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2025 Nonresidential Alterations: Reach Code Study

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Acronym List

B/C – Benefit-to-Cost Ratio

CBECC - California Building Energy Code Compliance

CBSC - California Building Standards Commission

CEC - California Energy Commission

CPAU – City of Palo Alto Utilities

CZ – Climate Zone

GHG - Greenhouse Gas

HP – Heat Pump

HVAC – Heating, Ventilation, and Air Conditioning (equipment)

IOU – Investor-Owned Utility

kWh – Kilowatt Hour

LSC – Long-term Systemwide Cost

MF – Mixed-Fuel

NPV – Net Present Value

POU – Publicly Owned Utility

PG&E – Pacific Gas & Electric (utility)

PV - Solar Photovoltaic

RTU – Rooftop Unit (equipment)

SCE – Southern California Edison (utility)

SCG – Southern California Gas (utility)

SDG&E – San Diego Gas & Electric (utility)

SMUD – Sacramento Municipal Utility District

SZAC – Single Zone Air Conditioner

SZHP – Single Zone Heat Pump

Title 24 – California Code of Regulations Title 24, Part 6

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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 emissions 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 Reach Code Team evaluated the energy savings and cost-effectiveness of various measures in three different vintages (1980s, 1990s, and 2000s) of the Small Office and Medium Retail prototypes for this report. The Team analyzed measures include packaged rooftop unit (RTU) replacements as well as efficiency measures, including cool roof, window film, lighting retrofit, HRV, DCV, and economizer FDD.

For packaged rooftop units, the Team found that Single Zone Heat Pump (SZHP) replacements of Single Zone Air Conditioners (SZAC) achieve energy savings and are generally cost-effective. For SZHP up to 20 tons, depending on the climate zone, some additional efficiency measures may be required to achieve cost-effectiveness, while SZHP up to 10 tons are cost-effective without additional efficiency measures. The energy savings and cost-effectiveness of individual energy efficiency measures applied to an existing building without an RTU retrofit or bundled with RTU replacements (both SZACs and SZHPs), vary by prototype, climate zone, and vintage.

Figure 1. Packaged RTU Images


Local jurisdictions may 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. Although a cost-effectiveness study is only required to amend Part 6 of the California Building Code, it is important 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.

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 combinations of measures that exceed the minimum requirements of the 2025 Building Energy Efficiency Standards, effective January 1, 2026, for existing nonresidential buildings. This report was developed in coordination with the California Statewide Investor-Owned Utilities (CA IOUs) Codes and Standards Reach Codes Program, key consultants, and engaged cities—collectively known as the Reach Code Team.

The purpose of this study is to evaluate the cost-effectiveness of measure packages to increase energy performance in existing nonresidential buildings. The Reach Code Team analyzed packages with different combinations of SZHP space heating equipment replacements, HVAC-related efficiency measures, envelope, and lighting efficiency measures. Analysis used the CBECC (California Building Energy Code Compliance) 2025 software. The Reach Code Team conducted stakeholder interviews and collected cost data for each measure analyzed to determine the cost-effectiveness and technical feasibility of the proposed measures.

The California Building Energy Efficiency Standards Title 24, Part 6 (Energy Code) (CEC, 2025) 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 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, Part 6. 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 [1]. 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 or appliances. High efficiency appliances are often the easiest and most affordable measures 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 higher performance.

2 Methodology and Assumptions

The Reach Codes Team used the cost-effectiveness methodology detailed in this section to analyze two prototype designs representing a medium retail building and a small office using, as described in Section 3.

The Reach Code Team performed energy simulations using the most recent software available for 2025 Energy Code compliance analysis, CBECC 2025 Subversion (SVN) Revision 8219. LSC results using 2025 software will provide a forward-looking indication of the feasibility of SZHP replacements and efficiency measure packages.

2.1 Cost-Effectiveness

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

2.1.1 Benefits

This analysis used both on-bill and Long-term Systemwide Cost (LSC) of energy-based approaches to evaluate cost-effectiveness. Both the on-bill and LSC approaches require estimating energy savings and quantifying costs (incremental measure costs and energy costs) associated with energy measures. The primary difference between on-bill and LSC is how energy is valued:

- **On-Bill**: This approach uses a customer-based lifecycle cost method that values energy based on estimated site energy usage and customer on-bill savings. It incorporates electricity and natural gas utility rate schedules over a 30-year period for the prototypes, accounting for a 3% discount rate and energy cost inflation as outlined in Appendix 10.3.2.
- **LSC**: LSC, formerly Time Dependent Valuation (TDV), was developed by the Energy Commission. LSC savings are calculated using hourly LSC factors for both electricity and natural gas provided by the Energy Commission These LSC hourly factors are projected over the 30-year life of the building and incorporate the hourly cost of marginal generation, transmission and distribution, fuel, capacity, losses, and cap-and-trade-based CO_2 emissions.[1]

2.1.2 Costs

The Reach Code Team assessed the incremental costs and savings of the energy packages over the 30-year lifecycle, which is consistent with the Energy Commission's approach to evaluating measures when the Energy Code is updated. Incremental costs represent the equipment, installation, replacements, and maintenance costs of the proposed measure relative to the 2025 Energy Code minimum requirements or standard industry practices.

[1] See Hourly Factors for Source Energy, Long-term Systemwide Cost, and Greenhouse Gas Emissions at https://www.energy.ca.gov/files/2025-energy-code-hourly-factors

The Reach Code Team obtained measure costs from manufacturer distributors, contractors, literature review, and online sources such as RS Means. Taxes and contractor markups were added as appropriate. Maintenance and replacement costs are included.

2.1.3 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.

Improving the energy performance of a building often requires an initial investment. In most cases, the benefit is represented by annual on-bill utility or LSC savings. The cost is represented by incremental first cost and replacement costs. However, some packages result in initial construction cost savings (negative incremental cost), 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”. Because of these situations, NPV savings are also reported, which, in these cases, are positive values.

2.1.4 Utility Rates

In coordination with the CA IOU rate team, and the publicly available information for several Publicly Owned Utilities (POUs), the Reach Code Team determined appropriate utility rates for each Climate Zone and package. The utility tariffs, summarized in Table 1, were determined based on the annual load profile of the prototype and the corresponding package and the most prevalent rate in each territory. A time-of-use (TOU) electric rate was applied to all cases. For a more details on the rates selected refer to Appendix 9.3.2 - Utility Rate Schedules.

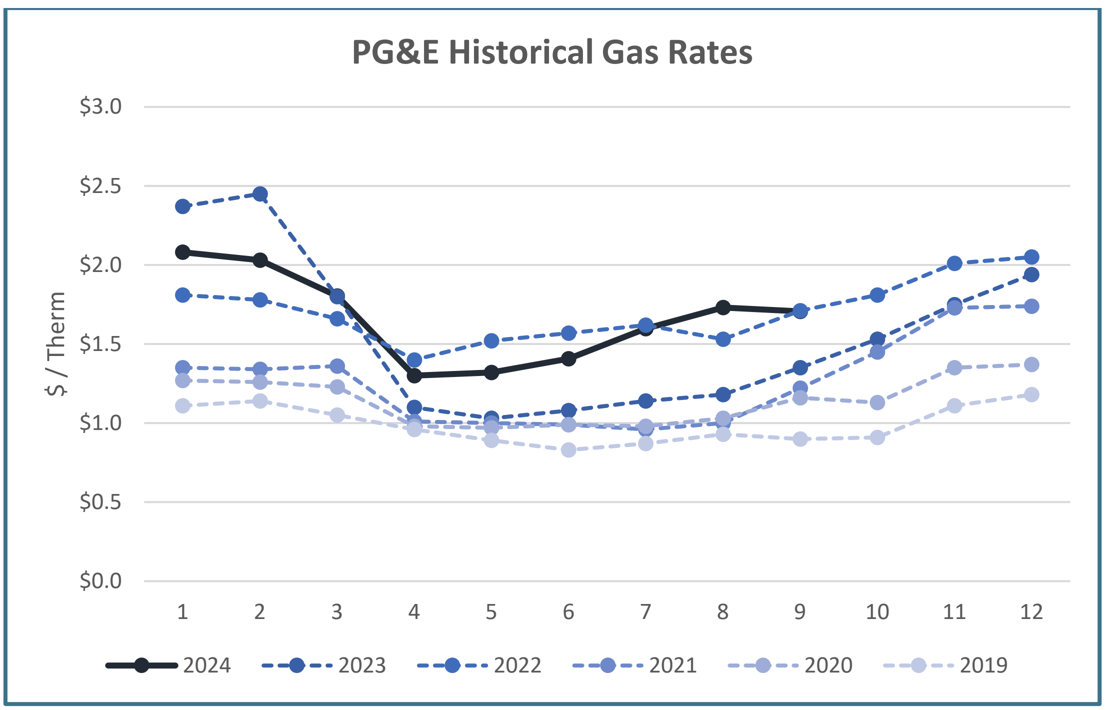
The analysis assumes that utility rates escalate over time for commercial buildings, as described in Appendix 9.4.7. Escalation rates above inflation for electricity beyond 2023 are assumed to be between 0.2% and 0.7%, before dropping to a steady 0.6% escalation per year in 2030. Natural gas is assumed to escalate at a relatively higher rate, peaking at 7.7% in 2024, then escalating more slowly to a rate of approximately 2% in the latter years of the analysis period.

Table 1. Utility Tariffs Used Based on Climate Zone

Climate Zones	Electric / Gas Utility	Electricity	Natural Gas
IOUs			
1-5,11-13,16	Pacific Gas & Electric Company (PG&E)	B-1 / B-10	G-NR1
6, 8-10, 14, 15	Southern California Edison (SCE) / Southern California Gas Company (SCG)	TOU-GS-1 / TOU-GS-2 / TOU-GS3	GN-10
5	PG&E / SCG	B-1 / B-10	GN-10
7, 10, 14	San Diego Gas and Electric Company (SDG&E)	TOU-A / AL-TOU	GN-3
POUs			
4	City of Palo Alto (CPAU)	E-2	G-2
12	Sacramento Municipal Utility District (SMUD) / PG&E	CITS-0 / CITS-1	G-NR1

The Reach Code Team conducted an analysis of the gas rates by month to determine seasonal fluctuations. An example of the historical gas rates for PG&E are shown in Figure 2.

Figure 2. Seasonal PG&E Historical Gas Rates



To develop the seasonal gas rates for each utility, the Reach Code Team used an average seasonal curve based on 5-year historical data. The Team then applied the seasonal trend to the current month's gas rate to reflect the most recent market conditions. In this study, the Reach Code Team collected gas rates from September 2024 for each utility and applied a factor for each month to normalize the monthly gas rate fluctuations.

2.2 Greenhouse Gas Emissions

The GHG emissions are calculated using the latest applicable GHG Emissions hourly factors published by the Energy Commission and used by the Energy Commission's reference code compliance software CBECC, and largely represent California IOUs. GHG emissions associated with community choice aggregators or POUs are not integrated into these multipliers and require a custom analysis, using the energy impacts in this report as a starting point.

3 Prototypes, Measure Packages, and Costs

This section describes the prototypes and the scope of analysis conducted by the Reach Code Team.

3.1 Prior Reach Code Study Research

In 2021, the Statewide CA IOU Reach Codes Team analyzed the cost-effectiveness of non-residential alterations projects for mixed-fuel plus efficiency, SZHP replacements plus efficiency, and demand flexibility packages (Statewide Reach Codes Team 2021). Using this analysis, the Reach Code Team presented reach code options for jurisdictions to consider adopting based on cost-effectiveness. The Reach Code Team leveraged some information from the previous report to develop the results and conclusions in this report, including prototype and vintage characteristics, potential efficiency measures, package combinations, and cost data.

3.2 Prototype Characteristics

The Reach Code Team used modified versions of the Department of Energy (DOE) building prototypes for Medium Retail and Small Office to evaluate cost-effectiveness of measure packages. Existing retail and office occupancies are two of the occupancies that are prescriptively required to have SZHP rooftop units for new or replacement applications under 65,000 BTU/h according to 2025 Energy Code, Section 141.0(b)2Cii and Table 141.0-E-1. This study analyzes retail and office prototypes specifically because they represent the largest portions of the existing building stock and represent similar occupancy schedules and load profiles as the other occupancies in Table 141.0-E-1, including grocery, school, financial institution, and library occupancies.

To identify appropriate characteristics, the Team created three vintages of each building prototype to represent historical construction practices by leveraging data and methodologies from previous IOU studies, Senate Bill 350 (SB350) analysis[2], and Commercial Building Energy Consumption Survey (CBECS)[3]. These datasets include estimates of retrofits/upgrades to older buildings as well as field data on existing conditions. The three vintages that the Reach Code Team analyzed include:

- **1980s:** represents buildings built prior to 1990 (code reference year 1982).
- **1990s:** represents buildings built during the 1990 era (code reference year 1992).
- **2000s:** represents buildings built during the 2000 era (code reference year 2006).

[2] This references an unpublished analysis developed in support of the Energy Commission's Senate Bill 350: https://www.energy.ca.gov/rules-and-regulations/energy-suppliers-reporting/clean-energy-and-pollution-reduction-act-sb-350.

[3] https://www.eia.gov/consumption/commercial/.

The analysis presented in this report assumes a certain set of existing conditions within each prototype, and that buildings operate as-intended (i.e., no faulty conditions[4]). Real building existing conditions are often a variety of old and new components, and equipment performance degrades over time. The analysis assumes some equipment replacement over time based on building system and envelope component, using assumptions from the SB350 analysis.

The Reach Code Team's prototypes and cost-effectiveness results represent a range of vintages to account for the variety of existing conditions in real buildings in a simplified way. Jurisdictions should consider how measure-specific findings would apply to the existing conditions in the buildings within their area.

Table 2 through Table 4 summarize the existing building prototype characteristics, with more detail available in Appendix 9.5.

Table 2. Existing Building Prototype Characteristics

	Small Office Prototype	Medium Retail Prototype
Conditioned floor area (ft^2)	5,502	24,563
Number of stories	1	1
Window-to-floor area ratio	24%	7%
Number of Conditioned Thermal Zones	5	4

[4] The economizer FDD individual measure analysis only assumes a faulty economizer in the existing building baseline.

Table 3. Small Office (SO) Prototype Characteristics, by Vintage

Vintage	1980s	1990s	2000s
HVAC System Type	Single Zone Packaged Rooftop Unit (RTU)	Single Zone Packaged Rooftop Unit (RTU)	Single Zone Packaged Rooftop Unit (RTU)
Cooling System	Direct Expansion (DX) EER: 8.2	DX EER: 8.8	DX EER: 10.3
Heating System	Gas Furnace AFUE: 67.5%	Gas Furnace AFUE: 78.1%	Gas Furnace AFUE: 78.1%
Supply Fan	Constant volume (CV) Fan Efficiency: 47.5%	CV Fan Efficiency: 50.8%	CV Fan Efficiency: 55.0%
Economizer Control	No Economizer if cooling capacity < 134 kBtuh, Otherwise, Economizer with Differential Dry Bulb control	No Economizer if cooling capacity < 75 kBtuh, Otherwise, Economizer with Differential Dry Bulb control	
Service Hot Water Heating	Electric Conventional Small Storage Energy Factor: 0.95		
Roof Insulation (U-Value)	Vary by CZ, see Appendix 9.5		
Steep-Sloped Roof Solar Reflectance	CZ01: 0.105 Others: 0.117	CZ01: 0.104 Others: 0.114	CZ01: 0.102 Others: 0.2
Metal-Framed Wall Insulation (U-Value)	Vary by CZ, see Appendix 9.5		
Windows	Vary by CZ, see Appendix 9.5		
LPD (W/ft^2)	1.2		

Table 4. Medium Retail (RE) Prototype Characteristics, by Vintage

Vintage	1980s	1990s	2000s
HVAC System Type	Single Zone Packaged Rooftop Unit (RTU)	Single Zone Packaged Rooftop Unit (RTU)	Single Zone Packaged Rooftop Unit (RTU)
Cooling System	DX EER: 8.2	DX EER: 8.8	DX EER: 10.3
Heating System	Gas Furnace AFUE: 0.675	Gas Furnace AFUE: 0.781	
Supply Fan	Control Method: CV Fan Efficiency: 47.5%	Control Method: CV Fan Efficiency: 50.8%	Control Method: CV Fan Efficiency: 55.0%
Economizer Control	No Economizer if cooling capacity < 134 kBtuh, Otherwise, Economizer with Integrated, Differential Dry Bulb control	No Economizer if cooling capacity < 75 kBtuh, Otherwise, Economizer with Integrated, Differential Dry Bulb control	
Service Hot Water Heating	Electricity Conventional Small Storage Energy Factor: 0.95		
Roof Insulation (U-Value)	Varies by CZ, see Appendix 9.5		
Low-Sloped Roof Solar Reflectance	0.182	0.166	0.552
Metal-Framed Wall Insulation (U-Value)	Varies by CZ, see Appendix 9.5		
Windows	Varies by CZ, see Appendix 9.5		
LPD (W/ft^2)	Retail spaces: 1.7 Back Space: 0.6 Front Entry: 1.5		

3.3 Measure Definitions and Costs

The Reach Code Team analyzed the efficiency measures and HVAC retrofit measures described in this section as applied to the Medium Retail and Small Office prototypes. The sources of measure definitions and associated costs are related to stakeholder interview findings and interpretation discussed in Section 4.

3.3.1 Baseline and Measure Packages

3.3.1.1 Individual Measures

The Reach Code Team analyzed several scenarios. Individual energy efficiency measures were analyzed compared to the existing building baseline.

- Existing Building Baseline: Mixed-fuel existing building including a packaged SZAC RTU with a gas-fired furnace, prescriptively built at the time of initial construction, assuming equipment turnover rates. See Appendix 9.5 for more details.
- Existing Building + Individual Efficiency Measures: Mixed-fuel existing building, with the following individual efficiency measures.

- Cool roof (Medium Retail only)
- Window film
- Lighting retrofit
- Economizer fault detection and diagnostics (Medium Retail only)

All measures assume that the building system alteration is not already included in the proposed alteration scope, except Cool Roof which assumes a roof replacement is already occurring.

3.3.1.2 RTU Replacement + Measure Packages

The Reach Code Team analyzed several scenarios that include a RTU replacement. The baseline for these packages is defined below:

- ***MF*** (Mixed-fuel SZAC Code Min Baseline): Mixed-fuel existing building that is replacing all RTUs in accordance with 2025 Energy Code prescriptive requirements. For units that are 5-ton and below in Climate Zones 3-13 and 15, RTUs are replaced with a single zone heat pump (SZHP) with efficiency set at federal code minimum and economizer. Units above 5-ton and in other Climate Zones will be replaced with a new code minimum single zone air conditioner (SZAC) packaged RTU including a gas-fired furnace.

The RTU replacement packages examined against the ***MF*** baseline package are defined below:

- ***MF-EFF*** (Mixed-fuel SZAC Code Min + Bundled Efficiency Measures): Mixed-fuel existing building replacing the packaged RTU with a new code minimum SZAC where prescriptively allowed. The following efficiency measures are applied to the package:
    - Demand controlled ventilation (DCV, Medium Retail only)
    - Window film
    - Lighting retrofit
- ***MF-HRV***, ***MF-DCV***, and ***MF-HRVDCV*** (Mixed-fuel SZAC Code Min + HVAC Measures): Mixed-fuel existing building replacing the packaged RTU with a new code minimum SZAC where prescriptively allowed. The following HVAC efficiency measures are applied to the package:
    - Demand controlled ventilation (DCV, Medium Retail only)
    - Heat recovery ventilation (HRV)
- ***HP*** (SZHP Code Min): Mixed-fuel existing building that is replacing all RTUs with a federal code minimum efficiency SZHP up to 20 tons. Units 5 tons and below in Climate Zones 3-13 and 15 are already SZHPs with economizers in the Mixed-fuel SZAC Code Min Baseline, so this package measures impacts from SZHP replacements in the 6-20 ton range and other Climate Zones.
- ***HP-10*** (SZHP Code Min ≤10-Ton): Mixed-fuel existing building that is replacing all RTUs with a federal code minimum SZHP up to 10 tons. Units 5 tons and below in

Climate Zones 3-13 and 15 are already SZHPs in the Mixed-fuel SZAC Code Min Baseline, so this package measures impacts from SZHP replacements in the 6-10 ton range and other Climate Zones. Note that this package is the same as *HP* for the Small Office prototype, because all units are below 10 tons.

- ***HP-DCV*** (SZHP Code Min + HVAC Measures): Mixed-fuel existing building that is replacing the packaged RTU with a federal code minimum SZHP for units up to 20 tons. The following HVAC efficiency measures are applied to the package:
  - Demand controlled ventilation (DCV, Medium Retail only)
  - Heat recovery ventilation (HRV)

The packages analyzed over the *MF* baseline are summarized in Table 5 below.

Table 5. Summary of Measure Packages

Package Name	SO	RE	Baseline Package	Proposed HVAC System[5]	HVAC Efficiency Measures	Energy Efficiency Measures
Individual Measures						
COOLROOF		X	Existing	Existing SZAC	-	Cool roof
WINDOWFILM	X	X	Existing	Existing SZAC	-	Window
LIGHTING	X	X	Existing	Existing SZAC	-	Lighting
ECONOMIZERFDD		X	Existing[6]	Existing SZAC	-	Economizer FDD
Mixed-Fuel SZAC Replacement Packages						
MF-EFF	X	X	MF	SZHP for units ≤ 5-tons in Climate Zones 3-13 and 15. SZAC elsewhere.	DCV (RE only)	Window, Lighting
MF-HRV	X	X	MF	Same as above	HRV	-
MF-DCV		X	MF	Same as above	DCV	-
MF-HRVDCV		X	MF	Same as above	HRV, DCV	-
SZHP Replacement Packages						
HP	X	X	MF	SZHP (≤ 20 tons)	-	-
HP-10		X	MF	SZHP (≤ 10 tons)	-	-
HP-DCV		X	MF	SZHP (≤ 20 tons)	HRV, DCV	-

3.3.2 Energy Efficiency Measures

The Reach Code Team identified and investigated efficiency measures applicable in alterations scenarios through stakeholder interviews and literature review.

[5] All replacement equipment is assumed to be code minimum. This is 81% AFUE and 14 SEER for SZAC packages, and 8 HSPF for SZHP packages.

[6] This measure assumes the baseline to be the existing building with a faulty economizer. The measure would restore the economizer on the existing HVAC equipment and add FDD.

3.3.2.1 Measure Descriptions

3.3.2.1.1 Envelope

Cool roof (low-sloped): This measure specifies solar reflectance exceeding 2025 Energy Code Section 141.0(b)2.B for low-sloped requirements when the renovation scope already includes replacing the roof.

- For Medium Retail (low-sloped roof), Climate Zones 2 and 4 through 16: The minimum aged solar reflectance is increased from 0.63 to 0.70.
- Climate Zones 1 and 3: No proposed roof measure.

The cool roof individual measure is compared to the minimum aged solar reflectance requirements.

This measure does not apply to steep-sloped Small Office prototype, as cool roof is already required by the Energy Code.

Window Film: This measure reduces window SHGC of existing windows to 0.39 by adding window film. In addition to reducing heat gain, window films can serve as safety and security measures by stabilizing broken glass. Please see Appendix 9.5 for the existing window SHGC, which varies by building type, Climate Zone, and by vintage.

3.3.2.1.2 Heating, Ventilation, and Air Conditioning

Economizer repair and fault detection and diagnostics (FDD): This measure restores existing economizers to be fully functional and installs standalone economizer FDD on existing air handling units with cooling capacity greater than 134,000 Btu/hr in vintage 1980s and 75,000 Btu/hr in vintage 1990s/2000s. The measure recognizes that existing economizers are often non-functional, with the dampers often either failed closed or partially open (DNV KEMA, 2013). This is a standalone measure that can be installed without RTU replacements.

Demand control ventilation (DCV): This measure uses CO_2 sensors to reduce ventilation based on actual occupancy for intermittent- or high-occupancy spaces. The DCV measure applies to retail spaces in the Medium Retail prototype. It doesn't apply to the Small Office prototype since there are no packaged units serving only conference room zones, and the occupancy profile is otherwise relatively flat, leaving no opportunities for occupancy-based savings. This measure is part of RTU replacements.

Heat Recovery Ventilation (HRV): This measure is a mechanical device intended to remove air from buildings, simultaneously replace it with outdoor air, and in the process transfer heat from the warmer to the colder of the simultaneous airflows. This measure adds a wheel-type HRV to the space conditioning system to reduce the heating and cooling demands of the building. The modeling assumptions include fixed temperature control method, fixed supply temperature of 75°F, and a return fan. This measure is implemented on SZAC RTU replacements only.

3.3.2.1.3 Lighting

Lighting retrofit: This measure is an additional improvement beyond the planned renovation scope, which replaces the existing luminaires. The measure reduces the existing LPD in select areas to the following, representing 2025 code-minimum upgrades:

Table 6. Lighting Retrofit Lighting Power Density Efficiency Measure Specifications

Prototype	Baseline LPD (W/ft^2)	LPD (W/ft^2)
Small office	1.2	0.60
Medium Retail	1.7	0.95

3.3.2.2 Measure Applicability and Costs

The Reach Code team used the efficiency measures summarized in Table 7 below by Climate Zone and prototype. Measure application varies due to existing building and HVAC system characteristics, as well as the retrofit scenario being analyzed.

Table 7. Applicability and Cost of Energy Efficiency Measures

Measure Name	Applicable Climate Zones	Existing Building + Individual Measures		MF-HRV or MF-HRVDCV		MF-EFF	
Prototype		SO	RE	SO	RE	SO	RE
Cool roof (low-sloped)	CZ 2,4-16		X				
Window film	1980s vintage 1990s vintage	X	X			X	X
Economizer FDD	CZ 2-16		X				
DCV	All				X		X
HRV	All			X	X		
Lighting retrofit	All	X	X			X	X

Table 8 summarizes the incremental measure costs, including cost data sources and total cost per prototype. Cost sources from previous years have been adjusted for inflation.

Table 8. Cost of Energy Efficiency Measures

Measure Name	Primary cost source(s)	Incremental Cost Description	Incremental First Cost for Small Office Prototype*	Incremental First Cost for Retail Prototype*	Useful Life / Replacement Year
Cool roof (low-sloped)	Distributor/online	$0.04/ft^2 of roof area	N/A	$1,263	30
Window film	RS Means	$8.83/ft^2 of window area	$7,884	$10,053	30
Lighting retrofit[7]	Distributor/online	RE: $3.93/ft^2 SO: $4.29/ft^2	$20,807	$87,735	15
DCV	IL TRM[8], adjusted for location	$1,764 per unit	N/A	$8,639	Same as HVAC equipment (15 years)
Economizer FDD	Distributors	$1,425 - $4,050 per unit depending on capacity	N/A	$8,861	Same as HVAC equipment (15 years)
HRV	Market data	$4,773 per unit	$23,867	$14,320	Same as HVAC equipment (15 years)

**When costs differ by vintage, the Team used the 2000s vintage as an example, except Window Film which uses the 1990s vintage. When costs differ by Climate Zone, CZ 12 is used as an example.*

3.3.3 HVAC Retrofit

The Team examined the potential for all-electric heat pump retrofits of packaged single zone (SZ) rooftop HVAC where the system size is less than 240,000 kBtuh (20 tons).[9] This threshold aligns with 2025 Energy Code new construction prescriptive requirements in section 140.4(a)2 and is representative of manufacturer HVAC products capable of heat pump heating.

The Team received cost estimates for all HVAC equipment from wholesale distributors and contractors. A mechanical contractor provided labor costs for typical new installations and noted that retrofit labor costs are highly variable due to building-specific considerations such as tight working conditions, prepping surfaces, elevated work, material handling, specialty rigging, and protecting existing finishes. The Team assumed the labor for a retrofit would be 25% more than a non-retrofit installation for both the mixed-fuel SZAC and the SZHP HVAC

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[7] The lighting costs include upgrading compact lighting, upgrading linear lighting, and adding luminaire level lighting controls.

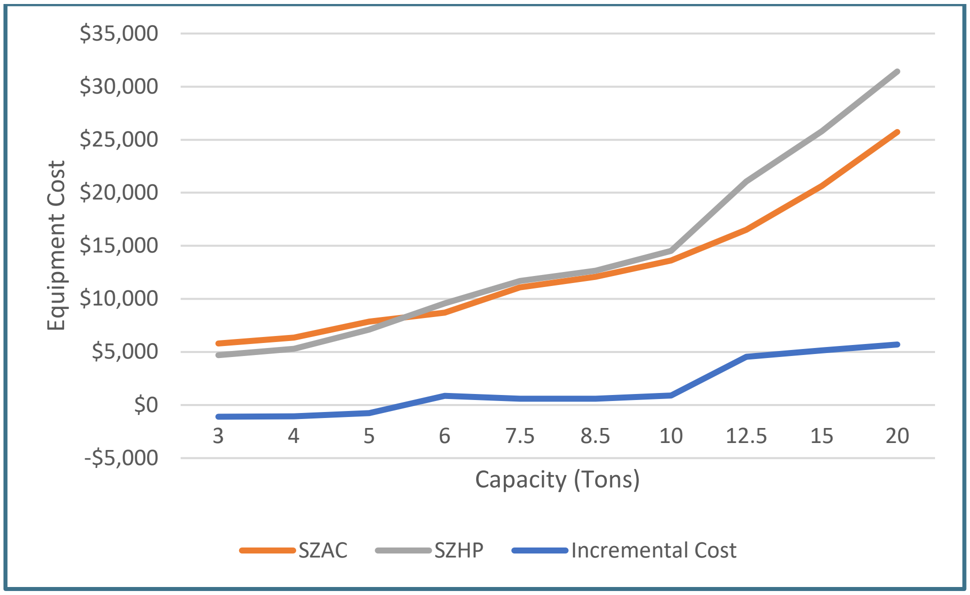
[8] 2024 IL-TRM Version 12.0 Volume 1: Commercial and Industrial Measures, accessed at https://icc.illinois.gov/downloads/public/il-trm-12/IL-TRM_Effective_010124_v12.0_Vol_2_C_and_I_09222023_FINAL_clean.pdf.

[9] For the purposes of this study, the SZHP retrofit package may have some gas usage depending on the vintage and climate zone. Space heating equipment over 20 tons are outside the scope of the analysis, and units of this size will remain the existing mixed-fuel HVAC equipment.

retrofits because in both cases, the packaged units are drop-in replacements at the system level, with no demolition required. No HVAC distribution changes are required as part of the heat pump retrofit.

The HVAC retrofit package costs are shown by unit capacity in Figure 3. This graph does not include labor costs, which are $4,568 for each unit, regardless of fuel type. Additionally, this graph does not include markups for overhead or Climate Zone specific adjustment factors.

Figure 3. Equipment Costs by Fuel Type and Unit Capacity



For these building types, we assume no impact on electrical infrastructure because equipment capacity is driven by the cooling load and not the heating load. Therefore, the equipment capacity (and the electrical infrastructure required) would be the same for the all-electric case as the mixed-fuel/existing building case.

The Team assumed that both SZAC HVAC equipment and SZHP HVAC equipment have a 15-year useful life [2]. We assume that HVAC equipment is replaced at the end of its useful life. The Team assumed that the maintenance requirements would be the same in the SZAC and SZHP scenarios, and do not have incremental impact.

3.3.3.1 Small Office

The existing HVAC system includes five packaged SZACs. The Reach Code Team selected packaged SZHPs to replace the existing packaged RTUs for the Small Office SZHP retrofit. Table 9 shows an example of the incremental cost associated with the SZHP package for Small Office over the 30-year lifecycle. In Climate Zones 3-13 and 15, all units are 5 tons or less which are SZHPs in the baseline for the 1990s and/or the 2000s vintage, so the table below uses Climate Zone 14 costs as an example to show the comparison across vintages.

Table 9. Small Office Retrofit Costs (Example: Climate Zone 14)

Vintage	SZAC Measure	SZAC Cost	SZHP Retrofit Measure	SZHP Retrofit Cost	SZHP Incremental First Cost	Equipment Capacities
1980s	Packaged SZAC + gas furnace	$93,733	Packaged SZHP	$87,422	- $6,311	One 4-ton unit, three 5-ton units, one 6-ton unit
1990s	Packaged SZAC + gas furnace	$85,744	Packaged SZHP	$75,052	- $10,693	One 3-ton unit, three 4-ton units, one 5-ton unit
2000s	Packaged SZAC + gas furnace	$85,164	Packaged SZHP	$75,229	- $9,936	Two 3-ton units, two 4-ton units, one 5-ton unit

As shown in Table 9, the incremental costs across vintages do not vary as much for Small Office compared to the Medium Retail prototype because all HVAC units have a capacity of less than 10 tons.

3.3.3.2 Medium Retail

The existing HVAC system includes four packaged SZ rooftop air-conditioners (AC) with gas furnaces which are less than 20 tons. Note that the core zone in the Medium Retail has a unit over 20 tons and is thus excluded from the analysis. The Reach Code Team selected packaged SZHPs to replace the three existing packaged RTUs below 20 tons for the Medium Retail SZHP retrofit. Table 10 shows an example of the incremental first cost associated with the SZHP package for Medium Retail over the 30-year lifecycle.

Table 10. Medium Retail HVAC Retrofit Costs (Example: Climate Zone 12)

Vintage	SZAC Measure	SZAC Cost	SZHP Retrofit Measure	SZHP Cost	SZHP Incremental First Cost	Equipment Capacities
1980s	Packaged SZAC + gas furnace	$94,531	Packaged SZHP	$111,596	$17,065	Three 12.5-ton units
1990s	Packaged SZAC + gas furnace	$82,431	Packaged SZHP	$84,368	$1,937	Three 10-ton units
2000s	Packaged SZAC + gas furnace	$78,147	Packaged SZHP	$79,204	$1,057	Two 9-ton units, one 10-ton unit

As shown in Table 10, the incremental cost can vary significantly across the vintages, which is mainly driven by the equipment capacities. In the 2000s vintage example, there is a modest incremental cost, and all HVAC units are 10 tons or less. More recent vintages often have smaller equipment capacities because of the efficiency improvements from code. In the 1980s vintage example, the incremental cost is significant due to the HVAC units all having a capacity of greater than 10 tons.

4 Stakeholder Interviews

To support the code pathway options, the Reach Code Team interviewed five HVAC designers, three HVAC contractors, and two equipment distributors/ manufacturer representatives ("reps") to gather information regarding their experience with replacing units within this size range, and their opinions of the challenges associated with replacing packaged SZAC + gas furnaces with packaged SZHP.

4.1 Objectives and Research Questions

The team conducted ten interviews focusing on the major factors that influence the replacement of a gas-fired packaged unit with a heat pump including physical constraints, electrical concerns, and capacity issues. The interview questions are provided in Appendix 9.6.

4.2 Results

Overall, eight of ten interviewees related challenges when replacing gas packs with heat pumps. Those challenges included:

- Leaving air temperature of heat pump being lower than a gas pack,
- Condensate production on the outdoor coil during heating cycle,
- Cool air being delivered to the space during the defrost cycle, particularly in occupancies with large outdoor air changes per hour and in colder climates,
- Difficulty handling high outside air loads and associated electrical upgrades, and
- Physical constraints, such as structural, footprint, existing duct configuration, and height issues.

The most common physical constraint reported by interviewees (n=6) was the need for an adapter curb during replacement, which has some minimal cost associated with configuration. Two interviewees noted that this was necessary about 50% of the time regardless of whether the retrofit involved a SZAC or SZHP.

All of the designers and contractors the team interviewed (n=8) noted electrical issues as being concerns during retrofit, but generally uncommon. While power for the cooling for the packaged SZ AC + gas furnace is equal to or larger than the power demand from a heat pump during heating mode, the main electrical concern had to do with the installation of electric resistance for defrost control. Defrost cycles occur when the outdoor coil freezes during heating, and the unit needs to switch to air-conditioning mode for three to five minutes to melt the frost and improve heating efficiency. This concern is minimal as it may only trigger a circuit upgrade and not a building service upgrade. One contractor, however, did state that electrical power is more of a concern in older buildings because of prior improvements to the building, and the potential for the building service to not have the capacity to handle an additional electrical upgrade.

The necessity of electric resistance for defrost control is debatable according to interview responses:

- There was no consensus as to a particular rule of thumb used for specification by designers. One cited an outside air load of more than 30-50%, another cited less than 20°F ambient conditions, and another mentioned specifying electric resistance as a precaution against minor discomfort.
- Similarly, there was no real consensus among contractors as two mentioned humid conditions in cold Climate Zones and another would simply include it as a precaution.
- Distributors had consistent answers. Two mentioned that it was installed for back up heat, and another mentioned cold ambient conditions less than 33°F. However, neither distributor interviewed had encountered a situation where a heat pump was not able to maintain the space setpoint because electric resistance hadn't been installed.

Interviewees commented that heating capacity is an issue during a heat pump retrofit. However, different interviewee groups cited varying issues:

- Designers had concerns with high outside air capacities and low ambient conditions hindering heat pump heating capacity.
- Contractors mainly cited the defrost cycle as the biggest heating issue with heat pumps since the supply air temperature is cooler during the defrost cycle.
- Distributors and manufacturer representatives also mentioned system performance at low outdoor ambient conditions and the defrost cycle as being heating concerns for heat pumps.

Two interviewees cited leaky building envelope issues as a heating concern, but this was unrelated to heat pump retrofits.

4.3 Interpretation

The Reach Code Team considered the issues raised by interviewees and concluded they do not result in significant cost implications, as described below:

- The lower leaving air temperature of heat pumps relative to gas packs increases heating duration but does not necessarily lead to comfort or feasibility issues.
- Condensate production during the heating cycle is normal and can be routed in a similar way as the cooling cycle condensation.
- Cool air being delivered to the space during the defrost cycle is likely to happen only during peak heating events when overnight temperatures approach freezing, which is limited in commercial applications that primarily have daytime occupancy and operation.
- Physical constraints, such as structural, footprint, and height issues occur when replacing old equipment with similar size new models and manufacturers and are not associated specifically with heat pump retrofits.

Due to conflicting interviewee feedback on the potential need for electric resistance for supplemental heat as well as defrost cycles, the Team performed additional analysis using CBECC.

Figure 4 depicts the auto-sized single-zone heat pump (SZHP) peak heating demand as a percentage of the peak cooling demand, along with the unmet heating load hours (UMLH) for units without electric resistance backup. In all Climate Zones, peak cooling demand is larger than peak heating demand and thus drives compressor sizing. Furthermore, for electrical supplemental heat, there are very limited UMLH, barely breach 200 hours in CZ16. This data suggests that backup electrical heat is not necessary in all California Climate Zones, except perhaps CZ16.

In Figure 5 the need for electric resistance heating for the purpose of defrost is tested by measuring the heating capacity of the heat pump unit, compared to the actual peak heating demand. Because the default heating capacity of the rooftop units is at least 120% of the peak heating demand for the building in all Climate Zones, the Team estimates that heat pumps will be able to defrost relatively quickly and without causing sustained discomfort.

Based on these two assessments, the need for electrical upgrades associated with heat pump retrofits appears to be minimal, and thus does not require inclusion in cost-effectiveness analysis.

Figure 4. Peak Heating Demand as a Percent of Peak Cooling Demand, and Unmet Heating Load Hours

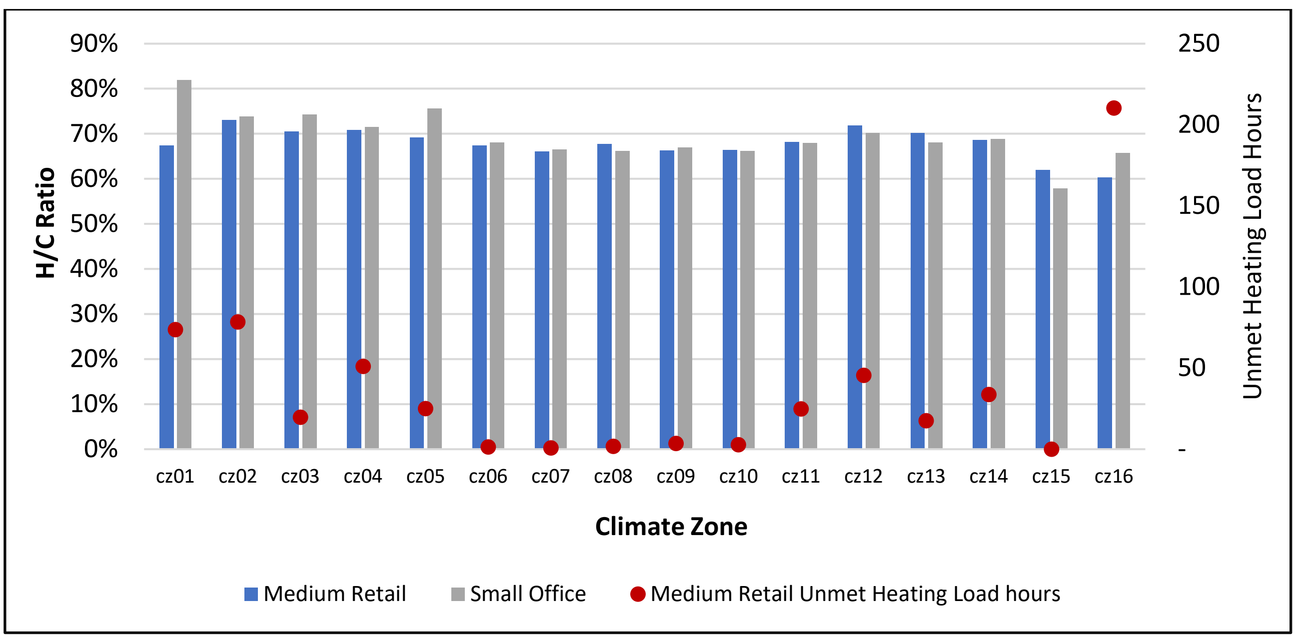
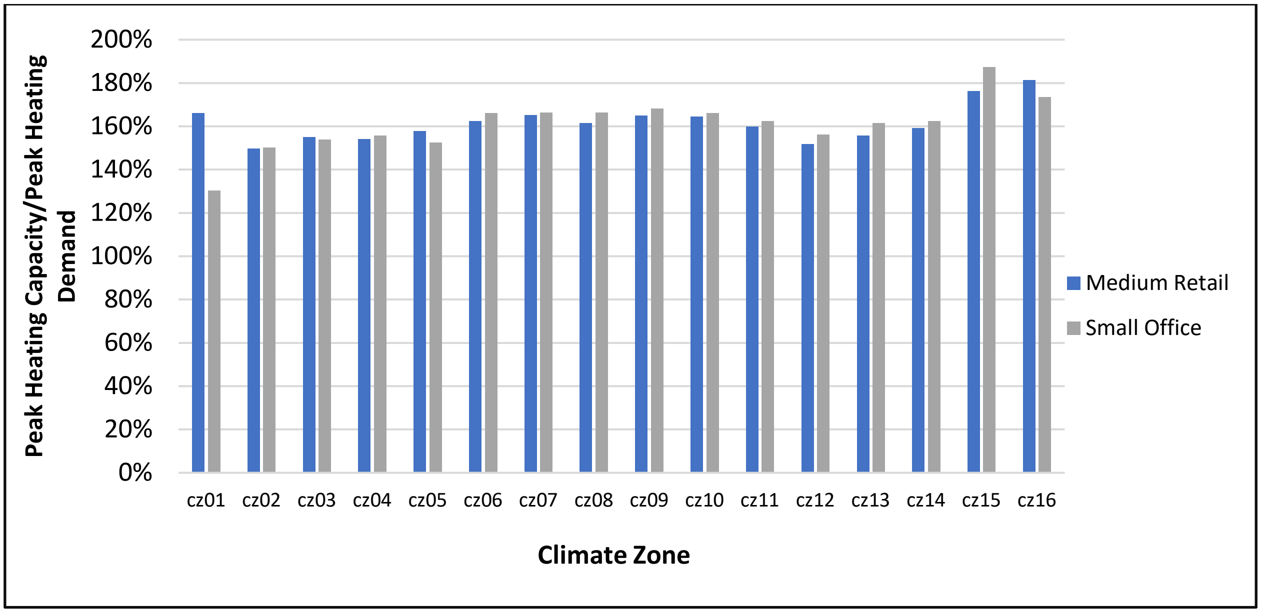


Figure 5. Heating Capacity as a Percent of Peak Heating Demand from CBECC



5 Cost-effectiveness Results

Results are presented as per the prototype-specific Measure Packages described in Section 3. The LSC and On-Bill based, cost-effectiveness results are presented in terms of B/C ratio and NPV section. What constitutes a benefit or a cost varies with the scenarios because both energy savings and incremental construction costs may be negative depending on the package. Typically, utility bill savings are categorized as benefits, while incremental construction costs are treated as costs. In cases where both construction costs are negative and utility bill savings are negative, the construction cost savings are treated as the benefit, while the utility bill negative savings are as the cost. In Table 11 through Table 13, the results **Both** (shown in green shading) indicates that the result is cost-effective in both On-Bill and LSC. The result ***On-Bill*** or ***LSC*** (shown in yellow shading) indicates that the result is either cost-effective in On-Bill or LSC, respectively. The result **[-]** (results with no shading) indicates that the result is not cost-effective On-Bill or LSC. Results that are **blank** (shown in gray shading) indicate that the package or measure is not applicable, for example, if there are not relevant tonnage of equipment in a vintage.

There are several overarching factors to keep in mind when reviewing the results including:

- SZHP packages will have lower **GHG emissions** than SZAC packages in all cases, due to the clean power sources currently available from California's power providers.
- To pass the Energy Commission's application process, local reach codes must have **at least one pathway that is cost-effective** and exceeds the energy performance budget using LSC (i.e., have a positive compliance margin). Other pathways must also exceed the energy performance budget but are not required to be cost-effective. To emphasize these two important factors, the modeling results that have demonstrated both LSC savings or are cost effective are highlighted in green in the figures within this section.
- As mentioned in Section 2.1.4, The Reach Code Team coordinated with utilities to select tariffs for each prototype given the annual energy demand profile and the most prevalent rates in each utility territory. The Reach Code Team did not compare a variety of tariffs to determine their impact on cost-effectiveness. Utility rate updates can affect cost-effectiveness results.
- As a point of comparison, **mixed-fuel SZAC baseline** energy figures are provided in *Appendix 9.2*.

For each prototype, the Reach Code Team assessed the viability of achieving a cost-effective outcome when combining efficiency measures with heat pump packages (e.g., the *Heat Pump HVAC + Bundled Efficiency Measures* packages) based on the NPVs achieved from each individual efficiency measure.

5.1 Small Office

5.1.1 Individual Efficiency Measure Results

Table 11 shows cost-effectiveness results of individual efficiency measures applied to the existing mixed-fuel Small Office prototype. *Window Film* and *Lighting Retrofit* are mostly On-Bill cost-effective in most Climate Zones across the vintages.

Table 11. Cost-Effectiveness for Individual Efficiency Measures: Small Office

Climate Zone	CZ1	CZ2	CZ3	CZ4	CZ4	CZ5	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ10	CZ11	CZ12	CZ12	CZ13	CZ14	CZ14	CZ15	CZ16
Utility	PG&E	PG&E	PG&E	PG&E	CPAU	PG&E	SCG	SCE	SDG&E	SCE	SCE	SDG&E	SCE	PG&E	PG&E	SMUD	PG&E	SDG&E	SCE	SCE	PG&E
Window Film 1980s	–	On-Bill	On-Bill	On-Bill	–	On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	On-Bill	On-Bill	–	On-Bill	On-Bill	–	Both	–
Window Film 1990s	–	On-Bill	On-Bill	On-Bill	–	On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	On-Bill	On-Bill	–	On-Bill	On-Bill	–	Both	–
Window Film 2000s																					
Lighting Retrofit 1980s	On-Bill	On-Bill	On-Bill	On-Bill	–	On-Bill	On-Bill	–	On-Bill	–	–	On-Bill	–	On-Bill	On-Bill	–	On-Bill	On-Bill	–	LSC	On-Bill
Lighting Retrofit 1990s	On-Bill	On-Bill	On-Bill	On-Bill	–	On-Bill	On-Bill	–	On-Bill	–	–	On-Bill	–	On-Bill	On-Bill	–	On-Bill	On-Bill	–	–	On-Bill
Lighting Retrofit 2000s	On-Bill	On-Bill	On-Bill	On-Bill	–	On-Bill	On-Bill	–	On-Bill	–	–	On-Bill	–	On-Bill	On-Bill	–	On-Bill	On-Bill	–	–	On-Bill

5.1.2 SZAC Package Results

Table 12 shows the cost-effectiveness results of the Small Office for SZAC packages. The *MF-EFF* package is mostly either On-Bill or LSC cost-effective in all applicable Climate Zones across the three vintages. Due to package optimization, there are some Climate Zones excluded because no cost-effective measures are applicable. The *MF-HRV* package is not presented in this table because it is not cost-effective in any Climate Zones across the three vintages. However, the results are included in the Results Workbook for reference.

Table 12. Cost-Effectiveness for SZAC Packages: Small Office

Climate Zone	CZ1	CZ2	CZ3	CZ4	CZ4	CZ5	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ10	CZ11	CZ12	CZ12	CZ13	CZ14	CZ14	CZ15	CZ16
Utility	**PG&E**	**PG&E**	**PG&E**	**PG&E**	**CPAU**	**PG&E**	**SCG**	**SCE**	**SDG&E**	**SCE**	**SCE**	**SDG&E**	**SCE**	**PG&E**	**PG&E**	**SMUD**	**PG&E**	**SDG&E**	**SCE**	**SCE**	**PG&E**
MF-EFF 1980s	LSC	LSC	On-Bill	On-Bill		On-Bill	On-Bill	–	On-Bill	LSC	On-Bill	On-Bill	–	On-Bill	On-Bill		On-Bill	LSC		–	LSC
MF-EFF 1990s	LSC	LSC	On-Bill	On-Bill		On-Bill	On-Bill	On-Bill	On-Bill	LSC	On-Bill	On-Bill	–	On-Bill	On-Bill		On-Bill	LSC		–	LSC
MF-EFF 2000s	LSC	LSC	On-Bill	On-Bill		On-Bill	On-Bill		On-Bill			On-Bill		On-Bill	On-Bill		On-Bill	LSC			LSC

5.1.3 SZHP Package Results

Table 13 shows the cost-effectiveness results of the Small Office for SZHP packages. The *HP* package is cost-effective in both metrics across most Climate Zones and vintages. In vintage 1990s and 2000s, only select Climate Zones are applicable, as most units are 5 tons or below and are prescriptively required to be SZHPs under the 2025 code.

Table 13. Cost-Effectiveness for SZHP Package: Small Office

Climate Zone	CZ1	CZ2	CZ3	CZ4	CZ4	CZ5	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ10	CZ11	CZ12	CZ12	CZ13	CZ14	CZ14	CZ15	CZ16
Utility	**PG&E**	**PG&E**	**PG&E**	**PG&E**	**CPAU**	**PG&E**	**SCG**	**SCE**	**SDG&E**	**SCE**	**SCE**	**SDG&E**	**SCE**	**PG&E**	**PG&E**	**SMUD**	**PG&E**	**SDG&E**	**SCE**	**SCE**	**PG&E**
HP 1980s	Both	Both	Both	Both	Both	Both	On-Bill	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
HP 1990s	Both	Both								On-Bill	On-Bill	On-Bill	On-Bill					Both			Both
HP 2000s	Both	Both																Both	Both		Both

5.2 Medium Retail

5.2.1 Individual Efficiency Measure Results

Table 14 shows cost-effectiveness results of individual efficiency measures applied to the existing mixed-fuel Medium Retail prototype. The *Cool Roof, Lighting Retrofit,* and *Economizer FDD* measures as individual measures are On-Bill and LSC cost-effective in most Climate Zones and vintages where they are applicable. *Window Film* is mostly On-Bill and LSC cost-effective in selected Climate Zones and vintages.

Table 14. Cost-Effectiveness for Individual Efficiency Measures: Medium Retail

Climate Zone	CZ1	CZ2	CZ3	CZ4	CZ4	CZ5	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ10	CZ11	CZ12	CZ12	CZ13	CZ14	CZ14	CZ15	CZ16
Utility	PG&E	PG&E	PG&E	PG&E	CPAU	PG&E	SCG	SCE	SDG&E	SCE	SCE	SDG&E	SCE	PG&E	PG&E	SMUD	PG&E	SDG&E	SCE	SCE	PG&E
Cool Roof 1980s		On-Bill		On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	–
Cool Roof 1990s		On-Bill		On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	–
Cool Roof 2000s		On-Bill		On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	Both	Both	On-Bill	On-Bill	On-Bill	Both	Both	Both	Both	–
Window Film 1980s	–	On-Bill	On-Bill	On-Bill	–	On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	On-Bill	On-Bill	–	On-Bill	On-Bill	–	Both	–
Window Film 1990s	–	On-Bill	–	On-Bill	–	On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	On-Bill	On-Bill	–	On-Bill	On-Bill	–	Both	–
Window Film 2000s																					
Lighting Retrofit 1980s	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
Lighting Retrofit 1990s	LSC	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
Lighting Retrofit 2000s	LSC	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
Economizer FDD 1980s		Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
Economizer FDD 1990s	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
Economizer FDD 2000s	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both

5.2.2 SZAC Package Results

Table 15 shows the cost-effectiveness results of the SZAC Medium Retail measure packages. The *MF-EFF* package is cost-effective in terms of LSC and On-Bill in most Climate Zones and vintages. The *MF-HRVDCV* package is partially cost-effective in terms of On-Bill due to the smaller savings compared to the incremental package cost.

Table 15. Cost-Effectiveness for SZAC Packages: Medium Retail

Climate Zone	CZ1	CZ2	CZ3	CZ4	CZ4	CZ5	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ10	CZ11	CZ12	CZ12	CZ13	CZ14	CZ14	CZ15	CZ16
Utility	**PG&E**	**PG&E**	**PG&E**	**PG&E**	**CPAU**	**PG&E**	**SCG**	**SCE**	**SDG&E**	**SCE**	**SCE**	**SDG&E**	**SCE**	**PG&E**	**PG&E**	**SMUD**	**PG&E**	**SDG&E**	**SCE**	**SCE**	**PG&E**
MF-EFF 1980s	LSC	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
MF-EFF 1990s	LSC	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
MF-EFF 2000s	LSC	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
MF-HRVDCV 1980s	Both	Both	On-Bill	Both	Both	Both	Both	–	On-Bill	On-Bill	On-Bill	On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	Both	Both
MF-HRVDCV 1990s	Both	Both	–	Both	Both	Both	Both	–	–	On-Bill	On-Bill	On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	On-Bill	Both
MF-HRVDCV 1990s	Both	Both	–	Both	Both	Both	Both	–	–	On-Bill	On-Bill	On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	On-Bill	Both
MF-HRVDCV 2000s	Both	Both	Both	Both	Both	Both	Both	–	–	On-Bill	On-Bill	Both	Both	Both	Both	Both	Both	Both	Both	On-Bill	LSC

5.2.3 SZHP Package Results

Table 16 shows the cost-effectiveness results of the SZHP packages for Medium Retail. The *HP* package is mostly cost-effective in terms of On-Bill in some Climate Zones in the 1980s and 1990s vintages. The Climate Zones where the package is not cost-effective is partly due to the large incremental first cost of switching to a SZHP HVAC system for larger capacity units over 10 tons. SZHP retrofits become cost effective in most Climate Zones in the 2000s vintage because of the lower incremental costs associated with smaller system sizes. Comparing this with the *HP-10* package where only units at 10-ton or below are replaced with SZHPs, we can see improvements in the cost-effectiveness in terms of LSC and On-bill in applicable Climate Zones.

Table 16. Cost-Effectiveness for SZHP Packages: Medium Retail

Climate Zone	CZ1	CZ2	CZ3	CZ4	CZ4	CZ5	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ10	CZ11	CZ12	CZ12	CZ13	CZ14	CZ14	CZ15	CZ16
Utility	PG&E	PG&E	PG&E	PG&E	CPAU	PG&E	SCG	SCE	SDG&E	SCE	SCE	SDG&E	SCE	PG&E	PG&E	SMUD	PG&E	SDG&E	SCE	SCE	PG&E
HP 1980s	Both	On-Bill	Both	On-Bill	On-Bill	Both	LSC	On-Bill	–	–	–	–	–	On-Bill	On-Bill	On-Bill	On-Bill	–	On-Bill	–	On-Bill
HP 1990s	Both	On-Bill	Both	On-Bill	On-Bill	On-Bill	–	–	–	–	On-Bill	–	–	Both	Both	Both	Both	LSC	Both	–	On-Bill
HP 2000s	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	–	On-Bill
HP-10 1980s	Both		Both			Both	Both	Both	Both												
HP-10 1990s	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	On-Bill	On-Bill		Both
HP-10 2000s	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	On-Bill	On-Bill
HP-DCV 1980s	Both	Both	Both	Both	Both	Both	LSC	On-Bill	–	–	On-Bill	On-Bill	On-Bill	Both	Both	Both	Both	LSC	Both	On-Bill	On-Bill
HP-DCV 1990s	Both	On-Bill	Both	Both	Both	On-Bill	–	–	–	On-Bill	On-Bill	On-Bill	On-Bill	Both	Both	Both	Both	LSC	Both	–	On-Bill
HP-DCV 2000s	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	–	Both	Both	–	Both	Both	–	–	On-Bill

6 Reach Code Options

Adopting a reach code based on this package of measures is feasible in Climate Zones where:

1. There is an LSC compliant package. This report prioritizes SZHP LSC compliance; and
2. SZHP and SZAC packages have equivalent LSC savings, allowing for both a SZHP and SZAC pathway; and
3. At least one of the SZHP or SZAC is either LSC or on-bill cost-effective.

If one package is cost-effective and the other package achieves LSC equivalency with the cost-effective package, then this reach code pathway could be considered within that Climate Zone.

HVAC RTU Replacement Reach Code Options include:

- **Option 1: *HP* OR *MF-HRV* OR *MF-HRVDCV*:** This reach code would require a SZHP up to 20 tons, or SZAC with additional HVAC efficiency measures.
- **Option 2: *HP-10* OR *MF-HRV* OR *MF-HRVDCV*:** This reach code would require SZHP replacements for units up to 10 tons or require additional HVAC efficiency measures for SZAC replacements.
- **Option 3: *HP-DCV* OR *MF-EFF*:** This reach code option increases the number of efficiency measures required as part of the RTU replacement and higher upfront costs and thus could be considered where Options 1 or 2 cannot be adopted. This reach code requires additional efficiency measures, including HVAC, as well as envelope and lighting if SZAC systems are installed.

The RTU replacement reach code options are evaluated in each Climate Zone and vintage and categorized based on the cost-effectiveness and LSC savings of the two pathways. For each reach code option, the primary pathway should be cost-effective under the assumption that the RTU will be replaced as part of the proposed project scope, and the alternative pathway should achieve at least as much LSC savings. The team evaluated several tiers of this reach code option with different requirements for the primary pathway. The primary pathway is a SZHP replacement for Option 1, SZHP replacements for units up to 10 tons only for Option 2, and SZHP replacements with additional HVAC measures for Option 3. If Option 1 is cost-effective, it will cover the broadest set of equipment with the simplest requirements for the SZHP. If Option 1 is not cost-effective, Options 2 or 3 may be considered.

The tables presented in this section show the results for each reach code option and Climate Zone. The primary pathway shows the number of prototypes that are cost-effective, and the number of prototypes analyzed. The alternative pathway shows the number of prototypes that meet or exceed the LSC savings of the primary pathway, regardless of whether they are cost-effective, and the number of prototypes that were analyzed. Note that due to differences in the prototypes, RTU capacities, and measure applicability, not all packages were able to be modeled for all Climate Zones, vintages, and building types.

Table 17 shows the results for the RTU Replacement Reach Code Option 1, where the SZHP replacement is the primary pathway. The alternative pathways analyzed for energy equivalency are the SZAC replacement with HRV only, which is not consistently cost-effective in all cases, and the SZAC replacement with HRV and DCV measures. The DCV measure was not modeled in the small office prototype because there are no packaged units serving only conference room zones and the occupancy profile is otherwise relatively flat. Because DCV was modeled in only one prototype, there are three modeled scenarios for this pathway (the Retail vintages) rather than six scenarios for the other pathways (both Small Office and Retail). However, because offices will have conference rooms and thus can achieve occupancy-based savings for DCV, the results are presented below and treated as widely applicable. Results show that the primary SZHP pathway is cost-effective for more than half of all Climate Zones and vintages.

Table 17. HVAC RTU Replacement Reach Code Option 1 Applicability

		Primary Pathway – Count of prototypes that are C/E	Alternative Pathway - Count of prototypes that achieve LSC equivalency	
Climate Zone	Utility	HP	MF-HRV	MF-HRVDCV
CZ1	PG&E	6 / 6	3 / 6	3 / 3
CZ2	PG&E	6 / 6	5 / 6	3 / 3
CZ3	PG&E	4 / 4	4 / 4	3 / 3
CZ4	PG&E	4 / 4	4 / 4	3 / 3
CZ4-2	CPAU	4 / 4	4 / 4	3 / 3
CZ5	PG&E	4 / 4	4 / 4	3 / 3
CZ5-2	SCG	3 / 4	4 / 4	3 / 3
CZ6	SCE	3 / 4	3 / 4	3 / 3
CZ7	SDG&E	2 / 4	2 / 4	3 / 3
CZ8	SCE	3 / 5	3 / 5	3 / 3
CZ9	SCE	4 / 5	3 / 5	3 / 3
CZ10	SDG&E	3 / 5	3 / 5	3 / 3
CZ10-2	SCE	3 / 5	3 / 5	3 / 3
CZ11	PG&E	4 / 4	4 / 4	3 / 3
CZ12	PG&E	4 / 4	4 / 4	3 / 3
CZ12-2	SMUD	4 / 4	4 / 4	3 / 3
CZ13	PG&E	4 / 4	4 / 4	3 / 3
CZ14	SDG&E	5 / 6	6 / 6	3 / 3
CZ14-2	SCE	3 / 6	6 / 6	3 / 3
CZ15	SCE	1 / 4	4 / 4	3 / 3
CZ16	PG&E	6 / 6	6 / 6	3 / 3

The Reach Code Team evaluated the cost-effectiveness as it relates to the average capacity of each variation and determined that the SZHP alone is generally cost-effective when the average capacity is around 10 tons or less. The Reach Code Team re-ran the above packages implementing a limit of 10 tons. For the RTU Replacement Reach Code Option 2 results presented in Table 18, the primary pathway is a SZHP replacement for units 5-10 tons, and units 10-20 tons remain the same as the baseline. The same measures are considered for the alternative SZAC pathway as RTU Replacement Reach Code Option 1.

Table 18. HVAC RTU Replacement Reach Code Option 2 Applicability

		Primary Pathway – Count of prototypes that are C/E	Alternative Pathway - Count of prototypes that achieve LSC equivalency	
Climate Zone	Utility	HP-10	MF-HRV	MF-HRVDCV
CZ1	PG&E	6 / 6	3 / 6	3 / 3
CZ2	PG&E	5 / 5	4 / 5	2 / 2
CZ3	PG&E	4 / 4	4 / 4	3 / 3
CZ4	PG&E	3 / 3	3 / 3	2 / 2
CZ4-2	CPAU	3 / 3	3 / 3	2 / 2
CZ5	PG&E	4 / 4	4 / 4	3 / 3
CZ5-2	SCG	4 / 4	4 / 4	3 / 3
CZ6	SCE	4 / 4	3 / 4	3 / 3
CZ7	SDG&E	4 / 4	3 / 4	3 / 3
CZ8	SCE	4 / 4	2 / 4	2 / 2
CZ9	SCE	4 / 4	2 / 4	2 / 2
CZ10	SDG&E	4 / 4	2 / 4	2 / 2
CZ10-2	SCE	4 / 4	2 / 4	2 / 2
CZ11	PG&E	3 / 3	3 / 3	2 / 2
CZ12	PG&E	3 / 3	3 / 3	2 / 2
CZ12-2	SMUD	3 / 3	3 / 3	2 / 2
CZ13	PG&E	3 / 3	3 / 3	2 / 2
CZ14	SDG&E	5 / 5	5 / 5	2 / 2
CZ14-2	SCE	2 / 5	5 / 5	2 / 2
CZ15	SCE	2 / 2	2 / 2	1 / 1
CZ16	PG&E	5 / 5	5 / 5	2 / 2

RTU Replacement Reach Code Option 3 results, summarized in Table 19, show the SZHP replacement with DCV as the primary pathway and the mixed-fuel SZAC replacement with DCV, lighting retrofit, and window film as the alternative pathway. The HRV measure is excluded from the primary pathway because it is not cost-effective across all Climate Zones. For Climate Zones and vintages that are cost-effective and energy equivalent for multiple reach code options, Option 1 is the more stringent option. Because there is an Option 1 RTU Replacement Reach Code available for all Climate Zones and vintages for Small Office, Option 3 was only evaluated for the Retail prototype.

Table 19. HVAC RTU Replacement Reach Code Option 3 Applicability (Retail only)

		Primary Pathway – Count of prototypes that are C/E	Alternative Pathway - Count of prototypes that achieve LSC equivalency
Climate Zone	Utility	HP-DCV	MF-EFF
CZ1	PG&E	3 / 3	3 / 3
CZ2	PG&E	3 / 3	3 / 3
CZ3	PG&E	3 / 3	3 / 3
CZ4	PG&E	3 / 3	3 / 3
CZ4-2	CPAU	3 / 3	3 / 3
CZ5	PG&E	3 / 3	3 / 3
CZ5-2	SCG	2 / 3	3 / 3
CZ6	SCE	2 / 3	3 / 3
CZ7	SDG&E	1 / 3	3 / 3
CZ8	SCE	2 / 3	3 / 3
CZ9	SCE	3 / 3	3 / 3
CZ10	SDG&E	3 / 3	3 / 3
CZ10-2	SCE	3 / 3	3 / 3
CZ11	PG&E	3 / 3	3 / 3
CZ12	PG&E	3 / 3	3 / 3
CZ12-2	SMUD	3 / 3	3 / 3
CZ13	PG&E	3 / 3	3 / 3
CZ14	SDG&E	2 / 3	3 / 3
CZ14-2	SCE	3 / 3	3 / 3
CZ15	SCE	1 / 3	3 / 3
CZ16	PG&E	3 / 3	3 / 3

7 Conclusions and Next Steps

The Reach Codes Team developed packages with SZHPs and energy efficiency measures, simulated them in building modeling software, and gathered costs to determine the cost-effectiveness of multiple scenarios. The Reach Codes Team coordinated with multiple utilities, cities, and building community experts to develop a set of assumptions considered reasonable in the current market. Changing assumptions—such as the period of analysis, measure selection, cost assumptions, energy escalation rates, or utility tariffs—are likely to change results.

Jurisdictions statewide can adopt a variety of building reach codes using the results in this report. While results are nuanced by vintage, Climate Zone, and utility, the overarching takeaways by prototype using the assumptions in this report are summarized below:

- **Small Office:** Code minimum packaged SZHP space conditioning replacements are cost-effective in all Climate Zones and vintages. The bundled efficiency measure package is cost-effective for both SZAC (like-for-like) and SZHP replacements. The HRV measure is not cost-effective with the SZHP replacement. There are some individual efficiency measures that are cost-effective, depending on Climate Zone and vintage, including window film and lighting retrofit.
- **Medium Retail:** Code minimum packaged SZHP space conditioning replacements are mainly cost-effective in the 2000s vintage, and where HVAC replacements are ≤ 10 tons. In the 1980s and 1990s vintages, which require larger equipment (>10 tons), SZHPs show more variation in cost-effectiveness based on the larger incremental cost of SZHP equipment. With the bundled efficiency measures, code minimum SZAC space heating replacements are cost-effective in all Climate Zones. There are several cost-effective individual efficiency measures, depending on Climate Zone and vintage, including cool roof, economizer FDD, window film, and lighting retrofit.

Based on these results, the Reach Code Team has identified the following potential measure packages that jurisdictions in most Climate Zones and utility territories may consider adopting based on cost-effectiveness during RTU replacements. The RTU Replacement Reach Code options are as follows:

- Option 1: SZHP Code Min (up to 20 tons) or Mixed-fuel SZAC Code Min + HVAC Measures
- Option 2: SZHP Code Min (up to 10 tons) or Mixed-fuel SZAC Code Min + HVAC Measures
- Option 3: SZHP Code Min + HVAC Measures or Mixed-fuel SZAC Code Min + Bundled Efficiency Measures

Generally, the Reach Code Team found that at least one RTU Replacement Reach Code option may be considered for adoption for all Climate Zones, although in several Climate Zones the option may not be cost-effective across all vintages and prototypes modeled. The

Reach Code options may be applied to a wider set of prototypes, including libraries, grocery, banks, and schools, as described in Section 3.2.

This analysis was limited to the measure packages and building types described. There may be other energy efficiency measures that are cost effective in some or all climate zones, and other building prototypes relevant to what is being retrofit in a particular region of California. To request custom analysis, please contact info@localenergycodes.com.

8 References

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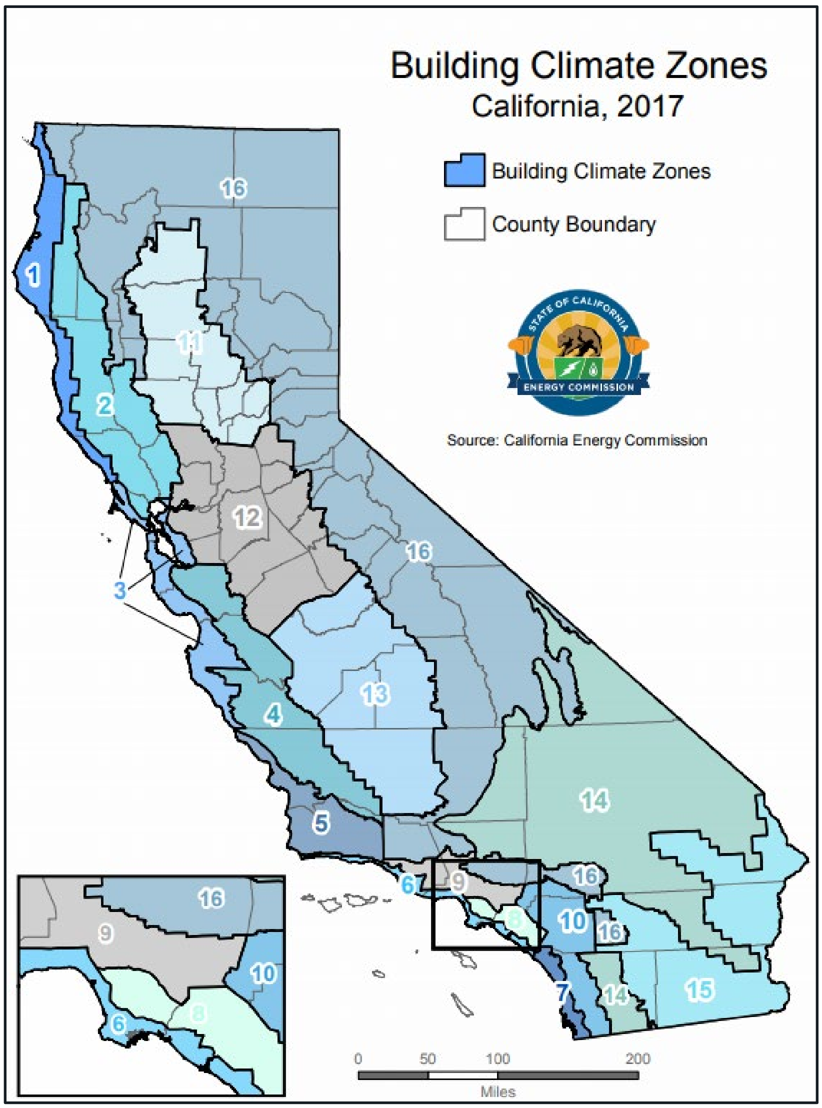
9 Appendices

9.1 Map of California Climate Zones

Climate zone geographical boundaries are depicted in Figure 6. Map of California climate zones. The map in Figure 6. Map of California climate zones. along with a zip-code search directory is available at:
https://ww2.energy.ca.gov/maps/renewable/building_climate_zones.html

Figure 6. Map of California climate zones.



9.2 Mixed-Fuel Baseline Energy Figures

Table 20. Medium Retail: Existing Mixed-Fuel Baseline 1980

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	362,829	3,411	$129,201	$6,796	$135,996	41
CZ2	PG&E	440,689	2,431	$162,498	$4,956	$167,454	39
CZ3	PG&E	405,363	1,690	$147,666	$3,423	$151,089	33
CZ4	PG&E	479,116	2,287	$176,888	$4,726	$181,613	40
CZ4-2	CPAU	479,116	2,287	$104,157	$6,375	$110,532	40
CZ5	PG&E	399,754	1,599	$148,036	$3,215	$151,252	32
CZ5-2	SCG	399,754	1,599	$148,036	$2,436	$150,473	32
CZ6	SCE	427,133	590	$114,657	$1,041	$115,698	28
CZ7	SDG&E	435,608	435	$160,261	$623	$160,884	27
CZ8	SCE	498,649	656	$139,534	$1,147	$140,681	31
CZ9	SCE	496,146	846	$140,014	$1,420	$141,434	32
CZ10	SDG&E	518,627	826	$192,271	$1,083	$193,353	33
CZ10-2	SCE	518,627	826	$144,216	$1,388	$145,604	33
CZ11	PG&E	511,565	2,767	$186,733	$5,736	$192,469	44
CZ12	PG&E	471,069	2,466	$172,369	$5,121	$177,490	40
CZ12-2	SMUD	471,069	2,466	$80,619	$5,121	$85,739	40
CZ13	PG&E	524,977	1,865	$190,257	$3,959	$194,217	39
CZ14	SDG&E	518,931	2,349	$180,950	$2,873	$183,824	42
CZ14-2	SCE	518,931	2,349	$135,571	$3,350	$138,920	42
CZ15	SCE	660,960	448	$174,838	$844	$175,682	37
CZ16	PG&E	444,960	4,278	$158,233	$8,542	166,775	51

Table 21. Medium Retail: Existing Mixed-Fuel Baseline 1990

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	337,880	2,543	$119,821	$5,120	$124,941	35
CZ2	PG&E	405,987	1,667	$149,136	$3,384	$152,520	33
CZ3	PG&E	370,768	1,094	$135,276	$2,258	$137,534	28
CZ4	PG&E	435,229	1,559	$160,056	$3,203	$163,258	33
CZ4-2	CPAU	435,229	1,559	$94,425	$4,945	$99,370	33
CZ5	PG&E	378,344	1,033	$139,394	$2,123	$141,517	28
CZ5-2	SCG	378,344	1,033	$139,394	$1,681	$141,075	28
CZ6	SCE	405,100	325	$107,392	$656	$108,048	25
CZ7	SDG&E	408,992	233	$148,909	$390	$149,299	25
CZ8	SCE	458,178	410	$122,006	$785	$122,792	28
CZ9	SCE	456,026	560	$122,445	$1,001	$123,446	29
CZ10	SDG&E	472,282	564	$173,098	$779	$173,876	29
CZ10-2	SCE	472,282	564	$125,599	$1,007	$126,606	29
CZ11	PG&E	458,080	1,808	$166,630	$3,726	$170,356	36
CZ12	PG&E	426,105	1,613	$155,174	$3,334	$158,508	33
CZ12-2	SMUD	426,105	1,613	$72,021	$3,425	$75,446	33
CZ13	PG&E	464,002	1,248	$167,727	$2,623	$170,350	33
CZ14	SDG&E	459,171	1,609	$159,827	$2,007	$161,834	34
CZ14-2	SCE	459,171	1,609	$118,811	$2,422	$121,233	34
CZ15	SCE	550,370	250	$141,683	$551	$142,234	30
CZ16	PG&E	406,009	3,099	$144,458	$6,244	$150,702	42

Table 22. Medium Retail: Existing Mixed-Fuel Baseline 2000

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	331,055	2,964	$116,618	$5,889	$122,507	37
CZ2	PG&E	368,892	2,133	$133,976	$4,359	$138,335	33
CZ3	PG&E	347,589	1,472	$125,426	$2,982	$128,409	29
CZ4	PG&E	389,542	2,098	$141,959	$4,340	$146,299	34
CZ4-2	CPAU	389,542	2,098	$84,047	$6,003	$90,050	34
CZ5	PG&E	352,283	1,414	$128,191	$2,841	$131,031	29
CZ5-2	SCG	352,283	1,414	$128,191	$2,194	$130,384	29
CZ6	SCE	367,634	518	$94,579	$934	$95,513	24
CZ7	SDG&E	370,947	404	$132,002	$587	$132,589	24
CZ8	SCE	407,793	625	$106,172	$1,101	$107,273	27
CZ9	SCE	407,765	825	$106,932	$1,388	$108,320	28
CZ10	SDG&E	414,731	658	$148,951	$886	$149,837	27
CZ10-2	SCE	414,731	658	$107,541	$1,142	$108,683	27
CZ11	PG&E	418,772	2,167	$151,246	$4,529	$155,775	36
CZ12	PG&E	391,670	1,996	$141,560	$4,177	$145,738	34
CZ12-2	SMUD	391,670	1,996	$65,293	$4,177	$69,470	34
CZ13	PG&E	424,029	1,561	$152,401	$3,249	$155,650	33
CZ14	SDG&E	415,063	2,050	$142,703	$2,522	$145,226	35
CZ14-2	SCE	415,063	2,050	$105,480	$2,980	$108,459	35
CZ15	SCE	489,705	344	$124,170	$689	$124,860	28
CZ16	PG&E	378,759	3,736	$133,970	$7,450	$141,421	44

Table 23. Medium Retail: Existing Mixed-Fuel FDD Baseline 1980

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E						
CZ2	PG&E	454,429	2,431	$166,955	$4,957	$171,911	39
CZ3	PG&E	410,069	1,718	$149,667	$3,477	$153,144	33
CZ4	PG&E	493,340	2,268	$181,340	$4,689	$186,029	40
CZ4-2	CPAU	493,340	2,268	$107,191	$6,337	$113,528	40
CZ5	PG&E	420,845	1,595	$153,940	$3,208	$157,147	33
CZ5-2	SCG	420,845	1,595	$153,940	$2,431	$156,371	33
CZ6	SCE	453,474	595	$116,544	$1,048	$117,591	29
CZ7	SDG&E	465,024	444	$165,911	$633	$166,545	29
CZ8	SCE	520,726	650	$142,311	$1,138	$143,449	32
CZ9	SCE	515,751	842	$142,484	$1,413	$143,897	33
CZ10	SDG&E	535,283	820	$194,944	$1,076	$196,019	34
CZ10-2	SCE	535,283	820	$146,313	$1,380	$147,693	34
CZ11	PG&E	521,719	2,769	$189,851	$5,734	$195,584	44
CZ12	PG&E	484,282	2,462	$176,675	$5,112	$181,787	41
CZ12-2	SMUD	484,282	2,462	$82,124	$5,112	$87,236	41
CZ13	PG&E	538,085	1,868	$194,411	$3,961	$198,371	40
CZ14	SDG&E	530,607	2,345	$184,263	$2,868	$187,132	42
CZ14-2	SCE	530,607	2,345	$137,213	$3,344	$140,557	42
CZ15	SCE	671,269	450	$176,129	$846	$176,975	37
CZ16	PG&E	459,029	4,288	$163,083	$8,558	$171,641	51

Table 24. Medium Retail: Existing Mixed-Fuel FDD Baseline 1990

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	343,733	2,534	$123,444	$5,104	$128,548	35
CZ2	PG&E	418,947	1,649	$153,333	$3,350	$156,683	33
CZ3	PG&E	390,900	1,085	$141,990	$2,241	$144,231	29
CZ4	PG&E	447,994	1,542	$164,034	$3,168	$167,202	33
CZ4-2	CPAU	447,994	1,542	$97,159	$4,911	$102,070	33
CZ5	PG&E	398,742	1,007	$145,166	$2,075	$147,241	29
CZ5-2	SCG	398,742	1,007	$145,166	$1,645	$146,811	29
CZ6	SCE	431,799	326	$109,424	$657	$110,081	26
CZ7	SDG&E	437,821	238	$154,396	$395	$154,790	26
CZ8	SCE	477,680	408	$124,303	$782	$125,085	28
CZ9	SCE	473,486	559	$124,510	$999	$125,510	29
CZ10	SDG&E	487,233	562	$175,501	$775	$176,276	30
CZ10-2	SCE	487,233	562	$127,366	$1,002	$128,368	30
CZ11	PG&E	466,851	1,808	$169,374	$3,722	$173,095	36
CZ12	PG&E	437,293	1,611	$158,828	$3,326	$162,154	33
CZ12-2	SMUD	437,293	1,611	$73,304	$3,417	$76,721	33
CZ13	PG&E	474,897	1,252	$171,129	$2,626	$173,755	33
CZ14	SDG&E	469,042	1,603	$162,673	$2,001	$164,674	35
CZ14-2	SCE	469,042	1,603	$120,229	$2,415	$122,645	35
CZ15	SCE	559,124	255	$142,698	$558	$143,255	31
CZ16	PG&E	418,885	3,099	$148,862	$6,244	$155,106	42

Table 25. Medium Retail: Existing Mixed-Fuel FDD Baseline 2000

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	334,133	2,955	$118,836	$5,874	$124,710	37
CZ2	PG&E	376,400	2,109	$136,465	$4,316	$140,781	34
CZ3	PG&E	359,362	1,460	$129,290	$2,962	$132,252	29
CZ4	PG&E	397,033	2,072	$144,339	$4,293	$148,632	34
CZ4-2	CPAU	397,033	2,072	$85,661	$5,953	$91,615	34
CZ5	PG&E	364,695	1,383	$131,734	$2,785	$134,519	29
CZ5-2	SCG	364,695	1,383	$131,734	$2,151	$133,885	29
CZ6	SCE	384,244	510	$96,104	$923	$97,028	25
CZ7	SDG&E	388,971	403	$135,619	$585	$136,205	25
CZ8	SCE	419,809	621	$107,602	$1,094	$108,696	27
CZ9	SCE	418,105	817	$108,172	$1,377	$109,548	28
CZ10	SDG&E	423,876	653	$150,475	$880	$151,355	27
CZ10-2	SCE	423,876	653	$108,644	$1,134	$109,778	27
CZ11	PG&E	424,497	2,169	$153,029	$4,528	$157,557	36
CZ12	PG&E	398,822	1,988	$143,941	$4,161	$148,103	34
CZ12-2	SMUD	398,822	1,988	$66,124	$4,161	$70,285	34
CZ13	PG&E	431,259	1,566	$154,654	$3,252	$157,906	33
CZ14	SDG&E	421,138	2,041	$144,521	$2,512	$147,033	35
CZ14-2	SCE	421,138	2,041	$106,356	$2,968	$109,324	35
CZ15	SCE	495,422	347	$124,838	$693	$125,531	29
CZ16	PG&E	387,411	3,733	$136,960	$7,444	$144,405	44

Table 26. Medium Retail: Mixed-Fuel SZAC Code Minimum Baseline 1980

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	330,146	3,634	$117,538	$7,104	$125,029	40
CZ2	PG&E	386,517	3,028	$142,626	$6,061	$148,784	39
CZ3	PG&E	350,383	2,205	$128,615	$4,472	$132,777	33
CZ4	PG&E	422,921	2,793	$156,411	$5,683	$162,326	39
CZ4-2	CPAU	422,921	2,793	$91,914	$7,369	$99,283	39
CZ5	PG&E	357,588	2,112	$133,079	$4,244	$137,183	32
CZ5-2	SCG	357,588	2,112	$133,079	$3,085	$136,164	32
CZ6	SCE	380,747	850	$102,047	$1,415	$103,121	26
CZ7	SDG&E	390,599	669	$144,977	$891	$145,908	26
CZ8	SCE	438,518	930	$119,049	$1,532	$120,395	29
CZ9	SCE	437,803	1,166	$120,876	$1,857	$122,464	31
CZ10	SDG&E	458,750	1,148	$173,011	$1,453	$174,689	31
CZ10-2	SCE	458,750	1,148	$125,076	$1,826	$126,902	31
CZ11	PG&E	456,417	3,295	$167,066	$6,765	$174,237	43
CZ12	PG&E	416,712	2,963	$152,974	$6,076	$159,597	40
CZ12-2	SMUD	416,712	2,963	$71,498	$6,076	$77,574	40
CZ13	PG&E	466,474	2,324	$169,400	$4,867	$174,919	38
CZ14	SDG&E	470,503	2,871	$165,898	$3,474	$170,600	41
CZ14-2	SCE	470,503	2,871	$122,830	$3,959	$126,790	41
CZ15	SCE	577,811	677	$153,714	$1,182	$154,982	33
CZ16	PG&E	399,719	4,978	$144,332	$9,824	$156,858	51

Table 27. Medium Retail: Mixed-Fuel SZAC Code Minimum Baseline 1990

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	322,594	2,731	$114,844	$5,381	$120,348	35
CZ2	PG&E	379,888	1,773	$139,052	$3,542	$142,545	32
CZ3	PG&E	344,512	1,518	$125,878	$3,054	$128,693	29
CZ4	PG&E	395,103	1,991	$145,396	$4,119	$149,382	33
CZ4-2	CPAU	395,103	1,991	$85,705	$5,794	$91,498	33
CZ5	PG&E	350,123	1,464	$129,954	$2,918	$132,715	29
CZ5-2	SCG	350,123	1,464	$129,954	$2,262	$132,217	29
CZ6	SCE	375,743	527	$99,724	$947	$100,368	24
CZ7	SDG&E	378,545	412	$138,486	$595	$138,989	24
CZ8	SCE	420,056	609	$113,165	$1,076	$113,920	27
CZ9	SCE	418,250	791	$113,537	$1,338	$114,473	28
CZ10	SDG&E	431,007	806	$161,040	$1,058	$162,204	28
CZ10-2	SCE	431,007	806	$116,142	$1,358	$117,500	28
CZ11	PG&E	425,508	2,241	$155,289	$4,668	$159,824	36
CZ12	PG&E	402,141	1,692	$146,265	$3,461	$149,864	32
CZ12-2	SMUD	402,141	1,692	$67,348	$3,552	$70,900	32
CZ13	PG&E	429,557	1,578	$155,836	$3,276	$159,386	32
CZ14	SDG&E	439,219	1,630	$153,147	$2,024	$155,666	33
CZ14-2	SCE	439,219	1,630	$112,586	$2,450	$115,036	33
CZ15	SCE	508,300	345	$129,173	$692	$129,792	29
CZ16	PG&E	375,366	3,762	$135,625	$7,477	$144,980	43

Table 28. Medium Retail: Mixed-Fuel SZAC Code Minimum Baseline 2000

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	321,233	3,071	$113,854	$5,975	$120,295	36
CZ2	PG&E	361,254	2,169	$131,810	$4,369	$136,118	33
CZ3	PG&E	330,971	1,926	$120,584	$3,914	$124,282	30
CZ4	PG&E	370,393	2,535	$136,586	$5,163	$141,648	35
CZ4-2	CPAU	370,393	2,535	$80,268	$6,862	$87,130	35
CZ5	PG&E	335,034	1,890	$123,792	$3,800	$127,347	30
CZ5-2	SCG	335,034	1,890	$123,792	$2,817	$126,609	30
CZ6	SCE	355,508	762	$93,744	$1,285	$94,620	25
CZ7	SDG&E	358,170	627	$130,391	$842	$131,108	24
CZ8	SCE	395,918	856	$105,868	$1,436	$106,879	27
CZ9	SCE	395,348	1,093	$106,814	$1,763	$108,063	28
CZ10	SDG&E	405,367	905	$149,399	$1,169	$150,412	27
CZ10-2	SCE	405,367	905	$107,416	$1,498	$108,914	27
CZ11	PG&E	417,708	2,183	$151,320	$4,538	$155,852	35
CZ12	PG&E	387,330	2,018	$140,877	$4,181	$145,153	33
CZ12-2	SMUD	387,330	2,018	$65,115	$4,181	$69,296	33
CZ13	PG&E	423,172	1,594	$152,705	$3,294	$156,178	32
CZ14	SDG&E	414,645	2,014	$144,695	$2,469	$147,726	34
CZ14-2	SCE	414,645	2,014	$106,914	$2,936	$109,850	34
CZ15	SCE	486,731	447	$123,568	$843	$124,277	28
CZ16	PG&E	369,114	3,405	$132,583	$6,739	$141,949	40

Table 29. Small Office: Existing Mixed-Fuel Baseline 1980

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	75,261	778	$31,724	$1,597	$33,321	9
CZ2	PG&E	100,788	373	$42,553	$834	$43,387	8
CZ3	PG&E	91,453	248	$38,556	$589	$39,145	7
CZ4	PG&E	110,793	350	$46,904	$797	$47,701	9
CZ4-2	CPAU	110,793	350	$24,048	$2,569	$26,618	9
CZ5	PG&E	91,961	267	$38,743	$622	$39,366	7
CZ5-2	SCG	91,961	267	$38,743	$569	$39,312	7
CZ6	SCE	99,673	67	$26,098	$278	$26,376	6
CZ7	SDG&E	101,642	44	$35,577	$171	$35,747	7
CZ8	SCE	114,050	81	$31,431	$299	$31,730	7
CZ9	SCE	114,398	105	$31,901	$334	$32,235	8
CZ10	SDG&E	118,460	102	$43,632	$239	$43,871	8
CZ10-2	SCE	118,460	102	$33,047	$329	$33,376	8
CZ11	PG&E	117,108	425	$49,743	$950	$50,693	10
CZ12	PG&E	106,223	394	$44,995	$888	$45,883	9
CZ12-2	SMUD	106,223	394	$20,060	$888	$20,948	9
CZ13	PG&E	119,384	287	$50,724	$680	$51,404	9
CZ14	SDG&E	118,563	427	$41,525	$621	$42,146	10
CZ14-2	SCE	118,563	427	$32,206	$809	$33,015	10
CZ15	SCE	152,540	56	$40,238	$263	$40,501	9
CZ16	PG&E	103,301	832	$43,580	$1,716	$45,296	11

Table 30. Small Office: Existing Mixed-Fuel Baseline 1990

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	72,021	438	$30,381	$953	$31,334	7
CZ2	PG&E	89,947	235	$37,988	$565	$38,553	7
CZ3	PG&E	83,347	147	$35,157	$392	$35,549	6
CZ4	PG&E	97,565	217	$41,303	$534	$41,837	7
CZ4-2	CPAU	97,565	217	$21,160	$2,309	$23,469	7
CZ5	PG&E	83,667	154	$35,270	$404	$35,674	6
CZ5-2	SCG	83,667	154	$35,270	$406	$35,675	6
CZ6	SCE	90,245	30	$23,698	$224	$23,921	6
CZ7	SDG&E	92,140	19	$32,220	$141	$32,362	6
CZ8	SCE	102,681	40	$28,184	$239	$28,423	6
CZ9	SCE	103,712	59	$28,728	$266	$28,994	7
CZ10	SDG&E	107,528	56	$39,322	$185	$39,507	7
CZ10-2	SCE	107,528	56	$29,772	$262	$30,034	7
CZ11	PG&E	100,240	236	$42,565	$573	$43,138	7
CZ12	PG&E	91,849	222	$38,909	$545	$39,454	7
CZ12-2	SMUD	91,849	222	$17,610	$545	$18,156	7
CZ13	PG&E	101,569	159	$43,140	$422	$43,563	7
CZ14	SDG&E	102,817	234	$36,438	$396	$36,835	7
CZ14-2	SCE	102,817	234	$28,177	$526	$28,703	7
CZ15	SCE	123,910	21	$33,089	$212	$33,301	7
CZ16	PG&E	92,250	482	$38,948	$1,041	$39,989	9

Table 31. Small Office: Existing Mixed-Fuel Baseline 2000

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	68,456	493	$28,883	$1,055	$29,938	7
CZ2	PG&E	79,179	293	$33,447	$677	$34,123	7
CZ3	PG&E	76,464	208	$32,260	$510	$32,770	6
CZ4	PG&E	88,126	296	$37,294	$691	$37,986	7
CZ4-2	CPAU	88,126	296	$19,064	$2,464	$21,528	7
CZ5	PG&E	76,492	220	$32,254	$532	$32,786	6
CZ5-2	SCG	76,492	220	$32,254	$501	$32,755	6
CZ6	SCE	81,829	50	$21,808	$254	$22,062	5
CZ7	SDG&E	83,863	33	$29,630	$158	$29,788	5
CZ8	SCE	91,235	65	$24,986	$276	$25,263	6
CZ9	SCE	92,122	90	$25,427	$313	$25,739	6
CZ10	SDG&E	89,493	67	$32,760	$198	$32,957	6
CZ10-2	SCE	89,493	67	$24,833	$278	$25,111	6
CZ11	PG&E	91,473	288	$38,808	$675	$39,483	7
CZ12	PG&E	84,414	277	$35,745	$655	$36,400	7
CZ12-2	SMUD	84,414	277	$16,165	$655	$16,820	7
CZ13	PG&E	92,371	201	$39,199	$507	$39,706	7
CZ14	SDG&E	93,481	297	$32,954	$470	$33,424	7
CZ14-2	SCE	93,481	297	$25,404	$619	$26,023	7
CZ15	SCE	110,070	30	$29,189	$224	$29,413	7
CZ16	PG&E	86,242	553	$36,412	$1,176	$37,588	9

Table 30. Small Office: Mixed-Fuel SZAC Code Minimum Baseline 1980

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	74,317	717	$31,326	$1,478	$32,805	9
CZ2	PG&E	84,591	488	$35,754	$1,049	$36,803	8
CZ3	PG&E	78,044	125	$32,919	$338	$33,257	6
CZ4	PG&E	94,705	166	$40,082	$420	$40,502	7
CZ4-2	CPAU	94,705	166	$20,479	$2,208	$22,687	7
CZ5	PG&E	78,443	135	$33,060	$351	$33,411	6
CZ5-2	SCG	78,443	135	$33,060	$374	$33,434	6
CZ6	SCE	83,582	43	$23,243	$242	$23,485	5
CZ7	SDG&E	85,477	31	$31,621	$155	$31,776	5
CZ8	SCE	96,775	48	$26,998	$250	$27,248	6
CZ9	SCE	97,201	62	$27,298	$271	$27,569	6
CZ10	SDG&E	100,456	63	$37,125	$193	$37,318	6
CZ10-2	SCE	100,456	63	$28,164	$271	$28,436	6
CZ11	PG&E	102,343	218	$43,454	$531	$43,985	8
CZ12	PG&E	92,336	198	$39,102	$488	$39,590	7
CZ12-2	SMUD	92,336	198	$17,582	$488	$18,070	7
CZ13	PG&E	103,162	156	$43,841	$411	$44,252	7
CZ14	SDG&E	102,851	511	$35,742	$719	$36,460	9
CZ14-2	SCE	102,851	511	$27,774	$931	$28,705	9
CZ15	SCE	121,320	123	$32,905	$362	$33,267	7
CZ16	PG&E	88,974	992	$37,598	$2,014	$39,612	11

Table 32. Small Office: Mixed-Fuel SZAC Code Minimum Baseline 1990

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	72,012	430	$30,378	$937	$31,315	7
CZ2	PG&E	88,161	235	$37,233	$565	$37,798	7
CZ3	PG&E	82,180	0	$34,654	$0	$34,654	5
CZ4	PG&E	96,068	0	$40,621	$0	$40,621	6
CZ4-2	CPAU	96,068	0	$20,735	$0	$20,735	6
CZ5	PG&E	82,723	0	$34,858	$0	$34,858	5
CZ5-2	SCG	82,723	0	$34,858	$0	$34,858	5
CZ6	SCE	88,041	0	$23,392	$0	$23,392	5
CZ7	SDG&E	89,827	0	$31,698	$0	$31,698	6
CZ8	SCE	88,742	30	$24,858	$224	$25,082	5
CZ9	SCE	89,591	41	$25,393	$239	$25,632	6
CZ10	SDG&E	92,812	42	$34,544	$168	$34,712	6
CZ10-2	SCE	92,812	42	$26,132	$240	$26,372	6
CZ11	PG&E	98,184	0	$41,613	$0	$41,613	6
CZ12	PG&E	90,993	0	$38,498	$0	$38,498	6
CZ12-2	SMUD	90,993	0	$17,003	$0	$17,003	6
CZ13	PG&E	98,807	0	$41,898	$0	$41,898	6
CZ14	SDG&E	99,107	232	$34,189	$394	$34,583	7
CZ14-2	SCE	99,107	232	$26,343	$523	$26,866	7
CZ15	SCE	115,611	0	$30,127	$0	$30,127	7
CZ16	PG&E	91,003	471	$38,419	$1,019	$39,438	9

Table 32. Small Office: Mixed-Fuel SZAC Code Minimum Baseline 2000

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Annual Electricity Cost	Annual Natural Gas Cost	Total Annual Utility Cost	Annual GHG Emissions (mtons)
CZ1	PG&E	68,453	484	$28,882	$1,038	$29,920	7
CZ2	PG&E	79,039	288	$33,386	$666	$34,052	6
CZ3	PG&E	76,443	204	$32,251	$502	$32,753	6
CZ4	PG&E	87,575	291	$37,051	$680	$37,731	7
CZ4-2	CPAU	87,575	291	$18,925	$2,454	$21,379	7
CZ5	PG&E	76,461	216	$32,241	$524	$32,765	6
CZ5-2	SCG	76,461	216	$32,241	$495	$32,736	6
CZ6	SCE	81,803	49	$21,763	$252	$22,016	5
CZ7	SDG&E	83,831	33	$29,562	$158	$29,720	5
CZ8	SCE	89,680	67	$24,461	$279	$24,740	6
CZ9	SCE	90,572	92	$24,860	$315	$25,175	6
CZ10	SDG&E	88,870	65	$32,096	$196	$32,292	6
CZ10-2	SCE	88,870	65	$24,294	$276	$24,570	6
CZ11	PG&E	90,527	282	$38,386	$665	$39,050	7
CZ12	PG&E	83,984	272	$35,554	$645	$36,198	7
CZ12-2	SMUD	83,984	272	$15,937	$645	$16,582	7
CZ13	PG&E	91,394	198	$38,761	$500	$39,260	7
CZ14	SDG&E	92,520	292	$32,310	$464	$32,774	7
CZ14-2	SCE	92,520	292	$24,839	$611	$25,450	7
CZ15	SCE	107,550	29	$28,186	$224	$28,410	6
CZ16	PG&E	85,337	542	$36,030	$1,152	$37,182	9

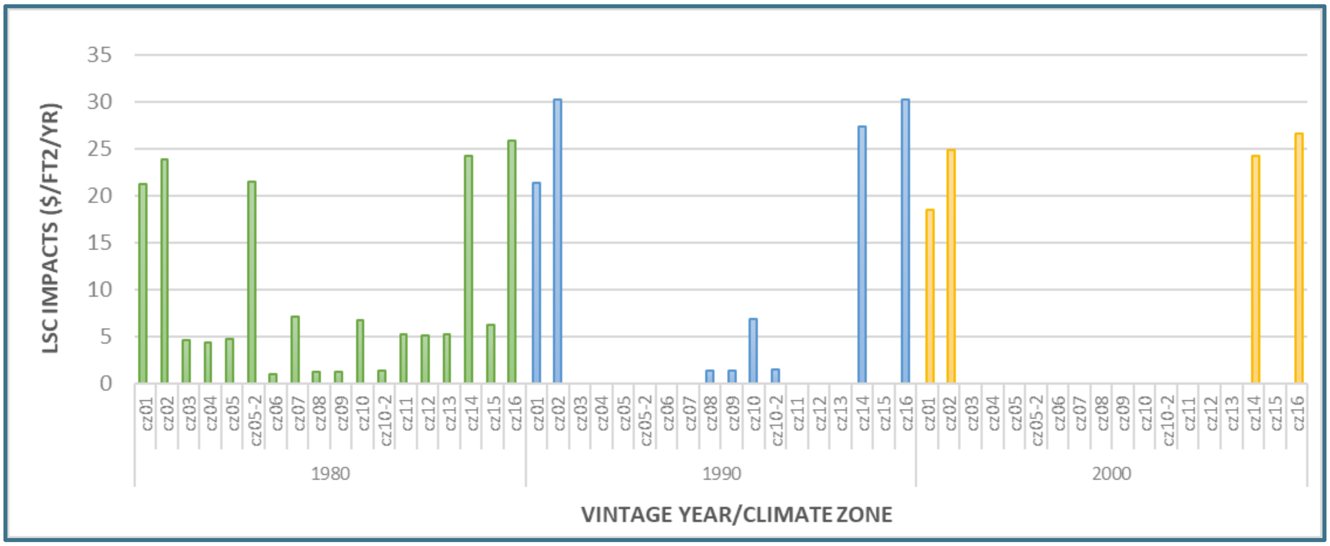
9.3 Long-Term Systemwide Cost (LSC) Impacts

This section compared LSC impacts of efficiency measure SZAC packages with SZHP Code Min package. These results help inform the energy-equivalency of the packages being analyzed.

9.3.1 Small Office

Figure 7 shows the LSC impacts results of the *MF-EFF* package compared to the *HP* code min package. The *MF-EFF* package for Small Office prototype includes window film and lighting retrofit measures where they have positive LSC impacts and are cost-effective. This package has LSC impacts exceeding the *HP* code min package in all applicable Climate Zones and vintages.

Figure 7. Small Office LSC Impacts: MF-EFF vs HP



9.3.2 Medium Retail

Figure 8 shows the LSC impacts results of the *MF-HRVDCV* package compared to the *HP* code min package. The *MF-HRVDCV* package for Medium Retail prototype includes DCV and HRV measures. The package has LSC impacts meeting or exceeding the *HP* code min package in all Climate Zones and vintages.

Figure 8. Medium Retail LSC Impacts: MF-HRVDCV vs HP

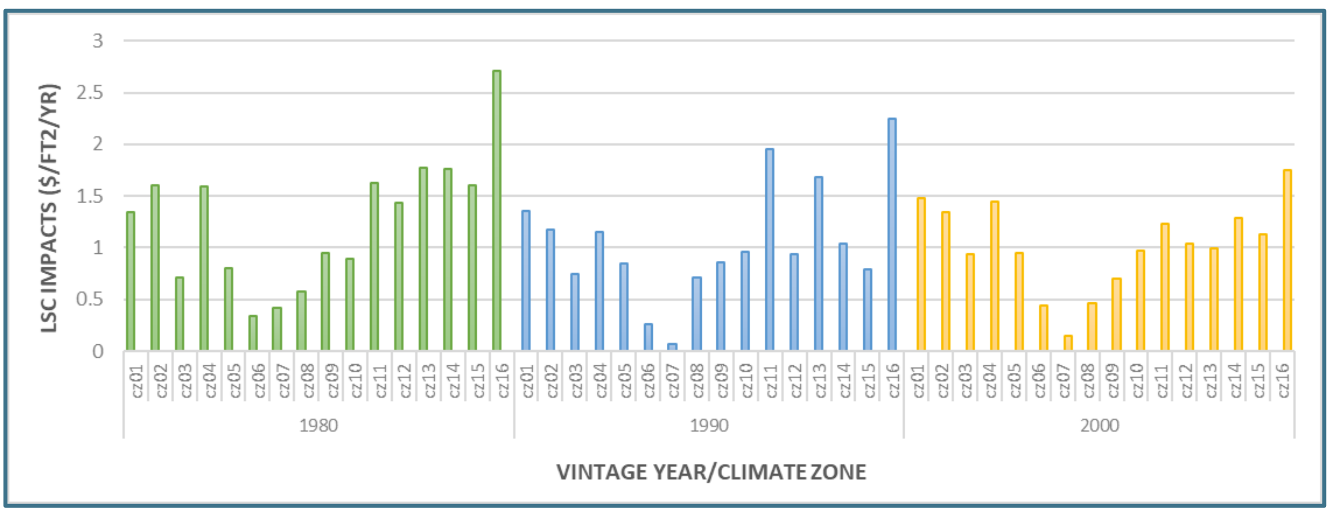
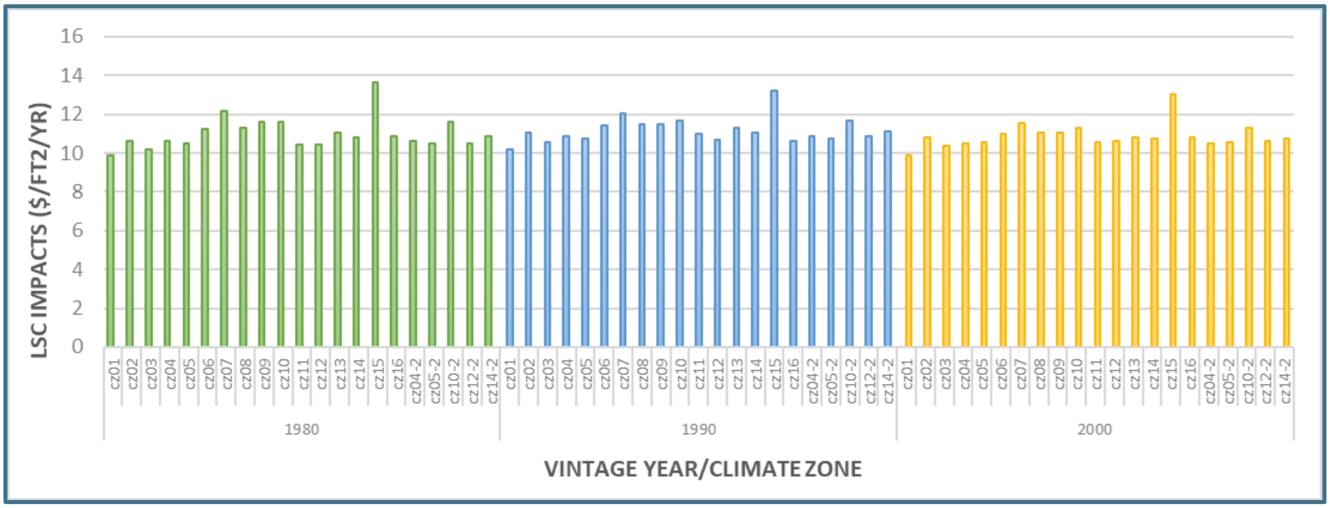


Figure 9 shows the LSC impacts results of the *MF-EFF* package compared to the *HP*-DCV. In addition to the HVAC measures, the *MF-EFF* package for the Medium Retail prototype includes DCV, window film and lighting retrofit measures in Climate Zones where they have positive LSC impacts and are cost-effective. This package has LSC impacts exceeding the *HP*-DCV in all Climate Zones and vintages.

Figure 9. Medium Retail LSC Impacts: MF-EFF vs HP-DCV



9.4 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.

9.4.1 Pacific Gas & Electric

Pacific Gas and Electric Company
U 39 *Oakland, California*

	Revised	*Cal. P.U.C. Sheet No.*	58719-E
Cancelling	Revised	*Cal. P.U.C. Sheet No.*	58550-E

ELECTRIC SCHEDULE B-1 Sheet 3
SMALL GENERAL SERVICE

RATES: Total bundled service charges are calculated using the total rates shown below. Direct Access (DA) and Community Choice Aggregation (CCA) charges shall be calculated in accordance with the paragraph in this rate schedule titled Billing.

Total Bundled Time-of-Use Rates	B-1 Rates		B1-ST Rates	
Total Customer Charge Rates				
Customer Charge Single-phase ($ per meter per day)	$0.32854		$0.32854	
Customer Charge Poly-phase ($ per meter per day)	$0.82136		$0.82136	
Demand Charge (for B1-ST only) Total Demand Rate (per metered kW/month assessed from 2:00 p.m. to 11:00 p.m. only)				
Summer	---		$8.01	(I)
Winter	---		$8.01	(I)
Total TOU Energy Rates ($ per kWh)				
Peak Summer	$0.49466	(I)	$0.52281	(I)
Part-Peak Summer	$0.44543	(I)	$0.38151	(I)
Off-Peak Summer	$0.42462	(I)	$0.33418	(I)
Peak Winter	$0.41924	(I)	$0.42486	(I)
Partial-Peak Winter (for B1-ST only)	---		$0.39536	(I)
Off-Peak Winter	$0.40312	(I)	$0.30631	(I)
Super Off-Peak Winter	$0.38670	(I)	$0.28989	(I)
PDP Rates (Consecutive Day and Five-Hour Event Option)*				
PDP Charges ($ per kWh)				
All Usage During PDP Event	$0.60			
PDP Credits				
Energy ($ per kWh)				
Peak Summer	($0.05841)			
Part-Peak Summer	($0.01735)			

* See PDP Detail, section g, for corresponding reduction in PDP credits and charges if other option(s) elected.

(Continued)

Advice	7382-E	*Issued by*	*Submitted*	September 30, 2024
Decision		***Shilpa Ramaiya***	*Effective*	October 1, 2024
		Vice President	*Resolution*	
		Regulatory Proceedings and Rates		

Pacific Gas and Electric Company®
U 39 Oakland, California

	Revised	*Cal. P.U.C. Sheet No.*	58721-E
Cancelling	Revised	*Cal. P.U.C. Sheet No.*	58552-E

ELECTRIC SCHEDULE B-10 Sheet 3
MEDIUM GENERAL DEMAND-METERED SERVICE

RATE:

Total bundled service charges shown on customers' bills are unbundled according to the component rates shown below. Direct Access (DA) and Community Choice Aggregation (CCA) charges shall be calculated in accordance with the paragraph in this rate schedule titled Billing.

TOTAL BUNDLED TIME-OF-USE RATES

	Secondary Voltage		Primary Voltage		Transmission Voltage	
Total Customer Charge Rates						
Customer Charge ($ per meter per day)	$11.51068	(I)	$11.51068	(I)	$11.51068	(I)
Total Demand Rates ($ per kW)						
Summer	$21.53	(I)	$20.84	(I)	$14.28	(I)
Winter	$21.53	(I)	$20.84	(I)	$14.28	(I)
Total Energy Rates ($ per kWh)						
Peak Summer	$0.36862	(I)	$0.34745	(I)	$0.25044	(I)
Part-Peak Summer	$0.30694	(I)	$0.28915	(I)	$0.19370	(I)
Off-Peak Summer	$0.27437	(I)	$0.25832	(I)	$0.16363	(I)
Peak Winter	$0.29236	(I)	$0.27460	(I)	$0.19739	(I)
Off-Peak Winter	$0.25688	(I)	$0.24097	(I)	$0.16456	(I)
Super Off-Peak Winter	$0.22054	(I)	$0.20463	(I)	$0.12822	(I)
PDP Rates (Consecutive Day and Five-Hour Event Option						
PDP Charges ($ per kWh)						
All Usage During PDP Event	$0.90		$0.90		$0.90	
PDP Credits						
Energy ($ per kWh)						
Peak Summer	($0.08103)		($0.08103)		($0.08103)	
Part-Peak Summer	($0.02807)		($0.02807)		($0.02807)	

* See PDP Details, section g, for corresponding reduction in PDP credits and charges if other option(s) elected.

(Continued)

Advice	7382-E	*Issued by*	*Submitted*	September 30, 2024
Decision		***Shilpa Ramaiya***	*Effective*	October 1, 2024
		Vice President	*Resolution*	
		Regulatory Proceedings and Rates		

9.4.2 Southern California Edison

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

Southern California Edison Revised Cal. PUC Sheet No. 88873-E
Rosemead, California (U 338-E) Cancelling Revised Cal. PUC Sheet No. 88283-E

Schedule TOU-GS-1 Sheet 5
TIME-OF-USE
GENERAL SERVICE
(Continued)

RATES (Continued)

Option D	Delivery Service									Generation[9]	
	Trans[1]	Distrbtn[2]	NSGC[3]	NDC[4]	PPPC[5]	WFC[6]	DWRA[11]	PUCRF[7]	Total[8]	UG**	DWREC[10]
Energy Charge - $/kWh											
Summer Season On-Peak	(0.00003)	0.04099 (I)	0.00869	0.00009	0.01818 (R)	0.00561	0.00000	0.00100	0.07453 (I)	0.11880 (R)	0.00000
Mid-Peak	(0.00003)	0.04099 (I)	0.00869	0.00009	0.01818 (R)	0.00561	0.00000	0.00100	0.07453 (I)	0.10728 (R)	0.00000
Off-Peak	(0.00003)	0.01704 (I)	0.00869	0.00009	0.01818 (R)	0.00561	0.00000	0.00100	0.05058 (I)	0.07031 (R)	0.00000
Winter Season											
Mid-Peak	(0.00003)	0.04099 (I)	0.00869	0.00009	0.01818 (R)	0.00561	0.00000	0.00100	0.07453 (I)	0.11182 (R)	0.00000
Off-Peak	(0.00003)	0.01704 (I)	0.00869	0.00009	0.01818 (R)	0.00561	0.00000	0.00100	0.05058 (I)	0.07894 (R)	0.00000
Super-Off-Peak	(0.00003)	0.00624 (I)	0.00869	0.00009	0.01818 (R)	0.00561	0.00000	0.00100	0.03978 (I)	0.05906 (R)	0.00000
Fixed Recovery Charge - $/kWh									0.00148		
MCAM Charge[12] - $/kWh									0.00058		
Customer Charge - $/day		0.468							0.468		
Facilities Related Demand Charge - $/kW	2.93	16.65 (I)							19.58 (I)		
Time Related Demand Charge - $/kW											
Summer Season On-Peak		4.81 (I)							4.81 (I)	16.74 (R)	
Winter Season Mid-peak - Weekdays (4-9pm)		0.00							0.00	5.14 (R)	
Three-Phase Service - $/day		0.046							0.046		
Voltage Discount, Energy - $/kWh											
From 2 kV to 50 kV	0.00000	0.00000							0.00000	(0.00048) (R)	
From 51 kV to 219 kV	0.00000	0.00000							0.00000	(0.00093) (R)	
220 kV and above	0.00000	(0.02387) (I)							(0.02387) (I)	(0.00095) (R)	
Voltage Discount, Demand - $/kW											
Facilities Related											
From 2 kV to 50 kV	0.00	(0.34) (I)							(0.34) (I)		
Above 50 kV but below 220 kV	0.00	(7.32) (I)							(7.32) (I)		
At 220 kV	0.00	(16.65) (I)							(16.65) (I)		
Voltage Discount, Summer On Peak Demand - $/kW											
From 2 kV to 50 kV		(0.08)							(0.08)	(0.20)	
Above 50 kV but below 220 kV		(1.44) (I)							(1.44) (I)	(0.47)	
At 220 kV		(1.44) (I)							(1.44) (I)	(0.47)	
Voltage Disc, Winter Weekdays (4-9pm) Demand - $/kW											
From 2 kV to 50 kV		0.00							0.00	(0.20)	
Above 50 kV but below 220 kV		0.00							0.00	(0.47)	
At 220 kV		0.00							0.00	(0.47)	
California Alternate Rates for Energy Discount - %		100.00*							100.00*		
California Climate Credit - $/meter		(86.00)							(86.00)		

* Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.
** The ongoing Competition Transition Charge (CTC) of $(0.00028) per kWh is recovered in the UG component of Generation.
1 Trans = Transmission and the Transmission Owners Tariff Charge Adjustments (TOTCA) which are FERC approved. The TOTCA represents the Transmission Revenue Balancing Account Adjustment (TRBAA) of $(0.00360) per kWh, Reliability Services Balancing Account Adjustment (RSBAA) of $(0.00006) per kWh, and Transmission Access Charge Balancing Account Adjustment (TACBAA) of $0.00351 per kWh
2 Distrbtn = Distribution
3 NSGC = New System Generation Charge
4 NDC = Nuclear Decommissioning Charge
5 PPPC = Public Purpose Programs Charge (includes California Alternate Rates for Energy Surcharge where applicable.)
6 WFC = Wildfire Fund Non-Bypassable Charge. The Wildfire Fund Non-Bypassable Charge supports the California Wildfire Fund and is not applicable to exempt Customers pursuant to D.19-10-056.
7 PUCRF = The PUC Reimbursement Fee is described in Schedule RF-E.
8 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.
9 Generation = The Generation rates are applicable only to Bundled Service Customers. See Special Condition below for PCIA recovery.
10 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.
11 DWRA = A refund from the California Department of Water Resources (DWR) relating to the purchase of power during the 2000-2001 energy crisis.
12 The Modified Cost Allocation Mechanism (MCAM) charge recovers the net cost associated with system reliability procurement ordered by the CPUC that SCE has procured on behalf of customers whose generation services are provided by certain Electric Service Providers or Community Choice Aggregators.

(Continued)

(To be inserted by utility) Issued by (To be inserted by Cal. PUC)
Advice 5379-E Michael Backstrom Date Submitted Sep 27, 2024
Decision Vice President Effective Oct 1, 2024
5C9 Resolution

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

Southern California Edison | Revised | Cal. PUC Sheet No. | 88885-E
Rosemead, California (U 338-E) | Cancelling | Revised | Cal. PUC Sheet No. | 88295-E

Schedule TOU-GS-2 | Sheet 4

TIME-OF-USE - GENERAL SERVICE - DEMAND METERED

(Continued)

RATES (Continued)

		Delivery Service									Generation[9]	
	Option D / Option D-CPP	Trans[1]	Distrbtn[2]	NSGC[3]	NDC[4]	PPPC[5]	WFC[6]	DWRA[11]	PUCRF[7]	Total[8]	UG**	DWREC[10]
TOU Pricing												
Energy Charge - $/kWh												
	Summer Season - On-Peak	(0.00003)	0.01937 (I)	0.00843	0.00009	0.01887 (R)	0.00561	0.00000	0.00100	0.05334 (I)	0.11446 (R)	0.00000
	Mid-Peak	(0.00003)	0.01774 (I)	0.00843	0.00009	0.01887 (R)	0.00561	0.00000	0.00100	0.05171 (I)	0.10436 (R)	0.00000
	Off-Peak	(0.00003)	0.01736 (I)	0.00843	0.00009	0.01887 (R)	0.00561	0.00000	0.00100	0.05133 (I)	0.06696 (R)	0.00000
	Winter Season - Mid-Peak	(0.00003)	0.01937 (I)	0.00843	0.00009	0.01887 (R)	0.00561	0.00000	0.00100	0.05334 (I)	0.07726 (R)	0.00000
	Off-Peak	(0.00003)	0.01774 (I)	0.00843	0.00009	0.01887 (R)	0.00561	0.00000	0.00100	0.05171 (I)	0.07773 (R)	0.00000
	Super-Off-Peak	(0.00003)	0.01679 (I)	0.00843	0.00009	0.01887 (R)	0.00561	0.00000	0.00100	0.05076 (I)	0.04081 (R)	0.00000
Fixed Recovery Charge - $/kWh										0.00137		
MCAM Charge[12] - $/kWh										0.00063		
Customer Charge - $/Meter/Month			239.34 (I)							239.34 (I)		
Facilities Related Demand Charge - $/kW		3.80	20.77 (I)							24.57 (I)		
Time Related Demand Charge - Summer Season - $/kW												
	On-Peak		17.18 (I)							17.18 (I)	21.24 (R)	
Winter Season - $/kW												
	Mid-peak - Weekdays (4-9pm)		2.78 (I)							2.78 (I)	5.58 (R)	
Single Phase Service - $/Month			(8.29) (R)							(8.29) (R)		
Voltage Discount, Demand - $/kW												
	Facilities Related											
	From 2 kV to 50 kV	0.00	(0.42) (I)							(0.42) (I)	0.00	
	Above 50 kV but below 220 kV	0.00	(9.13) (I)							(9.13) (I)	0.00	
	At 220 kV	0.00	(20.77) (I)							(20.77) (I)	0.00	
Voltage Discount, Summer On Peak - $/kW												
	From 2 kV to 50 kV	0.00	(0.35) (I)							(0.35) (I)	(0.49) (R)	
	Above 50 kV but below 220 kV	0.00	(6.48) (I)							(6.48) (I)	(1.11) (R)	
	At 220 kV	0.00	(17.18) (I)							(17.18) (I)	(1.12) (R)	
Voltage Discount, Winter Weekday Mid-Peak - $/kW												
	From 2 kV to 50 kV	0.00	(0.05)							(0.05)	(0.12) (R)	
	Above 50 kV but below 220 kV	0.00	(1.04) (I)							(1.04) (I)	(0.29) (R)	
	At 220 kV	0.00	(2.78) (I)							(2.78) (I)	(0.29) (R)	
Voltage Discount, Energy - $/kWh												
	From 2 kV to 50 kV	0.00000	(0.00035) (I)							(0.00035) (I)	(0.00094) (R)	
	Above 50 kV but below 220 kV	0.00000	(0.00625) (I)							(0.00625) (I)	(0.00207) (R)	
	At 220 kV	0.00000	(0.01658) (I)							(0.01658) (I)	(0.00209) (R)	
California Alternate Rates for Energy Discount - %			100.00*							100.00*		
TOU Optior	$/Meter/Month											
	RTEM		36.36 (I)							36.36 (I)		
California Climate Credit - $/meter			(86.00)							(86.00)		
Option D-CPP												
CPP Event Energy Charge - $/kWh											0.80000	
Summer CPP Non-Event Credit On-Peak Demand Credit - $/kW											(6.85)	
Maximum Available Credit - $/kW** Summer (4-9pm)											(21.24) (R)	

* Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.

** The ongoing Competition Transition Charge (CTC) of $(0.00029) 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 Trans = Transmission and the Transmission Owners Tariff Charge Adjustments (TOTCA) which are FERC approved. The TOTCA represents the Transmission Revenue Balancing Account Adjustment (TRBAA) of $(.00360) per kWh, Reliability Services Balancing Account Adjustment (RSBAA) of $(0.00006) per kWh, and Transmission Access Charge Balancing Account Adjustment (TACBAA) of $0.00351 per kWh.

2 Distrbtn = Distribution

3 NSGC = New System Generation Charge

4 NDC = Nuclear Decommissioning Charge

5 PPPC = Public Purpose Programs Charge (includes California Alternate Rates for Energy Surcharge where applicable.)

6 WFC = Wildfire Fund Non-Bypassable Charge. The Wildfire Fund Non-Bypassable Charge supports the California Wildfire Fund and is not applicable to exempt Customers pursuant to D.19-10-056.

7 PUCRF = The PUC Reimbursement Fee is described in Schedule RF-E.

8 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.

9 Generation = The Generation rates are applicable only to Bundled Service Customers. See Special Condition below for PCIA recovery.

10 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.

11 DWRA = A refund from the California Department of Water Resources (DWR) relating to the purchase of power during the 2000-2001 energy crisis.

12 The Modified Cost Allocation Mechanism (MCAM) charge recovers the net cost associated with system reliability procurement ordered by the CPUC that SCE has procured on behalf of customers whose generation services are provided by certain Electric Service Providers or Community Choice Aggregators.

(Continued)

(To be inserted by utility)	Issued by	(To be inserted by Cal. PUC)
Advice 5379-E	Michael Backstrom	Date Submitted Sep 27, 2024
Decision	Vice President	Effective Oct 1, 2024

SOUTHERN CALIFORNIA **EDISON**
An EDISON INTERNATIONAL Company

Southern California Edison		Revised	Cal. PUC Sheet No.	88900-E
Rosemead, California (U 338-E)	Cancelling	Revised	Cal. PUC Sheet No.	88310-E

Schedule TOU-GS-3 Sheet 3

TIME-OF-USE - GENERAL SERVICE - DEMAND METERED

(Continued)

RATES (Continued)

	Delivery Service									Generation[9]	
	Trans[1]	Distrbtn[2]	NSGC[3]	NDC[4]	PPPC[5]	WFC[6]	DWRA[11]	PUCRF[7]	Total[8]	UG**	DWREC[10]
Option D / Option D-CPP											
Energy Charge - $/kWh											
Summer Season - On-Peak	(0.00004)	0.01834 (I)	0.00785	0.00009	0.01720 (R)	0.00561	0.00000	0.00100	0.05005 (I)	0.10608 (R)	0.00000
Mid-Peak	(0.00004)	0.01679 (I)	0.00785	0.00009	0.01720 (R)	0.00561	0.00000	0.00100	0.04850 (I)	0.09673 (R)	0.00000
Off-Peak	(0.00004)	0.01648 (I)	0.00785	0.00009	0.01720 (R)	0.00561	0.00000	0.00100	0.04819 (I)	0.06533 (R)	0.00000
Winter Season											
Mid-Peak	(0.00004)	0.01834 (I)	0.00785	0.00009	0.01720 (R)	0.00561	0.00000	0.00100	0.05005 (I)	0.07539 (R)	0.00000
Off-Peak	(0.00004)	0.01679 (I)	0.00785	0.00009	0.01720 (R)	0.00561	0.00000	0.00100	0.04850 (I)	0.07585 (R)	0.00000
Super-Off-Peak	(0.00004)	0.01591 (I)	0.00785	0.00009	0.01720 (R)	0.00561	0.00000	0.00100	0.04762 (I)	0.03983 (R)	0.00000
Fixed Recovery Charge - $/kWh									0.00116		
MCAM Charge[12] - $/kWh									0.00061		
Customer Charge - $/Meter/Month		702.22 (I)							702.22 (I)		
Demand Charge - $/kW of Billing Demand/Meter/Month											
Facilities Related	4.23	19.04 (I)							23.27 (I)		
Time Related											
Summer Season - On-Peak		19.04 (I)							19.04 (I)	18.22 (R)	
Winter Season - Mid-Peak - Weekdays (4-9pm)		3.38 (I)							3.38 (I)	6.59 (R)	
Voltage Discount, Demand - $/kW											
Facilities Related											
From 2 kV to 50 kV	0.00	(0.36) (I)							(0.36) (I)		
Above 50 kV but below 220 kV	0.00	(7.88) (I)							(7.88) (I)		
At 220 kV	0.00	(19.04) (I)							(19.04) (I)		
Voltage Discount, Summer On Peak Demand - $/kW											
From 2 kV to 50 kV	0.00	(0.35) (I)							(0.35) (I)	(0.42) (R)	
Above 50 kV but below 220 kV	0.00	(6.55) (I)							(6.55) (I)	(0.97) (R)	
At 220 kV	0.00	(19.04) (I)							(19.04) (I)	(0.98) (R)	
Voltage Discount, Winter Weekdays (4-9pm) Demand - $/kW											
From 2 kV to 50 kV	0.00	(0.06)							(0.06)	(0.16) (R)	
Above 50 kV but below 220 kV	0.00	(1.16) (I)							(1.16) (I)	(0.35) (R)	
At 220 kV	0.00	(3.38) (I)							(3.38) (I)	(0.35) (R)	
Voltage Discount, Energy - $/kWh											
From 2 kV to 50 kV	0.00000	(0.00029) (I)							(0.00029) (I)	(0.00094) (R)	
Above 50 kV but below 220 kV	0.00000	(0.00536) (I)							(0.00536) (I)	(0.00206) (R)	
At 220 kV	0.00000	(0.01567) (I)							(0.01567) (I)	(0.00209) (R)	
Power Factor Adjustment - $/kVAR											
Greater than 50 kV		0.66							0.66		
50 kV or less		0.52							0.52		
California Alternate Rates for Energy Discount - %		100.00*							100.00*		
Option D-CPP											
CPP Event Energy Charge - $/kWh										0.80000	
Summer CPP Non-Event Credit On-Peak Demand Credit - $/kW										(7.55)	
Maximum Available Credit - $/kW**											
Summer (4-9pm)										(18.22) (R)	

* Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.
** The ongoing Competition Transition Charge (CTC) of $(0.00029) 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 Trans = Transmission and the Transmission Owners Tariff Charge Adjustments (TOTCA) which are FERC approved. The TOTCA represents the Transmission Revenue Balancing Account Adjustment (TRBAA) of $(0.00360) per kWh, Reliability Services Balancing Account Adjustment (RSBAA) of $(0.00005) per kWh, and Transmission Access Charge Balancing Account Adjustment (TACBAA) of $0.00351 per kWh.
2 Distrbtn = Distribution
3 NSGC = New System Generation Charge
4 NDC = Nuclear Decommissioning Charge
5 PPPC = Public Purpose Programs Charge (including California Alternate Rates for Energy Surcharge where applicable.)
6 WFC = Wildfire Fund Non-Bypassable Charge. The Wildfire Fund Non-Bypassable Charge supports the California Wildfire Fund and is not applicable to exempt Customers pursuant to D.19-10-056.
7 PUCRF = The PUC Reimbursement Fee is described in Schedule RF-E.
8 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.
9 Generation = The Generation rates are applicable only to Bundled Service Customers. See Special Condition below for PCIA recovery.
10 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.
11 DWRA = A refund from the California Department of Water Resources (DWR) relating to the purchase of power during the 2000-2001 energy crisis.
12 The Modified Cost Allocation Mechanism (MCAM) charge recovers the net cost associated with system reliability procurement ordered by the CPUC that SCE has procured on behalf of customers whose generation services are provided by certain Electric Service Providers or Community Choice Aggregators

(Continued)

(To be inserted by utility)	Issued by	(To be inserted by Cal. PUC)
Advice 5379-E	Michael Backstrom	Date Submitted Sep 27, 2024
Decision	Vice President	Effective Oct 1, 2024
3C9		Resolution

9.4.3 Southern California Gas

SOUTHERN CALIFORNIA GAS COMPANY	Revised	CAL. P.U.C. SHEET NO.	62162-G
LOS ANGELES, CALIFORNIA CANCELING	Revised	CAL. P.U.C. SHEET NO.	62131-G

Schedule No. G-10 Sheet 2

CORE COMMERCIAL AND INDUSTRIAL SERVICE

(Includes GN-10, GN-10C and GT-10 Rates)

(Continued)

RATES (Continued)

All Procurement, Transmission, and Commodity Charges are billed per therm.

GN-10:[4/] Applicable to natural gas procurement service to non-residential core customers, including service not provided under any other rate schedule.

		Tier I[1/]	Tier II[1/]	Tier III[1/]	
Procurement Charge:[2/]	G-CPNR	27.626¢	27.626¢	27.626¢	
Transmission Charge:	GPT-10	113.275¢	66.741¢	35.540¢	R
Commodity Charge:	GN-10	140.901¢	94.367¢	63.166¢	R

GN-10C[4/]: Core procurement service for previous non-residential transportation-only customers returning to core procurement service, including CAT customers with annual consumption over 50,000 therms, as further defined in Schedule No. G-CP.

		Tier I[1/]	Tier II[1/]	Tier III[1/]	
Procurement Charge:[2/]	G-CPNRC	28.095¢	28.095¢	28.095¢	
Transmission Charge:	GPT-10	113.275¢	66.741¢	35.540¢	R
Commodity Charge:	GN-10C	141.370¢	94.836¢	63.635¢	R

GT-10[4/]: Applicable to non-residential transportation-only service including CAT service, as set forth in Special Condition 13.

		Tier I[1/]	Tier II[1/]	Tier III[1/]	
Transmission Charge:	GT-10	113.275¢[3/]	66.741¢[3/]	35.540¢[3/]	R

[1/] Tier I rates are applicable for the first 250 therms used per month. Tier II rates are applicable for usage above Tier I quantities and up through 4,167 therms per month. Tier III rates are applicable for all usage above 4,167 therms per month. Under this schedule, the winter season shall be defined as December 1 through March 31 and the summer season as April 1 through November 30.

[2/] This charge is applicable for service to Utility Procurement Customers as shown in Schedule No. G-CP, in the manner approved by D.96-08-037, and subject to change monthly, as set forth in Special Condition 5.

[3/] These charges are equal to the core commodity rate less the following two components as approved in D.97-04-082: (1) the weighted average cost of gas; and (2) the core brokerage fee.

(Footnotes continue next page.)

(Continued)

(TO BE INSERTED BY UTILITY)	ISSUED BY	(TO BE INSERTED BY CAL. PUC)
ADVICE LETTER NO. 6369-G	Dan Skopec	SUBMITTED Sep 26, 2024
DECISION NO. D20-02-045; D24-07-013	Senior Vice President	EFFECTIVE Oct 1, 2024
2H7	Regulatory Affairs	RESOLUTION NO.

9.4.4 San Diego Gas & Electric

SDGE
San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 62379-E

Canceling Revised Cal. P.U.C. Sheet No. 61921-E

SCHEDULE AL-TOU

Sheet 4

GENERAL SERVICE - TIME METERED

RATES* (Continued)

Description – AL-TOU	Transm	Distr	PPP	ND	CTC	LGC	RS	TRAC	UDC Total
Energy Charges ($/kWh)									
On-Peak - Summer									
Secondary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Primary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Secondary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Primary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Transmission	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Off-Peak – Summer									
Secondary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Primary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Secondary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Primary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Transmission	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Super Off-Peak									
Secondary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Primary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Secondary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Primary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Transmission	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
On-Peak – Winter									
Secondary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Primary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Secondary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Primary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Transmission	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Off-Peak – Winter									
Secondary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Primary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Secondary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Primary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Transmission	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Super Off-Peak									
Secondary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Primary	(0.01945)	0.00177	0.01789 I	0.00007	0.00047	0.01798	0.00001		0.01874 I
Secondary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Primary Substation	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I
Transmission	(0.01945)	0.00130	0.01726 I	0.00007		0.01798	0.00001		0.01717 I

Notes: Transmission Energy charges include the Transmission Revenue Balancing Account Adjustment (TRBAA) of $(0.00289) per kWh and the Transmission Access Charge Balancing Account Adjustment (TACBAA) of $(0.01656) per kWh. The PPP rate is composed of Energy and Demand charges. For all voltage levels, the PPP Energy charges includes Low Income PPP rate (LI-PPP) $0.01515/kWh, Non-low Income PPP rate (Non-LI-PPP) $0.00211/kWh (pursuant to PU Code Section 399.8, the Non-LI-PPP rate may not exceed January 1, 2000 levels). For Secondary and Primary voltage levels, the PPP Energy charge also includes California Solar Initiative rate (CSI) of $(0.00045)/kWh and Self-Generation Incentive Program rate (SGIP) $ 0.00108 /kWh. For Secondary Substation, Primary Substation and Transmission voltage levels, the PPP rate includes Demand charges for CSI of $(0.16)/kW and SGIP of $0.39 /kW. I

*These rates are not applicable to TOU Period Grandfathering Eligible Customer Generators, please refer to SC 20 for applicable rates.

(Continued)

4C8

Advice Ltr. No. 4507-E

Decision No. D.24-07-013

Issued by
Dan Skopec
Senior Vice President
Regulatory Affairs

Submitted Sep 30, 2024

Effective Oct 1, 2024

Resolution No.

San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 62371-E

Canceling Revised Cal. P.U.C. Sheet No. 61914-E

SCHEDULE TOU-A

Sheet 6

GENERAL SERVICE - TIME OF USE SERVICE

SPECIAL CONDITIONS (continued)

TOU GRANDFATHERING RATES

Description TOU-A	Transm	Distr	PPP	ND	CTC	LGC	RS	TRAC	UDC Total
Basic Service Fee ($/mo									
Secondary									
0-5 kW		11.45							11.45
>5-20 kW		18.32							18.32
>20-50 kW		34.35							34.35
>50 kW		85.87							85.87
Primary									
0-5 kW		11.45							11.45
>5-20 kW		18.32							18.32
>20-50 kW		34.35							34.35
>50 kW		85.87							85.87
Energy Charges ($/kWh)									
On-Peak - Summer									
Secondary	0.02991	0.15287 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21794 I
Primary	0.02991	0.15209 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21716 I
Semi-Peak - Summer									
Secondary	0.02991	0.15287 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21794 I
Primary	0.02991	0.15209 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21716 I
Off-Peak - Summer									
Secondary	0.02991	0.15287 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21794 I
Primary	0.02991	0.15209 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21716 I
On-Peak - Winter									
Secondary	0.02991	0.15287 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21794 I
Primary	0.02991	0.15209 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21716 I
Semi-Peak - Winter									
Secondary	0.02991	0.15287 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21794 I
Primary	0.02991	0.15209 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21716 I
Off-Peak - Winter									
Secondary	0.02991	0.15287 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21794 I
Primary	0.02991	0.15209 I	0.01696 I	0.00007	0.00052	0.01760	0.00001		0.21716 I

TOU Grandfathering Time Periods

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

	Summer – June 1 – October 31	**Winter – November 1 – May 31**
On-Peak	11 a.m. - 6 p.m. Weekdays	5 p.m. - 8 p.m. Weekdays
Semi-Peak	6 a.m. - 11 a.m. Weekdays	6 a.m. - 5 p.m. Weekdays
	6 p.m. - 10 p.m. Weekdays	8 p.m. - 10 p.m. Weekdays
Off-Peak	10 p.m. - 6 a.m. Weekdays	10 p.m. - 6 a.m. Weekdays
	Plus Weekends & Holidays	Plus Weekends & Holidays

6C7

Advice Ltr. No. 4507-E

Decision No. D.24-07-013

Issued by
Dan Skopec
Senior Vice President
Regulatory Affairs

Submitted Sep 30, 2024

Effective Oct 1, 2024

Resolution No.

9.4.5 City of Palo Alto Utilities

RESIDENTIAL MASTER-METERED AND SMALL NON-RESIDENTIAL ELECTRIC SERVICE

UTILITY RATE SCHEDULE E-2

A. APPLICABILITY:

This Rate Schedule applies to the following Customers receiving Electric Service from the City of Palo Alto Utilities:

1. Non-residential Customers receiving Non-Demand metered Electric Service; and
2. Customers with Accounts at Master-Metered multi-family facilities receiving Non-Demand metered Electric Service.

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
Summer Period	$ 0.14926	$ 0.09735	$ 0.00549	$ 0.25210
Winter Period	0.09242	0.06623	0.00549	0.16414
Customer Charge ($/month)				5.60

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. Seasonal Rate Changes

The Summer Period is effective May 1 to October 31 and the Winter Period is effective from November 1 to April 30. When the billing period includes use in both the Summer and the Winter Periods, the usage will be prorated based on the number of days in each seasonal period, and the charges based on the applicable rates therein. For further discussion of bill calculation and proration, refer to Rule and Regulation 11.

CITY OF PALO ALTO UTILITIES
Issued by the City Council

CITY OF PALO ALTO UTILITIES

Supersedes Sheet No E-2-1
dated 7-1-2023

Sheet No **E-2-1**
Effective 7-1-2024

MEDIUM NON-RESIDENTIAL ELECTRIC SERVICE

UTILITY RATE SCHEDULE E-4

A. APPLICABILITY:

This Rate Schedule applies to Demand metered Secondary Electric Service for Customers with a maximum Demand below 1,000 kilowatts. This Rate Schedule may include Service to master-metered multi-family facilities or other facilities requiring Demand metered Service, as determined by the City.

B. TERRITORY:

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

C. UNBUNDLED RATES:

Rates per kilowatt (kW) and kilowatt-hour (kWh):

	Commodity	Distribution	Public Benefits	Total
Summer Period				
Demand Charge (per kW)	$ 10.98	$ 34.31		$ 45.29
Energy Charge (per kWh)	0.12318	0.02520	0.00549	0.15387
Winter Period				
Demand Charge (per kW)	$ 2.57	$ 21.16		$ 23.73
Energy Charge (per kWh)	0.07949	0.02520	0.00549	0.11018
Customer Charge ($/month)				113.73

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.

CITY OF PALO ALTO UTILITIES
Issued by the City Council

CITY OF PALO ALTO UTILITIES

Supersedes Sheet No E-4-1 dated 7-1-2023

Sheet No **E-4-1**
Effective 7-1-2024

MEDIUM NON-RESIDENTIAL ELECTRIC TIME OF USE SERVICE

UTILITY RATE SCHEDULE E-4 TOU

A. APPLICABILITY:

This voluntary Rate Schedule applies to Demand metered Secondary Electric Service for Customers with Demand between 500 and 1,000 kilowatts per month and who have sustained this level of usage for at least three consecutive months during the most recent 12 month period. This Rate Schedule may include Service to Master-Metered multi-family facilities or other facilities requiring Demand metered Service, as determined by the City.

B. TERRITORY:

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

C. UNBUNDLED RATES:

Rates per kilowatt (kW) and kilowatt-hour (kWh):

	Commodity	Distribution	Public Benefits	Total
Summer Period				
Demand Charge (per kW)				
Peak	$ 9.72	$ 17.18		$ 26.90
Max Demand	1.29	17.18		18.47
Energy Charge (per kWh)				
Peak	$ 0.17038	$ 0.02538	$ 0.00549	$ 0.20125
Mid-Peak	0.14041	0.02538	0.00549	0.17128
Off-Peak	0.10556	0.02538	0.00549	0.13643
Winter Period				
Demand Charge (per kW)				
Peak	$ 1.30	$ 10.73		$ 12.03
Max Demand	1.30	10.73		12.03
Energy Charge (per kWh)				
Peak	$ 0.11976	$ 0.02500	$ 0.00549	$ 0.15025
Mid-Peak	0.09452	0.02500	0.00549	0.12501
Off-Peak	0.06525	0.02500	0.00549	0.09574
Customer Charge ($/month)				113.73

D. SPECIAL NOTES:

CITY OF PALO ALTO UTILITIES
Issued by the City Council

Supersedes Sheet No E-4-TOU-1
dated 7-1-2023

Sheet No **E-4-TOU-1**
Effective 7-1-2024

RESIDENTIAL MASTER-METERED AND COMMERCIAL GAS SERVICE

UTILITY RATE SCHEDULE G-2

A. APPLICABILITY:

This schedule applies to the following Customers receiving Gas Service from the City of Palo Alto Utilities:

1. Commercial Customers who use less than 250,000 therms per year at one site;
2. Master-metered residential Customers in multi-family residential facilities.

B. TERRITORY:

This schedule applies anywhere the City of Palo Alto provides Gas Service.

C. UNBUNDLED RATES: Per Service

Monthly Service Charge: .... $ 156.90

		Per Therm
Supply Charges:		
	1. Commodity (Monthly Market Based)	$0.10-$4.00
	2. Cap and Trade Compliance Charges	$0.00-$0.25
	3. Transportation Charge	$0.00-$0.25
	4. Carbon Offset Charge	$0.00-$0.10
Distribution Charge:		$1.0809

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.

The Commodity Charge is based on the monthly natural gas Bidweek Price Index for delivery at PG&E Citygate, adjusted to account for delivery losses to the Customer's Meter. The Commodity Charge also includes adjustments to account for Council-approved programs implemented to reduce the cost of Gas, including a municipal purchase discount[1], and a maximum $0.15/per therm cost for capped price winter natural

1 Adopted via Resolution 9451, on September 15, 2014.

CITY OF PALO ALTO UTILITIES
Issued by the City Council

Supersedes Sheet No G-2-1
dated 11-1-2023

CITY OF PALO ALTO UTILITIES

Effective 7-1-2024
Sheet No **G-2-1**

City of Palo Alto
Utility Rate Schedule G-2 – Residential Master-Metered and Commercial Gas Service
Monthly Gas Volumetric and Service Charges

Effective Date	Commodity Charge (a)	Cap and Trade Compliance Charge (b)	Transportation Charge (c)	Carbon Offset Charge (d)	Total Supply Charge (a)+(b)+(c)+(d) =(e)	Distribution Charge (f)	Total Volumetric Charge (e)+(f)	Monthly Service Charge
	$ per Therm							$ per Month
10/1/2024	0.4450	0.1182	0.2500	0.0700	0.8832	1.0809	1.9641	156.90
9/1/2024	0.3411	0.1451	0.2500	0.0700	0.8062	1.0809	1.8871	156.90
8/1/2024	0.5179	0.1451	0.2201	0.0700	0.9531	1.0809	2.0340	156.90
7/1/2024	0.4197	0.1451	0.2206	0.0700	0.8554	1.0809	1.9363	156.90
6/1/2024	0.1918	0.1638	0.2206	0.0700	0.6462	0.8941	1.5403	129.78
5/1/2024	0.2142	0.1638	0.2206	0.0700	0.6686	0.8941	1.5627	129.78
4/1/2024	0.2388	0.1638	0.2206	0.0700	0.6932	0.8941	1.5873	129.78
3/1/2024	0.2956	0.1534	0.2104	0.0700	0.7294	0.8941	1.6235	129.78
2/1/2024	0.5967	0.1534	0.2022	0.0700	1.0223	0.8941	1.9164	129.78
1/1/2024	0.4805	0.1534	0.2022	0.0700	0.9061	0.8941	1.8002	129.78
12/1/2023	0.6901	0.1309	0.1350	0.0700	1.0260	0.8941	1.9201	129.78
11/1/2023	0.7383	0.1309	0.1350	0.0700	1.0742	0.8941	1.9683	129.78
10/1/2023	0.4065	0.1309	0.1350	0.0700	0.7424	0.8941	1.6365	129.78
9/1/2023	0.4928	0.1132	0.1350	0.0700	0.8110	0.8941	1.7051	129.78
8/1/2023	0.5263	0.1132	0.1345	0.0700	0.8440	0.8941	1.7381	129.78
7/1/2023	0.4486	0.1132	0.1344	0.0700	0.7662	0.8941	1.6603	129.78
6/1/2023	0.3627	0.1033	0.1345	0.0700	0.6705	0.7365	1.4070	106.90
5/1/2023	0.5197	0.1033	0.1345	0.0700	0.8275	0.7365	1.5640	106.90
4/1/2023	0.6634	0.0768	0.1345	0.0700	0.9447	0.7365	1.6812	106.90
3/1/2023	0.7706	0.0768	0.1345	0.0700	1.0519	0.7365	1.7884	106.90
2/1/2023	1.2588	0.0768	0.1345	0.0700	1.5401	0.7365	2.2766	106.90
1/1/2023	4.0000	0.0768	0.1584	0.0700	4.3052	0.7365	5.0417	106.90
12/1/2022	1.4153	0.0768	0.1584	0.0700	1.7205	0.7365	2.4570	106.90
11/1/2022	0.7310	0.0768	0.1584	0.0700	1.0362	0.7365	1.7727	106.90

The 'Commodity and Volumetric Rates' are selected for the latest available month of December 2020.[10]

[10] https://www.paloalto.gov/files/assets/public/v/29/utilities/business/business-rates/monthly-gas-volumetric-and-service-charges-commercial.pdf

9.4.6 Sacramento Municipal Utilities District (Electric Only)

Commercial & Industrial Time-of-Day
Rate Schedule CI-TOD1

II. Firm Service Rates

A. Commercial & Industrial Time-of-Day Rates

	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
CITS-0: C&I Secondary 0-20 kW					
Non-Summer Season (October - May)					
System Infrastructure Fixed Charge *per month per meter*	$35.15	$36.65	$37.65	$39.20	$40.30
Maximum Demand Charge *$ per monthly max kW*	$0.000	$0.713	$0.733	$1.505	$1.546
Electricity Usage Charge					
Peak *$/kWh*	$0.1440	$0.1446	$0.1485	$0.1491	$0.1532
Off-Peak *$/kWh*	$0.1364	$0.1335	$0.1371	$0.1341	$0.1377
Off-Peak Saver *$/kWh*	$0.1323	$0.1276	$0.1311	$0.1261	$0.1295
Summer Season (June - September)					
System Infrastructure Fixed Charge *per month per meter*	$35.15	$36.65	$37.65	$39.20	$40.30
Maximum Demand Charge *$ per monthly max kW*	$0.000	$0.713	$0.733	$1.505	$1.546
Electricity Usage Charge					
Peak *$/kWh*	$0.2554	$0.2718	$0.2792	$0.2968	$0.3049
Off-Peak *$/kWh*	$0.1349	$0.1359	$0.1396	$0.1410	$0.1448
CITS-1: C&I Secondary 21-299 kW					
Non-Summer Season (October - May)					
System Infrastructure Fixed Charge *per month per meter*	$158.30	$231.60	$237.95	$317.30	$326.05
Site Infrastructure Charge *per 12 months max kW or contract capacity*	$7.568	$7.106	$7.302	$6.806	$6.993
Electricity Usage Charge					
Peak *$/kWh*	$0.1230	$0.1283	$0.1319	$0.1374	$0.1412
Off-Peak *$/kWh*	$0.1158	$0.1170	$0.1202	$0.1214	$0.1248
Off-Peak Saver *$/kWh*	$0.1030	$0.0971	$0.0998	$0.0932	$0.0958
Summer Season (June - September)					
System Infrastructure Fixed Charge *per month per meter*	$158.30	$231.60	$237.95	$317.30	$326.05
Site Infrastructure Charge *per 12 months max kW or contract capacity*	$7.568	$7.106	$7.302	$6.806	$6.993
Summer Peak Demand Charge *$ per monthly Peak max kW*	$3.468	$5.351	$5.498	$7.525	$7.732
Electricity Usage Charge					
Peak *$/kWh*	$0.1983	$0.2056	$0.2113	$0.2192	$0.2252
Off-Peak *$/kWh*	$0.1119	$0.1129	$0.1160	$0.1171	$0.1203

Commercial rates beyond 2025 are effective as shown in Section VIII. Transition Schedule.

9.4.7 Fuel Escalation Rates

Utility rates are assumed to escalate over time, using assumptions from research conducted by Energy and Environmental Economics (E3). As stated by E3 in the TDV report, this latter assumption “does not presuppose specific new investments, changes in load and gas throughput, or other measures associated with complying with California’s climate policy goals” (i.e., business-as-usual is assumed).

Table 33 below demonstrates the escalation rates used for nonresidential buildings.

Table 33. Real Utility Rate Escalation Rate Assumptions

Year	Statewide Electric Nonresidential Average Rate (%/year, real)	Statewide Natural Gas Nonresidential Core Rate (%/year, real)
2024	0.7%	7.7%
2025	0.5%	5.5%
2026	0.7%	5.6%
2027	0.2%	5.6%
2028	0.6%	5.7%
2029	0.7%	5.7%
2030	0.6%	5.8%
2031	0.6%	3.3%
2032	0.6%	3.6%
2033	0.6%	3.4%
2034	0.6%	3.4%
2035	0.6%	3.2%
2036	0.6%	3.2%
2037	0.6%	3.1%
2038	0.6%	2.9%
2039	0.6%	3.2%
2040	0.6%	2.9%
2041	0.6%	3.5%
2042	0.6%	3.4%
2043	0.6%	3.4%
2044	0.6%	3.4%
2045	0.6%	3.5%
2046	0.6%	2.0%
2047	0.6%	1.8%
2048	0.6%	2.1%
2049	0.6%	1.7%
2050	0.6%	2.1%
2051	0.6%	2.8%
2052	0.6%	2.8%
2053	0.6%	2.8%

Source: Energy & Environmental Economics, 2019, Reach Code Team

9.5 Prototype Characteristics

Table 34. Non-res Roof U-Value by CZ for three vintages

	(Wood Framed and Other Roof)		
	1980 vintage	1990 vintage	2000 vintage
	Assembly U-value	Assembly U-value	Assembly U-value
CZ1	0.076	0.056	0.051
CZ2	0.085	0.056	0.051
CZ3	0.085	0.056	0.051
CZ4	0.086	0.056	0.051
CZ5	0.085	0.056	0.051
CZ6	0.093	0.077	0.075
CZ7	0.093	0.077	0.075
CZ8	0.093	0.077	0.075
CZ9	0.092	0.076	0.075
CZ10	0.089	0.074	0.051
CZ11	0.086	0.056	0.051
CZ12	0.086	0.056	0.051
CZ13	0.086	0.056	0.051
CZ14	0.085	0.056	0.051
CZ15	0.088	0.056	0.051
CZ16	0.08	0.056	0.051

Table 35 Non-res Exterior Wall U-Value by CZ for three vintages

	1980 vintage		1990 vintage	2000 vintage
	Medium Retail	Small Office	Assembly U-value	Assembly U-value
CZ1	0.277	0.333	0.182	0.216
CZ2	0.329	0.382	0.189	0.216
CZ3	0.331	0.384	0.189	0.223
CZ4	0.339	0.392	0.189	0.223
CZ5	0.329	0.382	0.189	0.223
CZ6	0.402	0.451	0.189	0.223
CZ7	0.381	0.431	0.189	0.223
CZ8	0.399	0.448	0.189	0.223
CZ9	0.368	0.419	0.189	0.223
CZ10	0.358	0.409	0.189	0.216
CZ11	0.338	0.39	0.182	0.216
CZ12	0.335	0.387	0.182	0.216
CZ13	0.34	0.393	0.182	0.216
CZ14	0.325	0.378	0.182	0.216
CZ15	0.389	0.438	0.182	0.216
CZ16	0.294	0.349	0.182	0.216

Table 36. Non-res Window U-Value, SHGC and VT for all vintages

	Window Assembly U-Value			Window SHGC			Window VT		
	1980 vintage	1990 vintage	2000 vintage	1980 vintage	1990 vintage	2000 vintage	1980 vintage	1990 vintage	2000 vintage
CZ1	1.144	0.689	0.468	0.568	0.549	0.427	0.36	0.383	0.4
CZ2	1.179	1.143	0.468	0.73	0.668	0.358	0.36	0.383	0.4
CZ3	1.209	1.168	0.763	0.735	0.672	0.407	0.36	0.383	0.4
CZ4	1.209	1.168	0.763	0.735	0.672	0.407	0.36	0.383	0.4
CZ5	1.209	1.168	0.763	0.735	0.672	0.407	0.36	0.383	0.4
CZ6	1.209	1.168	0.763	0.733	0.671	0.387	0.36	0.383	0.4
CZ7	1.209	1.168	0.763	0.733	0.671	0.387	0.36	0.383	0.4
CZ8	1.209	1.168	0.763	0.733	0.671	0.387	0.36	0.383	0.4
CZ9	1.209	1.168	0.763	0.733	0.671	0.387	0.36	0.383	0.4
CZ10	1.179	1.143	0.468	0.73	0.668	0.358	0.36	0.383	0.4
CZ11	1.144	0.689	0.468	0.561	0.544	0.358	0.36	0.383	0.4
CZ12	1.144	0.689	0.468	0.561	0.544	0.358	0.36	0.383	0.4
CZ13	1.144	0.689	0.468	0.561	0.544	0.358	0.36	0.383	0.4
CZ14	1.144	0.689	0.468	0.561	0.544	0.358	0.36	0.383	0.4
CZ15	1.144	0.689	0.468	0.561	0.544	0.358	0.36	0.383	0.4
CZ16	1.144	0.689	0.468	0.568	0.549	0.427	0.36	0.383	0.4

Table 37. Equipment Turnover Assumptions

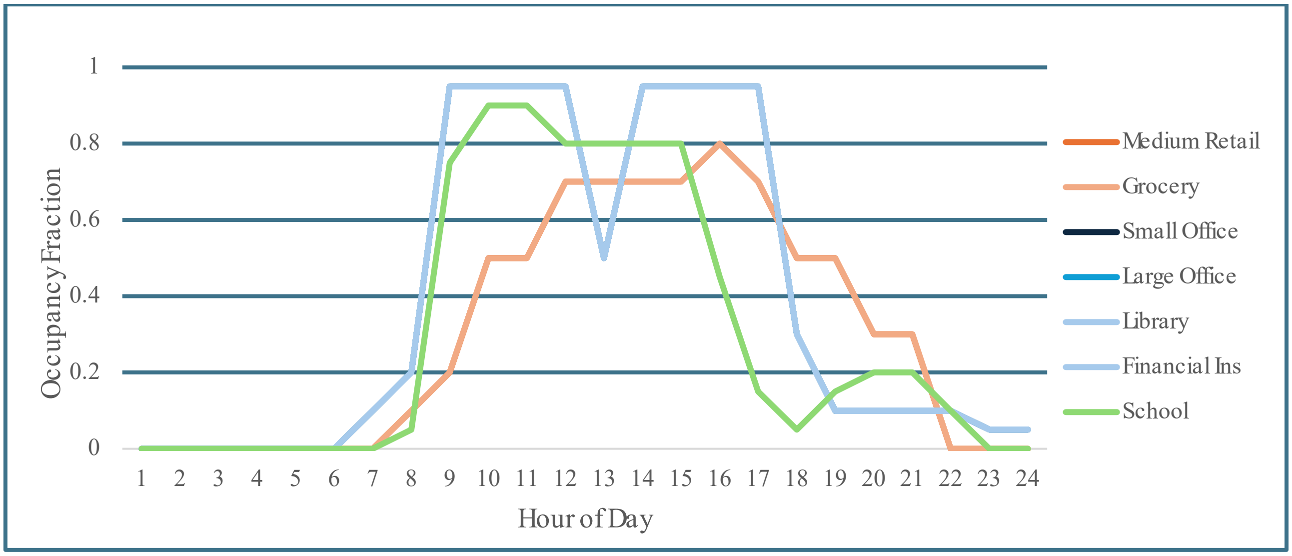
Measure Category	1980 Vintage				1990 Vintage				2000 Vintage			
	1980	1990	2000	2016	1980	1990	2000	2016	1980	1990	2000	2016
HVACSHW	71%	9%	14%	5%	0%	84%	12%	4%	0%	0%	97%	3%
Roofs	74%	8%	13%	5%	0%	86%	10%	4%	0%	0%	98%	2%
Windows	80%	7%	10%	4%	0%	89%	8%	3%	0%	0%	98%	2%
Walls	92%	3%	4%	1%	0%	96%	3%	1%	0%	0%	99%	1%
Process	63%	12%	19%	7%	0%	79%	15%	6%	0%	0%	96%	4%
Ltg	45%	15%	28%	12%	0%	67%	24%	9%	0%	0%	94%	6%
ExtLtg	71%	9%	14%	5%	0%	84%	12%	4%	0%	0%	97%	3%

The equipment turnover assumptions in Table 37 are based on SB350 Appendix B2-NR Vintage Data and represent best estimates for equipment replacements, not direct data. Existing equipment efficiencies were estimated by weighting the code minimum requirements by the replacement rates. For example, the AFUE was assumed to be 63% for 1980, 78% for 1990 and 2000, and 80% for 2016. Using the equipment turnover assumptions above, this calculates to a weighted average of 67.5% AFUE for the 1980s vintage, and 78.1% for the 1990s and 2000s vintages.

9.6 Occupancy Schedules and Building Types

The Reach Code Team explored how the results could apply to other building types with similar occupancy schedules. Figure 10 shows that Small Office shares similar occupancy schedules with Large Office, Library, and Financial Institutions, while Medium Retail aligns closely with Grocery. School, however, exhibits slightly different occupancy patterns, so the results may not be directly applicable to this building type. Other building types with significantly different occupancy schedules are not considered to be applicable.

Figure 10. Occupancies in 141.0-E-1 Schedules



9.7 Interview Guide

The Reach Code Team used the following guide for the market actor interviews. This guide asks similar questions for all market actors. For some questions, the wording is different for designers ("Des") and contractors ("Cont") — who work directly on projects, compared to distributors (Dist) and manufacturer reps (MFR) — who sell equipment, but still have an understanding of project challenges and opportunities through their involvement with the construction process and communication with their clients.

Introduction

Thank you for taking the time to speak with us today. As a reminder, we are conducting this interview on behalf of the California investor-owned utilities to understand HVAC retrofits. Specifically, we are interested in your experience with the retrofit of rooftop units. This would include replacing gas-fired rooftop units (gas packs) with packaged heat pumps, and your experience with other efficiency measures. All answers will be kept anonymous.

Do we have your permission to record this interview? This is solely for note-taking purposes.

a. Yes **[RECORD CONTACT INFORMATION; SETUP INTERVIEW TIME; EMAIL INTERVIEW TOPICS]**

b. No **[DISCUSS CONCERNS; ANSWER QUESTIONS; ATTEMPT TO CONVERT TO "YES"]**

1. (All) What is your role withing your organization?
2. (Cont/Des) What types of commercial projects have you worked on in the past year?
    a. (Dist/MFR) For what types of commercial projects have you sold HVAC products in the past 5 years?
3. (All) What area of California do you typically work in?
4. (Cont) Do you replace gas packs with heat pumps? How many replacements have you performed in the past year?
    a. (Dist/MFR) Do you sell equipment for replacing gas packs with heat pumps?
        i. If yes, how often is this equipment sold? (Always, almost always, sometimes, rarely, never)

Research Topic A: Replacing gas packs with heat pumps

1. (Des/Cont) In general, have you faced challenges replacing gas packs with heat pumps? Y/N
    a. If yes, what are those challenges?
2. (Dist/MFR) In general, have your customers faced challenges replacing gas packs with heat pumps? Y/N
    a. If yes, what are those challenges?

If they don't mention them, then probe:

3. (All)Are there any physical concerns or space constraints? Y/N
    a. If yes, what are those challenges? (don't ask, but if they don't volunteer, then probe)

       Probe for: unit footprint, curb height, equipment weight

    b. How often is a curb adapter required? What are the cost implications?
4. (Cont/Des) Are there electrical concerns? Y/N (*Interviewer can skip this section for Dist/MFR as these questions are geared for designers and contractors*)
    a. If yes, what are those concerns?
    b. What type of electrical upgrades are typical when replacing gas packs with heat pumps?
    c. Is the additional capacity of electric resistance defrost enough to require electrical upgrades?
5. (All) Are there building heating capacity issues with replacing gas packs with heat pumps? Y/N
    a. If yes, what are the issues? (*don't ask, but if they don't volunteer, then probe*)

       Probe for: meeting the building's space heating loads.

b. Under what conditions is electric resistance for defrost necessary?
    i. (*If they don't specify, then ask*): Is this unique to specific locations or climates?
c. (Dist/MFR) Have you ever not been able to keep up with heating setpoint temperature because electric resistance for defrost was not installed?

Research Topic B: Non-preempted ECMs for gas-for-gas HVAC unit replacement

We are looking to identify additional efficiency measures that could be installed as part of a gas-for-gas retrofit.

1. The first technology we're considering is an ERV/HRV.
    a. (All) Are you familiar with the technology? Y/N
        i. (Cont/Des): If Yes, how many times have you installed/specified them in the past year?
            1. (Dist/MFR): How many have you sold in the last year?
        ii. (All) Where in California are ERV/HRV most effective/appropriate?
        iii. (All) Are there areas of California where ERV/HRV would NOT be effective?
    b. (Des/Cont) Would you design/install an ERV/HRV separate from the rooftop unit or integrate them?
    c. (Dist/MFR) [If integrated]: By percentage, how many ERV/HRV units have you sold with gas pack replacements? (Provide the multiple-choice ranges only if they are unwilling to estimate a value.)
        i. <25%
        ii. Between 25% and 75%
        iii. More than 75%
        iv. Not sure
    d. (Dist/MFR) [If separate]: By percentage, how many ERV/HRV units have you sold with gas pack replacements? (Provide the multiple-choice ranges only if they are unwilling to estimate a value.)
        v. <25%
        vi. Between 25% and 75%
        vii. More than 75%
        viii. Not sure
2. Demand control ventilation (DCV) is another measure we are considering.
    a. Are you familiar with the technology?
    b. Is this a good measure for retrofits?
    c. (*If time*) Are there areas of California where this would NOT be effective?
3. We are also considering RTU fan ECM motor with staged controls.
    a. Are you familiar with the technology?
    b. Is this a good measure for retrofits?

c. (*If time*) Are there areas of California where this would NOT be effective?

4. We are also considering options for making a programmable thermostat more effective, such as by having it programmed by the installer.
   a. (Des/Cont) When you install/specify thermostats, how often do you set a schedule or setpoints?
   b. How do you determine a schedule for a thermostat when you program one?
   c. How often are you called back to reset a schedule for a programmable thermostat?
   d. (All) Which type of thermostat would be less likely to be overridden by the customer so that energy savings are actually achieved? Programmable where installer programs it according to customer preferences? Smart? Something else?
5. Do you have recommendations for any other efficiency measures to consider? (*if they don't volunteer, probe for DCV, RTU fan ECM motor with staged controls, DOAS)*
6. (*If time*) Another measure we are considering is a dedicated outdoor air system (DOAS).
   a. Are you familiar with the technology? Y/N
      i. If Yes, how often have you installed/specified them in the past year?
   b. What is your opinion on DOAS systems?
      i. Are there areas of California where DOAS saves more energy?

      Are there areas of California where DOAS would NOT be effective?
7. Are you able to provide some cost estimates for the measures discussed today as a follow-up via email?

Section C: Closing

Great! Thank you so much for your time. Those are all the questions we have for you today. For taking the time to speak to me today we will be emailing you a $150 e-gift card which you should receive in the next ten business days as a thank you. Before we finish, do you have any questions for me, or anything else you would like to add?

Get In Touch

The adoption of reach codes can differentiate jurisdictions as efficiency leaders and help accelerate the adoption of new equipment, technologies, code compliance, and energy savings strategies.

As part of the Statewide Codes & Standards Program, the Reach Codes Subprogram is a resource available to any local jurisdiction located throughout the state of California.

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.

If you are interested in finding out more about local energy reach codes, the Reach Codes Team stands ready to assist jurisdictions at any stage of a reach code project.

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