DR20.03 Demand Response Technology Enhancements

Overview

Demand response (DR) programs are important resources for keeping the electricity grid reliable and efficient, deferring increased generation capacity, reducing spikes and high loads to transmission and distribution systems, and providing societal economic and environmental benefits. SCE is committed to ensuring that customers have access to the most cost-effective technologies that are eligible for program incentives, thereby enabling customers to manage their energy costs and time of energy use.

The objective of this project is to study the continuing value in technologies that utilize dynamic pricing-based ADR and to provide a pathway for innovative emerging technologies that facilitate and increase customer participation in these programs and initiatives. The gaps in dynamic pricing-based ADR will be identified and assessed. Further, identification of innovative emerging technologies, software, and market solutions for new models of DR program needs will be identified.

The objectives are as follows:

- Identify applicable tariffs and their characteristics
- Determine what methods can be used to show these tariffs can be communicated to different customers using different communication technologies
- Establish the impacts of the emerging trends (such as IoT, energy storage systems, etc.) in improving the ADR

A point of convergence of the research is that to be eligible for incentives from SCE and other California public utilities, most of the future DR resources need to be automated through ADR to allow them to be dispatchable and flexible.

The CPUC-funded and related work at the LBNL Demand Response Research Center (DRRC) evaluated costs from DR automation programs and trends in the costs per kW of load-shed. Cost comparisons can only be made if there are standard methods of defining the costs for hardware, software, installation, configuration, and commissioning. The lowest cost sites are likely to be those with DR automation software embedded in controls. These lower costs may continue to become common as standardization in DR automation continues and vendors provide native DR in software. Also, various electrical end uses are often costly to automate or provide ADR-types of behavior due to their commercial or industrial facility type, or high cost of acquisition. The following chart illustrates how the DRRC identified ADR potential across those customer sectors.

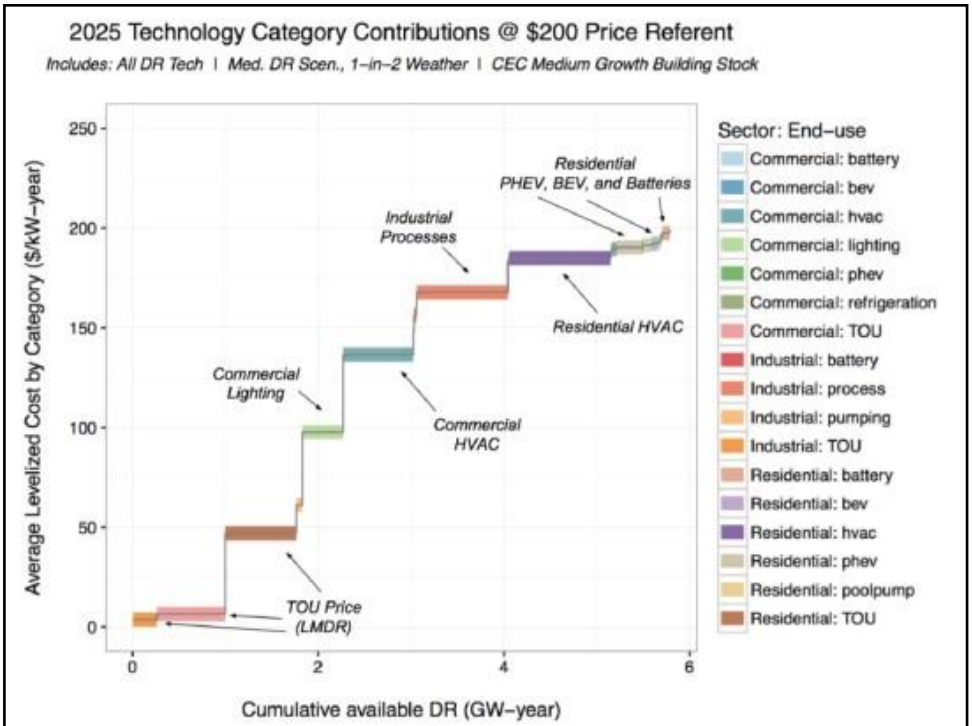

Figure 4: The 2025 technology category contributions below the $200/kW-year price referent. The average levelized costs for each technology category (y-axis) and their contributions to cumulative DR (GW-yr) are shown for the medium DR scenario, 1:2 weather year for all DR technologies.

Available DR Potential by End Use Technology

The DRRC's study also illustrated how market transformation has a synergistic impact with market barriers and a similar perspective should be explored for aggressively promoting a long-term commitment to DR in California. This may include new approaches such as upstream DR incentives for DR automation systems such as HVAC, lighting, or pumping systems. The DR automation market will become mainstream when control systems have communication hardware and software capabilities that can receive and send DR signals with minimal or no additional first costs. A "DR transformed" controls market would enable lower cost DR with greater levels of participation.

SCE's goal for realizing California's DR potential over the next 10 years will be based on new models of DR programs that embrace the technology category contributions for end-uses that can provide "shift" and the integration of preferred resources such as distributed generation, storage, changes in codes and standards, and dynamic pricing structures. DR also has the potential to be a local resource for distribution system operations. Improving understanding of DR technical and market potential is critical as utilities explore how to overcome new challenges to integrate renewables and manage a more dynamic grid.

This study will contribute to the understanding of strategies, software, systems, and advanced innovative enabling technologies and identify new opportunities for DR resources through emerging market engagement, increased DR customer participation, performance, and improved uptake of DR automation protocols across a broader spectrum of high-tech industries and manufacturers.

The project has a set of five objectives (Task 1 — Task 5, below) that examine the technical capabilities of the portfolio of existing ADR and EM&T projects and evaluate opportunities for new pilot and program concepts. The LBNL team would then work with the SCE team to organize these ideas into a set of recommendations. These recommendations would be based on the technical needs assessment and multi-year opportunity matrix that would focus on both pre-commercial and near cost-effective solutions to enhance future SCE DR activities in the EM&T program.

Task 1. Assess Current and Potential Future SCE Tariffs for Data Elements

The purpose of this task is to identify the information that needs to be communicated to customers for their end-uses to effectively respond to new models of dynamic pricing. LBNL plans to evaluate existing tariffs and consider ways that new tariffs may provide the data elements for effective OpenADR communications messaging to end-uses that can participate in new models of demand response. This analysis will include:

- Smart Energy Program tariff
- Residential and (optionally) Small Business time of Use tariff

This task will characterize tariffs in terms of the rate structure, periodicity, seasonality, potential frequency of adjustments or updates, possibilities for location-specific tariffs, and the number of customers in the various sectors and possible end-use classes at any location. Attention will be paid to details that affect the coordination of the messaging with both the need for customer action, or need for possible mitigation of renewable curtailment, and whether the rate is dependent on the direction of power flow at the meter. There will also be an assessment of the capabilities of the OpenADR messaging structure to provide effective messaging in either an embedded price structure at the customer device, or a day-ahead hourly price model that can be transmitted machine to machine.

Task 2. Data Models and Data Communication Architectures

This task will identify the overall structure of relaying and communicating tariff information from SCE to individual customer end-uses via digital signals, building on the results of Task 1. The end-use loads of most interest include basic HVAC systems, water heaters, appliances, EVs, and battery storage. The opportunities for "shift" for these end-uses and in concert with the SCE dynamic rate designs will be assessed. This task will describe the existing and emerging device characteristics involved to receive and

respond to digital communications, such as 1-way broadcast vs. 2-way systems, whether multiple communication channels are desirable and/or other features. The work will emphasize clarity on what parts of the system are the purview of the utility vs. those that are internal to the customer site, whether provided by an aggregator or manufacturer.

A key part of this task is to address not only the ideal future state in which all end uses can receive price and tariff data directly, but also the long transition time in which legacy devices need either external hardware control, or external software that interacts with legacy device control mechanisms. Considerations for the data models will include machine-to-machine and cloud-to-machine architectures for a "whole building" or "total premise" approach. Of significant interest is the future scenario of messaging to the "premise" rather than through the end-use, with the sub-operational functions coordinated in a distributed manner through a central "hub" or "smart integrator" acting as the communication end node.

Task 3. Supporting Technologies and Communication Standards

This task is to review the landscape of existing communication technologies and see how they are suitable for use in the architecture that results from Task 2. This review will cover both physical layer protocols as well as the application layer protocols that they carry. Existing technology capabilities and characteristics will be described. The review of tariff communication from the utility grid to customer sites will consider current protocols which include OpenADR 2.0 versions a and b, and will compare these with what is available in IEEE 2030.5 (SEP) using comparative studies already available through organizations such as the OpenADR Alliance. The task will also identify gaps in existing data model functionality that might require further investigation.

Other technologies that are suitable for communication within customer sites will be examined, including Zigbee, Z-wave, and Wi-Fi. Important physical layer technologies for wide-area use externally include broadband Internet, cellular radio, FM radio, and within building energy management systems include Ethernet and Wi-Fi, Bluetooth, Zigbee, Z-wave, and more. The summary report will describe which technologies can be used for core system operation. In some cases, there may be a single technology for a particular purpose.

Task 4. Evaluate Cost Trends, Persistence, Storage, Internet of Things (IOT), Trends, and Information Technology Opportunities

To further examine emerging technologies for ADR and opportunities for "shift", the LBNL team will assess the emerging ADR technology trends, the opportunities for ADR in the Internet of Things, and how other information technology systems used in other markets (healthcare, financial, biotech), can help reduce the cost and improve the

performance of automated DR systems. To drive broad adoption of automated DR systems, it is important to understand the costs associated with their installation. The lowest cost sites are those with DR automation software embedded in controls. Since costs might be reduced over time by leveraging the DR automation systems with other energy efficiency investments, they will be explored as well.

This task will also include a review of OpenADR and storage system capabilities. This is a new and emerging opportunity for both "shift" resources as well as resiliency and possible arbitrage during dynamic pricing periods. This effort will emphasize the use of OpenADR with customer end-uses and will require a review of the DR signals, gateways, costs for automation, and emerging connectivity issues. The deliverable for this task will be a technical memo and a webinar with SCE staff to discuss the results.

Task 5. Develop Final Report and Recommendations

LBNL will prepare a final report that summarizes the results of Tasks 1 through 4 and provide a set of short term, mid-term, and long-range strategic recommendations for SCE on future opportunities for the EM&T program. This will include short-, medium-, and long-term activities to enhance DR programs over time, with recommendations for assessments of emerging technologies. The report will include a summary of all the project's technical memorandums and a summary of each task.

The project was funded under the EM&T "Market Assessments" and "Technology Assessments" investment categories, as there are elements of both research goals in this study. The Market Assessments category is designed to create a better understanding of the emerging innovation and developments of new consumer markets for DR-enabling technologies and an awareness of consumer trends for smart devices. The Technology Assessments category assesses and reviews the performance of DR-enabling technologies through lab and field tests and demonstrations designed to verify or enable DR technical capabilities.

Collaboration

LBNL will be identifying new innovative technologies and software in the market. SCE's EM&T program will be utilizing LBNL to assist with market solutions for advancement of SCE's DR initiatives to its customers. The EM&T program works to enable customer participation in SCE's DR programs by providing input to the Codes and Standards (C&S) program, which draws on research into customer preferences and the market potential for DR in California's new construction markets. In addition, to further enable and expand DR in California, SCE is involved in ongoing collaboration and research with other statewide agencies and third-party stakeholders. While the EM&T program is funding the project through a contract with EPRI, SCE is also leveraging its membership in EPRI with learnings and best practices from the parallel research by other EPRI utility members as

a cost-sharing strategy. Also, as a corporate funding member of EPRI, SCE is co-fundingparallel research investments with other utilities and leveraging that research to assist inthis market assessment study, but no other direct cost-sharing or co-funding with any other parties was enabled.

Results/Status

The data gathering phase of the project was completed in early 2021 by researchers in accordance with the scope of work and has progressed as scheduled. Review of the key technology parameters were collected, including each type of DR tariff and program, storage system performance data, measurement and verification analysis, and customerpersistence issues that are being evaluated under the different tasks. Technical factor reviews are completed and under final review for OpenADR protocols for 2.0a versus 2.0b, and meetings with the review team have been held via webinar.

Next Steps

This research study is on track to develop a multi-year opportunity matrix that will focuson both pre-commercial and near-term cost-effective solutions to enhance future SCE DR activities in support of the DR products group as recommendations from the EM&T program. Each of the five project tasks are sequential and build upon the research in theprevious task. Interim reports have been delivered as the work has progressed, and additional technical review meetings have been held with relevant stakeholders via webinar in Q1 and Q2 2021. The final report is in draft form and is expected to be completed in Q3 2021.