Task 6: Operational Strategy Report

EPC-15-074: Meeting Customer and Supply-side Market Needs with Electrical and Thermal Storage, Solar, Energy Efficiency and Integrated Load Management Systems

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I. Executive Summary

This report presents an overview of operational strategies that will minimize customer cost of two distributed energy resource (DER) portfolios during wholesale market participation in the *EPC-15-074: Meeting Customer and Supply-side Market Needs with Electrical and Thermal Storage, Solar, Energy Efficiency and Integrated Load Management Systems (STEEL)* demonstration project. Load management strategies based on both existing and future wholesale and retail tariffs were developed to optimize energy and opportunity costs of wholesale market participation. Optimized strategies were developed based on identified data points by both portfolios.

Load management strategies were developed to optimize energy and opportunity costs of wholesale market participation.

Portfolio 1 (an aggregation of five public school facilities located in Chino Hills, CA) includes behind-the-meter solar photovoltaic (PV) and Tesla Powerpack battery energy storage systems (BESS), with the energy storage being sub-metered for performance evaluation. The load reduction operational strategy developed by Portfolio 1 relies on data points with varying forecasting techniques including retail tariff information, net load forecasts, and wholesale price forecasts.

Portfolio 2 (two hotel facilities located in San Diego, CA) uses advanced energy management software developed by Conectric Networks to evaluate whole-premises metered performance. The load reduction strategy developed by Portfolio 2 includes methods previously outlined in the *2025 California Demand Response Potential Study* that can be deployed together or separately, depending on host site needs, including: load-shape (and energy efficiency), load-shift, load-shed, and load-shimmy (i.e., frequency regulation). These operational strategies are inherently complex and require analyzing numerous onsite conditions when forecasting the delivery of energy resources. Data points and considerations identified by Portfolio 2 include market pricing information, load analysis, building characteristics, environmental factors, and building use profiles.

A final assessment identifies barriers and recommendations for each Portfolio's operational strategy to successfully participate in the CAISO wholesale market as Proxy Demand Resource (PDR). The assessment also identifies potential changes to existing institutional and regulatory structures that would facilitate greater resource optimization by aligning customer capabilities with system operational needs.

II. Operational Strategies

Portfolio 1

Overall Market Participation Strategy

Portfolio 1 intends to participate in the market in a way that balances wholesale revenue opportunity with the opportunity cost of foregoing some of the potential benefits of retail bill management. In hours where the site has an opportunity to reduce load below its baseline, the strategy will evaluate when such participation exceeds the estimated marginal opportunity cost of such a dispatch. When it is economically attractive to participate, load reduction will be implemented through behind-the-meter dispatch of the battery.

Necessary Data Points

The strategy for Portfolio 1 relies on several data streams, some of which have a variety of forecasting techniques that could be employed. Tesla has experience forecasting customer load and solar, and optimizing the dispatch of the battery given a specific rate/tariff. This functionality has been a core part of the commercial and industrial (C&I) storage offering for many years. The new objective is how wholesale participation is coordinated with this existing functionality.

The following data points and considerations will be used to inform Portfolio 1's bidding strategy:

Retail Tariff Information:

- The value of retail bill management in any given interval is dependent on the retail tariff that each individual site is on. The sites in this pilot are on Southern California Edison's (SCE) Time-of-Use (TOU)-8-R-APS-E tariff.[1] This tariff is composed of the following components:
  - A fixed monthly bill charge, which cannot be managed.
  - A seasonally-adjusted (two seasons per year) energy use charge with separate weekday and weekend daily time blocks that vary from roughly 6 cents per kilowatt-hour during off-peak to as much as 33 cents per kilowatt-hour during summer on-peak weekday afternoons.
  - A monthly peak demand charge of $16.64 per kilowatt[2]
  - A credit associated with the Automatic PowerShift-Enhanced program[3], which is a traditional SCE demand response program that cycles air conditioner load during a limited number of demand response event hours each year.

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[1] Additional detail on the SCE TOU-8-R-APS-E tariff can be found on the rate sheet "Cal. PUC Sheet No. 62668-E" online at: https://www.sce.com/NR/sc3/tm2/pdf/ce54-12.pdf.

[2] Assessed as the highest 15-minute demand interval in a given monthly billing cycle.

[3] Additional detail on the General Service Automatic Powershift-Enhanced program (Schedule GS-APS-E) offered by Southern California Edison can be found on the rate sheet "Cal. PUC Sheet No. 63203-E" online at: https://www.sce.com/NR/sc3/tm2/pdf/ce177.pdf.

Net Load Forecasts:

- Tesla's optimization algorithms try to anticipate what the customer's load will be over the next 24-hour period using a variety of statistical approaches. Forecasting load is important for optimizing retail bill management because the peak customer load that drives the monthly demand charge could occur in any hour. For instance, the algorithm can manage the state of charge of the battery and determine when the battery has "headroom" to spare without inadvertently increasing the customer's demand charge by draining the battery's state of charge to the point where it misses the peak. When the battery is paired with PV, as they are for the sites in Portfolio 1, a forecast of solar generation is also a part of the overall net load forecast input into the optimization.

Wholesale Price Forecasts:

- Assessing the tradeoff between retail bill management and wholesale revenues requires a view of what wholesale prices are likely to be over some future horizon. A variety of price forecasting techniques may be used, including statistical techniques that drive insights from patterns in historical data, as well as techniques using production cost models that model prices under a specific set of possible system conditions.

Data Collection and Control Capabilities

Once bids are submitted and market awards are received, Tesla can upload those economic price signals into the local optimization engine connected to the battery's controller. Under perfect 24-hour foresight when the day-ahead forecasted load and market price match up with actual conditions, the battery will dispatch at each scheduled hour in the day-ahead market and obtain a market award settlement in the exact amount as planned. However, as the day-ahead forecasts will inevitably be imperfect, the battery optimization will tailor the battery dispatch from its day-ahead program and use real-time (15-minute interval) market information to create an optimized real-time energy market bid. In sum, the optimization solves for battery dispatch in the day-ahead and real-time wholesale energy market based on the retail tariff, and forecasts of net load, potential market award, and imbalance charges (i.e. market penalty).

Tesla receives 15-minute metering and telemetry data from a variety of system assets, which include gross customer site load, PV generation, and battery state of charge, among other signals. This data can be used to benchmark the performance of a given strategy or forecasting technique in comparison to the ex-post review of perfect performance under the known net load and day-ahead prices.

Strategy Development

While the techniques for managing the battery for retail bill savings are well-established, the approaches to co-optimizing these with wholesale market participation are new for Tesla. As part of this pilot, Tesla will be testing different approaches to wholesale price forecasting, developing bids, and benchmarking performance. Economic performance of the system under various approaches will be evaluated over time, which will help drive improvements to the forecasting strategies and algorithms used.

Portfolio 2

Overall Market Participation Strategy

Portfolio 2 anticipates following a "price taker" strategy, meaning that the resource does not have a set price that wholesale markets must reach to submit a bid.[4] Rather, the portfolio plans to submit bids at times that are most technically feasible for the resource and accept the wholesale market price during those intervals (so long as the market allows).

To provide both retail and wholesale services, Portfolio 2 includes load management strategies, a list of necessary data points to collect, a data collection and load control protocol, and protocols to perform automated load management responses to varying grid conditions.

Load Management Strategies

Portfolio 2 involves three primary methods[5] to strategically manage site loads when participating in the wholesale market:

1) **Load Shift** by primarily using passive thermal energy storage.
2) **Load Shed** when peak-demand economic conditions merit additional reductions.
3) **Load Shimmy** which will be simulated through fast response motor control coupled with precise sub-metering and telemetry capabilities.

Though it is not a load management method needed to participate in the wholesale market, an additional strategy to manage loads, **Load Shape and Energy Efficiency** is also assessed.

1) Load Shift

The load shift strategy will involve increasing load at regular, pre-planned times to expand the potential to decrease load when participating in the wholesale market. Examples may include preheating or precooling unoccupied rooms during off-peak hours to reduce hotel loads during grid peak hours, using the buildings' thermal mass as passive energy storage.

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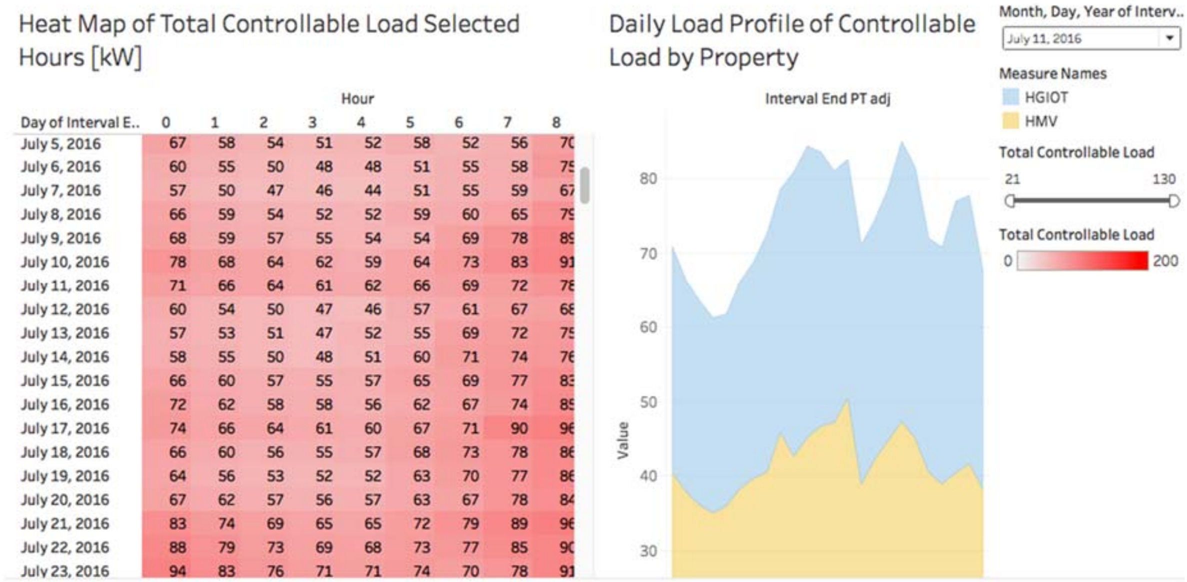
[4] Clarifying that "price taker" has limited range for demand response resources in the wholesale market due to FERC Order 745 Net Benefits Test (NBT), which establishes a bid price floor for demand response resources. More information is available on CAISO website at: http://www.caiso.com/informed/Pages/StakeholderProcesses/CompletedClosedStakeholderInitiatives/DemandResponseNetBenefitsTest.aspx.

[5] The demand response terminology that was established in the *2025 California Demand Response Potential Study* (2017) by Lawrence Berkeley National Laboratory that was adopted into the record of the Demand Response Proceeding at the California Public Utilities Commission (Rulemaking 13-09-011) and available online at: http://www.cpuc.ca.gov/General.aspx?id=10622.

This strategy will require computing a cost-benefit analysis that evaluates increasing the load at an earlier time of day, which comes at the expense of additional retail charges, against decreasing the load to a later time of day, which creates savings from retail charge reductions and wholesale market revenues. The thermal capacitance of the building can be calculated based on a set of conditions (including weather, available climate control capacity, and occupancy variables), allowing the control strategy to determine how much electrical power to input into the building to meet thermal load requirements (e.g. occupant comfort) at a later time period. For example, each 100 kWh of additional cooling input at an outdoor temperature of 80^{o} F would yield 75 kWh of reduced cooling input for a like number of hours at the same outdoor temperature following the initial input. Should the combined cost reduction in retail charges, demand charges and wholesale market revenue for each 75 kWh exceed the increased retail charges associated with each 100 kWh of additional cooling input during the initial charging period, then the demand shifting function should occur.[6] Figure 1 below shows how the available load shift can variate from day-to-day depending on room occupancy and outdoor weather conditions.

Portfolio 2 plans to demonstrate that the load shift strategy may be beneficial for the host customer and wholesale market without compromising the comfort of hotel guests by “charging” during the period of lowest cost energy and least occupant utilization and reducing consumption during the period of highest energy costs and highest occupant utilization.

[6] The upcoming Project Task 8 reports will include a building envelope analysis for each facility that will provide much more detail on the thermal capacity ranges and dynamics that will drive the load shift and load shed functions.



Day of Interval E..	0	1	2	3	4	5	6	7	8
July 5, 2016	67	58	54	51	52	58	52	56	70
July 6, 2016	60	55	50	48	48	51	55	58	75
July 7, 2016	57	50	47	46	44	51	55	59	67
July 8, 2016	66	59	54	52	52	59	60	65	79
July 9, 2016	68	59	57	55	54	54	69	78	89
July 10, 2016	78	68	64	62	59	64	73	83	91
July 11, 2016	71	66	64	61	62	66	69	72	78
July 12, 2016	60	54	50	47	46	57	61	67	68
July 13, 2016	57	53	51	47	52	55	69	72	75
July 14, 2016	58	55	50	48	51	60	71	74	76
July 15, 2016	66	60	57	55	57	65	69	77	83
July 16, 2016	72	62	58	58	56	62	67	74	85
July 17, 2016	74	66	64	61	60	67	71	90	96
July 18, 2016	66	60	56	55	57	68	73	78	86
July 19, 2016	64	56	53	52	52	63	70	77	86
July 20, 2016	67	62	57	56	57	63	67	78	84
July 21, 2016	83	74	69	65	65	72	79	89	96
July 22, 2016	88	79	73	69	68	73	77	85	90
July 23, 2016	94	83	76	71	71	74	70	78	91

Figure 1: An example graphical representation of the varying load shift availability by hour per hotel site

2) Load Shed

Load shed represents the traditional form of demand response—to reduce load at times of system or local peak demand or a grid emergency is imminent. The load shed strategy largely mimics the load shift strategy by establishing specific load management protocols to prepare and respond to changing market conditions. However, load shed strategies are constructed around less frequent, but potentially more lucrative wholesale market conditions that occur during critical (or emergency) peak demand. Load shed responses may include dimming or turning off lighting in common usage areas like hallways and hotel lobbies, lowering pre-cooling temperatures below the load shift thresholds and/or changing the start and stop endpoints for pre-cooling, and changing the start-stop cycling of building ventilation fans.

3) Load Shimmy (e.g. Frequency Regulation)

Load shimmy is not expected to create noticeable changes in the regular operation or timing of certain equipment and processes in either of the Portfolio 2 facilities. However, performing this grid service requires having certain sub-metering and telemetry devices directly attached to the equipment that is performing the service.[7] Conectric has invested and installed the necessary infrastructure to measure and transmit the data on load shimmy from facility central plant pumping motors equipped with variable frequency drives. Simulating frequency regulation not only shows that non-battery, behind-the-meter PDR can provide frequency regulation services, but it would also allow for direct and

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[7] For a detailed description of the systems' sub-metering and telemetry hardware layout see the project task 4 report, "Metering & Telemetry and Test Plans."

simultaneous comparison of frequency regulation simulation with Portfolio 1 (Tesla's) battery storage resources.

Load Shape (e.g., Demand Charge Management) and Energy Efficiency

Load shape and energy efficiency maximize long-term utility cost savings by pinpointing sources of wasted energy and identifying solutions that show a favorable return on investment through utility bill savings. This strategy relies on close examination of the data collected to reveal inefficienct loads and a thorough understanding of how the retail utility rate structure dictates energy costs. For example, the sensor network could reveal that certain lighting systems that are not demand-controlled and simply run 24 hours per day could be retrofitted with more efficient LED lights with pre-packaged network-enabled controls. This would result in lighting loads that are permanently reduced with the additional ability to be programmed to match more specific usage patterns for a given area of the facility.

An inherent tension exists between optimizing for load shape and energy efficiency, which decrease overall load capacity (e.g., demand) and maintaining available flexible demand capacity to perform load shift, shed and shimmy in the wholesale market. Upcoming project tasks[8] will closely examine this tension and the potential trade-offs between maximizing load shape and energy efficiency long-run investment returns against short-run wholesale market revenue from performing load shift and shed from the intelligently-managed flexible capacity resources.

Potential synergies may also be gained in DER customer outreach, investment and measure adoption, which will also be studied in upcoming project tasks. Gaining wholesale market revenues from intelligently-managed loads offers a new pathway for a customer to lower its utility costs, benefit the grid, and gain greater visibility into wasteful energy uses and insights into identifying energy efficient solutions that maximize both the customer and grid needs.

Necessary Data Points

Portfolio 2 implementation strategies are inherently complex and require analyzing numerous onsite conditions at the time of forecasting, in advance of delivery, and at delivery. Figure 2 provides a glimpse of the complexity involved in monitoring the numerous major load types at a monthly time scale. When taken together, the following data points and considerations will be used to inform Portfolio 2's use of load management and load shaping / energy efficiency shifting strategies:

Pricing Information:

- Time of use retail energy costs
- Retail demand charges
- Wholesale energy value for various markets (real-time, day-ahead etc.)

[8] Including Task 5: Price Responsiveness and Task 10: Customer and System Co-Optimization

Load Analysis:

- The load rating of the circuit or load which is being controlled
- The actual load which is being used on the circuit
- Available controllable loads
    - All controllable loads are identified and scheduled prior to implementing the load reduction and/or load shift solution. Those loads are then dynamically assigned as available or unavailable depending on the current conditions. For example, if a hotel guestroom is occupied then the fancoil motor in that room would be assigned to the unavailable list.
    - All controllable load circuits will be sub-metered to establish baseline values and behaviors and controlled values and behaviors. These baselines will inform how and when certain loads can be reduced or shifted.

Building Characteristics:

- Thermal characteristics of the building being controlled (quality of envelope, varying behaviors for different uses in different zones)
- The efficiency and power input and output of the mechanical systems (e.g. HVAC)
- Heating or cooling capacity
    - This is a function of the maximum available capacity of the mechanical systems, the current amount of capacity in use, and the difference between the two. For example, if the cooling system were already at near-full load, the opportunity to increase the cooling input power for a pre-cooling strategy will be limited to only the remaining available capacity.

Environmental Factors:

- Both indoor and outdoor environmental conditions are considered. As environmental conditions change, the amount of potential thermal capacity will change. Figure 2 below shows how certain energy loads change by each month and season.
    - For example, on a very hot day, the amount of incremental cooling capacity available may be limited or the duration of load shifting may be altered.
- Indoor humidity and the potential for altering temperatures based on thermal comfort indexes will be assessed so that should the humidity increase, the available temperature control range may decrease, and vice versa.

Building Use Profile:

- This includes physical human occupancy and utility of the building for each climate-controlled or energy-controllable zone or load, including the current and predicted conditions
- Strategies will be used to minimize occupant's perception of load control. Each specific controllable zone may have different thermal characteristics such that rooms on the 10th floor cool faster and therefore have a greater amount of temperature control than rooms on the 3rd floor.
- Unoccupied zone inventory
    - The building habitable zones are each monitored for occupancy. Zones that are currently unoccupied have the highest priority for maximum control. Those which are currently occupied become unavailable or are only controllable on a limited basis.

- Determining the probability of load control deliverability
  - The amount of load required to operate the building for a given weather condition or occupancy condition can be mapped against the amount of available controllable load. This will determine a probability for each interval and be used to identify the amount of load that can be bid for a given period.

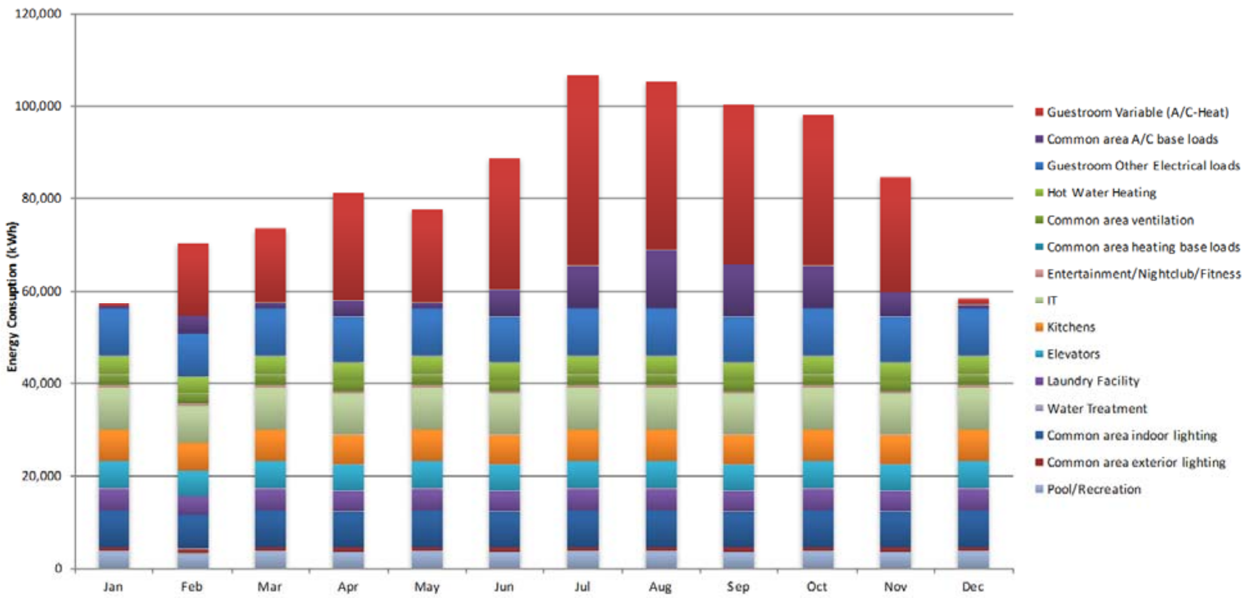

Figure 2: A snapshot of projected major load demands by month for one facility in Portfolio 2.

Data Collection and Control Capabilities

To collect the necessary data points, Conectric has designed a networking optimizer that can accept input and output from up to 50,000 sensors within its network of sensors and equipment controls.[9] Sensor data will include near-real-time collection of temperature, humidity, occupancy, door positioning, window position (in the case of movable windows/envelope), and electrical circuit energy. In addition to collection of sensor data, the optimizer will control loads independently through direct load control (signaling relays), thermostat control of individual HVAC zones (fancoils and ventilation), and existing building automation.

Data from sensors will be transported to the cloud and stored in an elastic cloud server for analysis (see Figure 3). Conectric is impartial to the cloud server or storage but will use the Google Cloud Platform for this project. The energy and sensor data is analyzed using an Open Source statistical software package

[9] The actual number of sensors per facility today is around 5,000-10,000.

called R, which correlates sensor events with weather and energy consumption to identify what circuits are optimized or sub-optimized and can be controlled to produce the load-shaping delivery.

Optimized control strategies are implemented via pre-defined algorithms which signal a change of state for the direct load control, the thermostat control or other identified controllable loads.

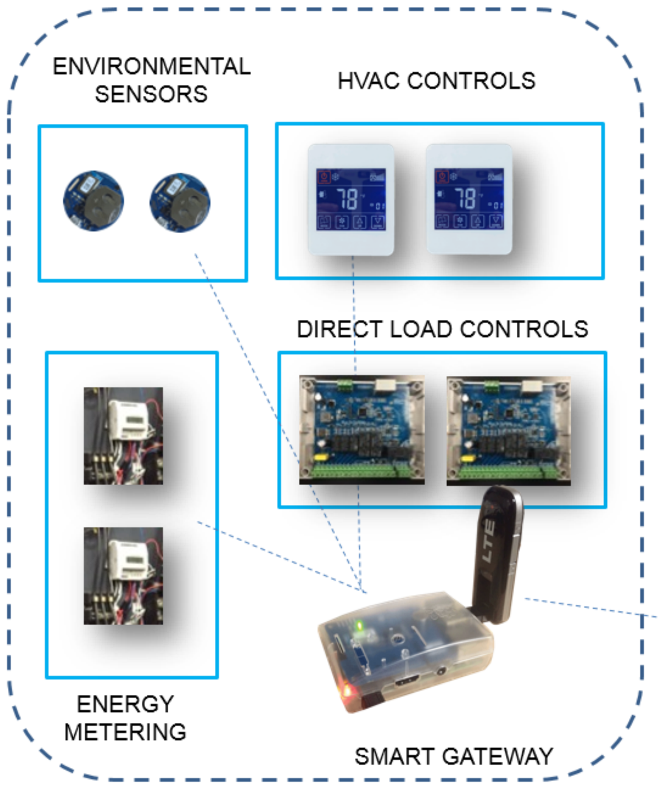

Figure 3: Schematic of how the Conectric smart gateway network integrates data collection from load monitoring devices and sends signals to load management controls.

Strategy Development

Conectric will use the data collected from its network of sensors and controls and cross-check its logged data with facility and equipment operational parameters to better understand how facility usage and occupany patterns relate to certain energy load changes. Conectric will then use its ongoing analysis of sensor data and facility usage patterns to adjust and optimize its network of controls to generate new energy savings and market participation revenue. Below is a description of different techniques that Portfolio 2 plans to implement to reduce and shift energy usage:

- Occupancy forecasting
  - Using detailed analysis of historical occupancy patterns provided by the hotel, probabilities will be assigned to the occupancy of a specific use area. For example, only

1% of rooms are occupied between 3pm and 4pm, increasing to 48% between 4pm and 5pm and 74% between 5pm and 6pm. The amount and duration of cooling load shifting in guestrooms can be matched to the occupancy probability.

- Pre-cooling strategies
  - The thermal characteristics of each zone and of each building as an aggregate compared to weather data and available heating and cooling capacity can determine the amount and duration of pre-cooling that is required to deliver a certain reduction in cooling requirement at a later time. This fits with the demand shifting or thermal energy storage function.
- Ventilation control
  - Ventilation is often left uncontrolled or based on schedules that are not regularly updated. By adding occupancy information to ventilation control, it may be possible to manage ventilation to perform energy load-shift, -shed or -shimmy functions.
- Pump control
  - Hotel buildings have sizable water management systems designed to pump, distribute, heat, cool and treat water. Some of the many water features include swimming pools, chillers for air conditioning, and boiler systems for hot water and heat; nearly all of which can be managed for energy load optimization. For example, it may be economically favorable to turn off water pumping functions for a certain period to perform load shift or shed if the forecasted wholesale market price crosses a certain threshold. Or another example may be that if rooms are unoccupied for multiple hours it may be unnecessary to pump as much hot water through portions of the facility.
- Lighting controls
  - Customers typically find it difficult to control common area lighting. A user interface can be developed to make it easier to create individual lighting branch control. Additionally, dimmable lights may be controlled to produce energy load-shift or shed functions.

III. Assessment of and Recommendations for Institutional Barriers

When developing their operational strategies, the project team identified several institutional barriers to expanding the use of demand response and wholesale market participation with behind-the-meter customers. These barriers, along with proposed solutions to overcome them, are identified below.

Lack of compensation for certain grid exports

Because the PDR framework is focused on load reductions, there is currently no mechanism to include exported energy as part of the performance measurement. A change to the PDR framework that views the PDR more holistically as a demand-side resource, and not simply a load reduction could remedy this situation. By limiting battery dispatch to the site load, a battery could be underutilized and unable to contribute to grid reliability to the fullest extent possible. For example, for a PV-paired system which exports solar PV under net energy metering. When solar generation exceeds site load, there may be intervals when the customer's net load is zero. In these intervals, even if prices are high, the battery cannot export to capture those high prices and contribute to grid reliability.[10]

No pathway for providing frequency regulation from PDR

Batteries are well-suited to provide frequency regulation given their ability to ramp quickly and match the automatic generation control (AGC) signal very accurately. However, behind-the-meter batteries participating as PDR are currently not allowed to provide regulation. To remedy this issue, CAISO would need to bring elements from its non-generating resource (NGR) model into the PDR framework.

Locational Marginal Price information accessibility

The price taker strategy for Portfolio 2 was originally decided upon due to the limitation of developing a market offer and resource strategy based on wholesale market prices. Although historical wholesale market prices are publicly available, it is difficult to identify market prices at a more granular level to their specific location on the grid. It is possible to take an average of many Locational Marginal Prices (LMP) to derive a general wholesale energy market value; however, due to the increasingly granular variable and dynamic nature of the modern grid, LMP average prices in some areas and at certain points in time may be an insufficient proxy to reveal wide-ranging prices that can occur at more granular sub-transmission levels. In California, these sub-transmission levels are called sub-load aggregation (sub-LAP) areas that each have P-Node pricing points where they interconnect. For instance, the SDG&E territory represents one of the largest sub-LAPs in the CAISO by capacity. It includes several climate zones from mild to extreme temperatures, high rooftop PV penetration (variable generation), a diverse customer base with unique electricity use profiles (e.g., the Navy), and wide-ranging grid architecture that is vulnerable to electricity distribution scarcity at times of high demand. P-Node prices within the SDG&E sub-LAP can thus vary widely depending on certain weather and load conditions.

Third party energy management firms would benefit from having a more easily accessible information platform that matches P-node price points with geo-located customer locations. This would make it much less costly for third-party energy management providers to target the areas of highest grid-value potential.

Wholesale market participation barriers to entry

To-date, only a small number of sophisticated and experienced customer energy management practitioners have successfully enrolled new customers into PDR or related CAISO market product portfolios. This is in part due to PDR being a very new product construct at the CAISO with several "bugs" that need to be addressed. In addition, it is an expensive and time-consuming process to prepare a customer for wholesale market participation. Upcoming project reports and outreach materials will

[10] Distributed Energy Resources Integration: Summarizing the Challenges and Barriers (2014) by Olivine, Inc. Online at: http://www.caiso.com/Documents/OlivineReport_DistributedEnergyResourceChallenges_Barriers.pdf.

discuss these challenges in greater detail and suggest solutions and pathways for PDR and similar CAISO products designed around DER wholesale market participation.

Baselines and Direct Metering

The baseline methodology for compensating the PDR participant via the metered generator output (MGO) construct for energy storage resources is reasonably clear and draws upon precise measurements of the sub-metered resource.[11] However, in the case of Portfolio 2, which draws upon a varied set of facility resources and equipment to perform demand response (load shed) and load shift in accordance with market price signals, the current PDR settlement methodology is less clear and runs the risk of leading to inaccurate market settlement. The “10-in-10” baseline is the only existing alternative to the MGO construct that PDR can use for market settlement.[12] The 10-in-10 baseline is designed for traditional demand response (load shed) where events rarely occur and therefore many non-event days and hours occur between event days. The 10-in-10 baseline is not a good fit for Portfolio 2 demand shifting, which could occur daily over a stretch of successional days.

While the Portfolio 2 resource can squarely observe the baseline rules and utilize them, there are several inefficiencies which become apparent. Firstly, the resource becomes under utilized because it must “turn off” periodically for no other reason than to set the baseline. Secondly, because the interval between baseline settings may be quite long, the conditions at the time of baseline evaluation may be irrelevant to the current conditions, leaving a large margin for over or under compensating the resource. It would be advisable to consider alternative baseline calculations which are more similar in nature to MGO constructs and preferably based on sub-metering of specific controlled loads. Other “metered savings” approaches that look at statistical probabilities of consumption over longer periods of time (days and weeks) may also be considered but may not capture the benefits of periodic demand shifting functions.

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[11] For more detail on MGO and how it is being used for Portfolio 1 in this project, see the EPC-15-074 Task 4 report, *Metering and Telemetry and Test Plans.*

[12] A suite of new baseline settlement methodologies for PDR are expected to be implemented at CAISO beginning in 2019. These new baseline settlement methodologies were developed through the CAISO Energy Storage and Distributed Energy Resources (ESDER) Phase Two Initiative. More information is available online: http://www.caiso.com/informed/Pages/StakeholderProcesses/EnergyStorage_DistributedEnergyResources.aspx.

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