CA IOU Comments - FDAS RFI

Additional submitted attachment is included below.

November 1, 2021

California Energy Commission
Docket Unit
715 P Street
Sacramento, CA 95814

Topic: California Investor-Owned Utility Codes and Standards Enhancement Team Joint Comments on Request for Information on Flexible Demand Appliance Standards

> Docket Number: 20-FDAS-01
> TN Number: 239571

Dear Commission Staff:

This letter comprises the comments of the Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric (SDG&E), and Southern California Edison (SCE) in response to the California Energy Commission (CEC) Request for Information (RFI) regarding Flexible Demand Appliance Standards (FDAS).

The signatories of this letter, collectively referred to herein as the California Investor-Owned Utilities (CA IOUs), represent some of the largest utility companies in the Western U.S., serving over 32 million customers. As energy companies, we recognize that flexible demand appliance standards could help support California's renewable energy goals, reduce greenhouse gas (GHG) emissions, and improve grid reliability, and we have a responsibility to our customers to advocate for standards that accurately reflect the climate and conditions of our respective service areas, so as to maximize these positive effects.

We appreciate this opportunity to provide the following comments on this RFI.[1] We commend the CEC for their effort to promote demand flexibility in appliances and support many of the proposed data sources and methodologies described in the RFI document. We look forward to continued engagement with the CEC and stakeholders on this topic.

General Appliance Information

1. **The CA IOUs support many of the in scope and out-of-scope examples in the CEC's appliance scoping matrix and offer clarifications to certain appliance definitions (Question 1).**

For thermostats, the CA IOUs support the recommended in scope and out-of-scope examples, and we agree that low-voltage thermostats should be in scope while line voltage thermostats should be exempt. For the exemption of line voltage thermostats, we note the United States Environmental Protection Agency (EPA) ENERGY STAR® Connected Thermostats program conducts this scope filtering via the

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[1] We offer comments on Questions 1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 15, 16, 17, 20, 23-29, 31, 32, 33-37, 38, 39, 41, and 42. At this time, the CA IOUs have no further recommendations regarding the other questions in the RFI.

following definition: *"Line Voltage Thermostat: Thermostat that is powered by and/or switches > 30 Vac"*.[2]

For pool pump controls, the CA IOUs support the exemption of pool pump controls for integral cartridge filter pumps and integral sand filter pumps. We note that the inclusion of integral pool pump controls, pool system controls, and pool timers is a reasonable approach that will incorporate into scope nearly all pool filtration pumping equipment. We note that product controls capable of controlling the speed of a variable speed pool pump may be capable of a more advanced feature set than on/off controls, such as wireless relays intended to operate a water feature pump or pressure cleaner booster pump (i.e., auxiliary pump units). Additionally, we note that the inclusion of pool system controls, which may be able to control a combination of devices such as automatic chlorinators, pool heaters, lighting and water features, and filtration/booster pumping, can provide significant flexible load benefit, but also have potential equipment interaction risks that should be mitigated as much as possible via direct collaboration with pool equipment manufacturers. For example, pool heaters should be given the opportunity to cool down with additional water flow after turning the unit off, before the cessation of filtration pumping. The CA IOUs have submitted a comment letter to the ENERGY STAR program covering several demand response (DR) interactions with pool equipment pad devices.[3] Finally, we note that pool pumps can be categorized into products with advanced onboard controls and products with simple controls. Variable speed pool pumps will automatically have speed control, and in newer product lines will typically have Internet of Things (IoT) control.[4] Although both variable speed and non-variable speed pool pump types could be in scope, we would support a different set of requirements to utilize the advanced capability of variable speed products, whereas non-variable speed products would likely rely on on/off strategies.

For dishwashers and electric clothes dryers, the CA IOUs are supportive of the CEC's in scope and out-of-scope examples; however, it would be beneficial for the CEC to provide a clear definition for what constitutes a commercial product. The U.S. Department of Energy (DOE) provides definitions for both consumer dishwashers and consumer clothes dryers,[5] but it does not provide these definitions for their commercial counterparts. Other commercial definitions have been published by various parties, but these definitions do not perfectly align across sources. ENERGY STAR provides definitions for both commercial products,[6] the DOE has published a general distinction between consumer and commercial products,[7] and the CEC previously proposed its own commercial clothes dryer definition.[8]

The CA IOUs support the coverage of all consumer electric storage water heaters (both electric resistance and heat pump) regardless of tank size, as well as some commercial electric storage water heaters. The FDAS requirements should not apply to commercial electric storage water heaters that offer limited DR capacity due to the nature of their usage patterns, where DR capacity is defined as the technically feasible gap in time between the consumption of electricity by the water heater and the consumption of hot water. Some commercial water heaters have limited DR capacity because they serve loads that consume a lot of hot water quickly and do not allow much time for the tank to recharge between draws (e.g., food service dishwashers). Such water heaters may be DR capable, but their usage profile prevents them from offering much DR capacity. Commercial water heaters designed for these high output applications tend to have high heat input rates relative to tank size, and one way to appropriately target the standard might be to only cover commercial electric storage water heaters with rated inputs of less than 4,000 BTU/hour per

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[2] [ENERGY STAR Connected Thermostats Program Requirements, V1.0](#), Section 1.
[3] [CA IOU Comments on ENERGY STAR Pool Pumps Specification Draft V 3.1](#)
[4] Examples of variable speed pool pumps products with IoT control capabilities include the Jandy [Aqualink RS](#), Pentair [Intelliconnect](#), and Hayward [VS Omni](#).
[5] Consumer electric clothes dryers include both vented and ventless (e.g., heat pump) clothes dryers.
[6] The ENERGY STAR consumer clothes dryer program requirements include a commercial clothes dryer definition. Commercial dishwashers have their own ENERGY STAR program specification document that includes a definition.
[7] [See consumer/commercial distinction under EPCA](#).
[8] [CEC Presentation on Draft Commercial Clothes Dryers Testing, Certification, and Marking Requirements](#)

gallon of stored water or a similar metric that would include water heaters that are more likely to be used to heat water over a longer period of time and then store it until needed.

For behind the meter (BTM) batteries or energy storage systems, the CA IOUs are supportive of the in-scope and out-of-scope examples to support DR events for overall grid reliability and to provide load reduction on the grid when necessary. Additionally, we would note that BTM energy can also provide energy services to support each individual IOU's distribution system needs, as well as the bulk energy market, consistent with applicable rules and tariffs. Finally, the CA IOUs believe that in addition to customer operation for personal demand management, these resources should ideally be operated in a manner most beneficial to the grid as part of their baseline operation and that any additional response should reflect extraordinary operation.

For Electric Vehicle Supply Equipment (EVSE), the CA IOUs note that EVSE technology continues to rapidly evolve. Currently, the ENERGY STAR for EVSE specification version 1.1[9] provides a good source for EVSE definitions. This specification defines the following EVSE types:

- Level 1: A galvanically-connected EVSE with a single-phase input voltage nominally 120 volts alternating current (AC) and maximum output current less than or equal to 16 amperes AC.
- Level 2: A galvanically-connected EVSE with a single-phase input voltage range from 208 to 240 volts AC and maximum output current less than or equal to 80 amperes AC.
- DC-output: A method that uses dedicated direct current (DC) electric vehicle/plug-in hybrid electric vehicle (EV/PHEV) supply equipment to provide energy from an appropriate off-board charger to the EV/PHEV in either private or public locations.
- Wireless/Inductive: An EVSE which transfers energy to the vehicle without a galvanic connection between the vehicle and EVSE.

We agree with the CEC that potential EVSE FDAS should not cover Level 1 devices. Level 2 and DC-output EVSE should be covered. To our knowledge, there is no universally understood definition of "Heavy Duty EVSE"; therefore, if the CEC wishes to exclude specific types of DC-output EVSE, it would be best to apply the standard to products rated at less than some upper amperage limit for output. These limits could be applied to both DC-output and wireless/inductive EVSE as defined by ENERGY STAR. Although there is limited experience with DC-output EVSE for heavy duty applications like charging buses and trucks, we expect most of these to have sophisticated controls that allow operators to minimize commercial tariff demand charges or take advantage of time-of-use (TOU) rates.

Flexible Demand Cost Assumptions

2. **The CA IOUs provide the following information regarding the market share of appliances with flexible demand features, other flexible demand approaches, and flexible demand test methods (Questions 3 and 4).**

Regarding the market share of appliances with flexible demand features, for pool pump controls, [10] we note that in reviewing current products in the marketplace, the capability to receive and respond to FM broadcast signals appears to be an uncommon feature in pool pump controls (as well as in other flexible demand appliances). The only FM-based pool control product we found in market research was the Astral Pool FM product.[11] Delay start functionality is not present on most pool pump products, as these are intended to be programmed in the field with time-of-day schedules. Regarding the current relative market share of demand response communication interfaces or protocols, CTA-2045-based control in pool pumps is significantly less common than OpenADR capability added to the Wi-Fi functionality of typical manufacturer smart interfaces. One potential reason is because the CTA-2045 port is not outdoor

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[9] ENERGY STAR Electric Vehicle Supply Equipment Version 1.1
[10] See also comment 14 below in this document.
[11] Astral Pool Genus II FM Remote - note, discontinued.

environment rated and therefore must be placed in a gasketed enclosure. However, there are select products that offer both CTA-2045 functionality (i.e., a port) and OpenADR functionality (i.e., a virtual end node that can accept an OpenADR signal from a utility or third-party server) – Pentair released a CTA-2045 port equipped variable speed pool pump into select markets in the 2019-2020 time period.[12]

For thermostats,[13] based on a review of the ENERGY STAR Qualified Products List (QPL) Database, we estimate a less than 1% market penetration of CTA-2045 in smart thermostat units.[14] A similar low penetration rate of CTA-2045 is not necessarily anticipated for HVAC equipment such as central air conditioning and air source heat pumps; future information on this topic will become available when AHRI launches the public facing certification program for AHRI Standard 1380, *Demand Response through Variable Capacity HVAC Systems in Residential and Small Commercial Applications*. The residential HVAC equipment industry was heavily involved in the development of and design of AHRI 1380.[15] This standard was designed around providing either a CTA-2045-based connected pathway, OpenADR 2.0, or both, for these products as a requirement to comply with the standard.

For flexible demand approaches for water heaters, the CEC could also consider the provisions of Joint Appendix JA13 under Title 24, Part 6. The CEC approved the Natural Resources Defense Council's Revised Application for a compliance option for Heat Pump Water Heater (HPWH) Demand Management Systems under Title 24 as an alternative procedure for demonstrating compliance with its provisions. The proposed JA13 specification includes criteria necessary to model the impacts of specific demand management features on hot water energy use. The CEC found that the proposed JA13 specification was technically feasible and that JA13 compliant HPWHs should result in reduction in Time Dependent Valuation energy.[16]

For pool pump controls, the CEC could consider the ENERGY STAR Pool Pump Demand Response methodology, as found in the ENERGY STAR version 3.1 Pool Pump Program Requirements.[17] As part of this process, the CA IOUs have provided past comments on maximum and minimum operational speeds, capability to shut off the pumping system, and other topics related to connected pool pumps.[18]

For thermostats, the CEC could also consider the flexible demand requirements provided in Joint Appendix JA5 for occupant controlled smart thermostats.[19] These include communication requirements to automatically rejoin the network when communication is interrupted, user interface requirements to display network and DR status, and additional requirements for DR functionality, including: default setpoint adjustments of +4°F for cooling and -4°F for heating (or occupant-modified default values) and an override function to allow occupants to change the event response at any time. Please refer to JA5 for descriptions of additional requirements.

For electric clothes dryers and dishwashers, the ENERGY STAR Specification Connected Product Criteria can be found in both current specifications, version 1.1 and 6.0 respectively, in addition to the in-process version 7.0 dishwasher specification. Both specifications include DR implementation strategies. Finally, more flexible demand strategies for a variety of applications can be found in the 2019 California Building Energy Efficiency Standards Nonresidential Compliance Manual Appendix D – Demand Responsive Controls.[20]

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[12] OpenADR Alliance Residential Thermostat and Water Heater Field Test, slide 2.
[13] See also comment 13 below in this document.
[14] For a CTA thermostat example, see this SkyCentrics product used in the Emerson White Rogers Thermostat.
[15] AHRI Standard 1380, Section 6.1.
[16] July 8, 2020, CEC Business Meeting. Item 5. Heat Pump Water Heater (HPWH) Demand Management Systems (19-BSTD-09)
[17] ENERGY STAR Version 3.1 Pool Pumps Final Specification, Section 4.4 D i-iii.
[18] CA IOU Comments on ENERGY STAR Draft 1 Version 3.1 ENERGY STAR Specification for Pool Pumps (Connected Criteria), Comment 2.
[19] CEC Joint Appendix 5 Requirements for Occupant Controlled Smart Thermostats
[20] 2019 Building Energy Efficiency Standards Nonresidential Compliance Manual, Appendix D - Demand Responsive Controls

3. **The CA IOUs recommend consideration of ENERGY STAR test methods to validate flexible demand functionality as well as the OpenADR protocol for demand response communication (Question 5).**

Regarding test methods to verify compliance with flexible demand approaches, the CA IOUs recommend the ENERGY STAR Test Method to Validate Demand Response for Pool Pumps[21] and the ENERGY STAR Test Method to Validate Demand Response for Residential Water Heaters.[22] Additionally, the ENERGY STAR specifications for both dishwashers and clothes dryers include tests to verify DR functionality. This includes both a Delay Appliance Load Capability and a Temporary Appliance Load Reduction Capability that enable demand responsive strategies for longer and shorter duration events, respectively.

Regarding verification of DR and dynamic rate communication capability, the CA IOUs recommend OpenADR certification. OpenADR certification is provided by the OpenADR Alliance (Alliance), a member-based association of industry stakeholders with a mission to support the development, testing, and deployment of the OpenADR communications protocol and accelerate widespread adoption. The Alliance contracts with independent and accredited test houses to which manufacturers submit their product for testing. The test house sends results to the Alliance, which then issues certification documents. The appliance is then added to the certified products list and posted on the Alliance website.[23]

Full OpenADR certification is recommended as opposed to just compliance with the OpenADR protocol. 'Compliant' implementations have been seen to require additional custom changes to receive DR event signals from the utility's DR management server. Typically, the challenges have been discovered only in the field.[24] A July 2021 article by GridFabric described interoperability challenges for virtual end nodes, including differing ranges of devices controlled, selection of different event types, and implementation of event opt-outs.[25, 26] We would expect these challenges to be more common with non-certified implementations.

In general, the CA IOUs support DR application layer message translation locally in the product or at a central cloud (such as an online platform managed by a device manufacturer), but we note that cloud communication is preferable for residential and small and medium businesses without professional energy management. Centralizing OpenADR communication functions in the cloud rather than embedding it in each device allows manufacturers to share costs across many customers. This lowers the price point per device, which supports affordability. Based on their participation in current DR programs, we have seen that many residential appliance manufacturers are moving to or have moved in this direction. Cloud-based applications should demonstrate operability by being certified with the current OpenADR communication protocols and standards (currently OpenADR 2.0). Sending OpenADR signals to cloud aggregators of device services (typically the device manufacturer or a third-party energy services company) allows the cloud aggregator to appropriately manage the devices for DR and dynamic rate participation rather than relying on end-use customers to manage that effort. Therefore, the CEC could consider transmission of OpenADR signals from the utility or grid operator system to vendor clouds as a distinct and realistic option, instead of solely considering the option to transmit OpenADR signals directly to end-use devices.

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[21] ENERGY STAR Pool Pumps Test Method to Validate Demand Response (Rev. May-2021)
[22] ENERGY STAR Connected Residential Water Heaters Test Method to Validate Demand Response
[23] OpenADR Certified Product Database
[24] Energy Central - How to do a Certification Program the Right Way (2014)
[25] GridFabric - Cloud VENs and interoperability (2021)
[26] In August 2021, the CA IOUs released similar comments on this topic as it relates to the ENERGY STAR Connected Thermostats Version 2.0 Discussion Document.

Another benefit of OpenADR is that the use of an open protocol helps prevent stranded assets[27] and allows customers to more easily move between DR programs and aggregators without requiring new equipment to translate the new provider's DR messaging. The CA IOUs made similar comments to the ENERGY STAR Connected Criteria for Large Load Products Discussion Guide in March 2019.[28]

> **4. The CA IOUs offer the following considerations on data sources for appliance stock information, including the relative reliability of various data sources (Questions 6 and 7).**

To estimate the stock of pool pumps, the CA IOUs support the use of the DOE Dedicated-Purpose Pool Pump (DPPP) Technical Support Document (TSD)[29] and National Impacts Analysis (NIA). We note that the 2016 DOE NIA spreadsheet estimates the 2021 national stock of variable speed mandated pool pumps as approximately 1.5 million.[30] The California Residential Appliance Saturation Survey (RASS) is the most recent and complete data set for the projected stocks of dishwashers and clothes dryers, and we support its use in developing the stock estimates for these two products. The CA IOUs suggest that once the CEC provides a definition for commercial dishwashers and clothes dryers, they confirm that their definitions align with the RASS survey questions that were used to develop the stock estimates. If the definitions do not align, we suggest that the CEC use alternative data sources that match their definitions. The CA IOUs also support the use of RASS estimates for water heaters and thermostats, but we consider the U.S. Energy Information Administration (EIA) Residential Energy Consumption Surveys (RECS) to be an effective secondary data source for these products. EVSE incidence was captured in the 2019 RASS, but because the market for EVSE is developing so rapidly the data may already be outdated. We suggest basing EVSE penetration estimates on California EV registrations (for home EVSE) and forecasts of public EVSE installations.

The CA IOUs offer the following considerations on the reliability of various data sources for appliance stock information.

- *DOE Technical Support Documents and National Impacts Analysis for Each Product*
    - Often built from confidential manufacturer shipment data, DOE's stock estimation methodology is comprehensive and subject to considerable stakeholder scrutiny. When manufacturer data is not available, DOE typically refers to the most recent EIA RECS data; therefore, this data source shares similar disadvantages with RECS (see below). Stock estimates fundamentally depend on the product lifetime parameter; if DOE's lifetime estimates greatly differ from CEC product lifetime estimates, we anticipate that stock forecasts will not agree well and may require adjustment. DOE typically uses a 3-parameter Weibull distribution when estimating lifetime.[31]
    - DOE documents do not generally support extraction of state level (e.g., California-specific) data, but relative percentages of equipment classes are expected to be representative. Note that these market averages would likely not account for purchasing habits unique to California or for the effects of existing CEC Title 20 appliance standards, such as the higher prevalence of variable speed pool pumps in California due to the now pre-empted Title 20 pool pump standards.
- *Northwest Energy Efficiency Alliance (NEEA) Residential Building Stock Assessment (RBSA) II* [32]

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[27] Stranded assets occur when the automated DR load shed controls at a participating site such as a building are no longer able to communicate with the DR event initiation server and cannot automatically participate in a DR event. The DR program no longer realizes that DR load shed value unless manual DR measure initiation takes place at each event.

[28] CA IOU Comments on ENERGY STAR Connected Criteria for Large Load Products Discussion Guide

[29] Final Rule Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Dedicated-Purpose Pool Pumps

[30] 2016 Final Rule Spreadsheet: National Impact Analysis (NIA) for Pool Pumps, tab Shipments, cells F195-196.

[31] For example, for DPPP DOE used RECS 2009 for residential data, CBECS 2012 for commercial data, a 2015 PK Data custom report, and the number of installed inground and above-ground pools in 2014 by state as provided by the Association of Pool & Spa Professionals. See EERE-2015-BT-STD-0008-0010, No. 31 at p. 14-15 and DOE DPPP TSD, 2016, Appendix 7A-1.

[32] NEEA Residential Building Stock Assessment; RBSA II Single-Family Homes Report (2016-2017)

- o This source is a comprehensive stratified billing data paired residential energy end use survey. Results are specific to the Pacific Northwest region, but appliance use patterns and relative market share of appliances may be more accurate than in older, less detailed data sources. This source may also be useful for validating existing stock and consumption estimates, though it should be noted that the RBSA II Single Family report uses a somewhat smaller sample size (761 households in the core sample) compared to some other sources.[33]
- *California Residential Appliance Saturation Survey (RASS)*
  - o RASS is the most recent and complete data set for the projected stocks of several key home appliances, including dishwashers and clothes dryers. This data source is recent and comprehensive; the latest data were released in 2019. High accuracy is predicted for this product dataset due to careful survey design and number of sites sampled (over 39,000 homes); see methodology for more information.[34] Of note, each sampling region has an average survey sample weight of 1,000 homes or less[35] in contrast to EIA RECS, in which an individual sampled home represents approximately 19,000 single family residences.[36]
- *U.S. Census Bureau American Housing Survey (AHS)*
  - o This source consists of a representative survey at the national level, but it often does not natively provide California-specific data.[37] The survey is performed every 2 years, and the most recent data is from 2019. A public use microdata file is available, see 2019 as an example.[38]
- *U.S. Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS)* This source is a stratified population sample with significant emphasis on the representativeness of selected surveyed households. It includes data on the number of homes represented by each datapoint and Fay balanced repeated replicate weights fields for estimating the confidence intervals of predictors. Since this data is less recent than other sources (last sample in 2015), trends like the energy consumption of select appliances (e.g., dishwashers) and the recent variable speed requirements for inground pool pumps may not be well reflected in the data. California-specific information can be accessed by filtering the RECS microdata by climate and region.[39]

5. The CA IOUs offer estimates for appliance product lifetimes based on a variety of data sources (Question 8).

The product lifetime of connected thermostats is contested, as some entities suggest that these products may follow early replacement patterns more typical of consumer electronics rather than those of traditional thermostats. The CEC's proposed 10-year product lifetime is similar to the 9.1-year estimated lifespan of residential connected thermostats in the California electronic Technical Resource Manual.[40] Previous CA IOU workpapers estimated smart thermostat lifetime at 11 years based on the conservative midpoint of empirical data of savings persistence of between 9.2-13.8 years.[41] Other efficiency program

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[33] id., Table 1 (p. 8).
[34] 2019 California Residential Appliance Saturation Study (RASS), Volume I: Methodology, p. 1.
[35] id., Table 10 (p. 32), column Average Weight.
[36] CA IOU Analysis of RECS 2015 microdata, average of the NWEIGHT field after segmenting to single family attached and detached homes. Mean result is 19,116 homes represented per DOE ID.
[37] American Housing Survey (AHS) Table Creator.
[38] AHS 2019 Public Use File
[39] To access California-specific information, users can filter the RECS microdata by census designation (Pacific) and climate (hot-dry, mixed-dry, and California-specific marine climate zones).
[40] This value is based on a 2019 memo to SCE – EUL analysis of Residential Smart Communicating Thermostat—Vendor A and B. The underlying data for this estimate indicated that median life was strongly vendor specific, with vendor A receiving an estimate of 7.9 to 11.8 years and vendor B receiving an estimate of 5.1 to 5.5 years (p. 5-6).
[41] DEER Ex-Ante Database: SCE17HC054.0, 2017, p. 13.

measure life values for residential smart thermostats include the Northwest Regional Technical Forum (RTF) estimate of 5 years[42] and the Illinois Technical Reference Manual estimate of 9.2 to 13.8 years.[43]

For pool pumps, we suggest that the CEC adopt DOE TSD lifetime estimates, which consist of mean lifetimes of 7.3 years for self-priming pumps and 5.3 years for non-self-priming pumps and booster pumps.[44] This could result in a lower weighted average lifetime than the proposed value of 7 years. The DOE TSDs are also a reasonable data source for electric clothes dryer and dishwasher product lifetimes. The most recent clothes dryer TSD,[45] published in April 2021, indicates an average lifetime of 14 years for all consumer clothes dryers, with no distinction between electric and gas appliances. The most recent dishwasher TSD,[46] published in November 2016, indicates an average product lifetime of 15 years. Alternatively, the Weibull distribution method used in the DOE TSDs could be developed with data collected in the California RASS to provide a more California-specific result.

HPWHs are a relatively new technology and little information is available to estimate product lifetimes. Most analysts assume that the lifetime of HPWHs will be similar to that of other residential storage electric water heaters, which is a reasonable estimate to use until more field data has been accumulated. There has been even less field experience with EVSE, but it may be reasonable to assume that EVSE have lifespans similar to duration of EV ownership. Ignoring Level 1 chargers as out-of-scope, we expect that the most common type of EVSE installed over the next decade will be residential Level 2 products, followed by commercial Level 2 products, and finally commercial DC-output products. Level 2 chargers are relatively simple electrical devices which should remain in service as long as the typical consumer owns an EV. Because EV technology continues to evolve, future EVs may offer features not accessible using older EVSE, therefore the purchase of a new EV may influence the purchase of new EVSE. An analysis of more than 5 million vehicles sold by their original owners estimates that the average new passenger vehicle (of all types) is owned for 8.4 years,[47] which may be a reasonable initial estimate for the lifespan of Level 2 EVSE. DC-output EVSE are significantly more complex and have different duty cycles. We have no estimate of DC-output EVSE lifespans at this time.

Estimated product lifetime plays an important role in cost-effectiveness calculations, and the CA IOUs suggest that estimates for product lifetime be subjected to a simple test for reasonableness when sufficient data are available. Market forces dictate that the total annual shipments of a product satisfy the demand for first-time installations and the demand to replace existing units that have failed or been upgraded. If service life is stable over time, and if the stock, annual shipments, and the shares of shipments going to either new installations or replacements are known, the following simplified equation applies:

$$Product\ Lifetime = \frac{(Stock - Retirements)}{(Shipments - New\ Installs)}$$

Where:
> **Stock** is the number of products currently in use
> **Retirements** are products removed from service but not replaced
> **Shipments** are total annual shipments of new products
> **New Installs** are Shipments for first-time installation

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[42] RTF Residential Connected Thermostat Measure Assessment Template, tab Summary, cell F54.
[43] Illinois TRM V9.0, p. 441 (document page 502), footnote 807: 2017 Residential Smart Thermostat Workpaper, prepared by SCE and Nest for SCE (Work Paper SCE17HC054, Revision #0). Estimate ability of smart systems to continue providing savings **after disconnection** and conduct statistical survival analysis which yields 9.2 to 13.8-year range.
[44] Final Rule Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Dedicated-Purpose Pool Pumps, Table 8D.2.1.
[45] Technical Support Document: Energy Efficiency Program For Consumer Products And Commercial And Industrial Equipment: Consumer Clothes Dryers
[46] Final Rule Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Dishwashers
[47] How Long Do People Keep Their Cars? - iSeeCars.com

For major residential appliances, Retirements are relatively small and occur when a house is removed, and New Installs are usually a function of new housing completions. A more sophisticated approach to estimating residential appliance lifetime has also been published by Lawrence Berkeley National Laboratory (LBNL).[48]

Load Shift Calculation Methodology

6. **The CA IOUs offer resources on price elasticity of demand for electricity and considerations for increased penetration of automated technologies (Question 11).**

The price elasticity of demand for electricity is a key value that may have important implications for future efforts outside of FDAS; therefore, the CA IOUs recommend that the CEC give careful consideration to determining this value. Price elasticity captures consumer responsiveness to changes in electricity prices. One study reported that residential consumers reduced their on-peak usage by 6.5% for every 10% increase in the peak to off-peak electricity price ratio, without enabling technologies (such as smart thermostats, etc.). This effect is amplified with the presence of enabling technologies; with such technologies, consumers reduced their peak usage by 11% for every 10% increase in price ratio. This highlights the fact that while pricing signals alone can lead to reduced peak usage, the presence of enabling technologies leads to even better outcomes for peak demand reduction.[49]

In general, EIA conducts studies to understand price elasticity of demand in commercial and residential buildings. This dynamic between price and quantity can be established for the same fuel (i.e., own-price elasticity) and across fuels (i.e., cross-price elasticity) as well as by end use (such as space heating, space cooling and water heating). Although factors such as demographics, income, climate, and energy prices, could potentially result in different elasticities for the state of California when compared to the entire U.S., these estimates will provide an initial understanding of the linkages between price and consumer responsiveness.[50] Price elasticities also vary between short-run values (up to three years) and long-run values; an example table is provided below in Figure 1, but the reference cited provides tabular information on own- and cross-price elasticities for multiple cases (by end use, by length of time, etc.).

	Short run		Long run	
	Year 1	Year 2	Year 3	Year 30
Commercial electricity				
Space heating	-0.14	-0.23	-0.28	-0.41
Space cooling	-0.14	-0.23	-0.27	-0.39
Water heating	-0.15	-0.25	-0.31	-0.60
Commercial natural gas				
Space heating	-0.13	-0.22	-0.26	-0.30
Space cooling	-0.12	-0.21	-0.25	-0.28
Water heating	-0.13	-0.22	-0.26	-0.28
Residential electricity				
Space heating	-0.16	-0.27	-0.33	-0.48
Space cooling	-0.17	-0.29	-0.34	-0.66
Water heating	-0.17	-0.31	-0.38	-0.93
Residential natural gas				
Space heating	-0.08	-0.13	-0.15	-0.21
Space cooling	-0.08	-0.14	-0.16	-0.16
Water heating	-0.08	-0.14	-0.17	-0.31

Figure 1. Own-price elasticities for various energy end uses
Source: EIA's Price Elasticity for Energy Use in Buildings in the United States[51]

Differences in price elasticity of demand for electricity in the short-run versus long-run scenarios could have significant policy implications. As shown in Figure 1, the price elasticity for the 30-year time period is higher than the observed value for other time periods. This is because price elasticity of demand

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[48] Estimating Residential Appliance Lifetime for Energy Efficient Policy Analysis (LBNL, 2018)
[49] The changing landscape of rate design (The Brattle Group, 2021)
[50] US EIA: Price Elasticity for Energy Use in Buildings in the United States
[51] Table 3 in source document.

typically grows with time. A recent study published in the *American Economic Journal: Applied Economics* provides evidence for the same trend using empirical data.[52] The study utilizes an econometric difference-in-difference approach to understand short-run and long-run price elasticity of demand for electricity, and as shown in Figure *2*, the analysis found that the price elasticity of demand for the long run (-0.348) is 30% more than the value for a three-year time period (-0.268). When considering aggregate demand for the entire state of California, this difference in values could add up to a significant difference in the estimated effect of regulation-driven price changes on electricity consumption. It takes about ten years for the average consumer to completely respond to price signals due to factors including: time needed to change consumer behavior (such as forming habits to turn off appliances or shift time of appliance use), time needed for appliance stock to turn over (for example, many consumers will not replace an inefficient product until it breaks), and time needed for customers to understand that prices have changed (for example, customers on equal monthly payment plans may not immediately notice small price changes). Therefore, it is important to consider the difference between short-run and long-run price elasticity of demand values, understanding that using long-run estimates will more accurately capture the impact of prices and regulations on energy consumption.

Period After Price Change	Point Estimate
Year 3	-0.268*** [-0.358, -0.195]
Year 5	-0.315*** [-0.462, -0.222]
Year 10	-0.345*** [-0.616, -0.242]
Long Run	-0.348*** [-1.007, -0.245]

Significance levels: * 10 percent, ** 5 percent, *** 1 percent.

Figure 2. Long-run elasticity forecasts from study model
Source: Deryugina, Tatyana, Alexander MacKay, and Julian Reif. 2020. "The Long-Run Dynamics of Electricity Demand: Evidence from Municipal Aggregation." American Economic Journal: Applied Economics, 12 (1): 86-114.[53]

Another resource is a September 2020 evaluation study completed by the Brattle Group for the Maryland Joint Utilities and submitted to the Maryland Public Service Commission.[54] This report studied the effect of price elasticity on the demand for electricity and noted that daily demand elasticity (defined as the extent to which changes in the daily average price result in changes to the total amount consumed in a day) ranged between -0.046 and -0.092 during the summer for residential customers across three utilities testing a TOU tariff. Non-summer elasticities were comparable, ranging from -0.023 to -0.122 (not including the months affected by the COVID-19 pandemic).[55] Importantly, this study found with statistical significance that low-to-moderate income (LMI) customers and non-LMI customers responded to TOU prices at similar magnitudes. The study further reported that residential customers with enabling technology and time-of-use rates on average produced greater DR performance than customers with only

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[52] The Long-Run Dynamics of Electricity Demand: Evidence from Municipal Aggregation. American Economic Journal: Applied Economics (2021). The article can be accessed online here.

[53] Table 4 in source document.

[54] PC44 Time of Use Pilots: Year One Evaluation (The Brattle Group, 2020)

[55] Inclusion of data during the pandemic months resulted in substantially higher elasticities of -0.234 to -0.312. These values are higher than averages reported in the literature, which typically fall in the range of -0.01 to -0.15. The Brattle Group hypothesized that a later start to the day experienced in many households during the pandemic months made it easier for customers to conserve or shift load.

TOU rates and no enabling technology. This result in Maryland was consistent with other residential dynamic pricing pilots across the country tracked by the Brattle Group, as shown in Figure 3.[56]
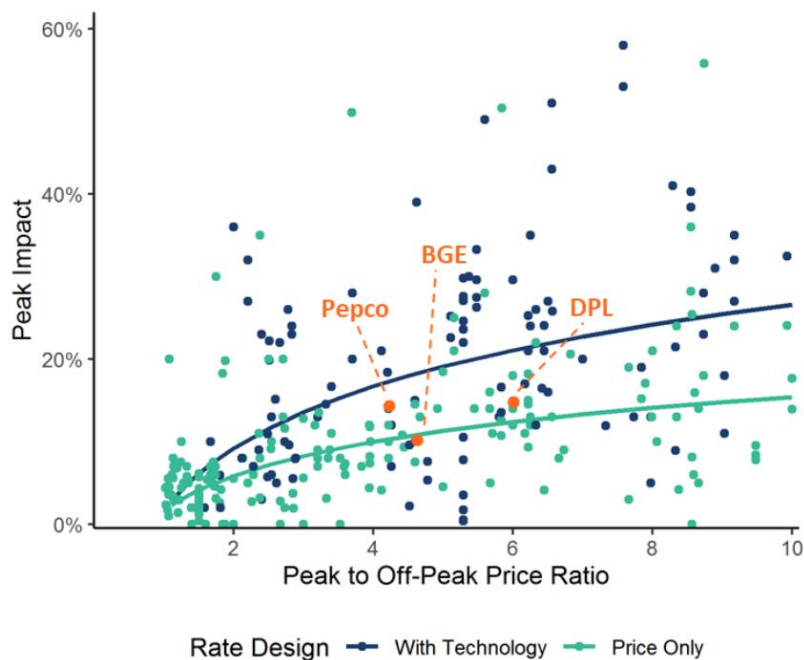

Figure 3. Peak Impact versus Price Ratio
Source: The Brattle Group's PC44 Time of Use Pilots: Year One Evaluation.[57]

Regarding the effects of automation, limited California-specific data was available from statewide load impact evaluation reports regarding DR event performance of non-residential automated DR customers (i.e., those with enabling technologies that participate in DR via automated load reduction signals from a utility or DR provider server) compared to manual DR customers (i.e., those that may or may not have enabling technologies and participate in DR using manually implemented strategies). Initial comparisons showed that automated DR customers had performed better (shed 7 to 30 percent more load on event days) than the combined performance of manual and automated DR customers. It would be more accurate to directly compare manual and automated DR customer performance, but this data was not provided in the reports.[58]

7. **The CA IOUs offer comments on the proposed approach to estimate flexible demand capability (Questions 9 and 12).**

In general, the CA IOUs recommend that the CEC work with the California Public Utilities Commission and other stakeholders to develop a load shift calculation methodology through workshops. This process would allow for the CEC to collect more dynamic and wide-ranging input on the proposed load shift calculation methodology, and it would facilitate alignment with other relevant regional and statewide efforts. Additionally, although we note that the CEC proposes to use an on-peak period of 5 to 8 PM for analysis, by default, many CA IOU customers are currently enrolled in a rate plan with an on-peak period of 4 to 9 PM.[59] Therefore, we would recommend that CEC expand their analysis to also consider impacts based on the 4 to 9 PM peak period in addition to the 5 to 8 PM peak period. Finally, in addition to

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[56] Less detailed data on California-specific load impacts based on a statewide TOU pricing pilot can be gleaned from the 2017 California Statewide Opt-in Time-of-Use Pricing Pilot Evaluation Report

[57] Figure 48 in source document.

[58] Automated Demand Response Non-Residential Incentive Structure Research Project Report (Energy Solutions and LBNL, 2020). Emerging Technologies Coordinating Council Report. Prepared for Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric.

[59] See SDG&E's Time-of-Use Plans, PG&E's Transition to Time-of-Use, and SCE's Time-of-Use Transition Options.

evaluating the flexible demand capability in terms of load shifting and emergency load shedding, we recommend evaluating a fuller range of potential FDAS benefits from load "shaping," "shifting," "shedding," and "shimmying," according to the analytical framework in LBNL's California Demand Response Potential Studies.[60]

Regarding the proposed methodology, using TOU rates is an adequate approach for measuring the value of FDAS to consumers, but consideration of other approaches may better capture important benefits to utilities and society at large. Time Dependent Valuation (TDV) is a methodology that has been used in the California Title 24 Building Energy Efficiency Standards process since 2005. TDV accounts for the actual cost of energy for utilities, customers, and society at large.[61] TDV has the added benefit of providing a more granular view of on-peak grid strain. While a TOU rate-focused analysis assumes no day-to-day variation within the same season (e.g., winter versus summer), the TDV methodology recognizes that 5 to 8 PM energy consumption can differ on an hourly and daily basis, even within the same season. The higher level of granularity in TDV (which provides prices for every hour of the day) in contrast to TOU (which provides prices for three or four blocks to represent a day) allows for the capture of more subtle changes in consumer behavior due to FDAS and may more accurately estimate the cost effectiveness of FDAS. The TDV methodology also provides value streams for reductions of different components (e.g., energy, greenhouse gases, generation, transmission, distribution, etc.) on a 15- and 30-year timescale, which includes long-term changes when estimating levelized cost of electricity savings. Because TDV represents another robust approach to estimate the value of FDAS, the CA IOUs suggest considering this approach in addition to using TOU rates.

Like grid strain, hour-to-hour appliance demand is not consistent. The Load Shift Calculation Methodology discussed in the RFI will evaluate the quantity of energy available to be shifted during the on-peak hours and will use this information to calculate the available peak load reduction. While this will provide an average peak load reduction for all appliances under evaluation, it is not necessarily the maximum peak load reduction capacity. Although some products under evaluation will likely have a similar average and maximum peak load during the peak hours, products with high-power, cycling operational patterns will not. For example, electric resistance clothes dryers typically operate in two active mode states: tumbling and tumbling plus heating. In an example of one electric clothes dryer that the CA IOU team has tested, the power consumption at the tumbling only state is 0.3 kW while the tumbling plus heating state power is ten times higher at 3 kW. If this unit spends half of its time in both states, the peak load reduction identified by the Load Shift Calculation Methodology would be 1.65 kW instead of the maximum peak load reduction of 3 kW when moving from tumbling plus heating to an off state, or 2.7 kW when moving from tumbling plus heating to a tumbling only state. This distinction is important when considering the use cases for flexible demand appliances, and a discussion of the two (average load reduction versus maximum load reduction) would be beneficial. Therefore, the CA IOUs recommend that when calculating flexible demand capability for each appliance type, the CEC carefully consider the different demand flexibility functions or operational modes that may occur within each load reduction window (e.g., time delay, reduction in heating patterns, changes in operational modes, partial versus complete shutoff, etc.).

We encourage the CEC to review the reports on the Emerging Technologies Coordinating Council (ETCC) website prepared for the California IOUs for additional details on different methods used to estimate flexible demand capacity. Methods described in these reports fall into three broad categories: computer modeling and simulation, laboratory testing in a controlled environment, and field testing. The CEC can also leverage studies on water heaters completed in other states such as Oregon and

[60] 2025 California Demand Response Potential Study - Charting California's Demand Response Future: Final Report on Phase 2 Results (LBNL, 2017).
[61] 2019 Building Energy Efficiency Standards - Reference Ace v23 - Time Dependent Valuation

Washington. For example, Bonneville Power Administration completed a report in 2018 on its DR demonstration and business case for heat pump water heater market transformation.[62]

8. The CA IOUs offer additional data sources for appliance load shape data (Question 13).

In addition to the sources cited in the RFI, we encourage the CEC to review ETCC reports for additional information on pool pump load shapes. For example, a 2008 report on pool pump demand response potential assessment[63] and a 2009 report on residential pool pump assessment for integration into Title 20[64] both include 24-hour load shapes in SCE territory for single speed pumps. For additional data on water heaters, the CEC could review the 2021 beta test report completed for PG&E on the use of water heater thermal storage to manage TOU peak periods.[65] Additionally, the CEC could consider other potential sources such as querying providers of distributed energy resource management systems and connected appliance clouds. The CA IOUs also encourage the CEC to review load shape data from PG&E's Home Energy Use Study – more detail on this study is provided in response number 15 below.

<u>Changes in GHG Emissions Calculation Methodology</u>

9. The CA IOUs suggest the use of long-run, marginal emission factors for estimating the impact of FDAS on GHG emissions (Questions 15 and 17).

The fundamental analytical approach for estimating changes in GHG emissions due to FDAS is to multiply an hourly forecast of the change in electricity consumption by an hourly forecast of the GHG emission intensity of electricity. Within this fundamental approach, there are different types of GHG emission factors (EFs) that can be used. EFs can vary across the following dimensions:

- **Forecast scenario:** Any EF projection for California will represent a certain assumed scenario for how California's generation mix will evolve in response to policy constraints and market forces. EF projections typically have underlying assumptions about how the cost and performance of electricity generation and storage technologies will evolve over time, which are sometimes captured in different technology and market scenarios. These price and performance assumptions affect the modeled mix of generation resources to meet the imposed policy constraints.

- **Temporal granularity:** Typically, EFs are *annual* or *8,760 hourly* (for each of the 8,760 hours of the year), although sometimes EFs are available at *month-hour* granularity (for the intersection of 12 months and 24 hours) or even *sub-hourly* timescales.[66] For weather-dependent end uses, analysts will sometimes aggregate 8,760 hourly EFs to month-hour granularity to avoid a potential mismatch in underlying hourly weather assumptions between electricity demand modeling and underlying EF modeling.

- **Average or marginal:** *Average* EFs represent the average emissions intensity for all electricity generation in a given region and timeframe. *Marginal* EFs represent the emissions intensity of the generation resource(s) that would supply an additional increment of electricity demand.[67] Marginal EFs are a more realistic representation of how the grid will actually respond to a change in demand.

- **Short-run or long-run:** *Short-run* EFs assume that the fleet of power plants is fixed in a given year and does not change in response to changes in electricity demand. *Long-run* EFs assume a persistent

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[62] CTA-2045 Water Heater Demonstration Report Including a Business Case for CTA-2045 Market Transformation (Bonneville Power Administration, 2018)

[63] Pool Pump Demand Response Potential: Demand and Runtime Monitored Data. Southern California Edison. June 2008. Emerging Technology Coordinating Council. DR 07.01

[64] Integration of Title 20 for Residential Pool Pumps. Phase 1: Demand Response Potential. Southern California Edison. November 2009. Emerging Technology Coordinating Council. DR 09.05.10.

[65] WatterSaver Beta Test: Use of Water Heater Thermal Storage to Manage TOU Peak Periods. Pacific Gas and Electric Company. February 2021. Emerging Technology Coordinating Council. ET20PGE1231

[66] How AER Works (WattTime, 2021)

[67] On the Use of Average versus Marginal Emission Factors. 8th International Conference on Smart Cities and Green ICT Systems (2019)

change in electricity demand and account for how the mix of grid assets would change (e.g., through the commissioning of new or decommissioning of existing generation resources).[68]

With respect to these dimensions, the CA IOUs suggest the following:

Table 1. Potential GHG emission factors for the CEC's FDAS analysis

Emission Factor Dimension	Recommendation	Rationale
Forecast scenario	A scenario that is compliant with renewable portfolio standard requirements, including Senate Bill (SB) 100	California's mandatory clean electricity targets should be reflected in the forecast of EFs.
Temporal granularity	8,760 hourly or month-hour	8,760 hourly would be a reasonable approach. For weather-dependent end uses, aggregating 8,760 EFs to month-hour granularity would avoid a potential mismatch in underlying weather-year assumptions between FDAS modeling and underlying EF modeling and is therefore slightly more accurate.
Average or marginal	Marginal	Marginal EFs are a more realistic representation of how a change in demand would affect emissions.
Short-run or long-run	Long-run	Long-run EFs are more realistic and appropriate for policy changes that will lead to persistent changes in demand that will in turn affect California's generation assets.

Sources that would meet the criteria described in Table 1 include the National Renewable Energy Laboratory (NREL)'s Cambium EFs[69] and the EFs underlying the CEC's 2022 Title 24 TDV modeling.[70] Either source would be a good choice for FDAS analysis.

NREL's Cambium EFs are published online and packaged in an Excel workbook that includes a worksheet with a California-specific forecast of long-run, marginal, hourly EFs that assumes compliance with California's current policy constraints.[71] These EFs may be the easiest EFs to for the CEC to access that meet the CA IOUs suggested criteria.

Alternatively, if the CEC wishes to align with analysis done for Title 24, they could use the EFs underlying the CEC's 2022 Title 24 TDV modeling. As part of the development of the source energy metric, E3 modeled hourly short-run and long-run marginal generation sources in an SB 100 compliant scenario. The EFs associated with the 2022 Title 24 TDV modeling were recently used in a study commissioned by the California Air Resources Board (CARB) on zero-carbon communities that analyzed the impact of load shifting for appliances, among other strategies.[72]

In general, as much as feasible, the CA IOUs recommend that the CEC harmonize the values used for this effort with those used for other relevant statewide efforts.

[68] Long-Run Marginal CO_2 Emissions Factors in National Electricity Systems. Applied Energy (2014)
[69] Long-run Marginal CO2 Emission Rates Workbooks for 2020 Standard Scenarios Cambium Data (NREL, 2021)
[70] Time Dependent Valuation of Energy for Developing Building Efficiency Standards: 2022 TDV and Source Energy Metric Data Sources and Inputs (E3, 2020)
[71] Long-run Marginal CO2 Emission Rates From the 2020 Standard Scenarios Cambium dataset: Mid-case Scenario (NREL, 2021)
[72] The Center for Resource Efficient Communities at UC Berkeley 2021. Zero-Carbon Buildings in California: A Feasibility Study

10. **The CA IOUs note the following additional resources for GHG emission factors (Question 16).**

As noted above, the CA IOUs suggest that the CEC consider the use of NREL's Cambium or the EFs underlying the CEC's 2022 Title 24 TDV modeling. Other resources for GHG EFs are:

- **SB 100 Joint Agency Report:** In the time since the 2022 TDV modeling was conducted, more in-depth modeling of how California could achieve its clean electricity policy mandates has been conducted to support the SB 100 Joint Agency Report.[73] If the SB 100 joint agency modeling team is able to produce long-run, marginal, hourly EFs, this is another strong option for FDAS EFs.
- **The CEC's 2021 Integrated Energy Policy Report (IEPR):** The most important characteristic of an EF forecast for flexible demand appliance standards is that the scenario is aligned with California's clean electricity policy mandates, so the IEPR forecast could be a reasonable choice if the other options discussed above prove impracticable. However, the disadvantage of the IEPR EFs is that they are hourly *average* EFs. Long-run marginal EFs are a more accurate way to model how persistent shifts in demand will affect the GHG emissions from the grid.

11. **The CA IOUs offer additional considerations on other values for the cost of GHG emissions (Question 20).**

In addition to the data sources proposed in the RFI, the CEC could also consider concepts such as the social cost of carbon (SCC). SCC represents the marginal social damage caused by emitting an additional metric ton of CO_2 into the environment – the attributed price represents the value that would theoretically reduce emissions to socially optimal levels. For example, in February 2021 DOE set the SCC value at $51 per metric ton of CO_2 which means that they will use this value in future calculations that relate to the value of GHG emissions savings. This represents an increase from the prior DOE SCC value of between $1 and $7 per metric ton.[74] While the single value chosen by DOE to use in calculations is often highlighted, it is important to understand the entire distribution of SCC values (as a function of different input parameters) in its analysis. Figure 4 below presents the distribution of SCC values as reported by DOE.[75] DOE's $51 SCC represents the average in the distribution of SCC estimates at a discount rate of 3.0%, but values as high as $152 per metric ton of CO_2 can be observed in the plot below. Because discount rates drive the rate at which we convert future costs into present value costs, SCC is dependent on the discount rates used to compute it.

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[73] SB 100 Joint Agency Report (CEC, 2021)
[74] Cost of Carbon Pollution Pegged at $51 a Ton (Scientific American, 2021)
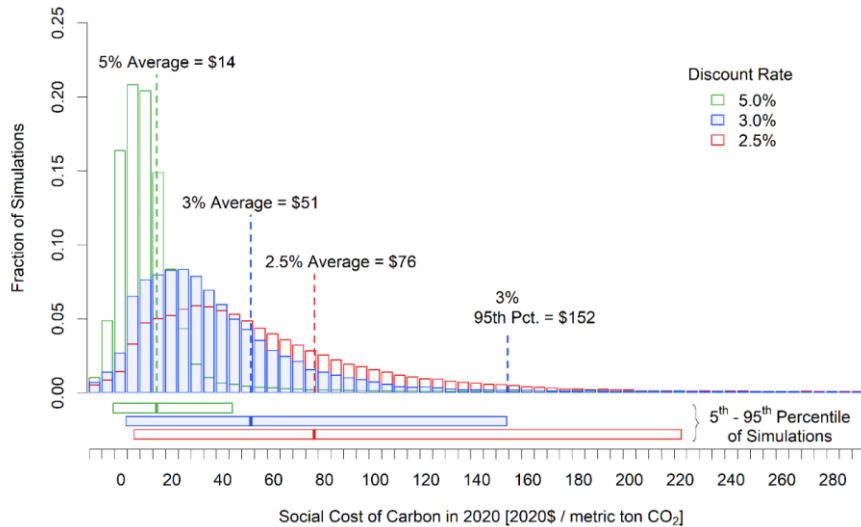[75] DOE Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide, February 2021.

Figure 4. Frequency distribution of social cost of carbon estimates for 2020
Source: DOE Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide, February 2021[76]

The value of $51 per metric ton of CO_2 is estimated using a discount rate of 3.0%. This discount rate was chosen as the basis for this DOE calculation based on a 2003 analysis of the real rate of return for 10-year treasury securities from the prior 30 years (1973-2002), which was around 3%.[77] While regulatory agencies still consistently use 3%, interest rates have declined in recent decades, as shown in Figure *5*. The average for the last 30 years (1991-2020) is 2.0%, and the congressional budget office forecasts that this value will be about 1.2% over the next thirty years.[78] Using a lower discount rate that reflects this change in the rate of return of treasury securities would result in a SCC higher than the current DOE value of $51.[79] Therefore, if the CEC chooses to consider SCC, we suggest performing a sensitivity analysis to examine the effect of a range of potential SCC values on the FDAS benefit evaluation.
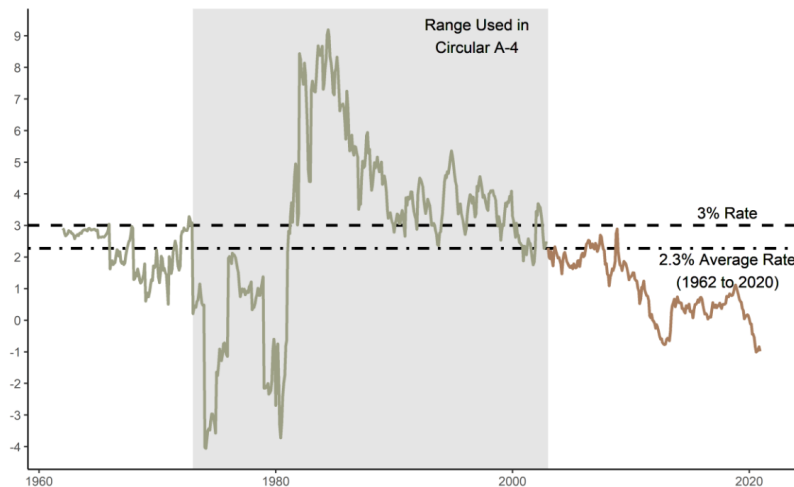

Figure 5. Monthly Inflation-Adjusted 10-Year Treasury Security Rates Over Time
Source: DOE Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide, February 2021[80]

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[76] Figure ES-1 in source document.
[77] U.S. Office of Management and Budget Circular A-4
[78] DOE Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide, p. 20
[79] For example, another source estimates the value of SCC as $258 per metric ton of CO_2 based on an analysis of factors including an updated understanding of the human mortality impacts of carbon emissions. (The mortality cost of carbon. Nature, 2021).
[80] Figure 1 in source document.

Consumer Consent and Equity

12. The CA IOUs offer the following information regarding consumer consent and equity considerations for FDAS (Questions 23 to 29).

In terms of consumer consent and protection, the CA IOUs suggest that the CEC leverage the lessons learned from prior efforts around connected devices and appliances (e.g., occupant-controlled smart thermostats). This could consist of ensuring that FDAS regulations have similar consumer consent mechanisms (e.g., user interface access and the ability to modify default responses or opt-out of events) as other prior standards with a connectivity component, such as JA5 or JA13. Additionally, the CEC could forecast the impact of FDAS on appliance prices to determine what, if any additional consumer protection mechanisms may be necessary to ensure that FDAS regulations are equitable.

One strategy to avoid unintended negative impacts and to maximize the benefits of FDAS for disadvantaged communities (DACs) would be to meaningfully involve DACs in the decision-making process by conducting outreach to environmental and social justice (ESJ) organizations and community-based organizations (CBOs). DAC engagement could also be facilitated by developing accessible materials that describe the FDAS process, how FDAS could affect Californians, and how members of the public can participate in the process. Such materials should be designed to appeal to DACs, produced in multiple languages, and distributed via trusted avenues and free platforms.[81]

Additionally, the CEC could incorporate equity impacts into FDAS screening and quantitative analysis. As with some other appliance standards, FDAS may produce smaller utility bill savings for Californians who participate in income-qualified utility bill discount programs. The CEC should consider the impact of discounted utility bills when assessing the cost-effectiveness of prospective standards for low-income households. It would be valuable to better understand the impact of potential incremental upfront costs on vulnerable California subpopulations as well as accessibility issues unique to FDAS, and ESJ organizations and/or CBOs could potentially provide that insight. Unlike traditional appliance efficiency standards, the benefits of FDAS are not automatic. Potential standards should ensure that DAC residents do not bear additional incremental costs associated with FDAS without also benefitting from the appliances' demand flexible capabilities and associated savings. If possible, the CEC should promote education and awareness efforts targeted to DACs and examine potential structural barriers that could reduce DAC participation in flexible demand programs (e.g., lack of access to high-speed internet). Aside from direct participation, FDAS could still confer a net benefit to DAC residents by improving grid reliability and reducing ambient air pollution, but ideally all Californians, including DAC residents, would be able to utilize the demand flexibility capabilities of FDAS compliant appliances at similar rates.

Appliance-Specific Questions

13. The CA IOUs provide additional detail on thermostat specific questions (Questions 31 and 32).

Regarding additional information on thermostat capabilities, we note that the ENERGY STAR Connected Thermostat program requires demand response support for any labeled connected thermostat, at minimum through processing open standard (e.g., OpenADR 2.0A or B) signals received by the manufacturer cloud.[82] As of 2020, EPA reports an estimated 58% market penetration of ENERGY STAR connected thermostats in the smart thermostat marketplace.[83] Most major manufacturers in the ENERGY STAR Connected Thermostat QPL report OpenADR 2.0 compatibility or compliance when the information is available; see for example:[84] Google Nest, Ecobee, EcoFactor, Pro1 IAQ, Venstar, Lennox, Ingersoll

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[81] Hand-in-Hand: Environmental and Social Justice Communities and Codes & Standards
[82] ENERGY STAR, Program Requirements for Connected Thermostats, Version 1.0, Section 5
[83] ENERGY STAR Program Unit Shipment Data Report, 2020.
[84] ENERGY STAR Connected Thermostats Qualified Product List, Web View.

Rand, Carrier Cor, Emerson, and Zen.[85] Honeywell/Resideo products note that all DR communication is conducted within the manufacturer cloud. As stated above in response number 3, we recommend full OpenADR certification as opposed to just compliance with the OpenADR protocol. Additionally, although many products report programmable functionality, this does not necessarily indicate that all customers that purchase these devices take advantage of this functionality.

14. The CA IOUs provide additional detail on pool pump control specific questions (Questions 33 through 37).

For definitions to describe a pool pump control integral to a pool pump, in the DOE DPPP regulation integral cartridge filters are defined as products where the cartridge filter cannot be bypassed.[86] Similarly, we anticipate that the effort to bypass an "integral" controller in this context would make the product inoperable while the control is bypassed or removed. This may be suitable to differentiate between integral controls and external supplemental controls, which can be removed without interfering with product operation.

For definitions to describe a pool pump control that is a separate device from a pool pump, a pool pump driven by a control that can be removed without preventing the operation of the pump or rendering the controller inoperable could be defined as controlled by a "separate device." Wireless relays are a common example of this technology, which can be used to control numerous different products including typical pool pump applications such as a pressure cleaner booster pump.

In terms of scheduling functions, all new sales of variable speed self-priming (also known as inground) pump products are anticipated to have scheduling ability, as the DOE DPPP regulation definition for variable-speed dedicated-purpose pool pumps requires distribution in commerce with either: "a user interface that changes the speed in response to pre-programmed user preferences and allows the user to select the duration of each speed and/or the on/off times" or "without a user interface that changes the speed in response to pre-programmed user preferences and allows the user to select the duration of each speed and/or the on/off times, but is unable to operate without the presence of a user interface."[87] No such requirements apply to other DPPP products. Pressure cleaner booster pumps are typically controlled via an equipment pad relay or external timer.

In terms of connectivity and DR capability, Pentair variable speed pool pump products report OpenADR 2.0 support in the ENERGY STAR Pool Pump QPL along with Wi-Fi connectivity.[88] Hayward VS Omni[89] and Omni Hub[90] products, Zodiac (Fluidra) iAquaLink,[91] and iQPump01[92] products all report that they "work with Alexa," indicating that the products are capable of receiving and/or sending cloud API requests. In the 2016 DOE DPPP Regulation Technical Support Document, DOE found that Pentair, Hayward, and Zodiac (Fluidra, Jandy) hold approximately 90% of the shipments of pool filter pump equipment in the marketplace.[93] All three of these major manufacturers offer wireless and cloud API capability in many of their flagship products.

15. The CA IOUs provide additional detail on dishwasher and electric clothes dryer specific questions (Questions 38, 39, 41 and 42).

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[85] Pro1 IAQ, Venstar, Carrier Cor, Emerson, and Zen devices are also JA5 Compliant.
[86] 10 CFR 431.462 - Definitions
[87] 10 CFR 431.462, definition for variable-speed dedicated-purpose pool pump.
[88] ENERGY STAR Pool Pumps Qualified Products List.
[89] Hayward VS Omni Spec Sheet, p. 2
[90] Hayward OmniHub Sell Sheet, p. 2
[91] iAquaLink Products Page
[92] Jandy iQPUMP01
[93] Final Rule Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Dedicated-Purpose Pool Pumps, p. 3-16.

Between late 2015 and early 2016, in-depth on-site surveys of 1,000 single-family and multi-family households in PG&E's service territory were completed for PG&E's Home Energy Use Study (HEUS). A representative, random sample of make and model numbers from 100 dishwashers and 100 electric clothes dryers were selected from the on-site sample, and the conclusions of the analysis of this sample are presented below. A web search was done for the 100 selected appliances to find manuals or other documents that presented information about delay start and/or scheduling function and web-enabled/connectivity features. To get to 100 sample points, we searched for data on 140 dishwashers and on 118 electric clothes dryers.

For dishwashers, regarding the percentage of devices with delay start and/or scheduling functions, the analysis of 100 dishwasher lookups found that 84% of dishwashers in homes in the 2015-2016 study period had a delay function. In owner's manuals, the delay function is almost always advertised specifically as a way to avoid using the dishwasher at peak times. Delay functions were found as far back as a dishwasher manufactured in 1988. Common delay options include:

- one single delay time (e.g., 4-hour button that can only delay dishwasher start by exactly 4 hours)
- multiple set delay times (e.g., options to delay dishwasher start by fixed 2-, 4-, or 6-hour increments)
- a range (e.g., up to X hours – the maximum time frame seen here is typically a 24-hour delay; usually users can select in 1-hour intervals)

Regarding dishwasher connectivity features, the analysis showed that 3% of dishwashers in homes in the 2015-2016 study period had some sort of connectivity feature (where connectivity means capable of being connected to a manufacturer specific app, home area network, or other communications hub). Models with connectivity included one 2014 LG model and two 2015 GE models. Connectivity capabilities included remote monitoring, control, and notifications (GE) and transmitting data through an app if problems arise (LG). As this data was collected in 2015 and 2016, the CA IOUs assume that this market has continued to grow, and this market penetration should be considered a floor. Connected functionality has been part of the ENERGY STAR specification for dishwashers since version 6.0, which took effect on January 29, 2016. Starting in 2018, products have been certified with the connected credit, and connected product availability has continued to increase in recent years. Five units were available on the market with ENERGY STAR-certified connected functionality in 2018, two additional units in 2019, six additional units in 2020, and nine additional units in 2021. We have no reason to believe this growth will not continue, and with more models available on the market with connected functionality, market penetration is likely to have grown since 2016.

Regarding the percentage of electric clothes dryers with delay start and/or scheduling functions, the analysis of 100 electric clothes dryers found that 5% of electric clothes dryers in homes in the 2015-2016 study period had a delay start timer. Two could delay start up to 19 hours, two could delay up to 18 hours, and one allowed the user to set the time for the device to begin operation. Additionally, one was a 2005 model, 2 were 2011 models, one was a 2013 model, and one was a 2014 model.

For clothes dryers with connectivity features, defined the same as for dishwashers, the analysis showed that 5% of electric clothes dryers in homes in the 2015-2016 study had some sort of connectivity feature.[94] Four products were able to send diagnostic data to a phone app, and one product was able to show dryer status. Four products had a manufacture year of 2015, and one had a manufacture year of 2013.[95] Connected functionality has been part of the clothes dryer ENERGY STAR specification since version 1.0, which took effect on January 1, 2015. The first ENERGY STAR certified connected product was on the market in 2016 with an additional ten models available since the start of 2018. This growth

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[94] One percent had both delay start and connectivity. Four percent had just delay start and four percent had just connectivity.
[95] Articles documenting introduction of Wi-Fi capable appliances seem to indicate that the connectivity capabilities started to become available around 2012 or 2013.

occurred after the 2015 and 2016 HEUS data was collected, so the study results should be considered a floor for market penetration.

In conclusion, the California IOUs commend the CEC for their effort to adopt flexible demand appliance standards in California, and we hope that the CEC considers the resources and recommendations in this letter. We thank the CEC for the opportunity to respond to this request, and we look forward to future opportunities for engagement.

Sincerely,

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