Report Summary - CEC-500-2020-057

Smart Home Study

Understanding how connected homes can serve the smart grid

Alternative Energy Systems Consulting
Prime Contractor, Project Administrative Lead, and Technical Advisory Committee Chair

San Diego Gas & Electric
Dynamic Tariff, Price Signal and IOU Subject Matter Expertise

Itron
Developer of the RDERMS and Lead Technologist

Center for Sustainable Energy
Tariff Analytics, Evaluation, Measurement and Verification

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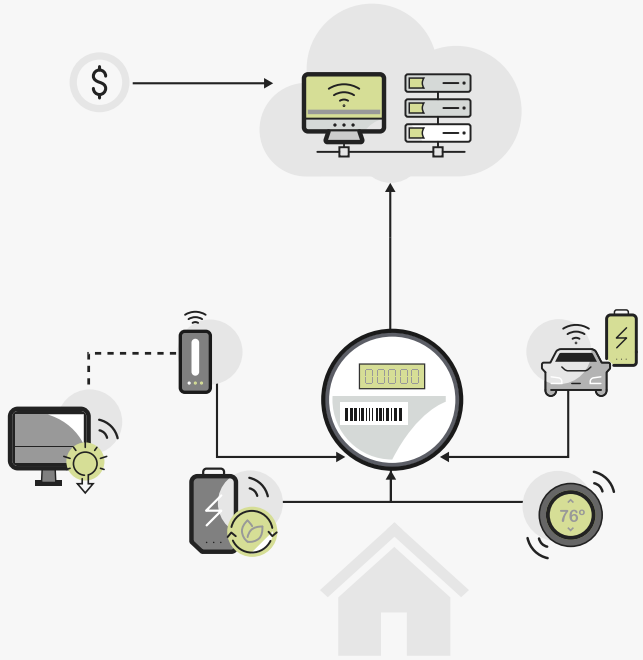
Study Objective

Under the auspices of California Energy Commission EPIC grant (EPC-15-048), the project team studied practical applications of DER control technologies to shift residential loads through dynamic pricing strategies. The primary goal was to advance research on how smart and connected devices can improve the health of the grid, reduce carbon emissions, and minimize the cost of energy to customers.

What is the Smart Home Study?

This project, known by its simplified name, Smart Home Study, shifted load shapes and minimized customer utility costs for 100 homeowners who were also San Diego Gas & Electric (SDG&E) residential electric customers. As part of the program, all participants with central air conditioning received a Honeywell Wi-Fi web-programmable thermostat, 30 participants received Webasto Level 2 Electric Vehicle charging stations (EVCS), and 30 received Sonnen battery energy storage systems (BESS). Also, Itron's Residential Distributed Energy Resource Management Systems (RDERMS) were installed to communicate with these Distributed Energy Resources (DERs). The project used RDERMS to shift electric loads and minimize customer costs while maintaining customer comfort.



The Smart Home Study utilized various home DERs, supporting load shifting models and dynamic price signaling.

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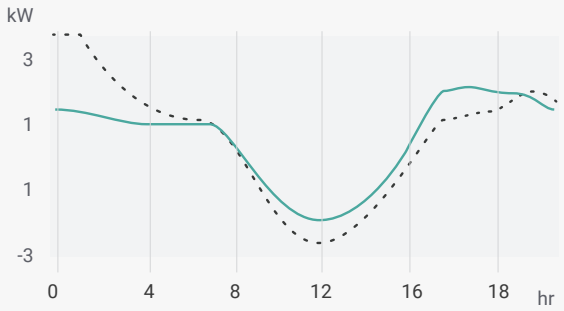
Study Results Summary

1. Was the RDERMS effective?

Yes- The RDERMS was effectively used to manage and control smart loads to shift from high-cost and high-carbon periods to periods with lower energy costs (and likely lower carbon content).

Average Daily Load Profile Before and During Study



Smart Thermostat, EVCS, and BESS

2. Was there a correct alignment between TOU rates and the targeted DERs?

Yes- Tariff modeling results confirmed that current time-of-use rate structures offered by SDG&E benefit customers and the grid through planned electric vehicle charging and energy storage dispatch. However, greater grid benefits can likely be achieved by further aligning distributed energy resource operations with dynamic (real-time) price signaling.

3. Is price signaling effective, and can it be managed by the RDERMS?

Yes- The study demonstrated the potential of price signals to effectively reward customers who shift loads to periods of high renewable resource generation, without increasing utility costs. The addition of DERs such as electric vehicle charging, batteries, and smart thermostats present an opportunity to help support load shift.

Bringing it all together

The study effectively demonstrated energy reductions during the 4 to 9 PM peak hours (the ”head” of the duck curve). However, the study did not show substantial reductions in midday energy export (during the “belly” of the duck) since current time-of-use rates and net energy metering policies do not provide the financial motivations to do so. The structure is financially optimized by charging the battery energy system at night during super off-peak rather than during the daylight hours when the batteries could have been used to help mitigate grid overgeneration.

Relatively minor adjustments to existing TOU rates could build load during beneficial hours (as determined by the CAISO) while reducing carbon emissions. Deploying a control technology such as the RDERMS can effectively achieve mutual benefits to the grid and to the customer.

About AESC: We are DER Solutions Integrators

As DER Solutions Integrators, we take a proactive approach to managing the complex world of today’s Distributed Energy Resources. Founded in 1994, Alternative Energy Systems Consulting, Inc. (AESC) is an energy engineering practice that drives solutions in energy efficiency, renewable energy, and software for utilities, regulators, public entities and private enterprises throughout the United States.

To view the full report of the Smart Home Study, including an in-depth analysis on electric vehicles and battery storage, visit https://ww2.energy.ca.gov/2020publications/CEC-500-2020-057/CEC-500-2020-057.pdf