

State of California



Memorandum

Date: April 5, 2019

To: Cassie Cuaresma – Southern California Edison (SCE); Chan U Paek – Southern California Gas (SoCalGas)

CC: Henry Liu – Pacific Gas & Electric (PG&E); Ed Reynoso – San Diego Gas & Electric (SDG&E)

From: Peter Biermayer – Utilities Engineer, Industrial/Agricultural Programs and Portfolio Forecasting Section, Energy Efficiency Branch, Energy Division, CPUC

Subject: Disposition for the Smart Communicating Thermostat SCE17HCO54 Rev 1 Workpaper

1. Summary

The existing Smart Communicating Thermostat SCE17HCO54 Revision 0 is valid through July 5, 2019.

The Smart Communicating Thermostat SCE17HCO54 Rev 1, submitted by Southern California Edison (SCE) and co-sponsored by Southern California Gas (SoCalGas), is conditionally accepted, provided the conditions listed below are met. This disposition accepts the extension request for gas savings measures to allow Program Administrators to complete their research. The following revisions are required:

Eliminate the “Residential Smart Thermostat Heat Pump” measure, until better verifiable savings are demonstrated. Heat pump equipment shall receive the same treatment as existing central air-conditioning equipment savings measure since the cooling savings of a heat pump and central air-condition unit are similar. Space heating savings are denied for lack of verifiable and demonstrable electric heating savings for heat pumps.

The annual per unit natural gas savings submitted in SCE17HCO54 Rev 1 (same as the current standard SCE17HCO54 Rev 0) for smart thermostats installed on conventional natural gas furnaces are approved through December 31, 2019. Complete the necessary research to update natural gas savings and submit a revised workpaper with the updated annual unit natural gas savings by August 1, 2019 for review and approval; the new workpaper effective date will be January 1, 2020.

All other parameters, excluding the natural gas savings, are approved through December 31, 2020.

SCE is directed to revise the workpaper for claims effective July 6, 2019, through December 31, 2019.

Prior to program year 2020, workpapers will need revisions to comply with the updated peak period definition per Resolution E-4952. In order to continue the program offerings in to 2020 the PAs shall submit a revised Workpaper before July 1, 2019.

2. Background and Discussion

A Smart Communicating Thermostat (smart thermostat) is a device that controls heating, ventilating, and air-conditioning (HVAC) equipment to regulate the temperature of the space in which it is installed. The thermostat can make automated adjustments to the HVAC system's set point and communicate with external sources through an Internet connection.

Smart thermostats have the potential to reduce annual energy use and demand for both natural gas and electricity. For example, SoCalGas offers thermostats in coordination with thirteen electric-serving entities through multiple channels, including rebates and various direct-install programs for both market and low-income-qualified single and multifamily homes and for both energy efficiency and demand management.

2.1. Workpaper History

The following table summarizes the major milestones in the smart thermostat workpaper development.

| Date | Event |
|--------------------------------|---|
| 07/19/2016 and 11/8/2016 | Two dispositions were issued with smart thermostat guidance in 2016: a July 19 disposition (July 2016 Disposition) and a November 8 Disposition (November 2016 Disposition). The dispositions raised substantive concerns and direction regarding methods for establishing energy savings, net-to-gross, measure life, and measure application type. ¹ |
| 3/2/2017 | Resolution E-4818 ² provided further clarification of measure application types and their baselines. |
| 3/15/2017 | Submission of the thermostat workpaper SCE17HC054 Rev 0 by SCE. |
| 6/2/2017 | Interim approval of SCE17HC054 Rev 0, since it was not selected for detailed review. By virtue of it receiving an automatic approval status, heating and cooling energy savings were established by the workpaper, which relied on an analysis of customer billing data and thermostat vendor HVAC run time data. |
| 10/11/2018 | Resolution E-4952, ³ the Database for Energy Efficient Resources (DEER) update resolution, provided further clarification on measure application type. |
| 12/31/2018 | Disposition extending SCE17HC054 Revision 0 through March 31, 2019. ⁴ |
| 2/15/2019 | Memo from SoCalGas requesting an extension of SCE17HC054 REV 0 natural gas savings through September 31, 2019 (Request Memo). The natural gas savings research completed to-date had not yielded acceptable results and, therefore, SoCalGas recommended completing additional research. |
| 2/28/2019 | Submission of SCE17HC054 Rev 1. |

Workpaper SCE17HC054 Rev 0 defined the measure application types as a blend of accelerated replacement (AR) and normal replacement (NR) with an 11 year EUL and estimated the influence of the program on the

¹ Both dispositions are available to download at <http://deeresources.net/workpapers>

² <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M156/K191/156191759.docx>

³ <http://docs.cpuc.ca.gov/publisheddocs/published/g000/m232/k459/232459122.pdf>

⁴ Available to download from <http://deeresources.net/workpapers>

target market at 55%, corresponding to a net-to-gross ratio (NTGR) of 0.55. On February 28, 2019, SCE submitted SCE17HC054 Rev 1, which revised the annual unit energy savings based on the billing analysis described below in Section 3.3 below and revised the effective useful life (EUL) of the smart thermostat from 11 years to 9.1 years based on the measure life analysis described in Section 3.2. The measure application type was also changed to just NR.

For comparison purposes, the unit cooling annual energy savings are 261, 178, and 319 kWh for SCE17HC054 Rev 0 and 198, 108, and 212 kWh for SCE17HC054 Rev 1 for climate zone 11, 12 and 13 respectively (which corresponds to the Central Valley, where the analysis accounts were located). There is an average decrease of 29% across all climate zones in annual electric savings, compared to the existing workpaper. This is primarily driven by the results of the billing analysis described in Section 3.3. The 29% does not include the reduction in thermostat lifetime from 11 years to 9.1 years. The total reduction due to both the billing analysis and the reduction in thermostat lifetime, results in a 42% decrease of energy savings as compared to the existing workpaper.

3. Review of Critical Issues and Guidance

This section addresses the key parameters driving energy savings via the revised workpaper SCE17HC054 Rev 1, submitted by SCE.

3.1. Definition of Measure Application Type

Normal Replacement (NR) is an appropriate measure application type for smart thermostats.

The application type of smart thermostat measures has already been addressed in two previous dispositions. The July 2016 Disposition classified smart thermostats as an accelerated replacement (AR) measure, arguing that a smart thermostat will replace an existing, functioning programmable/manual thermostat and therefore an AR classification is appropriate. However, the November 2016 Disposition revised the measure application type to an operational measure, arguing that a smart thermostat is “less tangible” and more reliant on software and therefore more likely to be overridden than a programmable thermostat. An operational measure is part of the Behavioral/Retro-commissioning/Operational (BRO) family of measures described in D. 16-08-019.⁵

SCE17HC054 Rev 1 proposed to classify the measure as an NR measure application type. SCE argues that smart thermostats are installed on existing HVAC equipment and that recent survey data,⁶ which shows that the average home using smart thermostat was built in 2001–2003, supports the conclusion that existing thermostats are at the end of their effective-useful-life. Therefore, SCE concludes, the NR classification of the new smart thermostat is appropriate.

Since the July 2016 and November 2016 Dispositions were issued, the Commission released additional guidance in Resolution E-4818 (March 2017) and Resolution E-4952 (October 2018) providing further clarification on the definition of BRO measures. In both documents, BRO measures are characterized as “activity” and non-BRO measures are characterized as “equipment upgrades.” BRO measures restore equipment performance to its nominal efficiency through activities such as recharging, cleaning, tuning, and reprogramming. Non-BRO measures consist of device-oriented equipment upgrades. Since a smart thermostat is clearly a device, a BRO

⁵ <http://ccag.ca.gov/wp-content/uploads/2016/10/6.5-Attachment-ALJ-Decision-16-08-019-081816.pdf>

⁶ “PG&E Smart Thermostat Program Process Evaluation”, by Opinion Dynamics, July 19, 2018

measure application type is not the right choice, leaving AR or NR as the choices for measure application type. Since there is evidence that the population of existing thermostats is at the end of their useful life, the NR is the appropriate selection, which is in agreement with SCE17HC054 Rev 1.

3.2. Assignment of an Effective Useful Life (EUL)

An EUL of 9.1 years is appropriate for smart thermostats.

There are two dimensions to lifetime energy savings of smart thermostats (as well as almost all other control measures). The first dimension is the EUL or the length of time that a device is left in place and maintains operational capability. The EUL is an estimate of the number of years when half (or the median) of measures installed under a program are still in place and operable. The second dimension is the persistence of savings, or the amount of savings maintained throughout the functional life of the device. For smart thermostats, persistence depends on how long and to what degree the savings algorithms continue to operate in the energy-savings mode without the customers disabling them.

The November 2016 Disposition assigned an EUL of 3 years to the smart thermostat based on the BRO measure application type. The disposition went on to note that “no data has been provided by the PAs or other interested parties regarding the persistence of smart thermostats” and therefore “encourages PAs to gather data and present an analysis which demonstrates the persistence of energy savings mode within installed residential smart thermostats.”

In SCE17HC054 Rev 1, SCE proposes an EUL of 9.1 years for smart thermostats based on a study conducted by Cadmus that analyzed a population of smart thermostats.⁷ This study presents evidence that smart thermostats remain in place and functioning beyond 5 years. The analysis presents results on thermostats for two vendors, as illustrated in the study’s figures below, representing over 700,000 smart thermostats. The curves in the figures show the percentage of smart thermostats that are still online and operational after installation as a function of time. For example, in Figure 3, approximately 85% of thermostats are still operational 4 years after installation. These curves can be extrapolated to where they cross the median line – that is, where 50% of the thermostats are still online – yielding an estimated EUL. The average EUL is 9.1 years, with a lower bound EUL estimate of 7.4 years.

Figure 3. Regression Model to Extrapolate the Survival Function for Vendor A

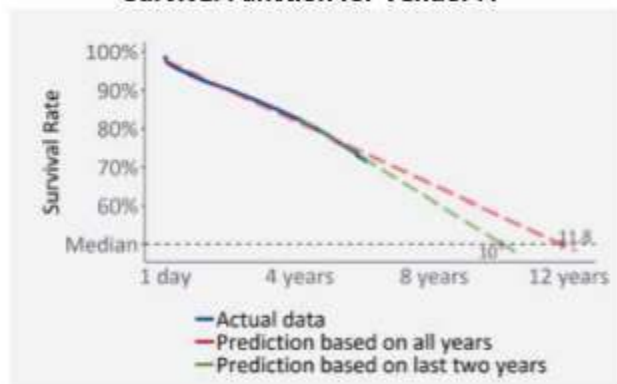
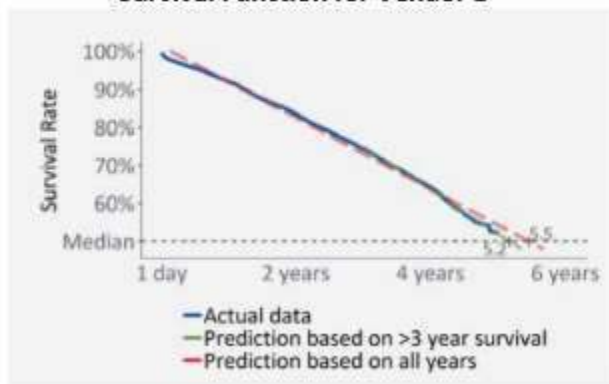


Figure 4. Regression Model to Extrapolate the Survival Function for Vendor B



⁷ “EUL Analysis of Residential Smart Communicating Thermostat – Vendor A and B,” Cadmus Memo, February 1, 2019

While there is excellent evidence for an EUL greater than 9.1 years, there is no evidence presented in SCE17HC054 Rev 1 that savings are maintained (persistence of savings); in addition, prior dispositions identified greater potential for degradation in savings for smart thermostats. **It may be feasible to assess savings persistence if thermostat data representing setpoints over time is available; however, there are challenges to accessing the required data from manufacturers.**

The Commission Staff concludes that an EUL of 9.1 years is a reasonable assessment of the evidence available. Future research should address savings persistence and expand the survival analysis to include additional years of data applying appropriate survival analysis techniques per the CA Energy Efficiency Evaluation Protocols.⁸

3.3. Electric Annual Unit Savings

The proposed central air-conditioning electric unit annual energy savings per household and the method for extrapolating savings to all California climate zones are acceptable.

SCE based the annual unit energy savings on billing analyses conducted by AEG⁹ of participants in a Pacific Gas & Electric (PG&E) Smart Thermostat Pilot. The study compared household energy consumption of houses that had a smart thermostat installed through the pilot with households that did not participate in the pilot. The analysis followed accepted billing analysis best practices of comparing pre- and post-installation consumption for both the participants and the control group. The study used a transparent methodology to extrapolate savings to other climate zones, expressing savings as a percentage of cooling using the DEER model prototypes.¹⁰

The study only looked at cooling savings and presumably these were all or mostly central air conditioners. The study also looked at heating savings for smart thermostats installed with gas furnaces. **The Commission approves electric savings for cooling but not for electric heating via a heat pump, as described below in Section 3.6.**

The July 2016 and November 2016 Dispositions did not address electric energy savings; however, they included the following comments on the natural gas savings methodology that apply here:

The July 2016 Disposition states that “ analysts are ignoring smart thermostat installations , which show increases in energy use compared with preexisting conditions.” The pilot design and the analysis, which is the basis of this workpaper, address this issue. The PG&E Smart Thermostat Pilot design takes into consideration the full randomized controlled trial of encouraged smart thermostat installers, non-installers, and control group members. All changes in consumption, both positive and negative, are accounted for in the analysis.

The same disposition expresses a concern that results are artificially inflated through weather-normalization and extrapolation to other climate zones. In their study of the pilot program, AEG used the PG&E-observed weather data to determine the fraction of cooling energy saved. AEG then applied this fraction, in a transparent manner, to the cooling component of the DEER building model prototypes for other climate zones.

⁸ CA Energy Efficiency Evaluation Protocols (p. 123), available online here: <http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5212>

⁹ “Update: Developing Ex-Ante Statewide Estimates of Savings Based on PG&E’s Smart Thermostat Study,” AEG, 1/22/2019

¹⁰ SCE17HC054.1 A6 - PGE Smart Thermostat - 1st Year Findings

The PG&E Smart Thermostat Pilot is a well-designed and executed analysis that utilizes a randomized encouragement design to establish a valid control group. This design produces an unbiased estimate of savings for the smart thermostat pilot effort. The results represent savings relative to the prior thermostat used in the home and net of natural adoption of smart thermostats in the control group. The pilot program's recruitment conditions were not identical to expected program conditions (the smart thermostat was free in the pilot but would only be subsidized in a program), but the study's calculations represent a robust estimate of smart thermostat electric savings.

The analysis results conform to the requirements of an NR measure, which requires a standard practice baseline. A standard practice baseline represents what the customer implements in the absence of program influence or intervention. The encouraged and control groups' pre-pilot thermostats are a good proxy for standard practice programmable thermostat control of home HVAC equipment in the absence of the program.

3.4. Natural Gas Annual Unit Savings

Natural gas savings are extended through 12/31/2019 to allow additional research to be completed.

The workpaper workplan for SCE17HCO54 Rev 1 proposed to re-analyze PG&E billing data collected in previous research in a single study (Co-Sponsored Study) by SCE for cooling savings and by SoCalGas for heating savings. When the Co-Sponsored Study failed to show natural gas savings, SoCalGas contracted with Navigant to conduct an evaluation of SoCalGas customers who participated in their smart thermostat program over the last three years (SoCalGas Navigant Study). Draft results from the SoCalGas Navigant Study were made available to the Commission consultant in January 2019, and they showed no significant natural gas savings.

The SoCalGas Request Memo noted in Section 2.1 presents arguments for extending current natural gas savings values until additional research is completed. Commission Staff agrees that further research is warranted. While two studies have shown no evidence of natural gas savings, the Commission Staff agrees with SoCalGas's contention that none of the participants in the studies were in high heat-load climate zones and that further research will improve the precision of the results.

Commission Staff also notes that smart thermostats have demonstrated a potential for accruing energy efficiency and demand management benefits for both electricity and natural gas through a single measure. Demand management is expected to become increasingly important with the growth of electric vehicles and solar photovoltaics. Disallowing natural gas savings at this time will cut-short efforts to understand the potential of this technology's role in streams that include multiple benefits. Commission Staff also recognizes that the PAs are striving to coordinate single, efficient delivery models that create interdependencies and that disallowing natural gas incentives for smart thermostats at this stage would disrupt multiple markets.

Commission Staff, therefore, directs SoCalGas to conduct the research proposed in their Request Memo in collaboration with the Commission Staff. SoCalGas, in coordination with other PAs as necessary, is directed to conduct the following research:

Expand the SoCalGas Navigant Study – The Request Memo proposes to expand the natural gas billing data using the 2018–2019 heating season billing data, which will increase the control group size.

Expand the Nest Learning Thermostat Pilot Study – The SoCalGas Memo proposes to expand the pilot through the 2018-2019 heating season. The original study, designed with a randomized control trial,

showed positive savings; however, the sample size was small and the precision was poor. The Commission believes that a larger participant pool in 2019 should improve the precision of the results. Analyze other available data in conjunction with billing data – smart thermostats collect data on HVAC unit on-off operation and setpoints, which can be used to further inform the analysis.

The Commission requires a workpaper workplan within 30 days of issuing this disposition that specifies details of the work scope, the proposed methods, and a milestone schedule. As SoCalGas noted, the earlier studies did not include higher heat-load climate zones; the workplan must specify how higher heat-load climate zone participants will be incorporated into one or more of the studies. The studies must be completed in time to be included in the revised workpaper. The revised workpapers are due to the Commission by August 1, 2019.

3.5. Net-to-Gross Ratio (NTGR)

A NTGR value of 0.55 should be applied to smart thermostats.

The July 2016 Disposition directs PAs to use a NTGR of 0.33 for the natural gas savings, arguing that the default value of 0.55 does not consider the impact of demand response and low incentives. The November 2016 Disposition approves a 0.55 NTGR through July 2017 and directs the PAs to conduct research to calculate market “lift”¹¹ based on an analysis of sales data as the basis of a revised NTGR. This market lift analysis would estimate the impact of a program intervention by analyzing changes in sales of thermostats correlated with program activity.

The market lift analysis is infeasible, since thermostat manufacturers consider sales data proprietary and are unwilling to share competitive data. The PAs hired Opinion Dynamics to pursue a process evaluation of PG&E's Smart Thermostat Rebate Program. That study provided evidence that the 47% of participants were “not likely to be free riders” based on their response to survey questions regarding whether they had considered smart thermostats, how likely they were to purchase one, and timing. The PAs offer this study as evidence that the NTGR was in the range of 0.55, the proposed default residential NTGR rate.

Commission Staff concludes that an NTGR of 0.55 is reasonable for thermostats. The Opinion Dynamics study was not intended to produce a definitive NTGR for thermostats but does provide corroboration of the default NTGR rate.

¹¹ In marketing, “lift” represents an increase in sales in response to some form of advertising or promotion. Monitoring, measuring, and optimizing lift may help a business grow more quickly. Reference: <https://www.practicalecommerce.com/How-to-Measure-Lift-from-Promotion-and-Advertising>

3.6. Heat Pump Application

The Commission rejects creating a separate measure from existing measures for installing a smart thermostat on a heat pump. Heat pump equipment shall receive the same treatment as existing central air-conditioning equipment savings measure since the cooling savings of a heat pump and central air-condition unit are similar. Space heating savings are denied for lack of verifiable and demonstrable electric heating savings for heat pumps.

SCE17HCO54 Rev 1 proposes two measures. The first measure assumes the smart thermostat is installed on a functioning central air-conditioner and conventional natural gas furnace, and the second assumes the smart thermostat is installed on a functioning heat pump, which provides both heating and cooling with electricity. The cooling savings for both measures are identical. The heat pump measure, however, also claims electric heating savings, which are calculated by applying a fixed savings fraction to the average modeled heating usage of DEER prototypes in each climate zone. The calculated electric energy savings are about 50% higher than cooling savings alone.

Commission Staff reject this analysis approach. Section 3.4 notes that neither of the two billing analysis studies submitted to the Commission for review has demonstrated heating savings; therefore, without any evidence of heating savings, it is unreasonable to assume that a heat pump smart thermostat will save heating energy. The efficiency of a heat pump varies significantly with outdoor ambient temperature, therefore, the savings profile of a heat pump will be very different from a natural gas-fired furnace.

Commission Staff also note that the workpaper includes both upstream and midstream program designs and that neither of these two models lend themselves to verification of the equipment type, which would be necessary to claim heat-pump-specific savings for a site, since in an upstream or midstream program, the consumer receives an incentive without inspection of the HVAC equipment type.

The PAs may provide incentives for a customer with heat pumps assuming the same savings for the central air-conditioning unit. The smart thermostat connected to the heat pump must meet all California Title-24 requirements for heat pump thermostats. With additional data and study, the PAs may provide a new workpaper to claim smart thermostat savings for electric heating from heat pumps.

3.7 Vendor Request on Savings Parameter

A vendor has contacted CPUC staff and suggested that the cooling energy savings need adjustment, because they are understated. The also suggest sharing data to facilitate future research and analyses. The current process is for vendors/stakeholders to provide this information via the utility sponsoring the Workpaper or via the Database of Energy Efficiency Resources update process open to all stakeholders. While the CPUC Staff and CPUC consultants acknowledge the memos submitted by the vendor we will work with the vendor through the PAs to ensure transparency and vendor neutrality is maintained in this process.

4. Disposition Summary

The PAs are directed as follows:

The smart thermostat workpaper SCE17HC054 Rev 1 is conditionally approved if all revisions are made as directed, with an effective date of July 6, 2019, and an expiration date of December 31, 2019. All other PA workpapers must adopt this revised workpaper.

The revised workpaper must remove the heat pump measure. Heat pumps will be treated identically to existing central air conditioning savings measure for the cooling mode.

Electric savings and all other parameters of SCE17HC054 Rev 1, with the exception of hours of peak electric demand, are approved through December 31, 2020.¹²

By July 1, 2019 the PAs shall submit a revised Workpaper that complies with new electric peak period, that impact demand savings for program year 2020.

For gas savings - the PAs, with SoCalGas as lead, are directed to conduct a study (or studies) to determine natural gas savings for all climate zones. Furthermore, the Commission requires a workpaper workplan within 30 days of issuance of this disposition specifying details of the work scope, the proposed methods, and a milestone schedule. The additional research must include the following:

- Expand the SoCalGas Navigant Study – The Request Memo proposes to expand the natural gas billing data using the 2018–2019 heating season billing data, which will increase the control group size.
- Expand the Nest Learning Thermostat Pilot Study – The Memo proposes to expand the pilot through 2018-2019 heating season. The original study, designed with a randomized control trial, showed positive savings; however, the sample size was small and the precision was poor. The Commission believes that a larger participant pool in 2019 should improve the precision of the results.
- Analyze other available data in conjunction with billing data – Smart thermostats collect data on HVAC unit on-off operation and setpoints, which can be used to further inform the analysis to support a heat pump measure in the future.
- The PAs must submit a revised workpaper by August 1, 2019, with updated natural gas savings to ensure that a final workpaper is approved by the end of the year.

¹² The program administrators should note that all program year 2020 measure will need to comply with updated peak period\definition.