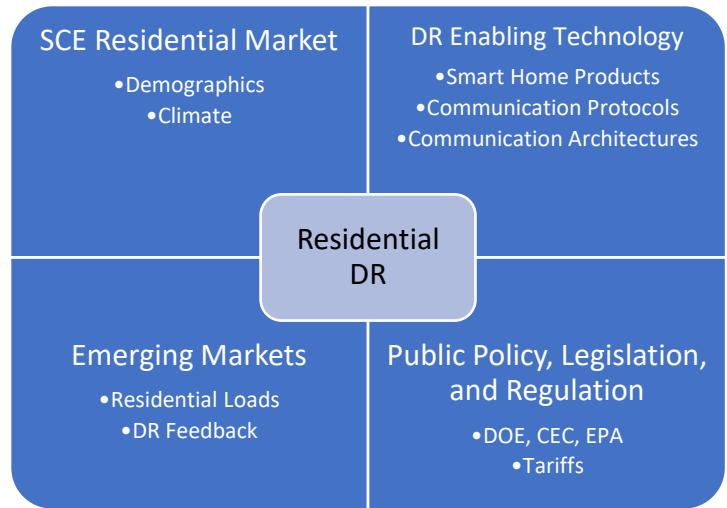


DR18.13 RESIDENTIAL DEMAND RESPONSE: Emerging Opportunities in Southern California

This is a summary of the research into the emerging opportunities in residential demand response (DR) within Southern California. Changes in the DR landscape may be revealing new opportunities that were previously unavailable. There are several factors that affect the future of DR:

- Increased adoption of intermittent renewables has shifted the grid peak towards early morning and late evening. This new peak better corresponds to residential loads than to typical business loads.¹
- Customers prefer coordinating with a third-party rather than a utility.
- New devices include increased communication abilities that enable "smart home" features which optimize energy use and comfort.
- New tech can store energy in new ways. For example, grid-enabled heat pump water heaters (HPWHs) can store heat and shift demand out of the peak period. HPWHs will become more significant as electrification progresses.
- Behind-the-meter storage (e.g., residential batteries, solar PV) is increasing.



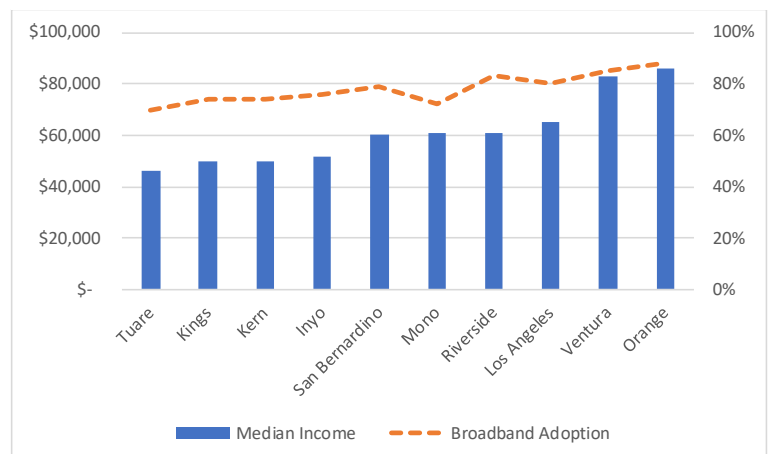
This project focuses on mass market residential DR opportunities and ways to enhance customer engagement through communication and coordination. The research had four primary areas of investigation: a characterization of SCE’s residential market, DR enabling technologies, new markets, and the impacts of public policies and legislation.

SCE RESIDENTIAL MARKET

SCE’s residential customers are primarily located in the metropolitan area, but the SCE territory spans multiple climate zones, counties, and geographical categories. These zones and geographical categories each have unique characteristics like climate, income levels, connectedness, and technological literacy.

This research found a correlation between household income and broadband access. This suggests that programs may need to accommodate the lower income customer base if they want to increase their participation in programs that rely on broadband access.

Figure 1. Broadband Adoption Versus Income, by County

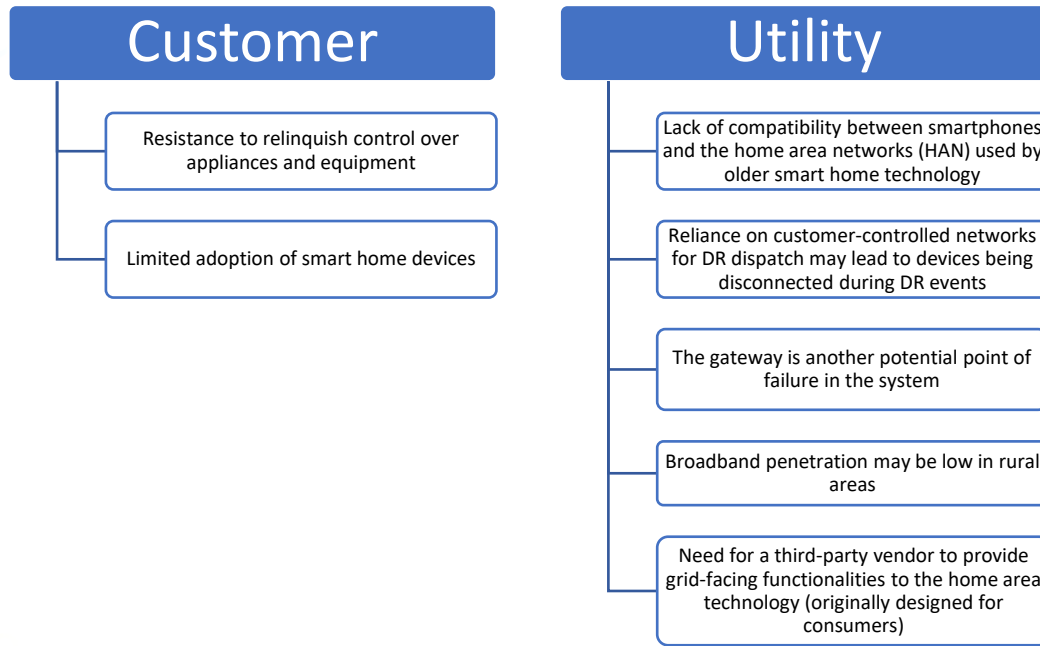


¹ SCE’s DR events have shifted from primarily 2 – 6 p.m. to 5 -9 p.m.

DR ENABLING TECHNOLOGY

This research reviews the history and forecast of DR programs and technology, while also presenting an overview of smart device communications. Advanced metering infrastructure (AMI) meters were used for DR by several utilities, but these attempts were limited by proximity issues, limited functionality, and loss of data. Subsequent demand response programs in the late-2000s relied on smart home technology, but existing communication protocols limited the programs' effectiveness (outlined in Figure 2).

Figure 2. Limitations of Previous Demand Response Programs in late-2000s



Current technologies include smart home devices like Amazon's Alexa and Echo, Google's Nest and Home, and Apple's HomeKit and HomePod. These manufacturer's smart speakers are being increasingly adopted and makes the smart home interaction more appealing. Smart home devices use various communication technologies and protocols to exchange information between devices. This can be a potential barrier to DR effectiveness.

Interoperability between devices and protocols is critical to their effectiveness in DR programs. Most smart home devices utilize proprietary communications, which presents risks to interoperability, security, and stranded assets. To reduce these risks, this report recommends that SCE remain brand agnostic and support open source communication tools like OpenADR, IEEE 2030.5, and CTA-2045.

EMERGING MARKETS FOR RESIDENTIAL DR

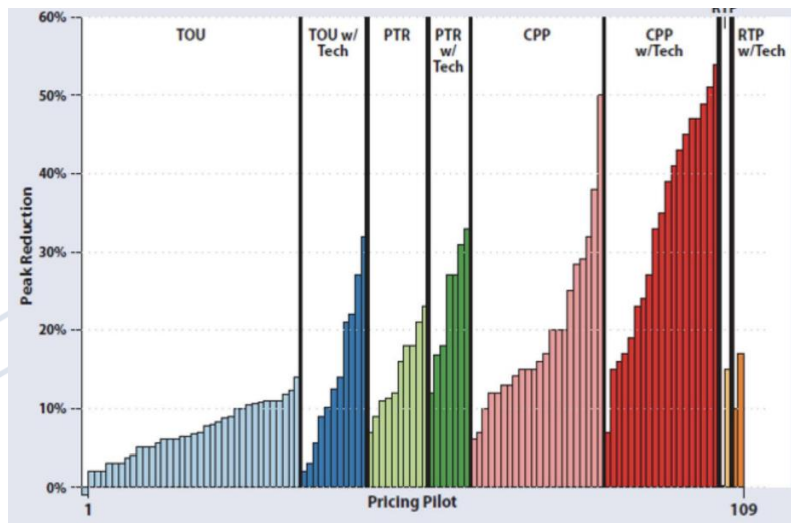
This portion of the research identifies options for implementing residential DR more effectively. It reviews the loads that can contribute to DR, the DR programs and how they can improve participation, and the communication technologies and applications that can help with coordination.

Residential loads were reviewed for DR potential and HVAC, ventilation fans, and pool pumps are most likely to provide a DR resource. One study suggests that ventilation can be reduced by 40%, with seasonal adjustments being more effective than daily or monthly. Interestingly, only the inland portions of the SCE territory have a pool pump usage peak during the evening, suggesting a possible regional DR opportunity.

Table 1. Shift vs. Shed DR Options for Key Residential Loads

Residential end use category	Shift strategies	Shed strategies
HVAC, with smart thermostat	Precool during lower priced times during the day when renewable resources are available	Change setpoint to reduce load for selected periods of time; can result in increased loads overall to make up for temperature changes during reduced load
Ventilation	Ventilate during lower priced times during the day when renewable resources are available	No: Ventilation is required in new construction (Title 24), so any reduction must be compensated.
Pool pumps	Run filtration and other pump-based tasks during lower priced times of the day when renewable resources are available	No: Most pool pump functions are required to occur within a 24-hour period, so they can't be shed without a compensating run time later.

Figure 3. Average Peak Reduction from Time-Varying Rate Pilots



The small size of individual residential loads means that DR requires coordination to provide utilities with expected reductions in demand. This research found that while time-varying tariffs do aggregate DR, it can be enhanced by coordinating with technology that more tightly coordinates the responses of residential devices. This report further investigates those technology options.

PUBLIC POLICY, LEGISLATION, & REGULATION

There are risks associated with SCE expanding its DR programs to incorporate IoT technology and smart grid-enabled appliances. These include:

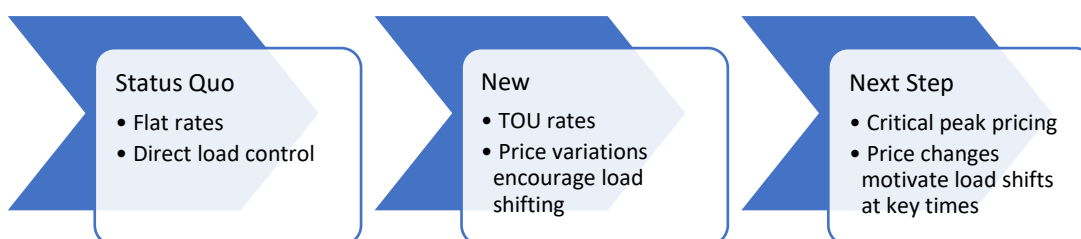
- Cybersecurity and customer privacy
- Customer may lose association with the utility
- Exclusion of customers without broadband access (i.e., rural, low-income)
- Smart devices promoted by a program may become obsolete or unsupported
- Customer overload if multiple devices or products cannot be used together or conveniently

This research reviewed current and planned legislation for their impact on DR. The effects of Senate Bills 100 and 1477 were deemed to occur outside of the two to five-year period considered in this research. However, Senate Bill 49 (enacted in 2019) may have shorter-term impacts. SB49 requires updates to appliance standards for those capable of providing DR and requires those appliances to use “interoperable or open source” connections. Other regulations that impact DR include:

- Title 24, California Building Code – This building code specifies that smart thermostats and grid-enabled water heaters be used in new construction.
- CEC Title 20, Chapter 4, Article 5 – This article specifies DR programs for central ACs and water heaters.

This research also reviewed tariffs and their role in DR programs. Typically, residential customers have been billed for energy on a monthly basis. Other time-varying rate structures like time-of-use (TOU) and critical peak pricing (CPP) mark a significant change to their previous experience. To alleviate the transition difficulty, a progression of rates should be to build experience and sophistication within the customer base.

Figure 4. DR Tariff Progression



Conclusion

Continued development of smart appliances and smart home devices, combined with a shifting peak period, present opportunities for residential DR to play an increased role in California achieving its GHG goals. This rapidly emerging opportunities also present added complexity and will require significant partnership between SCE and its customers.