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DER Orchestration Research - Request for Information (RFI)

The California Energy Commission (CEC) is gathering information for a potential future solicitation focused on research to expand the functionality of Virtual Power Plants (VPPs) to provide grid services that maintain power quality, which are traditionally met by legacy power plants with fossil gas-fired rotational generators.

Virtual Power Plants (VPPs) are an emerging distributed energy resource (DER) aggregation strategy to orchestrate the performance of DERs and dispatch them to provide grid services that have traditionally been served by conventional gas-fired power plants with spinning generators. Many VPPs today are commonly composed of aggregated flexible demand resources that provide load reduction during times of high grid congestion and peak energy demand. The CEC previously ran a grant solicitation on this topic, GFO-23-309, titled "Virtual Power Plant Approaches for Demand Flexibility (VPP-FLEX)." On October 4, 2024, the CEC selected three VPP project proposals for award under VPP-FLEX to demonstrate community-based VPPs that dispatch flexible loads and contribute to California's goal of 7,000 MW of load shifting resources by 2030.[1]

Beyond coordinating demand response to shed or shift load, VPP platforms have the potential to further orchestrate the operation of DERs to collectively provide frequency response, voltage regulation, power quality, and even power injection. But enhancing the range of VPP functionalities requires effectively valuing and coordinating dispatch of distributed inverter-based energy resources with grid operators.

The EPIC 4 Investment Plan identifies this research need under Topics 11 "Demonstrate Technologies to Maintain Reliability and Power Quality in the Inverter-centric Grid of the Future" and 12 "Furthering Cybersecurity with Highly Modulatable Grid Resources." Topic 11 focuses on developing and demonstrating technologies that help maintain power quality as the grid consists of more inverter-based resources and as traditional rotating generators are rapidly retired. Such technologies should be able to provide power quality services on par with legacy rotating generators, including rotational inertia, harmonics, power factor correction, and frequency/voltage regulation. Topic 12 identifies the need for consistent approaches to incorporating cybersecurity measures into DER projects as the grid becomes more decentralized. The topic would fund research to inform best practices to effectively secure safe coordination of aggregated DERs.
The prospective research under this Request for Information (RFI) would seek to advance VPPs that aggregate clusters of highly concentrated inverter-based resources (e.g., distributed energy storage and distributed solar generation) at the level of the distribution grid. These VPPs would need to perform similarly to conventional spinning generators in maintaining grid

[1] More information on the recent VPP-FLEX grant solicitation can be found here: https://www.energy.ca.gov/solicitations/2024-03/gfo-23-309-virtual-power-plant-approaches-demand-flexibility-vpp-flex.

harmonics, thereby offsetting reliance on centralized fossil gas-based generation. A key research goal would be to demonstrate how VPPs can serve bulk grid needs while simultaneously providing distribution grid-level services that both alleviate grid congestion due to electrification load growth and defer expensive infrastructure upgrades.

To achieve California's goal of 90 percent clean energy by 2035 and 100 percent by 2045, viable replacement resources for traditional fossil gas-fired power plants must exist before the plants can be phased out. Not only do these large power generators provide flexible ramping resources, but their spinning electromagnetic generators – used to generate three-phase AC power – also provide important physical inertia for maintaining power quality.

The clean energy transition necessitates that a growing percentage of energy generation will come from inverter-based resources (i.e., wind, solar, and energy storage – all based on direct current) that will replace conventional rotating generation. If most of these inverters are "grid-following," as they predominantly are now, this would lead to a fragile grid with unstable power quality and frequent outages. Grid-forming inverters, commonly used in microgrids, can be strategically deployed in certain parts of the grid, such as at utility-scale solar plants, to maintain grid inertia.

The amount of solar and storage resources that can be interconnected on a given distribution circuit is constrained by static hosting capacity, and excessive solar generation curtailment can be viewed as a missed opportunity that indicates a poor utilization of energy resources. High concentrations of DERs are needed to provide a coordinated response and have a meaningful impact on grid conditions, including voltage, current, and power factor. Furthermore, it is important to leverage multiple market mechanisms and value stacking to offer significant benefits and to be cost-competitive with traditional, expensive wires upgrades. Unlocking the potential for these VPPs to participate in wholesale energy markets while providing grid-balancing services akin to traditional rotating machines could allow these resources to draw from additional revenue streams to further improve the economics of DER adoption. Ongoing efforts to implement a dynamic hosting capacity that varies export limits by time of day would increase the amount of solar and storage that can be interconnected. This -- paired with dispatchable, coordinated clusters of DERs to serve grid reliability needs -- could be a keystone to achieving a stable and nimble grid in a high inverter-based DER future.

In addition, it is imperative that decentralized systems like VPPs are operated securely from end-to-end. To meet this need, the research scope may include a study of best practices in implementing cybersecurity measures for VPPs and DER aggregations. Utilities interact with DERs by using gateways as a communication interface, but there currently is no gateway-specific testing standard that is independent of the inverter to verify that the DERs will perform as expected.

The CEC would appreciate responses to the following questions to help define critical research needs in this area and identify high-impact use cases that a future research solicitation may

target. Interested members of the public are not required or expected to respond to every question of this RFI. In fact, members of the public are encouraged to respond specifically to the questions they feel most suits their knowledge and background.

Use Cases that Require Validation through Demonstration:

1. As California transitions away from traditional centralized fossil-gas generation and approaches a high penetration of intermittent renewables and inverter-based resources, what are the most needed grid service functions that aggregated DERs should be able to dispatch and that require validation in the near-term? Some examples are below:
    - Distribution-level voltage regulation (dispatched by a Distribution Service Operator or an electric utility provider)
    - Wholesale frequency regulation (dispatched by California Independent System Operator)
    - Ramping Support / Peak Power Injection (various markets)
    - Balance responding to multiple grid signals (i.e., Multi-Use Applications)

2. What performance metrics should a research demonstration achieve to assure confidence in resource dispatchability?

3. What role would Investor-Owned Utilities (IOUs) play in potential field demonstrations?
    - Would IOUs need to develop new programs for grant recipients to bid into, or could projects use existing agreement structures?
    - What role could dynamic hosting capacity have in expanding the depth of services that inverter-based DERs could provide to the grid?
    - Should a Letter of Support from an IOU be a minimum requirement?
    - Could utilities be potential technical reviewers during the application scoring phase as a means of providing insightful input to Evaluation Committee scorers?
    - Are there additional considerations for utility's role in project demonstrations?

Gateway Conformance Testing for Dispatchable DERs:

4. What is the industry need for dedicated testing and certification of DER gateway functionalities and conformance independent of the inverter or DER they are paired with? Would there be interest in a unified, open testing procedure that verifies DER gateways' functionality and adherence to utility-mandated communication requirements?

5. Which requirements should this testing tool cover in its scope? These requirements may include:
    - IEEE 2030.5-2023 "Standard for Smart Energy Profile Application Protocol"
    - IEEE 1547-2018 "Standard for Interconnection and Interoperability of DERs with Associated Electric Power Systems Interfaces"
    - IEEE 1547.1-2020 "Standard Conformance Test Procedures for Equipment Interconnecting DERs with Electric Power Systems and Associated Interfaces"

- IEEE 1547.3-2023 "Guide for Cybersecurity of DERs Interconnected with Electric Power Systems"
- Common Smart Inverter Profile (CSIP)
- Others that are not listed here

6. What should be the baseline performance requirements of DER gateways for the following functions?
    - Performance in DER communication
    - Interoperability of communication between DER devices from various manufacturers
    - Responsiveness in DER dispatch

7. Should this research scope (gateway conformance testing) be under a separate funding group to be conducted independent of the VPP demonstrations, or should this scope be incorporated as a phase of a larger VPP field deployment demonstration?

<u>Valuation of Aggregated DER Services:</u>

8. How could technology demonstrations be designed to increase confidence in the efficacy of market signals?

9. Identify existing market mechanisms that enable DER aggregators and VPP platforms to provide each of the grid services identified in Question 3. How effective are these market mechanisms in facilitating that service, and what barriers must be overcome for these market mechanisms to be more effective than they are now?

10. Are there existing market mechanisms for dispatching inverter-based resources to provide voltage regulation and transformer overload prevention at the secondary distribution level?

    - Which ancillary markets (e.g., fast frequency response, spinning/non-spinning reserves) would DER aggregations be best suited for? Note that these services may vary depending on a third-party aggregator's particular composition of DERs (e.g., energy storage, solar and hybrid smart inverters, Electric Vehicle chargers)

What consumer protections measures must be put in place for DER aggregation? This is especially important for projects to be designed with an equitable focus. For example, solicitation requirements could require including protections that ensure DER enrollees are fairly compensated by aggregators for the value they provide to the DER portfolio being dispatched. What are some examples of best practices?

Written comments must be submitted to the Docket Unit by 5:00 P.M. (PDT), March 28, 2025.

The California Energy Commission (CEC) encourages usage of its electronic commenting system. Please submit your comments to the Docket Unit. Select or enter a proceeding to be taken to the "Add Comment" page. Enter your contact information and a comment title describing the subject of your comment(s). Comments may be included in the "Comment Text" box or attached in a downloadable, searchable Microsoft Word (.doc, .docx) or Adobe Acrobat (.pdf) file. Maximum file size is 10 MB.

Written comments may also be submitted via email. Include docket number 23-ERDD-01 and "DER Orchestration – Request for Information" in the subject line and send to docket@energy.ca.gov.