SCE EM&T PROJECT: DR19.07 MEASURING BUILDER INSTALLED ELECTRICAL LOADS

Status: In progress

Overview

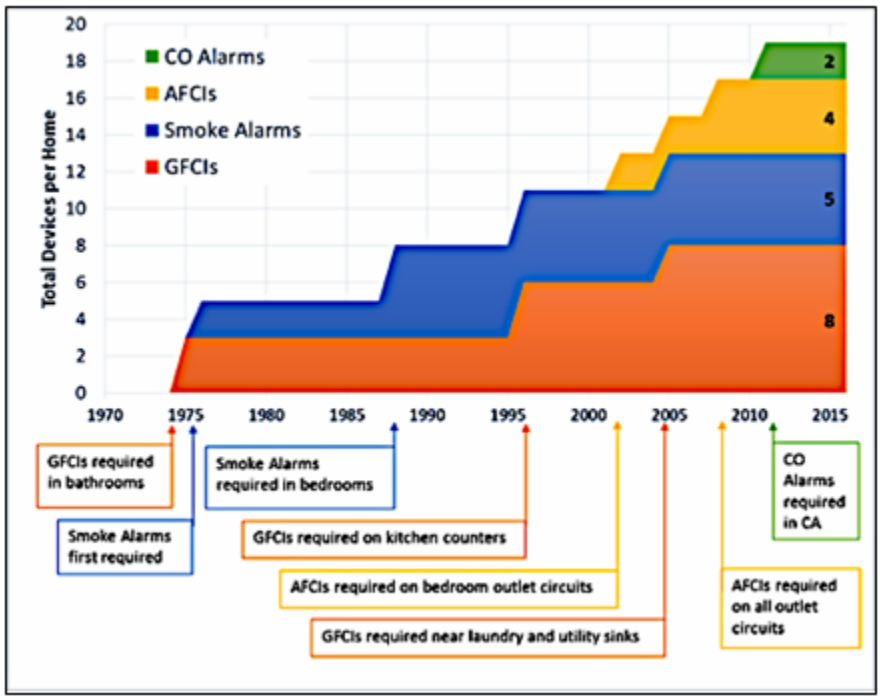
The home builder/contractor mostly selects and installs the permanent (or "hard-wired") electrical appliances and components in new homes. The minimum energy efficiencies for the common appliances — air conditioners, heat pumps, heat pump water heaters, pool pumps, refrigerators, etc. are determined by standards — so the home builder's impact on energy consumption is likely to be modest. At the same time, new homes — and especially new, "smart" homes — are outfitted with a second group of devices. This group includes EV chargers, communications infrastructure, batteries, and security equipment. These devices communicate through various protocols to both in-home hubs and via the cloud. The figure below illustrates just a few of the devices appearing in new homes.

Smart Home Technologies Illustration

These devices provide diverse services, but they are connected in the sense that the builder is responsible for their selection, installation, and commissioning.

Builders and clients are uniquely challenged to make rational trade-offs because little consistent information is available on costs, features of energy and power consumption, and demand. In contrast, SCE has close connections with developers and builders, which gives SCE a unique opportunity to influence decisions regarding equipment selection in future smart homes, either through information or incentives. The first step, however, is to understand the "builder-installed" loads.

Anecdotal data from an ongoing CEC EPIC project suggests that builder-installed electrical loads are contributing as much as 1,300 kWh/year in total power usage in new homes, even before occupants have moved in. No information is currently available to assess how this impacts load shape. This first phase of research is needed because this aspect of residential energy use has not yet been carefully studied. Also, as new homes receive PV, smart inverters, energy storage, and smart car charging systems, the impacts of these loads could increase.



Growth in Code-Required Systems in New Homes

The research objectives of this project are to:

- Examine opportunities for load management (shift and/or shed) of new construction hard-wired loads that could possibly be managed to reduce their small but growing impact on future overall residential energy load shapes and ultimately GHG emissions.

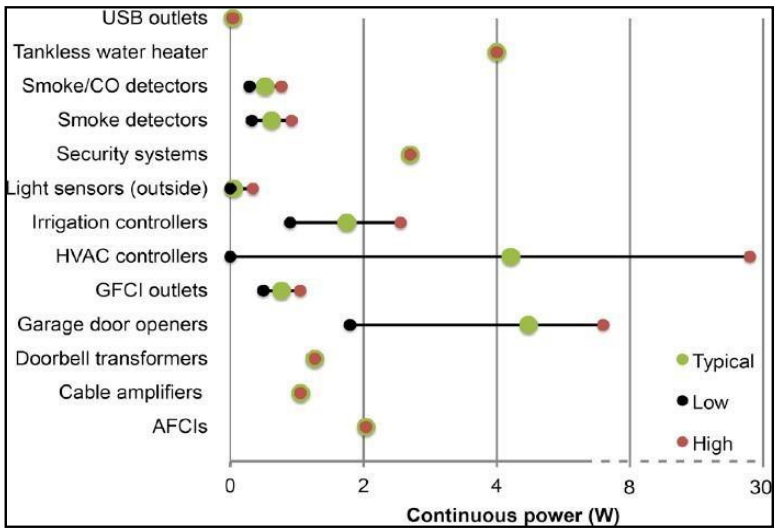
- Develop anticipated new load shapes and energy use of new, "smart homes" and new all electric homes, with a focus on builder-installed equipment. such as EV chargers, smart inverters, and battery storage systems.

- Develop a comprehensive assessment to provide a technical forecast for the demand response potential of such smart homes.

- Help SCE identify opportunities for load shifting, demand response, and energy savings with the new home technologies.

The first step in the study is to collect data on electricity consumed by equipment in newly constructed homes. Short-term, whole-house power measurements will be taken from new homes during a relatively short time period between the completion of construction and move-in of the homeowner. The research team will identify builder-installed electrical devices found in new, smart homes in California and other relevant locations. The team will collect bills of materials and information about actual construction practices in new homes. Focus would be on non-standard appliances and devices (that is, not air conditioners, refrigerators, lights, etc.) and all-electric homes. The team will prepare a list of devices and their technical characteristics. This includes estimating the power draw, load shapes, and energy consumption based on nameplate, laboratory measurements, and literature surveys.

The information will be assembled in the form of typical homes, with estimates of types of builder-installed devices, their power, load shape, and energy use. The focus will be less on conventional appliances and equipment (e.g., air conditioners, water heaters, etc.) and more on products associated with "smart" homes. Thus, the main product will be a portfolio of typical homes, along with their energy characteristics, for the devices typically installed by the builder before the occupants move in. The focus will be on early-adopter configurations; however, some homes with a more modest collection of smart devices will also be included.



Summary of Typical Builder Installed Loads

In the next phase of the project, the research team will create a model of prototype home data that can hold builder-installed device data and perform simple calculations. This will include home information such as floor area, and device characteristics such as load shape and demand shifting opportunities. The team will create five "smart home" prototypes with builder-installed devices based on the bill of materials. The team will then calculate the contribution of the builder-installed devices to the home's power draw, energy consumption, and load shape.

For a specific assessment of the demand response potential, the team will investigate the gross load impact of builder-installed devices, calculate the whole-house load shape for each prototype, and evaluate the load shifting potential of individual builder-installed devices, with an emphasis on dispatchable devices and possible interaction with either EV smart inverters or installed energy storage.

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

This project includes collaboration with internal SCE groups, including Emerging Technologies and the Business Customer Division. Stakeholders have an interest in finding demand responsive solutions for builders that will make the homes they construct less energy intensive while managing loads to minimize grid impacts. The study will be conducted with researchers located at the advanced buildings section of the LBNL facility, EPRI, and coordination with builders through SCE field services. The project is being co-funded by the SCE Emerging Technologies program and as a member of EPRI, SCE is also co-funding parallel research investments with other utilities and leveraging that research to assist in this study, but no other direct cost -sharing or co-funding with any other parties was enabled.

Results/Status

Originally, the project approach incorporated a strong focus on in-situ field measurements of the Builder-Installed Electrical Loads (BIELs). Due to COVID-19 restrictions, the approach to collect on-site data at new home developments was determined unfeasible, and the project scope was modified to place more emphasis on academic peer research and modeling, with plans to incorporate laboratory and alternative field measurement activities. Additionally, more emphasis was placed on the investigation of "smart" BIELs, such as solar inverters and EV chargers. While the core objectives of the research are still in focus, the modeling and peer research will be developed as substitutes for the field work, as access to new construction homes is no longer in scope.

A technical memo was developed in Q3-Q4, capturing the research study findings on BIEL technical characteristics. The paper study was comprised of literature surveys, info gathered from smart home builder websites, technology publications, manufacturer websites, ENERGY STAR-qualified product lists, interviews, and builder-supplied documents. A BIEL device library was also established as a living

document, detailing energy and power consumption, the expected types and numbers in a typical home, and other relevant characteristics. Over 100 devices were reviewed, and over 35 smart BIELs were identified.

Next Steps

The team will next focus on characterizing the overall energy usage patterns and breakdown of energy consumption by BIEL device through energy modeling of several identified prototype home models. Updates/refinements to the prototype home models characteristics will continue in 2021, and direct/indirect demand/energy impacts will be simulated, verified with lab and field measurements where possible as the team adjusts its approach. The team also plans to continue to provide a technical forecast for the demand response potential of such smart homes to ultimately help SCE identify opportunities for load shifting, demand response, and energy savings with the new anticipated home technologies.