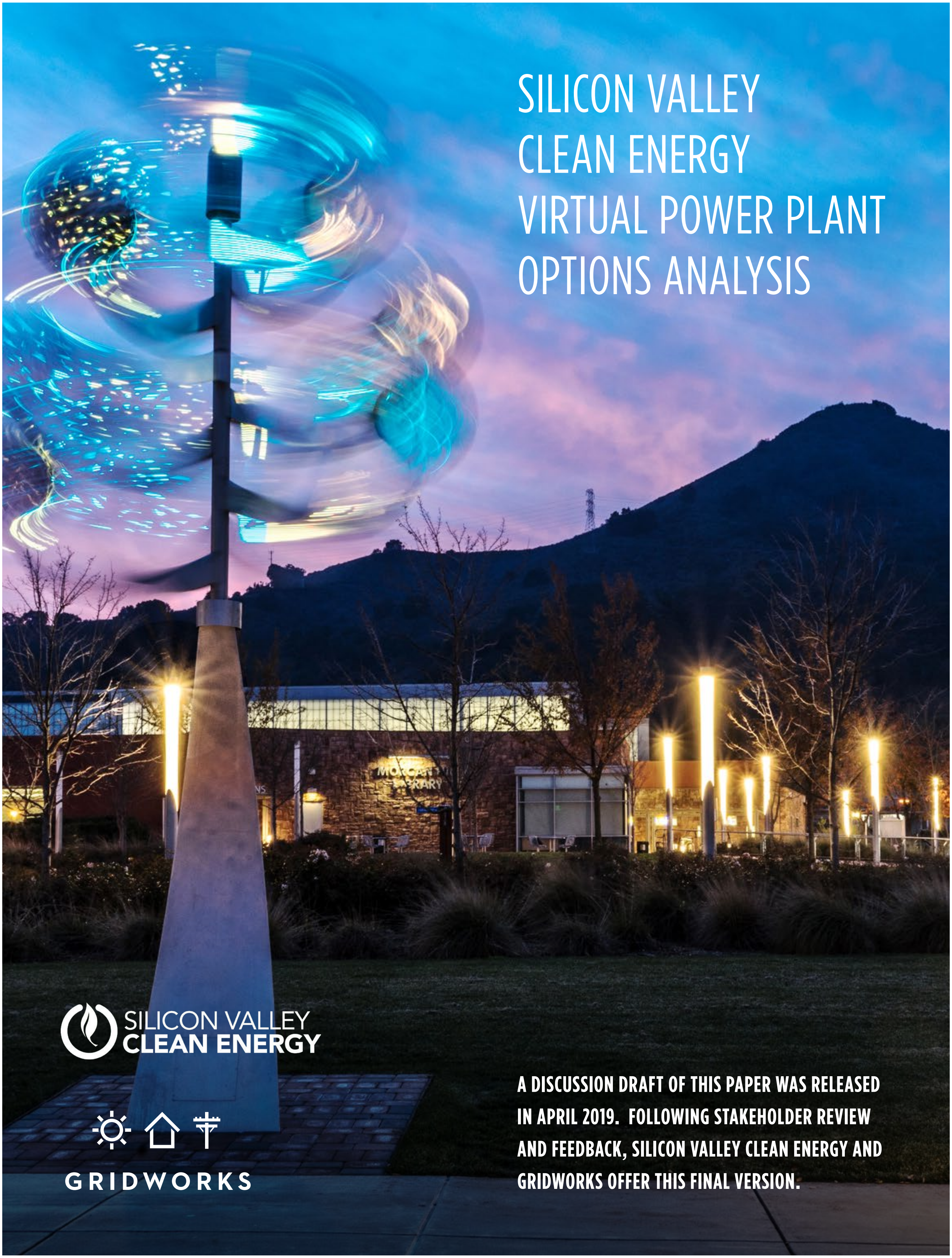

SILICON VALLEY CLEAN ENERGY VIRTUAL POWER PLANT OPTIONS ANALYSIS

SILICON VALLEY CLEAN ENERGY

GRIDWORKS

A DISCUSSION DRAFT OF THIS PAPER WAS RELEASED IN APRIL 2019. FOLLOWING STAKEHOLDER REVIEW AND FEEDBACK, SILICON VALLEY CLEAN ENERGY AND GRIDWORKS OFFER THIS FINAL VERSION.

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A Discussion Draft of this paper was released in April 2019. Following stakeholder review and feedback, Silicon Valley Clean Energy and Gridworks offer this final version.

EXECUTIVE SUMMARY

Virtual power plants are gaining traction as tools for decarbonization while meeting the power grid's needs. This paper identifies and evaluates potential virtual power plant program designs.

For this initiative, Gridworks partnered with Silicon Valley Clean Energy (SVCE) to assess five different virtual power plant options: Real Time Pricing, Peak Day Pricing, Demand Response Auction Mechanism, Load Shift Resource, and Distribution Services Model. Options were evaluated against SVCE's criteria, including customer and community value, emissions reductions, scalability and transferability, equity in service, core role for SVCE, and viability. Options were then reviewed with stakeholders and industry experts to better understand the challenges and opportunities of implementation.

Based upon the options analysis and stakeholder feedback, the following program designs are viable and valuable in the near term: Real Time Pricing, Demand Response Auction Mechanism, and Load Shift Resource - Grid Responsive. Which program provides the highest value depends on the load serving entity's (LSE's) near-term needs, whether they are Resource Adequacy, peak demand reduction, renewables integration, or another purpose. In the long term, LSEs could provide additional value to the distribution grid through virtual power plants. Further progress toward a Distribution System Operator model in California could enable this option.

1. INTRODUCTION

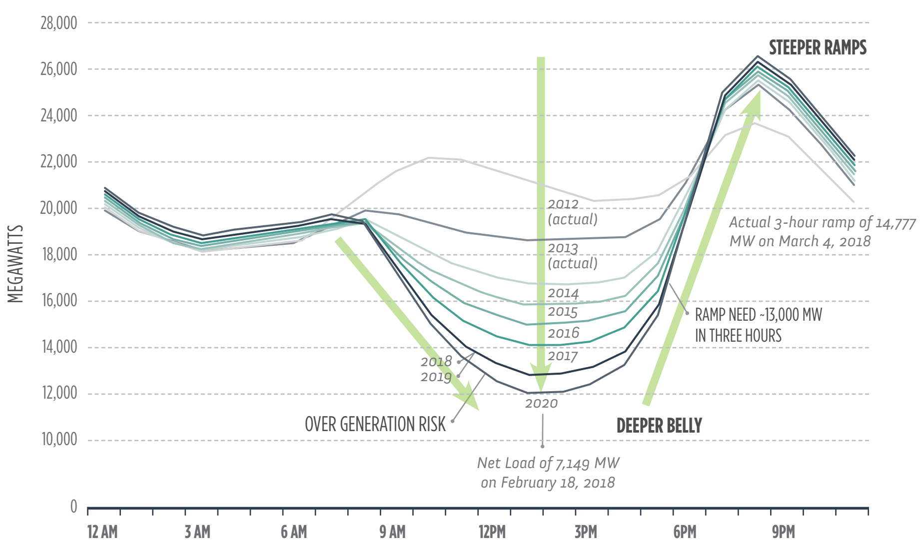
Silicon Valley Clean Energy's primary mission is to reduce greenhouse gas emissions and has set ambitious targets to achieve 30% reduction from 2015 baseline levels by 2021, 40% by 2025, and 50% by 2030. One critical component to achieving these milestones is monetizing and harnessing the value from distributed energy resources (DER) aggregations, also referred to as virtual power plants. The term "virtual power plant" has emerged as an industry term, though it has different connotations to different audiences. Here, we use the term virtual power plant to refer generally to shifts in energy demand or injections to the grid from distributed resources that provide grid services.[1] Grid services could be offered based on a range of triggers, from price signals to complex and focused load aggregation and shaping.

In developing a virtual power plant program, SVCE aims to proactively manage demand in step with its decarbonization strategy to electrify mobility and the built environment. SVCE's intention is to manage DER aggregations within a virtual power plant program to minimize near-term emissions, reduce power supply costs, and defer or avoid distribution grid upgrades, thereby lowering the overall costs of decarbonization.

In 2018, there were more than 160 MW of distributed solar and 26,600 electric vehicles within SVCE territory. In combination with a mild climate, the resulting energy load shape within SVCE territory is "peaky," and there is a steep ramp in electricity demand in the evening as solar production declines and residential customers return home. Increased distributed solar adoption, is expected to continue to concentrate energy supply in the middle of the day and demand in the evening, following the statewide Duck Curve (Figure 1), but could be mitigated or managed by harnessing loads resulting from increasing building electrification and transportation electrification.

Virtual power plants provide numerous benefits to customers, communities, and the electricity grid. For customers, virtual

FIGURE 1. Typical Spring Day



Source: California ISO

1 Virtual power plants would not have all the same characteristics as a physical power plant. Characteristics would depend on the load serving entity's needs and program goals. Grid services can include generation, capacity, and ancillary services.

power plants offer low- to zero-emissions electricity and help lower the cost of electrical service.[2] For communities, virtual power plants can replace high-emissions peaker plants, reducing localized air pollution.[3] On the electric grid, virtual power plants provide grid services such as capacity, ramp smoothing, and voltage regulation, and reduce the need to upgrade or construct transmission and distribution infrastructure.[4] Table 1 describes recent virtual power plant projects. These projects point to ongoing innovation in the realization of customer, community, and grid services through virtual power plants, setting an example of what can be achieved.

TABLE 1.

	SDG&E'S POWER YOUR DRIVE5	SUNRUN WHOLESALE CAPACITY MARKETS[6]	SCE/AMS HYBRID ELECTRIC BUILDINGS[7,8]
DESCRIPTION	Electric vehicle charging stations owned and maintained by SDG&E are grid-integrated through an hourly rate to encourage customers to charge at off-peak times. Multiple electric vehicle service providers were engaged to offer customers a choice of vendor, equipment, and service.	Network of roughly 5,000 distributed solar and storage systems providing 20 MW of capacity for the Independent System Operator (ISO) of New England.	Aggregation of batteries across 21 buildings in Southern California capable of providing up to 10 MW of instantaneous load reduction for up to four hours.
GRID SERVICES PROVIDED	Demand management, load shift, ancillary services	Generation, capacity, backup power	Demand management, load shift, generation, capacity, backup power
IMPACT/ OUTCOME	High customer interest and uptake, including at multi-family housing sites and workplaces - over 900 charging stations have been installed at 85 sites. 94% of vehicle charging time was during off-peak hours.	Demonstrates the capability of, and confidence in, distributed resources to provide reliable grid services.	Each building is capable of reducing building peak demand by 25% and reducing energy expenses and operating costs by about 10%. Batteries have also been dispatched as Proxy Demand Resources in the CAISO market.

2 Consolidated Edison Company, January 2018, *Brooklyn Queens Demand Management Program Implementation and Outreach Plan*, http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B8FF8D6D6-7E2B-4D83-9B9C-8B3E54612B8C%7D

3 NRDC, March 2018, *Replacing a Polluting Plant with Clean Energy*, Accessed April 7, 2019, https://www.nrdc.org/experts/mohit-chhabra/pge-replace-aging-jet-fuel-power-plant-oakland-s.

4 GridLab and Gridworks, August 2018, The Role of Distributed Energy Resources in Today's Grid Transition, https://gridlab.org/s/GridLab_RoleOfDER_online.pdf.

5 San Diego Gas & Electric, February 2019, *Electric Vehicle-Grid Integration Pilot Program (Power Your Drive) Fifth Semi-Annual Report (Corrected) of San Diego Gas & Electric Company*, https://www.sdge.com/regulatory-filing/10676/sdge-electric-vehicle-grid-integration-pilot-program

6 Spector, Julian, January 2019, *Sunrun Wins Big in New England Capacity Auction with Home Solar and Batteries*, Accessed April 7, 2019, https://www.greentechmedia.com/articles/read/sunrun-wins-new-england-capacity-auction-with-home-solar-and-batteries#gs.3kyfht

7 Advanced Microgrid Solutions, April 2018, *Irvine Company Complete's World's First Collection of Hybrid Electric Buildings; 21 High-Rises Outfitted with Tesla Energy Batteries*, Accessed April 7, 2019, http://advmicrogrid.com/irvine-company-completes-worlds-first-collection-of-hybrid-electric-buildings-21-high-rises-outfitted-with-tesla-energy-batteries.html

8 St. John, Jeff, April 2018, *Advanced Microgrid Solutions' Hygrid-Electric Building Fleet Goes Live*, Accessed April 7, 2019, https://www.greentechmedia.com/articles/read/advanced-microgrid-solutions-and-irvine-co-s-hybrid-electric-building-fleet#gs.3kysdj

2. ROLE OF COMMUNITY CHOICE AGGREGATORS

CCAs, such as SVCE, are well positioned to develop and offer virtual power plants. As community-owned agencies, CCAs have a detailed understanding of local values and needs, as well as an interest in reinvesting in their communities. CCAs are therefore able to offer tailored energy solutions in coordination and partnership with local communities. Benefits can also extend beyond the CCA's territory through reducing emissions from electricity generation, supporting local economic development, and advancing the clean energy market.

Transportation electrification and building decarbonization are priority initiatives for SVCE to help its communities meet their emissions reductions goals. These initiatives will inevitably increase electricity demand and dependence on the grid. Virtual power plants can help manage anticipated load growth by mitigating the burden on existing infrastructure and keep electricity costs low. New clean energy resources, technologies, and rate options deployed as virtual power plants are opportunities to serve customers and communities with low-emissions, low-cost electricity.

Virtual power plants, however, are in an emerging market and strategic evaluation of options available to CCAs is necessary to define viable models that help CCAs achieve their goals.

3. VIRTUAL POWER PLANT OPTIONS

SVCE has identified five virtual power plant options with varying levels of complexity for consideration. These options are not a comprehensive representation of virtual power plants options, nor are they necessarily mutually exclusive (i.e., SVCE may implement more than one option). There may be other options or modifications on options described below that would be a good fit to meet different types of program goals (e.g., load shift, reduce energy bills) and customer segments (e.g., residential or small and medium commercial). Although for the options described below, special equipment or software may not necessarily be required for a customer to participate, these tools enabling automated participation are embedded in most modern device offerings (e.g. smart thermostats, building energy management systems, storage, etc.). Most of the following program options target more sophisticated technologies that can receive and respond to dispatch signals such as electric vehicle chargers, advanced inverters with photovoltaic, and battery storage. The digitization of modern loads is expected to significantly increase participation compared to traditional demand management programs that relied on manual response and behavior change.

Real Time Pricing charges customers electricity rates that vary with wholesale electricity market prices and are generally higher during periods of high demand on the electricity system and lower during times of low demand. Customers leveraging Real Time Pricing may see lower electricity bills than with flat rate pricing without changing behavior.[9] Special equipment or software are not required for a customer to participate in Real Time Pricing, but those types of tools could enable a customer to respond to price signals more easily. Depending on program design and customer engagement, Real Time Pricing can be a relatively passive method to lower bills and encourage shifts in energy demand based on price signals.

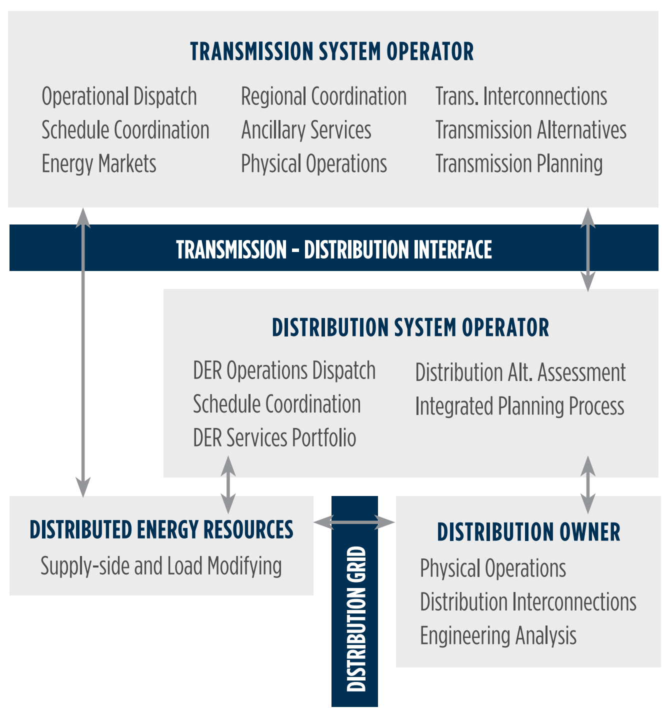
Peak Day Pricing is a rate option available to commercial and industrial (C&I) customers that offers a discount on summer electricity rates in exchange for higher prices during 9 to 15 Peak Pricing Event Days per year. Customers are notified the day before a Peak Pricing Event Day and expected to respond by lowering or shifting their demand to alleviate pressure on the system.[10] By lowering demand on those peak days, customers are able to lower their overall electricity bills over the course of the year. In 2018, less than half of the eligible PG&E customers participated in Peak Day Pricing.[11]

Demand Response Auction Mechanism (DRAM)is a procurement mechanism to aggregate demand response resources for Resource Adequacy (RA) and offer the energy in the California Independent System Operator (CAISO) wholesale market. Under this option, a portion of the load serving entity's (LSE's) RA requirement is set aside for DER aggregations to be procured via the LSE's own transparent, competitive process. The solicitation process may be modeled after an auction, or it may be structured as a Request for Proposals or Request for Offers. Lessons learned from the California Public Utilities Commission's (CPUC) recent DRAM pilot could be leveraged for detailed program design[12]. The third party aggregator would be responsible for bidding demand response resources into the CAISO wholesale market, making the role of SVCE potentially limited in scope.

Load Shift Resource (LSR) program is a generic term to describe a program that delivers load shift. Load Shift means enabling and incentivizing customers to meet their electricity needs ("take") during periods of surplus generation, lower energy prices, and lower emissions, while reducing their consumption ("shed") during periods of scarcity and higher emissions.[13] Here we focus on two program design options — one grid responsive program which is not integrated into wholesale markets, as is the approach for Sonoma Clean Power's GridSavvy program,[14] and one with market-integrated dispatchable resources, as newly possible through the CAISO's Proxy Demand Resource — Load Shift Resource (PDR-LSR) tariff. In a grid-responsive program, the implementer sends a signal to a customer to modify load based on a predetermined factor (e.g., low capacity, low cost, high emissions, etc.). The customer has the opportunity to be compensated for changing consumption patterns in real-time but retains the option to opt out as needed. Customers would be compensated based on energy market savings, capacity cost savings (generation, transmission, distribution), and other performance-based values.[15] In a market-integrated program, an LSE would aggregate dispatchable DERs and bid those resources into wholesale energy markets to take advantage of low or negative electricity prices. Resources would be capable of both "take" and "shed" under both design options.[16]

Distribution Service Model describes a paradigm where a Distribution System Operator (DSO) proactively coordinates with load serving entities, DER aggregators and the distribution system owner to procure and dispatch resources that meet distribution system needs. The DSO would optimize DERs to provide grid services and offer products into wholesale markets as appropriate. For the purposes of this document, the DSO was considered to be an independent non-profit entity modelled off CAISO.

FIGURE 2.



9 Zethmayr, Jeff, Kolata, David, and Environmental Defense Fund, November 2017, *The Costs and Benefits of Real Time Pricing*, https://citizensutilityboard.org/wp-content/uploads/2017/11/20171114_FinalRealTimePricingWhitepaper.pdf

10 PG&E Peak Day Pricing website, Accessed April 7, 2019, https://www.pge.com/en_US/small-medium-business/your-account/rates-and-rate-options/peak-day-pricing.page.

11 PG&E, January 2019, *Pacific Gas and Electric Company Monthly Report on Interruptible Load and Demand Response Programs for December 2018*, https://www.pge.com/pge_global/common/pdfs/save-energy-money/energy-management-programs/demand-response-programs/case-studies/December2018_ILPreport.pdf.

12 CPUC, January 2019, *Energy Division's Evaluation of Demand Response Auction Mechanism Final Report (Public Version - Redacted)*, http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442460092.

13 *Final Report of the California Public Utilities Commission's Load Shift Working Group.* January 2019.

14 Sonoma Clean Power, February 2019, *Residential Charging Station and GridSavvy Frequently Asked Questions*, Accessed April 7, 2019, https://sonomacleanpower.org/uploads/documents/GridSavvy-Program-FAQs-2.4.19.pdf

15 *The Final Report of the California Public Utilities Commission's Working Group on Load Shift*, January 2019, https://gridworks.org/wp-content/uploads/2019/02/LoadShiftWorkingGroup_report-1.pdf.

16 CAISO, July 2018, *Energy Storage and Distributed Energy Resources Phase 3 Draft Final Proposal Market and Infrastructure Policy*, http://www.caiso.com/Documents/Revised-DraftFinalProposal-EnergyStorage-DistributedEnergyResourcesPhase3.pdf.

Participating customers could be on a unique tariff that compensates distribution system grid services.[17] This model relies on a proactive approach to distribution system operations not currently in place in California, but under discussion. Figure 1 shows how a DSO could be structured to coordinate within an integrated systems operation framework.[18]

4. EVALUATION CRITERIA

To identify the virtual power plant options that best fit SVCE customers' needs, SVCE is evaluating possible options against its decarbonization criteria.[19] Virtual power plant options are evaluated on a 1-4 scale for each criterion. Table 2 details these criteria and what constitutes the bookend scores for each.

TABLE 2.

CRITERIA	DESCRIPTION	SCORE OF 1 ENTAILS	SCORE OF 4 INCLUDES
CUSTOMER, COMMUNITY, AND PUBLIC VALUE	Reduces costs and improves service quality of electricity grid	Increases electricity bills and offers no grid services	Customer able to earn on provision of grid services and grid services mitigate or avoid grid upgrades
EMISSIONS REDUCTIONS	Reduces emissions, including those which may result from transportation electrification and load growth in buildings	Does not reduce or increases emissions	Eliminates emissions and facilitates local renewables integration
SCALABLE AND TRANSFERRABLE	Ability to be expanded within and replicated beyond SVCE territory	Unable to be expanded or replicated	Easily transferable and able to accommodate various program sizes
EQUITY IN SERVICE[20]	Accessible to customers and limits negative impacts to non-participants	Inaccessible to majority of customers and significant cross subsidy from non-participants	Accessible to all customers and no cross subsidy from non-participants
CORE ROLE FOR SVCE	Leverages SVCE's position as a load serving entity and a joint powers authority with close customer and community ties[21]	Option could be implemented by any entity and does not rely on customer engagement	Option dependent on close customer relationships and engagement throughout design and implementation
VIABILITY	Operational, legal, and regulatory readiness/ risks of projects	Significant technical barriers and legal and regulatory action required	Option is able to launch today

17 *The Final Report of the California Public Utilities Commission's Working Group on Load Shift*, January 2019, https://gridworks.org/wp-content/uploads/2019/02/LoadShiftWorkingGroup_report-1.pdf.

18 De Martini, Paul and Kristov, Lorenzo, October 2015, *Distribution Systems in a High Distributed Energy Resources Future, Planning Market Design, Operation and Oversight*, https://emp.lbl.gov/sites/default/files/lbnl-1003797.pdf.

19 Silicon Valley Clean Energy, December 2018, *Decarbonization Strategy and Programs Roadmap*, https://www.svcleanenergy.org/wp-content/uploads/2018/12/SVCE-Decarb-Strategy-Programs-Roadmap_Dec-2018.pdf

20 Note SVCE's definition of this criteria is broader in the adopted *Decarbonization Strategy and Programs Roadmap*. This definition has been limited for the purposes of this evaluation.

21 SVCE is a joint powers authority comprised of thirteen local communities including Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Saratoga, Sunnyvale, and unincorporated Santa Clara County.

5. EVALUATION MATRIX AND DISCUSSION

Virtual power plant options are evaluated to indicate how well they align with criteria. **LOWEST SCORE** **HIGHEST SCORE**

OPTION	CUSTOMER, COMMUNITY, AND PUBLIC VALUE	EMISSIONS IMPACT	SCALABLE & TRANSFERABLE	EQUITY IN SERVICE	CORE ROLE FOR SVCE	VIABILITY
REAL TIME PRICING *rates based on hourly wholesale market prices*	Can lower customer bills but change in demand is not certain. Value increases and extends to community and public if significant response to price signals. Indirect impact on grid services.	Emissions are correlated with wholesale prices, so response to price signals increase emissions reductions.	Theoretically replicable but technical challenges for CCA to offer real time pricing exist, as introduced herein.	Available to all customers and is not dependent on special equipment. Exposure to real time prices limits cross-subsidy.	Sophisticated C&I customers already requesting dynamic pricing rate options. CCA could engage closely with its customers to offer technical assistance and guidance for customers to shift load.	Substantial, but addressable, technical barriers and deterrents to CCA implementation exist, as introduced herein.
PEAK DAY PRICING *commercial and industrial (C&I) rate structure that targets summer peak load reduction*	Year-round customer bill savings possible. Provides RA value. Decline in summer peak can improve grid stability and provide grid services but impacts limited to the season.	Reductions are limited to summer season. May lead to more consumption overall.	As an existing program, easily replicable, scalable, and transferrable.	Only available to C&I customers. Limited cross subsidy from non-participants.	Same as RTP.	If program design fits within utility billing structure, program could launch quickly.
DRAM *demand response aggregation for resource adequacy (RA)*	Direct impact on grid services, providing RA. Grid services such as capacity and load smoothing benefit the community.	Potential to reduce peak emissions but depends on when resources are scheduled.	Aggregation approach and auction design could be replicated and transferred to other load serving entities.	Accessible to all customer classes with controllable DERs . Limited cross subsidy from non-participants.	CCA's role in the community can engage participants closely and solicit innovative bids to meet RA requirements.	CCA could design and implement auction in short-term . Market nascence may make it challenging to keep customers engaged throughout CAISO integration process and realize total program potential; this challenge is not specific to a CCA.
LSR — GRID-RESPONSIVE *load shift from targeted dispatch signals, customer can opt out*	Customers can earn value on provision of grid services. Community and public benefit from grid services, increased DER integration, and avoided renewable curtailment.	Broad DER eligibility and grid-related dispatch signals can maximize emissions reductions.	Relatively easily scalable and transferable; depends on local DER adoption rates.	Accessible to all customers with communicating DERs. Non-participants benefit from optimized load management.	CCA's understanding of local DER adoption rates and grid needs are critical to success. CCA can leverage close customer relationships to target participants and ensure responses.	Program could launch relatively quickly but delayed access to customer meter data might impact operations.
LSR — MARKET- INTEGRATED *load shift to take advantage of low to negative prices, requires storage*	Customers can access low or negative energy prices. Community and public benefit from avoided renewable curtailment and local grid management.	Uses only emission-free electricity and avoids curtailment of renewable resources.	Limited scalability since currently only storage is eligible. Transferability is possible.	Only available to storage resources. DERs. Non-participants benefit from optimized load management.	CCA engagement would diversify market actors. Close customer relationships needed to engage participants.	Limited to storage resources. CAISO market is not open until Fall 2020.
DISTRIBUTION SERVICE MODEL *proactive, independent non-profit distribution system operator (DSO) optimizes DERs to provide grid services*	Customers earn on monetized grid services and contribution to local grid management. Community and public benefit from optimized operation of distribution grid, renewable integration, and avoided renewable curtailment	Assumes DERs replace conventional resources.	Dependence on DSO limits ability to scale or transfer.	All DERs could participate. Non-participants benefit from optimized distribution grid and load management.	CCA leverages close customer relationships and detailed understanding of local DER adoption rates to engage participants and liaise with DSO.	Lack of independent DSO, optimization tools, and access to grid and customer data are significant barriers.

REAL TIME PRICING

Real Time Pricing offers a relatively simple opportunity as a virtual power plant and there was broad support among stakeholders to leverage Real Time Pricing to better align customer rates with actual costs of providing electricity. A customer is not obligated to purchase equipment, making the program widely accessible, but it may take time for customers to understand when and how to change their energy load in response to price signals. This option is most relevant for sophisticated customers that have connected and controllable loads that enable automated response. Since impacts are based upon individual customers' demand elasticity and response (as opposed to obligations to offer resources), in the near-term, electricity, emissions, and grid services impacts can be uncertain.[22] A CCA could leverage targeted customer education and technical assistance to encourage greater customer engagement and value, load shift, and emissions reductions. Stakeholders suggested that, over the long-term, accurately reflecting the costs of electricity in rates would motivate customers to shift demand to lower cost times of day and relieve burden on other types of programs to modify energy demand. There are, however, barriers and deterrents that inhibit viability of Real Time Pricing (see call out box). Despite these issues, there is market-wide value in pursuing better alignment of customer rates with real time, actual costs of providing electricity.

PEAK DAY PRICING

Peak Day Pricing can also be a simple virtual power plant opportunity if it is designed to fit within utility billing constraints. Reduced use of peaker plants in the summer would contribute to grid reliability, provide grid services, and reduce emissions but impacts are limited to specific event days during the season. As an existing program type, it is scalable and transferable though it is limited to C&I customers. Given CCAs' close customer relationships and local insight, CCA administration could enhance program impacts and customer messaging and experience as new customers are enrolled and supported to respond to peak day events.[23] Although many utilities and some CCAs already offer a Peak Day Pricing program, this virtual power plant option did not receive much attention throughout stakeholder engagement on the Discussion Draft. One concern is that enrolling customers in a Peak Day Pricing pilot and securing responses on event days is challenging, even with a focused effort to engage customers. Similar to Real Time Pricing, it may take customers time to respond to price signals and dependence on customer behavior introduces uncertainty for program impacts. As with all program design options, the costs of enrolling customers and deploying a program should be weighed against its potential impact.

22 Barbose, Galen and Goldman, Charles, December 2004, *A Survey of Utility Experience with Real Time Pricing*, http://eta-publications.lbl.gov/sites/default/files/report-lbnl-54238.pdf

23 Sacramento Municipal Utility District, September 2014, *SmartPricing Options Final Evaluation*, https://www.smartgrid.gov/files/SMUD-CBS_Final_Evaluation_Submitted_DOE_9_9_2014.pdf.

Under California's Public Utilities Code, CCAs are free to set rates for the generation component of their customer bills as they choose, including Real Time Pricing. However, there are barriers and deterrents, including:

COMPARABILITY: variation between the rate designs of incumbent utilities and CCAs make it more difficult for customers to compare their relative cost of service under each option.

DATA ACCESS UNDER CONSOLIDATED BILLING: CCAs are currently required to rely on the incumbent utilities to issue customers consolidated bills. To ensure accurate bills, the CCA and utility need a shared understanding of billing determinants (e.g., time interval, rate), interoperable systems supporting automated daily billing, and a consistent, predictable exchange of billing quality meter data. The needed data access has been reliably achieved in Southern California Edison's territory, has not been achieved in PG&E's territory, and remains too soon to tell in San Diego Gas & Electric's territory.

DELIVERY CHARGE AND PCIA IMPACT ON RTP: Delivery charges and the PCIA are deducted from rates on a flat basis for every kWh consumed, making up at least 50% of charges, with no seasonality or TOU component. Achieving meaningful differences between peak and off-peak prices is difficult to accomplish as long as these charges can not be time differentiated.

INFORMED CUSTOMERS: In order to respond to RTP, a customer needs access to its load and price data. While some large C&I customers have this access, others do not and residential customers are lagging behind. These customers will need solutions.

DEMAND RESPONSE AUCTION MECHANISM

DRAM is a unique option for a CCA to implement an emerging market mechanism for RA. A CCA could leverage its position in the community to target underutilized participants and solicit innovative bids that can meet the CCA's RA needs. Under DRAM, the customer would need to own, directly control, or allow a third party to control a demand response resource, which might be as simple as an air conditioner or as complex as a data center. The customer has the opportunity to earn on its provision of RA and the broader community benefits from grid services such as capacity and load smoothing. Emissions reductions, however, are somewhat uncertain since DRAM resources in the CPUC pilot were scheduled far less frequently during the highest CAISO peak.[24] A CCA would benefit from insights gained through the CPUC pilot and could target scheduling to achieve program objectives. Market nascence, however, may also make it challenging to keep customers engaged and realize total program potential. Other challenges related to program viability, such as non-competitive bid prices[25] and lack of credit for exported energy and capacity, would not be unique or specific to a CCA.

24 CPUC, January 2019, *Energy Division's Evaluation of Demand Response Auction Mechanism Final Report (Public Version - Redacted)*, page 10, http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442460092.

25 Ibid.

LOAD SHIFT RESOURCE — GRID-RESPONSIVE

An LSR-grid responsive, out-of-market program is an option for providing more sophisticated load management in response to the grid but without bidding into the CAISO market. A majority of stakeholders favored SVCE pursuing this option throughout review. Customer value results from the provision of and compensation for grid services and the community benefits from increased DER integration and avoided renewable curtailment. Customers must own, directly control, or allow a third party to control a DER to participate. If the customer owns or directly controls the DER, they must be willing to engage with dispatch signals and respond to events (e.g., low prices, high emissions, low capacity, etc.). All communicating DERs would be eligible, which supports the potential for relatively greater customer and community value, emissions reductions, and operational viability. The CCA's understanding of local DER adoption rates and grid needs are critical to targeting participants and aligning grid services. Program launch is viable, as demonstrated in Sonoma Clean Power's GridSavvy program. Settling customer incentive payments, however, would be a challenge depending on timing of access to customer meter data. Vendor integration and projection of customer opt out rates can introduce uncertainty. Early program administrators are collaborating on solutions to settlement data. For instance, rather than settle customer payments based on meter data, an LSE could offer customers a flat rate rebate or monthly discount.

LOAD SHIFT RESOURCE — MARKET-INTEGRATED

A market-integrated LSR program adds complexity and sophistication to the virtual power plant. Resources could offer greater value to participants and communities as they are able to take advantage of low or negative energy prices, avoid renewable curtailment, and actively contribute to local energy management and emissions reductions. CAISO's pending PDR-LSR offering, which is expected to be available to market participants in the fall of 2020, is limited to storage resources, limiting access to customers able to purchase and actively manage or automate equipment response. CCA engagement with this program type would diversify market actors and facilitate local renewables integration. Strong relationships and communication lines with customers are essential to success.

DISTRIBUTION SERVICE MODEL

A Distribution Service Model is a technically complex option for a virtual power plant and would require substantial time and resources to develop. Stakeholders recommended simplifying the option to focus on procurement of specific, prioritized distribution grid services. The option offers localized control and contribution to distribution system management, including facilitating renewables integration and avoiding renewable curtailment, which could support added grid resilience and stability over other virtual power plant options. Customers are able to earn on monetized grid services and the broader community and public benefit from the DSO's optimization of the distribution grid. Assuming that DERs replace all conventional resources, this option maximizes emissions reductions and supports grid disaggregation. A CCA would leverage its close customer relationships and detailed understanding of local DER adoption rates to engage participants and work with the DSO. There are, however, significant operational, legal, and regulatory viability issues such as lack of an independent DSO, technologically advanced optimization tools, and access to grid and customer meter data.

6. RECOMMENDATIONS AND NEXT STEPS

Short-, medium-, and long-term recommendations emerge. In the short-term, Peak Day Pricing, DRAM, and LSR-grid responsive are viable options for a virtual power plant for SVCE customers. SVCE may choose to implement one or more of these options, depending on their grid and customer needs. Peak Day Pricing and DRAM offer the most viable near-term Resource Adequacy benefits, while Load Shift-Grid Responsive best mitigates the risk of new costs and emissions from the electrification of transportation and buildings. Given SVCE's focus on electrification as a means of decarbonization, a focus on Load Shift may best align with SVCE's needs. For Load Shift, the simplest solution would be to design a Grid Responsive option to begin, but in the medium- to long-term SVCE should plan to integrate the resource into CAISO's market through the Proxy Demand Response - Load Shift Resource (PDR-LSR) tariff.

In the medium-term, SVCE can make meaningful progress toward customer engagement, especially if it works with other CCAs and utilities to identify and test approaches for customer engagement, data access, and data processing. Other virtual power plant options may become viable if certain technical or regulatory barriers are addressed. For instance, Real Time Pricing and different Peak Day Pricing options could be more feasible and valuable if CCAs had more control over electric rates. For example, if CCAs had a means of paying delivery or PCIA charges in a way other than per-unit of consumption, they could then introduce greater differences between on- and off-peak prices, motivating valuable customer response.

In the long-term, virtual power plant program activities and outcomes should collectively build towards shared energy management goals, including enabling transparency in distribution planning and distributed energy resource integration. Although a Distribution Services Model may not be feasible in the near-term, program designs today can build the foundation to achieve that model in the future. As a starting point, SVCE should continue engaging stakeholders to identify priority grid services, maximizing the value of it's virtual power plant to the grid. . SVCE could thereby plant seeds that ultimately facilitate California's evolution to new Distribution System Operator models.

Overall, for all Californians to realize the benefits of DER aggregations and virtual power plants, additional transparency and information exchange regarding customer load profiles, distribution grid conditions, and grid management needs are imperative. CCAs' detailed understanding of local DER adoption rates and customer values allow a unique opportunity to offer virtual power plant solutions that can mitigate anticipated load growth and improve grid stability and resilience. CCAs should work with member cities and counties to share expected load growth and DER adoption scenarios, identify anticipated grid needs, and prioritize options that can serve all customers.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