

**Bidding Behind-the-Meter
Distributed Energy
Resources into the
Wholesale Electricity Market**
Market Participation Blueprint



Center for
Sustainable
Energy™



This market participation blueprint lays out the recommended steps for preparing a portfolio of distributed energy resources (DER) to participate in the wholesale electricity market in California.¹

From 2018 to 2020, CSE led the effort to pilot two DER portfolios of select schools and hotels to better understand the barriers and outcomes these entities experience when they attempt to bid their behind-the-meter (BTM) resources into the wholesale electricity market. While these pilot projects focus on host sites in California, they are generally applicable nationwide as utility customers increasingly look to DERs to reduce energy costs and electricity markets are faced with greater integration of solar and wind and more dynamic customer loads. Expanding participation of distributed energy resources (DERs) into wholesale electricity markets leads to more effective use of DER assets by generating value-add savings and benefits for the electric utility grid while lowering utility costs for customers.

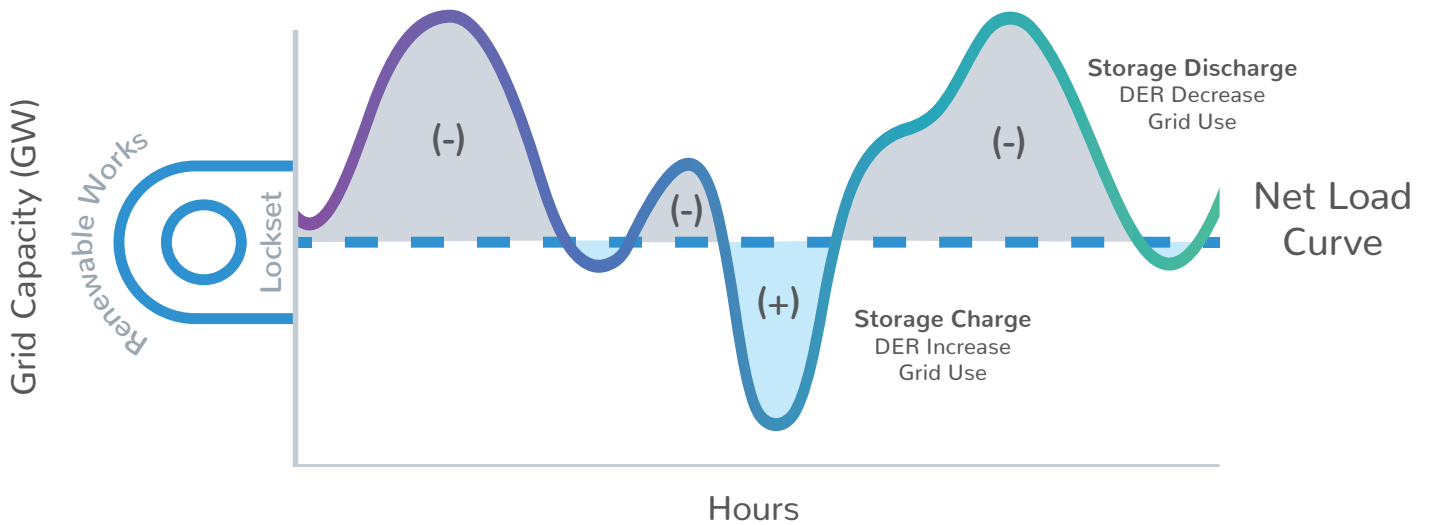
THE CHALLENGE FOR DER INTEGRATION

As a global climate solutions leader, California is committed to decarbonizing its electricity supply by requiring generation to be at least 60% qualifying renewable energy by 2030 and 100% noncarbon resources by 2045 (CA Senate Bill 100). Further, many cities, counties, community choice aggregation (CCA) suppliers and businesses throughout the state are committed to even more aggressive goals to achieve significant decarbonization targets in the future.

Most of California's renewable energy comes from wind and solar photovoltaic energy resources that generate electricity in response to weather and diurnal cycles (i.e., sunrise and sunset), which creates new forms of short-term variability for the grid. This variability is currently balanced by flexible natural gas generation.

The key to unlock the next level of grid decarbonization is being able to match high penetrations of wind and solar generation with low cost and highly scalable flexible DER and storage.

¹This Center for Sustainable Energy-led project is a four-year demonstration funded by the California Energy Commission to establish a blueprint to guide energy managers, vendors and customers of on-site DERs to become direct participants in California's wholesale electricity market. This project is bulk-funded by the California Energy Commission (CEC) Electric Program Investment Charge (EPIC) Grant Award EPC-15-074: "Meeting Customer and Supply-Side Market Needs with Electrical and Thermal Storage, Solar, Energy Efficiency and Integrated Load Management Systems."



Successful deployment of DER such as energy efficiency, demand management and battery energy storage depends on market valuation mechanisms that can reliably monetize the services and benefits provided by these resources. Grid services and benefits are generally monetized in three ways:

- Contracted energy services
- Utility retail tariff pricing
- Wholesale market participation

Of these three, wholesale market participation is the newest and least-tried method for DER monetization. To date, only a handful of customer-sited DER technologies throughout California have successfully integrated as direct-to-wholesale market participants due to technical, institutional and regulatory barriers.



Cost Reductions

DER systems have the potential to significantly lower on-site energy costs for individual host customers and electric utility system costs for all grid users and CAISO market participants.

For example, on the distribution circuit energy storage devices may defer the cost of expensive capital projects such as additional transformers or line upgrades.



Grid Reliability

As solar and wind generation expands in California, it will increase grid balancing needs and services.

Behind-the-meter energy storage and flexible grid-responsive resources represent two important resources capable of delivering local overload relief, power quality and ramp-rate mitigation, as well as customer backup power.



Environmental Impacts

Increased access to wholesale markets could allow DER systems to better accomplish California's ambitious climate and clean energy goals by reducing greenhouse gas emissions, deferring or substituting grid investments and improving grid reliability.



KEY STRATEGIES FOR SUCCESSFUL MARKET INTEGRATION

Conduct regular monthly analysis of DER capabilities and revenue potential

Successful DER market integration requires understanding the capabilities and revenue potential of the DER technologies. Also note that technologies must meet certain technical requirements to participate in wholesale markets.

Detailed understanding of utility tariff charges

Value stacking operational strategies must consider the cost and benefit of providing each service and value. As DER's primary value is typically retail bill management, successful operational strategies will be built around the need to provide utility bill savings.

Detailed understanding of wholesale market participation rules and regulatory framework

DERs must follow both retail and wholesale rules when participating in wholesale markets. DER operators must understand and have a plan to follow these rules before integrating DERs into wholesale markets.

MARKET RULES AND PRODUCTS FOR DER PARTICIPATION



DERs behind the meter can participate in the CAISO wholesale market through the Proxy Demand Response (PDR) product model.^{2,3}

The customer locations that make up a PDR must be within a single Sub-Load Aggregation Point (Sub-LAP).

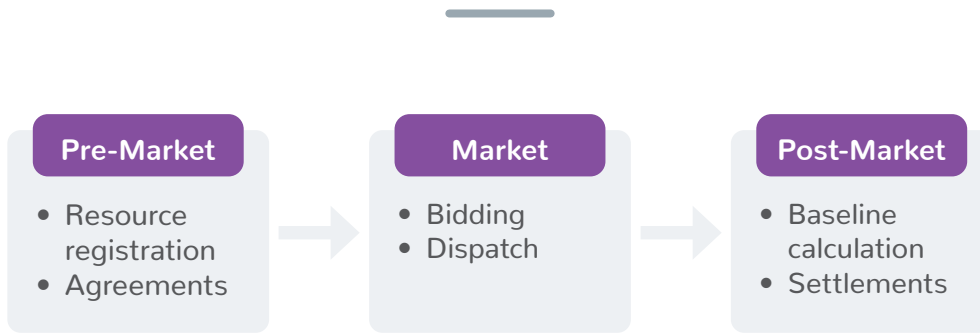
PDR portfolios must also contain an aggregate minimum of 100 kW of measurable load curtailment for energy markets. If the PDR is to provide additional ancillary services, the minimum portfolio aggregate threshold is 500kW.⁴

²A third CAISO market product known as Reliability Demand Response Resource (RDRR) only applies to DERs that participate in the market through a sub-set of specific reliability-based demand response programs run by the PG&E®, SCE® and SDG&E®.

³Additional information on PDR and RDRR products at CAISO can be found here: https://www.caiso.com/Documents/PDR_RDRRParticipationOverviewPresentation.pdf

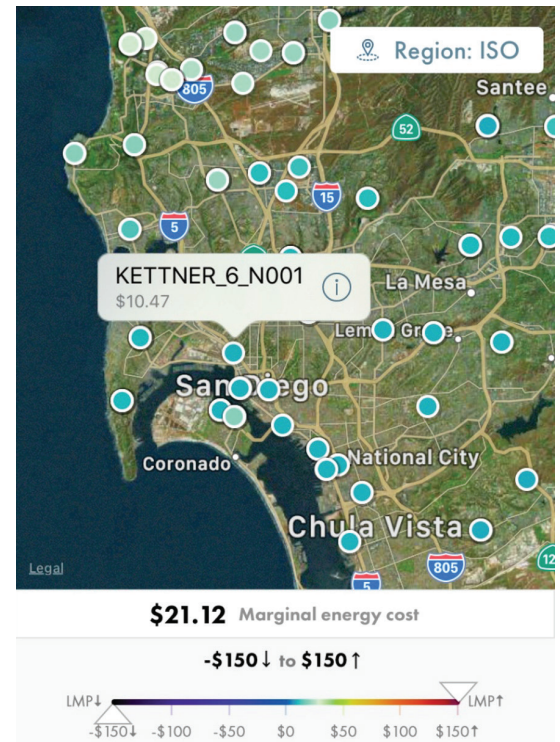
⁴Noting that once a given PDR proves that it is capable of supplying a minimum capacity of 100 kW for day-ahead and real-time energy at the CAISO, a PDR may make bid increments below 100 kW in the day-ahead and real-time energy markets; for ancillary services, a PDR must bid a minimum capacity of at least 500 kW and can bid higher amounts in increments less than 500 kW (e.g., 490 kW is not allowable but 510 kW bid is allowable)

STEPS TO WHOLESALE MARKET INTEGRATION



1. PRE-MARKET

- Data Release Agreement:** Each participating DER site host customer must complete a Customer Information Service Request (CISR) to grant a third-party wholesale certified distributed resources provider (DRP) utility meter data access from the respective investor-owned utility (IOU) billing meter account. The rules and procedures for this step are codified by the Ca. Public Utilities Commission (CPUC), known as “Rule 24” for PG&E and SCE customers and “Rule 32” for SDG&E customers.⁵ For vendors and customers note that expected time length for the IOU to complete the review and approval of the CISR form and establish the customers’ utility meter data connection to an external DRP data connection server is approximately 15 business days (3 weeks).
- DR Program Check and Program Unenrollment:** According to CPUC rules, DER customers are prohibited from dual participation in both a utility demand response program or DR tariff and direct wholesale market participation. A DER customer must unenroll from the utility DR program or tariff and wait at least one full billing cycle (i.e., one month) before participating in the wholesale market. The expected time frame to complete this step is approximately 30 business days (six weeks) and can be considered an action that can be completed in parallel with the data release agreement step above.
- Registration at the CAISO:** The DRP will then proceed to register the portfolio in the market. CAISO has established the demand response resource registration system (DRRS), which is the central repository of the PDR registration locations and resources to ensure that there is no duplication of customers. Required DRRS information includes the utility customer account identification number, customer name, geographical information (e.g., physical address, LSE, and Sub-LAP).
- Pricing Framework:** The CAISO offers two options, pre-defined or custom. PDR providing ancillary services must undertake the custom option.



⁵Further information on rules and procedures of Rules 24 and 32 can be found at the CPUC website here: <https://www.cpuc.ca.gov/General.aspx?id=8314>.

- Pre-defined: a PDR that is assigned to an aggregated Pricing Node (P-Node), which establishes the specific locational marginal price (LMP). The expected time frame to complete this option is approximately up to 2 months.
- Custom: a PDR undergoes a Full Network Model (FNM) build-analysis, along with conducting a series of CAISO testing and validation steps to prove the DERs' ability to perform ancillary (reliability) services. The expected time frame to complete this option is approximately 6-9 months.

PDR not providing ancillary services



PDR providing ancillary services

2. MARKET: BIDDING AND DISPATCH

PDR are eligible to bid energy in the day-ahead and real-time markets, as well as participate in two ancillary services markets: spinning and non-spinning reserves.

PDRs are compensated for the energy they provide at the locational marginal price (LMP). Ancillary service compensation is driven by market-wide auction. Important caution that ancillary services include potentially costly market penalties for non-performance.

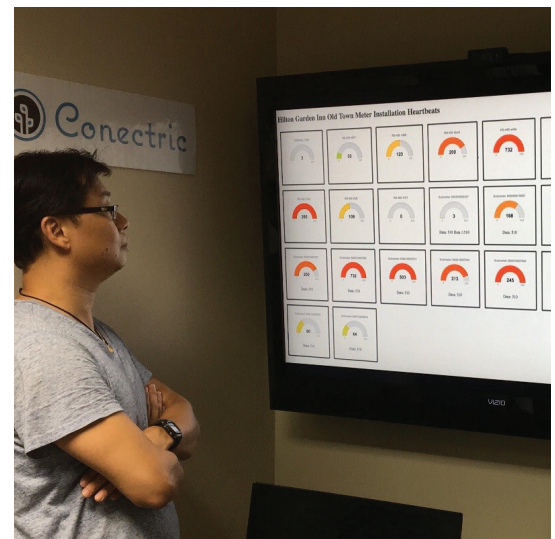
3. POST-MARKET: SETTLEMENT

Settlement involves reviewing the actual DER response using the agreed-upon settlement terms for the PDR. The settlement calculation and verification are performed by the DRP.⁶

Market settlement baseline options for PDR include:

a. Residential customers

- **4-Day Weather Match:** Candidate days are non-holiday weekdays. Event days are also excluded from candidate days if customers for whom the baselines are calculated are dually enrolled in that program. Eligible days must be within 90 days of the event day. Weather for that group of customers is determined by their zip code.
- **Control group:** Measuring the PDR to a "comparison of means" of similar non- participating customers.
- **"5-in-5" Day Matching:** Candidate days are non-holiday weekdays. Event days are also excluded from candidate days if customers for whom the baselines are calculated are dually enrolled in that program. The aggregate load on the five previous candidate days prior to the event are averaged to create the baseline.



⁶CAISO reserves the right to audit market settlement calculations performed by DRP's to ensure accuracy and market compliance.

b. Commercial and Industrial customers

- **4-Day Weather Match:** Candidate days are non-holiday weekdays. Event days are also excluded from candidate days if customers for whom the baselines are calculated are dually enrolled in that program. Eligible days must be within 90 days of the event day. Weather for that group of customers is determined by their zip code.
- **“10-in-10” Day Matching:** Candidate days are non-holiday weekdays. Event days are also excluded from candidate days if customers for whom the baselines are calculated are dually enrolled in that program. The average aggregate load on the ten previous candidate days prior to the event are averaged to create the baseline. Historically this has been the most common baseline settlement methodology. In this configuration, all end uses behind the meter – whether they are controlled for demand response or not – are reflected in performance calculations for settlement purposes.
- **Control group:** Comparing the PDR to a “comparison of means” of similar type non-participating customers.
- **Metering Generator Output (MGO):** Method to calculate demand response performance by relying on a sub-meter that directly measures the contribution (energy delivered) by the registered generation device located behind the whole-premises revenue meter.



PROJECT DEMONSTRATION PORTFOLIOS



SCHOOL DISTRICT PORTFOLIO – BATTERY STORAGE

Primary level education schools often lie within residentially dominant utility distribution circuits, which is becoming the dominant driver of net load demand (i.e., total grid demand minus the contribution from solar and wind generation in the wholesale market) for electricity throughout California. In other words, the now-famous California “Duck Curve” and new net-peak occurring well after sunset can be mitigated by demand-flexible DER at schools and hotels.

Five schools, each outfitted with solar photovoltaics (PV) carports and a collection of Tesla commercial battery storage units (pods) aggregated together with combined rated storage capacity of 1.1 megawatts and 2.1 megawatt-hours of energy. The batteries can discharge at their rated capacity for up to two hours and are based on the powertrain architecture and components of Tesla’s electric vehicles. The DC batteries are designed to cycle up to 365 times per year and supply AC energy.

HOTEL PORTFOLIO – SMART CONTROLS AND DEMAND RESPONSE

Because of their susceptibility to varying occupancy rates, meteorological conditions and multiple energy systems (HVAC, lighting), hotels represent an excellent opportunity to develop an integrated approach to the design, implementation and operation of energy efficiency, load control and passive energy storage measures.

Two Hilton Hotels in San Diego aggregated together with a combined ability to reduce their load capacity by as much as 215 kilowatts or 1,300 kilowatt-hours (4-hour duration). Each location also features passive thermal energy storage and an energy efficiency package.

- Central plant
- HVAC
- Pumps
- Drives



KEY PROJECT FINDINGS

The project team identified several existing market and policy barriers that currently stand in the way of expanding behind the meter DER and storage wholesale market participation:

- Lack of compensation for grid exports from PDR
- No pathway for providing frequency regulation from PDR
- Wholesale market participation barriers to entry
- Baselines and Direct Metering

INFORMING CLEAN ENERGY POLICY

The project team applied extensive policy research to better understand existing market and policy barriers and proposed workable solutions with the goal of expanding behind the meter DER participation in the wholesale market. The project team provided valuable research and input into several ongoing proceedings and working groups at the following regulatory agencies and market operations institutions:

CPUC

- Storage (R.15-03-011): Multiple Use Application report
- Demand Response (R.13-09-011)
- SGIP Program (R.12-11-005)
- The CPUC has solicited several sets of comments from stakeholders on DERs' ability to participate in the CAISO energy markets. CSE provided comments to inform the CPUC on its experience
- Safety and Eligibility of Energy Storage Technologies (R.15-03-011)

CEC

- Integrated Energy Policy Report
- Integrated Load Management Rulemaking (2020)

CAISO

- Energy Storage and Distributed Energy Resources (ESDER) Initiative

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