Function 6 on voltage data using the reporting methodologies, as specified previously.

In addition, we order the IOUs to report file quarterly and annual reports on their voltage complaint process following the mandatory activation of Function 6, as specified previously.

Conclusion of Issue 6

Therefore, we find the IOU proposal to be reasonable and adopt Function 6 into Rule 21. We also approve the IOUs' request to have mandatory activation of Function 6. We order the IOUs to collaborate with the Smart Inverter Working Group to develop reporting methodologies on voltage data and file a Tier 1 Advice Letter by October 1, 2018 on the proposed methodologies. We order the IOUs to report on voltage data following the mandatory activation of Function 6 in quarterly and annual reports via a Tier 1 Advice Letter. We also order the IOUs to report on the voltage complaint process as discussed in this section in quarterly and annual reports.

The IOUs shall incorporate Function 6 when making the supplemental compliance Advice Letter filing. The IOUs shall incorporate the default setting of 106% for the default of activation of Function 6, Volt Watt Mode, and the ability for customers to reduce real power as measured at the Point of Common Coupling, as specified in Appendix B.

Issue 7: Remove or Clarify Function 7, Dynamic Reactive Support

Protests

Several parties (CALSEIA, the Joint Stakeholders) contend that the tariff revisions left Function 7, Dynamic Reactive Power Support, as undefined and recommend that the function either be removed or clarified with additional details.

Workshop

Stakeholders at the October 25, 2017 workshop requested clarification on the proposed language of Functions 4 and 7 that the functions are “Optional Upon Mutual Agreement between Utility and Applicant.” Specifically, they inquired whether it was optional to have the capability or optional to activate the functions once the capability is mandatory.

Comments on Draft Resolution

In comments to this Resolution, CALSEIA reiterates concerns with Function 7, Dynamic Reactive Support. CALSEIA asserts that Function 7 must be better defined before it is required, that more discussion is warranted, and the Resolution is contradictory in regards to requiring the function.

Discussion

In regards to stakeholders’ request for clarification, we determine the function capabilities are required and the activation of the functions is optional. We clarify that the Phase 3 development is for establishing the capability of smart inverters. Our reason is that without requiring smart inverters to have these capabilities, this effort does not achieve the goal of enhancing DERs’ ability to integrate into the grid. Thus, we determine that the capability for Functions 4 and 7 is required for all new inverter-based Rule 21 interconnections, along with the other six functions.

We acknowledge the need for clarification of the technical requirements for these two functions. However, to avoid delaying the implementation of all smart inverter Phase 3 functions, we approve the proposed tariff revisions for Function 4 and Function 7 as proposed and order the IOUs to each file a Tier 2 Advice Letter no later than eight months after the approval of this Resolution. The Tier 2 ALs shall clarify the technical requirements for Functions 4 and 7. The IOUs are ordered to work with the SIWG to clarify these requirements. The IOUs shall attach to their ALs a report summarizing the degree of consensus achieved for the revised technical requirements of Functions 4 and 7.

Since the IOUs submitted the ALs, the update to IEEE 1547 was approved. The updated standard does not have Function 4 or Function 7. Requiring capability to perform Function 4 and Function 7 would create the need for additional certification development and, if the certification and certification process were not developed by December 2019, would result in a situation where there was a

requirement that no customer could comply with. To prevent this situation, the effective date of Function 4 is modified to 12 months after a nationally recognized standard with Function 4 is approved and the effective date of Function 7 is modified to 12 months after a nationally recognized standard with Function 7 is approved. The final set of approved effective dates is in Table 2 of this Resolution.

To address concerns expressed in comments, the Tier 2 Advice Letter filing was extended from five months to eight months and the effective dates of Function 4 and Function 7 were modified to 12 months after nationally recognized standards with Function 4 and Function 7 are approved.

Conclusion of Issue 7:

Therefore, we determine Functions 4 and 7 are required and order the IOUs to work with the Smart Inverter Working Group to clarify the technical requirements in eight months.

The IOUs shall incorporate Functions 4 and 7 as proposed when making the supplemental compliance Advice Letter filing. The IOUs shall make supplemental compliance Advice Letter filings to conform their Rule 21 tariffs to the agreed-upon effective dates approved in this Resolution in Table 2.

Table 2: Final Effective Dates

Function	Effective Date
Function 1 Monitor Key DER Data	9 months following SunSpec Alliance Communication Protocol Certification Test Standard.
Function 2 DER Disconnect and Reconnect Command (Cease to Energize and Return to Service)	Earlier of: 1) December 2019 or 2) 12 months after approval of the IEEE 1547.1 standard revision.
Function 3 Limit Maximum Active Power Mode	Earlier of: 1) December 2019 or 2) 12 months after approval of the IEEE 1547.1 standard revision.
Function 4 Set Active Power Mode	12 months after approval of a nationally recognized standard that includes the function.

Function	Effective Date
Function 5 Frequency Watt Mode	9 months following SunSpec Alliance Communication Protocol Certification Test Standard.
Function 6 Volt Watt Mode	9 months following SunSpec Alliance Communication Protocol Certification Test Standard.
Function 7 Dynamic Reactive Support	12 months after approval of a nationally recognized standard that includes the function.
Function 8 Scheduling Power Values and Modes	9 months following SunSpec Alliance Communication Protocol Certification Test Standard.

Issue 8: Need for Function 8

Protests

Several parties (SEIA, CALSEIA, Sunrun, the Joint Stakeholders) state that the need for Function 8, Scheduling Power Values and Modes, has not been demonstrated and it is unclear if, why, and when the functionality would be utilized. CALSEIA recommends that the function should be optional. Sunrun argues that the proposed Function 8 standards are California-specific, and that these standards and accelerated timelines for meeting the new requirements would diminish the health and vibrancy of California's inverter market. The Joint Stakeholders note that scheduling functionality is not part of the new IEEE 1547 standard and would be California-specific.

Comments on Draft Resolution

In comments to the Resolution, several parties (CALSEIA and Tesla) restated concerns on the need for Function 8, Scheduling Power Values and Modes. These parties argue that the function capability should be optional because the SIWG recommendation report stated that the functions were recommended to be included as mandatory or optional capabilities, and the capability is unnecessary.

Discussion

We do not find these arguments to be convincing to prevent smart inverter development in California. The SIWG Phase 1 functions were California-specific at the time of their adoption. It was only after the Phase 1 functions were placed into Rule 21 that the international standard IEEE 1547 developed similar

functionality. Furthermore, many if not all of the protestors are part of the Smart Inverter Working Group which set the Phase 3 advanced function recommendations and identified scheduling as a key capability to be added to Rule 21. Therefore, we reject CALSEIA's recommendation that the function be optional. We also note that the issue of developing forms and agreements to allow distributed energy resource aggregators to fulfill Rule 21 requirements which may include Function 8 is scoped into the R.17-07-007 and a Proposed Decision for the proceeding is estimated to be voted on Fall 2018.

Conclusion of Issue 8:

We find that requiring the capability to perform Function 8 is reasonable and will be required.

The IOUs shall incorporate Function 8 when making the supplemental compliance Advice Letter filing.

Issue 9: IOUs' Proposed Modifications to the Phase 2 Communications Requirements in Rule 21

Protests

Sunrun contends that the proposed monitoring, communications and control requirements go beyond establishing the capabilities needed to operationalize DER aggregation to implicating customers' privacy interests and would require substantial upfront investments with no corresponding opportunities for returns. Sunrun has concerns with excluding aggregators from fulfilling communication capability requirements.

The Joint Stakeholders argue that aggregators must be allowed to fulfill the communication capability requirements. The Joint Stakeholders recommend that the communication requirements should not be required as a capability until 12 months after either 1) aggregators are allowed to perform the monitoring and control, and the IOUs have approved implementation plans, which include funding for the utility and compensation for the inverter-based technologies, to use the communication capability or 2) the new IEEE P1547.1 standard is published.

SEIA also states that the communication requirements should remain as they are currently specified in Rule 21.

IOU Replies to Protests

The IOUs assert that additional regulatory work is required in order to implement the ability for smart inverter Phase 2 communications requirements to be fulfilled through an aggregator. SCE and SDG&E suggest that this aggregator work be placed within scope of the interconnection proceeding, R.17-07-007.

Discussion

In the Advice Letters, the IOUs proposed modifications to the communication requirements, which effectively prohibit the ability for aggregators to fulfill the communications requirements of smart inverters for Rule 21 at this time. The Commission already approved the Phase 2 communication requirements in Resolution E-4832 on April 6, 2017. Therefore, we reject the IOU-proposed modifications to the smart inverter communication requirements as they attempt to address a matter the Commission has already ruled upon.

Since the Commission already approved Phase 2 Communication requirements that named aggregators as capable of fulfilling Smart Inverter communication functions, we reiterate that aggregators will have a role in fulfilling Rule 21 Smart Inverter Functions. The Scoping Memo of the Rule 21 proceeding R.17-07-007, filed October 2, 2017, has scoped the development of forms and agreements to allow aggregators to fulfill Smart Inverter requirements. The Commission is scheduled to issue a Decision on aggregator forms and agreements in fall 2018. Stakeholders acknowledged this at the October 25, 2017 workshop and supported parallel timelines for the smart inverter communication function implementation date²⁹ and the development of the aggregator forms and agreements. We refer parties to participate in R.17-07-007 for further discussion of this issue, and therefore, determine that this issue is out of scope for this Resolution.

²⁹ The communication requirements are mandatory on or after the later of 1) March 1, 2018 or 2) 9 months after the release of the SunSpec Alliance communication protocol certification test standard or the release of another industry-recognized communication protocol certification test standard.

Finally, we reject the Joint Stakeholders' recommendation to change the implementation date for the communication requirements, because Resolution E-4832 already approved the effective date for Phase 2 smart inverter communications as well.

Conclusion of Issue 9:

We find that the Phase 2 communication requirements were already approved in Resolution E-4832 and reject the IOU proposal for modification.

The IOUs shall remove the proposed modifications to Rule 21 Phase 2 communication requirements when making the supplemental compliance Advice Letter filing.

Issue 10: All Functions to Be Permissible by Mutual Agreement Before the Mandatory DateWorkshop

At the October 25, 2017 workshop, stakeholders agreed to provide the option for the utilization of the functions before the effective dates upon mutual agreement between the utility and inverter-based generating facility.

Discussion

We find that the ability to utilize the Phase 3 Functions prior to the effective dates by mutual agreement between the utility and generating facility reflects the consensus of the Smart Inverter Working Group and should be adopted into the Rule 21 tariffs.

Conclusion of Issue 10:

We order the IOUs to add the following language to each Phase 3 function in Rule 21 with the effective dates discussed in the previous section.

The utilization of this function is permissible under mutual agreement between the utility and the generating facility before the effective date.

The IOUs shall make a supplemental compliance Advice Letter filing to modify their Rule 21 tariffs to incorporate the ability to utilize the Phase 3 Functions

prior to the effective dates by mutual agreement between the utility and the generating facility.

Issue 11: IOUs' Request for Additional Time to File Compliance Advice Letters

Comments on Draft Resolution

The joint IOUs request additional time to file the Tier 1 compliance Advice Letters to modify their Electric Rule 21 Tariffs to incorporate the changes as ordered in this Resolution.

Discussion

Given the workload required to make the adjustments and that the adjustments do not change the effective dates, we find it reasonable to grant additional time for the IOUs to submit the compliance Advice Letters and determine 30 days is sufficient.

Conclusion of Issue 11:

The IOUs shall have 30 days for the supplemental compliance Advice Letter filings.

Issue 12: The Federal Executive Agencies' Request for Exemption from Phase 3 Requirement

Comments on Draft Resolution

FEA requests an exemption for military installations to have smart inverters with Phase 3 functionality as they do not allow for remote internet connection to their infrastructure.

Discussion

On January 30, 2018, FEA met with the IOUs and determined that this Resolution is not the appropriate place to resolve their concerns. Further discussions for the FEA with the IOUs and the Energy Division are expected. There is sufficient time for discussion with the FEA on how implementation of Phase 2 and Phase 3 functions will work before the effective date. This will allow time to identify any potential concerns with cybersecurity and steps to address them.

Conclusion of Issue 12:

No change to this Resolution is necessary.

Table 3: Summary of Resolution Conclusions by Function

Function	Section of Resolution E-4898	Outcome of Resolution E-4898
Function 1 Monitor Key DER Data	Resolved through Issue 3.	We Adopt Technical Requirements Included in Appendix A.
Function 2 DER Disconnect and Reconnect Command (Cease to Energize and Return to Service)	Resolved through Issue 4.	We Determine There Is No Need to Prohibit Utilization of Function.
Function 3 Limit Maximum Active Power Mode	Resolved through Issue 4.	We Determine There Is No Need to Prohibit Utilization of Function.
Function 4 Set Active Power Mode	Resolved through Issue 7.	We Determine Function Is Required and Order IOUs to File Technical Requirements in Eight Months.
Function 5 Frequency Watt Mode	Resolved through Issue 5.	We Modify the Technical Requirement, Adopt the IOU Proposal that Activation Is Mandatory.
Function 6 Volt Watt Mode	Resolved through Issue 3 and Issue 5.	We Adopt Technical Requirements Included in Appendix B . We Adopt IOU Proposal that Activation Is Mandatory and Order IOUs to Monitor Voltage and Voltage Resolution Process.
Function 7 Dynamic Reactive Support	Resolved through Issue 7	We Determine Function Is Required and Order IOUs to File Technical Requirements in Eight Months.
Function 8 Scheduling Power Values and Modes	Resolved through Issue 3 and Issue 8.	We Adopt Technical Requirements Included in Appendix A. We Determine Capability Is Required.
Effective Dates	Resolved through Issue 2.	We Adopt Consensus Effective Dates.
Communication Requirements	Resolved through Issue 9.	We Determine that Communication Requirements Were Already Adopted in Resolution E-4832 and Reject IOUs' Proposal for

		Modification.
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COMMENTS

This Resolution was mailed December 6, 2017. Comments were timely filed on or before December 29, 2017 by the joint IOUs, the California Energy Storage Association (CESA), CALSEIA, SEIA, the Federal Executive Agencies (FEA), the Interstate Renewable Energy Council (IREC), Sunrun, and Tesla.

Our findings and determination are provided, by issue, in the Discussion Section above.

MARCH 22, 2018 COMMISSION MEETING

This Resolution was discussed at the March 22, 2018 Commission Meeting. In response to the discussion at the Commission Meeting, modifications are made to this Resolution. These modifications include amendments to the frequency and duration of reporting for Function 5 and Function 6, revisions to the technical requirements of Function 6, and adjustments to the effective date of Function 7.

FINDINGS

1. D.16-06-052 directed the IOUs to file Advice Letters to incorporate the Smart Inverter Working Group Phase 3 Advanced Functions Recommendations into Electric Rule 21 Tariff.
2. San Diego Gas & Electric filed AL 3106-E on August 17, 2017. Pacific Gas and Electric and Southern California Edison filed ALs 5129-E and 3647-E on August 18, 2017.
3. On October 25, 2017, the Energy Division held a public workshop to assist the IOUs and the Smart Inverter Working Group to reach consensus on the Phase 3 advanced functions requirements and to discuss the Advice Letters.
4. The Smart Inverter Working Group achieved significant consensus on technical requirements, testing and certification processes, and effective dates.

5. Pacific Gas and Electric, Southern California Edison and San Diego Gas & Electric properly filed revisions to Electric Rule 21 Tariff to comply with D.16-06-052 Ordering Paragraph 9.
6. Acceptance of a late protest was in the public's interest and there was no harm rendered in accepting a late protest.
7. The Smart Inverter Working Group is a collaborative process that often yields significant stakeholder consensus to help inform Commission decision making.
8. It is reasonable for the Commission to consider consensus and non-consensus view points of Smart Inverter Working Group members and make decisions on the merits of each issue.
9. The IOUs and the Smart Inverter Working Group worked in good faith to develop the technical requirements, testing and certification processes, and effective dates for the smart inverter Phase 3 advanced functions.
10. D.16-06-052 neither required nor prohibited the IOUs from proposing revisions to Electric Rule 21 Tariff setting forth mandatory activation requirements for Function 5, Frequency Watt Mode, and Function 6, Volt Watt Mode.
11. Activation of Function 5 and Function 6 does not preclude the Commission determining that customers should be compensated at a later time.
12. The revised effective dates for the Phase 3 advanced functions reflect consensus of the Smart Inverter Working Group.
13. It is reasonable to incorporate the consensus-based effective dates.
14. The Electric Rule 21 Tariff revisions in Appendix A reflect consensus technical requirements from the October 25, 2017 workshop.
15. It is reasonable to adopt the consensus technical requirements in Appendix A for Functions 1, Monitor Key DER Data and Function 8, Scheduling Power Values and Modes.
16. The proposed revisions for Function 2, DER Disconnect and Reconnect Command, and Function 3, Limit Maximum Active Power Mode, require smart inverters to have the capability to perform these functions and do not require the functions to be used.
17. It is reasonable to adopt the proposed revisions for Functions 2 and 3 as proposed.
18. It is reasonable to align with IEEE 1547 for Function 5.
19. The default setting of Function 5 does not prevent DER customers from participating in future frequency regulation markets.

20. The activation of Function 5 does not violate the Public Utility Regulatory Policies Act of 1978.
21. It is reasonable for the IOUs to require activation of Function 5.
22. It is reasonable to require the IOUs to report on frequency events.
23. The default setting of 106% nominal voltage for Function 6 is for backup purposes and not as a permanent voltage regulation solution.
24. Activating Volt Watt Mode as a default in smart inverters is expected to minimally impact a small number of DER customers based on the data the IOUs shared with the Commission and stakeholders.
25. The IOUs actively design and operate the grid to meet Electric Rule 2 Tariff requirements.
26. The IOUs have the capability to monitor voltage through smart meters.
27. Data obtained by the Commission's Energy Division shows that all three IOUs maintain voltage within Rule 2 limits over 99% of the time. Since Volt Watt Mode activates only after 106%, which is past the Rule 2 limits, the occurrence of curtailment of real power is expected to be low.
28. Under Rule 2, customers are obligated to resolve any service interferences they cause to other customers such as voltage deviations.
29. The IOUs have voltage complaint processes.
30. It is reasonable for the IOUs to require activation of Function 6, Volt Watt Mode.
31. It is reasonable to have the Smart Inverter Working Group hold discussions on standardizing reporting methodologies in order to monitor and report voltage excursions outside of Rule 2 limits.
32. It is reasonable to have the IOUs report on their voltage complaint processes.
33. The activation of Function 6 does not violate the Public Utility Regulatory Policies Act of 1978.
34. It is reasonable to adopt the technical requirements in Appendix B for Function 6, Volt Watt Mode.
35. Development of Function 4, Set Active Power Mode, and Function 7, Dynamic Reactive Current Support, requires additional discussion.
36. It is reasonable to require the utilities to propose additional technical requirements for Functions 4 and 7 eight months from the effective date of this Resolution.
37. It is reasonable for the IOUs to require the capability to perform Function 4 and Function 7 as proposed.
38. It is reasonable for the IOUs to require the capability to perform Function 8.

39. Resolution E-4832 approved the revisions to Electric Rule 21 Tariff to incorporate the Smart Inverter Working Group Phase 2 Communications Recommendations.
40. The Commission approved the ability of aggregators to fulfill smart inverter Phase 2 communication requirements in Resolution E-4832.
41. R.17-07-007 has scoped the issue of developing the forms and agreements for distributed energy resources aggregators to fulfill Rule 21 requirements related to smart inverters.
42. R.17-07-007 has scoped the operational requirements of smart inverters and the rules and procedures for adjusting smart inverter functions via communication controls.
43. It is reasonable to allow utilization of functions under mutual agreement between the utility and customer before the effective date of each function.

THEREFORE IT IS ORDERED THAT:

1. Advice Letters PG&E 5129-E, SCE 3647-E, and SDG&E 3106-E are approved as modified herein.
2. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall each file a supplemental Tier 1 compliance Advice Letter within 30 days to modify Electric Rule 21 Tariff to incorporate the changes as ordered herein:
 - a. The IOUs shall incorporate the consensus-based effective dates in Table 2 of this Resolution;
 - b. The IOUs shall incorporate the revisions to the technical capability requirements in Appendix A of this Resolution on Functions 1 and 8;
 - c. The IOUs shall incorporate the technical capability requirements of Functions 2, 3, 4, and 7, as proposed;
 - d. The IOUs shall incorporate the IEEE 1547 default setting for Function 5;
 - e. The IOUs shall incorporate the revisions to the technical capability requirements in Appendix B of this Resolution on Function 6;
 - f. The IOUs shall remove the proposed modifications to Phase 2 communications requirements; and
 - g. The IOUs shall incorporate the ability to utilize the Phase 3 Functions prior to the effective dates by mutual agreement between the utility and the generating facility.
3. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall develop reporting methodology to monitor the frequency and

duration of frequency events and, in consultation with the Commission's Energy Division, shall each file a Tier 1 Advice Letter on the proposed methodology no later than 90 days after the effective date of this Resolution.

4. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall each file quarterly reports via Tier 1 information-only Advice Letter for one year starting three months after the mandatory activation of Function 5 on frequency events with the methodology approved by the Tier 1 Advice Letters from Ordering Paragraph 3, and following the completion of the quarterly reports, shall file annual reports on frequency events via Tier 1 information-only Advice Letter. No sooner than five years after the activation of Function 5, the IOUs may file proposals via Tier 2 Advice Letter on whether to continue or modify the reporting requirement.
5. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall work with stakeholders to develop standardized reporting methodologies to monitor the frequency and amount of voltage excursions and, in consultation with the Commission's Energy Division, shall each file a Tier 1 Advice Letter on the proposed methodologies by October 1, 2018.
6. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall each file quarterly reports via Tier 1 information-only Advice Letter for one year starting three months after the mandatory activation of Function 6 on voltage data with the methodologies approved by the Tier 1 Advice Letters from Ordering Paragraph 5, and following the completion of the quarterly reports, shall file annual reports on voltage excursions via Tier 1 information-only Advice Letter. No sooner than five years after the activation of Function 6, the IOUs may file proposals via Tier 2 Advice Letter on whether to continue or modify the reporting requirement.
7. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall each file quarterly reports via Tier 1 information-only Advice Letter for one year starting three months after the mandatory activation of Function 6 on the voltage complaint process, and following the completion of the quarterly reports, shall file annual reports on the voltage complaint process via Tier 1 information-only Advice Letter. No sooner than five years after the activation of Function 6, the IOUs may file proposals via Tier 2 Advice Letter on whether to continue or modify the reporting requirement.
8. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall each file a Tier 2 Advice Letter proposing revisions to Electric Rule 21 Tariff setting forth additional technical requirements for Function 4

and Function 7 and a report on consensus and non-consensus, no later than eight months from the effective date of this Resolution.

This Resolution is effective today.

I certify that the foregoing resolution was duly introduced, passed and adopted at a conference of the Public Utilities Commission of the State of California held on April 26, 2018; the following Commissioners voting favorably thereon:

/s/ALICE STEBBINS
ALICE STEBBINS
Executive Director

MICHAEL PICKER
President

CARLA J. PETERMAN
LIANE M. RANDOLPH
MARTHA GUZMAN ACEVES
CLIFFORD RECHTSCHAFFEN
Commissioners

APPENDIX A – Electric Rule 21 Tariff Revisions Incorporating Agreed-Upon Technical Requirements from the October 25, 2017 Workshop

Note that the effective dates in the revised tariff language below do not yet reflect the consensus-based dates which were determined through the October 25, 2017 workshop and this Resolution. These have been marked for illustrative purposes. The consensus-based dates are in Table 2 of this Resolution.

Function 1, Monitor Key DER Data

Section Hh.7. Monitoring and Telemetry Requirements

The capability for this requirement will become mandatory for Generating Facilities utilizing inverter-based technologies for which an Interconnection Request is submitted ~~on or after the later of (a) March 1, 2018 or (b) nine months after the release of the SunSpec Alliance communication protocol certification test standard or the release of another industry recognized communication protocol certification test standard.~~ The Smart Inverter shall have the capability to communicate its performance information including:

- a. Smart Inverter production or consumption of active power (watts).
- b. Smart Inverter consumption or production of reactive power (vars)
- c. ~~Phase currents measure at the AC terminal of the Smart Inverter (amps)~~
- d. Phase measured at the AC terminals of the Smart Inverter (volts)
- e. Frequency measured at the AC terminals of the Smart Inverter (Hz)

The Smart Inverter shall be capable of communicating the ~~available kWh percentage of operations for the~~ energy-storage ~~capacity.~~ ~~Available kWh~~ **Operational energy** of the energy storage system is amount energy which can be used to support the energy needs of the electric system including the energy needs for the load within the generating facility or the Distribution System.

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

- *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.*
- *When a Generating Facility includes Smart Inverters and other technologies such as synchronous or induction generation systems, the Generating Facility shall communicate the following:*
 - *The production or consumption of active and reactive power shall be communicated in aggregate of all Smart Inverters within the Generating Facility.*
 - *The production or consumption of active and reactive power shall be communicated in aggregate of all the other technologies within the Generating Facility.*
- *When the Generating Facility with Smart Inverters includes one or multiple energy storage systems. The available ~~kWh~~*operational* energy should be communicated as an aggregate of all the energy storage systems.*

Function 8, Scheduling Power Values and Modes

Section Hh.6. Scheduling Capability Requirements

Generating Facilities which incorporate Smart Inverters shall incorporate scheduling capabilities with minimum scheduling memory capability of at least 24 events. The capability for this requirement will become mandatory for Generating Facilities utilizing inverter-based technologies for which an Interconnection Request is submitted on or after ~~the later of (a) March 1, 2018 or (b) nine months after the release of the SunSpec Alliance communication protocol certification test standard or the release of another industry recognized communication protocol certification test standard.~~ Each event is composed of modifications to each, selected group of, or all of the following Smart Inverter function:

- *Modifications to the voltage and reactive set-points of the Dynamic volt/var function.*

- ~~• Modification to the normal ramp-up rate and reconnect ramp-up rate set-points.~~
- Modifications to the reactive power set-points for the fixed power factor function.
- Modifications to the voltage and watt-reduction level set-points for the volt/watt function.

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

Scheduling capability requirements may be stored at the Generating Facility Energy Management System (GFEMS). The GFEMS shall communicate the necessary commands to the Smart Inverters within 10 minutes from when GFEMS received the scheduling information.

Scheduling capability requirements may be stored at the Smart Inverter Control Unit (SMCU) within the Generating Facility. The SMCU shall communicate necessary commands to the Smart Inverters within 10 minutes from when SMCU received the scheduling information.

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.

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

*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.*

*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*

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*duration time or shall enter a new operational mode as directed by the
scheduling control system.*

APPENDIX B - Electric Rule 21 Tariff Revisions Incorporating New Technical Requirements

Note that the effective dates in the revised tariff language below do not yet reflect the consensus-based dates which were determined through the October 25, 2017 workshop and this Resolution. These have been marked for illustrative purposes. The consensus-based dates are in Table 2 of this Resolution.

Function 6, Volt Watt Mode

Section Hh.2.m. Voltage-Watt Default Settings Requirements

This requirement will become mandatory for Generating Facilities utilizing inverter-based technologies for which an Interconnection Request is submitted ~~on or after 12 months from the Phase 3 Smart Inverter Function Advice Letter (AL 3647-E) was made effective by the Commission~~. Smart Inverters shall reduce their real power production as a function of measured voltage at the inverter terminal or at the Generating Facility Point of Common Coupling (PCC) in accordance with the following:

- *When the measured voltage is greater than 106% of nominal voltage (Example: 127.2 volts on a 120 volts nominal), the export of active power ~~at the PCC or the production of active power~~ by the Smart Inverter shall be reduced at a rate of ~~2550%~~ of active power nameplate rating per one percent of nominal voltage. Figure Hh-3 Volt-Watt Requirements illustrate the required rate of reduction. When export of active power is controlled, a certified inverter and control system shall be used.*
- *When the measured voltage is greater than ~~108~~10% of nominal voltage (Example: ~~129.6~~132 volts on a 120 volts nominal), the export of active power to the grid ~~at the PCC or the production of active power~~ by the Smart Inverter shall be reduced to 0 watts.*

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Pacific Gas and Electric, Southern California Edison, San Diego Gas & Electric
ALs 5129-E, 3647-E, & 3106-E / JK8

**APPENDIX C - Energy Division Voltage Data Request January 30, 2018 on
IOUs' Voltage Excursions Outside of American National Standard Institute's
C 84.1 Voltage Ranges.**

Voltage Deviations Outside of American National Standards Institute (ANSI) Ranges

Description: Each data point is one hourly reading per meter. To make a measurement, the voltage in an interval hour is used and then compared against the ANSI range of +/- 5% from nominal voltage.

	2017												Total	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
PG&E	% datapoints over 105% 0.23% 0.25% 0.34% 0.35% 0.38% 0.49% 0.34% 0.40% 0.44% 0.52% 0.50% 0.47% 0.44% % datapoints under 95% 0.08% 0.07% 0.06% 0.06% 0.07% 0.16% 0.16% 0.16% 0.16% 0.16% 0.16% 0.16% 0.11% 0.11% % datapoints within ANSI range (95-105%) 99.69% 99.68% 99.60% 99.60% 99.54% 99.35% 99.50% 99.45% 99.40% 99.41% 99.42% 99.42% 99.45%													
Count of datapoints over 105%	1,376,751	1,383,985	2,123,837	2,002,026	2,291,949	2,928,461	2,116,372	6,494,641	10,791,697	14,209,431	14,204,262	14,240,678	74,172,290	
Count of datapoints under 95%	469,887	383,410	342,216	319,845	437,511	972,250	976,598	2,559,345	3,807,200	2,071,846	2,071,846	3,326,349	17,825,672	
Total Meters Analyzed	837,667	836,628	836,044	833,504	832,237	838,076	896,726	3,276,535	3,846,203	4,042,519	4,044,464	4,045,967	-	
Total Interval Voltage Reads	601,100,424	560,391,473	619,952,966	579,461,136	596,405,341	699,516,436	622,821,027	1,637,819,234	2,442,322,946	2,754,545,700	2,813,535,778	3,003,397,964	16,639,270,425	
Notes: PG&E limited its response to individual residential meters at typical 240 V nominal. Historically, voltage was not retrieved and archived in order to stay within communication network bandwidths. In August 2017, PG&E enabled all of its meters that had the capability for voltage collection (4+ million). PG&E's data points are instantaneous at time of reads measurements and not average across an hour.														
SCE	% datapoints over 105% 0.61% 0.62% 0.61% 0.55% 0.56% 0.44% 0.37% 0.38% 0.52% 0.58% 0.67% 0.56% 0.54% % datapoints under 95% 0.39% 0.24% 0.15% 0.15% 0.18% 0.49% 0.99% 1.00% 0.69% 0.35% 0.15% 0.15% 0.42% % datapoints within ANSI range (95-105%) 99.04% 99.14% 99.23% 99.30% 99.26% 99.06% 99.63% 98.62% 98.80% 99.06% 99.18% 99.19% 99.04%													
Count of datapoints over 105%	18,178,622	16,586,819	15,903,013	15,814,888	16,819,792	12,686,638	11,192,462	11,376,431	15,047,665	17,504,968	19,342,640	16,089,702	186,742,840	
Count of datapoints under 95%	10,299,234	6,513,358	3,986,040	4,398,482	5,518,941	14,390,239	29,641,173	29,793,295	19,587,636	10,611,456	4,409,977	7,205,255	146,355,086	
Total Meters Analyzed	4,027,878	4,029,066	4,029,770	4,033,361	4,034,146	4,035,394	4,037,848	4,039,997	4,042,354	4,043,923	4,042,907	4,045,897	-	
Total Interval Voltage Reads	2,960,108,435	2,692,028,764	2,594,120,462	2,882,410,123	2,986,354,661	2,993,003,595	2,990,659,621	2,980,926,865	2,897,011,817	2,995,617,657	2,899,491,301	2,881,526,009	34,722,453,330	
Notes: SCE limited its response to individual customer meters at single phase 120 V and 120/240 V, which is approximately 4.1 million meters. SCE's data points are average voltage readings across an hour.														
SDG&E	% datapoints over 105% 0.08% 0.07% 0.09% 0.10% 0.09% 0.09% 0.08% 0.10% 0.10% 0.09% 0.09% 0.08% 0.09% % datapoints under 95% 0.16% 0.16% 0.16% 0.20% 0.20% 0.34% 0.32% 0.38% 0.26% 0.25% 0.25% 0.26% 0.24% % datapoints within ANSI range (95-105%) 99.76% 99.77% 99.74% 99.71% 99.71% 99.57% 99.60% 99.55% 99.64% 99.66% 99.66% 99.65% 99.67%													
Count of datapoints over 105%	2,833	2,112	3,320	3,332	3,266	3,203	2,900	3,367	3,458	3,282	3,097	2,819	37,029	
Count of datapoints under 95%	6,530	5,619	5,796	6,680	7,039	11,590	11,867	12,502	8,946	8,715	5,673	9,178	98,935	
Total Meters Analyzed	3,544	3,540	3,539	3,536	4,037	4,035	4,025	4,023	4,168	3,873	3,876	3,873	-	
Total Interval Voltage Reads	3,518,288	3,467,666	3,516,711	3,407,946	3,521,111	3,406,514	3,520,809	3,521,525	3,407,547	3,516,930	3,413,608	3,474,002	41,692,657	
Notes: SDG&E used the customer meters it has recording 5 minute interval voltage across its service territory. These reads are converted to an hourly read and presented. Expansion to two customer meters per every service transformer is expected later this year.														
PG&E	% datapoints over 105% 0.18% 0.18% 0.26% 0.21% 0.25% 0.32% 0.23% 0.23% 0.25% 0.24% 0.32% 0.26% 0.24% % datapoints under 95% 0.05% 0.05% 0.05% 0.05% 0.05% 0.15% 0.15% 0.10% 0.07% 0.04% 0.07% 0.08% 0.07% % datapoints within ANSI range (95-105%) 99.77% 99.77% 99.69% 99.75% 99.70% 99.53% 99.62% 99.67% 99.69% 99.72% 99.61% 99.65% 99.69%													
Count of datapoints over 105%	1,092,830	1,001,380	1,602,172	1,220,277	1,495,486	1,857,661	1,436,645	1,432,130	1,458,728	1,489,920	1,880,101	1,642,035	17,609,365	
Count of datapoints under 95%	510,124	271,178	325,328	275,528	346,798	719,598	397,487	387,487	387,487	268,090	305,054	320,044	5,394,790	
Total Meters Analyzed	814,070	816,607	816,134	822,880	820,666	840,194	838,879	838,966	836,965	835,998	835,047	838,361	-	
Total Interval Voltage Reads	604,472,723	547,436,213	605,131,321	590,717,394	607,814,926	587,114,123	623,006,303	622,671,090	581,940,937	621,121,578	581,480,289	621,732,619	7,195,450,466	
Notes: PG&E limited its response to individual residential meters at typical 240 V nominal. Historically, voltage was not retrieved and archived in order to stay within communication network bandwidths. In August 2017, PG&E enabled all of its meters that had the capability for voltage collection (4+ million). PG&E's data points are instantaneous at time of reads measurements and not average across an hour.														