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Renew Home Response to Request for Information

Additional submitted attachment is included below.

Renew Home

November 22, 2024

California Energy Commission
Docket No. 24-FDAS-03

Submitted Electronically

RE: Response to the Request for Information on Potential Flexible Demand Appliance Standards for Low Voltage Thermostats

Renew Home values the opportunity to provide a response to the California Energy Commission's (CEC) request for information on potential flexible demand appliance standards for low voltage thermostats.

Renew Home is building North America's largest residential virtual power plant and transforming American households into a cohesive force for energy management. By enabling homes to easily reduce and shift the timing of energy use, Renew Home unlocks household savings and supports grid reliability and energy affordability. Through collaborations with industry-leading manufacturers and planned support for more than 100 utility partnerships, we build programs to deliver flexible, dispatchable power at scale.

Renew Home has a direct integration with Google Nest smart thermostats. We are happy to share our knowledge of Nest thermostats to help the CEC understand how to utilize smart thermostats to manage heating and cooling energy loads to lower GHG emissions and utility bills for participating electricity customers, and to support grid reliability.

Respectfully submitted,

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1. Staff is considering the appliances in Table 1 as a baseline for the low-voltage thermostat rulemaking scope. Are there additional examples that might be considered in-scope or out-of-scope?

No, there are not additional examples that might be considered in- or out-of-scope.

2. Staff is considering the low-voltage thermostat market share from 2019 California Residential Appliance Saturation Study (RASS) in Table 2 as a baseline for the low-voltage thermostat scope. Are there additional data sources that might be considered?

Yes. The Energy Information Administration Residential Energy Consumption Survey (RECS) 2020 microdata includes data on thermostat type which we have summarized in the table below. When limited to homes with central air conditioning, the data are nearly identical to the table of 2019 Residential Appliance Saturation Study (RASS) data provided in the RFI.

	2019 RASS		2020 RECS all CA homes		2020 RECS CA homes w/ Central AC	
Thermostat Type	# tstats	%	# tstats	%	# tstats	%
Smart	1,430,449	21%	1,662,675	17%	1,416,610	21%
Programmable	3,983,601	57%	5,121,256	51%	3,697,690	56%
Non-programmable	1,523,552	22%	3,244,256	32%	1,498,483	23%
Total	6,937,602	100%	10,028,187	100%	6,612,783	100%

If the CEC needs more updated estimates of market share, the Environmental Protection Agency publishes total shipments of ENERGY STAR connected thermostats each year that may be useful in estimating the growth in the smart thermostat market share. Additionally, smart thermostat vendors have data on active thermostats over time that they may be willing to share in some form (e.g., thermostat growth over time). There are also private market research firms (e.g., Parks Associates) that publish estimates of smart thermostat market size over time in press releases and in proprietary reports.[1]

3. Staff is considering using hourly HVAC energy use estimates from the Hourly Electric Load Model (HELM). What other HVAC load-shape data sources are currently available?

The National Renewable Energy Laboratory End Use Load Profiles project provides detailed load shape estimates for a large synthetic sample of representative homes that have been calibrated to available meter data sources.[2] Another potentially useful data source might be aggregated telemetry data from smart thermostats, if available. This type of data may be useful as a crosscheck for the primary load shape estimates.

4. Staff assumes a 10-year lifetime for a low-voltage thermostat. Are there alternative assumptions for product lifetime that staff should consider? Please reference the sources of those alternative assumptions.

Ten years seems reasonable and is consistent with data we have seen.

5. Staff has identified a range of typical flexible demand functions associated with low-voltage thermostats. Staff may consider using Joint Appendix JA5 Technical Specifications For Occupant Controlled Smart Thermostats as a baseline standard for functions in low-voltage thermostats. Provide a current market share and likely incremental cost of including the following capabilities:

a. Bi-directional communications.

For smart thermostats: existing feature with 100% market share and no incremental cost

b. Hourly scheduling capability.

For smart thermostats: existing feature with 100% market share and no incremental cost

c. Device software optimization for GHG.

For Google Nest thermostats, this is an existing cloud-based feature that is freely available

[1] https://www.parksassociates.com/blogs/residential-energy-management/empty-nest-ers-beware-smart-thermostats-are-here-to-stay

[2] https://www.nrel.gov/buildings/end-use-load-profiles.html

d. Device software optimization for hourly electricity pricing rates.

For Google Nest thermostats, there is a freely available existing cloud-based feature for optimizing to TOU rates. If “hourly electricity pricing” refers to some sort of real time or day ahead pricing, then such a service would need software development. It is important to note that cross-device optimization for solar and solar/storage should be a consideration for hourly electricity price responsiveness; this topic is addressed in greater detail in Q&A #10 below.

e. Cybersecurity.

Google Nest thermostats already comply with the features described in the referenced Title 20 Section 1692(c).

6. Staff estimates the total incremental cost to consumers (the difference in purchase price between a flexible-demand low-voltage thermostat and a non flexible-demand low-voltage thermostat) to be $25. Staff is seeking input on whether this estimate is reasonable.

For smart thermostats, many models will already comply with most or even all these requirements and so the incremental cost may be smaller than $25. For manual and programmable thermostats that don’t have WiFi (or an app), $25 may be a low estimate. Market research of existing thermostat costs may help assess this estimate.

Enabling responsiveness to real time or day-ahead pricing would considerably increase the cost of a thermostat beyond an incremental $25 if the device itself is responding to price signals as it would require additional computation and memory capabilities. Other architectures, such as cloud based optimization or having a central device in the home that can perform the optimization and data storage needs, could reduce the cost per device. Cloud based optimization can also alleviate the hardware cost but does increase total system cost assuming the cloud provider requires revenue to operate.

7. Staff may consider using Title 20, California Code of Regulations, Section 1692(c) General Requirements as a baseline standard for cybersecurity in low-voltage thermostats. Are there any additional cybersecurity requirements to be considered?

Holistic consideration of cybersecurity includes the initial design, ongoing maintenance, and user consent and perception of security. Each of these topics are examined in further detail below.

1. Secure design initially: there are industry best practices that can be followed, and these do not incur significant cost to OEMs or users. However, the news of data breaches is ever present, showing that well-meaning actors struggle with security.

2. Ongoing maintenance: Security is not "do it once and you're done," it is an ongoing process of evaluating software and processes and updating devices. Without this ongoing support, security problems are likely to occur. This incurs ongoing costs to device OEMs and (potentially) technical complexity overhead to device users.

3. Perceived security and assuring informed consent from users: Users often do not

fully understand the choices they make because they are complex and/or presented in confusing ways. As a result, users may inadvertently enable features that leak data or enable undesired control, and they may have no way to understand what feature is causing their problem (or in the case of data leakage that the problem is even occurring). The Matter interoperability control standard currently does not allow users to know who or what made control actions in their home, and this lack of "actor" information is both a security risk (it is difficult to detect and track network intrusion) and an issue with ensuring users understand the services that are accessing their data and systems. Ensuring transparent actor information that extends outside the home and to the originating actor (an aggregator, utility, etc.) is critical for ensuring user trust and for managing and understanding security problems.

8. Provide information on any demand response programs currently used in California or other locations for HVAC loads that use the thermostat for load control, including the following.

a. How many low-voltage thermostats are used in these demand response programs?

Utilities will have the most up to date information on the number of thermostats participating in demand response programs, but a rough estimate would be around two hundred thousand.

b. How much energy load in kW is each low-voltage thermostat shifting?

In terms of load shift, published third-party studies of SCE DR have reported about 0.7 kW average for 2021 events but varied from 0.5kW in milder climates to 1 kW in hotter climates. Similarly, PG&E 2023 events averaged 0.65 kW but varied by region / sub-load aggregation point from about 0.4 kW to 1.0 kW.

c. What is the time shift duration?

In terms of event duration, SCE and PG&E DR events of recent years have been based on CAISO needs and mostly last 1-2 hours. Earlier versions of DR in California typically used a predefined 4 hour peak of 5PM-9PM.

d. What are the participation rates with an opt-in and opt-out framework?

Renew Home does not have specific data on participation rates for opt-in and opt-out frameworks. In our experience, the most important consideration for maximizing participation in an opt-in framework is simplicity and minimal input for the enrollment process. We have found that single click to enrollment results in twice as many enrollments than a DR program that requires linking to utility account number or even street address (note that in the single click enrollment, we have a validated address from a different step that is separate from the enrollment process).

There are some programs in which utility marketplaces offer thermostats for a reduced price and/or incentive that are pre-enrolled in a utility DR program. This approach facilitates lower friction for the customer to enroll their device into a program since the customer has already provided the necessary information by utilizing the utility marketplace.

Opt-out frameworks run the risk of complaints or resistance from customers who feel forced into participation; customers who are automatically enrolled may not fully understand the program or its participation requirements; may overestimate the level of sustained participation in the program; could result in higher administrative and implementation costs to properly educate customers and manage opt-outs. Customizing the magnitude of the temperature offset can help reduce these risks and ensure customer comfort.

9. Is there anything like a common communications protocol or platform with significant market share, and/or which could facilitate aggregation of HVAC systems via thermostatic controls? Please feel free to describe alternatives to ensuring effective and reliable communications with targeted aggregations of (customer-consented) HVAC loads.

VPPs, DERMs and device makers have developed various systems and APIs for running load shifting events on thermostat fleets. The Google Nest API controls a substantial fraction of smart thermostats enrolled in DR programs.

In theory, OpenADR could support much of the needs for communicating between aggregators and devices, and it could support direct to device communication (note the challenges with direct to device being suboptimal, expensive, etc.). Although OpenADR is designed to do these things, it's not yet widely used or properly designed for the real world implementation. Matter is another standard that is coming together to meet the needs for in-home communication between devices, but it is not fully developed nor has the existing version seen widespread adoption for major energy using appliances.

Due to significant consolidation around major end use OEMs (e.g., HVAC, thermostat, hot water, large appliance, automotive, etc.) direct integration with OEM cloud APIs could allow significant market share if those OEMs provided load shifting API support.

Alternatives include Google's Smart Home Platform, the Home Connectivity Alliance, Amazon's Alexa Smart Home, Apple's HomeKit, Samsung SmartThings among other smart home platforms that promise to integrate many devices under a common platform and data model. These are broader than any individual device OEM. The advantage of these platforms is that consumers tend to pick a single platform for their home if they choose to integrate devices together at all, and accessing the consumer chosen platform unifies some connectivity, authorization, and management tasks.

10.Please discuss strategies for low-voltage thermostats to best utilize the CEC's Market Informed Demand Automation Server (MIDAS), which provides access to

utilities' time-varying rates, GHG emission signals, and California Independent System Operator (California ISO) Flex Alerts. More details can be found here: Market Informed Demand Automation Server (MIDAS) (ca.gov)

Optimization of thermostat runtime in a home that can only use energy (i.e., does not have local generation) and cannot store electrical energy (i.e. does not have a behind the meter electrical battery or an EV capable of V2X) can occur with only information available through the thermostat, the weather forecast, and the real time prices and price forecasts (note: emissions or other factors can be included as additional pricing signals). Due to the low cost of the thermostat devices and the need for significant weather and runtime history to understand the thermal performance of the home and the HVAC system, on-device optimization will be challenging and expensive even in this simple case.

However, if there is local generation and asymmetric rates (i.e., the import and export rates differ) or electrical energy storage, optimization requires trading off runtime against resources that go beyond just the thermostat and the grid electricity price. As a result, whole home energy data as well as data on the performance and actions of multiple devices are required for appropriate optimization. In this more complex case, a thermostat is likely a poor location for this optimization and either cloud-based or in-home centralized optimization is likely required.

Why does it matter if you have asymmetric rates or a battery? The optimization is attempting to minimize cost when the cost of electricity may be near zero (in the case when energy is expected to be exported at a near-zero marginal rate similar to most hours of NEM3) but the information on the marginal rate depends upon a local forecast of consumption and production, something that cannot be gathered from grid prices alone. In the case of a battery, thermal energy storage in the home thermal mass depends upon many factors and is generally lower efficiency and has different charge and discharge characteristics than a chemical electricity storage battery. Due to the higher efficiency of the battery and the ability to move charge and discharge far apart in time, the optimization of the thermostat with the battery will produce lower overall user cost for a fixed user comfort requirement. In some cases, there can be optimal economic performance without any user comfort impact using almost entirely the electrical battery and minimizing the use of the thermal battery.

It is likely that cloud-based optimization will be attractive to OEMs because it enables easier and lower risk updates to algorithms when compared to updating embedded device software, it lowers the cost of the hardware when many users will not require or utilize the more advanced capabilities, it allows for a system that works across multiple generations of devices that integrate with various cloud services, and it enables OEMs to capture some recurring revenue to defray other ongoing costs associated with supporting devices in the field for many years after purchase. Local optimization and control may become attractive if dynamic pricing becomes widespread, consumers are willing to pay a price premium for local computation capabilities, there is acceptance and adoption of in-home communication standards, and device OEMs are willing to forego recurring revenue associated with cloud API access.

11. What percentage of low-voltage thermostats sold in California have an ability to

respond to data originated from MIDAS to alter the HVAC operating schedule? Describe whether low-voltage thermostats can respond to MIDAS's price, GHG, or flex Alert.

We are not aware of any commercially available residential thermostats that, at scale, offer these capabilities. We understand that some OEMs have participated in pilots for MIDAS dynamic price response and have demonstrated that it is possible to adjust thermostat parameters in response to these signals. Thermostats such as the Nest Thermostats can respond to signals via proprietary load shifting APIs. Nest Renew is a no cost, cloud-based service for shifting Nest Thermostat runtime in response to both Time of Use rates and marginal GHG signals, but this service does not integrate with MIDAS at this time.