Application No.:	A.20-03-004
Exhibit No.:	SCE-02-A
Witnesses:	E. Castano
	M. Thomas

SOUTHERN CALIFORNIA EDISON®

An *EDISON INTERNATIONAL®* Company

(U 338-E)

Amended and Corrected

Testimony of Southern California Edison Company in Support of Its 2020 Energy Storage Procurement and Investment Plan

Before the

Public Utilities Commission of the State of California

Rosemead, California

June 18, 2020

SCE-02-A: *Amended and Corrected* Supplemental Testimony of Southern California Edison Company in Support of Its 2020 Energy Storage Procurement and Investment Plan

Table of Contents

SCE-02-A: *Amended and Corrected* Supplemental Testimony of Southern California Edison Company in Support of Its 2020 Energy Storage Procurement and Investment Plan

Table Of Contents (continued)

SCE-02-A: *Amended and Corrected* Supplemental Testimony of Southern California Edison Company in Support of Its 2020 Energy Storage Procurement and Investment Plan

Table Of Contents (continued)

I.

INTRODUCTION

Southern California Edison Company (SCE) provides this amended and supplemental testimony in support of its Application for California Public Utilities Commission (CPUC or Commission) approval (Application) of SCE's 2020 Energy Storage Procurement and Investment Plan (the Plan), which proposes two pilot programs, the New Homes Energy Storage Pilot (NHESP) and the Smart Heat Pump Water Heater Pilot (SHPWHP) programs. Specifically, this testimony (1) supplements the testimony SCE served on its NHESP in response to queries from the Commission's Energy Division and the Public Advocates Office (Cal Advocates), and (2) amends and supplements the testimony it served in support of its SHPWH program to address questions presented by the Commission's Energy Division and to eliminate the SHPWHP equipment incentive as duplicative of numerous heat pump water heater (HPWH) incentives that will be available when the SHPWHP launches. SCE further amends and corrects its responses to those queries to reflect updates that are based upon the 2020 Avoided Cost Calculator (ACC).

II.

SUPPLEMENTAL TESTIMONY IN SUPPORT OF THE NHESP

SCE's Application and supporting testimony on the NHESP prompted questions from the Commission's Energy Division regarding the NHESP's consistency with Assembly Bill (AB) 2868's legislative intent and the regulatory requirements the Commission imposed in D.19-06-032. Those queries demonstrated to SCE that it was appropriate for SCE to provide answers to those questions not only to Energy Division, but also to all interested parties by supplementing its testimony in support of its proposal. The testimony below is organized by the questions presented by the Commission's Energy Division staff.

A. Additional Program Details Establishing Consistency with AB 2868

1. Justification for Allocating 25% of the Project Budget to Priority Customers

The Commission's Energy Division asked SCE to justify its proposal to allocate 25 percent of the project budget to priority customers, including information on the anticipated number of new single family and multifamily low-income affordable housing units that will be under development or permitted when the NHESP launches.

SCE allocated 25 percent of the incentive budget for affordable housing based upon data it has collected about its residential customers. As explained in SCE's initial testimony,[1] approximately 1.2 million low-income households in SCE's service area are enrolled in the California Alternate Rates for Energy (CARE) Program. This population represents about 25 percent of SCE's total 4.4 million residential accounts. SCE applied that same percentage to the NHESP affordable housing incentive budget.

Since SCE submitted its initial testimony, new information has become available that supports the 25 percent allocation. On March 23, 2020, the California Housing Partnership (CHP) released its California Affordable Housing Needs Report.[2] Statewide permit and Low-

---

[1] SCE-01, fn. 49, p. 31.

[2] https://chpc.net/resources/2020-statewide-housing-needs-report/

Income Housing Tax Credit data utilized in that report spanning a ten-year period from 2010 to 2019 show a combined average of approximately 16 percent of permitted statewide multifamily housing were dedicated to affordable housing projects. The CHP statistics, in conjunction with SCE's internal data about its population of residential customers, demonstrates that allocating 25 percent of the incentive budget for affordable housing is reasonable.

2. Details Regarding Terms that Would Require NHESP Homeowners to Use Energy Storage as Programmed

SCE intends to minimize onerous requirements so as not to deter home sales or create barriers to customers and developers installing energy storage. Instead, SCE will educate customers about their options, how to effectively use energy storage, and the benefits of operating their energy storage systems in such a manner. For instance, SCE will provide customers with easy to understand information on complex matters like energy arbitrage and greenhouse gas (GHG) emissions reduction. As SCE explained in its initial testimony, SCE plans to study a sampling of NHESP systems to assess whether the customer altered the programming and the benefits of the battery programming. SCE will provide the data it collects in that process in its pilot adoption report, or a later update if needed.

3. Measuring the NHESP's Impact on Petroleum Reduction

To have backup energy during an outage, customers may choose to install diesel generators, which must be operated regularly to maintain functionality. The NHESP incentives provide funds to customers to allow them to instead install clean energy storage systems. The Energy Division asked SCE to provide an estimate of the likely reduction in petroleum use due to the NHESP and/or propose an evaluation methodology to determine the impact of the NHESP on the reduction in petroleum use. SCE's pilot program design is based on 10 kWh / 5 kW energy storage systems; a diesel generator of comparable size to a residential energy storage system can consume approximately 0.77 gallons of fuel per hour.[3] The Environmental Protection Agency (EPA) estimates the emissions rate of diesel at 10.21 kg CO_2 per gallon.[4] SCE estimates that energy storage systems rebated by the NHESP program could avoid approximately 7.86 kg CO_2 / hour for any hour when a required Public Safety Power Shutoff (PSPS) event is called.

4. NHESP's Impact on Air Quality

Energy Division asked SCE to provide an estimate of the likely impact of NHESP on air quality and or explain if the program will be targeted in areas where air quality issues are significant. Although NHESP should reduce emissions and pollution by increasing load during hours where renewables are available as a marginal energy resource, reducing load during on-peak hours when natural gas peaker plants are likely operating, and reducing dependence upon diesel generators, SCE does not currently plan to specifically target NHESP adoption in areas with significant air quality issues. SCE plans to conduct post-installation measurements that should provide data on emission and pollution reduction.

5. NHESP Target GHG Reduction Goals

The Energy Division asked SCE to provide a target GHG emissions reduction goal for the NHESP and/or a method to measure the impact of the program on current GHG emissions. SCE proposes to measure the impact of the pilot on GHG emissions post-installation. A suitable methodology to use at that time can be found in the 2018 SGIP Energy Storage Impact Evaluation Report.[5]

---

[3] Based on Model RD020 (20 kW) generator operating at 25% of rated load (5 kW): https://www.generac.com/generaccorporate/media/library/content/all-products/generators/home-generators/protector-series/spec-sheet-15-50kw-diesel-spec-sheets_10000023912.pdf

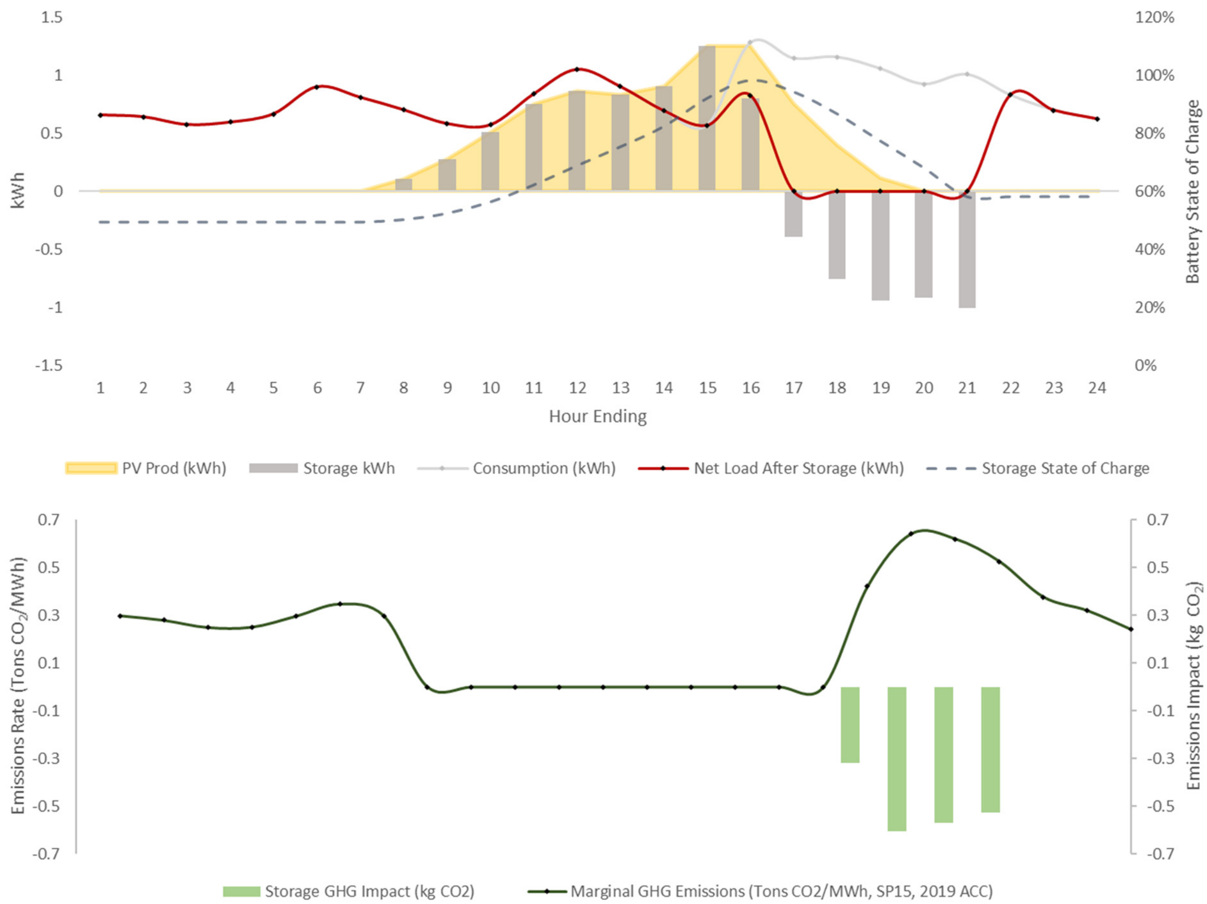
[4] https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf

[5] https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy/Energy_Programs/Demand_Side_Management/Customer_Gen_and_Storage/SGIP%20Advanced%20Energy%20Storage%20Impact%20Evaluation.pdf

If SCE were to apply the 2018 report's methods prior to NHESP installation, then the GHG impact of an energy storage system is the sum product of charge/discharge profiles and the marginal grid emissions rate. Using this approach, modeling that SCE conducted demonstrates that NHESP will produce first-year GHG emissions reductions of approximately 1340 metric tons of CO_2. To arrive at this figure, SCE modeled the dispatch of a 10 kWh/5kW residential energy storage system using representative load data and solar photovoltaic (PV) data. SCE assumed that a 10 kWh / 5 kW energy storage system: (1) operates within the entire 10 kWh / 5 kW range (*i.e.*, no minimum state of charge); (2) has a round-trip efficiency (RTE) of 78 percent, which is the average residential energy storage RTE observed in the SGIP Energy Storage Impact Evaluation Report; (3) is not allowed to export energy while it is discharging; and (4) is limited to only charging from the solar PV while discharging between 4 p.m. and 9 p.m. every day, consistent with current understanding of the behavior of energy storage systems performing time-of-use arbitrage.

The energy storage charge/discharge profile produced by modeling with these assumptions was consistent with the SP 15 marginal emissions rate from the CPUC 2019 Avoided Cost Calculator. Figure II-1 provides an illustration of a single day of energy storage charge/discharge behavior based on the assumptions listed above. The energy storage begins to charge during the hour ending 8 a.m. as PV production begins. Because the energy storage system is absorbing all the PV production, the customer's net load is equal to the consumption. During hour ending 16 (4 p.m.) the energy storage system has reached full capacity; therefore, charging is slightly less than full PV output. The following hour, the energy storage system begins to discharge in order to zero-out the net load, but the export constraint prevents the system from discharging at its full rated capacity (5 kW). Discharge continues in this manner until hour ending 21 (9 PM), after which point the energy storage system remains idle consistent with TOU-arbitrage findings until PV production resumes the following morning.

Figure II-1
Representative Output From Energy Storage Modeling



The lower half of Figure II-1 shows the greenhouse gas emissions associated with this modeled energy storage system. The solid green line shows the marginal emissions rate. During this spring day the avoided cost calculator indicates mid-day renewable curtailment therefore the marginal emissions rate is zero. This period aligns with the storage charging; therefore, the energy storage system generates zero greenhouse gas emissions while charging. Marginal emissions rates are non-zero during discharge, resulting in a reduction of 2.03 kg of CO_2 during the day.

Based on the complete analysis of 8,760 hours, SCE finds that a single 10 kWh energy storage system could reduce GHG emissions by approximately 536 kg CO_2/year. Extrapolating this estimate to the proposed 12.5 MW deployment target, first-year GHG emissions reductions would total approximately 1,340 Metric Tons of CO_2. Total GHG emissions reductions would depend on the useful life of the energy storage system.

6. Assumptions Relied Upon for NHESP Target MW Capacity and Customer Figures

The Energy Division asked SCE to provide an explanation of assumptions used to arrive at the proposed NHESP target MW capacity and customer figures. SCE's stated target of 12.5 MW assumes participation of approximately 2,581 homes,[6] with 143 of those homes utilizing NHESP's affordable housing incentive budget. SCE adopted these assumptions largely based on observations of existing energy storage deployment in SGIP.

For NHESP's capacity target, SCE assumed use of a single system (with 5 kW charge-discharge capacity) per household. Based on SGIP installation observation, current residential industry installation has largely centered on popular LG or Tesla battery models available in the market today. SCE's selection of a representative 5 kW maximum capacity system per household is based on publicly available[7] 2019 residential SGIP installation and reservation data for SCE in which the median capacity identified per residential project is 5 kW. SCE's representative battery selection is not intended to limit battery manufacturer/model participation in NHESP.

SCE also assumed a simple distribution of one such battery per household. SGIP's residential data for 2019 indicating a median capacity of 5 kW per project provided a strong indication of current installation practices aligning with common battery models in the marketplace. There was a dearth of data, however, for common battery use in multifamily

---

6 SCE-01, p. 29.

7 https://www.selfgenca.com/report/public/

applications. This lack of data combined with the wide variety of multi-family project build-outs (affordable housing or otherwise) means that SCE did not find any trends that would indicate strong reasoning for any battery distribution other than the simple distribution approach selected for building a capacity target. Multifamily participation (both affordable and otherwise) in NHESP is expected to offer further insights into useful market trends.

SCE's incentive rates that inform NHESP participation and capacity are designed to tie to forecasted SGIP incentive rates. This pilot incentive design is intended to act as a safeguard that ensures NHESP funds are used in a manner that is tied to best available market indications for battery incentives. Specifically, SCE's NHESP incentive rates are intended to operate at $0.135/Wh for market and mixed housing projects and $0.765/Wh for affordable housing projects.

7. <u>Estimated Target for Multifamily and Single-Family Homes</u>

The Energy Division asked SCE to provide an estimate of the total number of target units including multifamily and single-family homes. As explained in the previous section, SCE estimates a total of 2,581 homes will participate in NHESP. Of that total, SCE expects 2,438 units to participate in the market or mixed rate housing incentive and 143 units to participate in the affordable housing incentive budget.

The overall diversity of home sizes, types, battery applications, energy usage needs, and more helps underscore the challenges of identifying in advance capacity and participant targets for a battery incentive program. SGIP, for example, does not rely on forecasting targets. NHESP faces forecasting challenges for identical reasons, compounded by the newness of California's PV requirements in the construction marketplace.

8. <u>Bill Savings for NHESP Participants</u>

The Energy Division asked SCE to provide an illustration of the customer bill savings with the NHESP. SCE's illustration uses the same dispatch model discussed above, with the following three additional assumptions: (1) that without NHESP, the customer would still have solar PV and be served on SCE's default TOU-D-4-9PM rate[8]; (2) NHESP participants will also have installed energy storage but be served on SCE's TOU-D-PRIME rate; and (3) in both cases, the customer is in SCE's Baseline Zone 5, the baseline is all-electric, and the customer is an SCE bundled customer (i.e., not served by a community choice aggregator (CCA)).

A prototypical customer in the baseline case (PV only, TOU-D-4-9PM) would pay an annual NEM bill of $1,082.28 during the first twelve-month period, after accounting for all NEM credits/charges, non-bypassable charges, and minimum bill requirements. If this same customer were to also have energy storage on their solar system at the start of their first twelve-month billing period, they would reduce their bill over that timeframe to $822.78 (assuming battery dispatch as described in the previous response on SCE TOU-D-PRIME rate). The difference in the two bill totals represents first-year bill savings of approximately $259.50. Total lifetime bill savings would increase depending on the useful life of the energy storage system.

9. <u>Distribution Deferral Savings in Circuits with Capacity Constraints</u>

The Energy Division asked SCE to provide an explanation of the possible distribution grid deferment costs savings if NHESP targets circuits with capacity issues. SCE does not plan to specifically promote NHESP in areas with capacity constrained circuits but proposes in its original testimony an incentive reservation preference for projects on circuits identified in SCE's Distribution Deferral Opportunity Report (DDOR). If there is not a waitlist for incentives, SCE will award incentives on a "first come, first serve" basis. Likewise, because SCE will not, through the NHESP, separately measure, manage, or operate residential energy storage based on individual circuit needs, the NHESP will not estimate costs savings on a circuit capacity basis. However, if any NHESP projects are deployed in a DDOR identified area, the NHESP team will inform relevant SCE procurement teams of location and availability so that the procurement team can investigate and determine whether SCE can use NHESP assets for distribution deferral.

---

8 https://www.sce.com/residential/rates/Time-Of-Use-Residential-Rate-Plans

As a pilot, NHESP will deploy resources as required within its budget to validate its hypotheses about incentive demand. Evaluation measurements will thus focus on factors that are important to piloting, testing, and demonstrating, including modeling how incentives influence demand and the soundness of the NHESP analytic conclusions about incentive demand across customers in different situations.

10. <u>The Cost-Effectiveness Methodology for NHESP</u>

The Energy Division asked SCE to provide an explanation of the proposed cost-effective methodology for the NHESP and explained that proposed cost-efficient evaluation could consider benefits to the entire system rather than just individual ratepayers, and that cost-effective evaluation measurements could consider avoided energy system capacity, avoided renewable portfolio standard procurement and ancillary services, and avoided distribution and transmission costs with NHESP.

SCE maintains that, as a pilot, NHESP's objectives should not be centered around cost-effectiveness expectations that would be maintained for a program. The data from this pilot can and should be used to inform cost-effective or cost-efficient parameters for a program in the future.[9] Current cost-effectiveness evaluation of SGIP, for example, does not focus on retrospective evaluation of that program, and emphasizes that behind-the-meter storage cost-effectiveness valuation is "highly variable."[10]

If SCE were to use the 2019 Avoided Cost Calculator (ACC) to identify ratepayer benefits associated with NHESP, the average levelized value of electricity is $104.09 per

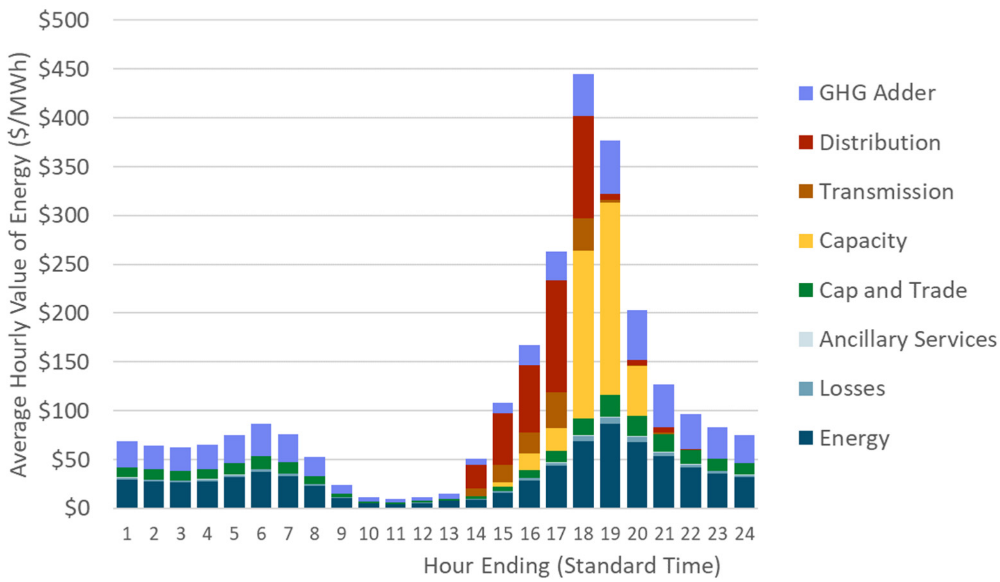
---

[9] If NHESP existed as part of a customer program, it would be assessed according to the Commission's Standard Practice Manual, which provides for four tests to evaluate energy saving investments -- the Total Resource Cost (TRC), Program Administrator Cost (PAC), Ratepayer Impact Measure (RIM), and Participant Cost Test (PCT)) – which assess the costs and benefits of demand-side resource programs from different stakeholder perspectives, including participants and non-participants. The 2019 SGIP Energy Storage Cost-Effectiveness Evaluation also provides examples of approaches to identifying cost-effectiveness for behind-the-meter energy storage applications.

[10] 2019 SGIP Energy Storage Cost-Effectiveness Evaluation, p. 1-5 and 1-6.

MWh.[11] This average value increases to $250/MWh for July, August, and September. By hour, as illustrated in Figure II-2, the average value increases dramatically from 4-9 p.m., illustrating the value in shifting load to off-peak hours.

Figure II-2
2019 Avoided Cost Calculator Average Hourly Value of Energy



Using the storage charging and discharging load shape described in section II.A.5 in the 2019 ACC, SCE calculated ratepayer benefits for each hour over the course of a year. The following table provides an example of how the ACC quantifies benefits per hour. SCE then multiplied those benefits with each hour of charge or discharge to identify an avoided cost for each hour of the year.

Example September 14 Benefits Calculation:

[11] Using the 2019 Avoided Cost Calculator, v1b,10-year levelized costs, assuming a ten-year useful life for NHESP batteries.

Table II-1
Hourly Levelized Cost of Electricity

Date/Time Stamp	Total Avoided Cost per Hour ($/MWh)	MWh charge / discharge	Avoided Cost per Hour*
9/14/2020 6:00	$89.99	-	$0.00
9/14/2020 7:00	$70.52	0.00004	$0.00
9/14/2020 8:00	$0.00	0.00025	$0.00
9/14/2020 9:00	$0.00	0.00054	$0.00
9/14/2020 10:00	$0.00	0.00082	$0.00
9/14/2020 11:00	$0.01	0.0012	$0.00
9/14/2020 12:00	$10.61	0.00156	$0.02
9/14/2020 13:00	$25.40	0.0021	$0.05
9/14/2020 14:00	$204.95	0.00065	$0.13
9/14/2020 15:00	$499.36	0.00014	$0.07
9/14/2020 16:00	$608.41	-0.00044	($0.27)
9/14/2020 17:00	$5,062.48	-0.00094	($4.74)
9/14/2020 18:00	$3,748.49	-0.00111	($4.15)
9/14/2020 19:00	$884.47	-0.00103	($0.91)
9/14/2020 20:00	$120.23	-0.00096	($0.12)
9/14/2020 21:00	$97.99	-	$0.00
*Negative Avoided Cost is positive ratepayer savings/benefits.			

The sum for one year of avoided cost benefits per hour is almost $456.93. The per-unit benefit if assuming a ten-year useful life for energy storage is $4,569.27. Total ratepayer benefits over ten years for all 2,581 participating units in SCE's forecast rounds to $11,793,298. Based on the pilot's cost of $5 million, NHESP is projected to have a Benefit / Cost Ratio of 2.36.

The above calculations identified in the avoided cost calculator are for a representative climate zone in SCE's service area[12]. SCE's findings are inclusive of values for avoided energy and line loss costs, avoided system capacity and ancillary service costs, avoided distribution and transmission costs, and a GHG cap-and-trade and adder cost designed to also capture the cost of avoiding renewable portfolio standard procurement.

[12] SCE Climate Zone 10, chosen because it is one of SCE's top climate zones by population.

11. Cost and Assumption Comparisons Between NHESP and SGIP

The Energy Division asked SCE to provide an explanation of the cost comparison between the NHESP and SGIP and confirm that SCE is using similar assumptions as SGIP to arrive at its $340/kW energy storage costs.

SCE stresses that the narrow cost comparison between the forecasted NHESP costs and SGIP costs that SCE provided in its initial testimony only compares the incentive dollar cost per kW of capacity. SCE's $340/kW figure for NHESP is based on the assumptions about installation plus incentive rates that SCE used to allocate its incentive budget, rounded down when needed to ensure whole-unit installation. To arrive at the SGIP $588/kW figure, SCE identified total incentive spend and capacity for 2019 residential projects in its service area that had either been designated as being "paid" or "reserved" as of February 27, 2020. SGIP data was gathered through the program's real-time public report service.[13]

12. NHESP Energy Storage Sizing Justification

The Energy Division asked SCE to provide a justification for the proposed NHESP energy storage size, noting that the size of SGIP energy storage projects is tied to the estimated peak load of the SGIP customer. As discussed above, SCE examined readily available and commonly installed energy storage battery models for residential applications in SGIP to identify a median battery capacity value. This value was then used for NHESP forecast requirements related to target capacity, budget, and participant count. SCE is not aware of an installer or manufacturer that offers highly customizable models to target specific customer load needs. Rather, they manufacture one-size, easily stackable modules to reduce production and installation costs.

---

[13] https://www.selfgenca.com/report/public/

B. Conformity with D.19-06-032 Ordering Paragraphs & Appendix A

1. NHESP Support for PSPS Down Protocols and Fire Threat Resiliency

The Energy Division asked SCE to provide an explanation of how proposed energy storage projects could support utility PSPS down protocols and how the location of proposed projects intersects with the CPUC Fire-Threat Map and could provide additional resiliency value to the electric distribution system. Although SCE disagrees that Appendix A of D.19-06-032 is applicable to the AB 2868 customer programs, SCE addresses the query. SCE's original NHESP testimony does not propose to offer elevated incentive rates or preference for energy storage installations in homes located in CPUC-designated Tier 2 or Tier 3 fire zones. NHESP systems that are located in high-fire risk areas are likely to offer resiliency benefits to individual customer projects via combined solar and storage systems managed by a control system that has capabilities to help support continued operation of electrical appliances, select medical equipment, or other needs during outages. Broader electric distribution system benefits are likely to be limited by system configuration and size. For example, NHESP is not designed to be a pilot to promote pairing of energy storage systems with a community solar array. Also, SCE expects outcomes emerging from the CPUC's Microgrid and Resiliency Strategies proceeding[14] to establish opportunities under which microgrid controllers can be added to energy storage technology to potentially offer meaningful resiliency benefits.

C. Questions Regarding AB 2514

The Energy Division characterized some of its questions as relating to AB 2514. AB 2514, however, does not apply to SCE's AB 2868 behind-the-meter customer programs. This testimony addresses factual, not legal, matters. SCE will address any legal issues regarding the relevance, if any, of AB 2514 to NHESP in briefing.

---

[14] Rulemaking 19-09-009.

1. Grid Optimization

The Energy Division asked SCE to provide details on how the NHESP incentive will target projects that promote optimal grid management, noting that SCE could target the program where there are capacity issues or provide an analysis of peak MW reduction with the program.

Setting aside that any such requirement of AB 2514 is not applicable to SCE's AB 2868 NHESP proposal, in general, the deployment of any reliable and available residential energy storage has the potential to promote grid management. Specific to NHESP assets, SCE will require all systems to have communication protocols that will enable them to become part of pooled grid assets in the future. That, however, is not the present focus of the NHESP (or at least something that can be fully explored and implemented in the timeline proposed for this pilot). The immediate objective is to incentivize new construction energy storage deployment. SCE thus intends to use the pilot to engage the builder community, and pilot design is built around distinctions among market, mixed, and affordable housing developers.

Similarly, SCE does not intend NHESP to mitigate capacity constraints, which typically would require a large concentration of energy storage deployment. The extent to which NHESP installations can address circuit capacity issues remains unknown given expected variation in individual circuit needs, concentration of energy storage installs, and customer participation in circuit-level grid management activities. Furthermore, NHESP does not propose to offer an incentive for utility control of batteries.

Regardless, at an individual participant level, the addition of storage paired with solar as proposed in NHESP has the potential to provide meaningful household-level optimization contributions, including to peak capacity and outage management backup benefits. SCE expects to use NHESP participants' energy usage data to better understand household-level optimization to inform future SCE pilots and programs.

2. Contribution to Reliability Needs

The Energy Division asked SCE to provide more specifics on the stated "outage management backup benefits"[15] from the program observing that the NHESP could prioritize circuits with high rates of outages.

As noted above, "circuit prioritization" is a requirement of AB 2514, thus it is not applicable to the NHESP. Regardless, in the event of an outage, these systems, irrespective of where they are located, will be configured to have battery capacity reserved for use during an outage. Specifically, this reserved capacity can be used to provide backup power to critical home appliances such as, but not limited to, medical equipment, lighting, refrigeration, internet router, garage door, fans, and smart phone charging.

With regard to circuits with high outage rates and prioritizing them for NHESP incentives, NHESP will offer an incentive reservation preference to projects on circuits identified in SCE's DDOR if there is a waitlist for funding. Absent a waitlist, SCE will award incentives on a first come, first serve basis. If any NHESP projects are deployed in a DDOR identified area, the NHESP team will inform SCE's procurement team of location and availability so SCE's procurement team can investigate and determine if NHESP assets could be utilized as part of solutions proposed to design and deliver to SCE.

3. Deferral of Transmission and Distribution Upgrades

The Energy Division asked SCE to provide details on the possible targeted circuits based on SCE's last DDOR to achieve greater program benefits such as distribution infrastructure deferral or deferred or avoided hosting capacity upgrades to the distribution system.[16] SCE's DDOR is published in August of each year, so new reports are likely to be released during NHESP implementation. These reports may outline additional areas of distributed energy resource deployment need. As a result, if NHESP projects are deployed in a

[15] SCE 2020 App, p.23.

[16] Protest of The Utility Reform Network (TURN), p. 4.

DDOR identified area, the NHESP team will inform SCE's procurement team of new assets that may be used to help distribution infrastructure deferral or deferred or avoided hosting capacity upgrades to the distribution system. SCE's procurement team will then be able to investigate if NHESP assets could be utilized as part of solutions proposed by solicitation participants or other industry activities.

D. NHESP Coordination with Other Programs

1. NHESP Incentives for MASH and SOMAH Customers

The Energy Division asked SCE to provide SCE's approach to addressing issues with solar installed in-front-of-the-meter (IFOM) if the NHESP will provide incentives to the multifamily affordable solar home (MASH) and solar on Multifamily affordable housing (SOMAH) programs, noting that these programs require solar be installed IFOM, creating a concern that energy storage installed behind-the-meter (BTM) may not be able to charge on solar during an outage.

NHESP is not applicable to MASH and SOMAH programs because NHESP is a new construction program for buildings that are not yet occupied.

2. Coordination with Other CPUC Programs Incentivizing All Electrical Construction

The Energy Division asked SCE to provide a narrative on the expected coordination with other CPUC programs incentivizing all electric construction. For example, SB 1477's BUILD program, SCE's proposed Energy Savings Assistance (ESA) Clean Energy Homes Programs, and the California Advanced Homes Program (CAHP).[17]

---

[17] The Building Initiative for Low-Emissions Development (BUILD) program was adopted in D.20-03-027. In SCE's Energy Savings Assistance Application 19-11-004 $21 million Clean Energy Homes Pilot program is proposed. In the Energy Efficiency proceeding R. 13-11-005 Pacific Gas & Electric has issued a Request for Proposal for the design of a statewide California Advanced Home Upgrade program.

In its original testimony, SCE stated that its NHESP proposal is not intended to limit developer participation in other new construction programs.[18] SCE developed NHESP in coordination with all identifiable new construction developments underway within workstreams and/or proceedings associated with potential new SB 1477 BUILD, ESA Clean Energy Homes, and CAHP programs. The timing of various proceeding activities may affect the potential for layering various program incentives. SCE intends to continue to coordinate activities, monitor incentive layering potential, and seek opportunities to market incentives together to housing developers wherever possible.

III.

SMART HEAT PUMP WATER HEATER PILOT PROGRAM

A. Program Overview and Objectives

As described in SCE's direct testimony, SCE-01, the goal of SCE's proposed Smart Heat Pump Water Heater Pilot Program (SHPWHP) – a BTM thermal storage program-- is to encourage participants to reduce or eliminate hot water heater load during peak evening hours. By shifting water heating load away from these peak usage hours, the smart water heaters and controllers can effectively "store" pre-heated water as thermal energy and provide hot water during peak usage hours without increasing demand during times when there is high demand on the grid. The SHPWHP incentives will allow customers with electric resistance and heat pump water heaters to switch to smart water heaters by adding control and communications equipment. By deploying approximately ~~4.76~~2.89 MW of BTM thermal storage by 2027 via existing electric resistance and new electric HPWHs, the SHPWHP will enhance grid management, mitigate negative environmental impacts by reducing residential and commercial GHG emissions, reduce participating customers' energy bills over the useful life of the storage device, shift or reduce distribution grid capacity need, and avoid electricity costs, due to increased use of low-cost mid-day generation.

[18] SCE testimony, p. 25.

Controllable electric water heaters[19] enhance grid management because they are flexible as to when they draw power from the grid, the draw time from the grid can be strategically controlled without any disruption to the customer at times of the day when power is cheaper and cleaner (e.g., mid-day when solar power is available or the middle of the night when wind generation is available), and the device can serve as thermal storage of energy supplied at other times of the day.[20]

The Energy Division asked SCE to explain its control strategies. For the SHWHP, SCE anticipates utilizing a "Load-Up & Shed" control strategy to take advantage of beneficial time-of-use (TOU) rates. More specifically, the strategy is to "load-up" or heat the water during off-peak hours when it would normally not operate, and "shed" or drop the water heater setpoint during peak hours.[21] Pre-heating water during off-peak periods enables hot water to be available for use at all hours of the day, including peak periods, without the need for electricity consumption during the more expensive peak periods.

SCE does not intend for the smart water heaters enrolled in the program to participate in the CAISO market. However, data collection from the field is necessary to better understand if/how this technology could, at some point, be bid into the CAISO market. CAISO and Resource Adequacy (RA) rules need to be tested to see if smart water heaters are appropriate to participate in Demand Response.

---

[19] The Energy Division noted that the term electric water heaters are used throughout the application and asked if this term applies to both existing electric resistance and existing heat pump water heaters, or just one of these types. When used, the term "electric water heaters" refers in general to both electric resistance and heat pump water heaters. SCE clarifies that the terms "electric resistance" or "heat pump" are used when referring to a specific technology.

[20] Beneficial Electrification of Water Heating, https://www.raponline.org/knowledge-center/beneficial-electrification-of-water-heating/

[21] Heat Pump Water Heater Electric Load Shifting: A Modeling Study, Ecotope Consulting Research Design; available at: https://ecotope-publications-database.ecotope.com/2018_001_HPWHLoadShiftingModelingStudy.pdf

B. Amendment of the Original Proposal to Eliminate the Equipment Incentive[22]

SCE's direct testimony, served on March 2, 2020, contained a proposal for the SHPWHP that included incentives for customers to replace existing propane-based or natural gas water heaters with heat pump water heaters. The purpose of the proposed incentives was to close the funding gap left by Energy Efficiency (EE) programs so that customers can realize the additional benefits of a smart or grid-integrated water heater. SCE has since determined that additional equipment incentives are duplicative and unnecessary given the number of heat pump water heater (HPWH) incentives that will be available when the SHPWHP launches, such as the incentives offered through SGIP, TECH Initiative (SB1477), 2021-2026 SCE Energy Savings Assistance (ESA) Program, and Building Electrification Pilot. This testimony amends SCE's proposed SHPWHP so that it will add value and complement, rather than duplicate other HPWH programs.

C. Proposed Incentives and Incentive Structure

The SHPWHP will offer financial incentives to customers who are willing to shift their electricity consumption to non-peak hours. SCE will offer customer incentives for the installation of control and communication equipment to electric water heaters[23] to provide thermal storage. SCE will also use pay-for-performance (P4P) incentives to encourage customers to limit water heating to off-peak hours and reduce or eliminate water heating during peak hours.

---

[22] The Energy Division had asked SCE several questions that are now moot given the amended testimony that removes this incentive. The mooted questions are summarized as follows:

(1) Provide an explanation of the potential costs and benefits of enabling larger SHPWH replacements.

(2) If SCE intends to apply dual baselines to the retirements, provide an estimated SHPWH program only replacement incentive and an additional program (*i.e.*, TECH, EE) replacement incentive level.

(3) Explain if the implementation budget specifically excludes natural gas water heaters.

(4) Explain how and which energy efficiency savings would be claimed through this program.

[23] The term electric water heaters refer to both electric resistance and electric heat pump water heaters.

The Energy Division asked SCE to explain the incentive structure, how it will be calculated, the amount for residential and small business customers, if there will be an enrollment incentive, and if there will be an ongoing participation incentive like PG&E's WatterSaver program. Final P4P incentive structure and levels will be determined upon final program design and selection of program implementer upon competitive solicitation process. For planning and budgetary purposes, an ongoing annual P4P, or participation incentive of $45 per participant is being used with an average enrollment period of four years. This annual incentive is similar to what SCE offers in its Smart Energy Program. The average length of active enrollment under the Smart Energy Program is approximately 3.2 years with numerous customers still enrolled since its launch in 2015.

D. Customer Eligibility and Conditions of Participation

The Energy Division noted that SCE's Application proposes to provide homeowners with incentives and asked if homeowners also include multifamily properties and renters and, if yes, if the program would look to enroll existing central SHPWHs into the program. The Energy Division also asked if customers with propane or water heaters are eligible only in DACs or SCE's entire service territory like electric resistance water heaters.

All account holders, including homeowners, renters, and multifamily property owners/renters with an electric resistance or heat pump water heater will be eligible to participate in the SHPWHP and to receive the proposed P4P incentives. However, the program will prioritize low-income,[24] public housing,[25] and residential and small business[26] customers who reside or operate in Disadvantaged Communities (DACs).

---

[24] Low-income customers are defined as residential customers enrolled in the California Alternate Rates for Energy (CARE) program or the Family Electric Rate Assistance (FERA) program.

[25] Public housing customers are residential customers who occupy affordable rental housing owned by a government authority. These customers have unique barriers to HPWH and smart control device technology adoption.

[26] Small business customers are defined as customers on an SCE commercial rate schedule that have a maximum demand less than 50 kW or usage less than 150,000 kWh per year.

Approximately 40 percent of SCE's residential service accounts within DACs are on a low-income rate plan (e.g. CARE, FERA). To reach this large population of low-income customers, SCE plans to leverage HPWH direct install activities proposed under its 2021-2026 Energy Savings Assistance (ESA) application[27]. SCE anticipates setting aside a percentage of the budget for public sector and low income for the first 24 months and if not spent, SCE could shift budget to serve a larger percentage of market rate customers.

SCE is currently in the process of transitioning residential customers to TOU rate plans and expects to have this effort completed by Q1-2022, which is prior to the anticipated launch of the SHWHP. SCE expects that approximately 87 percent of eligible customers will migrate to a TOU rate plan, with the estimated 13 percent opting out. SCE will default customers to the lowest cost of either a TOU-D-4-9PM or TOU-D-5-8PM plan, based on their last 12 months of usage history, and allow customers to remain on any low income programs in which they are currently enrolled, such as CARE/FERA, DAC-GT, or DAC-CSGT. Customers can also use the SCE Rate Plan Comparison Tool[28] to ultimately select the best rate plan for their household. To participate in the program, SCE will require that participants be enrolled in a residential TOU rate plan if they have not already been defaulted to one.

Small business customers have already transitioned to a TOU (GS-1 or GS-2) rate plan, which is determined by their total monthly demand. By participating in the SHPWHP, small business customers on GS-2 rates may be able to drop enough peak load to take advantage of the lower GS-1 rate, while existing GS-1 business customers can use the controls to help ensure they stay below the rate's required 20kW threshold.

As part of the proposal, SCE will develop educational materials to help customers better understand TOU rates and the load shifting benefits of the SHPWHP. SCE is also currently

---

[27] SCE has proposed to retrofit approximately 1,700-electric resistance water heaters and another 3,500-natural gas/propane water heaters with heat pump water heaters under the proposed ESA Tier 2 Retrofits and BE Pilot respectively.

[28] SCE Rate Plan Comparison Tool; available at: https://www.sce.com/residential/rates/rate-plan-comparison-tool

evaluating tools that analyze historic usage to determine the bill impacts of TOU rate schedules that are combined with shifting water heating load to off peak periods. These tools will further assist customers in making more informed decisions about their systems.

A recent statewide analysis by Energy and Environmental Economics (E3) assessed the impact of a flexible water heating schedule on residential consumer bills.[29] Table III-2 below shows the average annual consumer bill savings in SCE's service territory from a load shift water heating schedule compared to a regular water heating schedule.[30] Table III-2a below shows the average annual consumer bill savings for the two different electric water heater types along with two different residential TOU-rate schedules. The savings estimates were calculated by overlaying controlled and uncontrolled load shapes for both HPWH and ERWH to a typical household load shape. These load shapes were then analyzed using a modified version of the bill calculator developed for the NEM 2.0 lookback study to estimate customer bills under different situations.[31]

[29] Energy +Environmental Economics, Residential Building Electrification in California, available at: https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

[30] Energy +Environmental Economics, E3 Quantifies the Consumer and Emissions Impacts of Electrifying California Homes, available at: https://www.ethree.com/e3-quantifies-the-consumer-and-emissions-impacts-of-electrifying-california-homes/

[31] Decision (D.18-09-044) on NEM consumer protections authorized ratepayer funding for a formal and independent evaluation of NEM 2.0 to analyze the costs and benefits of customer-sited renewable resources taking service on the tariff and its variants. The final evaluation plan is available at: https://www.cpuc.ca.gov/General.aspx?id=6442463430

Table III-2
Average Annual Bill Savings from a Load Shift Water Heating Schedule

Climate Zone	Vintage	Low-Rise Multifamily	Single Family
CZ06	78	$43.14	$66.37
	90	$51.47	$43.54
CZ09	78	$28.37	$47.87
	90	$36.62	$28.28
CZ10	78	$48.97	$82.53
	90	$54.30	$75.95
Average Bill Savings		**$43.81**	**$57.42**

Table III-3a
Average Annual Bill Savings Water Heater Type and TOU Rate

Strategy/Rate	TOU D 4 – 9 PM	TOU D PRIME
ERWH – Uncontrolled	$2,254	$2,298
ERWH – Controlled	$2,194	$2,142
ERWH Savings	**$60**	**$156**
HPWH – Uncontrolled	$1,826	$1,926
HPWH – Controlled	$1,808	$1,881
HPWH Savings	**$18**	**$45**
Avg. Participant Savings	**$26.29**	**$67.52**

E. Program Budget and Customer Costs

At Energy Division's request, SCE provides an estimated break down of residential and small business program enrollments in the program budget and customer costs sections below.

1. Program Budget

SCE will competitively solicit a third-party implementer and will submit final program targets and budget in a Tier 3 Advice Letter. SCE estimates it will have 17,000 customers on the SHPWH Program by 2027, with an approximate total budget of $13.99 million, which is a reduction of approximately $1M from SCE's initial budget estimates.[32] SCE

[32] The budget reduction is primarily driven by the amendment in SCE's proposals. SCE's budget no longer includes a financial incentive for the early replacement of aging electric resistance, propane, or natural gas water heaters.

anticipates most participants will be residential customers with approximately 2 to 5 percent of program enrollments from small business customers.

Table III-3 shows both the estimated program costs by year, and the budget estimates for implementing the program, including administration, marketing, and customer acquisition costs, as well as incentives for customers to participate in the program. This supplemental and amended testimony makes no changes to program administration or ME&O costs. Direct implementation[33] costs will change because SCE is eliminating the equipment incentive and costs associated with that element.

Table III-4
Annual Program Budget by Spend Category, 2021-2027
(Thousands of Dollars)

Budget Category	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**Amount**
Program Administration	$350	$250	$225	$225	$225	$225	$1,500
Marketing, Education & Outreach (ME&O)	$400	$200	$100	$100	$100	$100	$1,000
Direct Implementation	$581	$1,744	$1,744	$1,600	$1,454	$1,309	$8,433
Incentives	$211	$633	$633	$580	$528	$475	$3,060
Total	**$1,543**	**$2,828**	**$2,703**	**$2,505**	**$2,306**	**$2,109**	**$13,993**

2. Customer Costs

SCE does not anticipate any customer costs because the amended SHPWHP will no longer include an incentive for the installation costs of replacing propane or natural gas.

F. Program Evaluation, Measurement & Verification Plan

The Energy Division asked SCE to provide an outline of a program evaluation proposal. Based on the stated program objectives, the evaluation will:

- Assess the program's ability and relative success of shifting water heating load away from peak usage hours, including customer load and bill impacts.

[33] The Direct Implementation budget covers funding to be reserved for all direct costs associated with retrofitting water heaters with a smart control device, programming of the smart control device with a load-shifting protocol, and connecting the device to the platform of the provider supplying the load-shifting protocol to the customer appliance.

- Examine approaches, methodologies and tools to best assess and calculate cost-effectiveness, as well as other expected rate payer benefits.
- Identify what conditions or criteria in terms of measures, pre-existing conditions of homes, appliances, and other factors provide the most viable or productive combinations of equipment and usage to deliver the desired peak load reduction.
- Profile if, how, and the extent to which the SHPWHP efforts have successfully complemented or added value to the implementation of programs offering heat pump incentives, or vice versa.
- Assess the extent to which the program intervention has increased customer knowledge and satisfaction with respect to effectively storing pre-heated water as thermal energy.

Each of the core objectives will be supported by several key research questions, including, but not necessarily limited to, the following:

- What approaches should be used to evaluate the performance of controlled water heaters to assess efficacy (GHG emission reductions, energy/demand impacts, pollutant reduction impacts and improved utilization of the transmission and distribution system)?
- How should the cost-effectiveness of controlled electric water heaters be analyzed?
- How many participants experienced reductions in their water heating energy costs?
- What can be learned from participants/contractors/stakeholders' feedback concerning program experience?
- What improvements can be made to the program design to improve service delivery, cost-effectiveness, and to address feedback?

Interim findings should be delivered at multiple stages of the program, with special focus on lessons learned and possible program modification to improve effectiveness.

The success of the SHPWHP will be measured against the stated program objectives. Following approval of the program and prior to implementation, SCE will develop a more refined evaluation plan that supports a viable assessment of the program including ongoing and new information acquired and necessary to execute the program.

The specific budget for the evaluation activities will be included in the overall program budget and depends on additional evaluation criteria that will be developed following approval of the program. The program evaluation is likely to cost approximately $500,000 subject to modification as part of the scoping process.

G. AB 2868 Mandates and Goals

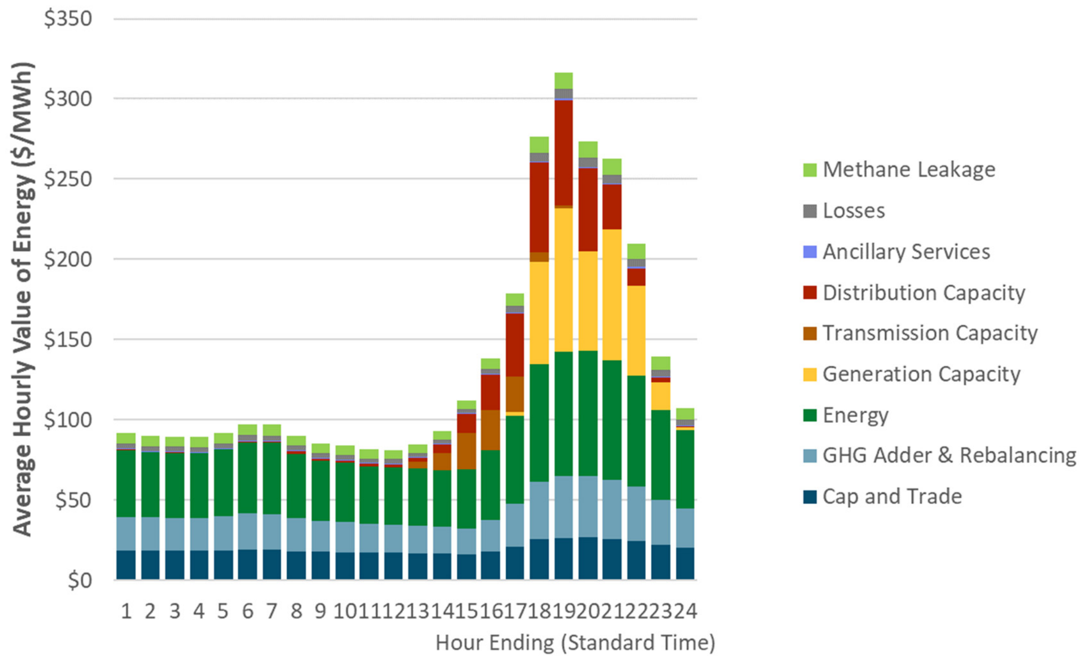
1. Ratepayer Benefits and Grid Optimization, Including Peak Reduction, Upgrade Deferral, and Renewable Integration

The Energy Division asked SCE to provide an estimated ratepayer benefit value for reducing 5 2.89 MW by 2027. Until there is an approved tool for estimating this pilot's load shift Heat Pump Water Heater (HPWH) and Electric Resistance Water Heater (ERWH) ratepayer benefits, the 20192020 Avoided Cost Calculator provides enough information for a simplified ratepayer benefits estimate. The average levelized value of electricity in the 20192020 ACC is $13504.909 per MWh.[34] The average value increases to more than $250221/MWh for July, August, and September. By hour, as illustrated in Figure III-3, the average value increases dramatically from 4-9 p.m. relative to the preceding 5 hours period, 11 a.m. – 4 p.m.

[34] 201920 Avoided Cost Calculator v1c, SCE Climate Zone 10, 13-year levelization.

Figure III-3

20~~19~~20 Avoided Cost Calculator Average Hourly Value of Energy



Using the ACC, SCE can estimate the ratepayer benefit for the load-shift component of the pilot's~~-~~controlled Heat Pump and Electric Resistance Water Heaters. SCE applied the 8760 load shapes referenced in PG&E's AL 5731-E and AL 5731-E-A to a levelized avoided cost load shape. ~~For every day, from the hours of 4-9 p.m., SCE will assume a 0.28 kW drop. SCE can then assume that demand load shifts to the 5 hours beforehand, 11 a.m. – 4 p.m., and calculate the ratepayer benefits from increasing load by 0.28 kW.~~ The table below provides an example ~~September~~ August 27 Load Shift Benefit Calculation for a controlled HPWH:

Table III-5
Hourly Levelized Cost of Electricity[35]

Date/Time Stamp	Total Avoided Cost per Hour ($/MWh)	Controlled HPWH (MWh load shape)	Controlled HPWH ($)
Aug-27 09:00	$103.31	-	$ -
Aug-27 10:00	$105.56	0.000193	$ 0.02
Aug-27 11:00	$110.71	0.000193	$ 0.02
Aug-27 12:00	$114.62	0.000193	$ 0.02
Aug-27 13:00	$120.77	0.000193	$ 0.02
Aug-27 14:00	$134.10	0.000193	$ 0.03
Aug-27 15:00	$153.63	-	$ -
Aug-27 16:00	$175.78	(0.000005)	$ (0.00)
Aug-27 17:00	$232.30	(0.000326)	$ (0.08)
Aug-27 18:00	$337.35	(0.000372)	$ (0.13)
Aug-27 19:00	$232.91	(0.000164)	$ (0.04)

The sum of ratepayer benefits for one year is $23~~98~~ per controlled HPWH and $108 per controlled ERWH ~~unit~~. Multiplied over the useful life of a ~~Heat Pump Water Heater~~ HPWH and ERWH and its controls (13 years[36]), that equates to $299 and $1,407 (HPWH and ERWH respectively) ~~$1,273~~ in load shift-related ratepayer benefits per unit. For the estimated 13~~7~~,~~0~~600 HPWH and 3,400 ERWH participating units, that's $8,851,173~~21,643,374~~ in total ratepayer benefits for 2,894 ~~4,760~~ kW, or ~~4.76~~2.89 MW.

If the program ~~For an even 5 MW and cutting off the~~ lifecycle benefits end at 2027 (so 7 years from 2021-2027), ~~instead of over the full lifecycle of the units, still~~ the program provides $4,085,157~~10,492,909~~ in ratepayer benefits.

[35] Negative Avoided Cost is positive ratepayer savings/benefits.

[36] Mahone, Amber, et al. Residential Building Electrification in California. Energy and Environmental Economics, Inc., Apr. 2019. https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

2. **Reducing Distribution System Upgrades Through Load Shifting**

The Energy Division asked SCE if it intends to study reducing distribution system upgrades through load shifting as a feature of the program to inform procurement through the Distribution Investment Deferral Framework. Households that convert from a gas or propane water heater to a heat pump water heater will increase their *electrical* consumption, however by participating in the SHPWHP and adding smart controls they can "shift" electrical load to off peak hours can make this increased load beneficial rather than detrimental. ~~The 2019 ACC lists 28 distinct hours when distribution avoided costs are non-zero during July and August. Loads shifted from these 28 hours to the remaining hours with zero distribution avoided cost value benefits the distribution system.~~

3. **Reduction of Petroleum Use**

The Energy Division asked SCE to provide an estimated reduction in petroleum use due to the proposed SHPWH program, explaining that the estimate can be based on the number of natural gas/propane water heaters replaced and natural gas saved through load shifting. SCE expects an ERWH without smart controls to burn 22.0 MMBTU per year of natural gas, while a controlled ERHW will consume 20.6 MMBTU of natural gas. Furthermore, SCE expects a HPWH without smart controls to burn ~~10.3~~8.4 MMBTU per year of natural gas, while a controlled SHPWH will consume ~~11.3~~8.0 MMBTU per year of natural gas. SCE thus expects the combined 17,000 controlled ~~SHPWH~~ smart water heaters to save ~~17,000~~9,535 MMBTU of natural gas per year.[37]

4. **Air Quality Standards and Reducing Pollution**

The Energy Division asked SCE to provide a narrative on ways that the proposed SHPWH program will meet the air quality mandate, indicating that the program could target

[37] Based on ~~2017~~2020 ACC emissions and load shapes from SGIP HPWH calculator by Delforge *et al.* using results from Kruis, N., Wilcox, B. Lutz, *California Residential Domestic Hot Water Draw Profile Selection Methodology* (May 18, 2016) available at: www.bwilcox.com/BEES/docs/Kruis%20-%20Dhw%20Analysis%205.docx and Brockway A., Delforge P., *Emissions Reduction Potential from Electric Heat Pumps in California Homes*, The Electricity Journal 31 (2018).

areas with air quality issues and/or propose methods to measure the impact of the program on air quality. It also asked SCE to provide estimated reductions in criteria air pollutants from load shifting activities that will occur with the program.

Controlled electric water heaters enable load management of hot water storage and the rate of hot water use. More importantly, they allow for flexible water heating load to align with the availability of no/low-emission, clean, renewable solar energy during the day. The SHPWHP will also make a concentrated effort to reach customers in DACs that are disproportionately burdened by, and vulnerable to, multiple sources of pollution as identified by California Environmental Protection Agency (CalEPA) Version 3.0 of the California Communities Environmental Health Screening Tool (CalEnviroScreen).

Measuring the impact on air quality starts with determining how emissions are reduced by the shifting water heater load. For ex-post evaluation, a sample of controlled equipment would likely be assessed to determine actual emissions as compared to baseline emissions (from uncontrolled equipment). The difference between the evaluated emissions and the estimated baseline emissions that would have occurred without the program would then be the emissions impact from the program.

Methodology and assumptions need to be developed and reviewed to appropriately value the emissions reduction potential of demand flexibility of water heaters. The proposed evaluation plan aims to examine approaches, methodologies and tools to best assess and calculate reductions in criteria air pollutants.

5. Reducing GHG Emissions

The Energy Division asked SCE to provide estimated GHG emissions reductions for the combined appliance replacement[38] and load shifting activities that will occur with the program.

---

[38] SCE does not address this aspect of the question because it is not claiming benefits from equipment replacement.

- An uncontrolled HPWH in SCE territory might be expected to consume nearly ~~1,300~~1,133 kWh and ~~increase~~ produce GHG emissions ~~by~~ of ~~0.44~~0.49 Tons of CO2 for one year.[39]
- A HPWH controlled to pre heat water in advance of a 4PM to 9M peak TOU period would increase consumption to ~~1,450~~1,155 kWh but due to more optimal timing of emissions reduce annual grid emissions ~~by over 10 percent~~ to~~0.41~~ 0.47 Tons of CO2.
- Each controlled HPWH saves ~~0.03~~.02 Tons of CO2 compared to an uncontrolled heat pump water. For the ~~17,000~~13,600 controlled units in this ~~program~~ pilot, the total savings equal ~~510~~280 Tons of CO2.
- An uncontrolled Electric Resistance Water Heater (ERWH) in SCE territory is estimated to consume approximately 2,860 kWh and produce GHG emissions of 1.29 Tons of CO2 for one year.
- An ERWH controlled to pre-heat water in advance of a 4PM to 9M peak TOU period would increase consumption to 2,939 kWh but due to more optimal timing of emissions reduce annual grid emissions from 1.29 to 1.21 Tons of CO2.
- Each controlled ERWH saves 0.08 Tons of CO2 compared to an uncontrolled heat pump water. For the estimated 3,400 controlled ERWHs in this pilot, the total savings equal 278 Tons of CO2.

In summary, the total combined savings is equal to 558 Tons of CO2 for the proposed 17,000 controlled units under this pilot.

---

39 Based on ~~2019~~ 2020 ACC emissions and load shapes from SGIP HPWH calculator by Delforge et all using results from Kruis, N., Wilcox, B. Lutz, California Residential Domestic Hot Water Draw Profile Selection Methodology. May 18, 2016 (http://www.bwilcox.com/BEES/docs/Kruis%20-%20Dhw%20Analysis%205.docx) and Brockway A., Delforge P., Emissions Reduction Potential from Electric Heat Pumps in California Homes, The Electricity Journal 31 (2018).

6. **Cost-Effectiveness**

The Energy Division asked SCE to propose a cost-effectiveness metric for the program, explaining that cost-effectiveness evaluation could and should consider all program benefits in alignment with the goals of AB 2868 including: achieving ratepayer benefits, reducing dependence on petroleum, meeting air quality standards, and reducing GHG emissions, and instructing SCE to consider:

- avoided utility marginal costs savings achieved through energy efficiency upgrades;
- avoided utility marginal costs savings achieved through load shifting;
- overall customer bill savings from replacing electric resistance, natural gas and propane water heaters with HPWHs;
- the value of demand response capacity provided by the 5 MW;
- avoided criteria air pollution from load shifting;
- avoided criteria air pollution from decreased petroleum usage;
- avoided GHG emissions from electric resistance, natural gas and propane water heaters with SHPWHs;
- avoided GHG emissions from load shifting; and
- any possible ancillary services benefits;

SCE proposes the following cost-effectiveness metric as an initial approach that includes some of the key benefits of the pilot, but looks to the evaluation for the final, comprehensive assessment. Please see the following files in the Appendix that make up the cost-effectiveness analysis below:

- "SCE HPWH_Calcs_Controls_July24_2": Location of 8760 load shapes as explained in the "Notes" tab.
- "Bill_Model_SCE_HPWH_4": Annual bill savings calculator and summary results for uncontrolled and controlled Heat Pump Water Heater (HPWH) and Electric Resistance Water Heater (ERWH).
- "2020 ACC Electric Model v1c_SGIP WH Data Req": Cost-effectiveness summary using a slightly modified 2020 ACC v1c.

1. **Benefits (Lifecycle, TOU-PRIME)**: $23,788,563~~31,325,384~~:
    a. Ratepayer benefits (see previous question):
        i. Lifecycle: $8,851,173~~21,643,374~~
        ii. Up to 2027: $4,085,157~~10,492,909~~
    b. Bill savings (TOU-PRIME): $14,937,390~~9,682,010~~
        i. Lifecycle: For example, ~~T~~ the average annual bill savings ~~are $43.81 for low-rise multifamily and $57.42 for single family. To be conservative for this initial analysis, SCE will use the lower $43.81 bill savings.~~ for TOU-PRIME HPWH is $45.29. Over the 13 years of useful life of a HPWH,[40] the lifecycle bill savings are $588.77~~69.53~~ per unit. Please see the “2020 ACC Electric Model v1c_SGIP WH Data Req” file for a summary of the bill savings whether the customer chooses TOU-4-9 or TOU-PRIME for the mix of HPWH and ERWH. ~~For the 17,000 units in this pilot, the pilot’s total bill savings are $9,682,010.~~
        ii. Up to 2027: For the bill savings just from 2021-2027 (6 years) for the HPWH example above, the per unit total bill savings are $271.74~~62.86~~, and for the mix of HPWH and ERWH~~17,000~~ units in this pilot, the pilot’s total bill savings are $6,894,180~~4,468,620~~.
2. **Costs**: $13,992,500~~$14,492,500~~

[40] Mahone, Amber, et al. Residential Building Electrification in California. Energy and Environmental Economics, Inc. Apr. 2019. https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

Because the program incentivizes the total cost of the controls, and includes additional P4P incentives and admin, marketing, and other utility costs, the cost of this pilot is the cost component for total resource cost (TRC) and the program administrator cost (PAC).

3. Benefit / Cost Ratio

a. Over 13-year lifecycle of measures, TOU-PRIME: 1.70 ($23,788,563~~31,325,384~~ / $13,992,500~~4,492,500~~)

b. Over 13-year life cycle of measures, TOU-4-9: 1.05 ($14,655,075 / $13,992,500)

c. Over 6 years, TOU-PRIME (assume 2021-2027): 0.78~~1.03~~ (Ratepayer benefits of $4,085,157~~10,492,909~~ + bill savings of $6,894,180~~$4,468,620~~ = $10,979,337) ~~$14,961,529)~~ / $13,992,500~~4,492,500~~)

d. Over 6 years, TOU-4-9 (assume 2021-2027): 1.03 (Ratepayer benefits of $4,085,157 + bill savings of $2,678,724 = $6,763,881) / $13,992,500)

H. Bill Savings

The Energy Division asked SCE to provide an example of projected customer bill savings under each incentive option. SCE is amending its testimony to eliminate incentive option 1. SCE therefore refers to the P4P incentive customer eligibility and participation conditions discussed in III.D above.

I. Compliance with Decision 19-06-032

1. Ordering Paragraph 9:

Ordering Paragraph 9 of D.19-06-032 encourages SCE "to include, in a future Application, considerations of how its proposed projects will allow for support of the heat pump water heater component of their San Joaquin Valley pilot projects as defined in D.18-12-015."[41]

[41] D.19-06-032, p. 95.

The Energy Division asked SCE to refer to Advice Letter 3951-E-A and to explain how the approved program interacts with the projected SHPWH installations in the San Joaquin Valley pilot, and how the proposed SHPWH program is or is not appropriate participate in that pilot.

Participants of the San Joaquin Valley Pilots will be eligible to participle in the SHPWHP. However, there is currently no planned direct coordination or interaction with the SJV Pilots because SCE anticipates those projects will be completed by the time the SHPWHP is scheduled to begin deployment in late 2022.

2. Ordering Paragraph 12

Ordering Paragraph 12 provides that "[a]ny program or investment . . . pursuant to Assembly Bill 2868 that requires the participating customers to be on mandatory time of use rates must include in its implementation plan a clear explanation of what customer outreach the utility will conduct to ensure their customers understand how their rates will change and what the bill impact would have been based on historical usage." The Energy Division asked SCE to provide which residential TOU rate would be the default for the program and if small business customers participate, the TOU rate to which those customers would default. The Energy Division additionally asked if residential and/or small and medium sized business customers would be able to participate in other TOU rates, other than the default TOU rate, to maximize customer bill savings, such as SCE's TOU-Prime Rate.[42] SCE provided information that answers this question in section III.D above.

J. D.19-06-032 Appendix A

1. Cost-Effectiveness

Section (b) of Appendix A provides that "The IOUs shall identify expected revenue collected from energy storage resources participating in the CAISO market when

[42] SCE's TOU Prime rate encourages the enrollment of electrification technologies by offering economically incentivizing rate differentials. Link to SCE's TOU Prime Rate Fact sheet: https://www.sce.com/sites/default/files/inline-files/TOU-D-PRIME%20Fact%20Sheet_WCAG%20(1).pdf

calculating the cost effectiveness of energy storage resources."[43] The Energy Division therefore requested that SCE explain whether the SHPWHs enrolled in the program intend to participate in the CAISO market. SCE addresses this issue in Section III.G.6 above.

2. Multiple Use Applications

Appendix A Section 2e) states, "For any project that is proposed to provide multiple uses, the IOUs must adhere to the Commission's policy for multiple use application procurement, including D.18-01-003. Each IOU must include information in its Application regarding how the proposal adheres to the Commission's rules for multiple use application procurement."[44] The Energy Division asked SCE to provide a narrative that explains how the SHPWHs could be applied to more than one use application such as reliability needs and or defer distribution upgrades. Please see Section III.G for discussion of matters relating to these applications.

K. Assumptions Used to Set Capacity Target

The Energy Division asked SCE to provide an explanation of assumptions used to arrive at the proposed SHPWH program capacity target of 5 MW and noted that using the 0.28 kW peak load reduction from the WatterSaver AL-5731-E, staff calculated a peak load reduction of 4760 kW, not 5000 kW. Section III.A labeled Introduction and Objectives provides the relevant information.

---

[43] D.19-06-032 Appendix, p. 1-2.

[44] D.19-06-032 Appendix, p. 3.