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2022 Cost-Effectiveness Study: Existing Single Family Building Upgrades

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Legal Notice

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Acronym List

2023 PV$ – Present value costs in 2023

ACH50 – Air Changes per Hour at 50 pascals pressure differential

ACM – Alternative Calculation Method

ADU – Accessory Dwelling Unit

AFUE – Annual Fuel Utilization Efficiency

B/C – Lifecycle Benefit-to-Cost Ratio

BEopt – Building Energy Optimization Tool

BSC – Building Standards Commission

CA IOUs – California Investor-Owned Utilities

CASE – Codes and Standards Enhancement

CBECC-Res – Computer program developed by the California Energy Commission for use in demonstrating compliance with the California Residential Building Energy Efficiency Standards

CEER – Combined Energy Efficiency Rating

CFI – California Flexible Installation

CFM – Cubic Feet per Minute

CO_2 – Carbon Dioxide

CPAU – City of Palo Alto Utilities

CPUC – California Public Utilities Commission

CZ – California Climate Zone

DFHP – Dual Fuel Heat Pump

DHW – Domestic Hot Water

DOE – Department of Energy

DWHR – Drain Water Heat Recovery

EDR – Energy Design Rating

EER – Energy Efficiency Ratio

EF – Energy Factor

GHG – Greenhouse Gas

HERS Rater – Home Energy Rating System Rater

HPA – High Performance Attic

HPSH – Heat Pump Space Heater

HPWH – Heat Pump Water Heater

HSPF – Heating Seasonal Performance Factor

HVAC – Heating, Ventilation, and Air Conditioning

IECC – International Energy Conservation Code

IOU – Investor Owned Utility

kBtu –British thermal unit (x1000)

kWh – Kilowatt Hour

LBNL – *Lawrence Berkeley National Laboratory*

LCC – Life Cycle Cost

LLAHU – Low Leakage Air Handler Unit

VLLDCS – Verified Low Leakage Ducts in Conditioned Space

LSC – Long-term Systemwide Cost

MF – Multifamily

MSHP – Mini-Split Heat Pump

NEEA – Northwest Energy Efficiency Alliance

NEM – Net Energy Metering

NPV – Net Present Value

NREL – *National Renewable Energy Laboratory*

PG&E – Pacific Gas and Electric Company

POU – Publicly-Owned-Utilities

PV – Photovoltaic

SCE – Southern California Edison

SDG&E – San Diego Gas and Electric

SEER – Seasonal Energy Efficiency Ratio

SF – Single Family

SMUD – Sacramento Municipal Utility District

SoCalGas – Southern California Gas Company

TDV – Time Dependent Valuation

Therm – Unit for quantity of heat that equals 100,000 British thermal units

Title 24 – Title 24, Part 6

TOU – Time-Of-Use

UEF – Uniform Energy Factor

VCHP – Variable Capacity Heat Pump, Title 24 compliance credit

ZNE – Zero-net Energy

Summary of Revisions

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Executive Summary

The California Codes and Standards (C&S) Reach Codes program provides technical support to local governments considering adopting a local ordinance (reach code) intended to support meeting local and/or statewide energy efficiency and greenhouse gas (GHG) reduction goals. The program facilitates adoption and implementation of the code when requested by local jurisdictions by providing resources such as cost-effectiveness studies, model language, sample findings, and other supporting documentation.

This report documents cost-effective measure upgrades in existing single family buildings that exceed the minimum state requirements. It evaluates efficiency measures such as adding insulation, replacing windows, and duct upgrades, fuel substitution measures that upgrade space heating and water heating to heat pumps, and solar photovoltaics (PV) across all 16 California climate zones. A 1,665 square foot single family home prototype with an attached garage was evaluated in this study.

This analysis used two different metrics to assess the cost-effectiveness of the proposed upgrades. Both methodologies require estimating and quantifying the incremental costs and energy savings associated with each energy efficiency measure over a 30-year analysis period. On-Bill cost-effectiveness is a customer-based lifecycle cost (LCC) approach that values energy based upon estimated site energy usage and customer utility bill savings using today's electricity and natural gas utility tariffs. Long-term Systemwide Cost (LSC) is the California Energy Commission's LCC methodology for the 2025 Title 24, Part 6 (Title 24) code cycle (previously referred to as Time Dependent Valuation (TDV)), which is intended to capture the long-term projected cost of energy including costs for providing energy during peak periods of demand, carbon emissions, grid transmission and distribution impacts. This is the methodology used by the Energy Commission in evaluating cost-effectiveness for efficiency measures in Title 24 code development.

The following summarizes key results from the study:

<u>Conclusions and Discussion</u>:

1. Envelope measures. Improving envelope performance is very cost-effective in many older homes. In addition to reducing utility costs, these measures provide many other benefits such as improving occupant comfort and satisfaction and increasing a home's ability to maintain temperatures during extreme weather events and power outages. Below is a discussion of the results of specific measures.
    a. Adding attic insulation is cost-effective based on both LSC and On-Bill in many climate zones in homes with no more than R-19 existing attic insulation levels. Increasing attic insulation from R-30 to R-49 was still found to be cost-effective based on at least one metric in the colder and hotter climates of Climate Zone 10 (SDG&E territory only) through 16.
    b. Insulating existing uninsulated walls is very cost-effective based on both metrics everywhere except Climate Zones 6 and 7 (in Climate Zone 8 it's only cost-effective based on LSC).
    c. Adding R-19 or R-30 floor insulation is cost-effective based on LSC in the older two vintages (Pre-1978 and 1978-1991) in all CZ except CZ 6-10.
    d. Replacing old single pane windows with new high-performance windows has a very high cost and is typically not done for energy savings alone. However, energy savings are substantial and justify cost-effectiveness of this measure based on at least one metric in Climate Zones 4, 8 through 12 (PG&E territory only), and 13 through 16.
    e. At time of roof replacement, a cool roof with an aged solar reflectance of 0.25 was found to be cost-effective in Climate Zones 4, 6 through 12 (PG&E territory only), and 13 through 15. When the roof deck is replaced during a roof replacement, adding a radiant barrier is low cost and provides substantial cooling energy savings, and was found to be cost-effective in almost all climate zones and homes.
2. Duct measures: Many older homes have old, leaky duct systems that should be replaced when they reach the end of life, typically 20-30 years. In this case, installing new ducts was found to be cost-effective based on at least one metric (both in most cases) everywhere except mild Climate Zone 7 and Climate Zones 5 and 6 in

the 1978-1991 vintage. If duct systems still have remaining life they should be sealed and tested to meet 10% leakage or lower; however, duct upgrades alone were only found to be cost-effective for newer homes in Climate Zones 10 (SDG&E territory only), 11, and 13 through 16. Duct upgrades may be able to be coupled with other measures to reduce the cost.

3. Heat pump space heating: HPSHs were found to be LSC cost-effective in many cases. The Dual Fuel Heat Pump (existing furnace) was LSC cost-effective everywhere except Climate Zone 15. The HPSH was LSC cost-effective everywhere except Climate Zones 8 and 15.
    a. Challenges to On-Bill cost-effectiveness include higher first costs and higher first-year utility costs due to higher electricity tariffs relative to gas tariffs. SMUD and CPAU are two exceptions where first year utility costs are lower for heat pumps than for gas equipment. Table 11 shows the impact of utility rates on cost-effectiveness of HPSH where the standard and high efficiency HPSH and the HPSH + PV measures are cost-effective under SMUD but not PG&E. Even with higher first year utility bills, there were some cases that still proved On-Bill cost-effective including the DFHP with an existing furnace in the central valley and northern coastal PG&E territories, the ducted MSHP in the central valley as well as Climate Zone 14 in SDG&E territory, and the HPSH + PV measure in CZ 3-5 (PGE), 7-11, and 12 (SMUD) – 15.
    b. The ductless MSHPs were only found to be cost-effective based on either metric in Climate Zones 1 and 16. Ductless MSHPs have a high incremental cost because it is a more sophisticated system than the base model of a wall furnace with a window AC unit. However, the ductless MSHP would provide greater comfort benefits if properly installed to directly condition all habitable spaces (as is required under the VCHP compliance credit as evaluated in this study) which may be an incentive for a homeowner to upgrade their system.
    c. Higher efficiency equipment lowered utility costs in all cases and improved cost-effectiveness in many cases, particularly with a ducted MSHP.
4. Heat pump water heating: All the HPWH measures were LSC cost-effective in all climate zones. Most measures were not On-Bill cost-effective with the exception of the HPWH + PV which was cost-effective On-Bill in CPAU, SMUD, and SDG&E territories in addition to Climate Zones 11, 13, 14, and 15. The HPWH measures share many of the same challenges as the HPSH measures to achieving cost-effectiveness including high first costs and utility rates and assumptions. Table 13 shows the impact of utility rates on cost-effectiveness where some HPWH measures are cost-effective under SMUD utility rates but are not cost-effective anywhere under PG&E rates in Climate Zone 12.
    a. Various HPWH locations were also explored, however there are some factors outside of cost-effectiveness that should also be considered.
        i. HPWHs in the conditioned space can provide benefits such as free-cooling during the summer, reduced tank losses, and shorter pipe lengths, and in some cases show improved cost-effectiveness over garage located HPWHs. However, there are various design considerations such as noise, comfort concerns, an additional heating load in the winter, and condensate removal. Ducting the inlet and exhaust air resolves comfort concerns but adds costs and complexity. Split heat pump water heaters address these concerns, but currently there are limited products on the market and there is a cost premium relative to the packaged products.
        ii. Since HPWHs extract heat from the air and transfer it to water in the storage tank, they must have adequate ventilation to operate properly. Otherwise, the space cools down over time, impacting the HPWH operating efficiency. This is not a problem with garage installations but needs to be considered for water heaters located in interior or exterior closets. For the 2025 Title 24 code the CEC is proposing that all HPWH installations meet mandatory ventilation requirements (California Energy Commission, 2023).
5. The contractor surveys revealed overall higher heat pump costs than what has been found in previous analyses. This could be due to incentive availability raising demand for heat pumps and thereby increasing the price. This price increase may be temporary and may come down once the market stabilizes. There are also

new initiatives to obtain current costs including the TECH Clean California program[1] that publishes heat pump data and costs; however, at the time of this analysis, the TECH data did not contain incremental costs because it only had the heat pump costs but not the gas base case costs.

6. Table 18 shows how CARE rates and escalation rate assumptions will impact cost-effectiveness.
   a. Applying CARE rates in the IOU territories has the overall impact to increase utility cost savings for an all-electric building compared to a code compliant mixed fuel building, improving On-Bill cost-effectiveness. This is due to the CARE discount on electricity being higher than that on gas. The reverse occurs with efficiency measures where lower utility rates reduce savings and subsequently reduce cost-effectiveness.
   b. If gas tariffs are assumed to increase substantially over time, in-line with the escalation assumption from the 2025 LSC development, cost-effectiveness substantially improves for the heat pump measures over the 30-year analysis period and many cases become cost-effective that were not found to be cost-effective under the CPUC / 2022 TDV escalation scenario. There is much uncertainty surrounding future tariff structures as well as escalation values. While it's clear that gas rates will increase, how much and how quickly is not known. Future electricity tariff structures are expected to evolve over time, and the CPUC has an active proceeding to adopt an income-graduated fixed charge that benefits low-income customers and supports electrification measures for all customers.[2] The CPUC will make a decision in mid-2024 and the new rates are expected to be in place later that year or in 2025. While the anticipated impact of this rate change is lower volumetric electricity rates, the rate design is not finalized. While lower volumetric electricity rates provide many benefits, it also will make building efficiency measures harder to justify as cost-effective due to lower utility bill cost savings.
7. Under NBT, utility cost savings for PV are substantially less than what they were under prior net energy metering rules (NEM 2.0); however, savings are sufficient to be On-Bill cost-effective in all climate zones except Climate Zones 1 through 3, 5, and 6.
   a. Combining a heat pump with PV allows the additional electricity required by the heat pump to be offset by the PV system while also increasing on-site utilization of PV generation rather than exporting the electricity back to the grid at a low rate.
   b. While not evaluated in this study, coupling PV with battery systems can be very advantageous under NBT increasing utility cost savings because of improved on-site utilization of PV generation and fewer exports to the grid.

Recommendations:

1. There are various approaches for jurisdictions who are interested in reach codes for existing buildings. Some potential approaches are listed below along with key considerations.
   a. Prescriptive measures: Non-preempted measures that are found to be cost-effective may be prescriptively required in a reach code. One example of this type or ordinance is a cool roof requirement at time of roof replacement. Another example is requiring specific cost-effective measures for larger remodels, such as high-performance windows when new windows are installed or duct sealing and testing when ducts are in an unconditioned space.
   b. Replacement equipment: This flavor of reach code sets certain requirements at time of equipment replacement. This study evaluated space heating and water heating equipment. Where a heat pump measure was found to be cost-effective based on either LSC or On-Bill, this may serve as the basis of a reach code given the following considerations.
      i. Where reach codes reduce energy usage and are not just fuel switching, cost-effectiveness calculations are required and must be based on equipment that does not exceed the federal minimum efficiency requirements.
      ii. Where reach codes are established using cost-effectiveness based on LSC, utility bill impacts and the owner's first cost should also be reviewed and considered.

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[1] TECH Public Reporting Home Page (techcleanca.com)
[2] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-costs/demand-response-dr/demand-flexibility-rulemaking

   iii. A gas path should also be prescriptively allowed to safely satisfy federal preemption requirements considering the CRA v. Berkeley case.[3] Additional requirements may apply to the gas path, as described in Section 3.3, as long as the paths are reasonably energy or cost equivalent.

   c. "Flexible Path", minimum energy savings target: This flexible approach establishes a target for required energy savings based on a measure or a set of measures that were found to be cost-effective based on either LSC or On-Bill. A points menu compares various potential upgrades ranging from efficiency, PV, and fuel substitution measures, based on site or source energy savings. The applicant must select upgrades that individually or in combination meet the minimum energy savings target. The maximum target value shown in the Cost-effectiveness Explorer is based on a combination of cost-effective, non-preempted measures.

2. Equipment replacement ordinances should consider appropriate exceptions for scenarios where it will be challenging to meet the requirements, such as location of the HPWH, total project cost limitations, or the need for service panel upgrades that wouldn't have been required as part of the proposed scope of work in absence of the reach code.
3. Consider extending relevant proposals made by the CEC for the 2025 Title 24 code (California Energy Commission, 2023) in ordinances that apply under the 2022 Title 24 code, such as the following:
   a. Mandatory ventilation requirements for HPWH installations (Section 110.3(c)7). The cost-effectiveness analysis can be found in the Multifamily Domestic Hot Water CASE report (Statewide Team, 2023).
   b. Requirement for HERS verified refrigerant charge verification for heat pumps in all climate zones (Table 150.1-A[4]). The cost-effectiveness analysis can be found in the Residential HVAC Performance CASE report (Statewide Team, 2023).
4. When evaluating reach code strategies, the Reach Codes Team recommends that jurisdictions consider combined benefits of energy efficiency alongside electrification. Efficiency and electrification have symbiotic benefits and are both critical for decarbonization of buildings. As demand on the electric grid is increased through electrification, efficiency can reduce the negative impacts of additional electricity demand on the grid, reducing the need for increased generation and storage capacity, as well as the need to upgrade upstream transmission and distribution equipment.
5. Education and training can play a critical role in ensuring that heat pumps are installed, commissioned, and controlled properly to mitigate grid impacts and maximize occupant satisfaction. Below are select recommended strategies.
   a. The Quality Residential HVAC Services Program[5] is an incentive program to train California contractors in providing quality installation and maintenance while advancing energy-efficient technologies in the residential HVAC industry. Jurisdictions can market this to local contractors to increase the penetration of contractors skilled in heat pump design and installation.
   b. Educate residents and contractors of available incentives, tax credits, and financing opportunities.
   c. Educate contractors on code requirements. Energy Code Ace provides free tools, training, and resources to help Californians comply with the energy code. Contractors can access interactive compliance forms, fact sheets, and live and recorded trainings, among other things, on the website: https://energycodeace.com/. Jurisdictions can reach out to Energy Code Ace directly to discuss offerings.
6. Health and safety
   a. Combustion Appliance Safety and Indoor Air Quality: Implementation of some of the recommended measures will affect the pressure balance of the home which can subsequently impact the safe operation of existing combustion appliances as well as indoor air quality. Buildings with older gas appliances can present serious health and safety problems which may not be addressed in a remodel

[3] https://www.publichealthlawcenter.org/sites/default/files/2024-01/CRA-v-Berkeley-Ninth-Circuit-Opinion-Jan2024.pdf
[4] This requirement does not show up in the Express Terms for alterations in Section 150.2(b)1F, but the Statewide Reach Codes Team expects that it will be added to the next release of the proposed code language in the 45-day language as it aligns with the proposal made by the Codes and Standards Enhancement Team (Statewide CASE Team, 2023).
[5] https://qualityhvac.frontierenergy.com/

if the appliances are not being replaced. It is recommended that the building department require inspection and testing of all combustion appliances located within the pressure boundary of the building after completion of retrofit work that involves air sealing or insulation measures.

b. Jurisdictions may consider requiring mechanical ventilation in homes where air sealing has been conducted. In older buildings, outdoor air is typically introduced through leaks in the building envelope. After air sealing a building, it may be necessary to forcefully bring in fresh outdoor air using supply and/or exhaust fans to minimize potential issues associated with indoor air quality.

Local jurisdictions may also adopt ordinances that amend different Parts of the California Building Standards Code or may elect to amend other state or municipal codes. The decision regarding which code to amend will determine the specific requirements that must be followed for an ordinance to be legally enforceable. For example, reach codes that amend Part 6 of the CA Building Code and require energy performance beyond state code minimums must demonstrate the proposed changes are cost-effective and obtain approval from the Energy Commission as well as the Building Standards Commission (BSC). Amendments to Part 11, such as requirements for increased water efficiency or electric vehicle infrastructure only require BSC approval. Although a cost-effectiveness study is only required to amend Part 6 of the CA Building Code, this study provides valuable context for jurisdictions pursuing other ordinance paths to understand the economic impacts of any policy decision. This study documents the estimated costs, benefits, energy impacts and greenhouse gas emission reductions that may result from implementing an ordinance based on the results to help residents, local leadership, and other stakeholders make informed policy decisions.

This report documents the key results and conclusions from the Reach Codes Team analysis. A full dataset of all results can be downloaded at https://localenergycodes.com/content/resources. Results alongside policy options can also be explored using the Cost-effectiveness Explorer at https://explorer.localenergycodes.com/. Model ordinance language and other resources are posted on the C&S Reach Codes Program website at LocalEnergyCodes.com. Local jurisdictions that are considering adopting an ordinance may contact the program for further technical support at info@localenergycodes.com.

1 Introduction

This report documents cost-effective measure upgrades in existing single family buildings that exceed the minimum state requirements, the 2022 Building Energy Efficiency Standards, effective January 1, 2023. Local jurisdictions in California may consider adopting local energy ordinances to achieve energy savings beyond what will be accomplished by enforcing building efficiency requirements that apply statewide. This report was developed in coordination with the California Statewide Investor-Owned Utilities (IOUs) Codes and Standards Program, key consultants, and engaged cities—collectively known as the Statewide Reach Codes Team.

The focus of this study is on existing single family buildings and does not apply to low or high-rise multifamily buildings. Each jurisdiction must establish the appropriate structure and threshold for triggering the proposed requirements. Some common jurisdictional structures include triggering the requirements at major remodels, additions, or date-certain (upgrades must be completed by a specific date). Some of these measures could be triggered with a permit for another specific measure, such as a re-roofing project. The analysis includes scenarios of individual measures and identifies cost-effective options based on the existing conditions of the building in all 16 California Climate Zones (CZ) (see Cost-Effectiveness Results for a graphical depiction of climate zone locations).

This report documents the key results and conclusions from the Reach Codes Team analysis. A full dataset of all results can be downloaded at https://localenergycodes.com/content/resources. Results alongside policy options can also be explored using the Cost-effectiveness Explorer at https://explorer.localenergycodes.com/.

The California Codes and Standards (C&S) Reach Codes program provides technical support to local governments considering adopting a local ordinance (reach code) intended to support meeting local and/or statewide energy efficiency and greenhouse gas reduction goals. The program facilitates adoption and implementation of the code when requested by local jurisdictions by providing resources such as cost-effectiveness studies, model language, sample findings, and other supporting documentation.

The California Building Energy Efficiency Standards Title 24, Part 6 (Title 24) (CEC, 2019) is maintained and updated every three years by two state agencies: the California Energy Commission (the Energy Commission) and the Building Standards Commission (BSC). In addition to enforcing the code, local jurisdictions have the authority to adopt local energy efficiency ordinances—or reach codes—that exceed the minimum standards defined by Title 24 (as established by Public Resources Code Section 25402.1(h)2 and Section 10-106 of the Building Energy Efficiency Standards). Local jurisdictions must demonstrate that the requirements of the proposed ordinance are cost-effective and do not result in buildings consuming more energy than is permitted by Title 24. In addition, the jurisdiction must obtain approval from the Energy Commission and file the ordinance with the BSC for the ordinance to be legally enforceable.

The Department of Energy (DOE) sets minimum efficiency standards for equipment and appliances that are federally regulated under the National Appliance Energy Conservation Act, including heating, cooling, and water heating equipment (E-CFR, 2020). Since state and local governments are prohibited from adopting higher minimum efficiencies than the federal standards require, the focus of this study is to identify and evaluate cost-effective packages that do not include high efficiency heating, cooling, and water heating equipment. High efficiency appliances are often the easiest and most affordable measure to increase energy performance. While federal preemption limits reach code mandatory requirements for covered appliances, in practice, builders may install any package of compliant measures to achieve the performance requirements.

2 Methodology and Assumptions

2.1 Analysis for Reach Codes

This section describes the approach to calculating cost-effectiveness including benefits, costs, metrics, and utility rate selection.

2.1.1 Modeling

The Reach Codes Team performed energy simulations using the 2025 research version of the Residential California Building Energy Code Compliance software (CBECC). The 2025 version of CBECC was used instead of the 2022 version to take advantage of updated weather files and metrics. Site energy results are similar between CBECC-Res 2022 and 2025; however, the 2025 compliance metrics applies assumptions reflective of an electrified future, such as high escalation for natural gas retail rates, which favors electric buildings. In addition, in 2025 the weather stations were changed in Climate Zones 4 and 6 from San Jose to Paso Robles and Torrance to Los Angeles International Airport, respectively.

Three unique building vintages are considered: pre-1978, 1978-1991, and 1992-2010. The vintages were defined based on review of historic Title 24 code requirements and defining periods with distinguishing features. Prospective energy efficiency measures were identified and modeled to determine the projected site energy (therm and kWh), source energy, GHG emissions, and LSC (long-term systemwide cost) impacts. Annual utility costs were calculated using hourly data output from CBECC, and current (as of 11/01/2023) electricity and natural gas tariffs for each of the investor-owned utilities (IOUs) appropriate for that climate zone.

Equivalent CO_2 emission reductions were calculated based on outputs from the CBECC-Res simulation software. Electricity emissions vary by region and by hour of the year. CBECC-Res applies two distinct hourly profiles, one for Climate Zones 1 through 5 and 11 through 13 and another for Climate Zones 6 through 10 and 14 through 16. Natural gas emissions do not vary hourly. To compare the mixed-fuel and all-electric cases side-by-side, GHG emissions are presented as lbs CO_2-equivalent (CO_2e) emissions.

The Statewide Reach Codes Team designed the analysis approach and selected measures for evaluation based on the 2019 existing building single family reach code analysis (Statewide Reach Codes Team, 2021) and work to support the 2025 Title 24 code development cycle as well as from outreach to architects, builders, and engineers.

2.1.2 Prototype Characteristics

The Energy Commission defines building prototypes which it uses to evaluate the cost-effectiveness of proposed changes to Title 24 requirements. Average home size has steadily increased over time,[6] and the Energy Commission single family new construction prototypes are larger than many existing single family homes across California. For this analysis, a 1,665 square foot prototype was evaluated. Table 1 describes the basic characteristics of the single family prototype. Additions are not evaluated in this analysis as they are already addressed in Section 150.2 of Title 24, Part 6. The CEC has proposed changes to the 2025 Energy Code that would remove the allowance of gas space heating and water heating equipment for additions and instead require additions to follow the same space heating and water heating equipment requirements as new construction (California Energy Commission, 2023). The proposed prescriptive requirements for single family new construction homes are heat pump space heaters and water heaters, with gas equipment only allowed in the performance approach.

[6] https://www.census.gov/const/C25Ann/sftotalmedavgsqft.pdf

Table 1. Prototype Characteristics

	Specification
Existing Conditioned Floor Area	1,665 ft^2
Num. of Stories	1
Num. of Bedrooms	3
Window-to-Floor Area Ratio	13%
Attached Garage	2-car garage

Three building vintages were evaluated to determine sensitivity of existing building performance on cost-effectiveness of upgrades. For example, it is widely recognized that adding attic insulation in an older home with no insulation is cost-effective, however, newer homes will likely have existing attic insulation reducing the cost-effectiveness of an incremental addition of insulation. The building characteristics for each vintage were determined based on either prescriptive requirements from Title 24 that were in effect or standard construction practice during that time period. Homes built under 2001 Title 24 are subject to prescriptive envelope code requirements very similar to homes built under the 2005 code cycle, which was in effect until January 1, 2010.

Table 2 summarizes the assumptions for each of the three vintages. Additionally, the analysis assumed the following features when modeling the prototype buildings. Efficiencies were defined by year of the most recent equipment replacement based on standard equipment lifetimes.

- Individual space conditioning and water heating systems, one per single family building.
- Split-system air conditioner with natural gas furnace.
    - Scenarios with an existing natural gas wall furnace without AC were also evaluated.
- Small storage natural gas water heater.
    - Scenarios with an existing electric resistance storage water heater were also evaluated.
- Gas cooktop, oven, and clothes dryer.

The methodology applied in the analyses begins with a design that matches the specifications as described in Table 2 for each of the three vintages. Prospective energy efficiency measures were modeled to determine the projected energy performance and utility cost impacts relative to the baseline vintage. In some cases, where logical, measures were packaged together.

Table 2. Efficiency Characteristics for Three Vintage Cases

Building Component Efficiency Feature	Vintage Case		
	Pre-1978	1978-1991	1992-2010
Envelope			
Exterior Walls	2x4, 16-inch on center wood frame, R-0[a]	2x4 16 inch on center wood frame, R-11	2x4 16 inch on center wood frame, R-13
Foundation Type & Insulation	Uninsulated slab (CZ 2-15) Raised floor, R-0 (CZ 1 & 16)	Uninsulated slab (CZ 2-15) Raised floor, R-0 (CZ 1 & 16)	Uninsulated slab (CZ 2-15) Raised floor, R-19 (CZ 1 & 16)
Ceiling Insulation & Attic Type	Vented attic, R-5 @ ceiling level for CZ 6 & 7, Vented attic, R-11 @ ceiling level (all other CZs)	Vented attic, R-19 @ ceiling level	Vented attic, R-30 @ ceiling level
Roofing Material & Color	Asphalt shingles, dark (0.10 reflectance, 0.85 emittance)	Asphalt shingles, dark (0.10 reflectance, 0.85 emittance)	Asphalt shingles, dark (0.10 reflectance, 0.85 emittance)
Radiant Barrier	No	No	No
Window Type: U-factor/SHGC[b]	Metal, single pane: 1.16/0.76	Metal, dual pane: 0.79/0.70	Vinyl, dual pane Low-E: 0.55/0.40
House Infiltration at 50 Pascals	15 ACH50	10 ACH50	7 ACH50
HVAC Equipment			
Heating Efficiency	78 AFUE (assumes 2 replacements)	78 AFUE (assumes 1 replacement)	78 AFUE
Cooling Efficiency	10 SEER (assumes 2 replacements)	10 SEER (assumes 1 replacement)	13 SEER, 11 EER
Duct Location & Details	Attic, R-2.1, 30% leakage at 25 Pa	Attic, R-2.1, 25% leakage at 25 Pa	Attic, R-4.2, 15% leakage at 25 Pa
Whole Building Mechanical Ventilation	None	None	None
Water Heating Equipment			
Water Heater Efficiency	0.575 Energy Factor (assumes 2 replacements)	0.575 Energy Factor (assumes 1 replacement)	0.575 Energy Factor
Water Heater Type	40-gallon gas storage	40-gallon gas storage	40-gallon gas storage
Pipe Insulation	None	None	None
Hot Water Fixtures	Standard, non-low flow	Standard, non-low flow	Standard, non-low flow

[a] Pre-1978 wall modeled with R-5 cavity insulation to better align wall system performance with monitored field data and not overestimate energy use.

[b] Window type selections were made based on conversations with window industry expert, Ken Nittler. If a technology was entering the market during the time period (e.g., Low-E during 1992-2010 or dual-pane during 1978-1991) that technology was included in the analysis. This provides a conservative assumption for overall building performance and additional measures may be cost-effective for buildings with lower performing windows, for example buildings with metal single pane windows in the 1978-1991 vintage.

2.1.3 Cost-Effectiveness Approach

2.1.3.1 Benefits

This analysis used two different metrics to assess the cost-effectiveness of the proposed upgrades. Both methodologies require estimating and quantifying the incremental costs and energy savings associated with each energy efficiency measure. The main difference between the methodologies is the way they value energy impacts (the numerator in the benefit cost calculation):

Utility Bill Impacts (On-Bill): This customer-based lifecycle cost (LCC) approach values energy based upon estimated site energy usage and customer utility bill savings using the latest electricity and natural gas utility tariffs available at the time of writing this report. Total savings are estimated over a 30-year duration and include discounting of future utility costs, as well as assumed energy cost inflation over time.

Long-term Systemwide Cost (LSC): Formerly known as Time Dependent Valuation (TDV) energy cost savings, LSC reflects the Energy Commission's current LCC methodology, which is intended to capture the total value or cost of energy use over 30 years. This method accounts for the hourly cost of marginal generation, transmission and distribution, fuel, capacity, losses, and cap-and-trade-based CO2 emissions (California Energy Commission, 2023). This is the methodology used by the Energy Commission in evaluating cost-effectiveness for efficiency measures in the 2025 Energy Code.

2.1.3.2 Costs

The Reach Codes Team assessed the incremental costs of the measures and packages over a 30-year analysis period. Incremental costs represent the equipment, installation, replacement, and maintenance costs of the proposed measure relative to the 2022 Title 24 Standards minimum requirements or standard industry practices. Present value of replacement cost is included only for measures with lifetimes less than the 30-year evaluation period. In cases where at the end of the analysis period the measure has useful life remaining, the value of this remaining life is calculated and credited in the total lifetime cost.

2.1.3.3 Metrics

Cost-effectiveness is presented using net present value (NPV) and benefit-to-cost (B/C) ratio metrics.

NPV: Equation 1 demonstrates how lifetime NPV is calculated. If the NPV of a measure or package is positive, it is considered cost-effective. A negative value represents a net increase in costs over the 30-year lifetime.

B/C Ratio: This is the ratio of the present value of all benefits to the present value of all costs over 30 years (present value benefits divided by present value costs). A value of one indicates the NPV of the savings over the life of the measure is equivalent to the NPV of the lifetime incremental cost of that measure. A value greater than one represents a positive return on investment. The B/C ratio is calculated according to Equation 2.

Equation 1

$$NPV = present\ value\ of\ lifetime\ benefit - present\ value\ of\ lifetime\ cost$$

Equation 2

$$Benefit - to - Cost\ Ratio = \frac{present\ value\ of\ lifetime\ benefit}{present\ value\ of\ lifetime\ cost}$$

Improving the efficiency of a project often requires an initial incremental investment. In most cases the benefit is represented by annual On-Bill utility or LSC savings, and the cost is represented by incremental first cost and future replacement costs. Some packages result in initial construction cost savings relative to the assumed base case scenario, and either energy cost savings (positive benefits), or increased energy costs (negative benefits). In cases where both construction costs and energy-related savings are negative, the construction cost savings are treated as the 'benefit' while the increased energy costs are the 'cost.' In cases where a measure or package is cost-effective immediately (i.e., upfront construction cost savings and lifetime energy cost savings), B/C ratio cost-effectiveness is represented by ">1".

The lifetime costs or benefits are calculated according to Equation 3.

Equation 3

$$Present\ value\ of\ lifetime\ cost\ or\ benefit = \sum_{t=0}^{n} \frac{(Annual\ cost\ or\ benefit)_t}{(1+r)^t}$$

Where:

1. n = analysis term in years
2. r = discount rate

The following summarizes the assumptions applied in this analysis to both methodologies.

3. Analysis term of 30 years
4. Real discount rate of three percent

Both base case measures and alternative energy efficiency measures may have different lifetime assumptions which impact life cycle economics. Future costing of many of the evaluated electrification measures are only based on current cost assumption, which may be overly conservative as the expected growth in heat pump-based technologies is growing rapidly and will likely lead to future cost reductions (at least relative to current fossil fueled equipment) as production volumes increase.

2.1.4 Utility Rates

In coordination with the CA IOU rate team (comprised of representatives from Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E)) and two Publicly-Owned-Utilities (POUs) (Sacramento Municipal Utility District (SMUD) and City of Palo Alto Utilities (CPAU)), the Reach Codes Team determined appropriate utility rates for each climate zone to calculate utility costs and determine On-Bill cost-effectiveness for the proposed measures and packages. The utility tariffs, summarized in Chapter 6.2, were determined based on the appropriate rate for each case in each territory. Utility rates were applied to each climate zone based on the predominant IOU serving the population of each zone, with a few climate zones evaluated multiple times under different utility scenarios. Climate Zones 10 and 14 were evaluated with both SCE for electricity and Southern California Gas Company (SoCalGas) for gas and SDG&E tariffs for both electricity and gas since each utility has customers within these climate zones. Climate Zone 5 is evaluated under both PG&E and SoCalGas natural gas rates. Two POU or municipal utility rates were also evaluated: SMUD in Climate Zone 12 and CPAU in Climate Zone 4.

For cases with onsite generation (i.e. solar photovoltaics (PV)), the approved NBT tariffs were applied along with monthly service fees and hourly export compensation rates for 2024.[7] In December 2022, the California Public Utilities Commission (CPUC) issued a decision adopting NBT as a successor to NEM 2.0 that went into effect April of 2023[8].

Utility rates are assumed to escalate over time according to the assumptions from the CPUC 2021 En Banc hearings on utility costs through 2030 (California Public Utilities Commission, 2021a). Escalation rates through the remainder of the 30-year evaluation period are based on the escalation rate assumptions within the 2022 TDV factors. The Statewide Natural Gas Residential Average Rate for 2023 through 2030 is projected to be 4.6%. The Electric Residential Average Rate for PG&E, SCE and SDG&E for 2023 through 2030 is projected to be 1.8%,1.6% and 2.8% respectively. A second set of escalation rates were also evaluated to demonstrate the impact that utility cost changes have on cost-effectiveness over time. This utility rate escalation sensitivity analysis, presented in Section 3.2.4, was based on those used within the 2025 LSC factors (LSC replaces TDV in the 2025 code cycle) which assumed steep

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[7] Hourly export compensation rates were based on the NBT spreadsheet model created by E3 for the CPUC. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/net-energy-metering-nem/nemrevisit/nbt-model--12142022.xlsb

[8] https://www.cpuc.ca.gov/nemrevisit

increases in gas rates in the latter half of the analysis period. See Appendix 6.2.7 Fuel Escalation Assumptions for details.

Future electricity tariff structures are expected to evolve over time, and the CPUC has an active proceeding to adopt an income-graduated fixed charge that benefits low-income customers and supports electrification measures.[10] These were not included in this analysis but may be evaluated later in 2024 once the rates are finalized.

2.1.5 Measure Cost Data Collection Approach

To support this effort, a detailed cost study was completed in the summer of 2023 to gather data from a range of contractors to inform actual installed costs in the areas they provide services. These areas include HVAC, plumbing, envelope and air-sealing, and PV installation. Home performance contractors were also approached to collect this data. Collecting this type of data is challenging, both due to contractor reticence to share cost information and due to the timing of the survey which unfortunately coincided with the summer busy season for most contractors, especially HVAC installers. With these known challenges, the outreach effort focused on leveraging existing relationships between the analysis team and contractors to both gain access and provide assurance that all cost data would remain confidential and aggregated. Contractors that provided feedback were nominally compensated for their time.

The collected cost data was intended to represent recent costs for a “typical” retrofit installation. Each home in which a contractor does work has different site-specific issues that will likely affect costs. In addition, different jurisdictions have different levels of building department installation oversight and permit fees. Finally, each contractor typically has a different manufacturer product line they prefer to install. All these factors will influence installed costs[11].

The most detailed and broad cost request was for the HVAC contractors, as there are a wide range of equipment replacement scenarios available for an existing ducted gas furnace with central split-system air conditioning. Options range from a base case scenario (like for like swap out), split-system heat pump replacement, dual fuel heat pumps (DFHP), ducted mini-split heat pumps, non-ducted mini-splits, etc. For plumbing contractors, a range of scenarios existed for water heater replacements including like-for-like replacement, HPWHs (in different locations- garage, indoor), need for electrical upgrade for HPWH installation, need for HPWH ducting, etc. Envelope measures focused on attic and wall insulation, window replacement, re-roofing (with Cool Roof materials or not), and attic ceiling plane air-sealing. PV costing included different system sizes, panel upgrades costs, and battery costs. Home performance contractors were asked to provide as much data as they could on the different measure options. All costing information requested was intended to represent most recent installations, in an effort to capture current pricing as best as possible.

The contractors that responded with their cost estimates work in different regions of the state, operate in different markets with (potentially) different local efficiency incentives, do varying amounts of work based on the size of their company, target different market demographic sectors, and install different brands of equipment. All these factors will contribute to price variability. The Team considered applying climate zone specific cost adjustments to reflect some of these differences, but ultimately decided not to since a climate zone is not a monolithic entity with uniform customer pricing throughout. The Team recognizes that “zip code” pricing is a reality, but for simplicity, as well as consistency with Title 24, Part 6 code development costing approaches, applied uniform statewide costs to all measures.

2.2 Measure Details and Cost

This section describes the details of the measures and documents incremental costs. All measure costs were obtained from the contractor survey unless otherwise noted. All contractor provided costs reflect the cost to the customer and

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[10] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-costs/demand-response-dr/demand-flexibility-rulemaking

[11] One HVAC contractor mentioned that equipment brand alone may contribute to a +/-%5 variation in the total bid cost.

include equipment, labor, permit fees, and required HERS testing. Additional details of the measures can be found in Appendix Section **Error! Reference source not found.**.

All measures are evaluated assuming they are not otherwise required by Title 24. For example, duct sealing is required by code whenever HVAC equipment is altered. For this analysis duct sealing was evaluated for those projects where it is not already triggered by code (i.e., no changes to the heating or cooling equipment). Where appropriate, measure requirements align with those defined in Title 24. In some cases, cost-effective measures were identified that exceed Title 24 requirements, such as attic insulation, cool roofs, and duct sealing.

2.2.1 Building Envelope & Duct Measures

The following are descriptions of each of the efficiency upgrade measures applied in this analysis.

Attic Insulation: Add attic insulation in buildings with vented attic spaces to meet either R-38 or R-49. The pre-1978 vintage assumes an existing condition of R-11, the 1978-1991 vintage assumes an existing condition of R-19, and the 1992-2010 vintage assumes R-30 as the existing insulation level. For pre-1978 vintage homes this measure was also evaluated to include air sealing of the attic. A 14% leakage reduction was modeled such that 15 ACH50 was reduced to 12.9 ACH50 in this measure. The costs for this measure include removing existing insulation.

Air Sealing and Weather-stripping: Apply air sealing practices throughout all accessible areas of the building. For this study, it was assumed that older vintage homes would be leakier than newer buildings and that approximately 30 percent improvement in air leakage is achievable through air sealing of all accessible areas. For modeling purposes, it was assumed that air sealing can reduce infiltration levels from 15 to ten air changes per hour at 50 Pascals pressure difference (ACH50) in the oldest vintages (pre-1978), to ten to seven ACH50 for the 1978-1991 vintage, and seven to five ACH50 in the 1992-2010 vintage.

Cool Roof: For steep slope roofs, install a roofing product rated by the Cool Roof Rating Council (CRRC) with an aged solar reflectance of 0.20 or 0.25 and thermal emittance of 0.75 or higher. This measure only applies to buildings that are installing a new roof as part of the scope of the remodel; the cost and energy savings associated with this upgrade reflects the incremental step between a standard roofing product with one that is CRRC rated with an aged solar reflectance of 0.20 or 0.25. This is similar to cool roof requirements in 2022 Title 24 Section 150.2(b)1Ii but assumes a higher solar reflectance.

Radiant Barrier: Add radiant barrier to any existing home vintage. This measure only applies to buildings that are installing a new roof as part of the scope of the remodel; the cost and energy savings associated with this upgrade reflects the incremental step between a standard roofing product with one that includes a laminated radiant barrier.

Raised Floor Insulation: In existing homes with raised floors and no insulation (pre-1978 and 1978-1991 vintages), add R-19 insulation. An upgraded R-30 floor insulation, assuming no current insulation, was evaluated in the pre-1978 and 1978-1991 vintages.

Wall Insulation: Blow-in R-13 wall insulation in existing homes without wall insulation (pre-1978 vintages).

Window Replacement: Replace existing windows with a non-metal dual-pane product, which has a U-factor equal to 0.28 Btu/hour-ft^2-°F or lower and a Solar Heat Gain Coefficient (SHGC) equal to 0.23 or lower, except in heating dominated climates (Climate Zones 1, 3, 5, and 16) where an SHGC of 0.35 was evaluated.

Duct Sealing, New Ducts, and Duct Insulation: Air seal all ductwork to meet the requirements of the 2022 Title 24, Part 6 Section 150.2(b)1E. For this analysis, final duct leakage values of ten percent (proposed revised leakage rate for 2022 Title 24) was evaluated. The pre-1978 and 1978-1992 vintages assume leaky existing ducts (25-30% leakage). The 1992-2010 vintage assumes moderately leaky existing ducts (15-20% leakage).

Replacing existing ductwork with entirely new ductwork to meet Sections 150.2(b)1Di and 150.2(b)1Diia of the 2022 Title 24 was also evaluated. This assumed new ducts meet 5% duct leakage and the option of R-6 and R-8 duct insulation in all climate zones.

Table 3 summarizes the cost assumptions for the building envelope and HVAC duct improvement measures evaluated. All the measures in Table 3 assume a 30-year effective useful life.

Table 3. Measure Cost Assumptions – Efficiency & Duct Measures

Measure	Performance Level	Incremental Cost – Single Family Building		
		Pre 1978	1978 – 1991	1992 - 2010
Wall Insulation	R-13	$2,950	N/A	N/A
Raised Floor Insulation	R-19	$3,633	$3,633	N/A
	R-30	$4,113	$4,113	$4,113
Attic Insulation	R-38	$6,762	$2,555	$1,781
	R-49	$7,446	$3,612	$1,827
Air Sealing	10 ACH50	$4,684	N/A	N/A
	7 ACH50	N/A	$4,684	N/A
	5 ACH50	N/A	N/A	$4,684
Cool Roof	0.25 Aged Solar Reflectance CZs 1-3,5-7,16	$2,407	$2,407	$2,407
	0.25 Aged Solar Reflectance CZs 4, 8-15	$1,203	$1,203	$1,203
Window U-factor/SHGC	0.28 U-factor. 0.23 SHGC in CZs 2,4,6-15.	$11,463	$11,463	$11,463
	0.28 U-factor. 0.35 SHGC in CZs 1,3,5,26	$11,871	$11,871	$11,871
Radiant Barrier	Add Radiant Barrier	$893	$893	$893
Duct Sealing	10% nominal airflow	$2,590	$2,590	$1,400
All New Duct System	R-6 ducts; 5% duct leakage	$4,808	$4,808	$4,808
	R-8 ducts; 5% duct leakage	$6,311	$6,311	$6,311

2.2.2 PV Measures

Installation of on-site PV is required in the 2022 Title 24 code for new construction homes, but there are no PV requirements for additions or alterations to existing buildings. PV was evaluated in CBECC-Res according to the California Flexible Installation (CFI) 1 assumptions and 98% solar access. To meet CFI eligibility, the requirements of 2022 Reference Appendices JA11.2.2 (California Energy Commission, 2021b) must be met. A 3 kW PV system was modeled both as a standalone measure as well as coupled with heat pump installations.

The costs for installing PV are summarized in Table 4. They include the first cost to purchase and install the system, future inverter replacement costs, and annual maintenance costs. Upfront solar PV system costs are estimated from the contractor surveys to be $4.58/$W_{DC}$ and are reduced by 30 percent to account for the federal income Residential Clean Energy Credit. The solar panels are estimated to have an effective useful life of 30 years and the inverter 25 years. The inverter replacement cost of $7,000 (future value) is also from the contractor surveys. System maintenance costs are taken from the 2019 PV CASE Report (California Energy Commission, 2017) and are assumed to be

$0.31/W_{DC}$ present value. These costs do not include costs associated with electrical panel upgrades, which will be necessary in some instances.

Table 4. Measure Descriptions & Cost Assumptions – PV

Measure	Performance Level	Incremental Cost		
		Pre 1978	1978 – 1991	1992 - 2010
PV	3 kW	$9,608		

2.2.3 Equipment Fuel Substitution Measures – Heat Pump Equipment

The fuel substitution measures are evaluated as replacements at the end of the life of the existing equipment. This means the baseline compared against is usually a like-for-like change-out of the natural gas equipment, and the upgrade is a heat pump.

For most of the space heating and water heating cases, costs for electrical service panel upgrades are not included as it is assumed many existing homes have the service capacity to support converting one appliance from gas to electric. For homes with existing air conditioners, any incremental electric capacity necessary to support a heat pump space heater is marginal. The same applies for homes with existing electric resistance equipment. Section 3.2.4 presents the impacts for select cases where an upgrade to the electric panel is required.

Heat Pump Space Heating

All the heat pump space heater (HPSH) measures are described below. All were evaluated with HERS verified refrigerant charge aligned with the proposed code requirements for the 2025 Title 24 code. Dual fuel heat pumps (DFHPs) were controlled to lockout furnace operation above 35°F.

DFHP (Existing Furnace): Replace existing ducted air conditioner (AC) with an electric heat pump and install controls to operate the heat pump to use the existing gas furnace for backup heat. A minimum federal efficiency (14.3 SEER2, 11.7 EER2, 7.5 HSPF2) heat pump was evaluated. Savings are compared to a new AC (14.3 SEER2, 11.7 EER2) alongside the existing furnace (78 AFUE).

DFHP (New Furnace): Replace existing ducted AC and natural gas furnace with an electric heat pump and new gas furnace plus controls to operate the heat pump and use the new gas furnace for backup heat. A minimum federal efficiency (14.3 SEER2, 11.7 EER2, 7.5 HSPF2) heat pump and furnace (80 AFUE) were evaluated to replace existing equipment. Savings are compared to a new ducted AC and natural gas furnace (14.3 SEER2, 11.7 EER2, 80 AFUE).

Heat Pump Space Heater: Replace existing ducted AC and natural gas furnace with an electric heat pump. Minimum federal efficiency (14.3 SEER2, 11.7 EER2, 7.5 HSPF2) and higher efficiency (17 SEER2, 12.48 EER2, 9.5 HSPF2) heat pumps were evaluated. Savings are compared to a new ducted natural gas furnace and AC (14.3 SEER2, 11.7 EER2, 80 AFUE).

Ducted Mini-Split Heat Pump (MSHP): Replace existing ducted AC and natural gas furnace with a ducted high efficiency MSHP (16.5 SEER2, 12.48 EER2, 9.5 HSPF2). Savings are compared to a new ducted AC and natural gas furnace (14.3 SEER2, 11.7 EER2, 80 AFUE).

Ductless MSHP: In a home without AC, replace existing wall furnace with a ductless MSHP. A standard efficiency unit meeting minimum federal efficiency standards (14.3 SEER2, 11.7 EER2, 7.5 HSPF2) was evaluated by modeling the variable capacity heat pump (VCHP) compliance credit in CBECC-Res. A premium, higher efficiency upgrade was also evaluated using CBECC-Res' detailed VCHP model[12] by simulating the performance of a representative high efficiency product (14.3 SEER2, 11.7 EER2, 7.5 HSPF2). Savings are compared to a new natural gas wall furnace with fan distribution (75% AFUE) and window AC (9 CEER).

Over the 30-year analysis period, certain changes are assumed when the equipment is replaced that impact both lifetime costs and energy use. Table 5 presents the lifetime scenario for the DFHP (existing furnace) measure. The analysis assumed a 20-year effective useful lifetime (EUL) for a furnace, a 15-year EUL for an air conditioner and a 15-year EUL for a heat pump. Lifetimes are based on the Database for Energy Efficient Resources (DEER) (California Public Utilities Commission, 2021b). The existing furnace is assumed to be halfway through its EUL at the beginning of the analysis period. After 10 years when the furnace reaches the end of its life and needs to be replaced, it will be subject to new federal efficiency standards for residential gas furnaces that go into effect in 2028 requiring 95 AFUE[13]. 5 years later the air conditioner reaches the end of its life and is replaced with a new air conditioner.

For the DFHP upgrade case, after 10 years when the furnace fails it's expected that the furnace will be abandoned in place since the heat pump serves primary heating and was sized to provide the full design heating load. In this case it is assumed that the fan motor would be replaced with a new aftermarket unit and would operate another 5 years until the heat pump fails and is replaced with a new heat pump and air handler.

The other ducted heat pump cases similarly apply a 95 AFUE furnace in the baseline when the furnace reaches its EUL after 20 years.

Table 5. Lifetime Analysis Replacement Assumptions for DFHP (Existing Furnace) Scenario

Year	Baseline	Upgrade
0	AC fails, install new AC, keep existing furnace	AC fails, install new HP, keep existing furnace
10	Furnace fails, install new 95AFUE furnace	Furnace fails, replace fan motor
15	AC fails, install new AC	HP fails, install new HP and air handler

Costs were applied based on the system capacity from heating and cooling load calculations in CBECC-Res as presented in Table 6. Air conditioner nominal capacity was calculated as the CBECC-Res cooling load, rounded up to the nearest half ton. Heat pump nominal capacity was calculated as the maximum of either the CBECC-Res heating or cooling load, rounded up to the nearest half ton. In both cases a minimum capacity of 1.5-ton was applied as this represents the typical smallest available split system heat pump equipment. Load calculations demonstrated that Climate Zones 2 - 15 were cooling-dominated while Climate Zones 1 and 16 were heating-dominated. In the heating dominated climate zones the heat pump needed to be upsized relative to an air conditioner that only provides cooling.

[12] The detailed VCHP option allows for the user to input detailed specifications based on the published National Energy Efficiency Partnership (NEEP) manufacturer specific performance data. It is not currently available for compliance analysis.

[13] https://www.energy.gov/articles/doe-finalizes-energy-efficiency-standards-residential-furnaces-save-americans-15-billion#:~:text=These%20furnace%20efficiency%20standards%20were,heat%20for%20the%20living%20space.

Table 6. System Sizing by Climate Zone

Climate Zone	Air Conditioner Capacity (tons)	Heat Pump Capacity (tons)
1	1.5	3.0
2	3.5	3.5
3	2.5	2.5
4	3.5	3.5
5	3.0	3.0
6	3.0	3.0
7	3.0	3.0
8	4.0	4.0
9	4.0	4.0
10	4.0	4.0
11	4.5	4.5
12	4.0	4.0
13	4.5	4.5
14	4.0	4.0
15	5.0	5.0
16	3.5	4.0

Table 7 presents estimated first and lifetime costs for the various ducted baseline and heat pump scenarios for 4-ton equipment. Costs include all material and installation labor including providing new 240 V electrical service to the air handler location for all new air handler installations and decommissioning of the furnace for the cases where the furnace is removed. DFHP costs incorporate controls installation and commissioning to ensure the heat pump and the furnace communicate properly and don’t operate at the same time. Future replacement costs do not include any initial costs associated with 240V electrical service or furnace decommissioning.

Table 8 presents estimated first and lifetime costs for the ductless baseline and 2 heat pump scenarios, also for 4-ton heat pump equipment. EULs are based on 20 years for the gas wall furnace, 10 years for the window AC, and 15 years for the heat pump.[14]

[14] The gas wall furnace and heat pump EULs were based on DEER (California Public Utilities Commission, 2021b). Gas wall furnace lifetime was assumed to be the same as for central gas furnace equipment. Room air conditioner EUL was based on the DOE’s latest rulemaking for room air conditioned (Department of Energy, 2023). DOE determined an average lifetime of 9.3 years, which was rounded up to 10 years for this analysis.

Table 7. Ducted HVAC Measure Cost Assumptions – 4-Ton Electric Replacements

Case	AC + Coil	Gas Furnace /AC	DFHP (Existing Furnace)	DFHP (New Furnace)	Min. Eff. Heat Pump	High Eff. Heat Pump	Ducted MSHP
Base Case	-	-	AC + Coil	Gas Furnace /AC	Gas Furnace /AC	Gas Furnace /AC	Gas Furnace /AC
First Cost	$10,402	$16,653	$12,362	$20,676	$17,825	$20,802	$18,075
Replacement Cost (Future Value)	$19,365	$19,365	$19,025	$19,025	$16,825	$19,802	$18,075
Replacement Cost (Present Value)	$13,346	$11,639	$12,334	$12,897	$10,800	$12,710	$11,601
Remaining Value at Year 30	$0	($1,846)	$0	($1,846)	$0	$0	$0
Total Lifecycle Cost	$23,748	$26,446	$24,696	$31,727	$28,625	$33,512	$29,676
Incremental Cost	**-**	**-**	**$948**	**$5,281**	**$2,179**	**$7,066**	**$3,230**

Table 8. Non-Ducted HVAC Measure Cost Assumptions – 4-Ton Electric Replacements

	Wall Furnace + Window AC	Min. Eff. Ductless MSHP	High Eff. Ductless MSHP
First Cost	$4,075	$17,412	$21,342
Replacement Cost (Future Value)	$4,075	$17,412	$21,342
Replacement Cost (Present Value)	$3,365	$11,176	$13,698
Remaining Value at Year 30	($532)	$0	$0
Total Lifecycle Cost	$6,908	$28,588	$35,040
Incremental Cost	**-**	**$21,680**	**$28,132**

Heat Pump Water Heating:

The heat pump water heater (HPWH) measures are described below, and costs are presented in Table 9 and Table 10. The most typical scenario in California is a home with existing natural gas storage tank water heaters. However, there are also many existing homes with existing electric resistance storage tank water heaters and this work considers both baselines. This analysis evaluates the following 65-gallon replacement HPWHs:

1. HPWH that meets the federal minimum efficiency requirements of UEF 2.0
2. HPWH that meets the Northwest Energy Efficiency Alliance (NEEA)[15] Tier 3 rating (3.45 UEF)
3. HPWH that meets the NEEA Tier 4 rating and that has demand response (DR) or load shifting control capability (4.02 UEF)
4. 120V HPWH that meets the NEEA Tier 3 rating (3.3 UEF).

[15] Based on operational challenges experienced in the past, NEEA established rating test criteria to ensure newly installed HPWHs perform adequately, especially in colder climates. The NEEA rating requires an Energy Factor equal to the ENERGY STAR® performance level and includes requirements regarding noise and prioritizing heat pump use over supplemental electric resistance heating.

The four cases above were evaluated with the HPWH located within an attached garage. Additionally, three separate cases for the federal minimum efficiency HPWH were analyzed to consider the impacts of location on performance and cost-effectiveness. These locations included the following:

1. Exterior closet.
2. Interior closet, no ducting.
3. Interior closet, ducted to the outside.

Additional costs for providing electrical wiring to these locations and for providing ductwork were included. Savings are compared to a new 50-gallon natural gas storage water heater (UEF 0.63) or a new 50-gallon electric water heater (UEF 0.92).

For this analysis, a HPWH that just meets the federal minimum efficiency standards of close to 2.0 Uniform Energy Factor (UEF) was evaluated in order to satisfy preemption requirements. However, the Reach Codes Team is not aware of any 2.0 UEF products that are available on the market. The lowest UEF reported for certified products in the Northwest Energy Efficiency Alliance (NEEA)[16] database is 2.73. In fact, of the four certification tiers offered by NEEA for high efficiency HPWHs, those meeting Tier 3 or Tier 4 are the dominant products on the market today. According to NEEA all major HPWH manufacturers are represented in NEEA's qualified product list[17] and there are fewer than 10 integrated products certified as Tier 1 or Tier 2, all of which have UEFs greater than 3.0.[18] Therefore, in this analysis, we refer to the NEEA rated HPWH as the "market standard" HPWH.

The HPWH costs for the 120V and NEEA certified units are based on a larger (60 or 65 gallon) HPWH, as most contractors are upsizing the HPWH tank size relative to an equal volume, but higher capacity gas storage water heater. Costs include all material and installation labor including providing a new 240 V electrical service to the water heater location (not needed for the 120V product). Water heating equipment lifetimes are based on DOE's recent water heater rulemaking (Department of Energy, 2022) and assume 15-year EULs for both the baseline water heaters and the HPWHs.[19] Future replacement costs for 240V HPWHs do not include any initial costs associated with 240V electrical service, condensate disposal, etc.

Table 9. Water Heating Measure Cost Assumptions – Existing Gas

	Gas Storage Water Heater	240V Fed. Min. HPWH	240V Market Std. NEEA HPWH	240V Market Std. NEEA HPWH + DR	120V Market Std. NEEA HPWH	240V Fed. Min. HPWH, Exterior Closet	240V Fed. Min. HPWH, Interior Closet, Not Ducted	240V Fed. Min. HPWH, Interior Closet, Ducted
First Cost	$2,951	$7,283	$8,144	$8,144	$5,844	$7,702	$7,363	$8,442
Replacement Cost (Future Value)	$2,951	$6,413	$7,274	$7,274	$5,101	$6,413	$6,413	$6,413
Replacement Cost (Present Value)	$1,894	$4,116	$4,669	$4,669	$3,274	$4,116	$4,116	$4,116
Total Lifecycle Cost	$4,845	$11,399	$12,813	$12,813	$9,118	$11,818	$11,479	$12,558
Incremental Cost	**-**	**$6,554**	**$7,968**	**$7,968**	**$4,273**	**$6,973**	**$6,634**	**$7,713**

[16] Based on operational challenges experienced in the past, NEEA established rating test criteria to ensure newly installed HPWHs perform adequately, especially in colder climates. The NEEA rating requires products comply with ENERGY STAR and includes requirements regarding noise and prioritizing heat pump use over supplemental electric resistance heating.
[17] https://neea.org/success-stories/heat-pump-water-heaters
[18] As of 12/21/23: https://neea.org/img/documents/residential-unitary-HPWH-qualified-products-list.pdf
[19] The recent DOE rulemaking references a lifetime of 14 years for gas storage water heaters and 14.8 years for electric storage water heaters. 15 years for each was used in this analysis for both types for simplification.

Table 10 presents similar costs to Table 9, except that the costs assume replacement of an existing 50-gallon electric storage water heater and does not include the 240 V electrical service cost.

Table 10. Water Heating Measure Cost Assumptions – Existing Electric Resistance

	Electric Storage Water Heater	240V Fed. Min. HPWH	240V Market Std. NEEA HPWH	240V Market Std. NEEA HPWH + DR	120V Market Std. NEEA HPWH	240V Fed. Min. HPWH, Exterior Closet	240V Fed. Min. HPWH, Interior Closet, Not Ducted	240V Fed. Min. HPWH, Interior Closet, Ducted
First Cost	$2,583	$6,413	$7,274	$7,274	$5,101	$6,413	$6,413	$7,492
Replacement Cost (Future Value)	$2,583	$6,413	$7,274	$7,274	$5,101	$6,413	$6,413	$6,413
Replacement Cost (Present Value)	$1,658	$4,116	$4,669	$4,669	$3,274	$4,116	$4,116	$4,116
Total Lifecycle Cost	$4,241	$10,529	$11,943	$11,943	$8,375	$10,529	$10,529	$11,608
Incremental Cost	**-**	**$6,288**	**$7,702**	**$7,702**	**$4,134**	**$6,288**	**$6,288**	**$7,367**

3 Results

The primary objective of the evaluation is to identify cost-effective energy upgrade measures and packages for existing single family buildings, to support the design of local ordinances requiring upgrades, which may be triggered by different events, such as at the time of a significant remodel or at burnout of mechanical equipment. In this report, the 1992-2010 vintage is shown for the equipment measures because it is the most conservative case (lowest loads), while the pre-1978 vintage is shown for the envelope and duct measures because some of those measures only apply to the pre-1978 vintage. A full dataset of all results can be downloaded at https://localenergycodes.com/content/resources. Results alongside policy options can also be explored using the Cost-effectiveness Explorer at https://explorer.localenergycodes.com/.

3.1 Cost-Effectiveness Results

The extensive analysis for this type of report leads to an overwhelming number of scenarios including different base cases, house vintages, replacement options, and climate zones. To simplify the reporting, the Statewide Reach Codes Team has relied on graphical representation of select key cases indicating high level measure cost effectiveness from either an On-Bill perspective, an LSC perspective, both metrics, or neither. Figure 1 through Figure 13 present this reduced set of results of the LSC and On-Bill cost-effectiveness conclusions across the 16 climate zones. In the cases where there are multiple utilities serving a single climate zone, an asterisk "*" label is added to separately show the alternate utility cases. These graphs provide a general sense of the findings. A full dataset of all results can be downloaded at https://localenergycodes.com/content/resources. Results alongside policy options can also be explored using the Cost-effectiveness Explorer at https://explorer.localenergycodes.com/.

3.1.1 HPSH Measures

Figure 1 through Figure 5 show the cost-effectiveness of space heating equipment replacement measures for the 1992-2010 vintage including the following cases. The 1992-2010 vintage results are presented here as this is the most conservative scenario for HPSH measures. In general, where a HPSH measure is cost-effective for a new home it was also found to be cost-effective for older homes.

- Dual fuel heat pump with existing furnace as backup.
- Standard efficiency ducted central heat pump replacement.
- High efficiency ducted central heat pump replacement.
- Ducted mini-split heat pump replacement.
- Standard efficiency ducted central heat pump replacement with 3kW PV system.

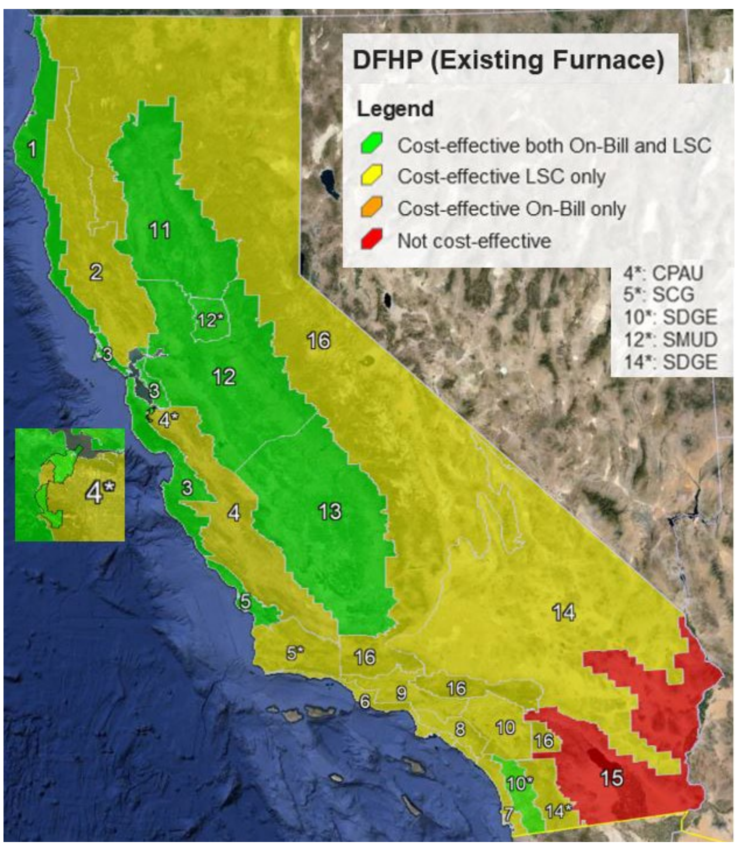


Figure 1: DFHP with Existing Furnace

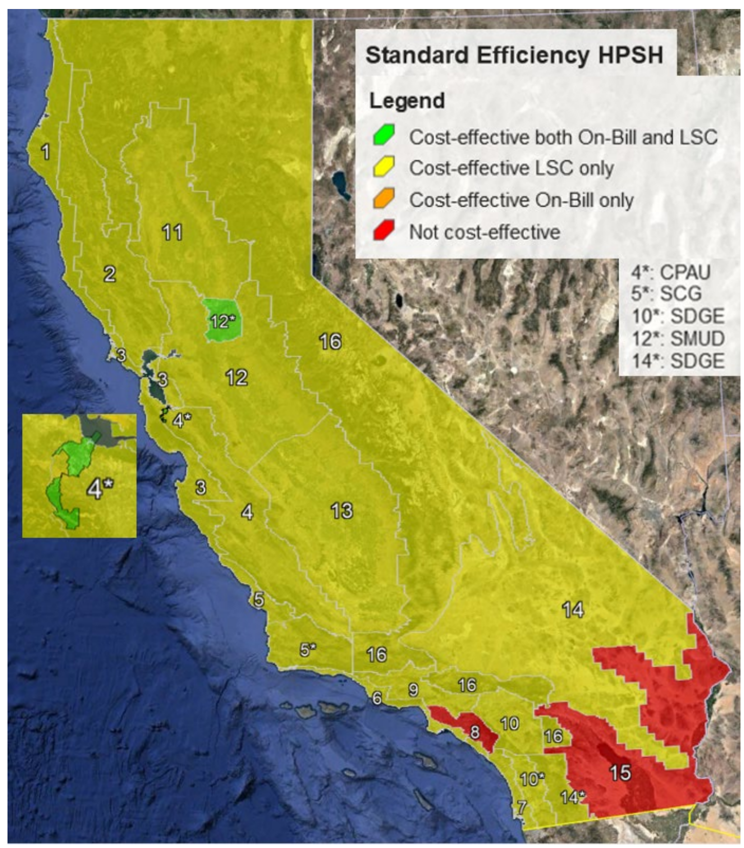


Figure 2: Standard Efficiency HPSH

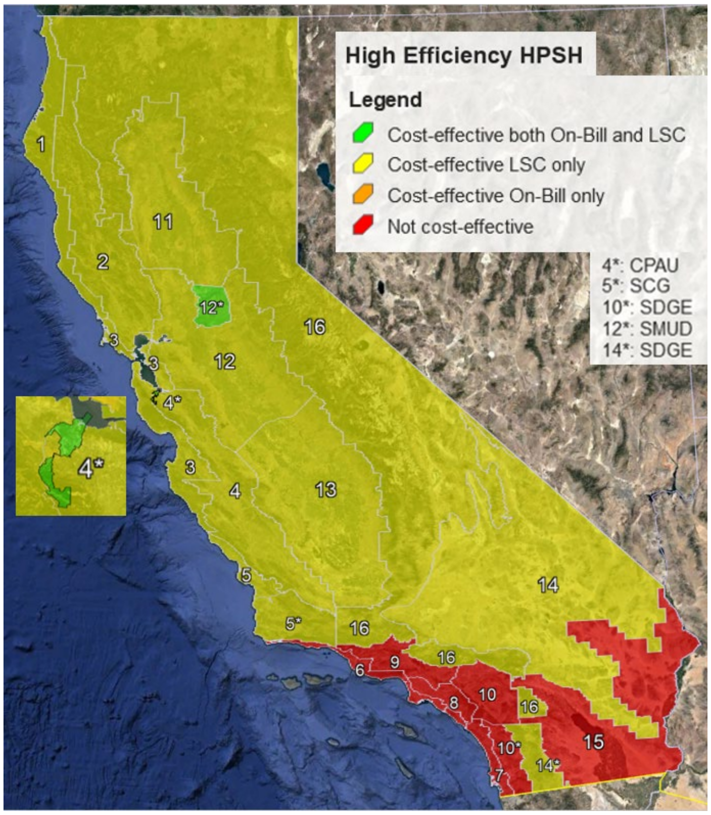


Figure 3: High Efficiency HPSH

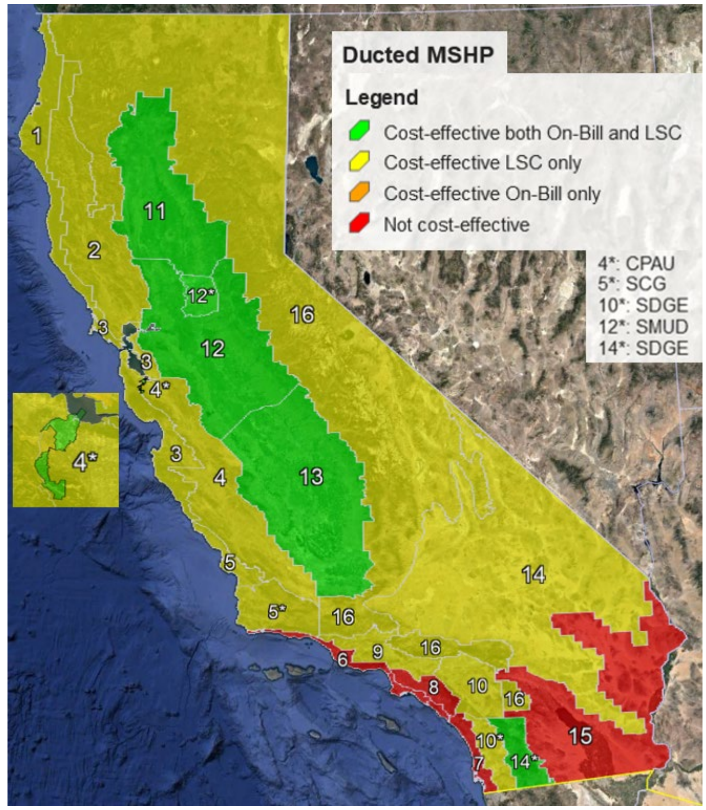


Figure 4: Ducted MSHP

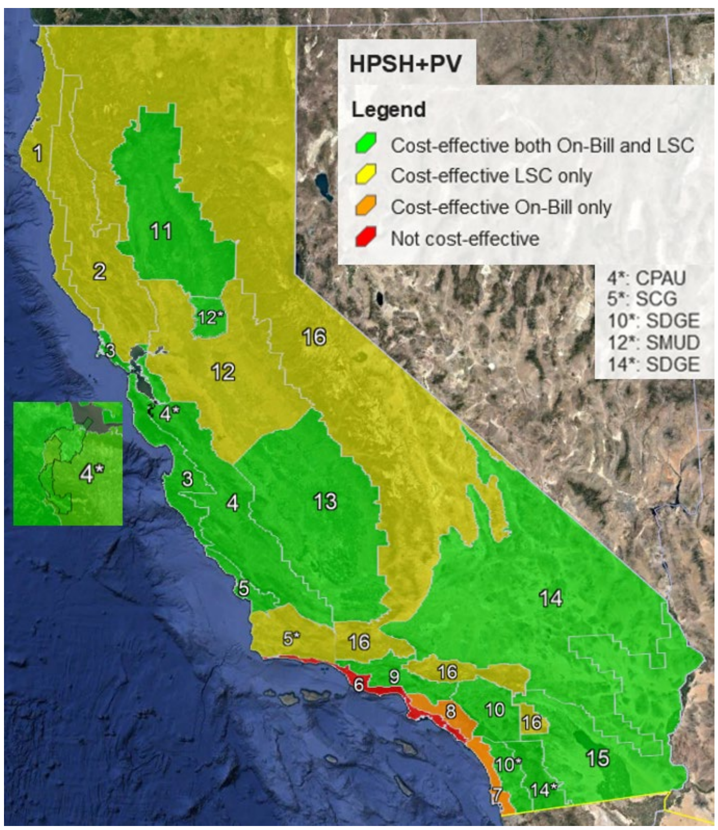


Figure 5: HPSH + PV

3.1.2 HPWH Measures

Figure 6 through Table 11 show the cost-effectiveness of water heater measures for the 1992-2010 vintage including the following cases. HPWH energy savings and LSC cost-effectiveness is not sensitive to home vintage but rather depends on the magnitude of hot water loads, which are typically driven by the number of occupants. On-Bill cost-effectiveness does vary slightly by vintage due to the impact of the electrification tariff relative to the load profile of the existing home. The impact is largest for the HPWH + PV case where On-Bill cost-effectiveness improves for older homes or homes with overall higher energy use resulting in less exports to the grid for a fixed size PV system.

- 240V federal minimum HPWH
- 240V market standard NEEA HPWH
- 120V market standard NEEA HPWH
- 240V federal minimum HPWH with 3kW PV

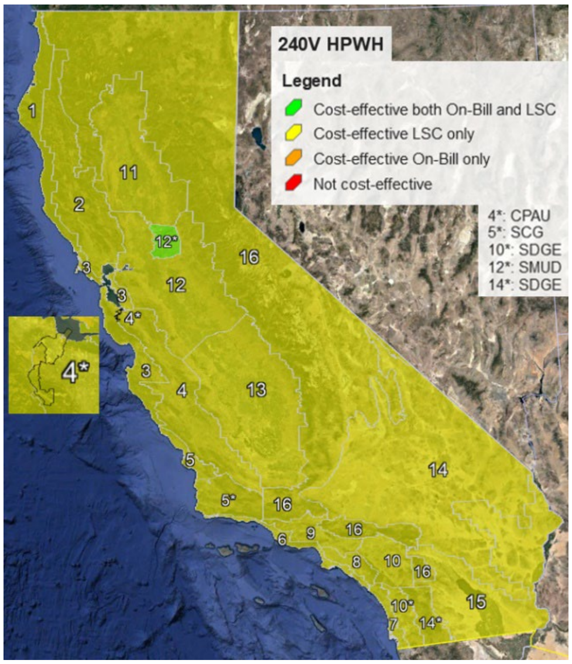


Figure 6: 240V Federal Minimum HPWH

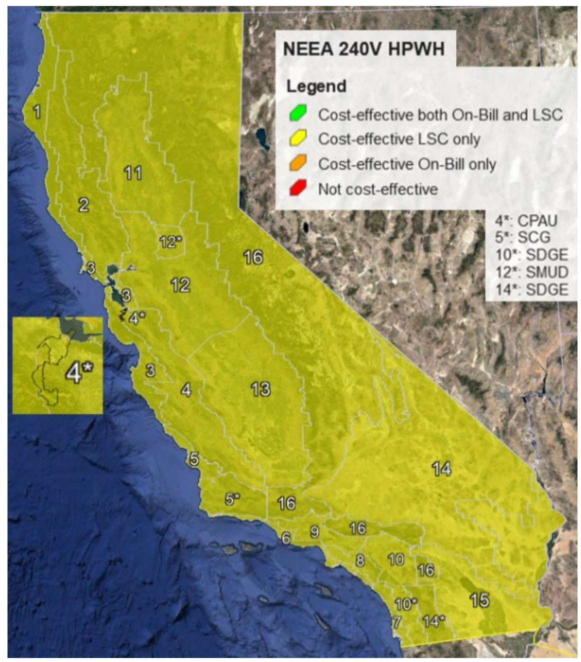


Figure 7: 240V Market Standard NEEA HPWH

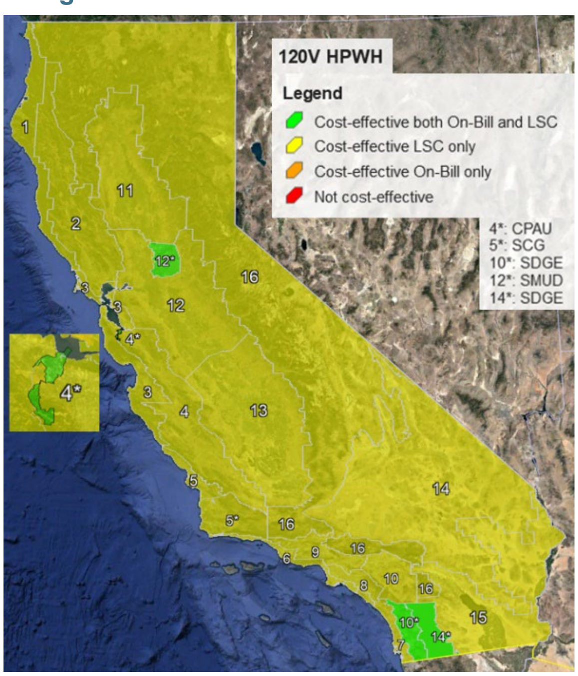


Figure 8: 120V Market Standard NEEA HPWH

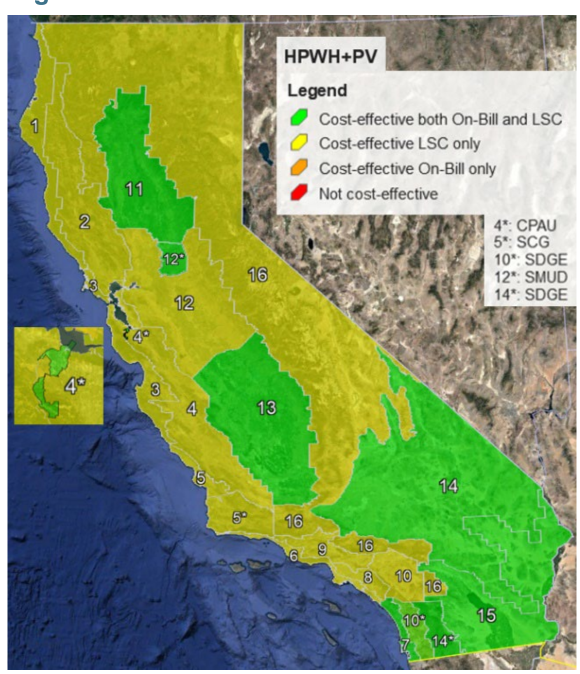
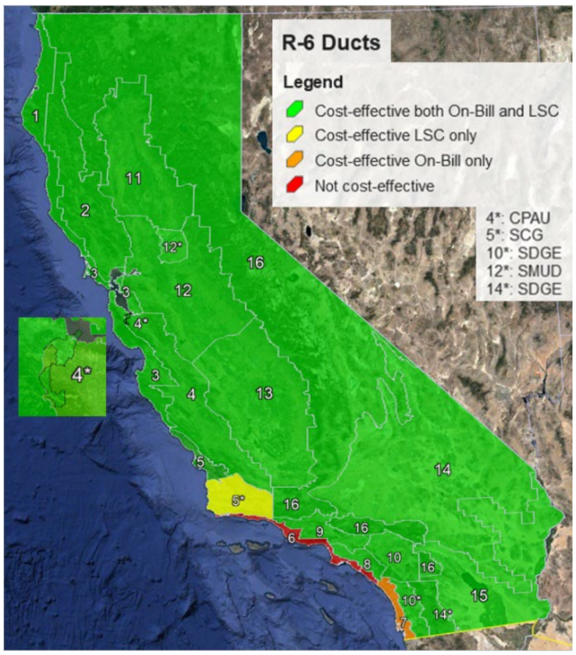


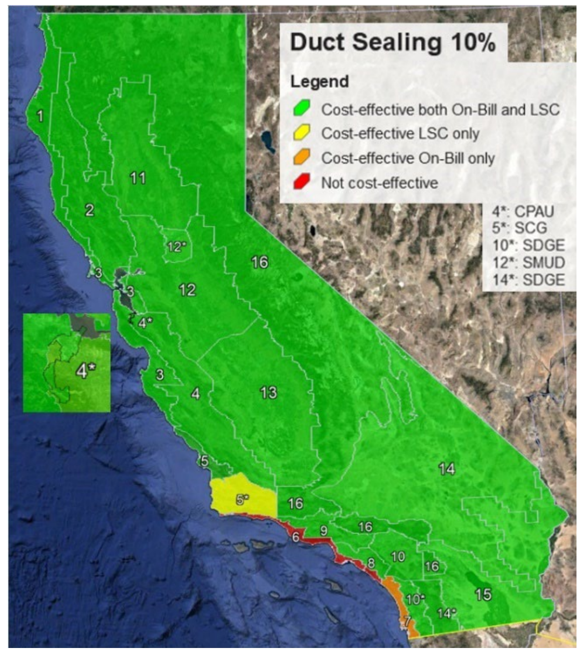
Figure 9: 240V Federal Minimum HPWH + PV

- Envelope and Duct Measures

Figure 10 through Figure 13 show the cost-effectiveness results of envelope and duct measures for the pre-1978 vintage including the following measures. The pre-1978 vintage is presented as representing the most favorable existing conditions for cost-effective upgrades. Newer homes with higher performing envelope may still benefit from these types of upgrade measures, but cost-effectiveness is reduced. Some measures, like R-13 wall insulation, aren't applicable to newer homes which would have been constructed originally with insulated walls.

- New R-6 ducts
- 10% duct leakage
- R-13 wall insulation
- R-49 attic insulation





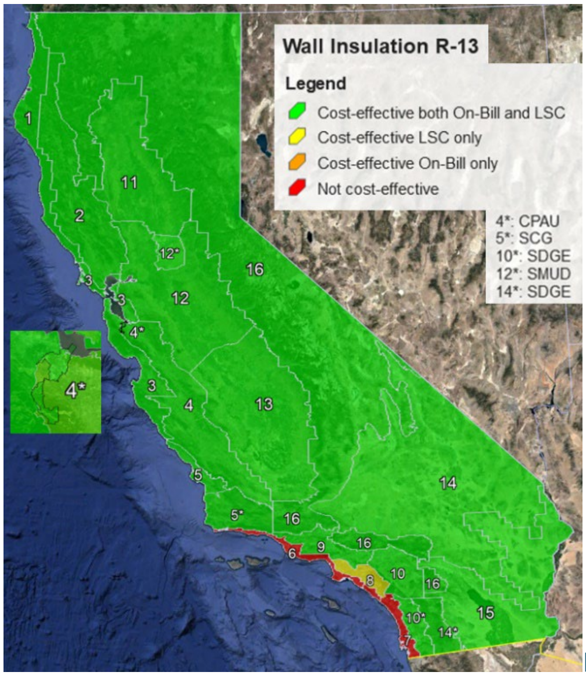


Figure 10: R-6 Ducts

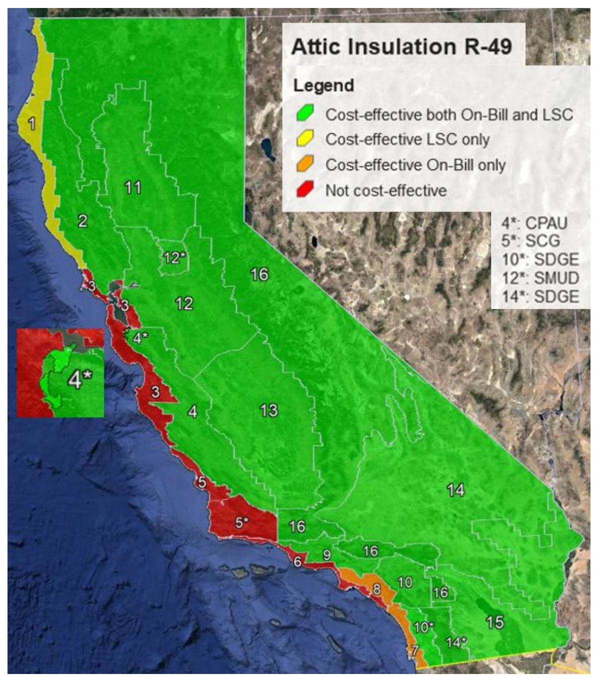


Figure 11: 10% Duct Leakage

Figure 12: R-13 Wall Insulation

Figure 13: R-49 Attic Insulation

3.2 Climate Zone Case Studies

To better understand the details of the results, a few climate zones were selected to provide a more detailed presentation of cost-effectiveness results. Section 3.2.1 through 3.2.3 show the first-year incremental cost, first-year utility savings, and NPV for a variety of cases. Section 3.2.4 shows the sensitivity of the cost effectiveness results due to varying utility escalation rates, the impact of CARE rates, future equipment cost assumptions, and the need for electrical panel upgrades. The climate zones were selected to be representative of areas of significant reach code activity. Please refer to the Cost-Effectiveness Explorer (Statewide Reach Codes, 2023) or the source dataset for the full analysis.

3.2.1 HPSH Cost-Effectiveness

Cost-effectiveness of heat pump space heating measures for Climate Zones 12 and 16 is summarized in Table 11 and Table 12 below. In Climate Zone 12, HPSH measures are cost-effective based on LSC in all cases except the ductless MSHP cases and are cost-effective On-Bill with SMUD rates in all cases except the DFHP case with a new furnace and the ductless MSHP cases. These measures are cost-effective On-Bill with PGE for the DFHP with an existing furnace and ducted MSHP measures. Climate Zone 16 provides an example of HPSH cost-effectiveness in a cold climate where almost all HPSH measures are cost effective based on LSC but not cost-effective On-Bill.

Table 11. HPSH CZ 12 [1992-2010]

Measure	First Incremental Cost	2025 LSC NPV	PGE		SMUD	
			First-year Utility Savings	On-Bill NPV	First-year Utility Savings	On-Bill NPV
DFHP Existing Furnace	$1,960	$7,093	($19)	$1,633	$247	$7,693
DFHP New Furnace	$4,023	$3,915	($34)	($3,134)	$234	$2,979
HPSH (Std Efficiency)	$1,172	$6,990	($147)	($2,151)	$246	$6,812
HPSH (High Efficiency)	$4,149	$5,366	$13	($3,368)	$300	$3,160
Ducted MSHP	$1,421	$9,136	$10	$378	$298	$6,951
Ductless MSHP (Std Efficiency)	$13,336	($9,175)	$30	($18,039)	$276	($12,428)
Ductless MSHP (High Efficiency)	$17,266	($6,753)	$409	($15,853)	$423	($15,532)
HPSH + PV	$10,780	$5,289	$452	($59)	$885	$9,821

Table 12. HPSH CZ 16 [1992-2010]

Measure	First Incremental Cost	2025 LSC NPV	PGE	
			First-year Utility Savings	On-Bill NPV
DFHP Existing Furnace	$2,397	$7,289	($116)	($1,891)
DFHP New Furnace	$4,757	$2,457	($133)	($6,322)
HPSH (Std Efficiency)	$2,725	$11,142	($480)	($8,532)
HPSH (High Efficiency)	$5,701	$12,099	($204)	($7,125)
Ducted MSHP	$2,155	$16,554	($221)	($2,853)
Ductless MSHP (Std Efficiency)	$13,336	($134)	($170)	($19,742)
Ductless MSHP (High Efficiency)	$17,266	$9,397	$539	($10,031)
HPSH + PV	$12,333	$10,640	$316	($1,949)

3.2.2 HPWH Cost-Effectiveness

Cost-effectiveness of heat pump water heating measures for Climate Zones 12 and 16 is summarized in Table 13 and Table 14 below. This sensitivity study looks at a wider range of HPWH tank locations and whether or not the unit has ducting for supply and exhaust air. All the HPWH measures in Climate Zones 12 and 16 are cost effective based on LSC.

Table 13. HPWH CZ 12 [1992-2010]

Measure	First Incremental Cost	2025 LSC NPV	PGE		SMUD	
			First-Year Utility Savings	On-Bill NPV	First-Year Utility Savings	On-Bill NPV
240V Fed. Min. HPWH	$4,332	$3,536	($213)	($8,738)	$191	$477
240V Market Std. NEEA HPWH	$5,193	$4,304	($82)	($7,164)	$230	($56)
240V Market Std. NEEA HPWH + DR	$5,193	$5,536	($21)	($5,773)	$248	$362
120V Market Std. NEEA HPWH	$2,893	$9,730	($2)	($1,651)	$254	$4,203
240V Fed. Min. HPWH (Exterior Closet)	$4,751	$2,834	($224)	($9,431)	$186	($78)
240V Fed. Min. HPWH (Interior Closet)	$4,413	$3,123	($71)	($6,138)	$188	($235)
240V Fed. Min. HPWH (Interior Closet, ducted)	$5,492	$3,359	($202)	($9,505)	$205	($231)
240V Fed. Min. HPWH + PV	$13,940	$3,567	$577	($2,300)	$831	$3,486

Table 14. HPWH CZ 16 [1992-2010]

Measure	First Incremental Cost	2025 LSC NPV	PGE	
			First-Year Utility Savings	On-Bill NPV
240V Fed. Min. HPWH	$4,332	$4,186	($250)	($9,307)
240V Market Std. NEEA HPWH	$5,193	$4,088	($160)	($8,652)
240V Market Std. NEEA HPWH + DR	$5,193	$5,653	($79)	($6,804
120V Market Std. NEEA HPWH	$2,893	$10,646	($13)	($1,602)
240V Fed. Min. HPWH (Exterior Closet)	$4,751	$3,317	($268)	($10,154)
240V Fed. Min. HPWH (Interior Closet)	$4,413	$5,004	($18)	($4,690)
240V Fed. Min. HPWH (Interior Closet, ducted)	$5,492	$4,857	($202)	($9,174)
240V Fed. Min. HPWH + PV	$13,940	$5,049	$620	($1,043)

3.2.3 Envelope & Duct Improvement Cost-Effectiveness

Cost-effectiveness of envelope and duct measures for Climate Zones 3, 10, and 12 is summarized in Table 15 through Table 17.

Table 15. Envelope and Duct Measures CZ 3 [Pre-1978]

Measure	First Incremental Cost	2025 LSC NPV	PG&E	
			First-year Utility Savings	On-Bill NPV
R-6 Ducts	$4,808	$2,851	$188	$463
R-8 Ducts	$6,311	$1,747	$198	($776)
10% Duct Sealing	$2,590	$1,956	$104	$397
R-13 Wall Insulation	$2,950	$3,476	$144	$1,221
R-38 Attic Insulation	$6,762	($1,567)	$127	($3,178)
R-49 Attic Insulation	$7,446	($1,768)	$139	($3,520)
R-30 Raised Floor Insulation	$4,113	$9,008	$224	$2,975
Cool Roof (0.20 Ref)	$893	($2,419)	($18)	($1,811)

Table 16. Envelope and Duct Measures CZ 10 [Pre-1978]

Measure	First Incremental Cost	2025 LSC NPV	SCE/SCG		SDGE	
			First-year Utility Savings	On-Bill NPV	First-year Utility Savings	On-Bill NPV
R-6 Ducts	$4,808	$7,463	$783	$13,168	$1,100	$22,155
R-8 Ducts	$6,311	$6,326	$800	$12,076	$1,125	$21,268
10% Duct Sealing	$2,590	$3,438	$370	$5,969	$518	$10,166
R-13 Wall Insulation	$2,950	$1,795	$179	$1,476	$250	$3,494
R-38 Attic Insulation	$6,762	$664	$416	$2,951	$582	$7,654
R-49 Attic Insulation	$7,446	$796	$467	$3,435	$655	$8.756
R-30 Raised Floor Insulation	$4,113	($999)	($29)	($4,235)	($46)	($4,687)
Cool Roof (0.20 Ref)	$893	$428	$174	$2,647	$246	$4,656

Table 17. Envelope and Duct Measures CZ 12 [Pre-1978]

Measure	First Incremental Cost	2025 LSC NPV	PG&E		SMUD	
			First-year Utility Savings	On-Bill NPV	First-year Utility Savings	On-Bill NPV
R-6 Ducts	$4,808	$11,609	$804	$14,727	$413	$5,816
R-8 Ducts	$6,311	$10,722	$828	$13,849	$427	$4,711
10% Duct Sealing	$2,590	$6,418	$397	$7,280	$222	$3,281
R-13 Wall Insulation	$2,950	$5,774	$262	$4,054	$187	$2,342
R-38 Attic Insulation	$6,762	$3,727	$499	$5,461	$261	$19
R-49 Attic Insulation	$7,446	$4,092	$552	$6,063	$288	$33
R-30 Raised Floor Insulation	$4,113	$5,245	$27	($1,176)	$156	$1,175
Cool Roof (0.20 Ref)	$893	($354)	$154	$2,123	$44	($386)

3.2.4 Sensitivities

Table 18 shows the On-Bill NPV results of Climate Zone 12 with PG&E utility rates and the impacts of escalation rates, and CARE rates. The "Standard Results" in Table 18 assumes the escalation rates used in the analysis presented elsewhere in this report. Table 19 shows the impact of electrical panel upgrades. The "Standard Results" in Table 19 does not assume a panel upgrade is required.

Table 18. Sensitivity Analysis Results for On-Bill NPV Cost-Effectiveness in Climate Zone 12, PG&E

Measure	Vintage	Standard Results	2025 LSC Escalation	CARE
DFHP Existing Furnace	1992-2010	$1,063	$8,443	$1,884
DFHP New Furnace	1992-2010	($6,770)	$383	($5,846)
HPSH (Std Efficiency)	1992-2010	($2,151)	$6,011	($220)
HPSH (High Efficiency)	1992-2010	($3,368)	$4,987	($2,721)
Ducted MSHP	1992-2010	$378	$8,729	$1,057
Ductless MSHP (Std Efficiency)	1992-2010	($18,039)	($10,732)	($17,623)
Ductless MSHP (High Efficiency)	1992-2010	($15,853)	($8,091)	($18,460)
HPSH + PV	1992-2010	($59)	$8,822	($1,255)
240V Fed. Min. HPWH	1992-2010	($8,738)	($2,433)	($6,448)
240V Market Std. NEEA HPWH	1992-2010	($7,164)	($694)	($5,918)
240V Market Std. NEEA HPWH + DR	1992-2010	($5,773)	$770	(5,014)
120V Market Std. NEEA HPWH	1992-2010	($1,651)	$4,930	(1,038)
240V Fed. Min. HPWH (Exterior Closet)	1992-2010	($9,431)	($3,184)	($7,055)
240V Fed. Min. HPWH (Interior Closet)	1992-2010	($6,138)	($1,000)	($5,098)
240V Fed. Min. HPWH (Interior Closet, ducted)	1992-2010	($9,505)	($2,836)	($7,271)
240V Fed. Min. HPWH + PV	1992-2010	($2,300)	$4,952	($4,858)
R-6 Ducts	Pre-1978	$14,727	$18,685	$8,592
R-8 Ducts	Pre-1978	$13,849	$17,990	$7,532
10% Duct Sealing	Pre-1978	$7,280	$9,752	$4,294
R-13 Wall Insulation	Pre-1978	$4,054	$6,898	$2,196
R-38 Attic Insulation	Pre-1978	$5,461	$8,126	$1,668
R-49 Attic Insulation	Pre-1978	$6,063	$8,978	$1,864
R-30 Raised Floor Insulation	Pre-1978	($1,776)	$2,468	($1,602)
Cool Roof (0.20 Ref)	Pre-1978	$2,123	$1,848	$851

Table 19. Electric Panel Upgrade Sensitivity for CZ 12 [1992-2010]

Measure	Standard Results		Electric Panel Upgrade	
	On-Bill NPV	LSC NPV	On-Bill NPV	LSC NPV
HPSH (Std Efficiency)	($2,151)	$6,990	($4,931)	$4,210
240V Fed. Min. HPWH	($8,738)	$3,536	($11,624)	$756

3.3 Gas Pathways for Heat Pump Replacements

Many jurisdictions are exploring policy options to accelerate the decarbonization of existing homes. A recent Ninth Circuit Court ruling in *California Rest. Ass'n v. City of Berkeley*[20] invalidated Berkeley's ordinance banning the installation of gas infrastructure in new construction. The ruling stated that the ordinance effectively banned covered products and was preempted by the Energy Policy and Conservation Act ("EPCA"), 42 U.S.C. § 6297(c). Given the possible impacts of that ruling, the Reach Codes Team analyzed policy options targeting equipment replacements that allow for the installation of either electric or gas-fueled equipment. These packages include gas equipment combined with additional efficiency measures resulting in options that are reasonably energy or LSC cost equivalent, to the extent feasible.

For space heating, the heat pump path is a DFHP (existing furnace).. The gas pathway is a new air conditioner with the following list of efficiency upgrades:

- 400 cfm/ton system airflow (HERS verified).
- 0.35 W/cfm fan efficacy (HERS verified).
- Refrigerant charge verification (HERS verified).
- R-8 ducts, 5% leakage (HERS verified).
- R-49 (from R-30) attic insulation.
- Air sealing of the ceiling from 7 to 6.5 ACH50.

The two pathways are presented in Figure 14 comparing total LSC energy use relative to the existing home for the 1992-2010 vintage. In most climate zones, the DFHP (existing furnace) path results in higher energy savings, in the milder climates the air conditioner path saves marginally more energy. A reach code that establishes requirements when an air conditioner is replaced or installed new, could allow for either a heat pump to be installed or an air conditioner as long as the performance measures listed above are met. Note that in this analysis a DFHP (existing furnace) was used; however, a reach code could require a different heat pump measure for the heat pump path. This approach aligns with the CEC's proposal for the 2025 Title 24 code cycle for heat pump alterations in single family homes (California Energy Commission, 2023).

[20] *California Rest. Ass'n v. City of Berkeley*, 65 F.4th 1045 (9th Cir. 2023) amended by 89 F.4th 1094 (9th Cir. 2024).

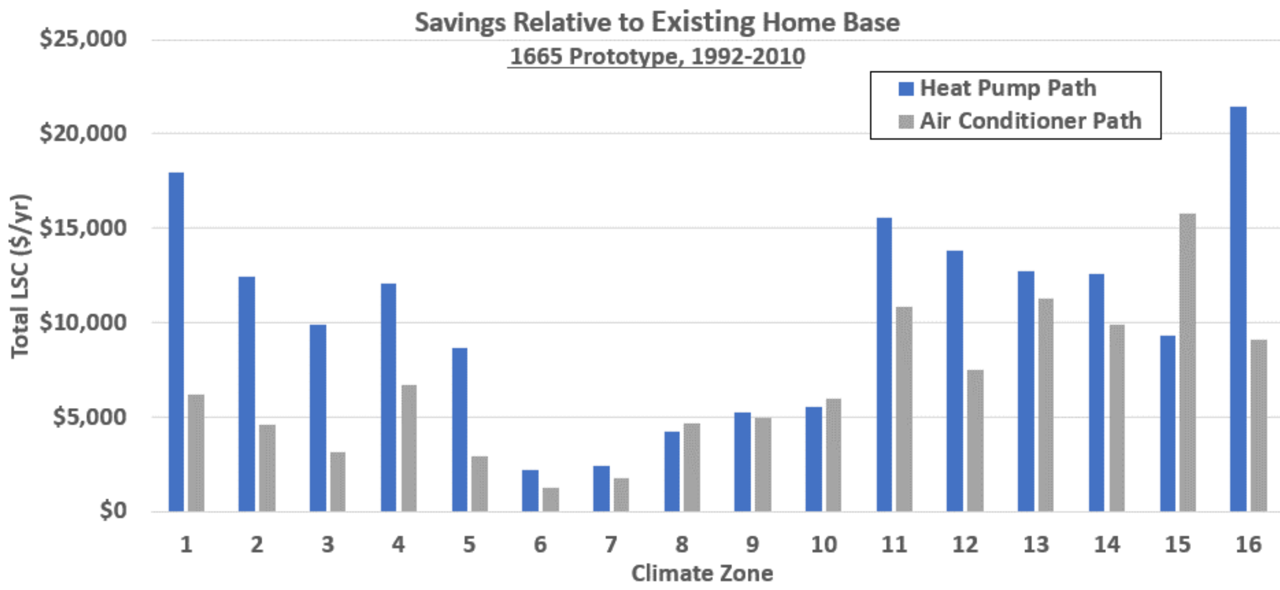


Figure 14. Heat pump space heater path compared to the air conditioner path.

For water heating, the federal minimum HPWH case was used to develop the package. The HPWH was compared to a new gas storage water heater with a 50% solar thermal backup system.

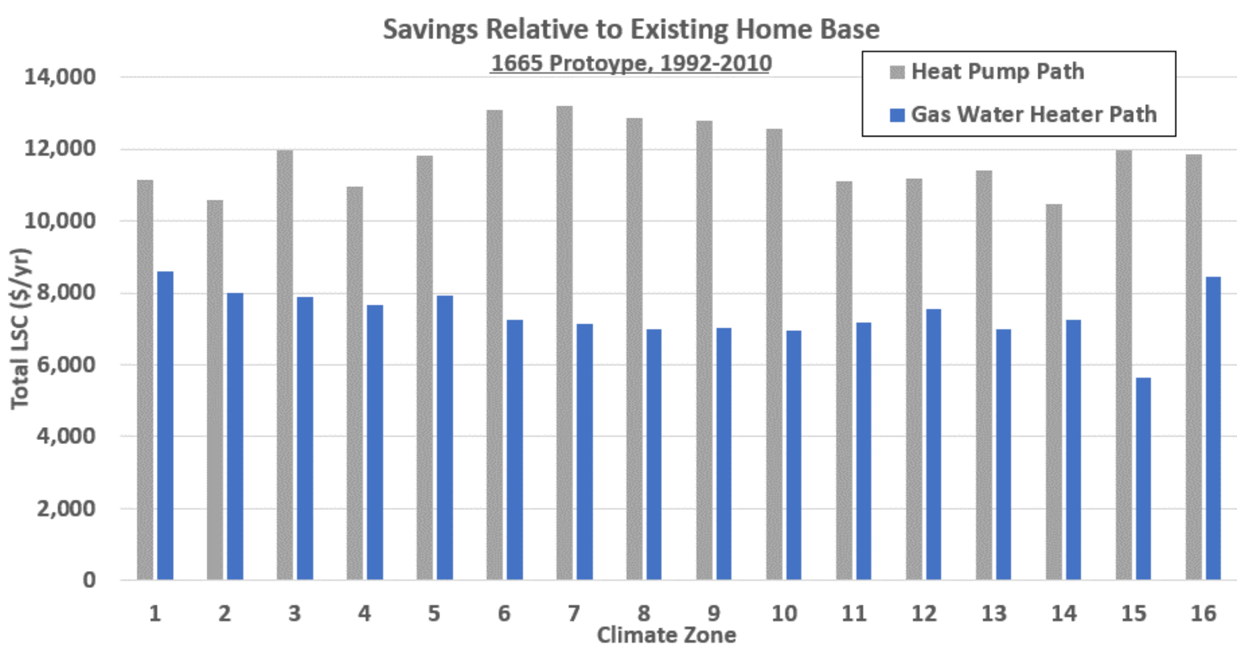


Figure 15. Heat pump water path compared to gas with solar thermal.

The two pathways are presented in Figure 15 comparing total LSC energy use relative to the existing home for the 1992-2010 vintage. In all climate zones, the heat pump path results in higher energy savings than the gas path. A reach code that establishes requirements when a water heater is replaced could allow for either a HPWH to be installed or a gas water heater in combination with a solar thermal system that meets the solar fraction requirements listed above.

4 Recommendations and Discussion

This analysis evaluated the feasibility and cost-effectiveness of retrofit measures in California existing homes built before 2010. The Statewide Reach Codes Team used both On-Bill and LSC-based LCC approaches to evaluate cost-effectiveness and quantify the energy cost savings associated with energy efficiency measures compared to the incremental costs associated with the measures.

Conclusions and Discussion:

1. Envelope measures. Improving envelope performance is very cost-effective in many older homes. In addition to reducing utility costs these measures provide many other benefits such as improving occupant comfort and satisfaction and increasing a home's ability to maintain temperatures during extreme weather events and power outages. Below is a discussion of the results of specific measures.
    a. Adding attic insulation is cost effective based on both LSC and On-Bill in many climate zones in homes with no more than R-19 existing attic insulation levels. Increasing attic insulation from R-30 to R-49 was still found to be cost-effective based on at least one metric in the colder and hotter climates of Climate Zone 10 (SDG&E territory only) through 16.
    b. Insulating existing uninsulated walls is very cost-effective based on both metrics everywhere except Climate Zones 6 and 7 (in Climate Zone 8 it's only cost-effective based on LSC).
    c. Adding R-19 or R-30 floor insulation is cost-effective based on LSC in the older two vintages (Pre-1978 and 1978-1991) in all climate zones except Climate Zones 6-10.
    d. Replacing old single pane windows with new high-performance windows has a very high cost and is typically not done for energy savings alone. However, energy savings are substantial and justify cost-effectiveness of this measure based on at least one metric in Climate Zones 4, 8 through 12 (PG&E territory only), and 13 through 16.
    e. At time of roof replacement, a cool roof with an aged solar reflectance of 0.25 was found to be cost-effective in Climate Zones 4, 6 through 12 (PG&E territory only), and 13 through 15. When the roof deck is replaced during a roof replacement, adding a radiant barrier is low cost and provides substantial cooling energy savings to be cost-effective in almost all climate zones and homes.
2. Duct measures: Many older homes have old, leaky duct systems that should be replaced when they reach the end of life, typically 20-30 years. In this case, installing new ducts was found to be cost-effective based on at least one metric (both in most cases) everywhere except mild Climate Zone 7 and Climate Zones 5 and 6 in the 1978-1991 vintage. If duct systems still have remaining life they should be sealed and tested to meet 10% leakage or lower; however, duct upgrades alone were only found to be cost-effective for newer homes in Climate Zones 10 (SDG&E territory only), 11, and 13 through 16. Duct upgrades may be able to be coupled with other measures to reduce the cost.
3. Heat pump space heating: HPSHs were found to be LSC cost-effective in many cases. The DFHP (existing furnace) was LSC cost-effective everywhere except Climate Zone 15. The HPSH was LSC cost-effective everywhere except Climate Zones 8 and 15.
    a. Challenges to On-Bill cost-effectiveness include higher first costs and higher first-year utility costs due to higher electricity tariffs relative to gas tariffs. SMUD and CPAU are two exceptions where first year utility costs are lower for heat pumps than for gas equipment. Table 11 shows the impact of utility rates on cost-effectiveness of HPSH where the standard and high efficiency HPSH and the HPSH + PV measures are cost-effective under SMUD but not PG&E. Even with higher first year utility bills, there were some cases that still proved On-Bill cost-effective including the DFHP with an existing furnace in the central valley and northern coastal PG&E territories, the ducted MSHP in the central valley as well as Climate Zone 14 in SDG&E territory, and the HPSH + PV measure in CZ 3-5 (PGE), 7-11, and 12 (SMUD) – 15.
    b. The ductless MSHPs, evaluated for homes with existing ductless systems, were only found to be cost-effective based on either metric in Climate Zones 1 and 16. Ductless MSHPs have a high incremental cost because it is a more sophisticated system than the base model of a wall furnace with a window AC unit. However, the ductless MSHP would provide greater comfort benefits if properly installed to

directly condition all habitable spaces (as is required under the VCHP compliance credit as evaluated in this study) which may be an incentive for a homeowner to upgrade their system.

    c. Higher efficiency equipment lowered utility costs in all cases and improved cost-effectiveness in many cases, particularly with a ducted MSHP.

4. Heat pump water heating: All the HPWH measures were LSC cost-effective in all climate zones. Most measures were not On-Bill cost-effective with the exception of the HPWH + PV which was cost-effective On-Bill in CPAU, SMUD, and SDG&E territories in addition to Climate Zones 11, 13, 14, and 15. The HPWH measures share many of the same challenges as the HPSH measures to achieving cost-effectiveness including high first costs and utility rates and assumptions. Table 13 shows the impact of utility rates on cost-effectiveness where some HPWH measures are cost-effective under SMUD utility rates but are not cost-effective anywhere under PG&E rates in Climate Zone 12.
    a. Various HPWH locations were also explored, however there are some factors outside of cost-effectiveness that should also be considered.
        i. HPWHs in the conditioned space can provide benefits such as free cooling during the summer, reduced tank losses, and shorter pipe lengths, and in some cases show improved cost-effectiveness over garage located HPWHs. However, there are various design considerations such as noise, comfort concerns, and condensate removal. Ducting the inlet and exhaust air resolves comfort concerns but adds costs and complexity. Split heat pump water heaters address these concerns, but currently there are limited products on the market and there is a cost premium relative to the packaged products.
        ii. Since HPWHs extract heat from the air and transfer it to water in the storage tank, they must have adequate ventilation to operate properly. Otherwise, the space cools down over time, impacting the HPWH operating efficiency. This is not a problem with garage installations but needs to be considered for water heaters located in interior or exterior closets. For the 2025 Title 24 code the CEC is proposing that all HPWH installations meet mandatory ventilation requirements (California Energy Commission, 2023).
5. The contractor surveys revealed overall higher heat pump costs than what has been found in previous analyses. This could be due to incentive availability raising demand for heat pumps and thereby increasing the price. This price increase may be temporary and may come down once the market stabilizes. There are also new initiatives to obtain current costs including the TECH Clean California program[21] that publishes heat pump data and costs; however, at the time of this analysis, the TECH data did not contain incremental costs because it only had the heat pump costs but not the gas base case costs.
6. Table 18 shows how CARE rates and escalation rate assumptions will impact cost-effectiveness.
    a. Applying CARE rates in the IOU territories has the overall impact to increase utility cost savings for an all-electric building compared to a code compliant mixed fuel building, improving On-Bill cost-effectiveness. This is due to the CARE discount on electricity being higher than that on gas. The reverse occurs with efficiency measures where lower utility rates reduce savings and subsequently reduce cost-effectiveness.
    b. If gas tariffs are assumed to increase substantially over time, in-line with the escalation assumption from the 2025 LSC development, cost-effectiveness substantially improves for the heat pump measures over the 30-year analysis period and many cases become cost-effective that were not found to be cost-effective under the CPUC / 2022 TDV escalation scenario. There is much uncertainty surrounding future tariff structures as well as escalation values. While it's clear that gas rates will increase, how much and how quickly is not known. Future electricity tariff structures are expected to evolve over time, and the CPUC has an active proceeding to adopt an income-graduated fixed charge that benefits low-income customers and supports electrification measures for all customers.[22] The CPUC will decide in mid-2024 and the new rates are expected to be in place later that year or in 2025.

[21] TECH Public Reporting Home Page (techcleanca.com)
[22] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-costs/demand-response-dr/demand-flexibility-rulemaking

While the anticipated impact of this rate change is lower volumetric electricity rates, the rate design is not finalized. While lower volumetric electricity rates provide many benefits, it also will make building efficiency measures harder to justify as cost-effective due to lower utility bill cost savings.

7. Under NBT, utility cost savings for PV are substantially less than what they were under prior net energy metering rules (NEM 2.0); however, savings are sufficient to be On-Bill cost-effective in all climate zones except Climate Zones 1 through 3 and 5 through 6.
    a. Combining a heat pump with PV allows the additional electricity required by the heat pump to be offset by the PV system while also increasing on-site utilization of PV generation rather than exporting the electricity back to the grid at a low rate.
    b. While not evaluated in this study, coupling PV with battery systems can be very advantageous under NBT increasing utility cost savings because of improved on-site utilization of PV generation and fewer exports to the grid.

<u>Recommendations</u>:

1. There are various approaches for jurisdictions who are interested in reach codes for existing buildings. Some potential approaches are listed below along with key considerations.
    a. Prescriptive measures: Non-preempted measures that are found to be cost-effective may be prescriptively required in a reach code. One example of this type or ordinance is a cool roof requirement at time of roof replacement. Another example is requiring specific cost-effective measures for larger remodels, such as high-performance windows when new windows are installed or duct sealing and testing where ducts are in unconditioned space.
    b. Replacement equipment: This flavor of reach code sets certain requirements at time of equipment replacement. This study evaluated space heating and water heating equipment. Where a heat pump measure was found to be cost-effective based on either LSC or On-Bill, this may serve as the basis of a reach code given the following considerations.
        i. Where reach codes reduce energy usage and are not just fuel switching, cost-effectiveness calculations are required and must be based on equipment that does not exceed the federal minimum efficiency requirements.
        ii. Where reach codes are established using cost-effectiveness based on LSC, utility bill impacts and the owner's first cost should also be reviewed and considered.
        iii. A gas path should also be prescriptively allowed to safely satisfy federal preemption requirements considering the CRA v. Berkeley case.[23] Additional requirements may apply to the gas path, as described in Section 3.3, as long as the paths are reasonably energy or cost equivalent.
    c. "Flexible Path", minimum energy savings target: This flexible approach establishes a target for required energy savings based on a measure or a set of measures that were found to be cost-effective based on either LSC or On-Bill. A points menu compares various potential upgrades ranging from efficiency, PV, and fuel substitution measures, based on site or source energy savings. The applicant must select upgrades that individually or in combination meet the minimum energy savings target. The measures used to set the target should be non-preempted measures.
2. Equipment replacement ordinances should consider appropriate exceptions for scenarios where it will be challenging to meet the requirements, such as location of the HPWH, total project cost limitations, or the need for service panel upgrades that wouldn't have been required as part of the proposed scope of work in absence of the reach code.
3. Consider extending relevant proposals made by the CEC for the 2025 Title 24 code (California Energy Commission, 2023) in ordinances that apply under the 2022 Title 24 code, such as the following:
    a. Mandatory ventilation requirements for HPWH installations (Section 110.3(c)7).

[23] https://www.publichealthlawcenter.org/sites/default/files/2024-01/CRA-v-Berkeley-Ninth-Circuit-Opinion-Jan2024.pdf

   b. Requirement for HERS verified refrigerant charge verification for heat pumps in all climate zones (Table 150.1-A[24]).
4. When evaluating reach code strategies, the Reach Codes Team recommends that jurisdictions consider combined benefits of energy efficiency alongside electrification. Efficiency and electrification have symbiotic benefits and are both critical for decarbonization of buildings. As demand on the electric grid is increased through electrification, efficiency can reduce the negative impacts of additional electricity demand on the grid, reducing the need for increased generation and storage capacity, as well as the need to upgrade upstream transmission and distribution equipment.
5. Education and training can play a critical role in ensuring that heat pumps are installed, commissioned, and controlled properly to mitigate grid impacts and maximize occupant satisfaction. Below are select recommended strategies.
   a. The Quality Residential HVAC Services Program[25] is an incentive program to train California contractors in providing quality installation and maintenance while advancing energy-efficient technologies in the residential HVAC industry. Jurisdictions can market this to local contractors to increase the penetration of contractors skilled in heat pump design and installation.
   b. Educate residents and contractors of available incentives, tax credits, and financing opportunities.
   c. Educate contractors on code requirements. Energy Code Ace provides free tools, trainings, and resource to help Californians comply with the energy code. Contractors can access interactive compliance forms, fact sheets, and live and recorded trainings, among other things, on the website: https://energycodeace.com/. Jurisdictions can reach out to Energy Code Ace directly to discuss offerings.
6. Health and safety
   a. Combustion Appliance Safety and Indoor Air Quality: Implementation of some of the recommended measures will affect the pressure balance of the home which can subsequently impact the safe operation of existing combustion appliances as well as indoor air quality. Buildings with older gas appliances can present serious health and safety problems which may not be addressed in a remodel if the appliances are not being replaced. It is recommended that the building department require inspection and testing of all combustion appliances located within the pressure boundary of the building after completion of retrofit work that involves air sealing or insulation measures.
   b. Jurisdictions may consider requiring mechanical ventilation in homes where air sealing has been conducted. In older buildings, outdoor air is typically introduced through leaks in the building envelope. After air sealing a building, it may be necessary to forcefully bring in fresh outdoor air using supply and/or exhaust fans to minimize potential issues associated with indoor air quality.

[24] This requirement does not show up in the Express Terms for alterations in Section 150.2(b)1F, but the Statewide Reach Codes Team expects that it will be added to the next release of the proposed code language in the 45-day language as it aligns with the proposal made by the Codes and Standards Enhancement Team (Statewide CASE Team, 2023).

[25] https://qualityhvac.frontierenergy.com/

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6 Appendices

6.1 Map of California Climate Zones

Climate zone geographical boundaries are depicted in Figure 16. The map in Figure 16 along with a zip-code search directory is available at: https://ww2.energy.ca.gov/maps/renewable/building_climate_zones.html

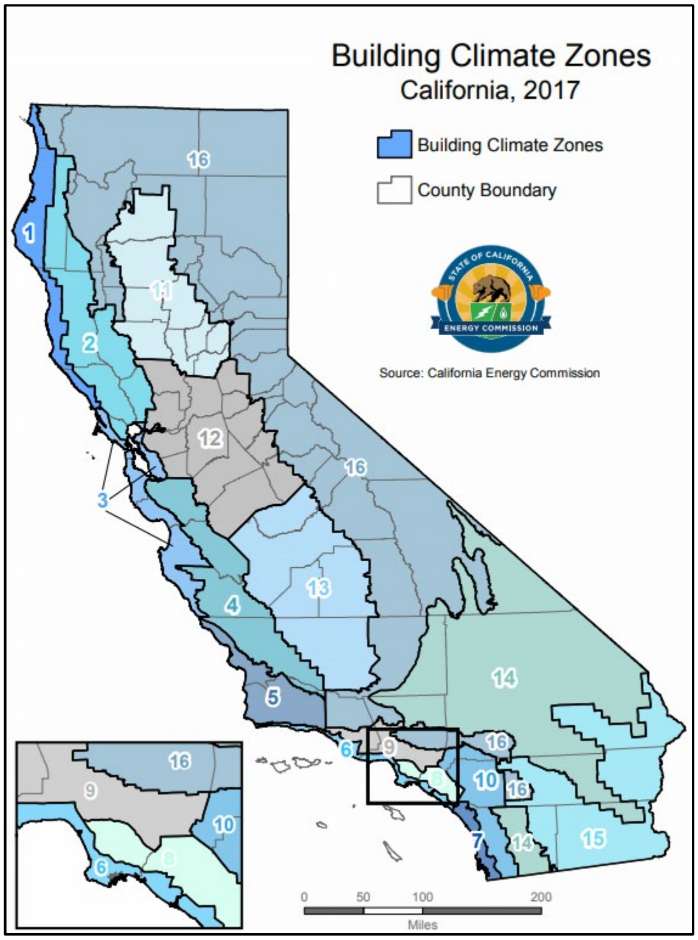

Figure 16. Map of California climate zones.

6.2 Utility Rate Schedules

The Reach Codes Team used the CA IOU and POU rate tariffs detailed below to determine the On-Bill savings for each package. The California Climate Credit was applied for both electricity and natural gas service for the IOUs using the 2023 credits shows below.[26] The credits were applied to reduce the total calculated annual bill, including any fixed fees or minimum bill amounts.

2023 Electric California Climate Credit Schedule

	February or March	April	May	June	July	Aug	Sept	Oct
PG&E	$38.39							$38.39
SCE	$71.00							$71.00
SDG&E	$60.70							$60.70

Residential Natural Gas California Climate Credit

In 2023, the 2023 Natural Gas California Climate Credit will be distributed in February or March instead of April.

	2018‡	2019	2020	2021	2022	2023	Total Value Received Per Household 2018-2023
PG&E	$30	$25	$27	$25	$48	$52.78	**$208**
SDG&E	*	$34	$21	$18	$43	$43.40	**$162**
Southwest Gas	$22	$25	$27	$28	$49	$56.35	**$207**
SoCalGas	*	$50	$26	$22	$44	$50.77	**$194**

Electricity rates reflect the most recently approved tariffs. Monthly gas rates were estimated based on recent gas rates (November 2023) and a curve to reflect how natural gas prices fluctuate with seasonal supply and demand. The seasonal curve was estimated from monthly residential tariffs between 2014 and 2023 (between 2017 and 2023 for CPAU). 12-month curves were created from monthly gas rates for each of the ten years (Seven years for CPAU). These annual curves were then averaged to arrive at an average normalized annual curve. This was conducted separately for baseline and excess energy rates. Costs used in this analysis were then derived by establishing the most recent baseline and excess rate from the latest tariff as a reference point (November 2023), and then using the normalized curve to estimate the cost for the remaining months relative to the reference point rate.

[26] https://www.cpuc.ca.gov/industries-and-topics/natural-gas/greenhouse-gas-cap-and-trade-program/california-climate-credit

6.2.1 Pacific Gas & Electric

The following pages provide details on the PG&E electricity and natural gas tariffs applied in this study. Table 20 describes the baseline territories that were assumed for each climate zone. A net surplus compensation rate of $0.07051/ kWh was applied to any net annual electricity generation based on a one-year average of the rates between December 2022 and November 2023.

Table 20. PG&E Baseline Territory by Climate Zone

Climate Zone	Baseline Territory
CZ01	V
CZ02	X
CZ03	T
CZ04	X
CZ05	T
CZ11	R
CZ12	S
CZ13	R
CZ16	Y

The PG&E monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in Table 21. These rates are based on applying a normalization curve to the November 2023 tariff based on ten years of historical gas data. Corresponding CARE rates reflect the 20 percent discount per the GL-1 tariff.

Table 21. PG&E Monthly Gas Rate ($/therm)

Month	Total Charge	
	Baseline	Excess
January	$2.05	$2.43
February	$2.08	$2.46
March	$1.92	$2.31
April	$1.80	$2.20
May	$1.77	$2.18
June	$1.78	$2.18
July	$1.80	$2.20
August	$1.85	$2.26
September	$1.92	$2.33
October	$1.99	$2.40
November	$2.06	$2.46
December	$2.05	$2.44

Residential
GAS
Baseline Territories and Quantities [1/]

Effective April 1, 2022 - Present

BASELINE QUANTITIES (Therms **Per Day** Per Dwelling Unit)

Individually Metered			
Baseline Territories	**Summer (April-October) Effective Apr. 1, 2022**	**Winter Off-Peak (Nov, Feb, Mar) Effective Nov. 1, 2022**	**Winter On-Peak (Dec, Jan) Effective Dec. 1, 2022**
P	0.39	1.88	2.19
Q	0.56	1.48	2.00
R	0.36	1.24	1.81
S	0.39	1.38	1.94
T	0.56	1.31	1.68
V	0.59	1.51	1.71
W	0.39	1.14	1.68
X	0.49	1.48	2.00
Y	0.72	2.22	2.58

Master Metered			
Baseline Territories	**Summer (April-October) Effective Apr. 1, 2022**	**Winter Off-Peak (Nov, Feb, Mar) Effective Nov. 1, 2022**	**Winter On-Peak (Dec, Jan) Effective Dec. 1, 2022**
P	0.29	1.01	1.13
Q	0.56	0.67	0.77
R	0.33	0.87	1.16
S	0.29	0.61	0.65
T	0.56	1.01	1.10
V	0.59	1.28	1.32
W	0.26	0.71	0.87
X	0.33	0.67	0.77
Y	0.52	1.01	1.13

Summer Season: Apr-Oct
Winter Off-Peak: Nov, Feb, Mar
Winter On-Peak: Dec, Jan

Advice Letter: 4589-G
Decision 21-11-016
GRC 2020 Ph II [Application 19-11-019]
Filed: Nov 22, 2019

Pacific Gas and Electric Company
U 39 Oakland, California

	Revised	*Cal. P.U.C. Sheet No.*	56550-E
Cancelling	Revised	*Cal. P.U.C. Sheet No.*	56229-E

ELECTRIC SCHEDULE E-TOU-C Sheet 2
RESIDENTIAL TIME-OF-USE (PEAK PRICING 4 - 9 p.m. EVERY DAY)

RATES:
(Cont'd.)

E-TOU-C TOTAL BUNDLED RATES

Total Energy Rates ($ per kWh)	PEAK		OFF-PEAK	
Summer				
Total Usage	$0.53933	(I)	$0.45589	(I)
Baseline Credit (Applied to Baseline Usage Only)	($0.08851)	(R)	($0.08851)	(R)
Winter				
Total Usage	$0.43662	(I)	$0.40827	(I)
Baseline Credit (Applied to Baseline Usage Only)	($0.08851)	(R)	($0.08851)	(R)
Delivery Minimum Bill Amount ($ per meter per day)	$0.37612			
California Climate Credit (per household, per semi-annual payment occurring in the March* and October bill cycles)	($38.39)			

Total bundled service charges shown on customer's bills are unbundled according to the component rates shown below. Where the delivery minimum bill amount applies, the customer's bill will equal the sum of (1) the delivery minimum bill amount plus (2) for bundled service, the generation rate times the number of kWh used. For revenue accounting purposes, the revenues from the delivery minimum bill amount will be assigned to the Transmission, Transmission Rate Adjustments, Reliability Services, Public Purpose Programs, Nuclear Decommissioning, Competition Transition Charges, Energy Cost Recovery Amount, Wildfire Fund Charge, and New System Generation Charges based on kWh usage times the corresponding unbundled rate component per kWh, with any residual revenue assigned to Distribution.

* Pursuant to D.23-02-014, disbursement of the April 2023 residential Climate Credit shall begin by March 1, 2023.

(Continued)

Advice	7009-E	*Issued by*	*Submitted*	August 25, 2023
Decision		***Meredith Allen***	*Effective*	September 1, 2023
		Vice President, Regulatory Affairs	*Resolution*	

Pacific Gas and Electric Company®
U 39 Oakland, California

	Revised	*Cal. P.U.C. Sheet No.*	56551-E
Cancelling	Revised	*Cal. P.U.C. Sheet No.*	56230-E

ELECTRIC SCHEDULE E-TOU-C Sheet 3
RESIDENTIAL TIME-OF-USE (PEAK PRICING 4 - 9 p.m. EVERY DAY)

RATES: (Cont'd.)

UNBUNDLING OF E-TOU-C TOTAL RATES

Energy Rates by Component ($ per kWh)	PEAK		OFF-PEAK	
Generation:				
Summer (all usage)	$0.19776		$0.13432	
Winter (all usage)	$0.14916		$0.12413	
Distribution:**				
Summer (all usage)	$0.17029	(I)	$0.15029	(I)
Winter (all usage)	$0.11618	(I)	$0.11286	(I)

Conservation Incentive Adjustment (Baseline Usage)	($0.02216)	(I)
Conservation Incentive Adjustment (Over Baseline Usage)	$0.06635	(I)
Transmission* (all usage)	$0.05254	
Transmission Rate Adjustments* (all usage)	$0.00059	
Reliability Services* (all usage)	$0.00069	
Public Purpose Programs (all usage)	$0.02578	
Nuclear Decommissioning (all usage)	$0.00135	
Competition Transition Charges (all usage)	$0.00030	
Energy Cost Recovery Amount (all usage)	($0.00071)	
Wildfire Fund Charge (all usage)	$0.00530	
New System Generation Charge (all usage)**	$0.00346	
Wildfire Hardening Charge (all usage)	$0.00254	
Recovery Bond Charge (all usage)	$0.00528	(R)
Recovery Bond Credit (all usage)	($0.00528)	(I)
Bundled Power Charge Indifference Adjustment (all usage)***	$0.01309	

* Transmission, Transmission Rate Adjustments and Reliability Service charges are combined for presentation on customer bills.
** Distribution and New System Generation Charges are combined for presentation on customer bills.
*** Direct Access, Community Choice Aggregation and Transitional Bundled Service Customers pay the applicable Vintaged Power Charge Indifference Adjustment. Generation and Bundled PCIA are combined for presentation on bundled customer bills.

(Continued)

Advice	7009-E	*Issued by*	*Submitted*	August 25, 2023
Decision		***Meredith Allen***	*Effective*	September 1, 2023
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Pacific Gas and Electric Company®
U 39 *Oakland, California*

	Revised	*Cal. P.U.C. Sheet No.*	56547-E
Cancelling	Revised	*Cal. P.U.C. Sheet No.*	56226-E

ELECTRIC SCHEDULE E-ELEC Sheet 2
RESIDENTIAL TIME-OF-USE (ELECTRIC HOME)
SERVICE FOR CUSTOMERS WITH QUALIFYING ELECTRIC TECHNOLOGIES

RATES:(Cont'd.)

TOTAL BUNDLED RATES

Base Services Charge ($ per meter per day) $0.49281

Total Energy Rates ($ per kWh)	PEAK		PART-PEAK		OFF-PEAK	
Summer Usage	$0.56589	(I)	$0.40401	(I)	$0.34733	(I)
Winter Usage	$0.33438	(I)	$0.31229	(I)	$0.29843	(I)

California Climate Credit (per household, per semi-annual payment occurring in the March† and October bill cycles) ($38.39)

Total bundled service charges shown on a customer's bills are unbundled according to the component rates shown below.

UNBUNDLING OF TOTAL RATES

Energy Rates by Component ($ per kWh)	PEAK		PART-PEAK		OFF-PEAK	
Generation:						
Summer Usage	$0.28164		$0.18253		$0.13743	
Winter Usage	$0.11951		$0.09954		$0.08619	
Distribution:**						
Summer Usage	$0.17932	(I)	$0.11655	(I)	$0.10497	(I)
Winter Usage	$0.10994	(I)	$0.10782	(I)	$0.10731	(I)
Transmission* (all usage)	$0.05254		$0.05254		$0.05254	
Transmission Rate Adjustments* (all usage)	$0.00059		$0.00059		$0.00059	
Reliability Services* (all usage)	$0.00069		$0.00069		$0.00069	
Public Purpose Programs (all usage)	$0.02578		$0.02578		$0.02578	
Nuclear Decommissioning (all usage)	$0.00135		$0.00135		$0.00135	
Competition Transition Charges (all usage)	$0.00030		$0.00030		$0.00030	
Energy Cost Recovery Amount (all usage)	($0.00071)		($0.00071)		($0.00071)	
Wildfire Fund Charge (all usage)	$0.00530		$0.00530		$0.00530	
New System Generation Charge (all usage)**	$0.00346		$0.00346		$0.00346	
Wildfire Hardening Charge (all usage)	$0.00254		$0.00254		$0.00254	
Recovery Bond Charge (all usage)	$0.00528	(R)	$0.00528	(R)	$0.00528	(R)
Recovery Bond Credit (all usage)	($0.00528)	(I)	($0.00528)	(I)	($0.00528)	(I)
Bundled Power Charge Indifference Adjustment (all usage)***	$0.01309		$0.01309		$0.01309	

* Transmission, Transmission Rate Adjustments and Reliability Service charges are combined for presentation on customer bills.
** Distribution and New System Generation Charges are combined for presentation on customer bills.
*** Direct Access, Community Choice Aggregation and Transitional Bundled Service Customers pay the applicable Vintaged Power Charge Indifference Adjustment. Generation and Bundled PCIA are combined for presentation on bundled customer bills.
† Pursuant to D.23-02-014, disbursement of the April 2023 residential Climate Credit shall begin by March 1, 2023.

(Continued)

Advice	7009-E	*Issued by*	*Submitted*	August 25, 2023
Decision		***Meredith Allen***	*Effective*	September 1, 2023
		Vice President, Regulatory Affairs	*Resolution*	

Pacific Gas and Electric Company®
U 39 San Francisco, California

Original *Cal. P.U.C. Sheet No.* 54738-E

ELECTRIC SCHEDULE E-ELEC Sheet 3 (N)
RESIDENTIAL TIME-OF-USE (ELECTRIC HOME) (N)
SERVICE FOR CUSTOMERS WITH QUALIFYING ELECTRIC TECHNOLOGIES

SPECIAL CONDITIONS:

1. TIME PERIODS: Times of the year and times of the day are defined as follows: (N)

   All Year:

   Peak: 4:00 p.m. to 9:00 p.m. every day including weekends and holidays.

   Partial-Peak: 3:00 p.m. to 4:00 p.m. and 9:00 p.m. to 12:00 a.m. every day including weekends and holidays.

   Off-Peak: All other hours.

2. SEASONAL CHANGES: The summer season is June 1 through September 30 and the winter season is October 1 through May 31. When billing includes use in both the summer and winter periods, charges will be prorated based upon the number of days in each period.

3. ADDITIONAL METERS: If a residential dwelling unit is served by more than one electric meter, the customer must designate which meter is the primary meter and which is (are) the additional meter(s).

4. BILLING: A customer's bill is calculated based on the option applicable to the customer.

   Bundled Service Customers receive generation and delivery services solely from PG&E. The customer's bill is based on the Unbundling of Total Rates set forth above.

   Transitional Bundled Service (TBS) Customers take TBS as prescribed in Rules 22.1 and 23.1, or take PG&E bundled service prior to the end of the six (6) month advance notice period required to elect PG&E bundled service as prescribed in Rules 22.1 and 23.1. TBS customers shall pay all charges shown in the Unbundling of Total Rates except for the Bundled Power Charge Indifference Adjustment and the generation charge. TBS customers shall also pay for their applicable Vintaged Power Charge Indifference Adjustment provided in the table below, and the short-term commodity prices as set forth in Schedule TBCC. (N)

(Continued)

Advice	6768-E	*Issued by*	*Submitted*	November 18, 2022
Decision	D.21-11-016	***Meredith Allen***	*Effective*	December 1, 2022
		Vice President, Regulatory Affairs	*Resolution*	

Pacific Gas and Electric Company®
U 39 San Francisco, California

	Revised	*Cal. P.U.C. Sheet No.*	54734-E
Cancelling	Revised	*Cal. P.U.C. Sheet No.*	53424-E

ELECTRIC SCHEDULE D-CARE Sheet 1

LINE-ITEM DISCOUNT FOR CALIFORNIA ALTERNATE RATES FOR ENERGY (CARE) CUSTOMERS

APPLICABILITY: This schedule is applicable to single-phase and polyphase residential service in single-family dwellings and in flats and apartments separately metered by PG&E and domestic submetered tenants residing in multifamily accommodations, mobilehome parks and to qualifying recreational vehicle parks and marinas and to farm service on the premises operated by the person whose residence is supplied through the same meter, where the applicant qualifies for California Alternate Rates for Energy (CARE) under the eligibility and certification criteria set forth in Electric Rule 19.1. CARE service is available on Schedules E-1, E-6, E-TOU-B, E-TOU-C, E-TOU-D, EV2, E-ELEC, EM, ES, ESR, ET and EM-TOU. (T)

TERRITORY: This rate schedule applies everywhere PG&E provides electric service.

RATES: Customers taking service on this rate schedule whose otherwise applicable rate (N) schedule has no Delivery Minimum Bill Amount (Schedule E-ELEC) will receive a | CARE percentage discount of 35.000% on their total bundled charges (except for | the California Climate Credit, which will not be discounted). (N) Customers taking service on this rate schedule whose otherwise applicable rate schedule has a (T) Delivery Minimum Bill Amount (all other schedules) will receive a CARE | percentage discount ("A" or "C" below) on their total bundled charges on their (T) otherwise applicable rate schedule (except for the California Climate Credit, which will not be discounted) and also will receive a percentage discount ("B" or "D" (T) below) on the delivery minimum bill amount, if applicable. The CARE discount will be calculated for direct access and community choice aggregation customers based on the total charges as if they were subject to bundled service rates. Discounts will be applied as a residual reduction to distribution charges, after D-CARE customers are exempted from the Wildfire Fund Charge, Recovery Bond Charge, Recovery Bond Credit, and the CARE surcharge portion of the public purpose program charge used to fund the CARE discount. These conditions also apply to master-metered customers and to qualified sub-metered tenants where the master-meter customer is jointly served under PG&E's Rate Schedule D-CARE and either Schedule EM, ES, ESR, ET, or EM-TOU.

For master-metered customers where one or more of the submetered tenants qualifies for CARE rates under the eligibility and certification criteria set forth in Rule 19.1, 19.2, or 19.3, the CARE discount is equal to a percentage ("C" below) of the total bundled charges, multiplied by the number of CARE units divided by the total number of units. In addition, master-metered customers eligible for D-CARE will receive a percentage discount ("D" below) on the delivery minimum bill amount, if applicable.

It is the responsibility of the master-metered customer to advise PG&E within 15 days following any change in the number of dwelling units and/or any decrease in the number of qualifying CARE applicants that results when such applicants move out of their submetered or non-submetered dwelling unit, or submetered permanent-residence RV or permanent-residence boat.

(L)
|
(L)

(Continued)

Pacific Gas and Electric Company®
U 39 San Francisco, California

	Revised	Cal. P.U.C. Sheet No.	56208-E
Cancelling	Revised	Cal. P.U.C. Sheet No.	56020-E

ELECTRIC SCHEDULE D-CARE Sheet 2

LINE-ITEM DISCOUNT FOR CALIFORNIA ALTERNATE RATES FOR ENERGY (CARE) CUSTOMERS

RATES: (Cont'd)

A. D-CARE Discount:	34.965	% (Percent)	(I)
B. Delivery Minimum Bill Discount:	50.000	% (Percent)	
C. Master-Meter D-CARE Discount:	34.965	% (Percent)	(I)
D. Master-Meter Delivery Minimum Bill Discount:	50.000	% (Percent)	

SPECIAL CONDITIONS:

1. OTHERWISE APPLICABLE SCHEDULE: The Special Conditions of the Customer's otherwise applicable rate schedule will apply to this schedule.

2. ELIGIBILITY: To be eligible to receive D-CARE the applicant must qualify under the criteria set forth in PG&E's Electric Rules 19.1, 19.2, and 19.3 and meet the certification requirements thereof to the satisfaction of PG&E. Qualifying Direct Access, Community Choice Aggregation Service, and Transitional Bundled Service customers are also eligible to take service on Schedule D-CARE. Applicants may qualify for D-CARE at their primary residence only. Customers or sub-metered tenants participating in the Family Electric Rate Assistance (FERA) program cannot concurrently participate in the CARE program.

Advice	6968-E	*Issued by*	*Submitted*	June 23, 2023
Decision		***Meredith Allen***	*Effective*	July 1, 2023
		Vice President, Regulatory Affairs	*Resolution*	

6.2.2 Southern California Edison

The following pages provide details on the SCE electricity tariffs applied in this study. Table 22 describes the baseline territories that were assumed for each climate zone. A net surplus compensation rate of $ 0.06030/ kWh was applied to any net annual electricity generation based on a one-year average of the rates between December 2022 and November 2023

Table 22: SCE Baseline Territory by Climate Zone

Climate Zone	Baseline Territory
CZ06	6
CZ08	8
CZ09	9
CZ10	10
CZ14	14
CZ15	15

Summer Daily Allocations (June through September)

Baseline Region Number	Daily kWh Allocation	All-Electric Allocation
5	17.2	17.9
6	11.4	8.8
8	12.6	9.8
9	16.5	12.4
10	18.9	15.8
13	22.0	24.6
14	18.7	18.3
15	46.4	24.1
16	14.4	13.5

Winter Daily Allocations (October through May)

Baseline Region Number	Daily kWh Allocation	All-Electric Allocation
5	18.7	29.1
6	11.3	13.0
8	10.6	12.7
9	12.3	14.3
10	12.5	17.0
13	12.6	24.3
14	12.0	21.3
15	9.9	18.2
16	12.6	23.1

Schedule TOU-D
TIME-OF-USE
DOMESTIC
(Continued)
Sheet 12 (T)

SPECIAL CONDITIONS

1. Applicable rate time periods are defined as follows:

Option 4-9 PM, Option 4-9 PM-CPP, Option PRIME, Option PRIME-CPP : (T)

TOU Period	Weekdays		Weekends and Holidays	
	Summer	Winter	Summer	Winter
On-Peak	4 p.m. - 9 p.m.	N/A	N/A	N/A
Mid-Peak	N/A	4 p.m. - 9 p.m.	4 p.m. - 9 p.m.	4 p.m. - 9 p.m.
Off-Peak	All other hours	9 p.m. - 8 a.m.	All other hours	9 p.m. - 8 a.m.
Super-Off-Peak	N/A	8 a.m. - 4 p.m.	N/A	8 a.m. - 4 p.m.
CPP Event Period	4 p.m. - 9 p.m.	4 p.m. - 9 p.m.	N/A	N/A

Southern California Edison Revised Cal. PUC Sheet No. 85111-E
Rosemead, California (U 338-E) Cancelling Revised Cal. PUC Sheet No. 74502-E

Schedule TOU-D
TIME-OF-USE
DOMESTIC
(Continued)

Sheet 2

RATES

Customers receiving service under this Schedule will be charged the applicable rates under Option 4-9 PM, Option 4-9 PM-CPP, Option 5-8 PM, Option 5-8 PM-CPP, Option PRIME, Option PRIME-CPP Option A, Option A-CPP, Option B, or Option B-CPP, as listed below. CPP Event Charges will apply to all energy usage during CPP Event Energy Charge periods and CPP Non-Event Energy Credits will apply as a reduction on CPP Non-Event Energy Credit Periods during Summer Season days, 4:00 p.m. to 9:00 p.m., as described in Special Conditions 1 and 3, below:

	Delivery Service	Generation[2]	
Option 4-9 PM / Option 4-9 PM-CPP	Total[1]	UG***	DWREC[3]
Energy Charge - $/kWh			
Summer Season - On-Peak	0.28829 (R)	0.28543 (I)	0.00000
Mid-Peak	0.28829 (R)	0.17707 (I)	0.00000
Off-Peak	0.24482 (R)	0.11382 (I)	0.00000
Winter Season - Mid-Peak	0.28829 (R)	0.21752 (I)	0.00000
Off-Peak	0.24482 (R)	0.13851 (I)	0.00000
Super-Off-Peak	0.22919 (R)	0.11890 (I)	0.00000
Baseline Credit**** - $/kWh	(0.09759) (I)	0.00000	
Fixed Recovery Charge - $/kWh	0.00090 (R)		
Basic Charge - $/day			
Single-Family Residence	0.031		
Multi-Family Residence	0.024		
Minimum Charge** - $/day			
Single Family Residence	0.346		
Multi-Family Residence	0.346		
Minimum Charge (Medical Baseline)** - $/day			
Single Family Residence	0.173		
Multi-Family Residence	0.173		
California Climate Credit[10]	(71.00) (I)		
California Alternate Rates for Energy Discount - %	100.00*		
Family Electric Rate Assistance Discou	100.00		
Option 4-9 PM-CPP			
CPP Event Energy Charge - $/kWh		0.80000	
Summer CPP Non-Event Credit On-Peak Energy Credit - $/kWh		(0.15170)	
Maximum Available Credit - $/kWh**** Summer Season		(0.67183) (R)	

* Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.
** The Minimum Charge is applicable when the Delivery Service Energy Charge, plus the applicable Basic Charge is less than the Minimum Charge.
*** The ongoing Competition Transition Charge CTC of ($0.00003) per kWh is recovered in the UG component of Generation. (I)
**** The Baseline Credit applies up to 100% of the Baseline Allocation, regardless of Time-of-Use time period. Additional Baseline Allocations apply for Customers with Heat Pump Water Heaters served under this Option. The Baseline Allocations are set forth in Preliminary Statement, Part H.
***** The Maximum Available Credit is the capped credit amount for CPP Customers dual participating in other demand response programs.
1 Total = Total Delivery Service rates are applicable to Bundled Service, Direct Access (DA) and Community Choice Aggregation Service (CCA Service) Customers, except DA and CCA Service Customers are not subject to the DWRBC rate component of this Schedule but instead pay the DWRBC as provided by Schedule DA-CRS or Schedule CCA-CRS.
2 Generation = The Gen rates are applicable only to Bundled Service Customers. See Special Condition below for PCIA recovery.
3 DWREC = Department of Water Resources (DWR) Energy Credit – For more information on the DWR Energy Credit, see the Billing Calculation Special Condition of this Schedule.
4 Applied on an equal basis, per household, semi-annually. See the Special Conditions of this Schedule for more information.

(Continued)

(To be inserted by utility)		Issued by	(To be inserted by Cal. PUC)	
Advice	4929-E	Michael Backstrom	Date Submitted	Dec 28, 2022
Decision		Vice President	Effective	Jan 1, 2023
2H13			Resolution	E-5217

EDISON

Southern California Edison — Revised — Cal. PUC Sheet No. 86132-E
Rosemead, California (U 338-E) — Cancelling Revised — Cal. PUC Sheet No. 85624-E

Schedule TOU-D
TIME-OF-USE
DOMESTIC
(Continued)

Sheet 6

RATES (Continued)

Option PRIME / Option PRIME-CPP	Delivery Service Total[1]	Generation[2] UG**	Generation[2] DWREC[3]
Energy Charge - $/kWh/Meter/Day			
Summer Season			
On-Peak	0.22789 (I)	0.42769 (I)	0.00000
Mid-Peak	0.22789 (I)	0.15221 (I)	0.00000
Off-Peak	0.15191 (I)	0.10162 (I)	0.00000
Winter Season			
Mid-Peak	0.23353 (I)	0.36028 (I)	0.00000
Off-Peak	0.14530 (I)	0.08630 (I)	0.00000
Super-Off-Peak	0.14530 (I)	0.08630 (I)	0.00000
Fixed Recovery Charge - $/kWh	0.00260 (I)		
Basic Charge - $/Meter/Day	0.427 (I)		
EV Meter Credit (Separately Metered E	(0.323) (N)		
EV Submeter Credit - $/Meter/Day	(0.111) (R)		
California Climate Credit[10]	(71.00)		
California Alternate Rates for Energy Discount - %	100.00*		
Family Electric Rate Assistance Discou	100.00		
Medical Line Item Discount - %	100.000		
Option PRIME-CPP			
CPP Event Energy Charge - $/kWh		0.80000	
Summer CPP Non-Event Credit			
On-Peak Energy Credit - $/kWh		(0.15170)	
Maximum Available Credit - $/kWh****			
Summer Season		(0.71812) (R)	

* Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.
** The ongoing Competition Transition Charge (CTC) of ($0.00003) per kWh is recovered in the UG component of Generation.
**** The Maximum Available Credit is the capped credit amount for CPP Customers dual participating in other demand response programs.
1 Total = Total Delivery Service rates are applicable to Bundled Service, Direct Access (DA) and Community Choice Aggregation Service (CCA Service) Customers, except DA and CCA Service Customers are not subject to the DWRBC rate component of this Schedule but instead pay the DWRBC as provided by Schedule DA-CRS or Schedule CCA-CRS.
2 Generation = The Gen rates are applicable only to Bundled Service Customers. See Special Condition below for PCIA recovery.
3 DWREC = Department of Water Resources (DWR) Energy Credit – For more information on the DWR Energy Credit, see the Billing Calculation Special Condition of this Schedule.
4 Applied on an equal basis, per household, semi-annually. See the Special Conditions of this Schedule for more information.

(Continued)

(To be inserted by utility)
Advice 5041-E
Decision
6H9

Issued by
Michael Backstrom
Vice President

(To be inserted by Cal. PUC)
Date Submitted May 30, 2023
Effective Jun 1, 2023
Resolution

Southern California Edison Revised Cal. PUC Sheet No. 85618-E
Rosemead, California (U 338-E) Cancelling Revised Cal. PUC Sheet No. 85109-E

Schedule D-CARE Sheet 1
CALIFORNIA ALTERNATE RATES FOR ENERGY
DOMESTIC SERVICE

APPLICABILITY

Applicable to domestic service to CARE households residing in a permanent Single-Family Accommodation or Multifamily Accommodation where the customer meets all the Special Conditions of this Schedule. Customers enrolled in the CARE program are not eligible for the Family Electric Rate Assistance (FERA) program.

Pursuant to Special Condition 12 herein, customers receiving service under this Schedule are eligible to receive the California Climate Credit as shown in the Rates section below.

TERRITORY

Within the entire territory served.

RATES

The applicable charges set forth in Schedule D shall apply to Customers served under this Schedule.

CARE Discount:

A 29.8 percent discount is applied to a CARE Customer's bill prior to the application of the Public Utilities Commission Reimbursement Fee (PUCRF) and any applicable user fees, taxes, and late payment charges. CARE Customers are required to pay the PUCRF and any applicable user fees, taxes, and late payment charges in full. In addition, CARE Customers are exempt from paying the CARE Surcharge of $0.00888 per kWh and the Wildfire Fund Non-Bypassable Charge of $0.00530 per kWh. The 29.8 percent discount, in addition to these exemptions result in an average effective CARE Discount of 32.5 percent. (R)

(Continued)

(To be inserted by utility)		Issued by	(To be inserted by Cal. PUC)	
Advice	4977-E	Michael Backstrom	Date Submitted	Feb 27, 2023
Decision	23-01-002	Vice President	Effective	Mar 1, 2023
1H12	22-12-031		Resolution	

6.2.3 Southern California Gas

Following are the SoCalGas natural gas tariffs applied in this study. Table 23 describes the baseline territories that were assumed for each climate zone.

Table 23. SoCalGas Baseline Territory by Climate Zone

Climate Zone	Baseline Territory
CZ05	2
CZ06	1
CZ08	1
CZ09	1
CZ10	1
CZ14	2
CZ15	1

The SoCalGas monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in Table 24. These rates are based on applying a normalization curve to the November 2023 tariff based on ten years of historical gas data. Long-term historical natural gas rate data was only available for SoCalGas' procurement charges.[27] The baseline and excess transmission charges were found to be consistent over the course of a year and applied for the entire year based on 2023 rates. CARE rates reflect the 20 percent discount per the GR tariff.

Table 24. SoCalGas Monthly Gas Rate ($/therm)

Month	Procurement Charge	Transportation Charge		Total Charge	
		Baseline	Excess	Baseline	Excess
January	$0.72	$0.86	$1.31	$1.92	$2.36
February	$0.50	$0.86	$1.31	$1.57	$2.02
March	$0.44	$0.86	$1.31	$1.48	$1.93
April	$0.39	$0.86	$1.31	$1.39	$1.84
May	$0.41	$0.86	$1.31	$1.43	$1.87
June	$0.46	$0.86	$1.31	$1.49	$1.93
July	$0.47	$0.86	$1.31	$1.51	$1.96
August	$0.51	$0.86	$1.31	$1.58	$2.03
September	$0.46	$0.86	$1.31	$1.52	$1.96
October	$0.45	$0.86	$1.31	$1.48	$1.92
November	$0.48	$0.86	$1.31	$1.54	$1.99
December	$0.57	$0.86	$1.31	$1.63	$2.08

Southern California Gas Company
Residential Rates
Nov-23

Customer Type / Rate Schedule	Commodity Charge	Rate Type	Procurement Charge ¢/therm	Transportation Charge ¢/therm	New Rate Effective 11/1/2023	New Rate Effective 10/1/2023	Absolute Rate Change	% Change
Residential Individually Metered								
Schedule No. GR	GR	Baseline	67.806	86.490	154.296	125.096	29.200	23.3%
Res. Service	GR	Non Baseline	67.806	131.037	198.843	169.726	29.117	17.2%
	GT-R	Baseline	00.000	86.490	86.490	87.038	-00.548	-0.6%
	GT-R	Non Baseline	00.000	131.037	131.037	131.668	-00.631	-0.5%

[27] The SoCalGas procurement and transmission charges were obtained from the following site: https://www.socalgas.com/for-your-business/energy-market-services/gas-prices RES2023.xlsx (live.com)

6.2.4 San Diego Gas & Electric

Following are the SDG&E electricity and natural gas tariffs applied in this study. Table 25 describes the baseline territories that were assumed for each climate zone. A net surplus compensation rate of $0.04542/ kWh was applied to any net annual electricity generation based on a one-year average of the rates between December 2022 and November 2023.

Table 25. SDG&E Baseline Territory by Climate Zone

Climate Zone	Baseline Territory
CZ07	Coastal
CZ10	Inland
CZ14	Mountain

The SDG&E monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in Table 26. These rates are based on applying a normalization curve to the November 2023 tariff based on ten years of historical gas data. CARE rates reflect the 20 percent discount per the G-CARE tariff.

Table 26. SDG&E Monthly Gas Rate ($/therm)

Month	Total Charge	
	Baseline	Excess
January	$2.34	$2.63
February	$2.28	$2.57
March	$2.21	$2.51
April	$2.14	$2.45
May	$2.18	$2.48
June	$2.23	$2.55
July	$2.26	$2.57
August	$2.32	$2.62
September	$2.26	$2.59
October	$2.21	$2.55
November	$2.24	$2.57
December	$2.38	$2.70

Baseline Usage: The following quantities of gas used in individually metered residences are to be billed at the baseline rates:

All Customers:	Daily Therm Allowance
Summer (May to Oct)	0.359
Winter On-Peak (Dec, Jan & Feb)	1.233
Winter Off-Peak (Nov, Mar, & Apr)	0.692

SDGE
San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 37022-E
Canceling Revised Cal. P.U.C. Sheet No. 36337-E

Sheet 2

SCHEDULE TOU-DR1

RESIDENTIAL TIME-OF-USE

RATES

Total Rates:

Description – TOU DR1	UDC Total Rate		DWR BC + WF-NBC		EECC Rate + DWR Credit		Total Rate	
Summer:								
On-Peak	0.25752	R	0.00530	I	0.57043	I	0.83325	I
Off-Peak	0.25752	R	0.00530	I	0.25697	I	0.51979	I
Super Off-Peak	0.25752	R	0.00530	I	0.09233	I	0.35515	I
Winter:								
On-Peak	0.43809	I	0.00530	I	0.19307	I	0.63646	I
Off-Peak	0.43809	I	0.00530	I	0.10855	I	0.55194	I
Super Off-Peak	0.43809	I	0.00530	I	0.08402	I	0.52741	I
Summer Baseline Adjustment Credit up to 130% of Baseline	(0.11724)	R					(0.11724)	R
Winter Baseline Adjustment Credit up to 130% of Baseline	(0.11724)	R					(0.11724)	R
Minimum Bill ($/day)	0.380	I					0.380	I

Description – TOU DR1-CARE	UDC Total Rate		DWR BC + WF-NBC	EECC Rate + DWR Credit		Total Rate		Total Effective Care Rate	
Summer – CARE Rates:									
On-Peak	0.25682	R	0.00000	0.57043	I	0.82725	I	0.55366	I
Off-Peak	0.25682	R	0.00000	0.25697	I	0.51379	I	0.33965	I
Super Off-Peak	0.25682	R	0.00000	0.09233	I	0.34915	I	0.22725	I
Winter – CARE Rates:									
On-Peak	0.43739	I	0.00000	0.19307	I	0.63046	I	0.41930	I
Off-Peak	0.43739	I	0.00000	0.10855	I	0.54594	I	0.36160	I
Super Off-Peak	0.43739	I	0.00000	0.08402	I	0.52141	I	0.34485	I
Summer Baseline Adjustment Credit up to 130% of Baseline	(0.11724)	R				(0.11724)	R	(0.08004)	R
Winter Baseline Adjustment Credit up to 130% of Baseline	(0.11724)	R				(0.11724)	R	(0.08004)	R
Minimum Bill ($/day)	0.190	I				0.190	I	0.190	I

Note:
(1) Total Rates consist of UDC, Schedule DWR-BC (Department of Water Resources Bond Charge), Schedule WF-NBC (CA Wildfire Fund charge) and Schedule EECC (Electric Energy Commodity Cost) rates, with the EECC rates reflecting a DWR Credit. EECC rates are applicable to bundled customers only. See Special Condition 16 for PCIA (Power Charge Indifference Adjustment) recovery.
(2) Total Rates presented are for customers that receive commodity supply and delivery service from Utility.
(3) DWR-BC and WF-NBC charges do not apply to CARE customers.
(4) As identified in the rates tables, customer bills will also include line-item summer and winter credits for usage up to 130% of baseline to provide the rate capping benefits adopted by Assembly Bill 1X and Senate Bill 695. R, I
(5) WF-NBC rate is 0.00530 + DWR-BC Bond Charge is 0.00000 .

(Continued)

2C8 | Issued by | Submitted Dec 30, 2022
Advice Ltr. No. 4129-E | **Dan Skopec** | Effective Jan 1, 2023
Decision No. | Senior Vice President Regulatory Affairs | Resolution No. E-5217

Time Periods

All time periods listed are applicable to local time. The definition of time will be based upon the date service is rendered.

TOU Periods – Weekdays	Summer	Winter
On-Peak	4:00 p.m. – 9:00 p.m.	4:00 p.m. – 9:00 p.m.
Off-Peak	6:00 a.m. – 4:00 p.m.; 9:00 p.m. - midnight	6:00 a.m. – 4:00 p.m. Excluding 10:00 a.m. – 2:00 p.m. in March and April; 9:00 p.m. - midnight
Super Off-Peak	Midnight – 6:00 a.m.	Midnight – 6:00 a.m. 10:00 a.m. – 2:00 p.m. in March and April
TOU Period – Weekends and Holidays	Summer	Winter
On-Peak	4:00 p.m. – 9:00 p.m.	4:00 p.m. – 9:00 p.m.
Off-Peak	2:00 p.m. – 4:00 p.m.; 9:00 p.m. - midnight	2:00 p.m. – 4:00 p.m.; 9:00 p.m. - midnight
Super Off-Peak	Midnight – 2:00 p.m.	Midnight – 2:00 p.m.

Seasons: Summer June 1 – October 31
Winter November 1 – May 31

15. Baseline Usage: The following quantities of electricity are used to calculate the baseline adjustment credit.

	Baseline Allowance For Climatic Zones*			
	Coastal	Inland	Mountain	Desert
Basic Allowance				
Summer (June 1 to October 31)	9.0	10.4	13.6	15.9
Winter (November 1 to May 31)	9.2	9.6	12.9	10.9
All Electric**				
Summer (June 1 to October 31)	6.0	8.7	15,2	17.0
Winter (November 1 to May 31)	8.8	12.2	22.1	17.1

* Climatic Zones are shown on the Territory Served, Map No. 1.
** All Electric allowances are available upon application to those customers who have permanently installed space heating or who have electric water heating and receive no energy from another source.

San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 37217-E

Canceling Revised Cal. P.U.C. Sheet No. 37016-E

SCHEDULE EV-TOU-5

Sheet 1

COST-BASED DOMESTIC TIME-OF-USE FOR HOUSEHOLDS WITH ELECTRIC VEHICLES

APPLICABILITY

Service under this schedule is specifically limited to customers who require service for charging of a currently registered Motor Vehicle, as defined by the California Motor Vehicle Code, which is: 1) a battery electric vehicle (BEV) or plug-in hybrid electric vehicle (PHEV) recharged via a recharging outlet at the customer's premises; or 2) a natural gas vehicle (NGV) refueled via a home refueling appliance (HRA) at the customer's premises. This schedule is not available to customers with a conventional charge sustaining (battery recharged solely from the vehicle's on-board generator) hybrid electric vehicle (HEV).

Residential customers taking service on Schedule NBT, who are required to utilize EV-TOU-5 as their otherwise applicable schedule (OAS) for electric service, do not require a qualifying motor vehicle, as described above to participate on Schedule EV-TOU-5. N N N

Customers on this schedule may also qualify for a semi-annual California Climate Credit $(60.70) per Schedule GHG-ARR.

TERRITORY

Within the entire territory served by the utility.

RATES

Total Rates:

Description – EV-TOU-5 Rates	UDC Total Rate		DWR BC + WF-NBC		EECC Rate + DWR Credit		Total Rate	
Basic Service Fee	16.00						16.00	
Summer								
On-Peak	0.28032	I	0.00530	I	0.53067	I	0.81629	I
Off-Peak	0.28032	I	0.00530	I	0.19567	I	0.48129	I
Super Off-Peak	0.05588	I	0.00530	I	0.09233	I	0.15351	I
Winter								
On-Peak	0.28032	I	0.00530	I	0.22587	I	0.51149	I
Off-Peak	0.28032	I	0.00530	I	0.16213	I	0.44775	I
Super Off-Peak	0.05588	I	0.00530	I	0.08402	I	0.14520	I

(Continued)

1C5

Issued by

Advice Ltr. No. 4154-E

Decision No. D.22-12-056

Submitted Jan 30, 2023

Effective Mar 1, 2023

Resolution No.

SDGE
San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 37019-E

Canceling Revised Cal. P.U.C. Sheet No. 35912-E

Sheet 4

SCHEDULE EV-TOU-5

COST-BASED DOMESTIC TIME-OF-USE FOR HOUSEHOLDS WITH ELECTRIC VEHICLES

Notes: Transmission Energy charges include the Transmission Revenue Balancing Account Adjustment (TRBAA) of $(0.00242) per kWh and the Transmission Access Charge Balancing Account Adjustment (TACBAA) of $(0.01631) per kWh. PPP Energy charges includes Low Income PPP rate (LI-PPP) $0.01669/kWh, Non-low Income PPP rate (Non-LI-PPP) $0.00333/kWh (pursuant to PU Code Section 399.8, the Non-LI-PPP rate may not exceed January 1, 2000 levels), Procurement Energy Efficiency Surcharge Rate of $0.00422 /kWh, California Solar Initiative rate (CSI) of $0.00000/kWh and Self-Generation Incentive Program rate (SGIP) $0.00122/kWh. The basic service fee of $16 per month is applied to a customer's bill and a 50% discount is applied for CARE, Medical Baseline, or Family Electric Rate Assistance Program (FERA) customers resulting in their basic service fees to be $8 per month. R, R I R I I

Rate Components
The Utility Distribution Company Total Rates (UDC Total) shown above are comprised of the following components (if applicable): (1) Transmission (Trans) Charges, (2) Distribution (Distr) Charges, (3) Public Purpose Program (PPP) Charges, (4) Nuclear Decommissioning (ND) Charge, (5) Ongoing Competition Transition Charges (CTC), (6) Local Generation Charge (LGC), (7) Reliability Services (RS), and (8) the Total Rate Adjustment Component (TRAC).

Certain Direct Access customers are exempt from the TRAC, as defined in Rule 1 – Definitions.

Franchise Fee Differential
A Franchise Fee Differential of 5.78% will be applied to the monthly billings calculated under this schedule for all customers within the corporate limits of the City of San Diego. Such Franchise Fee Differential shall be so indicated and added as a separate item to bills rendered to such customers.

Time Periods:

All time periods listed are applicable to actual "clock" time)

TOU Period – Weekdays	Summer	Winter
On-Peak	4:00 p.m. – 9:00 p.m.	4:00 p.m. – 9:00 p.m.
Off-Peak	6:00 a.m. – 4:00 p.m.; 9:00 p.m. – midnight	6:00 a.m. – 4:00 p.m. Excluding 10:00 a.m.–2:00 p.m.in March and April; 9:00 p.m. - midnight
Super-Off-Peak	Midnight – 6:00 a.m.	Midnight – 6:00 a.m. 10:00 a.m. – 2:00 p.m. in March and April

TOU Period – Weekends and Holidays	Summer	Winter
On-Peak	4:00 p.m. – 9:00 p.m.	4:00 p.m. – 9:00 p.m.
Off-Peak	2:00 p.m. – 4:00 p.m.; 9:00 p.m. – midnight	2:00 p.m. – 4:00 p.m. 9:00 p.m. - midnight
Super-Off-Peak	Midnight – 2:00 p.m.	Midnight – 2:00 p.m.

Seasons:

Summer June 1 – October 31

Winter November 1 – May 31

(Continued)

4C8

Advice Ltr. No. 4129-E	Issued by **Dan Skopec**	Submitted	Dec 30, 2022
	Senior Vice President	Effective	Jan 1, 2023
Decision No.	Regulatory Affairs	Resolution No.	E-5217

San Diego Gas & Electric Company
San Diego, California

Original Cal. P.U.C. Sheet No. 37195-E

Canceling Cal. P.U.C. Sheet No.

SCHEDULE TOU-ELEC

Sheet 1 N

DOMESTIC TIME-OF-USE FOR HOUSEHOLDS WITH ELECTRIC VEHICLES, ENERGY STORAGE, OR ELECTRIC HEAT PUMPS N

APPLICABILITY N

Service under this schedule is available on a voluntary basis for all residential customers who meet one or more of the following criteria: 1) require service for charging of a currently registered Motor Vehicle, as defined by the California Motor Vehicle Code, which is: a) a battery electric vehicle (BEV) or plug-in hybrid electric vehicle (PHEV) recharged via a recharging outlet at the customer's premises; or b) a natural gas vehicle (NGV) refueled via a home refueling appliance (HRA) at the customer's premises; 2) have a behind-the-meter energy storage device that is interconnected through Electric Rule 21; or 3) have an electric heat pump for water heating or climate control. This schedule is not available to customers with a conventional charge sustaining (battery recharged solely from the vehicle's on-board generator) hybrid electric vehicle (HEV).

This schedule is also available to customers who meet the above criteria as well as qualify for the California Alternate Rates for Energy (CARE) Program as outlined in Schedule E-CARE, and/or Medical Baseline as outlined in Special Condition (SC) 5. The rates for CARE customers and/or Medical Baseline are identified in the rate tables below as TOU-ELEC-CARE and TOU-ELEC-MB rates, respectively.

There is a cap of 10,000 customers who may take service on this rate, as defined in SC 10.

Pursuant to D.22-11-022, customers that opt-in to schedule TOU-ELEC within its first year of being offered have the option to return to their previous rate schedule prior to the 12-month requirement. See SC4 Terms of Service for all requirements.

Customers on this schedule may also qualify for a semi-annual California Climate Credit $(60.70) per Schedule GHG-ARR.

TERRITORY

Within the entire territory served by the utility.

RATES

Total Rates:

Description – TOU-ELEC Rates	UDC Total Rate	DWR BC + WF-NBC	EECC Rate	Total Rate
Monthly Service Fee	16.00			16.00
Summer				
On-Peak	0.22228	0.00530	0.51568	0.74326
Off-Peak	0.22228	0.00530	0.14644	0.37402
Super Off-Peak	0.22228	0.00530	0.09785	0.32543
Winter				
On-Peak	0.22228	0.00530	0.27460	0.50218
Off-Peak	0.22228	0.00530	0.13323	0.36081
Super Off-Peak	0.22228	0.00530	0.08905	0.31663

N

(Continued)

1H6 Issued by Submitted Jan 31, 2023

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Decision No. D.22-11-022 Resolution No.

SDGE
San Diego Gas & Electric Company
San Diego, California

Original Cal. P.U.C. Sheet No. 37196-E

Canceling Cal. P.U.C. Sheet No.

SCHEDULE TOU-ELEC

Sheet 2 N

DOMESTIC TIME-OF-USE FOR HOUSEHOLDS WITH ELECTRIC VEHICLES, ENERGY STORAGE, OR ELECTRIC HEAT PUMPS N

RATES (Continued) N

Description – TOU-ELEC CARE Rates	UDC Total Rate	DWR BC + WF-NBC	EECC Rate	Total Rate	Total Effective CARE Rate
Monthly Service Fee	16.00			16.00	16.00
Summer – CARE Rates:					
On-Peak	0.22158	0.00000	0.51568	0.73726	0.49222
Off-Peak	0.22158	0.00000	0.14644	0.36802	0.24013
Super Off-Peak	0.22158	0.00000	0.09785	0.31943	0.20696
Winter – CARE Rates:					
On-Peak	0.22158	0.00000	0.27460	0.49618	0.32763
Off-Peak	0.22158	0.00000	0.13323	0.35481	0.23111
Super Off-Peak	0.22158	0.00000	0.08905	0.31063	0.20095

Description – TOU-ELEC MB Rates	UDC Total Rate	DWR BC + WF-NBC	EECC Rate	Total Rate	Total Effective MB Rate
Monthly Service Fee	16.00			16.00	16.00
Summer – MB Rates:					
On-Peak	0.22228	0.00000	0.51568	0.73796	0.59037
Off-Peak	0.22228	0.00000	0.14644	0.36872	0.29498
Super Off-Peak	0.22228	0.00000	0.09785	0.32013	0.25610
Winter – MB Rates:					
On-Peak	0.22228	0.00000	0.27460	0.49688	0.39750
Off-Peak	0.22228	0.00000	0.13323	0.35551	0.28441
Super Off-Peak	0.22228	0.00000	0.08905	0.31133	0.24906

Note:

(1) Total Rates consist of UDC, Schedule DWR-BC (Department of Water Resources Bond Charge), Schedule WF-NBC (CA Wildfire Fund charge) and Schedule EECC (Electric Energy Commodity Cost) rates. EECC rates are applicable to bundled customers only. See Special Condition 9 for PCIA (Power Charge Indifference Adjustment) recovery.

(2) Total Rates presented are for customers that receive commodity supply and delivery service from Utility. Differences in total rates paid by Direct Access (DA) and Community Choice Aggregation (CCA) customers are identified in Schedule DA-CRS and CCA-CRS, respectively.

(3) DWR-BC and WF-NBC charges do not apply to CARE or Medical Baseline customers.

(4) WF-NBC rate is 0.00530 + DWR-BC Bond Charge is 0.00000

N

2H5

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Decision No. D.22-11-022

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Resolution No.

San Diego Gas & Electric Company
San Diego, California

Original Cal. P.U.C. Sheet No. 37197-E

Canceling Cal. P.U.C. Sheet No.

SCHEDULE TOU-ELEC

Sheet 3 N

DOMESTIC TIME-OF-USE FOR HOUSEHOLDS WITH ELECTRIC VEHICLES, ENERGY STORAGE, OR ELECTRIC HEAT PUMPS N

RATES (CONTINUED) N

UDC Rates

Description – TOU-ELEC	Transm	Distr	PPP	ND	CTC	LGC	RS	TRAC	UDC Total
Monthly Service Fee ($/Mo)		16.00							16.00
Summer:									
On-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228
Off-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228
Super Off-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228
Winter:									
On-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228
Off-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228
Super Off-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228

Description – TOU-ELEC – CARE Rates	**Transm**	**Distr**	**PPP**	**ND**	**CTC**	**LGC**	**RS**	**TRAC**	**UDC Total**
Monthly Service Fee ($/Mo		16.00							16.00
Summer CARE Rates:									
On-Peak	0.07340	0.10726	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22158
Off-Peak	0.07340	0.10726	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22158
Super Off-Peak	0.07340	0.10726	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22158
Winter CARE Rates:									
On-Peak	0.07340	0.10726	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22158
Off-Peak	0.07340	0.10726	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22158
Super Off-Peak	0.07340	0.10726	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22158

Description – TOU-ELEC – MB Rates	**Transm**	**Distr**	**PPP**	**ND**	**CTC**	**LGC**	**RS**	**TRAC**	**UDC Total**
Monthly Service Fee ($/Mo))		16.00							16.00
Summer – MB Rates									
On-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228
Off-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228
Super Off-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228
Winter – MB Rates									
On-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228
Off-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228
Super Off-Peak	0.07340	0.10796	0.02546	0.00007	0.00153	0.01383	0.00003	0.00000	0.22228

N

(Continued)

3H11

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Decision No. D.22-11-022

Issued by

Submitted Jan 31, 2023

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Resolution No.

San Diego Gas & Electric Company
San Diego, California

Original Cal. P.U.C. Sheet No. 37198-E

Canceling Cal. P.U.C. Sheet No.

SCHEDULE TOU-ELEC

Sheet 4 N

DOMESTIC TIME-OF-USE FOR HOUSEHOLDS WITH ELECTRIC VEHICLES, ENERGY STORAGE, OR ELECTRIC HEAT PUMPS N

Notes: Transmission Energy charges include the Transmission Revenue Balancing Account Adjustment (TRBAA) of $(0.00242) per kWh and the Transmission Access Charge Balancing Account Adjustment (TACBAA) of $(0.01631) per kWh. PPP Energy charges includes Low Income PPP rate (LI-PPP) $0.01669/kWh, Non-low Income PPP rate (Non-LI-PPP) $0.00333/kWh (pursuant to PU Code Section 399.8, the Non-LI-PPP rate may not exceed January 1, 2000 levels), Procurement Energy Efficiency Surcharge Rate of $0.00422 /kWh, California Solar Initiative rate (CSI) of $0.00000/kWh and Self-Generation Incentive Program rate (SGIP) $0.00122/kWh. N

Rate Components

The Utility Distribution Company Total Rates (UDC Total) shown above are comprised of the following components (if applicable): (1) Transmission (Trans) Charges, (2) Distribution (Distr) Charges, (3) Public Purpose Program (PPP) Charges, (4) Nuclear Decommissioning (ND) Charge, (5) Ongoing Competition Transition Charges (CTC), (6) Local Generation Charge (LGC), (7) Reliability Services (RS), and (8) the Total Rate Adjustment Component (TRAC).

Certain Direct Access customers are exempt from the TRAC, as defined in Rule 1 – Definitions.

Franchise Fee Differential

A Franchise Fee Differential of 5.78% will be applied to the monthly billings calculated under this schedule for all customers within the corporate limits of the City of San Diego. Such Franchise Fee Differential shall be so indicated and added as a separate item to bills rendered to such customers.

Time Periods:

All time periods listed are applicable to actual "clock" time)

TOU Period – Weekdays	Summer	Winter
On-Peak	4:00 p.m. – 9:00 p.m.	4:00 p.m. – 9:00 p.m.
Off-Peak	6:00 a.m. – 4:00 p.m.; 9:00 p.m. – midnight	6:00 a.m. – 4:00 p.m. Excluding 10:00 a.m.–2:00 p.m.in March and April; 9:00 p.m. - midnight
Super-Off-Peak	Midnight – 6:00 a.m.	Midnight – 6:00 a.m. 10:00 a.m. – 2:00 p.m. in March and April

TOU Period – Weekends and Holidays	Summer	Winter
On-Peak	4:00 p.m. – 9:00 p.m.	4:00 p.m. – 9:00 p.m.
Off-Peak	2:00 p.m. – 4:00 p.m.; 9:00 p.m. – midnight	2:00 p.m. – 4:00 p.m. 9:00 p.m. - midnight
Super-Off-Peak	Midnight – 2:00 p.m.	Midnight – 2:00 p.m.

Seasons:

Summer June 1 – October 31

Winter November 1 – May 31 N

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4H7 Issued by Submitted Jan 31, 2023

Advice Ltr. No. 4152-E Effective Jan 31, 2023

Decision No. D.22-11-022 Resolution No.

San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 35718-E
Canceling Revised Cal. P.U.C. Sheet No. 32576-E

SCHEDULE E-CARE

Sheet 1

CALIFORNIA ALTERNATE RATES FOR ENERGY

APPLICABILITY

This schedule provides a California Alternate Rates for Energy (CARE) discount to each of the following types of customers listed below that meet the requirements for CARE eligibility as defined in Rule 1, Definitions, and herein, and is taken in conjunction with the customer's otherwise applicable service schedule.

1) Customers residing in a permanent single-family accommodation, separately metered by the Utility.

2) Multi-family dwelling units and mobile home parks supplied through one meter on a single premises where the individual unit is submetered.

3) Non-profit group living facilities.

4) Agricultural employee housing facilities.

TERRITORY

Within the entire territory served by the Utility.

DISCOUNT

1) Residential CARE: Qualified residential CARE customers will receive a total effective discount according to the following:

	2015	2016	2017	2018	2019	2020 and beyond
Effective Discount	**40%**	**39%**	**38%**	**38%**	**36% R**	**35%**

Pursuant to Commission Decision (D.) 15-07-001, the average effective CARE discount for residential customers will decrease 1% each year until an average effective discount of 35% is reached in 2020.

The average effective CARE discount consists of: (a) exemptions from paying the CARE Surcharge, Department of Water Resources Bond Charge (DWR-BC), Vehicle-Grid Integration (VGI) costs, and California Solar Initiative (CSI); (b) a 50% minimum bill relative to Non-CARE; (c) the California Wildfire Fund Charge (WF-NBC) and (d) a separate line-item bill discount for all qualified residential CARE customers with the exclusion of CARE Medical Baseline customers taking service on tiered rates schedules. D.15-07-001 retained the rate subsidies in Non-CARE Medical Baseline tiered rates and thereby a separate line-item discount is provided for these CARE Medical Baseline customers T

(Continued)

1C5

Advice Ltr. No. 3928-E

Issued by
Dan Skopec
Vice President

Submitted Dec 30, 2021
Effective Jan 1, 2022

6.2.5 City of Palo Alto Utilities

Following are the CPAU electricity and natural gas tariffs applied in this study. The CPAU monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in Table 27. These rates are based on applying a normalization curve to the October 2023 tariff based on seven years of historical gas data. The monthly service charge applied was $14.01 per month per the November 2023 G-1 tariff.

Table 27. CPAU Monthly Gas Rate ($/therm)

Month	G1 Volumetric Total Baseline	G1 Volumetric Total Excess
January	$1.83532	$3.35639
February	$1.38055	$2.59947
March	$1.32506	$2.47695
April	$1.29680	$2.44038
May	$1.29511	$2.43804
June	$1.32034	$2.45406
July	$1.35688	$2.61519
August	$1.40696	$2.67944
September	$1.42130	$2.70301
October	$1.42310	$2.48300
November	$1.46286	$2.45547
December	$1.62415	$2.62128

RESIDENTIAL ELECTRIC SERVICE

UTILITY RATE SCHEDULE E-1

A. APPLICABILITY:

This Rate Schedule applies to separately metered single-family residential dwellings receiving Electric Service from the City of Palo Alto Utilities.

B. TERRITORY:

This rate schedule applies everywhere the City of Palo Alto provides Electric Service.

C. UNBUNDLED RATES:

Per kilowatt-hour (kWh)	Commodity	Distribution	Public Benefits	Total
Tier 1 usage	$ 0.09999	$ 0.06954	$ 0.00568	$ 0.17521
Tier 2 usage Any usage over Tier 1	0.13873	0.10225	0.00568	0.24666
Minimum Bill ($/day)				0.4181

D. SPECIAL NOTES:

1. Calculation of Cost Components

The actual bill amount is calculated based on the applicable rates in Section C above and adjusted for any applicable discounts, surcharges and/or taxes. On a Customer's bill statement, the bill amount may be broken down into appropriate components as calculated under Section C.

2. Calculation of Usage Tiers

Tier 1 Electricity usage shall be calculated and billed based upon a level of 11 kWh per day, prorated by Meter reading days of Service. As an example, for a 30-day bill, the Tier 1 level would be 330 kWh. For further discussion of bill calculation and proration, refer to Rule and Regulation 11.

{End}

CITY OF PALO ALTO UTILITIES
Issued by the City Council

Supersedes Sheet No E-1-1
dated 7-1-2022

Sheet No **E-1-1**
Effective 7-1-2023

6.2.6 Sacramento Municipal Utilities District (Electric Only)

Following are the SMUD electricity tariffs applied in this study. The rates effective January 2023 were used.

Residential Time-of-Day Service
Rate Schedule R-TOD

II. Firm Service Rates

A. Time-of-Day (5-8 p.m.) Rate

	Effective as of January 1, 2023	Effective as of January 1, 2024	Effective as of May 1, 2024	Effective as of January 1, 2025	Effective as of May 1, 2025
Time-of-Day (5-8 p.m.) Rate (RT02)					
Non-Summer Season (October - May)					
System Infrastructure Fixed Charge *per month per meter*	$23.50	$24.15	$24.80	$25.50	$26.20
Electricity Usage Charge					
Peak *$/kWh*	$0.1547	$0.1590	$0.1633	$0.1678	$0.1724
Off-Peak *$/kWh*	$0.1120	$0.1151	$0.1183	$0.1215	$0.1248
Summer Season (June - September)					
System Infrastructure Fixed Charge *per month per meter*	$23.50	$24.15	$24.80	$25.50	$26.20
Electricity Usage Charge					
Peak *$/kWh*	$0.3279	$0.3369	$0.3462	$0.3557	$0.3655
Mid-Peak *$/kWh*	$0.1864	$0.1914	$0.1967	$0.2021	$0.2077
Off-Peak *$/kWh*	$0.1350	$0.1387	$0.1425	$0.1464	$0.1505

B. Optional Critical Peak Pricing Rate

1. The CPP Rate base prices per time-of-day period are the same as the prices per time-of-day period for TOD (5-8 p.m.).
2. The CPP Rate provides a discount per kWh on the Mid-Peak and Off-Peak prices during summer months.
3. During CPP Events, customers will be charged for energy used at the applicable time-of-day period rate plus the CPP Rate Event Price per kWh as shown on www.smud.org.
4. During CPP Events, energy exported to the grid will be compensated at the CPP Rate Event Price per kWh as shown on www.smud.org.
5. The CPP Rate Event Price and discount will be updated annually at SMUD's discretion and posted on www.smud.org.

C. Plug-In Electric Vehicle Credit (rate categories RT02 and RTC1)

This credit is for residential customers who have a licensed passenger battery electric plug-in or plug-in hybrid electric vehicle.
Credit applies to all electricity usage charges from midnight to 6:00 a.m. daily.
Electric Vehicle Credit………………………………..……………. -$0.0150/kWh

III. Electricity Usage Surcharges

Refer to the following rate schedules for details on these surcharges.

A. Hydro Generation Adjustment (HGA). Refer to Rate Schedule HGA.

IV. Rate Option Menu

A. Energy Assistance Program Rate. Refer to Rate Schedule EAPR.
B. Medical Equipment Discount Program. Refer to Rate Schedule MED.
C. Joint Participation in Medical Equipment Discount and Energy Assistance Program Rate. Refer to Rate Schedule MED.

SACRAMENTO MUNICIPAL UTILITY DISTRICT Sheet No. **R-TOD-2**
Resolution No. 23-09-09 adopted September 21, 2023 Effective: **September 22, 2023**

A. Time-of-Day (5-8 p.m.) Rate (rate category RT02)

1. The TOD (5-8 p.m.) Rate is the standard rate for SMUD's residential customers. Eligible customers can elect the Fixed Rate under Rate Schedule R as an alternative rate.

2. The TOD (5-8 p.m.) Rate is an optional rate for customers who have an eligible renewable electrical generation facility under Rate Schedule NEM1 that was approved for installation by SMUD prior to January 1, 2018.

3. This rate has five kilowatt-hour (kWh) prices, depending on the time-of-day and season as shown below. Holidays are detailed in Section V. Conditions of Service.

Summer (Jun 1 - Sept 30)	**Peak**	Weekdays between 5:00 p.m. and 8:00 p.m.
	Mid-Peak	Weekdays between noon and midnight except during the Peak hours.
	Off-Peak	All other hours, including weekends and holidays[1].
Non-Summer (Oct 1 - May 31)	**Peak**	Weekdays between 5:00 p.m. and 8:00 p.m.
	Off-Peak	All other hours, including weekends and holidays[1].

[1] See Section V. Conditions of Service

6.2.7 Fuel Escalation Assumptions

The average annual escalation rates in Table 28 were used in this study. These are based on assumptions from the CPUC 2021 En Banc hearings on utility costs through 2030 (California Public Utilities Commission, 2021a). Escalation rates through the remainder of the 30-year evaluation period are based on the escalation rate assumptions within the 2022 TDV factors. No data was available to estimate electricity escalation rates for CPAU and SMUD, therefore electricity escalation rates for PG&E and statewide natural gas escalation rates were applied. Table 29 presents the average annual escalation rates used in the utility rate escalation sensitivity analysis shown in Section 3.2.4. Rates were applied for the same 30-year period and are based on the escalation rate assumptions within the 2025 LSC factors from 2027 through 2053.[28] These rates were developed for electricity use statewide (not utility-specific) and assume steep increases in gas rates in the latter half of the analysis period. Data was not available for the years 2024, 2025, and 2026 and so the CPUC En Banc assumptions were applied for those years using the average rate across the three IOUs for statewide electricity escalation.

Table 28: Real Utility Rate Escalation Rate Assumptions, CPUC En Banc and 2022 TDV Basis

	Statewide Natural Gas Residential Average Rate (%/year, real)	Electric Residential Average Rate (%/year, real)		
		PG&E	SCE	SDG&E
2024	4.6%	1.8%	1.6%	2.8%
2025	4.6%	1.8%	1.6%	2.8%
2026	4.6%	1.8%	1.6%	2.8%
2027	4.6%	1.8%	1.6%	2.8%
2028	4.6%	1.8%	1.6%	2.8%
2029	4.6%	1.8%	1.6%	2.8%
2030	4.6%	1.8%	1.6%	2.8%
2031	2.0%	0.6%	0.6%	0.6%
2032	2.4%	0.6%	0.6%	0.6%
2033	2.1%	0.6%	0.6%	0.6%
2034	1.9%	0.6%	0.6%	0.6%
2035	1.9%	0.6%	0.6%	0.6%
2036	1.8%	0.6%	0.6%	0.6%
2037	1.7%	0.6%	0.6%	0.6%
2038	1.6%	0.6%	0.6%	0.6%
2039	2.1%	0.6%	0.6%	0.6%
2040	1.6%	0.6%	0.6%	0.6%
2041	2.2%	0.6%	0.6%	0.6%
2042	2.2%	0.6%	0.6%	0.6%
2043	2.3%	0.6%	0.6%	0.6%
2044	2.4%	0.6%	0.6%	0.6%
2045	2.5%	0.6%	0.6%	0.6%
2046	1.5%	0.6%	0.6%	0.6%
2047	1.3%	0.6%	0.6%	0.6%
2048	1.6%	0.6%	0.6%	0.6%
2049	1.3%	0.6%	0.6%	0.6%
2050	1.5%	0.6%	0.6%	0.6%
2051	1.8%	0.6%	0.6%	0.6%
2052	1.8%	0.6%	0.6%	0.6%
2053	1.8%	0.6%	0.6%	0.6%

[28] https://www.energy.ca.gov/files/2025-energy-code-hourly-factors. Actual escalation factors were provided by consultants E3.

Table 29: Real Utility Rate Escalation Rate Assumptions, 2025 LSC Basis

Year	Statewide Natural Gas Residential Average Rate (%/year, real)	Statewide Electricity Residential Average Rate (%/year, real)
2024	4.6%	2.1%
2025	4.6%	2.1%
2026	4.6%	2.1%
2027	4.2%	0.6%
2028	3.2%	1.9%
2029	3.6%	1.6%
2030	6.6%	1.3%
2031	6.7%	1.0%
2032	7.7%	1.2%
2033	8.2%	1.1%
2034	8.2%	1.1%
2035	8.2%	0.9%
2036	8.2%	1.1%
2037	8.2%	1.1%
2038	8.2%	1.0%
2039	8.2%	1.1%
2040	8.2%	1.1%
2041	8.2%	1.1%
2042	8.2%	1.1%
2043	8.2%	1.1%
2044	8.2%	1.1%
2045	8.2%	1.1%
2046	8.2%	1.1%
2047	3.1%	1.1%
2048	-0.5%	1.1%
2049	-0.6%	1.1%
2050	-0.5%	1.1%
2051	-0.6%	1.1%
2052	-0.6%	1.1%
2053	-0.6%	1.1%

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Our experts develop robust toolkits as well as provide specific technical assistance to local jurisdictions (cities and counties) considering adopting energy reach codes. These include Cost-effectiveness research and analysis, model ordinance language and other code development and implementation tools, and specific technical assistance throughout the code adoption process.

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