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TN #:	259270
Document Title:	City of Brisbane Cost Effectiveness Results Summary
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Cost Effectiveness Explorer

EXPLORER.LOCALENERGYCODES.COM

Cost-Effectiveness Results Summary

City of Brisbane

Climate Zone 3

Generated July 24, 2024 from the Cost-Effectiveness Explorer

https://explorer.localenergycodes.com/jurisdiction/brisbane-city/study-results/3-PGE?only_study_type=new-buildings

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Single Family Homes | All Electric

Study Source: Single Family New Construction[1] | Release Date: 05/20/2024 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	**On-Bill (2022 Esc)** ≥ 1.0 is cost effective	**TDV** ≥ 1.0 is cost effective	**EDR1 Compliance Margin** (EDR1)	**Incremental Cost**	**Annual Bill Savings** (on-bill)	**Baseline Fuel Type**
Electrification + Basic EE	1.0	25.3	9.1	-$4,854	-$303	Mixed-fuel
Electrification + EE	1.1	∞	10.6	-$3,371	-$218	Mixed-fuel
Electrification + EE + High Eff Equipment	--	--	12.2	$0	$0	Mixed-fuel
Electrification + EE + PV	0.8	2.8	13.1	$1,878	$44	Mixed-fuel
Electrification + EE + PV + Battery	1.1	1.1	24.2	$8,726	$815	Mixed-fuel

Single Family Homes | All Electric

Study Source: Single Family New Construction[1] | Release Date: 05/20/2024 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	Affected Units (lifecycle)	Emissions Reductions (lifecycle MTCOe)	Lifecycle Savings (on-bill)
Electrification + Basic EE	3	33.6	-$14,340
Electrification + EE	3	34.8	-$10,346
Electrification + EE + High Eff Equipment	3	36.1	$0
Electrification + EE + PV	3	48.3	$2,067
Electrification + EE + PV + Battery	3	47.6	$38,582

Single Family Homes | Mixed-fuel

Study Source: Single Family New Construction[1] | Release Date: 05/20/2024 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	**On-Bill (2022 Esc)** ≥ 1.0 is cost effective	**TDV** ≥ 1.0 is cost effective	**EDR1 Compliance Margin** (EDR1)	**Incremental Cost**	**Annual Bill Savings** (on-bill)	**Baseline Fuel Type**
EE + High Eff Equipment	--	--	3.6	$0	$0	Mixed-fuel
EE + PV + Battery	1.1	0.7	12.8	$8,708	$785	Mixed-fuel

Single Family Homes | Mixed-fuel

Study Source: Single Family New Construction[1] | Release Date: 05/20/2024 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	**Affected Units** (lifecycle)	**Emissions Reductions** (lifecycle MTCOe)	**Lifecycle Savings** (on-bill)
EE + High Eff Equipment	8	15.8	$0
EE + PV + Battery	8	16.4	$111,593

ADU | All Electric

Study Source: Single Family New Construction[1] | Release Date: 05/20/2024 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	**On-Bill (2022 Esc)** ≥ 1.0 is cost effective	**TDV** ≥ 1.0 is cost effective	**EDR1 Compliance Margin** (EDR1)	**Incremental Cost**	**Annual Bill Savings** (on-bill)	**Baseline Fuel Type**
Electrification + Basic EE	--	--	2.9	-$863	-$377	Mixed-fuel
Electrification + EE	--	--	4.0	$526	-$347	Mixed-fuel
Electrification + EE + High Eff Equipment	--	--	5.9	$0	$0	Mixed-fuel
Electrification + EE + PV	0.8	1.1	7.1	$7,817	$367	Mixed-fuel
Electrification + EE + PV + Battery	0.8	0.8	22.8	$14,735	$902	Mixed-fuel

ADU | All Electric

Study Source: Single Family New Construction[1] | Release Date: 05/20/2024 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	**Affected Units** (lifecycle)	**Emissions Reductions** (lifecycle MTCOe)	**Lifecycle Savings** (on-bill)
Electrification + Basic EE	1	6.11	-$4,461
Electrification + EE	1	6.22	-$4,112
Electrification + EE + High Eff Equipment	1	6.39	$0
Electrification + EE + PV	1	10.9	$4,342
Electrification + EE + PV + Battery	1	10.9	$10,675

ADU | Mixed-fuel

Study Source: Single Family New Construction[1] | Release Date: 05/20/2024 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	**On-Bill (2022 Esc)** ≥ 1.0 is cost effective	**TDV** ≥ 1.0 is cost effective	**EDR1 Compliance Margin** (EDR1)	**Incremental Cost**	**Annual Bill Savings** (on-bill)	**Baseline Fuel Type**
EE + High Eff Equipment	--	--	3.0	$0	$0	Mixed-fuel
EE + PV + Battery	0.8	0.6	11.8	$11,879	$781	Mixed-fuel

ADU | Mixed-fuel

Study Source: Single Family New Construction[1] | Release Date: 05/20/2024 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	**Affected Units** (lifecycle)	**Emissions Reductions** (lifecycle MTCOe)	**Lifecycle Savings** (on-bill)
EE + High Eff Equipment	2	2.13	$0
EE + PV + Battery	2	8.85	$27,758

5-Story Multifamily Building | All Electric

Study Source: New Multifamily Buildings[2] | Release Date: 05/23/2023 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	**On-Bill (2022 Esc)** ≥ 1.0 is cost effective	**TDV** ≥ 1.0 is cost effective	**EDR1 Compliance Margin** (EDR1)	**Incremental Cost**	**Annual Bill Savings** (on-bill)	**Baseline Fuel Type**
Electrification + Basic EE	0.8	2.5	0.0	$608	-$46	Mixed-fuel
Electrification + Basic EE + PV	2.8	3.2	0.0	$2,121	$327	Mixed-fuel

5-Story Multifamily Building | All Electric

Study Source: New Multifamily Buildings[2] | Release Date: 05/23/2023 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	**Affected Units** (lifecycle)	**Emissions Reductions** (lifecycle MTCOe)	**Lifecycle Savings** (on-bill)
Electrification + Basic EE	1	10.2	-$818
Electrification + Basic EE + PV	1	12.8	$5,800

5-Story Multifamily Building | Mixed-fuel

Study Source: New Multifamily Buildings[2] | Release Date: 05/23/2023 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	**On-Bill (2022 Esc)** ≥ 1.0 is cost effective	**TDV** ≥ 1.0 is cost effective	**EDR1 Compliance Margin** (EDR1)	**Incremental Cost**	**Annual Bill Savings** (on-bill)	**Baseline Fuel Type**
EE	0.9	0.7	0.0	$132	$2	Mixed-fuel
EE + PV	1.3	3.5	0.0	$801	$119	Mixed-fuel

5-Story Multifamily Building | Mixed-fuel

Study Source: New Multifamily Buildings[2] | Release Date: 05/23/2023 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	Affected Units (lifecycle)	Emissions Reductions (lifecycle MTCOe)	Lifecycle Savings (on-bill)
EE	3	0.0324	$105
EE + PV	3	3.43	$6,358

3-Story Multifamily Building | All Electric

Study Source: New Multifamily Buildings[2] | Release Date: 05/23/2023 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	**On-Bill (2022 Esc)** ≥ 1.0 is cost effective	**TDV** ≥ 1.0 is cost effective	**EDR1 Compliance Margin** (EDR1)	**Incremental Cost**	**Annual Bill Savings** (on-bill)	**Baseline Fuel Type**
Electrification + Basic EE	0.7	9.9	0.0	$697	-$26	Mixed-fuel
Electrification + Basic EE + PV	3.8	3.4	0.0	$3,076	$614	Mixed-fuel

3-Story Multifamily Building | All Electric

Study Source: New Multifamily Buildings[2] | Release Date: 05/23/2023 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	Affected Units (lifecycle)	Emissions Reductions (lifecycle MTCOe)	Lifecycle Savings (on-bill)
Electrification + Basic EE	1	9.85	-$464
Electrification + Basic EE + PV	1	14.0	$10,913

3-Story Multifamily Building | Mixed-fuel

Study Source: New Multifamily Buildings[2] | Release Date: 05/23/2023 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	On-Bill (2022 Esc) ≥ 1.0 is cost effective	TDV ≥ 1.0 is cost effective	EDR1 Compliance Margin (EDR1)	Incremental Cost	Annual Bill Savings (on-bill)	Baseline Fuel Type
EE	0.3	0.8	0.0	$132	$5	Mixed-fuel
EE + PV + Battery	1.6	1.5	0.0	$3,700	$423	Mixed-fuel

3-Story Multifamily Building | Mixed-fuel

Study Source: New Multifamily Buildings[2] | Release Date: 05/23/2023 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	**Affected Units** (lifecycle)	**Emissions Reductions** (lifecycle MTCOe)	**Lifecycle Savings** (on-bill)
EE	3	0.0830	$255
EE + PV + Battery	3	8.05	$22,517

Small Hotel | Mixed-fuel

Study Source: Nonresidential New Construction[3] | Release Date: 01/31/2023 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	On-Bill (2022 Esc) ≥ 1.0 is cost effective	TDV ≥ 1.0 is cost effective	EDR1 Compliance Margin (EDR1)	Incremental Cost	Annual Bill Savings (on-bill)	Baseline Fuel Type
Mixed Fuel + EE	4.3	3.9	0.0	$3,668	$1,046	Mixed-fuel

Small Hotel | Mixed-fuel

Study Source: Nonresidential New Construction[3] | Release Date: 01/31/2023 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	**Affected Units** (lifecycle)	**Emissions Reductions** (lifecycle MTCOe)	**Lifecycle Savings** (on-bill)
Mixed Fuel + EE	10,143	19.5	$9,438

Medium Office | Mixed-fuel

Study Source: Nonresidential New Construction[3] | Release Date: 01/31/2023 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	On-Bill (2022 Esc) ≥ 1.0 is cost effective	TDV ≥ 1.0 is cost effective	EDR1 Compliance Margin (EDR1)	Incremental Cost	Annual Bill Savings (on-bill)	Baseline Fuel Type
Mixed Fuel + EE	∞	∞	0.0	$0	$378	Mixed-fuel

Medium Office | Mixed-fuel

Study Source: Nonresidential New Construction[3] | Release Date: 01/31/2023 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	**Affected Units** (lifecycle)	**Emissions Reductions** (lifecycle MTCOe)	**Lifecycle Savings** (on-bill)
Mixed Fuel + EE	40,909	5.49	$13,760

Quick Service Restaurant | All Electric

Study Source: Nonresidential New Construction[3] | Release Date: 01/31/2023 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	**On-Bill (2022 Esc)** ≥ 1.0 is cost effective	**TDV** ≥ 1.0 is cost effective	**EDR1 Compliance Margin** (EDR1)	**Incremental Cost**	**Annual Bill Savings** (on-bill)	**Baseline Fuel Type**
Partial Electrification + EE	1.2	0.7	0.0	$176,686	$14,297	Mixed-fuel
Partial Electrification + EE + Load Flex	1.1	0.7	0.0	$198,317	$14,272	Mixed-fuel
Partial Electrification + EE + PV	1.8	0.8	0.0	$378,236	$44,940	Mixed-fuel
Electrification + EE	-0.7	-0.6	0.0	$693,060	-$30,292	Mixed-fuel

Quick Service Restaurant | All Electric

Study Source: Nonresidential New Construction[3] | Release Date: 01/31/2023 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	**Affected Units** (lifecycle)	**Emissions Reductions** (lifecycle MTCOe)	**Lifecycle Savings** (on-bill)
Partial Electrification + EE	78	4.24	$986
Partial Electrification + EE + Load Flex	78	4.22	$984
Partial Electrification + EE + PV	78	5.40	$3,099
Electrification + EE	78	11.4	-$2,089

Quick Service Restaurant | Mixed-fuel

Study Source: Nonresidential New Construction[3] | Release Date: 01/31/2023 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	On-Bill (2022 Esc) ≥ 1.0 is cost effective	TDV ≥ 1.0 is cost effective	EDR1 Compliance Margin (EDR1)	Incremental Cost	Annual Bill Savings (on-bill)	Baseline Fuel Type
Mixed Fuel + EE	3.2	2.0	0.0	$90,123	$19,151	Mixed-fuel

Quick Service Restaurant | Mixed-fuel

Study Source: Nonresidential New Construction[3] | Release Date: 01/31/2023 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	Affected Units (lifecycle)	Emissions Reductions (lifecycle MTCOe)	Lifecycle Savings (on-bill)
Mixed Fuel + EE	233	4.54	$3,962

Medium Retail | All Electric

Study Source: Nonresidential New Construction[3] | Release Date: 01/31/2023 | Newest Version | Code Cycle: 2022

Table 1 of 2

	Cost-Effectiveness		Per Home Results			
Package	On-Bill (2022 Esc) ≥ 1.0 is cost effective	TDV ≥ 1.0 is cost effective	EDR1 Compliance Margin (EDR1)	Incremental Cost	Annual Bill Savings (on-bill)	Baseline Fuel Type
Electrification + EE	6.0	3.5	0.0	$5,211	$2,081	All Electric

Medium Retail | All Electric

Study Source: Nonresidential New Construction[3] | Release Date: 01/31/2023 | Newest Version | Code Cycle: 2022

Table 2 of 2

	City-Wide Estimates		
Package	Affected Units (lifecycle)	Emissions Reductions (lifecycle MTCOe)	Lifecycle Savings (on-bill)
Electrification + EE	3,218	3.12	$5,956

Cost Effectiveness Explorer

EXPLORER.LOCALENERGYCODES.COM

Sources

1 **Single Family New Construction (May 20, 2024)**
California Codes and Standards Program, PG&E. Produced by: Frontier Energy, Inc., Misti Bruceri & Associates.
https://localenergycodes.com/download/1240/file_path/fieldList/2022%20Single%20Family%20NewCon%20Cost-eff%20Study.pdf

2 **New Multifamily Buildings (May 23, 2023)**
California Codes and Standards Program, PG&E. Produced by: Frontier Energy, Inc., Misti Bruceri & Associates.
https://localenergycodes.com/download/1552/file_path/fieldList/2022%20Multifamily%20NewCon%20Cost-Eff%20Report.pdf

3 **Nonresidential New Construction (January 31, 2023)**
California Codes and Standards Program, Southern California Edison. Produced by: Avani Goyal, Farhad Farahmand, TRC Companies Inc.
https://localenergycodes.com/download/1266/file_path/fieldList/2022%20Nonres%20New%20Construction%20Cost-eff%20Report.pdf

Generated July 24, 2024 from the Cost-Effectiveness Explorer

https://explorer.localenergycodes.com/jurisdiction/brisbane-city/study-results/3-PGE?only_study_type=new-buildings

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

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2022 Cost-Effectiveness Study: Single Family New Construction

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Acronym List

2023 PV$ – Present value costs in 2023

ACH50 – Air Changes per Hour at 50 pascals pressure differential

ACM – Alternative Calculation Method

ADU – Accessory Dwelling Unit

AFUE – Annual Fuel Utilization Efficiency

B/C – Lifecycle Benefit-to-Cost Ratio

BEopt – Building Energy Optimization Tool

BSC – Building Standards Commission

CA IOUs – California Investor-Owned Utilities

CASE – Codes and Standards Enhancement

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

CFI – California Flexible Installation

CFM – Cubic Feet per Minute

CO_2 – Carbon Dioxide

CPAU – City of Palo Alto Utilities

CPUC – California Public Utilities Commission

CZ – California Climate Zone

DHW – Domestic Hot Water

DOE – Department of Energy

DWHR – Drain Water Heat Recovery

EDR – Energy Design Rating

EER – Energy Efficiency Ratio

EF – Energy Factor

GHG – Greenhouse Gas

HERS Rater – Home Energy Rating System Rater

HPA – High Performance Attic

HPWH – Heat Pump Water Heater

HSPF – Heating Seasonal Performance Factor

IECC – International Energy Conservation Code

IOU – Investor Owned Utility

kBtu – kilo-British thermal unit

kWh – Kilowatt Hour

LBNL – *Lawrence Berkeley National Laboratory*

LCC – Lifecycle Cost

LLAHU – Low Leakage Air Handler Unit

LSC – Long-term System Cost (2025 Title 24, Part 6 compliance metric)

MF – Multifamily

NEEA – Northwest Energy Efficiency Alliance

NEM – Net Energy Metering

NPV – Net Present Value

NREL – *National Renewable Energy Laboratory*

PG&E – Pacific Gas and Electric Company

POU – Publicly-Owned-Utilities

PV – Photovoltaic

SCE – Southern California Edison

SDG&E – San Diego Gas and Electric

SEER – Seasonal Energy Efficiency Ratio

SF – Single Family

SMUD – Sacramento Municipal Utility District

SoCalGas – Southern California Gas Company

TDV – Time Dependent Valuation (2022 Title 24, Part 6 compliance metric)

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

Title 24 – Title 24, Part 6

TOU – Time-Of-Use

UEF – Uniform Energy Factor

VLLDCS – Verified Low Leakage Ducts in Conditioned Space

ZNE – Zero-net Energy

Summary of Revisions

Date	Description	Reference (page or section)
9/12/2022	Original Release (1.0)	N/A
3/25/2024	Updated analysis (1.1)	• New simulation results with latest CBECC-Res version (Section 2.1.1) • Updated utility cost estimates using recent utility tariff and net billing tariff (Section 2.1.3) • New measure costs for heat pumps, batteries, and PV (Section 3.3) • Revised packages (Section 3.4) • Revised Results, Summary, References, and Appendices (Sections 4-7)
4/26/2024	Corrected errors (1.2)	• Corrected incorrect results in Tables 16-19, 23, 26
5/30/2024	Corrected errors (1.3)	• Corrected incorrect results in Tables 15-18, 22-28

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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 (GHG) reduction goals. The program facilitates adoption and implementation of the code when requested by local jurisdictions by providing resources such as cost-effectiveness studies, model language, sample findings, and other supporting documentation.

This report documents cost-effectiveness analysis results for traditional new detached single family and detached accessory dwelling unit (ADUs) building types. It evaluates mixed fuel and all-electric package options in all sixteen California climate zones (CZs). Packages include combinations of efficiency measures, on-site renewable energy, and battery energy storage.

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

The following are key takeaways and recommendations from the analysis.

<u>Conclusions and Discussion:</u>

- All-electric buildings have lower GHG emissions than mixed fuel buildings, due to the clean power sources currently available from California's power providers as well as accounting for increased penetration of renewables in the future. Almost all the all-electric packages evaluated resulted in greater GHG emission savings than the mixed fuel packages, with the exception of the mixed fuel package with battery storage in climate zones with low heating loads.
- The Reach Codes Team found code-compliant all-electric new construction to be feasible and cost-effective based on TDV for single family homes in all cases except Climate Zone 16.
- All-electric single family new construction was On-Bill cost-effective in all cases except Climate Zones 1, 3, 14, and 16.
- The all-electric ADU home was cost-effective based on TDV in all cases except in Climate Zones 3, 4, 13, and 14 where the higher cost of installing a ducted heat pump water heater (HPWH) instead of the prescriptively required gas tankless water heater exceed the resulting energy cost savings. In the other climate zones there were first cost savings for installing a heat pump space heater instead of a gas furnace, contributing to an overall TDV cost-effective result.
- Few cases were cost-effective On-Bill for the ADU.
- All-electric code minimum construction results in an increase in first lifetime costs relative to a mixed fuel home, except for CPAU and SMUD where electricity rates are much lower than for the investor-owned utilities (IOUs). The addition of efficiency measures, market dominant HPWHs that meet the Northwest Energy Efficiency Alliance's (NEEA's) Advanced Water Heating Specification[1], high efficiency heat pumps, increased solar photovoltaics (PV), and batteries all reduce utility costs, and the combination of these options was found to reduce annual utility costs relative to a mixed fuel home in all cases.

[1] Refer to Section 0 for an explanation of HPWHs certified through NEEA's Advanced Water Heating Specification, their market status, and how they compare to federal minimum efficiency standards.

- Under the Net Billing Tariff (NBT)[2], utility cost savings for increasing PV system size beyond code minimum are substantially less than what they were under prior net energy metering rules (NEM 2.0); however, savings are sufficient to be On-Bill cost-effective in all climate zones for the all-electric single family home except climate zones 1, 3, and 16. Coupling PV with battery systems increases utility cost savings as a result of improved on-site utilization of PV generation and fewer exports to the grid.
- Applying California Alternate Rates for Energy (CARE) rates in the IOU territories improves On-Bill cost-effectiveness for all-electric buildings, as compared to the same case under standard rates, due to higher utility cost savings compared to a code compliant mixed fuel building also on a CARE rate. This is due to the CARE discount on electricity being higher than that on gas.
- If gas tariffs are assumed to increase substantially over time, in line with the escalation assumption from the 2025 LSC development, all-electric new construction was found to be On-Bill cost-effective in almost all single family and most ADU scenarios over the 30-year analysis period. There is much uncertainty surrounding future tariff structures as well as escalation values. While it's clear that gas rates are anticipated to increase, how much and how quickly is not known. Electricity tariff structures are expected to evolve over time, and the California Public Utilities Commission (CPUC) has an active proceeding to adopt an income-graduated fixed charge that benefits low-income customers and supports electrification measures[3]. The CPUC will make a decision in mid-2024 and the new rates are expected to be in place later that year or in 2025. While the anticipated impact of this rate change is lower volumetric electricity rates, the rate design is not finalized. While lower volumetric electricity rates provide many benefits like incentivizing electrification, it also will make building efficiency measures harder to justify as cost-effective due to lower utility bill cost savings.

<u>Recommendations:</u>

- A reach code with a single performance target based on source energy (EDR1) can be structured to strongly encourage electrification. This approach requires equivalent performance for all buildings and allows mixed fuel buildings which minimizes the risk of violating federal preemption. Below are examples of how a reach code for single family homes could be set up based on the results summarized in Table 27.
    - A jurisdiction in Climate Zone 12 could set a performance target at an EDR1 margin of 11.5 (the EDR1 margin for the all-electric Code Minimum package). Any all-electric home meeting or exceeding the prescriptive requirements would comply, and a mixed fuel home would likely need to incorporate a combination of efficiency measures and a battery system to comply.
    - Similarly, a jurisdiction in Climate Zone 7 may consider setting a performance target of 2.8 EDR1 margin (also the EDR1 margin for the all-electric Code Minimum package). Any all-electric home meeting or exceeding the prescriptive requirements would comply, but a mixed fuel home would likely be able to comply with only a suite of above-code efficiency measures (no battery). Alternatively, a higher EDR1 margin target of 5 would incentivize more energy efficiency or additional PV for all-electric construction, and mixed fuel construction would likely need to incorporate a battery system to comply.
    - A jurisdiction in Climate Zone 16 may want to set a performance target at an EDR1 margin of 20.4 (the EDR1 margin for the mixed fuel efficiency + PV + battery package). This would establish a target that a mixed fuel home could On-Bill cost-effectively meet, likely only after incorporating a combination of efficiency measures and a battery system, and that an all-electric home could easily meet.
- The 2022 Title 24 code's new source energy metric combined with the heat pump baseline encourage all-electric construction, providing an incentive that allows for some amount of prescriptively required building efficiency to be traded off, still meeting minimum code compliance. This compliance benefit for all-electric homes highlights a unique opportunity for jurisdictions to incorporate efficiency into all-electric reach codes. Efficiency and electrification have symbiotic benefits and are both critical for decarbonization of buildings. As demand on the electric grid is increased through electrification, efficiency can reduce the negative impacts of

[2] Refer to Section 2.1.3 for discussion on NBT and NEM
[3] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-costs/demand-response-dr/demand-flexibility-rulemaking

additional electricity demand on the grid, reducing the need for increased generation and storage capacity, as well as the need to upgrade upstream transmission and distribution equipment. The Reach Codes Team recommends that jurisdictions adopting a reach code for single family buildings also include an efficiency requirement with EDR1 margins at minimum consistent with the all-electric code minimum package results in Table 27.

- The code compliance margins for the ADU all-electric code minimum package are lower than for the single family prototype; code compliance and cost-effectiveness can be more challenging for smaller dwelling units. As a result, the Reach Codes Team does not recommend EDR1 targets above those reported for the all-electric Code Minimum package in Table 28.

This report presents measures or measure packages that local jurisdictions may consider adopting to achieve energy savings and emissions reductions beyond what will be accomplished by enforcing minimum state requirements, the 2022 Building Energy Efficiency Standards (Title 24, Part 6), effective January 1, 2023.

Local jurisdictions may also adopt ordinances that amend different Parts of the California Building Standards Code or may elect to amend other state or municipal codes. The decision regarding which code to amend will determine the specific requirements that must be followed for an ordinance to be legally enforceable. For example, jurisdictions may amend Part 11 instead of Part 6 of the CA Building Code requiring review and approval by the Building Standards Commission (BSC) but not the California Energy Commission (Energy Commission). Reach codes that amend Part 6 of the CA Building Code and require energy performance beyond state code minimums must demonstrate the proposed changes are cost-effective and obtain approval from the Energy Commission. Although a cost-effectiveness study is only required to amend Part 6 of the CA Building Code, this study provides valuable context for jurisdictions pursuing other ordinance paths to understand the economic impacts of any policy decision. This study documents the estimated costs, benefits, energy impacts and greenhouse gas emission reductions that may result from implementing an ordinance based on the results to help residents, local leadership, and other stakeholders make informed policy decisions.

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. In addition, jurisdictions in a CCA territory with rates or rate structures that are significantly different than IOU rates may email the program at info@localenergycodes.com to request a custom analysis.

1 Introduction

This report documents cost-effective combinations of measures that exceed the minimum state requirements, the 2022 Building Energy Efficiency Standards, effective January 1, 2023, for newly constructed single family buildings. This report was developed in coordination with the California Statewide Investor-Owned Utilities (CA IOUs) Codes and Standards Program, key consultants, and engaged cities—collectively known as the Reach Codes Team.

The analysis considers traditional detached single family and detached accessory dwelling unit (ADUs) building types and evaluates mixed fuel and all-electric package options in all sixteen California climate zones (CZs).[4] Packages include combinations of efficiency measures, on-site renewable energy, and battery energy storage.

This report documents the key results and conclusions from the Reach Codes Team analysis. A full dataset of all results can be downloaded from the Local Energy Codes Resources[5] webpage. Results alongside policy options and the potential citywide impacts for specific jurisdictions can also be explored using the Cost-effectiveness Explorer at https://explorer.localenergycodes.com/.

The California Building Energy Efficiency Standards Title 24, Part 6 (Title 24) (California Energy Commission, 2021a) is maintained and updated every three years by two state agencies: the California Energy Commission (Energy Commission) and the Building Standards Commission (BSC). In addition to enforcing the code, local jurisdictions have the authority to adopt local energy efficiency ordinances—or reach codes—that exceed the minimum standards defined by Title 24 (as established by Public Resources Code Section 25402.1(h)2 and Section 10-106 of the Building Energy Efficiency Standards). Local jurisdictions must demonstrate that the requirements of the proposed ordinance are cost-effective and do not result in buildings consuming more energy than is permitted by Title 24. In addition, the jurisdiction must obtain approval from the Energy Commission and file the ordinance with the BSC for the ordinance to be legally enforceable.

The Department of Energy (DOE) sets minimum efficiency standards for equipment and appliances that are federally regulated under the National Appliance Energy Conservation Act, including heating, cooling, and water heating equipment (E-CFR, 2020). Since state and local governments are prohibited from adopting higher minimum efficiencies than the federal standards require — herein referred to as federal preemption — the focus of this study is to identify and evaluate cost-effective packages that do not include high efficiency heating, cooling, and water heating equipment. High efficiency appliances are often the easiest and most affordable 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 the performance requirements.

[4] See Appendix 7.1 Map of California Climate Zones for a graphical depiction of climate zone locations.
[5] https://localenergycodes.com/content/resources/?q=newly%20constructed%20buildings:%20efficiency%20and%20electrification

2 Methodology and Assumptions

2.1 Analysis for Reach Codes

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

2.1.1 Modeling

The Reach Codes Team performed energy simulations using software approved for 2022 Title 24 Code compliance analysis, CBECC-Res 2022.3.0.

The general approach applied in this analysis is to evaluate performance and determine cost-effectiveness of various energy efficiency upgrade measures, individually and as packages, in single family buildings. Using the 2022 baseline as the starting point, prospective measures and packages were identified and modeled in each of the prototypes to determine the projected energy use (therm and kWh) and compliance impacts. A large set of parametric runs were conducted to evaluate various options and develop packages of measures that met or exceeded minimum code performance. The analysis utilized a Python based parametric tool to automate and manage the generation of CBECC-Res input files. This allowed for quick evaluation of various efficiency measures across multiple climate zones and prototypes and improved quality control. The batch process functionality of CBECC-Res was utilized to simulate large groups of input files at once.

2.1.2 Cost-effectiveness

2.1.2.1 Benefits

This analysis used two different metrics to assess cost-effectiveness of the proposed upgrades. Both methodologies require estimating and quantifying the incremental costs and energy savings associated with each energy efficiency measure. The main difference between the methodologies is the manner in which they value energy and thus the cost savings of reduced or avoided energy use:

Utility Bill Impacts (On-Bill): Customer-based lifecycle cost (LCC) approach that values energy based upon estimated site energy usage and customer utility bill savings using today's electricity and natural gas utility tariffs. Total savings are estimated over a 30-year duration and include discounting of future costs and energy cost inflation.

Time Dependent Valuation (TDV): Energy Commission LCC methodology, which is intended to capture the total value or cost of energy use over 30 years. This method accounts for long-term projected costs, such as the cost of providing energy during peak periods of demand, and other societal costs, such as projected costs for carbon emissions as well as grid transmission and distribution impacts. This metric values energy use differently depending on the fuel source (natural gas, electricity, and propane), time of day, and season. For example, electricity used (or saved) during peak periods has a much higher value than electricity used (or saved) during off-peak periods due to the less inefficient energy generation sources providing peak electricity (Horii, Cutter, Kapur, Arent, & Conotyannis, 2014). This is the methodology used by the Energy Commission in evaluating cost-effectiveness for efficiency measures in Title 24, Part 6.

2.1.2.2 Costs

The Reach Codes Team assessed the incremental costs of the measures and packages over a 30-year lifecycle. Incremental costs represent the equipment, installation, replacement, and maintenance costs of the proposed measure relative to the 2022 Title 24 Standards minimum requirements or standard industry practices. Present value of replacement cost is included only for measures with lifetimes less than the 30-year evaluation period.

In calculating On-Bill cost-effectiveness, incremental first costs were assumed to be financed into a mortgage or loan with a 30-year loan term and four percent interest rate. Financing was not applied to future replacement or maintenance costs. In calculating TDV cost-effectiveness, incremental first costs were not assumed to be financed into a mortgage or loan.

2.1.2.3 Metrics

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

NPV Savings: The lifetime NPV savings is reported as a cost-effectiveness metric; Equation 1 demonstrates how this is calculated. If the net savings of a measure or package is positive, it is considered cost-effective. Negative savings represent net costs.

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

Equation 1

$$NPV\ Savings = Present\ value\ of\ lifetime\ benefit - Present\ value\ of\ lifetime\ cost$$

Equation 2

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

Improving the efficiency of a project often requires an initial incremental investment. In most cases the benefit is represented by annual On-Bill utility or TDV savings, and 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".

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

Equation 3

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

Where: *n* = analysis term in years

$r = discount\ rate$

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

Analysis term of 30 years
Real discount rate of three percent

TDV is a normalized monetary format and there is a unique procedure for calculating the present value benefit of TDV energy savings. The present value of the energy cost savings in dollars is calculated by multiplying the TDV savings (reported by the CBECC-Res simulation software) by a NPV factor developed by the Energy Commission (see (Energy + Environmental Economics, 2020)). The 30-year residential NPV factor is $0.173/kTDV kBtu for the 2022 code cycle.

Equation 4

$$TDV\ PV\ of\ lifetime\ benefit = TDV\ energy\ savings * NPV\ factor$$

2.1.3 Utility Rates

In coordination with the CA IOU rate team (comprised of representatives from Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E)) and two Publicly-Owned-Utilities (POUs) (Sacramento Municipal Utility District (SMUD) and City of Palo Alto Utilities (CPAU)), the Reach Codes Team determined appropriate utility rates for each climate zone in order to calculate utility costs and determine On-Bill cost-effectiveness for the proposed measures and packages. The utility tariffs, summarized in Table 1, were determined based on the most prevalent active rate in each territory. Utility rates were applied to each climate zone based on the predominant IOU serving the population of each zone, with a few climate zones evaluated multiple times under different utility scenarios. Climate Zones 10 and 14 were evaluated with both SCE/SoCalGas and SDG&E tariffs since each utility has customers within these climate zones. Climate Zone 5 is evaluated under both PG&E and SoCalGas natural gas rates. Two POU or municipal utility rates were also evaluated: SMUD in Climate Zone 12 and CPAU in Climate Zone 4.

Some community choice aggregations (CCAs) have utility rates that are very similar to IOU rates, often within $0.02 per kWh. For these CCA customers, total utility costs will be very similar to those calculated in this study and the results from this study will generally apply. The study results cannot be easily applied to CCAs with rates that do not closely track the IOU rates or municipal utilities outside of SMUD and CPAU.

First-year utility costs were calculated using hourly electricity and natural gas output from CBECC-Res and applying the utility tariffs summarized in Table 1. Annual costs were also estimated for IOU customers eligible for the CARE tariff discounts on both electricity and natural gas bills. Appendix 7.2 Utility Rate Schedules includes details of each utility tariff. For cases with onsite generation (i.e. solar photovoltaics (PV)), the approved Net Billing Tariff (NBT) was applied along with monthly service fees and hourly export compensation rates for 2024[6]. In December 2022, the California Public Utilities Commission (CPUC) issued a decision adopting NBT as a successor to prior net energy metering rules (NEM 2.0) that went into effect April of 2023.[7] The ADU was assumed to have separate electric and gas meters from the main house.

Table 1: Utility Tariffs Used Based on Climate Zone

IOUs

Climate Zones	Electric / Gas Utility	Electricity Tariff	Natural Gas Tariff
1-5,11-13,16	PG&E / PG&E	E-ELEC	G1
5	PG&E / SoCalGas	E-ELEC	GR
6, 8-10, 14, 15	SCE / SoCalGas	TOU-D-PRIME	GR
7, 10, 14	SDG&E / SDG&E	EV-TOU-5 (TOU-ELEC for ADU cases without PV systems[8])	GR

POUs

Climate Zones	Electric / Gas Utility	Electricity Tariff	Natural Gas Tariff
4	CPAU / CPAU	E-1	G1
12	SMUD / PG&E	R-TOD	G1

Utility rates are assumed to escalate over time according to the CPUC 2021 En Banc hearings on utility costs through 2030 (California Public Utilities Commission, 2021a). Escalation rates through the remainder of the 30-year evaluation period are based on the escalation rate assumptions within the 2022 TDV factors. A second set of escalation rates were also evaluated to demonstrate the impact that utility cost changes over time have on cost-effectiveness. This

[6] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/net-energy-metering-nem/nemrevisit/nbt-model--12142022.xlsb
[7] https://www.cpuc.ca.gov/nemrevisit
[8] See Section 3.2 Prototype Characteristics for a description of ADU cases that don't require solar PV prescriptively.

utility rate escalation sensitivity analysis, presented in Section 4.6.3, was based on those used within the 2025 Long-term System Cost (LSC) factors (LSC replaces TDV in the 2025 code cycle) which assumed steep increases in gas rates in the latter half of the analysis period. See Appendix 7.2.7 Fuel Escalation Assumptions for details.

2.2 Greenhouse Gas Emissions

The analysis reports the greenhouse gas (GHG) emission estimates based on assumptions within CBECC-Res. There are 8,760 hourly multipliers accounting for time-dependent energy use and carbon based on source emissions, including renewable portfolio standard projections. There are two strings of multipliers—one for Northern California climate zones, and another for Southern California climate zones.[9] GHG emissions are reported as average annual metric tons of CO_2 equivalent over the 30-year measure analysis period.

2.3 Energy Design Rating

The 2019 Title 24 Code introduced California's Energy Design Rating (EDR) as the primary metric to demonstrate compliance with the energy code for single family buildings. This EDR was based on the hourly TDV energy use from a building that is compliant with the 2006 International Energy Conservation Code (IECC) as the Reference Building. The Reference Building has an EDR score of 100 while a zero-net energy (ZNE) home has an EDR score of zero. While the Reference Building is used to set the scale for the rating, the Proposed Design is still compared to the Standard Design based on the Title 24 prescriptive baseline assumptions to determine compliance. In the 2022 Title 24 Code a second new EDR metric was introduced based on hourly source energy. The two EDR metrics are described below:

EDR1 is calculated based on source energy.
EDR2 is calculated based on TDV energy.

EDR1 has only one component, "Total EDR1" which represents source energy use for the entire building. EDR2 is composed of two components for compliance purposes: the "Efficiency EDR2", which represents the energy efficiency features of a home, and the PV/Flexibility EDR2, which includes the effects of PV and battery storage systems. "Total EDR2" combines all energy use of the building including both the Efficiency and PV/Flexibility impacts. While the Efficiency EDR2 does not include the full impact of a battery system, it can include a self-utilization credit for batteries if certain conditions are met.

For a new, single family building to comply with the 2022 Title 24 Code, three criteria must be met:

1. The Proposed Total EDR1 must be equal to or less than the Total EDR1 of the Standard Design, and
2. The Proposed Efficiency EDR2 must be equal to or less than the Efficiency EDR2 of the Standard Design, and
3. The Proposed Total EDR2 must be equal to or less than the Total EDR2 of the Standard Design.

This concept, consistent with California's "loading order" which prioritizes energy efficiency ahead of renewable generation, requires projects to meet a minimum Efficiency EDR2 before PV is credited but allows for PV to be traded off with additional efficiency when meeting the Total EDR2. A project may improve building efficiency beyond the minimum required and subsequently reduce the PV generation capacity necessary to achieve the required Total EDR2. However, it may not increase the size of the PV system and trade this off with a reduction of efficiency measures.

Results from this analysis are presented as EDR Margin, a reduction in the EDR score relative to the Standard Design. EDR Margin is a better metric to use than absolute EDR in the context of a reach code because absolute values vary based on the home design and characteristics such as size and orientation. This approach aligns with how compliance is reported for the 2019 and 2022 Title 24 Code. The EDR Margin is calculated according to Equation 5.

Equation 5

[9] CBECC-Res multipliers are the same for CZs 1-5 and 11-13 (Northern California), while there is another set of multipliers for CZs 6-10 and 14-16 (Southern California).

$$EDR\ Margin = Standard\ Design\ EDR - Proposed\ Design\ EDR$$

3 Prototypes, Measure Packages, and Costs

This section describes the prototypes and the scope of analysis drawing from previous research where necessary, including the 2019 low-rise residential single family reach code study (Statewide Reach Codes Team, 2019).

3.1 Prior Reach Code Research

In 2019, the Reach Codes Team analyzed the cost-effectiveness of residential single family new construction projects for mixed fuel and all-electric packages (Statewide Reach Codes Team, 2019). Using this analysis, several cities and counties in California adopted local energy code amendments encouraging or requiring that low-rise residential new construction be all-electric. As there were few changes to the single family requirements, this analysis for the 2022 code cycle leveraged the work completed for the 2019 reports. Initial efficiency packages were based on the final packages from the 2019 research and were revised to reflect measure specifications and costs based on new data.

3.2 Prototype Characteristics

The Energy Commission defines building prototypes which it uses to evaluate the cost-effectiveness of proposed changes to Title 24 requirements. For the 2022 code cycle the Energy Commission used two single family prototypes, both of which were used in this analysis. Additional details on the prototypes can be found in the Alternative Calculation Method (ACM) Approval Manual (California Energy Commission, 2018).

Additionally, a detached new construction ADU prototype was developed to reflect recent trends in California construction related to the high cost of housing (TRC, 2021). ADUs are additional dwelling units typically built on the property of an existing single-family parcel. ADUs are defined as new construction in the energy code when they are ground-up developments, do not convert an existing space to livable space, and are not attached to the primary dwelling. The evaluated prototype is not representative of an attached ADU constructed as an addition to an existing home.

The Reach Codes Team leveraged prior research to define the detached ADU baseline and measure packages. The house size and number of bedrooms were based on data from a survey conducted by UC Berkeley's Center for Community Innovation (UC Berkeley Center for Community Innovation, 2021). The survey found that the average square footage for new ADUs statewide is 615 square feet and that the majority (61 percent) of new ADUs have one bedroom.

Table 2 describes the basic characteristics of each prototype. The prototypes have equal geometry on all walls, windows and roof to be orientation neutral.

Table 2: Prototype Characteristics

Characteristic	Single Family One-Story	Single Family Two-Story	ADU
Conditioned Floor Area	2,100 ft^2	2,700 ft^2	625 ft^2
Num. of Stories	1	2	1
Num. of Bedrooms	3	4	1
Window-to-Floor Area Ratio	20%	20%	19.2%

The Energy Commission's protocol for the two single family prototypes is to weigh the simulated energy impacts by a factor that represents the distribution of single-story and two-story homes being built statewide. Consistent with this protocol, this study assumed 50 percent single-story and 50 percent two-story. Simulation results in this study are characterized and presented according to this ratio, which is approximately equivalent to a 2,400-square foot (ft^2) house.[10] ADU results are presented separately.

The methodology used in the analyses for each of the prototypical building types begins with a design that precisely meets the minimum 2022 prescriptive requirements (zero compliance margin). Table 150.1-A in the 2022 Standards (California Energy Commission, 2021a) lists the prescriptive measures that determine the baseline design in each climate zone. Other features are consistent with the Standard Design in the ACM Reference Manual (California Energy Commission, 2022), and are designed to meet, but not exceed, the minimum requirements. See Appendix 7.4 for a list of prescriptive values relevant to the measures explored in this analysis.

Table 3 describes additional characteristics as they were applied to the base case, or baseline, energy model in this analysis. In a shift from the 2019 Standards, the 2022 Standards apply a prescriptive fuel source for space heating and water, where one is gas-fueled and one is a heat pump depending on climate zone. This establishes a prescriptive heat pump baseline. In most climate zones the prescriptive base case includes a heat pump water heater and a natural gas furnace for space heating. In Climate Zones 3, 4, 13, and 14 this is reversed, where the base case has a heat pump space heater and natural gas tankless water heater.

Table 4 summarizes the PV capacities for the base case packages.

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[10] 2,400 ft^2 = (50% x 2,100 ft^2) + (50% x 2,700 ft^2)

Table 3: Base case Characteristics of the Prototypes

Characteristic	Single Family	ADU
Space Heating/Cooling[1,2]	CZs 1-2,5-12,15-16: Natural gas furnace, split AC 80 AFUE, 14.3 SEER2, 11.7 EER2 CZs 3-4,13-14: Split heat pump – 7.5 HSPF2, 14.3 SEER2, 11.7 EER2	Same as single family
Air Distribution	Ductwork located in vented attic	Same as single family
Water Heater[1,2]	CZs 1-2,5-12,15-16: Heat pump water heater (HPWH) UEF = 2.0 located in the garage CZs 3-4,13-14: Natural gas tankless – UEF = 0.81	Same equipment type as SF except HPWH is located inside the conditioned space with the supply air ducted from outside and exhaust air ducted to outside.[3]
Hot Water Distribution	Code minimum CZs 1,16: Basic compact distribution credit	Same as single family
Cooking	Natural Gas	Same as single family
Clothes Drying	Natural Gas	Same as single family
PV System	Sized to offset 100% of electricity use for space cooling, ventilation, lighting, appliance, & other miscellaneous electric loads. Size differs by climate zone ranging from 2.64 kW to 5.21 kW, see Table 4.	PV is not required when the PV system size required based on the prescriptive calculations is less than 1.8 kW, as is the case in Climate Zones 1-9, 12, 14, and 16. In the other climate zones the PV size ranges from 1.73 kW to 2.51 kW, see Table 4.[4]
Foundation	Slab-on-grade	Same as single family

[1] Equipment efficiencies are equal to minimum federal appliance efficiency standards.
[2] AFUE = annual fuel utilization efficiency. SEER = seasonal energy efficiency ratio. EER = energy efficiency ratio. HSPF = heating seasonal performance factor. UEF = uniform energy factor.
[3] This version of CBECC-Res used in this analysis did not have the capability to directly model ducted HPWHs even though this configuration is called out as the Standard Design in the 2022 ACM (California Energy Commission, 2022). This was modeled by indicating that the tank is located within the conditioned space with the compressor unit located outside.
[4] Exception 2 to Section 150.1(I)14 states that “no PV system is required when the minimum PV system size specified by section 150.1(c)14 is less than 1.8 kWdc.” In this analysis this exception is applied based on the sizes calculated per Equation150.1-C of Section 150.1(c)14. The performance software sizes the PV system based on the estimated energy use, which differs slightly from the prescriptive sizing. As a result, the baseline PV capacity from the performance software for Climate Zone 10 is less than 1.8 kWdc.

Table 4: Base Package PV Capacities (kW-DC)

Climate Zone	Base Package	
	Single Family	ADU
CZ01	3.57	0
CZ02	3.03	0
CZ03	2.83	0
CZ04	2.91	0
CZ05	2.64	0
CZ06	2.65	0
CZ07	2.83	0
CZ08	3.11	0
CZ09	2.96	0
CZ10	3.17	1.73
CZ11	3.90	2.06
CZ12	3.14	0
CZ13	4.05	2.09
CZ14	3.15	0
CZ15	5.21	2.51
CZ16	2.93	0

3.3 Measure Definitions and Costs

Measures evaluated in this study fall into two categories: those associated with general efficiency — onsite generation (solar PV), and demand flexibility (batteries) — and those associated with building electrification. Furthermore, general efficiency measures are broken into those that are federally preempted and those that are not; see Section 1 for background information on preemption and Section 3.4 for details of measure packages evaluated in this study. The Reach Codes Team selected measures based on cost-effectiveness as well as decades of experience with residential architects, builders, and engineers along with general knowledge of the relative consumer acceptance of many measures.

The following sections describe the details and incremental cost assumptions for each of the measures. Incremental costs represent the equipment, installation, replacement, and maintenance costs of the proposed measures relative to the base case.[11] Replacement costs are applied for roofs, mechanical equipment, PV inverters and battery systems over the 30-year evaluation period. Maintenance costs are estimated for PV systems, but not any other measures. Costs were estimated to reflect costs to the building owner. All costs are provided as present value in 2023 (2023 PV$).

The Reach Codes Team obtained measure costs from distributors, contractors, literature review, and online sources such as Home Depot and RS Means. Contractor markups are incorporated. These are the Reach Codes Team's best estimates of average costs statewide. However, it's recognized that local costs may differ, and that inflation and supply chain issues may also impact costs.

3.3.1 Efficiency, Solar PV, and Batteries

The following are descriptions of each of the efficiency, PV, and battery measures evaluated under this analysis and applied in at least one of the packages presented in this report, including how they compare to the current prescriptive requirements. Throughout this report, "Efficiency" measures refer specifically to the following non-preempted

[11] All first costs are assumed to be financed in a mortgage and interest costs due to financing are included in the incremental costs. See Section 2.1.2 for details.

measures. These measures are in addition to or in place of the relevant 2022 base case prototype characteristics outlined in Table 3, and their applicability to measure packages are summarized in Table 39 through Table 41. Table 5 summarizes the incremental cost assumptions for each of these measures.

Reduced Infiltration (ACH50): Reduce infiltration in single family homes from the default infiltration assumption of five (5) air changes per hour at 50 Pascals (ACH50)[12] by 40 percent to 3 ACH50. HERS rater field verification and diagnostic testing of building air leakage according to the procedures outlined in the 2022 Reference Appendices RA3.8 (California Energy Commission, 2021b).

Lower U-Factor Fenestration: Reduce window U-factor to 0.24. The prescriptive U-factor is 0.30 in all climate zones.

Higher SHGC Fenestration: Increase solar heat gain coefficient (SHGC) to 0.50 in climate zones where heating loads dominate (1, 3, 5 and 16). The baseline SHGC applied in the Standard Design is 0.35 in these climate zones.

Cool Roof: Install a roofing product that's rated by the Cool Roof Rating Council to have an aged solar reflectance (ASR) equal to or greater than 0.25. Steep-sloped roofs were assumed in all cases. The prescriptive ASR is 0.20 for Climate Zones 10 through 15.

Increased Ceiling Insulation: Increase ceiling level insulation in a vented attic to R-38, R-49, or R-60 insulation.

Slab Insulation: Install R-10 perimeter slab insulation at a depth of 16-inches. This measure doesn't apply to Climate Zone 16 where slab insulation is required prescriptively.

Low Pressure Drop Ducts: Upgrade the duct distribution system to reduce external static pressure and meet a maximum fan efficacy of 0.35 Watts per cfm (compared to the prescriptively required 0.45 W/cfm). This may involve upsizing ductwork, reducing the total effective length of ducts, and/or selecting low pressure drop components such as filters. Fan watt draw must be verified by a HERS rater according to the procedures outlined in the 2022 Reference Appendices RA3.3 (California Energy Commission, 2021b). This applies to the single family prototype only.

Buried Radial Duct Design: Bury all ductwork in ceiling insulation by laying the ducts across the ceiling joists or in-between ceiling joists directly on the ceiling drywall. Duct design is based on a radial design where individual ducts are run to each supply register. This allows for smaller diameter ducts, reducing duct losses and more easily meeting fully or deeply buried conditions.[13] Duct burial and duct system design must be verified by a HERS rater according to the procedures outlined in the 2022 Reference Appendices RA3.1.4.1.5 and RA3.1.4.1.6 (California Energy Commission, 2021b). This applies to the single family prototype only.

Ductless Mini-Split Heat Pump: In the ADU prototype install a ductless mini-split heat pump with three indoor heads. The system is evaluated as meeting the criteria for the variable capacity heat pump (VCHP) credit, introduced in the 2019 code cycle, which must be verified by a HERS rater according to the procedures outlined in the 2022 Reference Appendices RA3.4.4.3 (California Energy Commission, 2021b). This credit requires verification of refrigerant charge, that all equipment is entirely within conditioned space, that airflow is directly supplied to all habitable space, and that wall mounted thermostats serve any zones greater than 150 square feet. This measure is non-preempted because it does not require the installation of equipment with efficiencies above federal minimum requirements.

Compact Hot Water Distribution: Design the hot water distribution system to meet minimum requirements for the basic compact hot water distribution credit according to the procedures outlined in the 2022 Reference Appendices RA4.4.6 (California Energy Commission, 2021b). In many single family homes this may require moving the water heater from an exterior to an interior garage wall. CBECC-Res software assumes a 30% reduction in distribution losses for the basic credit. This is prescriptively required in Climate Zones 1 and 16 only.

Solar PV: Installation of on-site PV is required in the 2022 residential code unless an exception is met. The PV sizing methodology in each package was developed to offset annual building electricity use and avoid oversizing. In all cases,

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[12] Whole house leakage tested at a pressure difference of 50 Pascals between indoors and outdoors.
[13] The duct systems in the Central Valley Research Homes Project Final Project Report are illustrative of this approach (Proctor, Wilcox, & Chitwood, 2018).

PV is evaluated in CBECC-Res according to the California Flexible Installation (CFI) 1 assumptions. To meet CFI eligibility, the requirements of 2022 Reference Appendices JA11.2.2 (California Energy Commission, 2021b) must be met.

The Reach Codes Team used two options within the CBECC-Res software for sizing the PV system. The first option, "Standard Design PV", was applied in the base case simulations and packages where the PV system size was not changed from the minimum system size required[14]. For the PV packages, the second option, "Specify PV System Scaling", was used. In these cases, a scaling of 100 was applied, indicating that the PV system be sized to offset 100% of the estimated electricity use of the Proposed Design case.

One exception to the PV requirement is when the minimum PV system size required is less than 1.8 kW. This exception applies to the ADU models in Climate Zones 1-9, 12, 14, and 16. For these cases no PV system is required by code and no PV system was modeled in the base case simulations.

Battery Energy Storage: A 10 kWh battery system was evaluated in CBECC-Res with control type set to "Basic" and with default efficiencies of 95% for both charging and discharging. 10kWh battery capacity is representative of systems installed in single family homes based on the Self-Generation Incentive Program (SGIP) participant data. The "Basic" control option charges the battery system anytime PV generation is greater than the house load and discharges the battery whenever the house load exceeds PV generation. The battery does not discharge to the grid, maximizing on-site utilization of the PV system and in turn utility bill benefits under NBT. To qualify for the battery storage compliance credit the battery system must meet the requirements outlined in the 2022 Reference Appendices JA12 (California Energy Commission, 2021b). Batteries are not prescriptively required in any climate zone.

Table 5: Incremental Cost Assumptions: Efficiency, PV, and Battery Measures

Measure	Performance Level	Incremental Cost (2023 PV$)[1] Single Family	ADU	Source & Notes
Reduced Infiltration	3.0 vs 5.0 ACH50	$591	$362	$0.115/ft^2 based on NREL's BEopt cost database plus $250 HERS rater verification.
Window U-factor	0.24 vs 0.30	$2,280	$285	$4.23/ft^2 window area based on analysis conducted for the 2019 and 2022 Title 24 cycles (Statewide CASE Team, 2018).
Window SHGC	0.50 vs 0.35	$0	$0	Based on feedback from Statewide CASE Team that higher SHGC does not necessarily have any incremental cost (Statewide CASE Team, 2017).
Cool Roof	0.25 vs 0.20 aged solar reflectance	$219	$53	$0.07per ft^2 of roof area first incremental cost for asphalt shingle product based on the 2022 Nonresidential High Performance Envelope CASE Report (Statewide CASE Team, 2020a). Total costs assume present value of replacement at year 20 and residual cost for remaining product life at end of 30-year analysis period. Higher reflectance values for lower cost are achievable for tile roof products
Attic Insulation	R-49 vs R-30	$872	n/a	Based on costs from the 2022 Residential Additions & Alterations CASE Report (Statewide CASE Team, 2020b).
	R-60 vs R-30	$1,420	n/a	
	R-60 vs R-38	$1,096	n/a	
Slab Edge Insulation	R-10 vs R-0	$651	$449	$4 per linear foot of slab perimeter based on internet research. Assumes 16in depth.

[14] The Standard Design PV system is sized to offset the electricity use of the building loads which are typically electric in a mixed fuel home, which includes all loads except space heating, water heating, clothes drying, and cooking.

Measure	Performance Level	Incremental Cost (2023 PV$)[1] Single Family	ADU	Source & Notes
Low Pressure Drop Ducts	0.35 vs 0.45 W/cfm	$99	n/a	Costs assume one-hour labor for single family and half-hour for the ADU. Labor rate of $88 per hour is from 2022 RS Means for sheet metal workers and includes a weighted average City Cost Index for labor for California.
Buried Ducts	Buried, radial design	$281	n/a	No cost for laying ducts on attic floor versus suspending, in some cases there will be cost savings. Neutral cost for radiant design versus trunk and branch design. A $250 HERS Rater verification fee is included.
Duct Insulation	R-8 vs R-6	$201	n/a	Based on costs from the 2022 Residential Additions & Alterations CASE Report (Statewide CASE Team, 2020b).
Ductless Mini-Split Heat Pump	Ductless system meeting the VCHP credit vs. ducted split heat pump	n/a	$1,571	Costs were developed based on data from E3's 2019 report Residential Building Electrification in California (Energy & Environmental Economics, 2019) and the 2022 All-Electric Multifamily CASE Report (Statewide CASE Team, 2020c). Equipment costs are from the CASE Report for the 10-story multifamily prototype assuming similar sized equipment between the multifamily dwelling unit and the ADU. Thermostat, wiring, electrical, and ducting costs are from the E3 study. A $250 HERS Rater verification fee is also included. Where this measure is applied to the mixed fuel home with a gas furnace, this cost is in addition to the cost difference for a heat pump versus a gas furnace/split AC reported in Section 3.3.2.
Compact Hot Water Distribution	Basic credit – homes with gas tankless	$196	$0	For single family homes with a gas tankless water heater (mixed fuel homes in Climate Zones 3, 4, 13, 14) assumes adding 20-feet venting at $14.69 per linear foot to locate water heater on interior garage wall, less 20-feet savings for PEX and pipe insulation at $5.98 per linear foot. Costs obtained from online retailers. For single family homes with a HPWH there is an incremental cost savings from less pipe being required. For the ADU it is assumed the credit can be met without any changes to design and there is no cost impact.
	Basic credit – homes with HPWH	-$134	$0	
PV System	First Cost	$3.11/ W	$3.11/ W	First costs are from LBNL's Tracking the Sun 2022 (Barbose, Galen; Darghouth, Naim; O'Shaughnessy, Eric; Forrester, Sydney, 2022) and represent median costs in California in 2022 of $3.78/WDC for residential systems. The first cost was reduced by the solar energy Investment Tax Credit of 30%.[2] Inverter replacement cost of $0.14/WDC present value includes replacements at year 11 at $0.15/WDC (nominal) and at year 21 at $0.12/WDC (nominal) per the 2019 PV CASE Report (California Energy Commission, 2017). System maintenance costs of $0.31/WDC present value assume $0.02/WDC (nominal) annually per the 2019 PV CASE Report (California Energy Commission, 2017).
	Inverter replacement	$0.14/ W	$0.14/ W	
	Maintenance	$0.31/ W	$0.31/ W	
	Replacement cost	$648/ kWh	$648/ kWh	

Measure	Performance Level	Incremental Cost (2023 PV$)[1] Single Family	ADU	Source & Notes
Battery (10 kWh)	First cost	$782/ kWh	$782/ kWh	First costs of $1,101/kWh are from SGIP residential participant cost data for single family projects between 2020 and 2023. The first cost is reduced by 30% due to the Investment Tax Credit[2] and also by $0.15/Wh due to the base SGIP incentive[3]. The SGIP incentive is only accounted for in IOU territories and not for SMUD and CPAU analyses. Replacement cost at years 10 and 20 was calculated based on the first cost reduced by 7% annually over the next 10 years for a future value cost of $533/kWh. The 7% reduction is based on SDG&E's Behind-the-Meter Battery Market Study (E-Source companies, 2020). For projects constructed in 2024 or 2025, the first replacement at year 10 would occur in 2034 or 2035. This replacement cost includes an average Investment Tax Credit of 22% in 2034 and 0% in 2035[2].

[1]All first costs are assumed to be financed in a mortgage and interest costs due to financing are included in the incremental costs. See Section 2.1.2 for details. Interest costs were not included for calculating TDV cost-effectiveness.

[2]As part of the Inflation Reduction Act in August 2022 the Section 25D Investment Tax Credit was extended and raised to 30% through 2032 with a step-down beginning in 2033. https://www.seia.org/sites/default/files/2022-08/Inflation%20Reduction%20Act%20Summary%20PDF%20FINAL.pdf

[3]SGIP incentives vary by 'steps' which reflect utility-specific funding across program implementation years. See: https://www.selfgenca.com/home/program_metrics/

3.3.2 Electrification

This analysis compared a code compliant mixed fuel prototype, which uses natural gas for three appliances (cooking, clothes drying and either space heating or water heating), with a code compliant all-electric prototype. The associated costs included the relative costs between natural gas and electric appliances, differences between in-house electricity and natural gas infrastructure, and the associated infrastructure costs for providing natural gas to the building. To estimate costs the Reach Codes Team leveraged costs from the 2019 reach code cost-effectiveness studies for residential new construction (Statewide Reach Codes Team, 2019) and detached accessory dwelling units (Statewide Reach Codes Team, 2021b), 2022 RS Means, PG&E data, published utility schedules and rules, and online research.

3.3.2.1 Utility Infrastructure

This section addresses utility infrastructure costs during construction; appliance-specific infrastructure costs are addressed in Section 0. Table 6 presents total costs for natural gas infrastructure for a single family building within CA gas IOU territory, including distribution and service line extensions, meter installation, and plan review. These costs are applied as cost savings for an all-electric home when compared to a mixed fuel home. This is the component with the highest degree of variability for all-electric homes, as they are project-dependent and may be significantly impacted by such factors as utility territory, site characteristics, distance to the nearest natural gas main and main location, joint trenching, whether work is conducted by the utility or a private contractor, and number of dwelling units per development. All gas utilities participating in this study were solicited for cost information. The CA IOU costs for single family homes presented are based on cost data provided by PG&E.

Extension of service lines from a main distribution line to the home were provided separately for a new subdivision in an undeveloped area ($1,300) as well as an infill development ($6,750). The service extension is typically more costly in an infill scenario due to the disruption of existing roads, sidewalks, and other structures. For this analysis an average of the new subdivision and infill development costs was used, representing 80 percent of the new subdivision and 20 percent infill. In the case of distribution line extensions, the estimated cost is for new greenfield development.

For the single family analysis, based on the Reach Codes Team's conversations with the industry it is assumed that no upgrades to the electrical panel are required and that a 200 Amp panel is typically installed for both mixed fuel and all-electric homes.

Table 6: Single Family IOU Total Natural Gas Infrastructure Costs

Item	Cost
Distribution Line Extension	$1,020
Service Line Extension	$2,390
Meter	$300
Plan Review Costs	$850
Total	**$4,560**

CPAU provides gas service to its customers and therefore separate costs were evaluated based on CPAU gas service connection fees.[15] Table 7 presents the breakdown of gas infrastructure costs used in this analysis for CPAU. There is no main distribution line component since Palo Alto has little greenfield space remaining and most of the development is infill.

[15] CPAU Schedule G-5 effective 09-01-2019: https://www.cityofpaloalto.org/files/assets/public/utilities/utilities-engineering/general-specifications/gas-service-connection-fees.pdf

Table 7: Single Family CPAU Total Natural Gas Infrastructure Costs

Item	Cost
Service Extension	$5,892
Meter	$1,012
Plan Review Costs	$924
Total	**$7,828**

Electricity infrastructure costs for single family homes were not estimated as part of this work as they are expected to be the same for both all-electric and mixed fuel construction. This will change in July 2024 based on the CPUC's recent decision to eliminate electric line extension subsidies for new construction projects that use natural gas and/or propane.[16] This will increase the utility infrastructure costs for mixed fuel homes, relative to all-electric homes, improving the cost-effectiveness of all-electric construction. The Reach Codes Team intends to quantify this impact in future studies.

Table 8 presents utility infrastructure costs for the detached ADU, both mixed fuel and all-electric designs. These costs are directly from the 2019 detached ADU reach code report (Statewide Reach Codes Team, 2021b) and were obtained from stakeholder interviews and RS Means. For the ADU scenario it's assumed that natural gas infrastructure already exists on the lot and is being extended to the location of the ADU typically at the back of the lot. There are incremental cost savings for an all-electric ADU from not extending the natural gas service; however, there is also a small incremental cost for upgrading the electric service to accommodate the additional electrical load. The Reach Codes Team found that a new detached ADU would require that the building owner upgrade the service connection to the lot in both the mixed fuel ADU design and the all-electric design. The most common size for this upgrade is to upsize the existing panel to 225A, which would not represent an incremental cost from the mixed fuel project to the all-electric project. Feeder wiring to the ADU and the ADU subpanel, on the other hand, will need to be slightly upgraded for the all-electric design.

Table 8: ADU Utility Infrastructure Total and Incremental Costs

Mixed Fuel Measure	Mixed Fuel Total Cost	All-Electric Measure	All-Electric Total Cost	All-Electric Incremental Cost
Site natural gas service extension	$1,998	No site natural gas service	$0	($1,998)
Site electrical service connection upgrade 225A	$3,500	Site electrical service connection upgrade 225A	$3,500	$0
100A feeder to ADU with breaker	$933	125A feeder to ADU with breaker	$1,206	$273
100A ADU subpanel	$733	125A ADU subpanel	$946	$213
Totals	**$7,164**		**$5,652**	**($1,512)**

3.3.2.2 Equipment

This section provides descriptions and costs of the equipment applied to electrify mixed fuel homes in the all-electric packages. The equipment meets but does not exceed federal efficiency requirements to avoid federal preemption concerns.

[16] https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-eliminates-last-remaining-utility-subsidies-for-new-construction-of-buildings-using-gas-2023

For the water heating and space conditioning equipment analyzed, cost analyses incorporated the equipment's effective useful lifetime (EUL), which are summarized in Table 9. The EUL for the heat pump, furnace, and air conditioner are based on the Database for Energy Efficient Resources (DEER) (California Public Utilities Commission, 2021b). Water heating equipment lifetimes are based on DOE's recent water heater rulemaking (Department of Energy, 2022). Replacement costs are applied when equipment reaches its EUL within the 30-year evaluation period, and in such cases are included in the total lifetime costs. Residual value of the gas furnace and gas tankless at the end of the 30-year analysis period was accounted for to represent the remaining life of the equipment.

In this analysis, replacement costs assume a like-for-like replacement of equipment type and fuel (as listed in Table 9). However, this may be precluded in the future due to efforts to prohibit the sale of gas equipment currently being considered or undertaken by air districts (ex. BAAQMD, SCAQMD) and the California Air Resources Board (ex. zero NOx appliance rules).

Table 9: Effective Useful Lifetime (EUL) of Water Heating & Space Conditioning Equipment

Measure	EUL (Years)
Gas Furnace	20
Air Conditioner	15
Heat Pump	15
Gas Tankless Water Heater	20
Heat Pump Water Heater	15

Space Conditioning: This measure covers replacing a prescriptive air conditioner and gas furnace with a minimum efficiency heat pump in applicable climate zones (1, 2, 5 to 12, 15 and 16; see Table 3). Typical incremental costs for this equipment were based on contractor feedback and price variation by system capacity from the AC Wholesalers website and the RS Means cost database (RSMeans, 2022). Costs were applied based on the system capacity from heating and cooling load calculations in CBECC-Res as presented in Table 10. Air conditioner nominal capacity was calculated as the CBECC-Res cooling load, rounded up to the nearest half ton. Heat pump nominal capacity was calculated as the maximum of either the CBECC-Res heating or cooling load, rounded up to the nearest half ton. In both cases a minimum capacity of 1.5-ton was applied as this represents the typical smallest available split system heat pump equipment. Load calculations demonstrated that Climate Zones 2, 5 to 12, and 15 were cooling-dominated while Climate Zones 1 and 16 were heating-dominated. In the heating dominated climate zones the heat pump for the single family home needs to be upsized relative to an air conditioner that only provides cooling.

Replacement costs were estimated based on a contractor survey conducted by the Statewide Reach Codes Team in 2023 (Statewide Reach Codes Team, tbd), less any gas and electric infrastructure costs, and the equipment lifetimes listed in Table 9. Resultant incremental costs are presented in Table 11.

This measure, and thus the incremental cost, does not apply to climate zones where heat pump space conditioning is already prescriptively required (Climate Zones 3, 4, 13, and 14).

Table 10: Space Conditioning System Nominal Capacities

Climate Zone	Single Family		ADU	
	Air Conditioner Capacity (tons)	Heat Pump Capacity (tons)	Air Conditioner Capacity (tons)	Heat Pump Capacity (tons)
1	1.5	2.5	1.5	1.5
2	3	3	1.5	1.5
3	-	-	-	-
4	-	-	-	-
5	3	3	1.5	1.5
6	3	3	1.5	1.5
7	3	3	1.5	1.5
8	2.5	2.5	1.5	1.5
9	2.5	2.5	1.5	1.5
10	2.5	2.5	1.5	1.5
11	3	3	1.5	1.5
12	2.5	2.5	1.5	1.5
13	-	-	-	-
14	-	-	-	-
15	4	4	1.5	1.5
16	2	3.5	1.5	1.5

Table 11: Space Conditioning System Incremental Costs (2023 PV$)

Climate Zone	Single Family		ADU	
	First Cost	Total Lifetime Cost (Financed)	First Cost	Total Lifetime Cost (Financed)
1	$803	$2,705	($2,120)	($1,717)
2	($1,044)	($44)	($2,120)	($1,717)
3	-	-	-	-
4	-	-	-	-
5	($1,044)	($44)	($2,120)	($1,717)
6	($1,044)	($44)	($2,120)	($1,717)
7	($1,044)	($44)	($2,120)	($1,717)
8	($1,445)	($673)	($2,120)	($1,717)
9	($1,445)	($673)	($2,120)	($1,717)
10	($1,445)	($673)	($2,120)	($1,717)
11	($1,044)	($44)	($2,120)	($1,717)
12	($1,445)	($673)	($2,120)	($1,717)
13	-	-	-	-
14	-	-	-	-
15	($1,032)	$368	($2,120)	($1,717)
16	$2,331	$5,123	($2,120)	($1,717)

Water Heater: This measure covers replacing a prescriptive gas tankless water heater with a minimum efficiency HPWH in applicable climate zones (3, 4, 13, and 14; see Table 3). Typical incremental costs were based on costs from prior reach code work and recent contractor feedback. Incremental first costs assume a 65-gal HPWH and incremental replacement costs account for equipment lifetimes listed in Table 9. Replacement costs assume no change in cost from the first cost estimates before accounting for inflation, less any gas and electric infrastructure costs. For the ADU analysis the water heater is evaluated within the conditioned space with the supply air ducted from the outside and exhaust air ducted to the outside. A mechanical contractor provided a cost estimate of $943 for ducting through the attic in an ADU where the water heater is in an interior room. This cost is included in the equipment and installation total for the ADU. Resultant incremental costs are presented in Table 12.

Table 12: Heat Pump Water Heating System Incremental Costs (2023 PV$)

Item	ADU		Single Family	
	First Cost	Total Lifetime Cost (Financed)	First Cost	Total Lifetime Cost (Financed)
Equipment & Installation	$2,243	$3,930	$1,300	$2,267
Electric Service Upgrade	$43	$48	$45	$51
In-House Gas Piping	($580)	($651)	($580)	($651)
Total	**$1,706**	**$3,327**	**$765**	**$1,666**

For this electrification analysis, a HPWH that just meets the federal minimum efficiency standards[17] of close to 2.0 Uniform Energy Factor (UEF) was evaluated in order to satisfy preemption requirements. However, the Reach Codes Team is not aware of any 2.0 UEF products that are available on the market. The Northwest Energy Efficiency Alliance (NEEA) established its own rating system for high efficiency HPWHs[18] and maintains a database of qualified products. The lowest UEF currently reported in the database is 2.73. In fact, of the four rating tiers offered by NEEA, those meeting Tier 3 or Tier 4 are the dominant products on the market today. According to NEEA all major HPWH manufacturers are represented in NEEA's qualified product list[19] and there are fewer than 10 integrated products certified as Tier 1 or Tier 2, all of which have UEFs greater than 3.0.[20]

NEEA Tier 3 water heaters were included in the high-efficiency measure packages (see Section 3.4).

Clothes Dryer and Range: After review of various sources, the Reach Codes Team concluded that the cost difference between gas and electric resistance equipment for clothes dryers and stoves is negligible and that the lifetimes of the two technologies are similar. Resultant incremental costs are presented in Table 13. Note that while induction stoves may be a more likely installation option in many homes, CBECC-Res does not currently differentiate between electric technologies for stoves and therefore they were not considered in this analysis. Relative to electric resistance, induction stoves use less energy and improve performance and user satisfaction, at an additional cost.

Electric Service Upgrade (appliance-specific): The 2022 Title 24 Code requires electric readiness for gas appliances; as a result, the incremental costs to provide electrical service for electric appliances are minimal. The incremental costs accounted for in this study — shown in Table 13 — are calculated as the cost to install 220V service for the electric appliances less the cost for the electric ready requirements and for installing 110V service for the

[17] The Department of Energy establishes minimum energy conservation standards for consumer products, as directed in the Energy Policy and Conservation Act. See https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32.

[18] Based on operational challenges experienced in the past, NEEA established rating test criteria to ensure newly installed HPWHs perform adequately, especially in colder climates. The NEEA rating requires products comply with ENERGY STAR and includes requirements regarding noise and prioritizing heat pump use over supplemental electric resistance heating.

[19] https://neea.org/success-stories/heat-pump-water-heaters

[20] As of 3/8/2024: https://neea.org/img/documents/residential-unitary-HPWH-qualified-products-list.pdf

comparable gas appliance. Incremental costs are applied for the space conditioner, water heater, and cooking range. Based on builder surveys, it's assumed that in a typical mixed fuel home both electric and gas service are provided to the dryer location and therefore no incremental costs for the dryer were applied. Costs assume 50A service for the range and 30A service for the space conditioner and water heater. Costs are assumed to be the same for the single family and ADU analyses.

In-House Natural Gas Infrastructure (from meter to appliances): Installation cost to run a natural gas line from the meter to the appliance location was estimated at $580 per appliance, as shown in Table 13. These costs were based on material costs from Home Depot and labor costs from 2022 RS Means. The material costs were about 1/3 higher in RS Means than Home Depot, so the Reach Codes Team used the lower costs from Home Depot. The Reach Codes Team conducted a pipe sizing analysis for the two single family and one ADU prototype homes to estimate the length and diameter of gas piping required assuming the home included a gas furnace, gas tankless water heater, gas range, and gas dryer. Total estimated costs were very similar for each of the three prototypes and an average cost per appliance of $580 was determined. Costs are assumed to be the same for the single family and ADU analyses.

Table 13: Single Family All-Electric Appliance Incremental Costs

Item	ADU & Single Family	
	First Cost	Total Lifetime Cost (Financed)
Electric Resistance vs Gas Cooking		
Equipment & Installation	$0	$0
Electric Service Upgrade	$100	$113
In-House Gas Piping	($580)	($651)
Total	**($480)**	**($539)**
Electric Resistance vs Gas Clothes Drying		
Equipment & Installation	$0	$0
Electric Service Upgrade	$0	$0
In-House Gas Piping	($580)	($651)
Total	**($580)**	**($651)**

3.4 Measure Packages

The Reach Codes Team evaluated two packages for mixed fuel homes and five packages for all-electric homes for each prototype and climate zone, as described below.

1. All-Electric Code Minimum: This package applied the prescriptive requirements of the 2022 Title 24 Code and replaced gas equipment with minimum efficiency electric equipment.
2. Efficiency Only, all-electric: This package used only efficiency measures that don't trigger federal preemption issues including envelope, water heating distribution, and duct distribution efficiency measures. For ADUs, this also included ductless variable capacity heat pumps (VCHPs). This package was evaluated for the all-electric homes only.
3. Efficiency + High Efficiency (Preempted) Equipment, all-electric and mixed fuel: This package builds off the Efficiency Only package, adding water heating and space conditioning equipment that is more efficient than federal standards. The Reach Codes Team considers this more reflective of how builders meet above code requirements in practice. This package was evaluated to compare compliance results against the other non-preempted packages (see Table 27 and Table 28), however cost-effectiveness was not evaluated for this package since it cannot serve as the basis for adoption of a local ordinance. Specifically, it applied:
    a. Water heating, all-electric: Heat pump water heaters with a NEEA Tier 3 rating (3.45 UEF).
    b. Water heating, mixed fuel: High efficiency (0.95 UEF) gas tankless.

   c. Space conditioning, single family: High efficiency (16 SEER2/8 HSPF2) heat pumps. In mixed fuel packages, for climate zones with prescriptive gas heating, high efficiency (16 SEER2/95 AFUE) units were applied.

4. Efficiency + PV, all-electric: This package also builds on the Efficiency Only package, excluding preempted equipment. Instead, PV capacity was added to offset all of the estimated annual electricity use. This package was evaluated for the all-electric homes only.
5. Efficiency + PV + Battery, all-electric and mixed fuel: Using the Efficiency + PV package as a starting point for the all-electric analysis, a battery system was added. For mixed fuel homes the package of efficiency measures differed from the all-electric homes in some climate zones to arrive at a cost-effective solution.

To reiterate previous statements, the non-preempted measures used in all of the above packages (except for the All-Electric Code Minimum package) are referred to as “Efficiency measures”. As noted above, these measures may differ by prototype (single family vs. ADU) and by package. See Table 40 and Table 41 for the details of these measures.

4 Results

Section 4.1 presents compliance results for all-electric versus mixed fuel code minimum packages to provide a broad overview of how these different approaches impact code compliance. Sections 4.2 to 4.5 present EDR results along with other savings data for packages of particular interest, as well as cost-effectiveness results for all packages. Section 4.5 presents results for sensitivity analyses. All results reflect savings over a 30-year analysis period and are compared against the 2022 prescriptive baseline.

4.1 Compliance Results: All-Electric vs. Mixed Fuel Code Minimum

The Reach Codes Team evaluated the compliance impacts of a prescriptive all-electric home as well as a traditional mixed fuel home with four gas appliances (space heating, water heating, cooking, clothes drying). Compliance is relative to the 2022 prescriptive base case home with three gas appliances which, by definition, has a compliance margin of zero in all climate zones. The impacts for the all-electric single family home and the ADU are presented in Figure 1 and Figure 2, respectively. The all-electric single family and ADU home prototypes are code compliant with both EDR1 (source energy) and efficiency EDR2 (TDV energy) in all climate zones, though the compliance margin is highly variable across climate zones. The four gas appliance single family home is presented in Figure 3. This case is not code compliant in any climate zone.

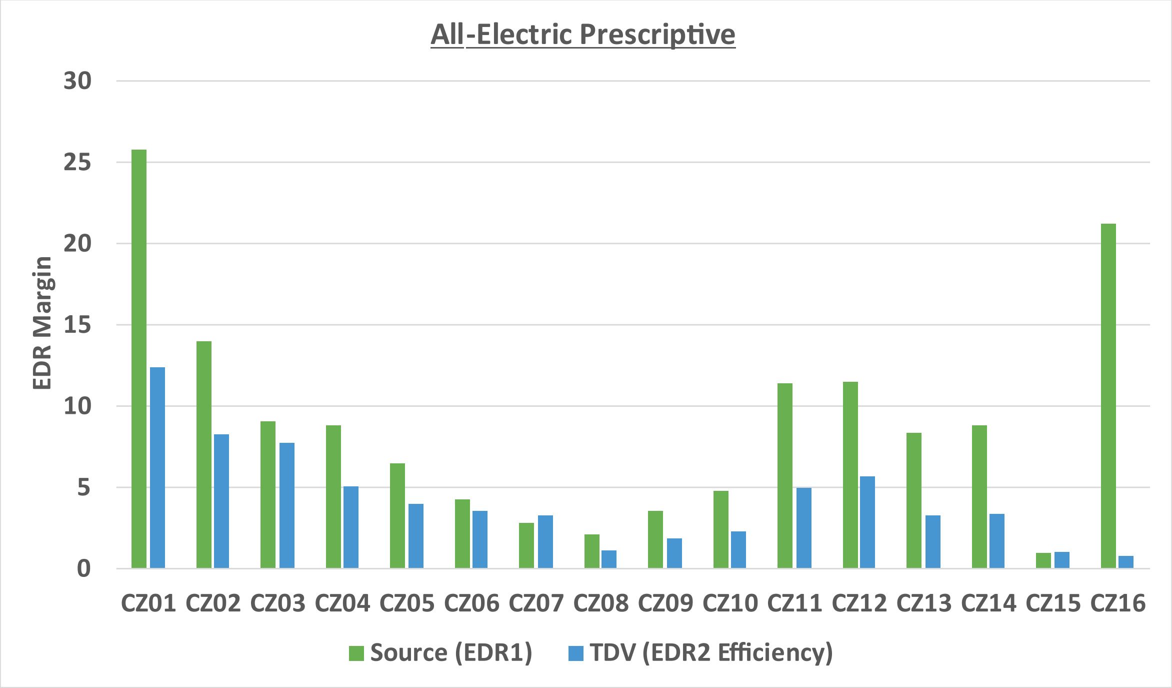

Figure 1: Single family all-electric home compliance impacts.

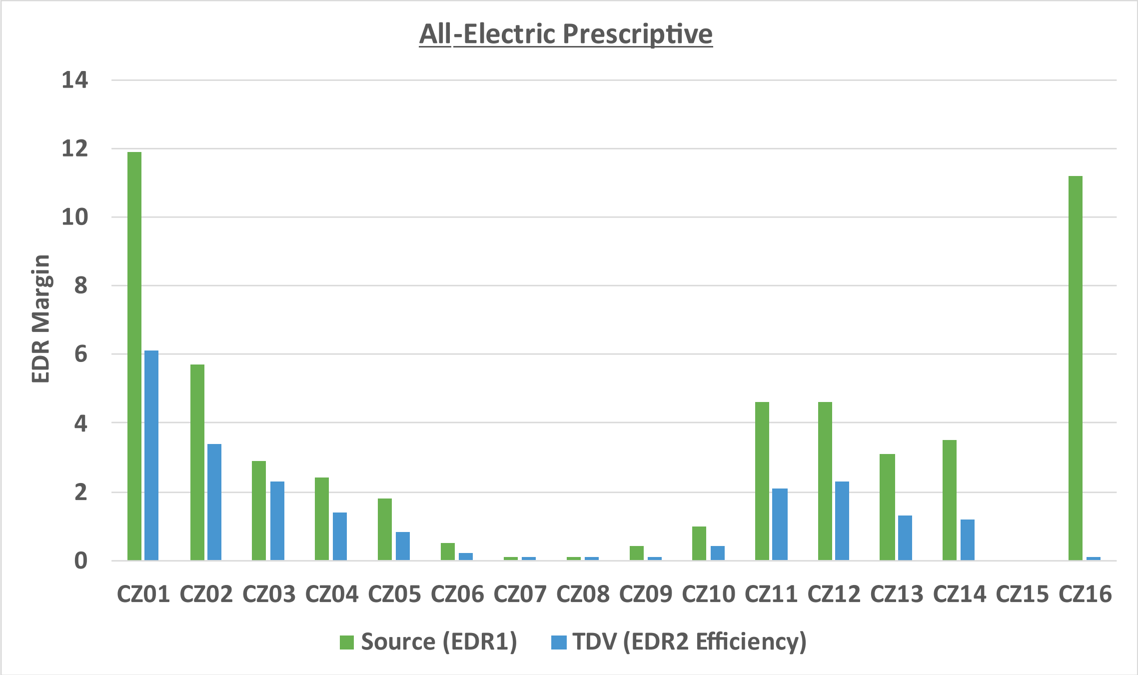

Figure 2: ADU all-electric home compliance impacts.

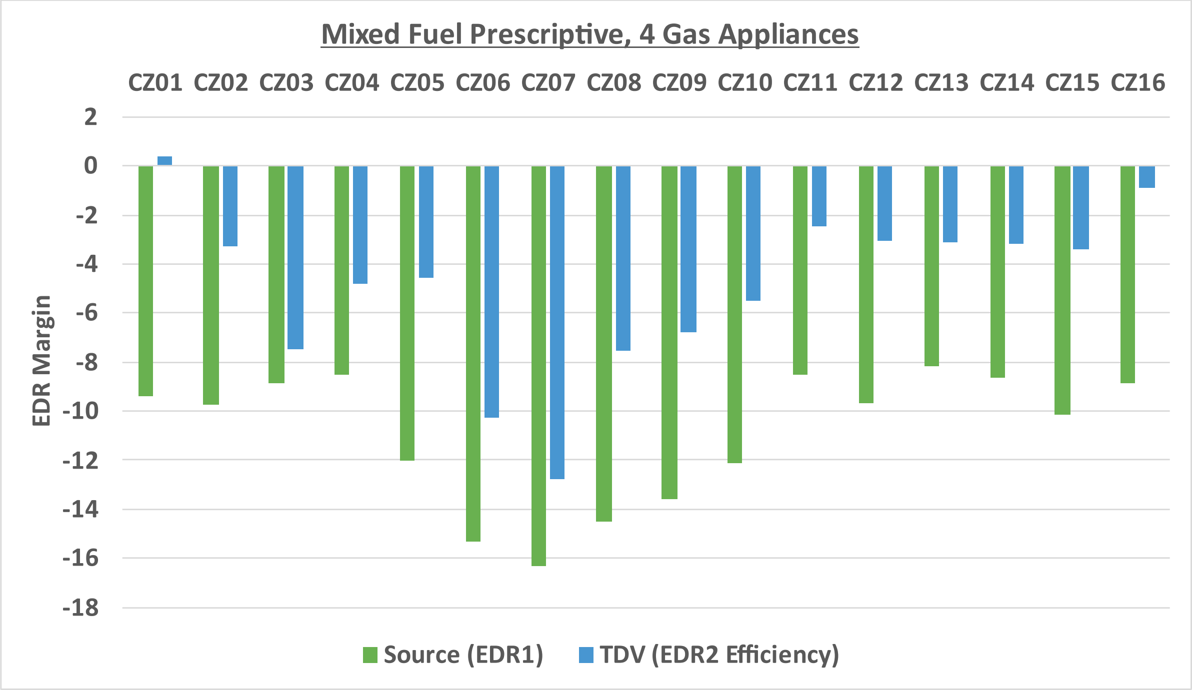

Figure 3: Single family four gas appliance home compliance impacts.

This analysis illustrates a couple of interesting points:

1. The 2022 compliance metrics are important drivers encouraging electrification. The compliance penalties associated with the four gas appliance home scenarios are significant and will require deep efficiency measures to overcome.
2. The 2022 Title 24 Code's new source energy metric combined with the heat pump baseline encourage all-electric construction, providing a compliance benefit that allows for some amount of prescriptively required building efficiency to be traded off and still comply when using the performance method.

4.2 All-Electric Code Minimum Results

Table 14 shows results for the single family all-electric Code Minimum measure package. Utility cost savings are negative, indicating an increase in utility costs for the all-electric building, everywhere except in CPAU and SMUD territories. In all cases the incremental cost is negative, which reflects cost savings for the all-electric building due to elimination of gas infrastructure costs. The package is cost-effective based on TDV in all cases but one (Climate Zone 16); it's not cost-effective On-Bill in Climate Zones 1, 3, 14, and 16.

Table 15 shows the all-electric Code Minimum package results for the ADU. Utility savings and incremental costs reflect the same general trend as single family homes; CPAU territory is the only case where utility costs decrease. Cost-effectiveness is less favorable than the single family application, with TDV cost-effectiveness not met in Climate Zones 3, 4, 13, and 14, and On-Bill cost-effectiveness met only in Climate Zones 4 in CPAU territory, 10 in SCE/SCG territory, 12 in SMUD/PG&E territory, 11 and 15. Cost-effectiveness in Climate Zones 3, 4, 13, and 14 is worse than in the other climate zones due to the higher cost of converting from a gas tankless to a ducted HPWH (see Table 3) which isn't offset enough by the energy savings. Cost savings due to elimination of gas infrastructure costs are also lower for the ADU relative to the single family home.

Table 14: Single Family Cost-Effectiveness: All-Electric Code Minimum

Climate Zone	Electric /Gas Utility	Total EDR1 Margin	Efficiency EDR2 Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost[1]		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	25.8	12.4	(4,308)	398	($431)	($3,873)	($4,816)	($3,605)	0.9	($268)	>1	$5,702
CZ02	PGE	14.0	8.3	(2,888)	246	($327)	($4,000)	($6,664)	($6,355)	1.6	$2,355	>1	$7,711
CZ03	PGE	9.1	7.7	(2,433)	171	($303)	($4,734)	($4,854)	($4,644)	0.98	($90)	25.3	$3,887
CZ04	PGE	8.8	5.0	(2,232)	163	($251)	($3,665)	($4,854)	($4,644)	1.3	$979	>1	$4,494
CZ04	CPAU	8.8	5.0	(2,232)	163	($36)	$2,123	($8,122)	($8,314)	>1	$10,437	>1	$7,762
CZ05	PGE	6.5	4.0	(1,960)	133	($292)	($4,981)	($6,664)	($6,355)	1.3	$1,373	6.1	$4,633
CZ05	PGE/SCG	6.5	4.0	(1,960)	133	($277)	($4,532)	($6,664)	($6,355)	1.4	$1,823	6.1	$4,633
CZ06	SCE/SCG	4.2	3.5	(1,432)	84	($231)	($4,015)	($6,664)	($6,355)	1.6	$2,339	4.7	$4,353
CZ07	SDGE	2.8	3.2	(1,293)	69	($266)	($5,731)	($6,664)	($6,355)	1.1	$624	4.2	$4,211
CZ08	SCE/SCG	2.1	1.1	(1,293)	67	($228)	($4,192)	($7,065)	($6,983)	1.7	$2,792	4.2	$4,674
CZ09	SCE	3.6	1.9	(1,453)	84	($237)	($4,153)	($7,065)	($6,983)	1.7	$2,831	5.5	$5,013
CZ10	SCE/SCG	4.8	2.3	(1,683)	107	($258)	($4,342)	($7,065)	($6,983)	1.6	$2,642	7.4	$5,287
CZ10	SDGE	4.8	2.3	(1,683)	107	($265)	($5,158)	($7,065)	($6,983)	1.4	$1,825	7.4	$5,287
CZ11	PGE	11.4	4.9	(2,712)	226	($306)	($3,803)	($6,664)	($6,355)	1.7	$2,552	>1	$7,153
CZ12	PGE	11.5	5.6	(2,554)	212	($294)	($3,773)	($7,065)	($6,983)	1.9	$3,210	>1	$7,504
CZ12	SMUD/PGE	11.5	5.6	(2,554)	212	$79	$4,731	($7,065)	($6,983)	>1	$11,714	>1	$7,504
CZ13	PGE	8.3	3.2	(2,095)	154	($224)	($3,164)	($4,854)	($4,644)	1.5	$1,480	>1	$4,490
CZ14	SCE/SCG	8.8	3.3	(2,291)	159	($322)	($5,166)	($4,854)	($4,644)	0.9	($522)	>1	$4,105
CZ14	SDGE	8.8	3.3	(2,291)	159	($344)	($6,361)	($4,854)	($4,644)	0.7	($1,717)	>1	$4,105
CZ15	SCE/SCG	0.9	1.0	(1,167)	53	($217)	($4,152)	($6,652)	($5,942)	1.4	$1,791	3.0	$3,439
CZ16	PG&E	21.3	0.7	(4,729)	403	($548)	($6,581)	($3,289)	($1,187)	0.2	($5,394)	0.4	($1,339)

[1] Though uncommon, incremental costs can be negative, reflecting initial construction cost savings. When paired with increased energy costs (negative benefits), the construction cost savings are treated as the 'benefit' while the increased energy costs are the 'cost,' which may yield positive cost effectiveness. See Section 2.1.2.3 for more information.

Table 15: ADU Cost-Effectiveness: All-Electric Code Minimum

Climate Zone	Electric /Gas Utility	Total EDR1 Margin	Efficiency EDR2 Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost[1]		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	11.9	6.1	(1,641)	114	($353)	($6,682)	($4,692)	($4,605)	0.7	($2,077)	3.9	$2,986
CZ02	PGE	5.7	3.4	(1,245)	75	($312)	($6,347)	($4,692)	($4,605)	0.7	($1,742)	2.7	$2,515
CZ03	PGE	2.9	2.3	(1,672)	123	($377)	($7,138)	($863)	$442	0.0	($7,581)	0.0	($1,489)
CZ04	PGE	2.4	1.4	(1,612)	118	($366)	($6,964)	($863)	$442	0.0	($7,406)	0.0	($801)
CZ04	CPAU	2.4	1.4	(1,612)	118	$25	$3,035	($863)	$442	6.9	$2,592	0.0	($801)
CZ05	PGE	1.8	0.8	(1,026)	49	($302)	($6,517)	($4,692)	($4,605)	0.7	($1,912)	2.0	$2,021
CZ05	PGE/SCG	1.8	0.8	(1,026)	49	($257)	($5,178)	($4,692)	($4,605)	0.9	($574)	2.0	$2,021
CZ06	SCE/SCG	0.5	0.2	(904)	38	($243)	($4,923)	($4,692)	($4,605)	0.9	($318)	2.1	$2,135
CZ07	SDGE	0.1	0.1	(884)	37	($337)	($7,903)	($4,692)	($4,605)	0.6	($3,298)	2.2	$2,205
CZ08	SCE/SCG	0.1	0.1	(878)	36	($241)	($4,894)	($4,692)	($4,605)	0.9	($289)	2.3	$2,274
CZ09	SCE	0.4	0.1	(903)	38	($243)	($4,914)	($4,692)	($4,605)	0.9	($310)	2.4	$2,321
CZ10	SCE/SCG	1.0	0.4	(952)	43	($189)	($3,629)	($4,692)	($4,605)	1.3	$976	2.8	$2,577
CZ10	SDGE	1.0	0.4	(952)	43	($249)	($5,689)	($4,692)	($4,605)	0.8	($1,084)	2.8	$2,577
CZ11	PGE	4.6	2.1	(1,209)	71	($224)	($4,405)	($4,692)	($4,605)	1.1	$200	3.5	$2,870
CZ12	PGE	4.6	2.3	(1,183)	69	($306)	($6,315)	($4,692)	($4,605)	0.7	($1,710)	3.0	$2,684
CZ12	SMUD/PGE	4.6	2.3	(1,183)	69	($65)	($808)	($4,692)	($4,605)	5.7	$3,797	3.0	$2,684
CZ13	PGE	3.1	1.3	(1,611)	112	($218)	($3,689)	($863)	$442	0.0	($4,131)	0.0	($858)
CZ14	SCE/SCG	3.5	1.2	(1,714)	115	($375)	($6,933)	($863)	$442	0.0	($7,375)	0.0	($1,089)
CZ14	SDGE	3.5	1.2	(1,714)	115	($483)	($10,348)	($863)	$442	0.0	($10,790)	0.0	($1,089)
CZ15	SCE/SCG	0.0	0.0	(864)	36	($172)	($3,359)	($4,692)	($4,605)	1.4	$1,246	2.6	$2,477
CZ16	PG&E	11.2	0.1	(1,781)	122	($379)	($7,167)	($4,692)	($4,605)	0.6	($2,562)	2.1	$2,133

[1] Though uncommon, incremental costs can be negative, reflecting initial construction cost savings. When paired with increased energy costs (negative benefits), the construction cost savings are treated as the 'benefit' while the increased energy costs are the 'cost,' which may yield positive cost effectiveness. See Section 2.1.2.3 for more information.

4.3 All-Electric Efficiency, PV, and Battery Results

Table 16 and Table 17 compare cost-effectiveness results for the all-electric packages for the single family and ADU prototypes, respectively, with the exception of the all-electric Efficiency + High Efficiency (Preempted) Equipment package (cost-effectiveness was not evaluated for this package but see Table 27 and Table 28 for a comparison of compliance impacts). In almost all cases the single family packages are cost-effective based on TDV. For ADUs, all climate zones show an increase in TDV-cost effectiveness for the Efficiency + PV case but a decrease when a battery is added. On-Bill cost-effectiveness generally improves with the addition of efficiency measures for single family, but not for ADUs, which generally follows the same trend as TDV cost-effectiveness . A summary of measures included in each package is provided in Appendix 7.3 Summary of Measures by Package. The efficiency measures added to the all-electric package to meet minimum code requirements are described in Table 39 and Table 41.

Table 16: Single Family Cost-Effectiveness: Comparison of All-Electric Efficiency Only, PV, and Battery Packages

Climate Zone	Electric /Gas Utility	All-Electric Code Minimum				All-Electric Efficiency Only				All-Electric-Efficiency + PV				All-Electric Efficiency + PV + Battery			
		On-Bill		TDV		On-Bill		TDV		On-Bill		TDV		On-Bill		TDV	
		B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	0.9	($268)	>1	$5,702	>1	$2,945	>1	$8,168	0.9	($1,313)	1.8	$9,817	1.0	$1,012	1.2	$4,391
CZ02	PGE	1.6	$2,355	>1	$7,711	8.9	$3,870	>1	$9,325	1.5	$2,242	4.2	$12,452	1.3	$4,962	1.5	$8,190
CZ03	PGE	0.98	($90)	25.3	$3,887	1.1	$168	>1	$3,939	0.8	($903)	2.8	$6,465	1.1	$2,114	1.1	$1,347
CZ04	PGE	1.3	$979	>1	$4,494	1.7	$1,054	>1	$4,849	1.1	$204	3.5	$7,893	1.2	$3,709	1.3	$4,506
CZ04	CPAU	>1	$10,437	>1	$7,762	>1	$10,021	>1	$8,117	>1	$14,776	>1	$11,161	0.9	($1,076)	1.5	$6,724
CZ05	PGE	1.3	$1,373	6.1	$4,633	1.6	$1,975	>1	$4,985	2.2	$1,457	8.5	$7,927	1.3	$5,551	1.2	$3,296
CZ05	PGE/SCG	1.4	$1,823	6.1	$4,633	1.9	$2,424	>1	$4,985	2.6	$1,907	8.5	$7,927	1.4	$6,001	1.2	$3,296
CZ06	SCE/SCG	1.6	$2,339	4.7	$4,353	1.6	$1,813	>1	$4,119	109.5	$2,638	152.4	$6,727	1.5	$7,153	1.2	$2,276
CZ07	SDGE	1.1	$624	4.2	$4,211	1.2	$839	8.3	$4,070	5.7	$469	>1	$6,079	2.0	$13,798	1.1	$1,186
CZ08	SCE/SCG	1.7	$2,792	4.2	$4,674	1.8	$2,574	17.7	$4,642	>1	$3,329	>1	$7,492	1.7	$8,899	1.2	$2,085
CZ09	SCE	1.7	$2,831	5.5	$5,013	1.9	$2,699	>1	$5,087	>1	$3,634	>1	$8,007	1.7	$9,151	1.3	$3,630
CZ10	SCE/SCG	1.6	$2,642	7.4	$5,287	2.0	$2,668	>1	$5,376	>1	$3,765	>1	$8,347	1.7	$10,088	1.3	$3,901
CZ10	SDGE	1.4	$1,825	7.4	$5,287	1.8	$2,438	>1	$5,376	>1	$2,539	>1	$8,347	2.4	$19,463	1.3	$3,901
CZ11	PGE	1.7	$2,552	>1	$7,153	>1	$4,159	>1	$8,524	1.8	$2,984	4.6	$11,310	1.4	$7,781	1.5	$8,757
CZ12	PGE	1.9	$3,210	>1	$7,504	4.6	$3,742	>1	$8,084	1.9	$2,561	5.5	$11,063	1.3	$6,021	1.5	$8,216
CZ12	SMUD/PGE	>1	$11,714	>1	$7,504	>1	$10,665	>1	$8,084	5.8	$13,407	5.5	$11,063	0.9	($1,237)	1.4	$7,166
CZ13	PGE	1.5	$1,480	>1	$4,490	>1	$2,876	>1	$5,773	1.7	$2,334	3.7	$8,341	1.4	$7,848	1.4	$7,005
CZ14	SCE/SCG	0.9	($522)	>1	$4,105	1.8	$811	>1	$5,461	1.6	$2,558	3.6	$9,965	1.6	$10,569	1.4	$6,204
CZ14	SDGE	0.7	($1,717)	>1	$4,105	1.5	$643	>1	$5,461	1.2	$922	3.6	$9,965	2.1	$20,099	1.4	$6,204
CZ15	SCE/SCG	1.4	$1,791	3.0	$3,439	8.0	$3,267	>1	$4,669	>1	$3,940	>1	$6,120	2.0	$13,576	0.99	($80)
CZ16	PG&E	0.2	($5,394)	0.4	($1,339)	0.2	($1,946)	1.7	$1,894	0.8	($3,199)	1.6	$6,711	1.0	$206	1.1	$1,690

Table 17: ADU Cost-Effectiveness: Comparison of All-Electric Efficiency Only, PV, and Battery Packages

Climate Zone	Electric /Gas Utility	All-Electric Code Minimum				All-Electric Efficiency Only				All-Electric Efficiency + PV				All-Electric Efficiency + PV + Battery			
		On-Bill		TDV		On-Bill		TDV		On-Bill		TDV		On-Bill		TDV	
		B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	0.7	($2,077)	3.9	$2,986	0.6	($1,727)	>1	$2,900	1.2	$2,003	1.5	$5,010	0.997	($79)	0.9	($2,884)
CZ02	PGE	0.7	($1,742)	2.7	$2,515	0.5	($2,541)	>1	$1,945	1.4	$3,532	1.8	$6,360	1.1	$1,302	0.98	($410)
CZ03	PGE	0.0	($7,581)	0.0	($1,489)	0.0	($8,981)	0.0	($2,680)	0.8	($2,489)	1.1	$1,436	0.8	($4,949)	0.8	($5,369)
CZ04	PGE	0.0	($7,406)	0.0	($801)	0.0	($8,705)	0.4	($1,762)	0.9	($1,480)	1.3	$3,589	0.9	($3,501)	0.8	($3,849)
CZ04	CPAU	6.9	$2,592	0.0	($801)	1.3	$944	0.4	($1,762)	1.7	$8,498	1.3	$3,589	0.7	($9,161)	0.8	($4,899)
CZ05	PGE	0.7	($1,912)	2.0	$2,021	0.4	($3,310)	1.4	$650	1.6	$4,015	1.9	$5,436	1.1	$1,265	0.9	($1,611)
CZ05	PGE/SCG	0.9	($574)	2.0	$2,021	0.6	($1,972)	1.4	$650	1.8	$5,353	1.9	$5,436	1.2	$3,836	0.9	($1,611)
CZ06	SCE/SCG	0.9	($318)	2.1	$2,135	0.6	($1,579)	2.1	$1,103	2.0	$5,866	2.2	$6,551	1.1	$2,799	0.95	($852)
CZ07	SDGE	0.6	($3,298)	2.2	$2,205	0.4	($4,255)	1.8	$941	1.8	$5,667	1.9	$5,493	1.5	$10,358	0.9	($1,804)
CZ08	SCE/SCG	0.9	($289)	2.3	$2,274	0.6	($1,432)	2.1	$1,179	2.0	$6,364	2.3	$7,936	1.2	$4,058	0.97	($609)
CZ09	SCE	0.9	($310)	2.4	$2,321	0.6	($1,494)	2.3	$1,280	2.0	$6,568	2.4	$7,709	1.2	$4,314	0.99	($279)
CZ10	SCE/SCG	1.3	$976	2.8	$2,577	0.96	($106)	3.7	$1,593	2.2	$734	6.7	$3,496	0.9	($860)	0.7	($3,944)
CZ10	SDGE	0.8	($1,084)	2.8	$2,577	0.6	($1,787)	3.7	$1,593	0.0	($1,465)	6.7	$3,496	1.3	$5,079	0.7	($3,944)
CZ11	PGE	1.1	$200	3.5	$2,870	0.96	($96)	>1	$2,531	0.7	($602)	3.2	$4,037	0.9	($1,125)	0.9	($1,893)
CZ12	PGE	0.7	($1,710)	3.0	$2,684	0.5	($2,538)	>1	$1,878	1.6	$4,644	1.9	$6,675	1.1	$2,970	1.0	$178
CZ12	SMUD/PGE	5.7	$3,797	3.0	$2,684	13	$1,980	>1	$1,878	1.7	$5,737	1.9	$6,675	0.6	($9,432)	0.96	($872)
CZ13	PGE	0.0	($4,131)	0.0	($858)	0.0	($4,502)	0.6	($1,223)	0.3	($4,759)	1.1	$305	0.8	($4,729)	0.7	($5,491)
CZ14	SCE/SCG	0.0	($7,375)	0.0	($1,089)	0.0	($7,929)	0.5	($1,684)	1.1	$1,555	1.5	$5,935	1.0	$1,222	0.9	($1,525)
CZ14	SDGE	0.0	($10,790)	0.0	($1,089)	0.0	($10,375)	0.5	($1,684)	1.2	$2,956	1.5	$5,935	1.4	$10,678	0.9	($1,525)
CZ15	SCE/SCG	1.4	$1,246	2.6	$2,477	2.4	$1,243	>1	$2,342	>1	$1,729	52.2	$3,560	1.2	$2,631	0.8	($2,812)
CZ16	PG&E	0.6	($2,562)	2.1	$2,133	0.5	($2,378)	>1	$2,282	1.6	$5,433	2.0	$7,875	1.2	$3,618	1.0	$611

4.4 Mixed Fuel Results

Table 18 and Table 19 show results for the mixed fuel Efficiency + PV + Battery package for Single Family and ADU prototypes, respectively. On a TDV basis, this package is cost-effective only in Climate Zone 1 for single family and in no cases for ADUs. However, this package is cost-effective On-Bill for the single family home in all climate zones except 4 in CPAU territory and 12 in SMUD/PG&E territory. On-Bill cost-effectiveness for the ADU home, on the other hand, is seen only in Climate Zones 2, 5, 7 through 9, 10 in SDG&E territory, 12 in PG&E territory, 14, and 16.

Table 18: Single Family Cost-Effectiveness: Mixed Fuel Efficiency + PV + Battery

Climate Zone	Electric /Gas Utility	Total EDR1 Margin	Efficiency EDR2 Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	22.6	18.8	1,571	116	$1,084	$26,667	$11,160	$20,166	1.3	$6,501	1.0	$500
CZ02	PGE	14.1	7.4	1,257	34	$913	$21,353	$10,268	$18,868	1.1	$2,486	0.9	($1,282)
CZ03	PGE	12.8	4.3	858	7	$785	$18,003	$8,708	$16,900	1.1	$1,104	0.7	($4,777)
CZ04	PGE	13.2	4.3	790	6	$803	$18,394	$9,623	$17,938	1.0	$456	0.8	($3,925)
CZ04	CPAU	13.2	4.3	790	6	$123	$2,877	$10,673	$19,172	0.2	($16,295)	0.7	($4,975)
CZ05	PGE	14.8	4.9	1,178	13	$905	$20,821	$9,441	$17,885	1.2	$2,936	0.8	($3,468)
CZ05	PGE/SCG	14.8	4.9	1,178	13	$900	$20,690	$9,441	$17,885	1.2	$2,805	0.8	($3,468)
CZ06	SCE/SCG	18.3	5.5	888	6	$864	$19,539	$9,266	$17,587	1.1	$1,951	0.8	($3,941)
CZ07	SDGE	18.7	4.8	832	4	$1,134	$27,505	$9,214	$17,537	1.6	$9,867	0.7	($4,817)
CZ08	SCE/SCG	17.1	3.0	777	2	$920	$20,754	$9,134	$17,410	1.2	$3,344	0.7	($4,341)
CZ09	SCE	16.2	3.1	833	3	$922	$20,804	$9,152	$17,435	1.2	$3,369	0.8	($3,839)
CZ10	SCE/SCG	14.4	2.7	846	2	$958	$21,608	$8,489	$16,733	1.3	$4,875	0.7	($3,859)
CZ10	SDGE	14.4	2.7	846	2	$1,288	$31,210	$8,489	$16,733	1.9	$14,477	0.7	($3,859)
CZ11	PGE	12.9	5.1	1,025	26	$1,031	$23,949	$9,828	$18,296	1.3	$5,653	0.9	($1,066)
CZ12	PGE	13.2	4.8	1,098	23	$923	$21,415	$10,065	$18,616	1.2	$2,800	0.9	($1,194)
CZ12	SMUD/PGE	13.2	4.8	1,098	23	$253	$6,133	$11,115	$19,850	0.3	($13,717)	0.9	($2,244)
CZ13	PGE	12.3	4.2	1,006	5	$1,016	$23,250	$9,831	$18,236	1.3	$5,013	0.9	($2,354)
CZ14	SCE/SCG	13.4	5.4	1,514	6	$1,093	$24,697	$10,741	$19,342	1.3	$5,354	0.9	($1,910)
CZ14	SDGE	13.4	5.4	1,514	6	$1,421	$34,477	$10,741	$19,342	1.8	$15,135	0.9	($1,910)
CZ15	SCE/SCG	13.5	3.8	531	2	$1,140	$25,708	$8,586	$16,630	1.6	$9,078	0.6	($5,490)
CZ16	PG&E	20.4	14.2	1,228	114	$1,070	$26,218	$12,086	$20,964	1.3	$5,254	0.98	($444)

Table 19: ADU Cost-Effectiveness: Mixed Fuel Efficiency + PV + Battery

Climate Zone	Electric /Gas Utility	Total EDR1 Margin	Efficiency EDR2 Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	18.5	7.7	3,666	20	$1,078	$24,880	$15,432	$25,919	0.96	($1,040)	0.7	($6,719)
CZ02	PGE	16.6	3.5	3,472	11	$1,042	$23,928	$13,846	$23,790	1.0	$138	0.8	($4,128)
CZ03	PGE	11.8	1.2	2,679	0	$781	$17,816	$11,879	$21,215	0.8	($3,399)	0.6	($6,826)
CZ04	PGE	13.3	1.6	2,799	0	$859	$19,588	$12,213	$21,598	0.9	($2,011)	0.7	($5,306)
CZ04	CPAU	13.3	1.6	2,799	0	$391	$8,911	$13,263	$22,833	0.4	($13,922)	0.7	($6,356)
CZ05	PGE	16.9	1.1	3,309	2	$1,031	$23,539	$12,668	$22,274	1.1	$1,265	0.8	($4,765)
CZ05	PGE/SCG	16.9	1.1	3,309	2	$1,031	$23,520	$12,668	$22,274	1.1	$1,246	0.8	($4,765)
CZ06	SCE/SCG	19.8	1.2	3,285	1	$953	$21,468	$12,496	$22,043	0.97	($575)	0.8	($3,877)
CZ07	SDGE	20.3	1.2	3,278	0	$1,296	$31,370	$12,869	$22,545	1.4	$8,825	0.8	($4,633)
CZ08	SCE/SCG	20.4	0.5	3,505	0	$1,040	$23,434	$12,952	$22,678	1.0	$755	0.8	($3,522)
CZ09	SCE	19.6	0.5	3,497	0	$1,030	$23,213	$12,691	$22,327	1.0	$886	0.8	($3,318)
CZ10	SCE/SCG	19.0	0.6	729	0	$537	$12,107	$8,436	$16,606	0.7	($4,499)	0.5	($7,344)
CZ10	SDGE	19.0	0.6	729	0	$813	$19,671	$8,436	$16,606	1.2	$3,065	0.5	($7,344)
CZ11	PGE	17.6	3.0	871	10	$663	$15,273	$9,218	$17,568	0.9	($2,295)	0.7	($5,528)
CZ12	PGE	16.7	2.7	3,594	9	$1,112	$25,496	$13,764	$23,710	1.1	$1,786	0.8	($3,321)
CZ12	SMUD/PGE	16.7	2.7	3,594	9	$537	$12,380	$14,844	$24,944	0.5	($12,564)	0.8	($4,371)
CZ13	PGE	14.5	2.2	273	0	$551	$12,569	$7,979	$15,904	0.8	($3,335)	0.5	($6,903)
CZ14	SCE/SCG	14.5	3.2	3,499	0	$1,006	$22,671	$12,815	$22,325	1.0	$346	0.8	($3,423)
CZ14	SDGE	14.5	3.2	3,499	0	$1,351	$32,711	$12,815	$22,325	1.5	$10,386	0.8	($3,423)
CZ15	SCE/SCG	19.2	1.8	551	0	$683	$15,387	$8,478	$16,574	0.9	($1,187)	0.5	($7,021)
CZ16	PG&E	18.3	6.3	3,680	24	$1,117	$25,838	$13,872	$23,801	1.1	$2,037	0.8	($3,759)

4.5 Greenhouse Gas Reductions

Table 20 and Table 21 present greenhouse gas reductions for the single family and ADU prototypes, respectively. Savings represent average annual savings over the 30-year lifetime of the analysis. Greenhouse gas reductions are greatest for the all-electric Efficiency + PV + Battery package in all cases. For the single family homes, the all-electric Code Minimum case reduces greenhouse gas emissions as much or greater than the mixed fuel Efficiency + PV + Battery package in Climate Zones 1 through 4, 11 through 13, and 16—showcasing the benefit of all-electric construction over even the most ambitious of mixed fuel construction packages evaluated in this study. The trend differs for the ADU where the mixed fuel Efficiency + PV + Battery package results in more greenhouse gas savings than the all-electric Code Minimum in all climate zones except Climate Zones 3, 4, and 13. In most of the climate zones (1, 2, 5 through 12, 15, and 16) the all-electric ADU involves electrification of space heating, cooking, and clothes drying. The space heating loads for the ADU are very low, even in the colder climates, and as a result the greenhouse gas savings from efficiency measures, PV and battery are greater than just code minimum electrification. This is also the case for single family homes in Climate Zones 5 through 10, and 15 where space heating loads are low.

Table 20: Single Family Greenhouse Gas Reductions (metric tons)

Climate Zone	Single Family All-Electric					Single Family Mixed Fuel	
	Code Minimum	Efficiency Only	Efficiency + High Efficiency Equipment	Efficiency + PV	Efficiency + PV + Battery	Efficiency + High Efficiency Equipment	Efficiency + PV + Battery
CZ01	1.5	1.7	1.8	1.8	2.3	0.8	1.1
CZ02	0.9	1.0	1.1	1.1	1.6	0.5	0.7
CZ03	0.7	0.7	0.8	0.8	1.3	0.2	0.5
CZ04	0.7	0.7	0.8	0.8	1.3	0.2	0.5
CZ05	0.4	0.5	0.6	0.6	1.1	0.2	0.6
CZ06	0.3	0.3	0.3	0.4	0.9	0.1	0.5
CZ07	0.2	0.2	0.3	0.3	0.8	0.1	0.5
CZ08	0.2	0.2	0.3	0.3	0.8	0.1	0.5
CZ09	0.3	0.3	0.3	0.4	0.9	0.1	0.5
CZ10	0.3	0.4	0.4	0.5	1.0	0.1	0.5
CZ11	0.8	0.9	1.0	1.0	1.5	0.4	0.7
CZ12	0.7	0.8	0.9	0.9	1.4	0.4	0.6
CZ13	0.6	0.7	0.8	0.8	1.3	0.2	0.6
CZ14	0.6	0.7	0.8	0.9	1.4	0.2	0.6
CZ15	0.2	0.2	0.3	0.3	0.7	0.1	0.5
CZ16	1.4	1.7	1.7	1.9	2.3	1.0	1.1

Table 21: ADU Greenhouse Gas Reductions (metric tons)

Climate Zone	ADU All-Electric					ADU Mixed Fuel	
	Code Minimum	Efficiency Only	Efficiency + High Efficiency Equipment	Efficiency + PV	Efficiency + PV + Battery	Efficiency + High Efficiency Equipment	Efficiency + PV + Battery
CZ01	0.4	0.5	0.5	0.6	1.0	0.2	0.5
CZ02	0.2	0.3	0.3	0.4	0.8	0.1	0.5
CZ03	0.5	0.5	0.6	0.7	1.0	0.1	0.3
CZ04	0.5	0.5	0.5	0.7	1.0	0.1	0.4
CZ05	0.1	0.2	0.2	0.3	0.7	0.0	0.4
CZ06	0.1	0.1	0.1	0.3	0.6	0.0	0.4
CZ07	0.1	0.1	0.1	0.3	0.6	0.0	0.4
CZ08	0.1	0.1	0.1	0.3	0.6	0.0	0.5
CZ09	0.1	0.1	0.1	0.3	0.7	0.0	0.5
CZ10	0.1	0.1	0.2	0.2	0.6	0.0	0.4
CZ11	0.2	0.3	0.3	0.3	0.7	0.1	0.4
CZ12	0.2	0.3	0.3	0.4	0.7	0.1	0.5
CZ13	0.4	0.5	0.5	0.5	0.9	0.1	0.3
CZ14	0.4	0.5	0.5	0.7	1.1	0.1	0.5
CZ15	0.1	0.1	0.1	0.2	0.6	0.0	0.4
CZ16	0.4	0.5	0.5	0.7	1.0	0.2	0.6

4.6 Sensitivity Analysis

In response to jurisdictional interest, several cases were evaluated under circumstances different than those presented above in order to assess their impact on cost-effectiveness. Altered circumstances include:

1. CARE versus standard tariffs. This comparison is presented for the all-electric Code Minimum and the mixed fuel Efficiency + PV+ Battery packages and shows the impact on On-Bill cost-effectiveness for income qualified utility customers.
2. Infill versus new subdivision single family developments. This comparison applied to the all-electric Code Minimum package demonstrates how cost-effectiveness is impacted due to the magnitude of cost savings for all-electric construction from elimination of the natural gas infrastructure.
3. Utility rate escalation factors. The impact on On-Bill cost-effectiveness is presented for the all-electric Code Minimum package from varying the assumptions for escalation of electricity and natural gas utility rates over the 30-year analysis period.

4.6.1 CARE Rate Comparison

Table 22 and Table 23 present a comparison of On-Bill cost-effectiveness results for CARE tariffs relative to standard IOU tariffs for the all-electric Code Minimum package for the single family and ADU prototypes, respectively. Applying the CARE rates lowers both electric and gas utility bills for the consumer. In the case of the all-electric home, the net impact of CARE rates is improved cost-effectiveness relative to the standard tariffs. This is because the discount on electricity is greater than that for natural gas. The opposite trend occurs for the mixed fuel packages, where the lower CARE rates result in lower utility cost savings and subsequently lower benefit-to-cost ratios.

Table 22: On-Bill Cost-Effectiveness with CARE Tariffs: All-Electric Code Minimum

Climate Zone	Electric /Gas Utility	Single Family				ADU			
		Standard		CARE		Standard		CARE	
		B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	0.9	($268)	>1	$3,886	0.7	($2,077)	1.2	$696
CZ02	PGE	1.6	$2,355	5.1	$5,107	0.7	($1,742)	1.1	$580
CZ03	PGE	0.98	($90)	1.7	$1,968	0.0	($7,581)	0.0	($4,596)
CZ04	PGE	1.3	$979	2.3	$2,619	0.0	($7,406)	0.0	($4,526)
CZ05	PGE	1.3	$1,373	2.2	$3,467	0.7	($1,912)	1.1	$237
CZ05	PGE/SCG	1.4	$1,823	2.5	$3,841	0.9	($574)	1.4	$1,321
CZ06	SCE/SCG	1.6	$2,339	2.3	$3,535	0.9	($318)	1.4	$1,225
CZ07	SDGE	1.1	$624	2.1	$3,309	0.6	($3,298)	0.9	($627)
CZ08	SCE/SCG	1.7	$2,792	2.3	$3,945	0.9	($289)	1.4	$1,231
CZ09	SCE	1.7	$2,831	2.4	$4,074	0.9	($310)	1.4	$1,230
CZ10	SCE/SCG	1.6	$2,642	2.4	$4,083	1.3	$976	1.7	$1,923
CZ10	SDGE	1.4	$1,825	3.0	$4,642	0.8	($1,084)	1.3	$1,114
CZ11	PGE	1.7	$2,552	5.0	$5,077	1.1	$200	1.6	$1,634
CZ12	PGE	1.9	$3,210	5.0	$5,587	0.7	($1,710)	1.1	$545
CZ13	PGE	1.5	$1,480	2.7	$2,924	0.0	($4,131)	0.0	($2,754)
CZ14	SCE/SCG	0.9	($522)	1.3	$1,191	0.0	($7,375)	0.0	($4,754)
CZ14	SDGE	0.7	($1,717)	2.0	$2,295	0.0	($10,790)	0.0	($6,496)
CZ15	SCE/SCG	1.4	$1,791	1.9	$2,831	1.4	$1,246	1.8	$2,031
CZ16	PG&E	0.2	($5,394)	0.8	($351)	0.6	($2,562)	1.1	$453

Table 23: On-Bill Cost-Effectiveness with CARE Tariffs: Mixed Fuel Efficiency + PV+ Battery Package

Climate Zone	Electric /Gas Utility	Single Family				ADU			
		Standard		CARE		Standard		CARE	
		B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	1.3	$6,501	0.9	($2,072)	0.96	($1,040)	0.7	($9,009)
CZ02	PGE	1.1	$2,486	0.7	($5,286)	1.0	$138	0.7	($7,683)
CZ03	PGE	1.1	$1,104	0.6	($5,980)	0.8	($3,399)	0.6	($9,288)
CZ04	PGE	1.0	$456	0.6	($6,790)	0.9	($2,011)	0.6	($8,586)
CZ05	PGE	1.2	$2,936	0.7	($4,995)	1.1	$1,265	0.7	($6,642)
CZ05	PGE/SCG	1.2	$2,805	0.7	($5,100)	1.1	$1,246	0.7	($6,657)
CZ06	SCE/SCG	1.1	$1,951	0.7	($5,232)	0.97	($575)	0.7	($5,976)
CZ07	SDGE	1.6	$9,867	1.1	$1,601	1.4	$8,825	0.9	($2,435)
CZ08	SCE/SCG	1.2	$3,344	0.7	($4,574)	1.0	$755	0.8	($5,331)
CZ09	SCE	1.2	$3,369	0.7	($4,547)	1.0	$886	0.8	($5,198)
CZ10	SCE/SCG	1.3	$4,875	0.8	($3,354)	0.7	($4,499)	0.5	($8,010)
CZ10	SDGE	1.9	$14,477	1.3	$4,789	1.2	$3,065	0.8	($3,001)
CZ11	PGE	1.3	$5,653	0.8	($3,358)	0.9	($2,295)	0.5	($8,074)
CZ12	PGE	1.2	$2,800	0.7	($5,212)	1.1	$1,786	0.7	($6,653)
CZ13	PGE	1.3	$5,013	0.8	($4,024)	0.8	($3,335)	0.5	($8,497)
CZ14	SCE/SCG	1.3	$5,354	0.8	($3,665)	1.0	$346	0.7	($5,727)
CZ14	SDGE	1.8	$15,135	1.2	$4,127	1.5	$10,386	0.9	($1,393)
CZ15	SCE/SCG	1.6	$9,078	0.95	($877)	0.93	($1,187)	0.6	($6,708)
CZ16	PG&E	1.3	$5,254	0.8	($3,523)	1.1	$2,037	0.7	($6,282)

4.6.2 Utility Infrastructure Cost Sensitivity

Table 24 compares cost-effectiveness results for the natural gas service line extension cost scenarios that inform the average values presented in Table 8. The average cost scenario reflects the cost-effectiveness results for the single family all-electric Code Minimum package presented in Table 16. Relative to a new subdivision, gas infrastructure cost savings are higher for the infill development case, which translates to higher cost-effectiveness. This is shown by positive cost-effectiveness in all metrics except one – On-Bill for Climate Zone 16 – for infill development. Compared to the average cost scenario, there are two cases – On-Bill for Climate Zone 4 in PG&E territory and Climate Zone 7 – where the all-electric Code Minimum package is no longer cost-effective based on the new subdivision costs.

Table 24: Single Family Cost-Effectiveness Comparison with Range of Natural Gas Utility Infrastructure Costs: All-Electric Code Minimum

Climate Zone	Electric /Gas Utility	Average				New Subdivision				Infill Development			
		On-Bill		TDV		On-Bill		TDV		On-Bill		TDV	
		B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	0.9	($268)	>1	$5,702	0.6	($1,492)	>1	$4,612	2.2	$4,628	>1	$10,062
CZ02	PGE	1.6	$2,355	>1	$7,711	1.3	$1,131	>1	$6,621	2.8	$7,250	>1	$12,071
CZ03	PGE	0.98	($90)	25.3	$3,887	0.7	($1,314)	18.5	$2,797	2.0	$4,806	52.6	$8,247
CZ04	PGE	1.3	$979	>1	$4,494	0.9	($245)	>1	$3,404	2.6	$5,875	>1	$8,854
CZ04	CPAU	>1	$10,437	>1	$7,762	>1	$10,437	>1	$7,762	>1	$10,437	>1	$7,762
CZ05	PGE	1.3	$1,373	6.1	$4,633	1.0	$149	4.9	$3,543	2.3	$6,269	11.0	$8,993
CZ05	PGE/SCG	1.4	$1,823	6.1	$4,633	1.1	$599	4.9	$3,543	2.5	$6,719	11.0	$8,993
CZ06	SCE/SCG	1.6	$2,339	4.7	$4,353	1.3	$1,115	3.8	$3,263	2.8	$7,235	8.4	$8,713
CZ07	SDGE	1.1	$624	4.2	$4,211	0.9	($600)	3.4	$3,121	2.0	$5,519	7.5	$8,571
CZ08	SCE/SCG	1.7	$2,792	4.2	$4,674	1.4	$1,568	3.5	$3,584	2.8	$7,687	7.3	$9,034
CZ09	SCE	1.7	$2,831	5.5	$5,013	1.4	$1,607	4.6	$3,923	2.9	$7,726	9.5	$9,373
CZ10	SCE/SCG	1.6	$2,642	7.4	$5,287	1.3	$1,418	6.1	$4,197	2.7	$7,537	12.6	$9,647
CZ10	SDGE	1.4	$1,825	7.4	$5,287	1.1	$601	6.1	$4,197	2.3	$6,721	12.6	$9,647
CZ11	PGE	1.7	$2,552	>1	$7,153	1.3	$1,328	>1	$6,063	3.0	$7,448	>1	$11,513
CZ12	PGE	1.9	$3,210	>1	$7,504	1.5	$1,986	>1	$6,414	3.1	$8,106	>1	$11,864
CZ12	SMUD/PGE	>1	$11,714	>1	$7,504	>1	$10,490	>1	$6,414	>1	$16,610	>1	$11,864
CZ13	PGE	1.5	$1,480	>1	$4,490	1.1	$256	>1	$3,400	3.0	$6,376	>1	$8,850
CZ14	SCE/SCG	0.9	($522)	>1	$4,105	0.7	($1,746)	>1	$3,015	1.8	$4,374	>1	$8,465
CZ14	SDGE	0.7	($1,717)	>1	$4,105	0.5	($2,941)	>1	$3,015	1.5	$3,179	>1	$8,465
CZ15	SCE/SCG	1.4	$1,791	3.0	$3,439	1.1	$567	2.4	$2,349	2.6	$6,687	5.6	$7,799
CZ16	PG&E	0.2	($5,394)	0.4	($1,339)	0.0	($6,618)	0.0	($2,429)	0.9	($498)	2.4	$3,021

4.6.3 Utility Rate Escalation

In this sensitivity analysis, an alternative set of annual utility escalation rates was applied to the gas and electricity savings in select measure packages to show the impact that utility cost changes over time have on cost-effectiveness. This set of rates, detailed in Section 7.2.7, reflects those used by the Energy Commission in their development of the LSC factors for the 2025 code cycle (LSC replaces TDV in the 2025 code cycle). The rates assume steep increases in gas rates starting in 2030. Increased gas rates range from 2% to 6.7% higher than annual rates used in the 2022 code cycle; electricity rates are only marginally (about 0.5%) higher each year.

On-Bill cost-effectiveness results are shown for in Table 25 for the all-electric Code Minimum scenario and Table 26 for the mixed fuel Efficiency + PV + Battery measure package. The alternative rates described above (“2025 LSC”) are shown alongside those reported elsewhere in this report (“CPUC / 2022 TDV”, described in Section 2.1.3) for comparison. In all cases, the 2025 LSC escalation rates improve cost-effectiveness. In some cases, this improvement is enough to change the result from not cost-effective to cost-effective, these cases are summarized below:

- *All-Electric Code Minimum package*
  - *Climate Zones 1, 3, 14, and 16 for the single family home*
  - *Climate Zones 1, 5 in PG&E/SCG territory, 6, 8, 9, 10 in SDG&E territory, and 16 for the ADU home*
- *Mixed fuel Efficiency + PV + Battery package*
  - *Climate Zones 1, 6, and 15 for the ADU home*

Table 25: On-Bill Cost-Effectiveness, 2025 LSC Basis: All-Electric Code Minimum

Climate Zone	Electric /Gas Utility	Single Family				ADU			
		CPUC / 2022 TDV		2025 LSC		CPUC / 2022 TDV		2025 LSC	
		B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	0.9	($268)	>1	$13,867	0.7	($2,077)	1.2	$833
CZ02	PGE	1.6	$2,355	>1	$10,458	0.7	($1,742)	0.95	($228)
CZ03	PGE	0.98	($90)	>1	$4,883	0.0	($7,581)	0.0	($4,465)
CZ04	PGE	1.3	$979	>1	$5,728	0.0	($7,406)	0.0	($4,466)
CZ04	CPAU	>1	$10,437	>1	$17,647	6.9	$2,592	20.7	$8,704
CZ05	PGE	1.3	$1,373	5.3	$5,148	0.7	($1,912)	0.8	($1,386)
CZ05	PGE/SCG	1.4	$1,823	13.5	$5,884	0.9	($574)	1.2	$807
CZ06	SCE/SCG	1.6	$2,339	4.0	$4,751	0.9	($318)	1.2	$630
CZ07	SDGE	1.1	$624	1.9	$3,008	0.6	($3,298)	0.7	($2,394)
CZ08	SCE/SCG	1.7	$2,792	3.0	$4,650	0.9	($289)	1.1	$591
CZ09	SCE	1.7	$2,831	4.0	$5,233	0.9	($310)	1.2	$634
CZ10	SCE/SCG	1.6	$2,642	5.4	$5,700	1.3	$976	1.9	$2,147
CZ10	SDGE	1.4	$1,825	7.4	$6,038	0.8	($1,084)	1.0	$102
CZ11	PGE	1.7	$2,552	>1	$9,997	1.1	$200	1.6	$1,669
CZ12	PGE	1.9	$3,210	>1	$10,077	0.7	($1,710)	0.9	($430)
CZ12	SMUD/PGE	>1	$11,714	>1	$19,028	5.7	$3,797	>1	$5,367
CZ13	PGE	1.5	$1,480	>1	$5,987	0.0	($4,131)	0.0	($1,228)
CZ14	SCE/SCG	0.9	($522)	6.0	$3,876	0.0	($7,375)	0.0	($4,363)
CZ14	SDGE	0.7	($1,717)	>1	$4,799	0.0	($10,790)	0.0	($6,285)
CZ15	SCE/SCG	1.4	$1,791	2.2	$3,214	1.4	$1,246	1.9	$2,210
CZ16	PG&E	0.2	($5,394)	>1	$8,516	0.6	($2,562)	1.2	$629

Table 26: On-Bill Cost-Effectiveness, 2025 LSC Basis: Mixed Fuel Efficiency + PV + Battery

Climate Zone	Electric /Gas Utility	Single Family				ADU			
		CPUC / 2022 TDV		2025 LSC		CPUC / 2022 TDV		2025 LSC	
		B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	1.3	$6,501	1.6	$12,598	0.96	($1,040)	1.0	$993
CZ02	PGE	1.1	$2,486	1.3	$4,914	1.0	$138	1.1	$1,816
CZ03	PGE	1.1	$1,104	1.1	$2,287	0.8	($3,399)	0.9	($2,462)
CZ04	PGE	1.0	$456	1.1	$1,645	0.9	($2,011)	0.95	($980)
CZ04	CPAU	0.2	($16,295)	0.2	($15,990)	0.4	($13,922)	0.4	($13,453)
CZ05	PGE	1.2	$2,936	1.3	$4,506	1.1	$1,265	1.1	$2,574
CZ05	PGE/SCG	1.2	$2,805	1.2	$4,291	1.1	$1,246	1.1	$2,543
CZ06	SCE/SCG	1.1	$1,951	1.2	$3,420	0.97	($575)	1.0	$847
CZ07	SDGE	1.6	$9,867	1.6	$9,930	1.4	$8,825	1.4	$8,570
CZ08	SCE/SCG	1.2	$3,344	1.3	$4,750	1.0	$755	1.1	$2,288
CZ09	SCE	1.2	$3,369	1.3	$4,812	1.0	$886	1.1	$2,407
CZ10	SCE/SCG	1.3	$4,875	1.4	$6,334	0.7	($4,499)	0.8	($3,703)
CZ10	SDGE	1.9	$14,477	1.9	$14,289	1.2	$3,065	1.2	$2,904
CZ11	PGE	1.3	$5,653	1.4	$7,967	0.9	($2,295)	0.94	($1,126)
CZ12	PGE	1.2	$2,800	1.3	$4,806	1.1	$1,786	1.1	$3,458
CZ12	SMUD/PGE	0.3	($13,717)	0.4	($12,515)	0.5	($12,564)	0.5	($11,582)
CZ13	PGE	1.3	$5,013	1.4	$6,448	0.8	($3,335)	0.8	($2,674)
CZ14	SCE/SCG	1.3	$5,354	1.4	$7,138	1.0	$346	1.1	$1,827
CZ14	SDGE	1.8	$15,135	1.8	$15,116	1.5	$10,386	1.5	$10,107
CZ15	SCE/SCG	1.6	$9,078	1.7	$10,819	0.9	($1,187)	0.99	($182)
CZ16	PG&E	1.3	$5,254	1.5	$10,999	1.1	$2,037	1.2	$4,285

5 Summary

The purpose of this study was to examine and document the code compliance and cost-effectiveness impacts of improving performance among single family new construction – both standard sized homes and ADUs. To this end, the Reach Codes Team evaluated packages of energy efficiency measures as well as packages combining energy efficiency with solar PV generation and battery storage, 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.

Table 27 (single family) and Table 28 (ADU) summarize results for each prototype and depict the EDR1 compliance margins achieved for each climate zone and package. Because local reach codes must both exceed the energy code (i.e., have a positive compliance margin in the performance approach) and be cost-effective, the Reach Codes Team highlighted cells meeting these two requirements to help clarify the upper boundary for potential reach code policies. All results presented in this study have a positive compliance margin.

- Cells highlighted in **green** depict a positive compliance margin and cost-effective results using both On-Bill and TDV approaches.
- Cells highlighted in **yellow** depict a positive compliance and cost-effective results using either the On-Bill or TDV approach.
- Cells **not highlighted** depict a package that was not cost-effective using either the On-Bill or TDV approach.
- Cells highlighted in **grey** depict the high efficiency equipment packages where cost-effectiveness was not evaluated.

The following are key takeaways and recommendations from the analysis.

Conclusions and Discussion:

- All-electric buildings have lower GHG emissions than mixed fuel buildings, due to the clean power sources currently available from California's power providers as well as accounting for increased penetration of renewables in the future. Almost all the all-electric packages evaluated resulted in greater GHG emission savings than the mixed fuel packages, with the exception of the mixed fuel package with battery storage in climate zones with low heating loads.
- The Reach Codes Team found code-compliant, all-electric new construction to be feasible and cost-effective based on TDV for single family homes in all cases except Climate Zone 16.
- All-electric code minimum single family new construction was On-Bill cost-effective in all cases except Climate Zones 1, 3, 14, and 16.
- The all-electric code minimum ADU home was cost-effective based on TDV in all cases except in Climate Zones 3, 4, 13, and 14 where the higher cost of installing a ducted HPWH instead of the prescriptively required gas tankless water heater outweigh the resulting energy cost savings. In the other climate zones there were first cost savings for installing a heat pump space heater instead of gas furnace, contributing to an overall TDV cost-effective result.
- Few cases were cost-effective On-Bill for the ADU.
- All-electric code minimum construction results in an increase in lifetime utility costs relative to a mixed fuel home, except for CPAU and SMUD where electricity rates are much lower than for the IOUs. The addition of efficiency measures, market dominant HPWHs that meet NEEA's Advanced Water Heating Specification, high efficiency heat pumps, increased PV, and batteries all reduce utility costs, and the combination of these options was found to reduce annual utility costs relative to a mixed fuel home in all cases.
- Under NBT, utility cost savings for increasing PV system size beyond code minimum are substantially less than under prior net energy metering rules (NEM 2.0); however, savings are sufficient to be On-Bill cost-

effective in all climate zones for the all-electric single family home except climate zones 1, 3, and 16. Coupling PV with battery systems increases utility cost savings as a result of improved on-site utilization of PV generation and fewer exports to the grid.

- Applying CARE rates in the IOU territories improves On-Bill cost-effectiveness for all-electric buildings, as compared to the same case under standard rates, due to higher utility cost savings compared to a code compliant mixed fuel building also on a CARE rate, improving On-Bill cost-effectiveness. This is due to the CARE discount on electricity being higher than that on gas.
- If gas tariffs are assumed to increase substantially over time, in-line with the escalation assumption from the 2025 LSC development, all-electric new construction was found to be On-Bill cost-effective in all single family and most ADU scenarios over the 30-year analysis period. There is much uncertainty surrounding future tariff structures as well as escalation values. While it's clear that gas rates will increase, how much and how quickly is not known. Electricity tariff structures are expected to evolve over time, and the CPUC has an active proceeding to adopt an income-graduated fixed charge that benefits low-income customers and supports electrification measures.[21] The CPUC will make a decision in mid-2024 and the new rates are expected to be in place later that year or in 2025. While the anticipated impact of this rate change is lower volumetric electricity rates, the rate design is not finalized. While lower volumetric electricity rates provide many benefits including incentivizing electrification, it also will make building efficiency measures harder to justify as cost-effective due to lower utility bill cost savings.

Recommendations:

- A reach code with a single performance target based on source energy (EDR1) can be structured to strongly encourage electrification. This approach requires equivalent performance for all buildings and allows mixed fuel buildings which minimizes the risk of violating federal preemption. Below are examples of how a reach code for single family homes could be setup based on the results summarized in Table 27.
    - A jurisdiction in Climate Zone 12 could set a performance target at an EDR1 margin of 11.5 (the EDR1 margin for the all-electric Code Minimum package). Any all-electric home meeting or exceeding the prescriptive requirements would comply, and a mixed fuel home would likely need to incorporate a combination of efficiency measures and a battery system to comply.
    - Similarly, a jurisdiction in Climate Zone 7 may consider setting a performance target of 2.8 EDR1 margin (also the EDR1 margin for the all-electric Code Minimum package). Any all-electric home meeting or exceeding the prescriptive requirements would comply, but a mixed fuel home would likely be able to comply with only a suite of above-code efficiency measures (no battery). Alternatively, a higher EDR1 margin target of 5 would incentivize more energy efficiency or additional PV for all-electric construction, and mixed fuel construction would likely need to incorporate a battery system to comply.
    - A jurisdiction in Climate Zone 16 may want to set a performance target at an EDR1 margin of 20.4 (the EDR1 margin for the mixed fuel efficiency + PV + battery package). This would establish a target that a mixed fuel home could On-Bill cost-effectively meet, likely only after incorporating a combination of efficiency measures and a battery system, and that an all-electric home could easily meet.
- The 2022 Title 24 code's new source energy metric combined with the heat pump baseline encourage all-electric construction, providing an incentive that allows for some amount of prescriptively required building efficiency to be traded off, still meeting minimum code compliance. This compliance benefit for all-electric homes highlights a unique opportunity for jurisdictions to incorporate efficiency into all-electric reach codes. Efficiency and electrification have symbiotic benefits and are both critical for decarbonization of buildings. As demand on the electric grid is increased through electrification, efficiency can reduce the negative impacts of additional electricity demand on the grid, reducing the need for increased generation and storage capacity, as well as the need to upgrade upstream transmission and distribution equipment. The Reach Codes Team recommends that jurisdictions adopting a reach code for single family buildings also include an efficiency

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

requirement with EDR1 margins at minimum consistent with the all-electric code minimum package results in Table 27.

- The code compliance margins for the ADU all-electric code minimum package are lower than for the single family prototype; code compliance and cost-effectiveness can be more challenging for smaller dwelling units. As a result, the Reach Codes Team does not recommend EDR1 targets above those reported for the all-electric Code Minimum package in Table 28.

Local jurisdictions may also adopt ordinances that amend different Parts of the California Building Standards Code or may elect to amend other state or municipal codes. The decision regarding which code to amend will determine the specific requirements that must be followed for an ordinance to be legally enforceable. For example, jurisdictions may amend Part 11 instead of Part 6 of the CA Building Code requiring review and approval by the BSC but not the Energy Commission. Reach codes that amend Part 6 of the CA Building Code and require energy performance beyond state code minimums must demonstrate the proposed changes are cost-effective and obtain approval from the Energy Commission.

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

Table 27: Summary of Single Family EDR1 Margins and Cost-Effectiveness

Climate Zone	Electric /Gas Utility	All-Electric					Mixed Fuel	
		Code Minimum	Efficiency	Efficiency + High Efficiency Equipment	Efficiency + PV	Efficiency + PV + Battery	Efficiency + High Efficiency Equipment	Efficiency + PV + Battery
CZ01	PGE	25.8	29.1	31.4	32.6	41.4	14.8	22.6
CZ02	PGE	14.0	16.3	18.0	18.9	28.3	9.1	14.1
CZ03	PGE	9.1	10.6	12.2	13.1	24.2	3.6	12.8
CZ04	PGE	8.8	10.4	11.9	12.8	24.6	3.8	13.2
CZ04	CPAU	8.8	10.4	11.9	12.8	24.6	3.8	13.2
CZ05	PGE	6.5	7.9	10.2	10.8	23.3	5.2	14.8
CZ05	PGE/SCG	6.5	7.9	10.2	10.8	23.3	5.2	14.8
CZ06	SCE/SCG	4.2	5.3	6.6	8.4	24.6	4.0	18.3
CZ07	SDGE	2.8	3.6	4.9	6.9	23.6	3.2	18.7
CZ08	SCE/SCG	2.1	2.9	4.2	5.6	21.3	2.7	17.1
CZ09	SCE/SCG	3.6	4.4	5.7	7.1	21.8	3.2	16.2
CZ10	SCE/SCG	4.8	5.8	7.2	8.5	21.9	3.9	14.4
CZ10	SDGE	4.8	5.8	7.2	8.5	21.9	3.9	14.4
CZ11	PGE	11.4	13.4	15.0	15.6	24.5	7.7	12.9
CZ12	PGE	11.5	13.3	14.8	15.5	25.2	7.2	13.2
CZ12	SMUD/PGE	11.5	13.3	14.8	15.5	25.2	7.2	13.2
CZ13	PGE	8.3	10.3	11.9	12.3	22.3	4.1	12.3
CZ14	SCE/SCG	8.8	11.5	13.2	14.3	24.7	4.7	13.4
CZ14	SDGE	8.8	11.5	13.2	14.3	24.7	4.7	13.4
CZ15	SCE/SCG	0.9	2.4	3.7	3.8	15.7	3.5	13.5
CZ16	PG&E	21.3	25.6	27.0	29.1	37.5	16.3	20.4

Table 28: Summary of ADU EDR1 Margins and Cost-Effectiveness

Climate Zone	Electric /Gas Utility	All-Electric					Mixed Fuel	
		Code Minimum	Efficiency	Efficiency + High Efficiency Equipment	Efficiency + PV	Efficiency + PV + Battery	Efficiency + High Efficiency Equipment	Efficiency + PV + Battery
CZ01	PGE	11.9	15.7	18.5	19.3	33.5	9.9	18.5
CZ02	PGE	5.7	7.9	9.7	10.8	25.4	5.6	16.6
CZ03	PGE	2.9	4.0	5.9	7.1	22.8	3.0	11.8
CZ04	PGE	2.4	3.9	5.5	6.8	23.5	3.7	13.3
CZ04	CPAU	2.4	3.9	5.5	6.8	23.5	3.7	13.3
CZ05	PGE	1.8	2.9	4.8	6.4	23.6	2.7	16.9
CZ05	PGE/SCG	1.8	2.9	4.8	6.4	23.6	2.7	16.9
CZ06	SCE/SCG	0.5	1.3	2.6	5.0	25.4	1.8	19.8
CZ07	SDGE	0.1	0.9	2.1	5.0	25.9	1.5	20.3
CZ08	SCE/SCG	0.1	0.7	1.8	4.2	25.4	1.6	20.4
CZ09	SCE	0.4	1.1	2.3	4.5	24.9	1.9	19.6
CZ10	SCE/SCG	1.0	2.0	3.5	5.4	25.3	2.5	19.0
CZ10	SDGE	1.0	2.0	3.5	5.4	25.3	2.5	19.0
CZ11	PGE	4.6	7.0	8.6	9.6	25.0	5.4	17.6
CZ12	PGE	4.6	6.6	8.3	9.3	24.4	5.0	16.7
CZ12	SMUD/PGE	4.6	6.6	8.3	9.3	24.4	5.0	16.7
CZ13	PGE	3.1	5.5	6.9	7.8	25.1	3.9	14.5
CZ14	SCE/SCG	3.5	6.3	8.0	9.6	26.8	4.3	14.5
CZ14	SDGE	3.5	6.3	8.0	9.6	26.8	4.3	14.5
CZ15	SCE/SCG	0.0	2.2	2.6	4.4	24.8	2.3	19.2
CZ16	PG&E	11.2	14.7	15.7	18.3	32.0	8.3	18.3

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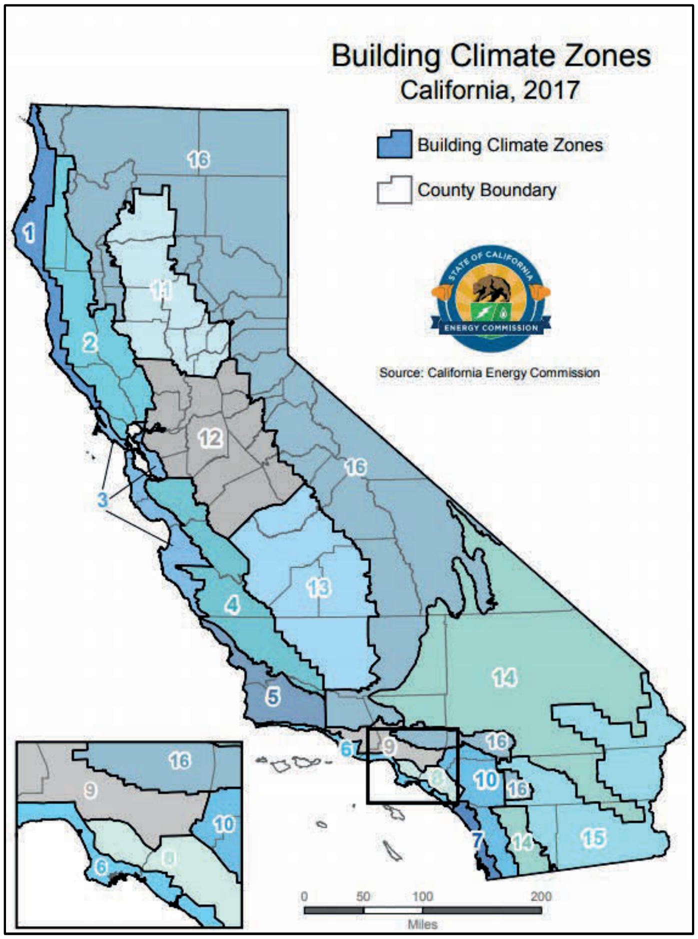
7 Appendices

7.1 Map of California Climate Zones

Climate zone geographical boundaries are depicted in Figure 4. The map in Figure 4 along with a zip-code search directory is available at: https://ww2.energy.ca.gov/maps/renewable/building_climate_zones.html

Figure 4: Map of California climate zones.



7.2 Utility Rate Schedules

The Reach Codes Team used the CA IOU and POU rate tariffs detailed below to determine the On-Bill savings for each package. The California Climate Credit was applied for both electricity and natural gas service for the IOUs using the 2023 credits shows below.[22] The credits were applied to reduce the total calculated annual bill, including any fixed fees or minimum bill amounts.

2023 Electric California Climate Credit Schedule

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

Residential Natural Gas California Climate Credit

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

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

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

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

7.2.1 Pacific Gas & Electric

The following pages provide details on the PG&E electricity and natural gas tariffs applied in this study. Table 29 describes the baseline territories that were assumed for each climate zone. A net surplus compensation rate of $0.07051/ kWh was applied to any net annual electricity generation based on a one-year average of the rates between December 2022 and November 2023.

Table 29: PG&E Baseline Territory by Climate Zone

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

The PG&E monthly gas rate for G-1 in $/therm was applied on a monthly basis according to the rates shown in Table 30. These rates are based on applying a normalization curve to the November 2023 tariff based on ten years of historical gas data. Corresponding CARE rates reflect the 20 percent discount per the GL-1 tariff.

Table 30: PG&E Monthly Gas Rate ($/therm)

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

Residential
GAS
Baseline Territories and Quantities [1/]

Effective April 1, 2022 - Present

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

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

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

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

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

Pacific Gas and Electric Company®
U 39 Oakland, California

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

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

RATES:
(Cont'd.)

E-TOU-C TOTAL BUNDLED RATES

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

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

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

(Continued)

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

Pacific Gas and Electric Company
U 39 Oakland, California

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

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

RATES:
(Cont'd.)

UNBUNDLING OF E-TOU-C TOTAL RATES

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

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

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

(Continued)

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

Pacific Gas and Electric Company
U 39 Oakland, California

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

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

RATES:(Cont'd.)

TOTAL BUNDLED RATES

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

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

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

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

UNBUNDLING OF TOTAL RATES

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

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

(Continued)

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

Pacific Gas and Electric Company
U 39 San Francisco, California

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

ELECTRIC SCHEDULE D-CARE Sheet 1

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

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

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

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

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

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

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(L)

(Continued)

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

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

ELECTRIC SCHEDULE D-CARE Sheet 2
LINE-ITEM DISCOUNT FOR CALIFORNIA ALTERNATE RATES FOR ENERGY (CARE) CUSTOMERS

RATES: (Cont'd)

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

SPECIAL CONDITIONS:

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

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

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

7.2.2 Southern California Edison

The following pages provide details on the SCE electricity tariffs applied in this study. Table 31 describes the baseline territories that were assumed for each climate zone. A net surplus compensation rate of $ 0.06030/ kWh was applied to any net annual electricity generation based on a one-year average of the rates between December 2022 and November 2023.

Table 31: SCE Baseline Territory by Climate Zone

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

Summer Daily Allocations (June through September)

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

Winter Daily Allocations (October through May)

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

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

SPECIAL CONDITIONS

1. Applicable rate time periods are defined as follows:

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

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

SOUTHERN CALIFORNIA EDISON

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

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

Sheet 2

RATES

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

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

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

(Continued)

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

EDISON

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

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

Sheet 6

RATES (Continued)

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

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

(Continued)

(To be inserted by utility) Issued by (To be inserted by Cal. PUC)
Advice 5041-E Michael Backstrom Date Submitted May 30, 2023
Decision Vice President Effective Jun 1, 2023
6H9 Resolution

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

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

APPLICABILITY

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

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

TERRITORY

Within the entire territory served.

RATES

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

CARE Discount:

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

(Continued)

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

7.2.3 Southern California Gas

Following are the SoCalGas natural gas tariffs applied in this study. Table 32 describes the baseline territories that were assumed for each climate zone.

Table 32: SoCalGas Baseline Territory by Climate Zone

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

The SoCalGas monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in Table 33. These rates are based on applying a normalization curve to the November 2023 tariff based on ten years of historical gas data. Long-term historical natural gas rate data was only available for SoCalGas' procurement charges.[23] The baseline and excess transmission charges were found to be consistent over the course of a year and applied for the entire year based on 2023 rates. CARE rates reflect the 20 percent discount per the GR tariff.

Table 33: SoCalGas Monthly Gas Rate ($/therm)

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

Southern California Gas Company
Residential Rates
Nov-23

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

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

7.2.4 San Diego Gas & Electric

Following are the SDG&E electricity and natural gas tariffs applied in this study. Table 34 describes the baseline territories that were assumed for each climate zone. A net surplus compensation rate of $0.04542/ kWh was applied to any net annual electricity generation based on a one-year average of the rates between December 2022 and November 2023.

Table 34: SDG&E Baseline Territory by Climate Zone

Climate Zone	Baseline Territory
CZ07	Coastal
CZ10	Inland
CZ14	Mountain

The SDG&E monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in Table 35. These rates are based on applying a normalization curve to the November 2023 tariff based on ten years of historical gas data. CARE rates reflect the 20 percent discount per the G-CARE tariff.

Table 35: SDG&E Monthly Gas Rate ($/therm)

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

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

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

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San Diego, California

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

SCHEDULE TOU-DR1

Sheet 2

RESIDENTIAL TIME-OF-USE

RATES

Total Rates:

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

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

Note:

(1) Total Rates consist of UDC, Schedule DWR-BC (Department of Water Resources Bond Charge), Schedule WF-NBC (CA Wildfire Fund charge) and Schedule EECC (Electric Energy Commodity Cost) rates, with the EECC rates reflecting a DWR Credit. EECC rates are applicable to bundled customers only. See Special Condition 16 for PCIA (Power Charge Indifference Adjustment) recovery.

(2) Total Rates presented are for customers that receive commodity supply and delivery service from Utility.

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

(4) As identified in the rates tables, customer bills will also include line-item summer and winter credits for usage up to 130% of baseline to provide the rate capping benefits adopted by Assembly Bill 1X and Senate Bill 695. R, I

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

(Continued)

2C8

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

Time Periods

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

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

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

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

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

* Climatic Zones are shown on the Territory Served, Map No. 1.

** All Electric allowances are available upon application to those customers who have permanently installed space heating or who have electric water heating and receive no energy from another source.

San Diego Gas & Electric Company
San Diego, California

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

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

SCHEDULE EV-TOU-5

Sheet 1

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

APPLICABILITY

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

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

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

TERRITORY

Within the entire territory served by the utility.

RATES

Total Rates:

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

(Continued)

1C5 Issued by Submitted Jan 30, 2023

Advice Ltr. No. 4154-E Effective Mar 1, 2023

Decision No. D.22-12-056 Resolution No.

San Diego Gas & Electric Company
San Diego, California

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

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

SCHEDULE EV-TOU-5 Sheet 4

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

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

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

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

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

Time Periods:

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

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

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

Seasons:

Summer June 1 – October 31

Winter November 1 – May 31

(Continued)

4C8

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

SDGE
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San Diego, California

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

SCHEDULE E-CARE

Sheet 1

CALIFORNIA ALTERNATE RATES FOR ENERGY

APPLICABILITY

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

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

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

3) Non-profit group living facilities.

4) Agricultural employee housing facilities.

TERRITORY

Within the entire territory served by the Utility.

DISCOUNT

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

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

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

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

(Continued)

1C5
Advice Ltr. No. 3928-E
Issued by
Dan Skopec
Vice President
Submitted Dec 30, 2021
Effective Jan 1, 2022

7.2.5 City of Palo Alto Utilities

Following are the CPAU electricity and natural gas tariffs applied in this study. The CPAU monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in Table 36. These rates are based on applying a normalization curve to the October 2023 tariff based on seven years of historical gas data. The monthly service charge applied was $14.01 per month per the November 2023 G-1 tariff.

Table 36: CPAU Monthly Gas Rate ($/therm)

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

RESIDENTIAL ELECTRIC SERVICE

UTILITY RATE SCHEDULE E-1

A. APPLICABILITY:

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

B. TERRITORY:

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

C. UNBUNDLED RATES:

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

D. SPECIAL NOTES:

1. Calculation of Cost Components

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

2. Calculation of Usage Tiers

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

{End}

CITY OF PALO ALTO UTILITIES
Issued by the City Council

CITY OF PALO ALTO UTILITIES

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

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

7.2.6 Sacramento Municipal Utilities District (Electric Only)

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

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

II. Firm Service Rates

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

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

B. Optional Critical Peak Pricing Rate

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

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

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

III. Electricity Usage Surcharges

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

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

IV. Rate Option Menu

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

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

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

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

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

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

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

[1] See Section V. Conditions of Service

7.2.7 Fuel Escalation Assumptions

The average annual escalation rates in Table 37 were used in this study. These are based on assumptions from the CPUC 2021 En Banc hearings on utility costs through 2030 (California Public Utilities Commission, 2021a). Escalation rates through the remainder of the 30-year evaluation period are based on the escalation rate assumptions within the 2022 TDV factors. No data was available to estimate electricity escalation rates for CPAU and SMUD, therefore electricity escalation rates for PG&E and statewide natural gas escalation rates were applied. Table 38 presents the average annual escalation rates used in the utility rate escalation sensitivity analysis shown in Section 4.6.3. Rates were applied for the same 30-year period and are based on the escalation rate assumptions within the 2025 LSC factors from 2027 through 2053.[24] These rates were developed for electricity use statewide (not utility-specific) and assume steep increases in gas rates in the latter half of the analysis period. Data was not available for years 2024, 2025, and 2026 and so the CPUC En Banc assumptions were applied for those years using the average rate across the three IOUs for statewide electricity escalation.

Table 37: Real Utility Rate Escalation Rate Assumptions, CPUC En Banc and 2022 TDV Basis

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

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

Table 38: Real Utility Rate Escalation Rate Assumptions, 2025 LSC Basis

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

7.3 Summary of Efficiency Measures

Table 39 provides the details of the efficiency (non-preempted) measures, by climate zone, included in the following all-electric packages for the single family prototype:

- Efficiency Only
- Efficiency + High Efficiency (Preempted) Equipment
- Efficiency + PV
- Efficiency + PV + Battery

The efficiency measures for the single family mixed fuel packages are presented in Table 40, and Table 41 presents the efficiency measures for all the ADU packages. In all tables, the lack of an "X" indicates that the prescriptive values for that climate zone were not changed. See Appendix 7.4 for a list of prescriptive values by climate zone. Efficiency measures are described in Section 3.3.1.

Table 39: All-Electric Single Family Efficiency Measures, Various Packages

Climate Zone	3 ACH50	R-10 Slab	Attic Ceiling Insulation	0.25 Roof Solar Reflectance	0.24 U-Factor / 0.50 SHGC Windows	0.35 W/cfm	Buried Ducts	Basic Compact Hot Water Credit
1		X	R-60				X	
2		X	R-60			X	X	X
3			R-60			X	X	X
4		X	R-60			X	X	X
5		X[1]	R-49			X	X	X
6			R-60			X	X	X
7			R-49				X	X
8			R-60			X	X	X
9			R-60			X	X	X
10			R-60	X		X	X	X
11		X	R-60	X		X	X	X
12		X	R-60	X		X	X	X
13		X	R-60	X		X	X	X
14	X	X	R-60	X		X	X	X
15		X	R-60	X		X	X	X
16			R-60		X	X	X	

[1] This measure in Climate Zone 5 was only evaluated for the Efficiency + PV + Battery package.

Table 40: Mixed Fuel Single Family Measures, Efficiency Only & Efficiency + PV + Battery Packages

Climate Zone	3 ACH50	R-10 Slab	Attic: EE Only	Attic: EE + PV + Bat	0.25 Roof Solar Reflec-tance	0.24 U-Factor / 0.50 SHGC Windows	0.30 U-Factor / 0.50 SHGC Windows	0.35 W/cfm	Buried Ducts	CDHW[1]: EE Only	CDHW: EE + PV + Bat
1		X	R-60 vs R-38				X		X		
2		X	R-60 vs R-38	R-49				X	X	X	X
3			R-60 vs R-30	R-38			X	EE Only	X		X
4		X	R-60 vs R-38	R-49				X	X		X
5			R-60 vs R-38	R-49				X	X	X	X
6			R-49 vs R-30	R-49				X	X	X	X
7			R-49 vs R-30	R-49					X	X	X
8			R-60 vs R-30	R-49				X	X	X	X
9			R-49 vs R-30	R-49				X	X	X	X
10			R-60 vs R-38		X			X	X	X	X
11		X	R-60 vs R-38	R-49	X			X	X	X	X
12		X	R-60 vs R-38	R-49	X			X	X	X	X
13		X	R-60 vs R-38	R-49	X			X	X		X
14	X	X	R-60 vs R-38	R-49	X			X	X		X
15		X	R-60 vs R-38	R-49	X			X	X	X	X
16			R-60 vs R-38	R-49		X		X	X		

[1] CDHW stands for basic Compact Domestic Hot Water credit

Table 41: Efficiency Measures for All ADU Packages

Climate Zone	3 ACH50	R-10 Slab	Attic[1]	0.25 Roof Solar Reflectance	0.24 U-Factor / 0.50 SHGC Windows	Ductless VCHP[2]	Basic Compact Hot Water Credit[3]
1		X	R-60 vs R-38			X	
2		X	R-60 vs R-38			X	X
3			R-60 vs R-30			X	X
4		X	R-60 vs R-38			X	X
5			R-60 vs R-38			X	X
6			R-60 vs R-30			X	X
7			R-60 vs R-30			X	X
8			R-60 vs R-30			X	X
9			R-60 vs R-30			X	X
10			R-60 vs R-38	X		X	X
11		X	R-60 vs R-38	X		X	X
12		X	R-60 vs R-38	X		X	X
13		X	R-60 vs R-38	X		X	X
14	X	X	R-60 vs R-38	X		X	X
15		X	R-60 vs R-38	X		X	X
16			R-60 vs R-38		X	X	

[1] This measure was added to all ADU packages except the Mixed Fuel Efficiency + High Efficiency Equipment package.
[2] The ductless VCHP measure was only applied to the all-electric packages; the mixed fuel packages instead applied 0.35 W/cfm fans in Climate Zones 2, 4-6, and 8-15.
[3] The compact hot water measure was only applied to the all-electric packages.

7.4 Summary of Applicable Prescriptive Base Case Measures

This appendix lists the prescriptive values, by climate zone, of building components relevant to the measures included in this analysis. Table 42 outlines envelope, PV, and battery values; Table 43 outlines space conditioning values, and Table 44 outlines domestic water heating (DHW) values.

Table 42: Prescriptive Envelope, PV, and Battery Measures by Climate Zone

CZ	Air Infiltration[1]	Foundation	Wall Insulation[2]	Attic Insulation[3]	Roof Aged Solar Reflectivity	Window U-Factor / SHGC	PV[4]	Battery
1	5 ACH50	Uninsulated slab	R-21 + R-5	R-38	0.1	0.30 / 0.35	code min.	none
2	5 ACH50	Uninsulated slab	R-21 + R-5	R-38	0.1	0.30 / 0.23	code min.	none
3	5 ACH50	Uninsulated slab	R-21 + R-5	R-30	0.1	0.30 / 0.35	code min.	none
4	5 ACH50	Uninsulated slab	R-21 + R-5	R-38 + R-19	0.1	0.30 / 0.23	code min.	none
5	5 ACH50	Uninsulated slab	R-21 + R-5	R-30	0.1	0.30 / 0.35	code min.	none
6	5 ACH50	Uninsulated slab	R-15 + R-4	R-30	0.1	0.30 / 0.23	code min.	none
7	5 ACH50	Uninsulated slab	R-15 + R-4	R-30	0.1	0.30 / 0.23	code min.	none
8	5 ACH50	Uninsulated slab	R-21 + R-5	R-38 + R-19	0.1	0.30 / 0.23	code min.	none
9	5 ACH50	Uninsulated slab	R-21 + R-5	R-38 + R-19	0.1	0.30 / 0.23	code min.	none
10	5 ACH50	Uninsulated slab	R-21 + R-5	R-38 + R-19	0.2	0.30 / 0.23	code min.	none
11	5 ACH50	Uninsulated slab	R-21 + R-5	R-38 + R-19	0.2	0.30 / 0.23	code min.	none
12	5 ACH50	Uninsulated slab	R-21 + R-5	R-38 + R-19	0.2	0.30 / 0.23	code min.	none
13	5 ACH50	Uninsulated slab	R-21 + R-5	R-38 + R-19	0.2	0.30 / 0.23	code min.	none
14	5 ACH50	Uninsulated slab	R-21 + R-5	R-38 + R-19	0.2	0.30 / 0.23	code min.	none
15	5 ACH50	Uninsulated slab	R-21 + R-5	R-38 + R-19	0.2	0.30 / 0.23	code min.	none
16	5 ACH50	R-7, 16" slab insulation	R-21 + R-5	R-38 + R-19	0.1	0.30 / 0.35	code min.	none

[1] 5 ACH50 is prescriptively required however verification is not required.
[2] Cavity wall insulation + continuous rigid insulation.
[3] Ceiling/attic insulation R-value. R-38 + R-19 reflect High Performance Attics (HPAs) as defined by Option B in Table 150.1-A.
[4] Prescriptive PV capacities (kW-DC) by climate zone are summarized in Table 4.

Table 43: Prescriptive HVAC Measures by Climate Zone

CZ	Heating Type	AC Type	Heating Efficiency[1]	HVAC Efficiency (SEER2/EER2)	HVAC Fan Efficacy (W/cfm)	Ducts[2]
1	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
2	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
3	Heat pump	Heat pump	7.5	14.3 / 11.7	0.45	R-6, 5%, in attic (not buried)
4	Heat pump	Heat pump	7.5	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
5	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-6, 5%, in attic (not buried)
6	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-6, 5%, in attic (not buried)
7	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-6, 5%, in attic (not buried)
8	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
9	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
10	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
11	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
12	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
13	Heat pump	Heat pump	7.5	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
14	Heat pump	Heat pump	7.5	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
15	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)
16	Gas Furnace	AC	80%	14.3 / 11.7	0.45	R-8, 5%, in attic (not buried)

[1] AFUE for gas furnaces, HSPF2 for heat pumps.
[2] Duct insulation R-value, duct leakage, duct location.

Table 44: Prescriptive Water Heating Measures by Climate Zone

CZ	DHW Type	Location: Single Family	Location: ADU	Basic Compact Distribution Credit
1	Heat pump	Garage	In conditioned space, ducted to/from outside	Yes
2	Heat pump	Garage	In conditioned space, ducted to/from outside	No
3	Gas tankless	Garage	In conditioned space, ducted to/from outside	No
4	Gas tankless	Garage	In conditioned space, ducted to/from outside	No
5	Heat pump	Garage	In conditioned space, ducted to/from outside	No
6	Heat pump	Garage	In conditioned space, ducted to/from outside	No
7	Heat pump	Garage	In conditioned space, ducted to/from outside	No
8	Heat pump	Garage	In conditioned space, ducted to/from outside	No
9	Heat pump	Garage	In conditioned space, ducted to/from outside	No
10	Heat pump	Garage	In conditioned space, ducted to/from outside	No
11	Heat pump	Garage	In conditioned space, ducted to/from outside	No
12	Heat pump	Garage	In conditioned space, ducted to/from outside	No
13	Gas tankless	Garage	In conditioned space, ducted to/from outside	No
14	Gas tankless	Garage	In conditioned space, ducted to/from outside	No
15	Heat pump	Garage	In conditioned space, ducted to/from outside	No
16	Heat pump	Garage	In conditioned space, ducted to/from outside	Yes

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.

Visit LocalEnergyCodes.com to access our resources and sign up for newsletters.

Contact info@localenergycodes.com for no-charge assistance from expert Reach Code advisors.

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2022 Cost-Effectiveness Study: Multifamily New Construction

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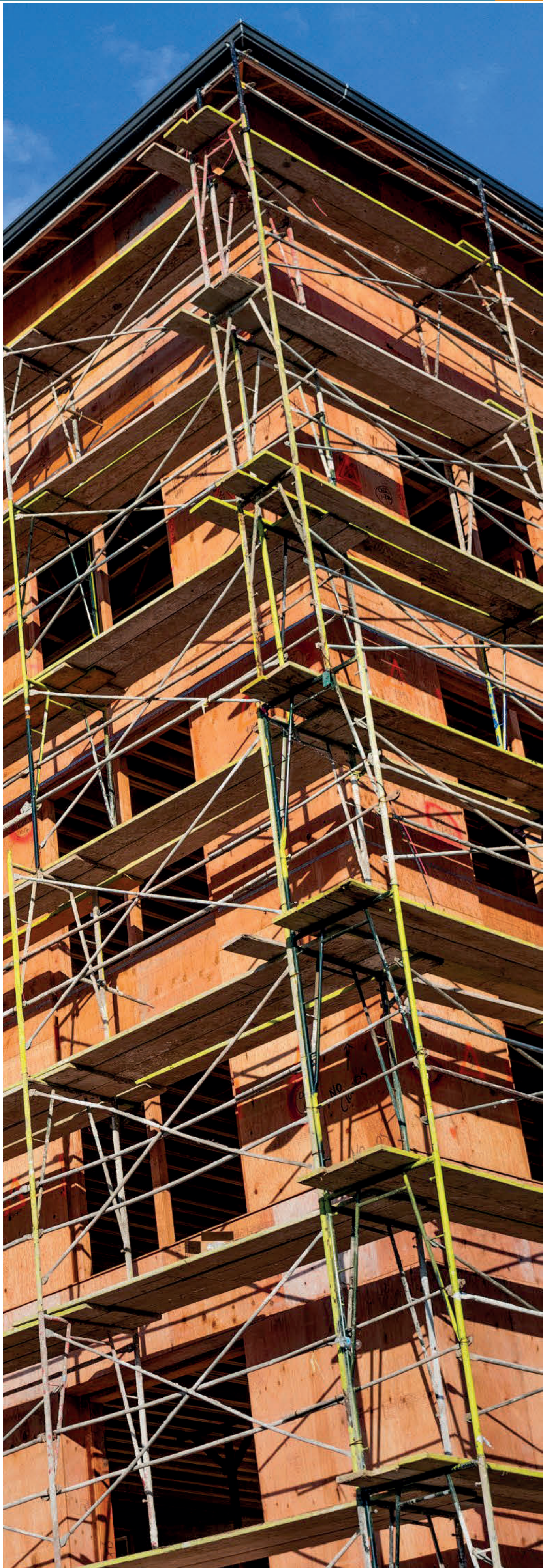

Legal Notice

Acronym List

2023 PV$ – Present value costs in 2023

ACH50 – Air Changes per Hour at 50 pascals pressure differential

ACM – Alternative Calculation Method

ADU – Accessory Dwelling Unit

AFUE – Annual Fuel Utilization Efficiency

B/C – Lifecycle Benefit-to-Cost Ratio

BEopt – Building Energy Optimization Tool

BSC – Building Standards Commission

CA IOUs – California Investor-Owned Utilities

CASE – Codes and Standards Enhancement

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

CFI – California Flexible Installation

CFM – Cubic Feet per Minute

CO_2 – Carbon Dioxide

CPAU – City of Palo Alto Utilities

CPUC – California Public Utilities Commission

CZ – California Climate Zone

DHW – Domestic Hot Water

DOE – Department of Energy

DWHR – Drain Water Heat Recovery

EDR – Energy Design Rating

EER – Energy Efficiency Ratio

EF – Energy Factor

GHG – Greenhouse Gas

HERS Rater – Home Energy Rating System Rater

HPA – High Performance Attic

HPWH – Heat Pump Water Heater

HSPF – Heating Seasonal Performance Factor

HVAC – Heating, Ventilation, and Air Conditioning

IECC – International Energy Conservation Code

IOU – Investor Owned Utility

kBtu – kilo-British thermal unit

kWh – Kilowatt Hour

LBNL – *Lawrence Berkeley National Laboratory*

LCC – Lifecycle Cost

LLAHU – Low Leakage Air Handler Unit

VLLDCS – Verified Low Leakage Ducts in Conditioned Space

MF – Multifamily

NEEA – Northwest Energy Efficiency Alliance

NEM – Net Energy Metering

NPV – Net Present Value

NREL – *National Renewable Energy Laboratory*

PG&E – Pacific Gas and Electric Company

POU – Publicly-Owned-Utilities

PV – Photovoltaic

SCE – Southern California Edison

SDG&E – San Diego Gas and Electric

SEER – Seasonal Energy Efficiency Ratio

SF – Single Family

SMUD – Sacramento Municipal Utility District

SoCalGas – Southern California Gas Company

TDV – Time Dependent Valuation

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

Title 24 – Title 24, Part 6

TOU – Time-Of-Use

UEF – Uniform Energy Factor

ZNE – Zero-net Energy

Summary Of Revisions

Date	Description	Reference (page or section)
2/28/2022	Original Release	N/A
6/20/2023	Minor revisions to content; no change to results	2, 3, 32, 33

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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 (GHG) reduction goals. The program facilitates adoption and implementation of the code when requested by local jurisdictions by providing resources such as cost-effectiveness studies, model language, sample findings, and other supporting documentation.

This report documents cost-effective combinations of measures that exceed the minimum state requirements, the 2022 Building Energy Efficiency Standards (Title 24, Part 6 or Energy Code), effective January 1, 2023, for newly constructed multifamily buildings. The analysis considers low-rise and mid-rise multifamily building types and evaluates mixed fuel and all-electric package options in all sixteen California climate zones (CZs) Packages include a code compliant electrification package and a mixed fuel efficiency package, as well as the addition of above-code on-site solar photovoltaic (PV) capacity and battery energy storage. The 2022 Energy Code established electric heat pumps as the prescriptive baseline for space heating in most climate zones. As a result, this analysis primarily focuses on the electrification of central water heating. Space heating electrification was also evaluated where the prescriptive heat pump baseline didn't apply: In Climate Zone 16 for multifamily buildings three habitable stories or fewer, and Climate Zones 1 and 16 for multifamily buildings greater than three habitable stories.

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

Two multifamily prototypes were evaluated in this study. A 3-story loaded corridor and a 5-story mixed use prototype, which combined are estimated to represent 91 percent of new multifamily construction in California.

The following summarizes key results from the study:

- The Reach Codes Team found all-electric new construction to be feasible and cost-effective based on the California Energy Commission's Time Dependent Valuation (TDV) metric in all cases. In many cases all-electric prescriptive code construction results in an increase in utility costs and is not cost-effective On-Bill. Some exceptions include the SMUD and CPAU territories where lower electricity rates relative to gas rates result in lower overall utility bills.
- All-electric packages have lower GHG emissions than mixed fuel packages in all cases, due to the clean power sources currently available from California's power providers.
- The 2022 Energy Code's new source energy metric combined with the heat pump space heating baseline in most climate zones encourages all-electric construction. While the code does not include an electric baseline for water heating, the penalty for central electric water heating observed in the performance approach in past code cycles has been removed and a credit is provided for well-designed central heat pump water heaters in most cases.
- Electrification combined with increased PV capacity results in utility cost savings and was found to be On-Bill cost-effective in all cases.
- The results in this study are based on today's net energy metering (NEM 2.0) rules and do not account for recently approved changes to the NEM tariff (referred to as the net billing tariff). The net billing tariff decreases the value of PV to the consumer as compared to NEM 2.0. As a result, the cost-effectiveness of the packages that include above-code PV capacity is expected to be less under the net billing tariff. Conversely, the net

billing tariff is expected to increase On-Bill cost-effectiveness of the all-electric prescriptive code scenario. An all-electric home has better on-site utilization of generated electricity from PV than a mixed fuel home with a similar sized PV system, and as a result exports less electricity to the grid. Since the net-billing tariff values exports less than under NEM 2.0, the relative impact on annual utility costs to the mixed fuel baseline is greater.

- This analysis does justify a modest reach based on either efficiency TDV or source energy for all-electric buildings. However, this may be challenging for some projects given the recent changes to which the industry must adapt, including the efficiency updates and multifamily restructuring in the 2022 Title 24, Part 6 code. While project compliance margins using a CO_2 refrigerant heat pump water heating system are high, the Reach Code Team found lower compliance margins using other heat pump water heater system designs. Focusing on supporting projects to electrify water heating is expected to support the market shift towards more central heat pump water heaters.
- For jurisdictions interested in a reach code that allows for mixed fuel buildings, a mixed fuel efficiency and PV package (and battery for the 3-story prototype) was found to be cost-effective based on TDV in all cases and cost-effective On-Bill in most climate zones. This path, referred to as "Electric-Preferred", allows for mixed fuel buildings but requires a higher building performance than for all-electric buildings. The efficiency measures evaluated in this study did not provide significant compliance benefit. As a result, the Reach Codes Team recommends establishing a compliance margin target based on source energy or total TDV. This would allow for PV and battery above minimum code requirements to be used to meet the target.
- Jurisdictions interested in increasing affordable multifamily housing should know that applying the CARE rates has the overall impact of increasing utility cost savings for an all-electric building in most climate zones compared to a code compliant mixed fuel building, improving On-Bill cost-effectiveness.

Table ES-1 summarizes results for each prototype and depicts the efficiency TDV compliance margins achieved for each climate zone and package. All results presented in the table have a positive compliance margin (greater than zero percent). Cells highlighted in **green** depict cases with a positive compliance margin and cost-effective results using both On-Bill and TDV approaches. Cells highlighted in **yellow** depict cases with a positive compliance margin and cost-effective results using either the On-Bill or TDV approach. Cells **not highlighted** depict cases with a positive compliance margin but that were not cost-effective using either the On-Bill or TDV approach.

Table ES-1. Summary of Efficiency TDV Compliance Margins and Cost-Effectiveness

Climate Zone	Electric /Gas Utility	3-Story				5-Story			
		All-Electric Prescriptive Code	All-Electric + PV	Mixed Fuel Efficiency	Mixed Fuel Efficiency + PV + Battery	All-Electric Prescriptive Code	All-Electric + PV	Mixed Fuel Efficiency	Mixed Fuel Efficiency + PV
CZ01	PGE	26%	26%	1%	1%	14%	14%	0%	0%
CZ02	PGE	20%	20%	1%	1%	9%	9%	1%	1%
CZ03	PGE	21%	21%	1%	1%	11%	11%	0%	0%
CZ04	PGE	18%	18%	1%	1%	9%	9%	1%	1%
CZ04	CPAU	18%	18%	1%	1%	9%	9%	1%	1%
CZ05	PGE	23%	23%	1%	1%	12%	12%	0%	0%
CZ05	PGE/SCG	23%	23%	1%	1%	12%	12%	0%	0%
CZ06	SCE/SCG	18%	18%	1%	1%	9%	9%	0%	0%
CZ07	SDGE	20%	20%	0%	0%	11%	11%	0%	0%
CZ08	SCE/SCG	13%	13%	1%	1%	8%	8%	1%	1%
CZ09	SCE	13%	13%	1%	1%	7%	7%	1%	1%
CZ10	SCE/SCG	14%	14%	3%	3%	7%	7%	2%	2%
CZ10	SDGE	14%	14%	3%	3%	7%	7%	2%	2%
CZ11	PGE	14%	14%	3%	3%	8%	8%	2%	2%
CZ12	PGE	17%	17%	2%	2%	9%	9%	2%	2%
CZ12	SMUD/PGE	17%	17%	2%	2%	9%	9%	2%	2%
CZ13	PGE	13%	13%	4%	4%	7%	7%	2%	2%
CZ14	SCE/SCG	13%	13%	3%	3%	6%	6%	2%	2%
CZ14	SDGE	13%	13%	3%	3%	6%	6%	2%	2%
CZ15	SCE/SCG	5%	5%	5%	5%	3%	3%	3%	3%
CZ16	PG&E	24%	24%	5%	5%	9%	9%	2%	2%

Local jurisdictions may also adopt ordinances that amend different Parts of the California Building Standards Code or may elect to amend other state or municipal codes. The decision regarding which code to amend will determine the specific requirements that must be followed for an ordinance to be legally enforceable. Reach codes that amend Part 6 of the CA Building Code and require energy performance (including PV and storage) beyond state code minimums must demonstrate that the proposed changes are cost-effective and obtain approval from the Energy Commission prior to filing with the BSC.

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 state requirements, the 2022 Building Energy Efficiency Standards, effective January 1, 2023, for newly constructed multifamily buildings. This report was developed in coordination with the California Statewide Investor-Owned Utilities (CA IOUs) Codes and Standards Program, key consultants, and engaged cities—collectively known as the Reach Codes Team. The CA IOU Codes and Standards Program is comprised of IOUs representatives from Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E) and two Publicly-Owned-Utilities (POUs) – Sacramento Municipal Utility District (SMUD) and City of Palo Alto Utilities (CPAU),

The analysis considers low-rise and mid-rise multifamily building types and evaluates mixed fuel and all-electric package options in all sixteen California climate zones (CZs)[1] Packages include combinations of efficiency measures, on-site renewable energy, and battery energy storage.

The California Building Energy Efficiency Standards Title 24, Part 6 (Energy Code) (California Energy Commission, 2022a) is maintained and updated every three years by two state agencies: the California Energy Commission (Energy Commission) and the Building Standards Commission (BSC). In addition to enforcing the code, local jurisdictions have the authority to adopt local energy efficiency ordinances—or reach codes—that exceed the minimum standards defined by Title 24 (as established by Public Resources Code Section 25402.1(h)2 and Section 10-106 of the Building Energy Efficiency Standards (California Energy Commission, 2022a)). Local jurisdictions must demonstrate that the requirements of the proposed ordinance are cost-effective and do not result in buildings consuming more energy than is permitted by Title 24. In addition, the jurisdiction must obtain approval from the Energy Commission and file the ordinance with the BSC for the ordinance to be legally enforceable.

The Department of Energy (DOE) sets minimum efficiency standards for equipment and appliances that are federally regulated under the National Appliance Energy Conservation Act, including heating, cooling, and water heating equipment (E-CFR, 2020). Since state and local governments are prohibited from adopting higher minimum efficiencies than the federal standards require, the focus of this study is to identify and evaluate cost-effective packages that do not include high efficiency heating, cooling, and water heating equipment. High efficiency appliances are often the easiest and most affordable 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 the performance requirements.

[1] See Appendix 7.1 Map of California Climate Zones for a graphical depiction of climate zone locations.

2 Methodology and Assumptions

2.1 Analysis for Reach Codes

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

2.1.1 Modeling

The Reach Codes Team performed energy simulations using software approved for 2022 Title 24 Code compliance analysis, CBECC 2022.2.0.

Using the 2022 baseline as the starting point, prospective energy efficiency measures were identified and modeled to determine the projected site energy (therm and kWh) and compliance impacts. Annual utility costs were calculated using hourly data output from CBECC, and electricity and natural gas tariffs for each of the investor-owned utilities (IOUs).

This analysis focused on residential apartments only (a prior study and report analyzed the cost-effectiveness of above code packages for nonresidential buildings (Statewide Reach Codes Team, 2022b). The Statewide Reach Codes Team selected measures for evaluation based on the single family 2022 reach code analysis (Statewide Reach Codes Team, 2022a) and the multifamily 2019 reach code analysis [(Statewide Reach Codes Team, 2020), (Statewide Reach Codes Team, 2021)] as well as experience with and outreach to architects, builders, and engineers.

2.1.2 Cost-Effectiveness

2.1.2.1 Benefits

This analysis used two different metrics to assess the cost-effectiveness of the proposed upgrades. Both methodologies require estimating and quantifying the incremental costs and energy savings associated with each energy efficiency measure. The main difference between the methodologies is the manner in which they value energy and thus the cost savings of reduced or avoided energy use:

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

Time Dependent Valuation (TDV): This reflects the Energy Commission's current LCC methodology, which is intended to capture the total value or cost of energy use over 30 years. This method accounts for long-term projected costs, such as the cost of providing energy during peak periods of demand, costs for carbon emissions, and grid transmission and distribution impacts. This metric values energy use differently depending on the fuel source (natural gas, electricity, and propane), time of day, and season. Electricity used (or saved) during peak periods has a much higher value than electricity used (or saved) during off-peak periods due to the less inefficient energy generation sources providing peak electricity (Horii, Cutter, Kapur, Arent, & Conotyannis, 2014). This is the methodology used by the Energy Commission in evaluating cost-effectiveness for efficiency measures in the 2022 Energy Code.

2.1.2.2 Costs

The Reach Codes Team assessed the incremental costs of the measures and packages over a 30-year lifecycle. Incremental costs represent the equipment, installation, replacements, and maintenance costs of the proposed measure relative to the 2022 Energy Code minimum requirements or standard industry practices. Present value of replacement cost is included for measures with lifetimes less than the evaluation period.

2.1.2.3 Metrics

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

NPV: The lifetime NPV is reported as a cost-effectiveness metric, Equation 1 demonstrates how this is calculated. If the NPV of a measure or package is positive, it is considered cost-effective. A negative values represent net costs.

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

Equation 1

$$NPV = PV\ of\ lifetime\ benefit - PV\ of\ lifetime\ cost$$

Equation 2

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

Improving the efficiency of a project often requires an initial incremental investment. In most cases the benefit is represented by annual On-Bill utility or TDV savings, and the cost is represented by incremental first cost and replacement costs. 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".

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

Equation 3

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

Where:

- *n* = analysis term in years
- *r* = discount rate

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

- Analysis term of 30 years
- Real discount rate of three percent

TDV is a normalized monetary format and there is a unique procedure for calculating the present value benefit of TDV energy savings. The present value of the energy cost savings in dollars is calculated by multiplying the TDV savings (reported by the CBECC simulation software) by a NPV factor developed by the Energy Commission (see E3's 2022 TDV report for details (Energy + Environmental Economics, 2020)). The 30-year residential NPV factor is $0.173/kTDV for the 2022 Energy Code.

Equation 4

$$TDV\ PV\ of\ lifetime\ benefit = TDV\ energy\ savings\ *\ NPV\ factor$$

2.1.3 Utility Rates

In coordination with the CA IOU rate team (comprised of representatives from PG&E, SCE, SDG&E, SMUD, and CPAU), the Reach Codes Team determined appropriate utility rates for each climate zone in order to calculate utility costs and determine On-Bill cost-effectiveness for the proposed measures and packages. The utility tariffs, summarized in Table 1, were determined based on the most prevalent active rate in each territory. Utility rates were applied to each climate zone based on the predominant IOU serving the population of each zone, with a few climate zones evaluated multiple times under different utility scenarios. Climate Zones 10 and 14 were evaluated with both SCE for electricity and Southern California Gas Company (SoCalGas) for gas and SDG&E tariffs for both electricity and gas since each utility has customers within these climate zones. Climate Zone 5 is evaluated under both PG&E and SoCalGas natural gas rates. Two POU or municipal utility rates were also evaluated: SMUD in Climate Zone 12 and CPAU in Climate Zone 4.

For the IOUs in-unit gas was evaluated under the G1 rate and central gas for water heating was evaluated under the relevant master metered gas tariff, GM. Electricity use for central water heating was evaluated using the residential TOU rates. The water heating utility bill was calculated separately from the in-unit electricity bill. Photovoltaic (PV) and battery energy storage benefits were applied according to virtual net energy metering (VNEM) rules.[2] PV was first assigned to the central water heating meter to offset 100 percent of the electricity use. The remaining PV and all of the battery impacts were then split evenly across the apartment meters. The same approach was applied for CPAU and SMUD using the rates described in Table 1.

The multifamily prototypes used in this analysis include common area spaces that serve the residents (lobby, leasing office, corridors, etc.). Most of the energy use for these spaces could not be separated from that for the dwelling units within the CBECC model. As a result, average per dwelling unit hourly energy use was calculated to include both the dwelling unit and common space energy use.

First-year utility costs were calculated using hourly electricity and natural gas output from CBECC and applying the utility tariffs summarized in Table 1. Annual costs were also estimated for customers eligible for the CARE tariff discounts on both electricity and natural gas bills. The CARE tariff was only applied to the in-unit apartment meters. Appendix 7.2 Utility Rate Schedules includes details of each utility tariff.

For cases with PV generation, the approved NEM 2.0 tariffs were applied along with minimum daily use billing and mandatory non-bypassable charges. In December the California Public Utilities Commission (CPUC) issued a decision adopting a net billing tariff (NBT) as a successor to NEM 2.0 that will go into effect April of 2023[3] Given the recent timing of this decision there was not time to incorporate these changes into this analysis. The Reach Codes Team conducted a limited sensitivity analysis on the impacts of NBT relative to NEM 2.0 on utility bills. It was found that utility costs will increase for all homes with PV systems; however, the increase was less for an all-electric building compared to a mixed fuel building with a similarly sized PV system. As a result of better onsite utilization of PV generation and thus fewer exports to the grid, the Reach Codes Team expects the cost-effectiveness for the electrification scenarios for the all-electric home evaluated in this report to improve under NBT. Conversely, cost-effectiveness of increasing PV capacity is expected to be reduced under NBT.

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[2] PG&E: https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_SCHEDS_NEM2V.pdf
SDG&E: https://tariff.sdge.com/tm2/pdf/tariffs/ELEC_ELEC-SCHEDS_NEM-V-ST.pdf
SCE:
https://edisonintl.sharepoint.com/teams/Public/TM2/Shared%20Documents/Forms/AllItems.aspx?ga=1&id=%2Fteams%2FPublic%2FTM2%2FShared%20Documents%2FPublic%2FRegulatory%2FTariff%2DSCE%20Tariff%20Books%2FElectric%2FSchedules%2FOther%20Rates%2FELECTRIC%5FSCHEDULES%5FNEM%2DV%2DST%2Epdf&parent=%2Fteams%2FPublic%2FTM2%2FShared%20Documents%2FPublic%2FRegulatory%2FTariff%2DSCE%20Tariff%20Books%2FElectric%2FSchedules%2FOther%20Rates

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

Table 1. Utility Tariffs Used Based on Climate Zone

IOUs

Climate Zones	Electric / Gas Utility	Electricity	Natural Gas
1-5,11-13,16	PG&E / PG&E	E-TOU Option C	G1 (in-unit) & GM (central water heating)[1]
5	PG&E / SoCalGas	E-TOU Option C	GM
6, 8-10, 14, 15	SCE / SoCalGas	TOU-D Option 4-9	GM
7, 10, 14	SDG&E / SDG&E	TOU-DR-1	GM

POUs

Climate Zones	Electric / Gas Utility	Electricity	Natural Gas
4	CPAU / CPAU	E-1 (in-unit) & E-2 (central water heating)	G-2
12	SMUD / PG&E	R-TOD, RT02 (in-unit) & RSMM (central water heating)	GM

[1]G1 rate applied to gas use within the apartment units, which only occurs in Climate Zones 1 and 16, see Section 3 for details. GM rate applied to gas use for central water heating.

Utility rates are assumed to escalate over time according to the assumptions from the CPUC 2021 En Banc hearings on utility costs through 2030 (California Public Utilities Commission, 2021a). Escalation rates through the remainder of the 30-year evaluation period are based on the escalation rate assumptions within the 2022 TDV factors. See Appendix 7.2.7 Fuel Escalation Assumptions for details.

2.2 2022 T24 Compliance Metrics

2022 Title 24, Part 6 Section 170.1 defines the energy budget of the building based on source energy and TDV energy for space-conditioning, indoor lighting, mechanical ventilation, PV and battery storage systems, service water heating and covered process loads. In 2022, the Energy Commission introduced the new compliance metric of source energy, which differs by fuel source (as does TDV) and is a reasonable proxy for greenhouse gas emissions. Additionally, for multifamily buildings four habitable stories and higher prescriptive requirements for PV and battery systems were also introduced. This led to the need to differentiate an efficiency compliance metric, which ensured that the building met minimum efficiency standards, and a total energy compliance metric which incorporated the PV and battery standards. In order to be compliant with the building code a building needs to comply with all three compliance metrics described below:

- **Efficiency TDV**. Efficiency TDV accounts for all regulated end-uses but does not include the impacts of PV and battery storage.
- **Total TDV**. Total TDV includes regulated end-uses and accounts for PV and battery storage contributions.
- **Source Energy**. Source energy is based on fuel used for power generation and distribution.

2.3 Greenhouse Gas Emissions

The analysis reports the greenhouse gas (GHG) emission estimates based on assumptions within CBECC. There are 8,760 hourly multipliers accounting for time dependent energy use and carbon based on source emissions, including renewable portfolio standard projections. There are two series of multipliers—one for Northern California climate zones, and another for Southern California climate zones.[4] GHG emissions are reported as average annual metric tons of CO_2 equivalent over the 30-year building lifetime.

[4] CBECC multipliers are the same for CZs 1-5 and 11-13 (Northern California), while there is another set of multipliers for CZs 6-10 and 14-16 (Southern California).

3 Prototypes, Measure Packages, and Costs

This section describes the prototypes, measures, costs, and the scope of analysis drawing from previous reach code research where appropriate.

3.1 Prototype Characteristics

The Energy Commission defines building prototypes which it uses to evaluate the cost-effectiveness of proposed changes to Title 24 requirements. There are 4 multifamily prototypes used in code development: a 2-story garden style, a 3-story loaded corridor, a 5-story mixed use and a 10-story mixed use. Based on work completed for the 2022 Title 24 code development, the 3-story and the 5-story represent 33 percent and 58 percent, respectively, of new multifamily construction in California. As a result, these two prototypes are used in this analysis. Additional details on all four prototypes can be found in the Multifamily Prototypes Report (TRC, 2019).

Table 2 describes the basic characteristics of each prototype.

Table 2. Prototype Characteristics

Characteristic	3-Story Loaded Corridor	5-Story Mixed Use
Conditioned Floor Area	39,372 ft^2	113,100 ft^2 total: 33,660 ft^2 nonresidential 79,440 ft^2 residential
Num. of Stories	3	6 Stories total: 1 story parking garage (below grade) 1 story of nonresidential space 4 stories of residential space
Num. of Bedrooms	(6) Studio (12) 1-bed (12) 2-bed (6) 3-bed	(8) studios (40) 1-bed units (32) 2-bed units (8) 3-bed units
Window-to-Wall Area Ratio	25%	25%
Wall Type	Wood framed	Wood frame over a first-floor concrete podium
Roof Type	Flat roof	Flat roof
Foundation	Slab-on-grade	Concrete podium with underground parking

The methodology used in the analyses for each of the prototypical building types begins with a design that precisely meets the minimum 2022 prescriptive requirements.[5] Table 170.2-A and 170.2-B in the 2022 Standards (California Energy Commission, 2022a) list the prescriptive measures that determine the baseline design in each climate zone. Other features are designed to meet, but not exceed, the minimum requirements and are consistent with the Standard Design in the ACM Reference Manual (California Energy Commission, 2022c). The analysis also assumed electric resistance cooking in the apartment units to reflect current market data. The 3-story building prototype includes a central laundry facility, and the 5-story assumes laundry in the units. Laundry equipment was assumed to be electric in all cases; electrification of laundry equipment was not addressed in this study. The nonresidential 2022 reach code analysis (Statewide Reach Codes Team, 2022b) did consider electrification of central laundry facilities within the small hotel prototype.

Table 3 describes characteristics as they were applied to the base case energy model in this analysis. In a shift from the 2019 Standards, the 2022 Standards define a prescriptive fuel source for space heating establishing an electric

[5]Due to planned software updates to how the prescriptive requirements are applied in the Standard Design and challenges for certain space types with sizing heating and cooling equipment the same in the Proposed Design as in the Standards, the results compliance margins for the base case models were not exactly zero percent..

heat pump baseline in all climate zones except 16 for multifamily buildings three habitable stories and fewer and 1 and 16 for multifamily buildings four habitable stories and greater.

Table 3. Base Case Characteristics of the Prototypes

Characteristic	3-Story Loaded Corridor	5-story Mixed Use
Space Heating/Cooling[1]	Individual split systems with ducts in conditioned space CZ 1-15: Heat pump CZ 16: Natural gas furnace with air conditioner	Individual split systems with ducts in conditioned space CZ2-15: Heat pump CZ1, 16: Dual-fuel heat pump with natural gas backup
Ventilation	Individual balanced fans, continuously operating	Individual balanced fans, continuously operating
Water Heater[1]	Natural gas central boiler with solar thermal sized to meet the prescriptive requirements by climate zone.	Natural gas central boiler with solar thermal sized to meet the prescriptive requirements by climate zone.
Hot Water Distribution	Central recirculation	Central recirculation
Cooking	Electric	Electric
Clothes Drying	Electric (central)	Electric (in-unit)
PV System	Sized according to the prescriptive requirements in Equation 170.2-C of the 2022 Title 24 Standards. Size differs by climate zone ranging from 1.60 kW to 2.90 kW per dwelling unit, see Table 4.	Sized according to the prescriptive requirements in Equation 170.2-D of the 2022 Title 24 Standards. Size differs by climate zone ranging from 2.26 kW to 3.34 kW per dwelling unit, see Table 4.
Battery System	None	None

[1] Equipment efficiencies are equal to minimum federal appliance efficiency standards.

Table 4 summarizes the PV capacities for the base case packages.

Table 4. Base Package PV Capacities (kW-DC)

Climate Zone	Base Package	
	3-Story	5-Story
CZ01	2.00	2.26
CZ02	1.79	2.68
CZ03	1.70	2.26
CZ04	1.75	2.68
CZ05	1.60	2.26
CZ06	1.77	2.68
CZ07	1.67	2.68
CZ08	1.91	2.68
CZ09	1.92	2.68
CZ10	1.98	2.68
CZ11	2.21	2.68
CZ12	1.96	2.68
CZ13	2.33	2.68
CZ14	1.94	2.68
CZ15	2.90	3.34
CZ16	1.76	2.26

3.2 Measure Definitions and Costs

Measures evaluated in this study fall into two categories: those associated with general efficiency, onsite generation, and demand flexibility and those associated with building electrification. The Reach Codes Team selected measures based on cost-effectiveness as well as decades of experience with residential architects, builders, and engineers along with general knowledge of the relative consumer acceptance of many measures. This analysis focused on measures that impacted the residential dwelling units only.

The following sections describe the details and incremental cost assumptions for each of the measures. Incremental costs represent the equipment, installation, replacement, and maintenance costs of the proposed measures relative to the base case. Replacement costs are applied for roofs, mechanical equipment, PV inverters and battery systems over the 30-year evaluation period. Incremental maintenance costs are estimated for PV systems, but not any other measures. Costs were estimated to reflect costs to the building owner. All costs are provided as present value in 2023 (2023 PV$).

The Reach Codes Team obtained measure costs from distributors, contractors, literature review, and online sources such as Home Depot and RS Means. Contractor markups are incorporated. These are the Reach Codes Team best estimate of average costs statewide. Regional variation in costs is not accounted for, although it's recognized that local costs may differ. Cost increases due to recent high inflation rates and supply chain delays are not included.

3.2.1 Efficiency, Solar PV, and Batteries

The following are descriptions of each of the efficiency, PV, and battery measures evaluated under this analysis and applied in at least one of the packages presented in this report. Table 5 summarizes the incremental cost assumptions for each of these measures. These measures were evaluated for all climate zones but were ultimately adopted in a subset of climate zones based on cost-effectiveness outcomes.

Lower U-Factor Fenestration: Reduce window U-factor to 0.24. The prescriptive U-factor is 0.30 in all climate zones except Climate Zones 7 and 8 where it is 0.34. This measure is included in Climate Zone 16 only.

Cool Roof: Install a roofing product that's rated by the Cool Roof Rating Council to have an aged solar reflectance (ASR) equal to or greater than 0.70. Low-sloped roofs were assumed in all cases. The 2022 Title 24 specifies a prescriptive ASR of 0.63 for Climate Zones 9 through 11 and 13 through 15. This measure is included in Climate Zones 9 through 15.

Low Pressure Drop Ducts: Upgrade the duct distribution system to reduce external static pressure and meet a maximum fan efficacy of 0.35 Watts per cfm. This may involve upsizing ductwork, reducing the total effective length of ducts, and/or selecting low pressure drop components such as filters. Fan watt draw must be verified by a HERS rater according to the procedures outlined in the 2022 Reference Appendices RA3.3 (California Energy Commission, 2022b). This measure is included in Climate Zones 1 and 10 through 16.

Verified Low Leakage Ducts in Conditioned Space: Seal the ducts to achieve a measured leakage no greater than 25 cfm leakage to outside. This may be verified using a guarded blower door test to isolate leakage to outside. Alternatively, this can also be satisfied by demonstrating that total leakage is not greater than 25 cfm. Ducts are assumed to already be located in conditioned space in the baseline. This measure is included in all climate zones.

Solar PV: Installation of on-site PV is required in the 2022 residential code unless an exception is met. The PV sizing methodology in each package was developed to offset annual building electricity use and avoid oversizing which would violate net energy metering (NEM) rules.[6] In all cases, PV is evaluated in CBECC according to the California Flexible Installation (CFI) assumptions. This measure is included in all climate zones.

Battery Energy Storage: A battery system was evaluated in CBECC-Res with control type set to "Time-of-Use" and with default efficiencies of 95% for both charging and discharging. This control option assumes the battery system will

[6] NEM rules apply to the IOU territories only.

charge or discharge based on a utility tariff time-of use signal. To qualify, the battery system must meet the requirements outlined in the 2022 Reference Appendices JA12.2.3.2 (California Energy Commission, 2022b). This measure is included in all climate zones but only for the 3-story prototype. A 100kWh battery was applied following the battery sizing requirements for multifamily buildings more than three habitable stories per Equation 170.2-E of the 2022 Energy Code.

Table 5. Incremental Cost Assumptions

Measure	Performance Level	Incremental Cost per Dwelling Unit (2023 PV$) 3-Story	5-Story	Source & Notes
Non-Preempted Measures				
Window U-factor	0.24 vs 0.30	$536	$489	$4.23/ft² of window area based on analysis conducted for the 2019 and 2022 Title 24 cycles (Statewide CASE Team, 2018).
Low-Sloped Cool Roof Aged Solar Reflectance	0.63 vs 0.10	$314	$222	$0.525/ft² of roof area first incremental cost based on the 2022 Residential Additions and Alterations CASE Report (Statewide CASE Team, 2020b).Total costs assume present value of replacement at year 15.
	0.70 vs 0.63	$24	$17	$0.04/ft² of roof area first incremental cost based on the 2022 Nonresidential High Performance Envelope CASE Report (Statewide CASE Team, 2020a). Costs assume a blended average across roofing product types. Total costs assume present value of replacement at year 15.
Low Pressure Drop Ducts	0.35 vs 0.45 W/cfm	$44	$44	Costs assume half-hour labor per multifamily dwelling unit. Labor rate of $88 per hour is from 2022 RS Means for sheet metal workers and includes a weighted average City Cost Index for labor for California.
Verified Low Leakage Ducts in Conditioned Space	≤25 cfm leakage to outside	$132	$132	Costs assume half-hour labor per multifamily dwelling unit and a $100 HERS Rater fee. Labor rate of $88 per hour is from 2022 RS Means for sheet metal workers and includes a weighted average City Cost Index for labor for California. Ducts are already assumed to be located in conditioned space and the incremental costs reflect additional sealing and testing only.
PV + Battery				
PV System	First Cost	$1.47/W	$1.47/W	First costs from LBNL's Tracking the Sun 2022 costs (Barbose, Darghouth, O'Shaughnessy, & Forrester, 2022) and represent median costs in California in 2021 of $2.10/WDC for nonresidential greater than 100kWDC systems. The first cost was reduced by the solar energy Investment Tax Credit (ITC) of 30%.[1] Costs are presented as the average of 2023, 2024, and 2025.
	Inverter replacement	$0.14/W	$0.14/W	Inverter replacement cost of $0.14/WDC present value includes replacements at year 11 at $0.15/WDC (nominal) and at year 21 at $0.12/WDC (nominal) per the 2019 PV CASE Report (California Energy Commission, 2017).
	Maintenance	$0.31/W	$0.31/W	System maintenance costs of $0.31/WDC present value assume $0.02/WDC (nominal) annually per the 2019 PV CASE Report (California Energy Commission, 2017).

Measure	Performance Level	Incremental Cost per Dwelling Unit (2023 PV$) 3-Story	5-Story	Source & Notes
Battery	First cost	$700/kWh	n/a	First cost of $1,000/kWh from LBNL's Tracking the Sun 2022 costs (Barbose, Darghouth, O'Shaughnessy, & Forrester, 2022) for residential systems > 30kWh. The report derived costs from California's Self-Generation Incentive Program (SGIP) residential participant cost data. First cost is reduced by the solar energy ITC of 30%.[1] No SGIP incentives are included. Costs are assumed to remain consistent at $1,000/kWh through 2025 and then reduced by 7% annually based on SDG&E's Behind-the-Meter Battery Market Study (E-Source companies, 2020) over a 10 year period. Replacement is assumed at years 10 and 20. At year 10 the replacement cost is based on the average of expected 2033, 2034, and 2035 costs after applying the ITC for a future value cost of $435. Replacement cost at year 20 is based on a future value cost of $484 and does not include any ITC reduction.
	Replacement cost	$564/kWh	n/a	

[1]As part of the Inflation Reduction Act in August 2022 the Section 25D Investment Tax Credit was extended and raised to 30% through 2032 with a step-down to 26% in 2033 and 22% in 2034. It's assumed that the ITC is not renewed and is 0% starting in 2035. https://www.irs.gov/pub/taxpros/fs-2022-40.pdf.

3.2.2 All-Electric

This analysis compared a code compliant mixed fuel prototype, which uses natural gas for water heating only in most climate zones, with a code compliant all-electric prototype. In these cases, the relative costs between natural gas and electric appliances and natural gas infrastructure and the associated infrastructure costs for not providing natural gas to the building were included.

To estimate costs the Reach Codes Team leveraged costs from the 2022 Multifamily All-Electric CASE Report (Statewide CASE Team, 2020c) and the 2019 reach code multifamily cost-effectiveness studies ((Statewide Reach Codes Team, 2020), (Statewide Reach Codes Team, 2021)), and online equipment research. Present value replacement costs are included in the total lifetime incremental costs.

3.2.2.1 Water Heating

Federal regulations establish minimum efficiency requirements for heat pump water heaters with rated storage volume less than 120 gallons. While some heat pump water heaters falling into this regulated category can be used in a central water heater design, they are not required and therefore this measure does not trigger federal preemption and heat pump equipment of any efficiency level may be used for this analysis to justify the basis of a reach code.

For the central heat pump water heating system in the 3-story prototype the system design was based on the 2022 All-Electric Multifamily CASE Report (Statewide CASE Team, 2020c) and used CO_2 refrigerant based heat pump water heaters (four Sanden GS3-45HPA-US units), 525 gallons of storage, and a 250 gallon electric resistance swing tank. The 2022 CASE work based the 5-story system design on Colmac R-134a refrigerant heat pump water heaters. While this is an acceptable design, R-134a or R-410a refrigerant heat pump water heaters were found to be less cost-effective for the prototypes evaluated in this analysis due to higher incremental costs and lower overall performance relative to CO_2 refrigerant products. As such, the Reach Codes Team evaluated a CO_2 refrigerant system for the 5-story prototype for this analysis. As part of the 2025 Energy Code update cycle, designs for both multifamily prototypes are being reexamined using CO_2 refrigerant heat pump water heaters. While full design and cost information was not yet available for this analysis, preliminary design data was used to inform sizing of a Sanden system for this prototype. The system used 10 heat pump water heaters (Sanden GS3-45HPA-US units), 800 gallons of storage, and a 200 gallon electric resistance swing tank.

Table 6 reports costs for the central heat pump water heating systems relative to a gas boiler system with solar thermal that meets the prescriptive requirements of 20% solar fraction in Climate Zones 1 through 9 and 35% solar fraction in Climate Zones 10 through 16. Costs include equipment and labor, gas piping within the building for the boiler system, and additional electrical service necessary for the heat pump system. Replacement costs are based on an effective useful life of 15 years for the water heaters and tanks, and 20 years for the solar thermal collectors. For the solar thermal systems, it’s also assumed that the glycol is replaced at years 9, 18 and 27. Additional details on cost assumptions are presented in Appendix 7.3 Cost Details.

Table 6. Heat Pump Water Heater Incremental System Costs (Present Value (2023$))

Item		3-Story		5-Story		Source & Notes
		Central Gas Boiler	Central Heat Pump	Central Gas Boiler	Central Heat Pump	
First Cost	CZs 1-9	$173,772	$211,531	$279,163	$343,920	3-story costs directly from 2022 Multifamily All-Electric CASE Report. 5-story costs estimated based on component costs for the 3-story from the CASE report.
	CZs 10-16	$182,810		$300,883		
Replacement Cost	CZs 1-9	$32,297	$44,263	$59,930	$110,659	
	CZs 10-16	$36,943		$69,361		
Total Incremental Cost	**CZs 1-9**	n/a	**$49,725**	n/a	**$115,486**	
	CZs 10-16		**$36,041**		**$84,335**	
Incremental Cost per Dwelling Unit	**CZs 1-9**		**$1,381**		**$1,312**	
	CZs 10-16		**$1,001**		**$958**	

3.2.2.2 Space Heating

Table 7 presents the costs for heat pump space heater conversion from gas equipment. In most climate zones the baseline per the 2022 Energy Code is a heat pump space heater, so these costs are only applied in a couple of instances. For the 3-story prototype the baseline in Climate Zone 16 is a gas furnace and air conditioner. For the 5-story prototype the baseline in Climate Zones 1 and 16 is a dual fuel heat pump with a gas furnace as backup. Costs include equipment and labor, gas piping within the building for the boiler system, and additional electrical service necessary for the heat pump system. Most of the cost difference between the two systems is attributed to higher labor costs to install the gas system as a result of gas piping and venting. Additional details on cost assumptions are presented in Appendix 7.3 Cost Details.

Table 7. Heat Pump Space Heater Costs per Dwelling Unit (Present Value (2023$)

Item	3-Story		5-Story		Source & Notes
	Furnace + Split AC	Heat Pump	Furnace + Split HP	Heat Pump	
First Cost	$20,667	$16,776	$21,245	$16,597	Costs largely based on the 2022 Multifamily All-Electric CASE Report with some updates to reflect online equipment cost research and labor cost alignments.
Replacement Cost	$8,059	$7,326	$9,052	$7,326	See lifetimes referenced in Table 8. Residual value at the end of the 30-year analysis period was accounted for to represent the remaining life of any equipment.
Residual Value	($1,591)	$0	$0	$0	
Total	$27,135	$24,102	$30,296	$23,924	
Incremental Cost		**($3,032)**		**($6,373)**	

Equipment lifetimes applied in this analysis for the space conditioning measures are summarized in Table 8. The lifetime for the heat pump, furnace, and air conditioner are based on the Database for Energy Efficient Resources (DEER) (California Public Utilities Commission, 2021b). In DEER, heat pump and air conditioner measures are assigned an effective useful lifetime (EUL) of 15 years and a furnace an EUL of 20 years. The heating and cooling system components are typically replaced at the same time when one reaches the end of its life and the other is near it. Therefore, it is assumed that both the furnace and air conditioner are replaced at the same time at year 17.5, halfway between 15 and 20 years. For HVAC system costing, air-conditioning is included in all cases in both the base case and proposed models.

Table 8. Lifetime of Water Heating & Space Conditioning Equipment Measures

Measure	Lifetime
Gas Furnace	17.5
Air Conditioner	17.5
Heat Pump	15
Dual Fuel Heat Pump	15

3.2.2.3 Natural Gas Infrastructure

Eliminating natural gas to a building saves costs associated with connecting a service line from the street main to the building, piping distribution within the building, and monthly meter customer charges from the utility. This section focuses on the first item, not connecting gas service to the building. The latter two are captured in the appliance costs and the utility bill analysis. Cost savings for removing natural gas infrastructure to a multifamily building in IOU territory are presented in Table 9 and Table 10. These costs are applied as cost savings for the all-electric case when compared to the mixed fuel baseline.

These costs are project dependent and may be significantly impacted by such factors as utility territory, site characteristics, distance to the nearest natural gas main and main location, joint trenching, whether work is conducted by the utility or a private contractor, and number of dwelling units per development. All gas utilities participating in this study were solicited for cost information.

Service Extension: Service extension costs to the building were taken from a PG&E memo dated December 5, 2019 to Energy Commission staff (see Appendix 7.4 PG&E Gas Infrastructure Cost Memo for a copy of the memo). The estimated cost of $6,750 excludes costs for trenching and assumes nonresidential new construction within a developed area. For the 5-story building the cost is apportioned between the residential and nonresidential spaces in the building based on associated conditioned floor areas where 84 percent is residential. All of the spaces in the 3-story building are residential based.

Today, total costs are reduced to account for deductions per the Utility Gas Main Extensions rules.[7] These rules categorize distribution line extensions as “refundable” costs, which are offset or subsidized by all other ratepayers. The CPUC issued a Decision in September 2022 that eliminates the subsidies effective July 1, 2023 (California Public Utilities Commission, 2022). Since most of the development that will occur during the three-year 2022 code cycle (2023-2025) will not be subject to these deduction allowances they are not included in this analysis.

Meter: Cost per meter provided by PG&E of $3,600 for a commercial meter to serve the central water heating and $600 per multifamily dwelling unit. The $600 dwelling unit meter is only applied in Climate Zone 16 for the 3-story prototype and Climate Zones 1 and 16 for the 5-story prototypes where gas is used either for primary or backup space heating. Two scenarios are presented in the tables. One is the case with electric space heating, no in-unit gas and the only residential gas use is to serve the central water heating system. The other case represents the scenario where there is in-unit gas to service space heating.

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[7] PG&E Rule 15: https://www.pge.com/tariffs/assets/pdf/tariffbook/GAS_RULES_15.pdf.
SoCalGas Rule 20: https://www.socalgas.com/regulatory/tariffs/tm2/pdf/20.pdf.
SDG&E Rule 15: https://tariff.sdge.com/tm2/pdf/GAS_GAS-RULES_GRULE15.pdf.

Natural Gas Plan Review: Total costs are based on TRC's 2019 reach code analysis for Palo Alto (TRC, 2018). The cost for the 5-story prototype is apportioned between the residential and nonresidential spaces in the building in the same way as was done for the service extension costs.

Table 9. IOU Natural Gas Infrastructure Cost Savings for All-Electric Building

Item		3-Story	5-Story
Service Extension		$6,750	$5,695
Meter	No In-Unit Gas (Gas DHW only)	$3,600	$3,600
	In-Unit Gas	$25,200	$56,400
Plan Review		$2,316	$1,954

Table 10. Multifamily IOU Total Natural Gas Infrastructure Costs

Prototype	Scenario	Total Building	Per Dwelling Unit
3-Story	No In-Unit Gas	$12,666	$352
	In-Unit Gas	$34,266	$952
5-Story	No In-Unit Gas	$11,248	$128
	In-Unit Gas	$64,048	$728

CPAU provides gas service to its customers and therefore separate costs were evaluated based on CPAU gas service connection fees.[8] Table 11 presents the breakdown of gas infrastructure costs used in this analysis for CPAU. The same approach to apportioning the total building costs to the residential spaces as described in the IOU section was applied here for the service extension and plan review costs for the 5-story prototype. Meter costs were based on $1,772 for an 800 cubic foot per hour commercial meter for the central water heating system.

Table 11. Multifamily CPAU Total Natural Gas Infrastructure Costs

Item	3-Story	5-Story
Service Extension	$5,892	$4,971
Meter	$1,772	$1,772
Plan Review	$2,557	$2,157

3.3 Measure Packages

The Reach Codes Team evaluated three packages for mixed fuel homes and five packages for all-electric homes for each prototype and climate zone, as described below.

1. All-Electric Prescriptive Code: This package meets all the prescriptive requirements of the 2022 Energy Code.
2. All-Electric Prescriptive Code + PV: Using the code minimum package as a starting point, PV capacity was added to offset 100 percent of the estimated annual electricity use.
3. Mixed Fuel Efficiency Only: This package uses only efficiency measures that do not trigger federal preemption including envelope and duct distribution efficiency measures.

[8] CPAU Schedule G-5 effective 09-01-2019: https://www.cityofpaloalto.org/files/assets/public/utilities/utilities-engineering/general-specifications/gas-service-connection-fees.pdf

4. Mixed Fuel Efficiency + PV + Battery: Using the Efficiency Package as a starting point, PV capacity was added to offset 100 percent of the estimated annual electricity use. A battery system was also added. This package only applies to the 3-story prototype. The 5-story prototype includes a battery system in the baseline per the 2022 prescriptive requirements.
5. Mixed Fuel Efficiency + PV: Using the Efficiency Package as a starting point, PV capacity was added to offset 100 percent of the estimated annual electricity use. This package only applies to the 5-story prototype.

4 Results

Cost-effectiveness results are presented per prototype and measure packages described in Section 3.3. The TDV and On-Bill based cost-effectiveness results are presented in terms of B/C ratio and NPV. Energy savings, compliance margin, utility bill savings, and incremental costs are also shown.

In the following figures, green highlighting indicates that the case is cost-effective with a B/C ratio greater than or equal to 1 and a NPV greater than or equal to 0. Red highlighting indicates the case is not cost-effective.

Compliance margins are presented as percentages both for the efficiency TDV and the source energy metrics. A compliance margin that is equal to or greater than 0 indicates the case is code compliant.

4.1 All-Electric Prescriptive Code

Table 12 and Table 13 shows results for the multifamily all-electric prescriptive code case compared to the 2022 baseline. For both prototypes this scenario is cost-effective based on TDV in all climate zones. This scenario is only On-Bill cost-effective in a few climate zones. The 3-story all-electric case is cost-effective On-Bill in Climate Zones 1 through 3, 4 in CPAU territory, 12 in SMUD territory, and 16. The 5-story all-electric case is cost-effective On-Bill in Climate Zones 1, 4, 12 in SMUD territory, and 16.

In most cases there is a small net increase in utility cost in the first year.

There is an incremental cost for the central heat pump water heater ranging from $361 to $697 per dwelling unit.

The all-electric packages applied to the 3-story prototype in Climate Zone 16 and the 5-story prototype in Climate Zones 1 and 16 incorporate both gas to electric water heating and gas to electric space heating measures. In these cases, there are significant cost savings due to the avoided first costs of installing a gas furnace as compared to a heat pump. As a result, these cases are On-Bill cost-effective.

These results reflect a CO_2 refrigerant based central heat pump water heating system. The 5-story prototype was also evaluated with a R-134a refrigerant based central heat pump water heater and these results are shown in Appendix 7.5 Central Heat Pump Water Heater Comparison.

Table 12. 3-Story Cost-Effectiveness Results per Dwelling Unit: All-Electric Prescriptive Code

Climate Zone	Electric /Gas Utility	Efficiency TDV Comp Margin	Source Comp Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	26%	15%	-904	135	($19)	$1,676	$97	$429	3.9	$1,247	>1	$4,158
CZ02	PGE	20%	11%	-801	115	($30)	$1,061	$697	$1,029	1.0	$32	9.9	$2,998
CZ03	PGE	21%	10%	-789	115	($26)	$1,148	$697	$1,029	1.1	$119	9.9	$2,990
CZ04	PGE	18%	9%	-759	109	($31)	$922	$697	$1,029	0.9	($108)	9.2	$2,767
CZ04	CPAU	18%	9%	-759	109	$233	$8,191	$765	$1,097	7.5	$7,094	7.7	$2,700
CZ05	PGE	23%	9%	-789	112	($30)	$1,009	$697	$1,029	0.98	($21)	9.3	$2,782
CZ05	PGE/SCG	23%	9%	-789	112	($79)	($515)	$697	$1,029	0.0	($1,545)	9.3	$2,782
CZ06	SCE/SCG	18%	7%	-709	100	($61)	($226)	$697	$1,029	0.0	($1,255)	8.6	$2,551
CZ07	SDGE	20%	8%	-704	102	($69)	($427)	$697	$1,029	0.0	($1,456)	9.1	$2,712
CZ08	SCE/SCG	13%	6%	-689	96	($61)	($302)	$697	$1,029	0.0	($1,331)	8.2	$2,432
CZ09	SCE	13%	5%	-698	96	($64)	($351)	$697	$1,029	0.0	($1,380)	8.0	$2,363
CZ10	SCE/SCG	14%	7%	-701	83	($88)	($1,109)	$446	$649	0.0	($1,758)	>1	$1,959
CZ10	SDGE	14%	7%	-701	83	($112)	($1,803)	$446	$649	0.0	($2,452)	>1	$1,959
CZ11	PGE	14%	10%	-740	91	($64)	($177)	$446	$649	0.0	($826)	>1	$2,212
CZ12	PGE	17%	11%	-755	94	($62)	($70)	$446	$649	0.0	($719)	>1	$2,297
CZ12	SMUD/PGE	17%	11%	-755	94	$68	$2,942	$446	$649	4.5	$2,293	>1	$2,297
CZ13	PGE	13%	9%	-717	86	($65)	($291)	$446	$649	0.0	($940)	>1	$2,050
CZ14	SCE/SCG	13%	7%	-748	83	($102)	($1,413)	$446	$649	0.0	($2,063)	>1	$1,759
CZ14	SDGE	13%	7%	-748	83	($128)	($2,191)	$446	$649	0.0	($2,841)	>1	$1,759
CZ15	SCE/SCG	5%	2%	-607	64	($89)	($1,403)	$446	$649	0.0	($2,053)	>1	$1,305
CZ16	PG&E	24%	29%	-1,928	185	($178)	($1,066)	($4,045)	($2,983)	2.8	$1,917	>1	$4,352

Table 13. 5-Story Cost-Effectiveness Results per Dwelling Unit: All-Electric Prescriptive Code

Climate Zone	Electric /Gas Utility	Efficiency TDV Comp Margin	Source Comp Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	14%	9%	-1,146	147	($49)	$1,209	($4,639)	($5,788)	>1	$6,998	>1	$9,816
CZ02	PGE	9%	6%	-888	120	($45)	$809	$608	$1,185	0.7	($375)	3.0	$2,270
CZ03	PGE	11%	7%	-874	120	($46)	$778	$608	$1,185	0.7	($407)	3.1	$2,421
CZ04	PGE	9%	6%	-824	113	$18	$2,130	$608	$1,185	1.8	$945	3.1	$2,393
CZ04	CPAU	9%	6%	-824	113	$230	$8,205	$635	$1,211	6.8	$6,994	3.0	$2,367
CZ05	PGE	12%	6%	-871	117	($47)	$706	$608	$1,185	0.6	($479)	2.8	$2,065
CZ05	PGE/SCG	12%	6%	-871	117	($99)	($919)	$608	$1,185	0.0	($2,103)	2.8	$2,065
CZ06	SCE/SCG	9%	5%	-739	104	($10)	$986	$608	$1,185	0.8	($199)	2.9	$2,183
CZ07	SDGE	11%	6%	-735	106	($74)	($500)	$608	$1,185	0.0	($1,685)	2.9	$2,215
CZ08	SCE/SCG	8%	4%	-710	100	($79)	($644)	$608	$1,185	0.0	($1,829)	3.0	$2,259
CZ09	SCE	7%	4%	-725	100	($53)	($51)	$608	$1,185	0.0	($1,236)	3.0	$2,274
CZ10	SCE/SCG	7%	4%	-729	84	($111)	($1,615)	$361	$831	0.0	($2,445)	2.7	$1,374
CZ10	SDGE	7%	4%	-729	84	($137)	($2,404)	$361	$831	0.0	($3,234)	2.7	$1,374
CZ11	PGE	8%	5%	-790	92	($86)	($663)	$361	$831	0.0	($1,494)	3.1	$1,656
CZ12	PGE	9%	6%	-809	96	($83)	($527)	$361	$831	0.0	($1,358)	3.0	$1,620
CZ12	SMUD/PGE	9%	6%	-809	96	$62	$2,831	$361	$831	3.4	$2,000	3.0	$1,620
CZ13	PGE	7%	5%	-754	88	($83)	($686)	$361	$831	0.0	($1,517)	3.0	$1,570
CZ14	SCE/SCG	6%	3%	-803	84	($131)	($2,085)	$361	$831	0.0	($2,916)	2.2	$928
CZ14	SDGE	6%	3%	-803	84	($165)	($3,106)	$361	$831	0.0	($3,937)	2.2	$928
CZ15	SCE/SCG	3%	1%	-602	65	($105)	($1,775)	$361	$831	0.0	($2,606)	1.9	$695
CZ16	PG&E	9%	11%	-1,388	142	($127)	($675)	($4,886)	($6,142)	9.1	$5,467	>1	$6,704

4.2 All-Electric Plus PV

Table 14 and Table 15 present cost-effectiveness results for the all-electric plus PV packages for the 3-story and 5-story prototypes, respectively. All cases are cost-effective both On-Bill and based on TDV.

Table 14. 3-Story Cost-Effectiveness Results per Dwelling Unit: All-Electric 100% PV

Climate Zone	Electric /Gas Utility	Efficiency TDV Comp Margin	Source Comp Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	26%	24%	2,127	135	$782	$20,242	$3,638	$5,034	4.0	$15,208	3.2	$9,448
CZ02	PGE	20%	20%	1,835	115	$653	$16,910	$3,294	$4,406	3.8	$12,504	3.3	$8,632
CZ03	PGE	21%	20%	1,711	115	$614	$15,998	$3,076	$4,123	3.9	$11,875	3.4	$8,209
CZ04	PGE	18%	18%	1,558	109	$559	$14,587	$2,841	$3,818	3.8	$10,770	3.6	$8,230
CZ04	CPAU	18%	18%	1,558	109	$489	$14,138	$2,909	$3,886	3.6	$10,253	3.6	$8,162
CZ05	PGE	23%	20%	1,604	112	$579	$15,137	$2,826	$3,798	4.0	$11,338	3.6	$8,026
CZ05	PGE/SCG	23%	20%	1,604	112	$531	$13,613	$2,826	$3,798	3.6	$9,814	3.6	$8,026
CZ06	SCE/SCG	18%	17%	1,207	100	$378	$9,795	$2,364	$3,197	3.1	$6,598	3.8	$7,092
CZ07	SDGE	20%	21%	1,528	102	$723	$19,318	$2,777	$3,734	5.2	$15,584	3.5	$7,623
CZ08	SCE/SCG	13%	17%	1,393	96	$426	$10,842	$2,569	$3,464	3.1	$7,378	3.9	$7,908
CZ09	SCE	13%	15%	1,204	96	$379	$9,756	$2,335	$3,160	3.1	$6,596	3.9	$7,158
CZ10	SCE/SCG	14%	18%	1,381	83	$404	$10,130	$2,237	$2,978	3.4	$7,152	4.1	$7,031
CZ10	SDGE	14%	18%	1,381	83	$621	$16,493	$2,237	$2,978	5.5	$13,514	4.1	$7,031
CZ11	PGE	14%	19%	1,843	91	$625	$15,782	$2,940	$3,893	4.1	$11,889	3.4	$7,748
CZ12	PGE	17%	19%	1,704	94	$579	$14,777	$2,756	$3,654	4.0	$11,124	3.6	$7,607
CZ12	SMUD/PGE	17%	19%	1,704	94	$399	$10,615	$2,756	$3,654	2.9	$6,961	3.6	$7,607
CZ13	PGE	13%	17%	1,572	86	$544	$13,822	$2,567	$3,408	4.1	$10,415	3.6	$7,148
CZ14	SCE/SCG	13%	18%	1,572	83	$449	$11,152	$2,300	$3,060	3.6	$8,092	4.2	$7,668
CZ14	SDGE	13%	18%	1,572	83	$688	$18,158	$2,300	$3,060	5.9	$15,098	4.2	$7,668
CZ15	SCE/SCG	5%	11%	1,163	64	$330	$8,164	$1,966	$2,626	3.1	$5,539	3.9	$5,567
CZ16	PG&E	24%	38%	1,371	185	$700	$19,307	($1,064)	$894	21.6	$18,412	58.9	$11,596

Table 15. 5-Story Cost-Effectiveness Results per Dwelling Unit: All-Electric 100% PV

Climate Zone	Electric /Gas Utility	Efficiency TDV Comp Margin	Source Comp Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	14%	21%	1,437	147	$629	$16,919	($1,574)	($1,803)	>1	$18,721	>1	$18,222
CZ02	PGE	9%	14%	428	120	$262	$7,918	$1,930	$2,904	2.7	$5,015	4.0	$8,679
CZ03	PGE	11%	16%	682	120	$327	$9,417	$2,121	$3,152	3.0	$6,265	4.0	$9,285
CZ04	PGE	9%	13%	92	113	$207	$6,524	$1,476	$2,313	2.8	$4,211	4.1	$7,054
CZ04	CPAU	9%	13%	92	113	$337	$10,667	$1,502	$2,340	4.6	$8,327	4.0	$7,027
CZ05	PGE	12%	16%	451	117	$259	$7,806	$1,815	$2,754	2.8	$5,052	4.0	$8,096
CZ05	PGE/SCG	12%	16%	451	117	$207	$6,182	$1,815	$2,754	2.2	$3,427	4.0	$8,096
CZ06	SCE/SCG	9%	12%	-163	104	$98	$3,449	$1,127	$1,859	1.9	$1,590	3.8	$5,035
CZ07	SDGE	11%	15%	74	106	$192	$6,131	$1,387	$2,198	2.8	$3,934	3.9	$6,204
CZ08	SCE/SCG	8%	14%	265	100	$154	$4,666	$1,516	$2,365	2.0	$2,301	4.0	$7,053
CZ09	SCE	7%	12%	60	100	$122	$3,930	$1,307	$2,093	1.9	$1,837	3.7	$5,636
CZ10	SCE/SCG	7%	13%	289	84	$131	$3,912	$1,266	$2,007	1.9	$1,905	3.9	$5,749
CZ10	SDGE	7%	13%	289	84	$238	$6,951	$1,266	$2,007	3.5	$4,945	3.9	$5,749
CZ11	PGE	8%	17%	1,091	92	$417	$10,990	$2,226	$3,256	3.4	$7,734	4.2	$10,472
CZ12	PGE	9%	16%	594	96	$263	$7,487	$1,712	$2,587	2.9	$4,901	4.3	$8,544
CZ12	SMUD/PGE	9%	16%	594	96	$260	$7,419	$1,712	$2,587	2.9	$4,889	4.3	$8,544
CZ13	PGE	7%	17%	1,036	88	$398	$10,479	$2,064	$3,045	3.4	$7,434	4.2	$9,715
CZ14	SCE/SCG	6%	11%	182	84	$102	$3,250	$1,170	$1,883	1.7	$1,368	4.0	$5,515
CZ14	SDGE	6%	11%	182	84	$194	$5,858	$1,170	$1,883	3.1	$3,975	4.0	$5,515
CZ15	SCE/SCG	3%	10%	387	65	$153	$4,119	$1,238	$1,971	2.1	$2,148	3.6	$4,998
CZ16	PG&E	9%	23%	1,007	142	$501	$13,864	($2,682)	($3,275)	>1	$17,139	>1	$16,140

4.3 Mixed Fuel Efficiency

Table 16 and Table 17 show results for the Mixed Fuel Efficiency packages. The packages are cost-effective based on at least one of the two metrics in Climate Zones 1, 2, 4, and 8 through 16 for the 3-story prototype and in Climate Zones 2, 4, 6, and 8 through 15 for the 5-story prototype. In all cases the NPV values, whether negative or positive, are small. The compliance impacts are also small.

A summary of measures included in each package is provided in Appendix 7.6 Summary of Measures by Package.

Table 16. 3-Story Cost-Effectiveness Results per Dwelling Unit: Mixed Fuel Efficiency

Climate Zone	Electric /Gas Utility	Efficiency TDV Comp Margin	Source Comp Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	1%	1%	41	0	$12	$273	$176	$176	1.6	$98	1.2	$38
CZ02	PGE	1%	0%	24	0	$7	$162	$132	$132	1.2	$30	1.5	$62
CZ03	PGE	1%	0%	17	0	$5	$111	$132	$132	0.8	($21)	0.8	($27)
CZ04	PGE	1%	0%	21	0	$6	$141	$132	$132	1.1	$9	1.3	$46
CZ04	CPAU	1%	0%	21	0	$3	$74	$132	$132	0.6	($58)	1.3	$46
CZ05	PGE	1%	0%	19	0	$5	$123	$132	$132	0.9	($9)	0.8	($32)
CZ05	PGE/SCG	1%	0%	19	0	$5	$123	$132	$132	0.9	($9)	0.8	($32)
CZ06	SCE/SCG	1%	0%	9	0	$2	$56	$132	$132	0.4	($75)	0.7	($44)
CZ07	SDGE	0%	0%	7	0	$3	$72	$132	$132	0.5	($60)	0.4	($81)
CZ08	SCE/SCG	1%	0%	20	0	$6	$140	$132	$132	1.1	$9	1.5	$59
CZ09	SCE	1%	0%	28	0	$8	$192	$146	$156	1.2	$36	1.6	$88
CZ10	SCE/SCG	3%	1%	65	0	$20	$447	$190	$199	2.2	$247	2.4	$277
CZ10	SDGE	3%	1%	65	0	$27	$683	$190	$199	3.4	$484	2.4	$277
CZ11	PGE	3%	1%	91	0	$30	$699	$190	$199	3.5	$499	3.5	$489
CZ12	PGE	2%	0%	98	0	$33	$766	$381	$514	1.5	$252	1.5	$273
CZ12	SMUD/PGE	2%	0%	98	0	$17	$396	$381	$514	0.8	($118)	1.5	$273
CZ13	PGE	4%	1%	99	0	$33	$765	$190	$199	3.8	$566	3.9	$574
CZ14	SCE/SCG	3%	1%	88	0	$26	$585	$190	$199	2.9	$385	3.1	$427
CZ14	SDGE	3%	1%	88	0	$36	$886	$190	$199	4.4	$686	3.1	$427
CZ15	SCE/SCG	5%	2%	182	0	$54	$1,226	$190	$199	6.1	$1,026	5.8	$957
CZ16	PG&E	5%	4%	16	12	$34	$1,012	$712	$712	1.4	$300	1.3	$184

Table 17. 5-Story Cost-Effectiveness Results per Dwelling Unit: Mixed Fuel Efficiency

Climate Zone	Electric /Gas Utility	Efficiency TDV Comp Margin	Source Comp Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	0%	0%	5	0	$2	$39	$176	$176	0.2	($137)	0.2	($136)
CZ02	PGE	1%	0%	11	0	$2	$38	$132	$132	0.3	($94)	1.9	$118
CZ03	PGE	0%	0%	7	0	$2	$46	$132	$132	0.3	($86)	0.8	($23)
CZ04	PGE	1%	0%	12	0	$2	$40	$132	$132	0.3	($92)	1.9	$114
CZ04	CPAU	1%	0%	12	0	$2	$39	$132	$132	0.3	($93)	1.9	$114
CZ05	PGE	0%	0%	6	0	$1	$17	$132	$132	0.1	($114)	0.4	($73)
CZ05	PGE/SCG	0%	0%	6	0	$1	$17	$132	$132	0.1	($114)	0.4	($73)
CZ06	SCE/SCG	0%	0%	12	0	$2	$51	$132	$132	0.4	($81)	1.4	$49
CZ07	SDGE	0%	0%	10	0	$0	$0	$132	$132	0.0	($132)	0.9	($7)
CZ08	SCE/SCG	1%	0%	24	0	$8	$184	$132	$132	1.4	$53	2.2	$152
CZ09	SCE	1%	0%	28	0	$4	$96	$142	$149	0.6	($52)	2.1	$163
CZ10	SCE/SCG	2%	1%	66	0	$21	$491	$186	$192	2.6	$298	3.2	$425
CZ10	SDGE	2%	1%	66	0	$30	$751	$186	$192	3.9	$558	3.2	$425
CZ11	PGE	2%	1%	83	0	$29	$665	$186	$192	3.5	$473	4.2	$621
CZ12	PGE	2%	0%	84	0	$29	$681	$321	$414	1.6	$267	2.3	$546
CZ12	SMUD/PGE	2%	0%	84	0	$16	$372	$321	$414	0.9	($42)	2.3	$546
CZ13	PGE	2%	1%	95	0	$33	$765	$186	$192	4.0	$573	4.9	$742
CZ14	SCE/SCG	2%	1%	75	0	$11	$246	$186	$192	1.3	$54	3.9	$561
CZ14	SDGE	2%	1%	75	0	$34	$847	$186	$192	4.4	$654	3.9	$561
CZ15	SCE/SCG	3%	2%	172	0	$55	$1,257	$186	$192	6.5	$1,065	7.3	$1,212
CZ16	PG&E	2%	2%	40	4	$23	$616	$665	$665	0.9	($49)	0.999	($0)

4.4 Mixed Fuel Plus PV (Plus Battery for the 3-Story Prototype)

Table 18 presents the Mixed Fuel Efficiency + PV + Battery package for the 3-story prototype. The battery system is a 100kWh battery. This scenario is cost-effective for all climate zones and under both metrics except for On-Bill in Climate Zone 4 in CPAU territory. Table 19 presents the Mixed Fuel Efficiency + PV package for the 5-story prototype. This package is cost-effective under TDV in all climate zones and cost-effective On-Bill everywhere except in Climate Zones 6 and 7. In the cases where it is not cost-effective, it is very close to being so with small negative NPV. In Climate Zone 6 in the 5-story prototype there is no upgrade to the PV system capacity as the prescriptive PV system already offset all of the estimated electricity use.

Table 18. 3-Story Cost-Effectiveness Results per Dwelling Unit: Mixed Fuel Efficiency + PV + Battery

Climate Zone	Electric /Gas Utility	Efficiency TDV Comp Margin	Source Comp Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	1%	16%	2,068	0	$543	$12,588	$4,603	$6,917	1.8	$5,671	1.5	$3,724
CZ02	PGE	1%	16%	1,757	0	$462	$10,718	$3,881	$5,990	1.8	$4,728	1.6	$3,820
CZ03	PGE	1%	17%	1,624	0	$423	$9,797	$3,700	$5,754	1.7	$4,043	1.5	$3,157
CZ04	PGE	1%	17%	1,476	0	$383	$8,878	$3,518	$5,518	1.6	$3,360	1.6	$3,067
CZ04	CPAU	1%	17%	1,476	0	$171	$3,967	$3,518	$5,518	0.7	($1,551)	1.6	$3,067
CZ05	PGE	1%	18%	1,520	0	$393	$9,107	$3,503	$5,498	1.7	$3,609	1.6	$3,526
CZ05	PGE/SCG	1%	18%	1,520	0	$393	$9,107	$3,503	$5,498	1.7	$3,609	1.6	$3,526
CZ06	SCE/SCG	1%	18%	1,112	0	$336	$7,677	$3,127	$5,009	1.5	$2,668	1.4	$1,917
CZ07	SDGE	0%	20%	1,431	0	$550	$13,713	$3,498	$5,493	2.5	$8,220	1.6	$3,159
CZ08	SCE/SCG	1%	18%	1,311	0	$413	$9,427	$3,328	$5,270	1.8	$4,156	1.4	$2,277
CZ09	SCE	1%	17%	1,129	0	$367	$8,375	$3,129	$5,017	1.7	$3,359	1.4	$1,937
CZ10	SCE/SCG	3%	19%	1,342	0	$420	$9,584	$3,321	$5,254	1.8	$4,331	1.5	$2,588
CZ10	SDGE	3%	19%	1,342	0	$533	$13,303	$3,321	$5,254	2.5	$8,049	1.5	$2,588
CZ11	PGE	3%	17%	1,833	0	$500	$11,587	$3,914	$6,025	1.9	$5,562	1.6	$3,852
CZ12	PGE	2%	17%	1,701	0	$442	$10,239	$3,926	$6,105	1.7	$4,133	1.6	$3,583
CZ12	SMUD/PGE	2%	17%	1,701	0	$285	$6,609	$3,926	$6,105	1.1	$503	1.6	$3,583
CZ13	PGE	4%	17%	1,568	0	$431	$9,983	$3,594	$5,609	1.8	$4,374	1.7	$3,944
CZ14	SCE/SCG	3%	19%	1,556	0	$477	$10,886	$3,388	$5,341	2.0	$5,545	1.6	$3,434
CZ14	SDGE	3%	19%	1,556	0	$607	$15,155	$3,388	$5,341	2.8	$9,815	1.6	$3,434
CZ15	SCE/SCG	5%	19%	1,241	0	$421	$9,616	$3,136	$5,013	1.9	$4,603	1.6	$3,076
CZ16	PG&E	5%	17%	1,286	12	$357	$8,508	$3,894	$5,833	1.5	$2,674	1.6	$3,219

Table 19. 5-Story Cost-Effectiveness Results per Dwelling Unit: Mixed Fuel Efficiency + PV

Climate Zone	Electric /Gas Utility	Efficiency TDV Comp Margin	Source Comp Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	0%	5%	1,446	0	$341	$7,917	$1,889	$2,403	3.3	$5,514	3.0	$4,757
CZ02	PGE	1%	2%	444	0	$55	$1,275	$567	$697	1.8	$578	4.4	$2,365
CZ03	PGE	0%	4%	693	0	$119	$2,766	$801	$1,002	2.8	$1,764	4.4	$3,423
CZ04	PGE	1%	1%	112	0	$14	$324	$226	$254	1.3	$69	3.5	$632
CZ04	CPAU	1%	1%	112	0	$13	$307	$226	$254	1.2	$53	3.5	$632
CZ05	PGE	0%	3%	464	0	$56	$1,310	$550	$676	1.9	$634	4.2	$2,165
CZ05	PGE/SCG	0%	3%	464	0	$56	$1,310	$550	$676	1.9	$634	4.2	$2,165
CZ06	SCE/SCG	0%	0%	12	0	$2	$51	$132	$132	0.4	($81)	1.4	$49
CZ07	SDGE	0%	1%	95	0	$0	$0	$212	$237	0.0	($237)	2.8	$423
CZ08	SCE/SCG	1%	3%	299	0	$42	$968	$388	$465	2.1	$504	4.3	$1,527
CZ09	SCE	1%	1%	99	0	$12	$284	$204	$230	1.2	$54	3.0	$465
CZ10	SCE/SCG	2%	3%	364	0	$57	$1,296	$450	$536	2.4	$759	4.2	$1,720
CZ10	SDGE	2%	3%	364	0	$103	$2,566	$450	$536	4.8	$2,030	4.2	$1,720
CZ11	PGE	2%	7%	1,178	0	$281	$6,521	$1,276	$1,610	4.1	$4,911	4.8	$6,162
CZ12	PGE	2%	4%	683	0	$120	$2,791	$898	$1,164	2.4	$1,627	4.2	$3,716
CZ12	SMUD/PGE	2%	4%	683	0	$102	$2,362	$898	$1,164	2.0	$1,198	4.2	$3,716
CZ13	PGE	2%	7%	1,137	0	$274	$6,347	$1,179	$1,484	4.3	$4,863	4.8	$5,599
CZ14	SCE/SCG	2%	2%	266	0	$33	$748	$342	$395	1.9	$353	4.7	$1,447
CZ14	SDGE	2%	2%	266	0	$62	$1,554	$342	$395	3.9	$1,158	4.7	$1,447
CZ15	SCE/SCG	3%	5%	567	0	$125	$2,851	$535	$646	4.4	$2,204	5.6	$2,994
CZ16	PG&E	2%	6%	1,051	4	$237	$5,569	$1,601	$1,883	3.0	$3,686	3.1	$4,011

4.5 CARE Rate Comparison

Table 20 presents a comparison of On-Bill cost-effectiveness results for CARE tariffs relative to standard tariffs for the all-electric prescriptive code case. The CARE rates apply to the apartment meters only and don't impact the central water heating utility costs. Applying the CARE rates lowers both electric and gas utility bills for the consumer and the net impact for an all-electric building in most climate zones is lower overall bills and improved cost-effectiveness relative to the standard tariffs. Although not presented here, the all-electric + PV packages are all still On-Bill cost-effective using the CARE tariffs.

Table 20. On-Bill IOU Cost-Effectiveness Comparison with CARE Tariffs, Results per Dwelling Unit: All-Electric Prescriptive Code

Climate Zone	Electric /Gas Utility	3-Story				5-Story			
		Standard		CARE		Standard		CARE	
		B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	3.9	$1,247	9.5	$3,637	>1	$6,998	>1	$10,045
CZ02	PGE	1.0	$32	3.1	$2,139	0.7	($375)	2.5	$1,831
CZ03	PGE	1.1	$119	3.1	$2,187	0.7	($407)	2.6	$1,901
CZ04	PGE	0.9	($108)	2.8	$1,884	1.8	$945	2.9	$2,218
CZ05	PGE	0.98	($21)	3.0	$2,041	0.6	($479)	2.5	$1,773
CZ05	PGE/SCG	0.0	($1,545)	1.5	$517	0.0	($2,103)	1.1	$148
CZ06	SCE/SCG	0.0	($1,255)	0.9	($57)	0.8	($199)	2.1	$1,349
CZ07	SDGE	0.0	($1,456)	1.8	$856	0.0	($1,685)	1.3	$343
CZ08	SCE/SCG	0.0	($1,331)	0.8	($165)	0.0	($1,829)	1.2	$271
CZ09	SCE	0.0	($1,380)	0.8	($204)	0.0	($1,236)	1.6	$750
CZ10	SCE/SCG	0.0	($1,758)	0.1	($574)	0.0	($2,445)	0.5	($447)
CZ10	SDGE	0.0	($2,452)	0.8	($162)	0.0	($3,234)	0.0	($1,590)
CZ11	PGE	0.0	($826)	2.7	$1,119	0.0	($1,494)	1.7	$616
CZ12	PGE	0.0	($719)	2.9	$1,263	0.0	($1,358)	2.0	$793
CZ13	PGE	0.0	($940)	2.4	$936	0.0	($1,517)	1.6	$491
CZ14	SCE/SCG	0.0	($2,063)	0.0	($803)	0.0	($2,916)	0.3	($613)
CZ14	SDGE	0.0	($2,841)	0.0	($3,407)	0.0	($3,937)	1.1	$61
CZ15	SCE/SCG	0.0	($2,053)	0.0	($1,036)	0.0	($2,606)	0.0	($1,452)
CZ16	PG&E	2.8	$1,917	>1	$5,527	9.1	$5,467	>1	$8,557

Error! Not a valid bookmark self-reference. presents the comparison for the mixed fuel efficiency and PV packages. Generally, the opposite trend occurs here for the mixed fuel packages where the CARE rate lowers utility cost savings and the benefit-to-cost ratios decline.

Table 21. On-Bill IOU Cost-Effectiveness Comparison with CARE Tariffs, Results per Dwelling Unit: Mixed Fuel Packages

Climate Zone	Electric /Gas Utility	3-Story (Efficiency + PV + Battery)				5-Story (Efficiency + PV)			
		Standard		CARE		Standard		CARE	
		B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	1.8	$5,671	1.2	$1,113	3.3	$5,514	2.2	$2,765
CZ02	PGE	1.8	$4,728	1.2	$907	1.8	$578	1.5	$337
CZ03	PGE	1.7	$4,043	1.1	$579	2.8	$1,764	2.0	$1,028
CZ04	PGE	1.6	$3,360	1.0	$259	1.3	$69	0.8	($44)
CZ05	PGE	1.7	$3,609	1.1	$414	1.9	$634	1.7	$442
CZ05	PGE/SCG	1.7	$3,609	1.1	$414	1.9	$634	1.7	$442
CZ06	SCE/SCG	1.5	$2,668	0.9	($515)	0.4	($81)	0.3	($92)
CZ07	SDGE	2.5	$8,220	1.7	$4,106	0.0	($237)	0.0	($237)
CZ08	SCE/SCG	1.8	$4,156	1.1	$446	2.1	$504	1.3	$137
CZ09	SCE	1.7	$3,359	0.99	($26)	1.2	$54	0.9	($28)
CZ10	SCE/SCG	1.8	$4,331	1.1	$577	2.4	$759	1.3	$180
CZ10	SDGE	2.5	$8,049	1.8	$4,180	4.8	$2,030	0.0	($536)
CZ11	PGE	1.9	$5,562	1.2	$1,435	4.1	$4,911	2.7	$2,744
CZ12	PGE	1.7	$4,133	1.1	$517	2.4	$1,627	1.8	$905
CZ13	PGE	1.8	$4,374	1.2	$883	4.3	$4,863	2.9	$2,777
CZ14	SCE/SCG	2.0	$5,545	1.3	$1,395	1.9	$353	1.3	$136
CZ14	SDGE	2.8	$9,815	1.4	$2,292	3.9	$1,158	0.0	($395)
CZ15	SCE/SCG	1.9	$4,603	1.2	$887	4.4	$2,204	1.9	$586
CZ16	PG&E	1.5	$2,674	0.97	($162)	3.0	$3,686	2.0	$1,908

4.6 Greenhouse Gas Reductions

Figure 1 and Figure 2 compare greenhouse gas reductions across all the packages for the multifamily 3-story and 5-story prototypes, respectively. Savings represent average annual savings per dwelling unit over the 30-year lifetime of the analysis. Electrification of gas uses represents the greatest greenhouse gas reductions, followed by PV. Greenhouse gas reductions are greatest for the all-electric + PV package.

Figure 1. 3-Story greenhouse gas reductions (metric tons) per dwelling unit

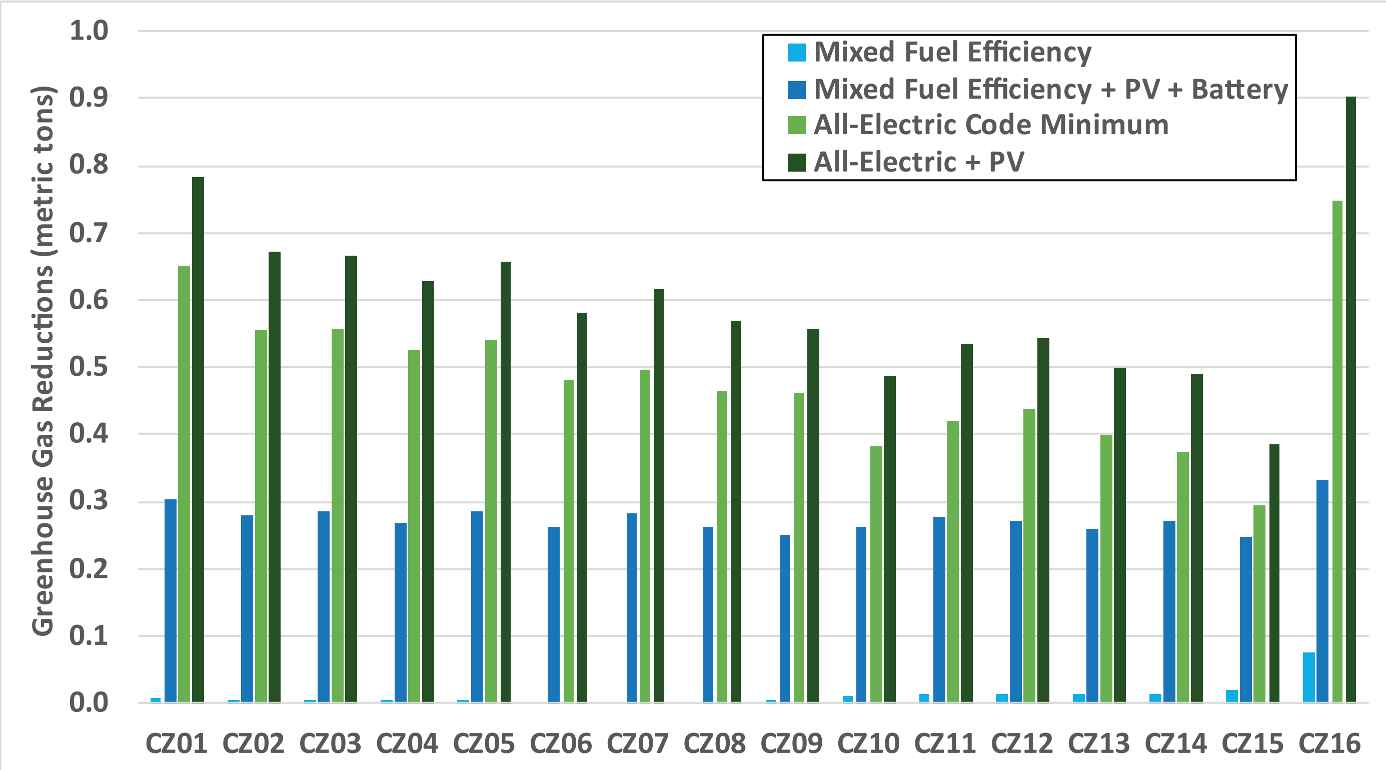
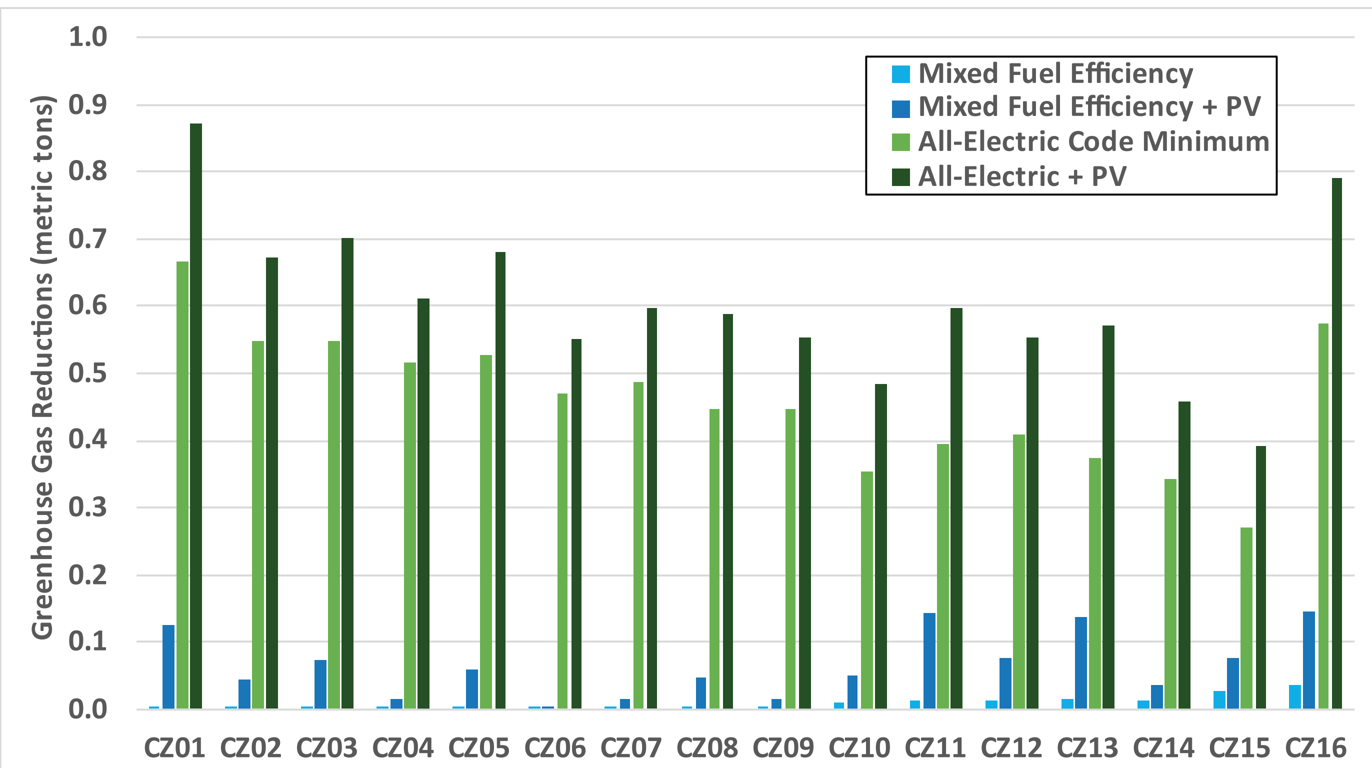


Figure 2. 5-Story greenhouse gas savings (metric tons) per dwelling unit



5 Summary

The Reach Codes Team identified packages of electrification and energy efficiency measures as well as packages combining these measures with solar PV generation and battery storage, simulated them using 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.

Table 22 summarizes results for each prototype and depicts the efficiency TDV compliance margins achieved for each climate zone and package. Because local reach codes must both exceed the Energy Commission performance budget (i.e., have a positive compliance margin) and be cost-effective, the Reach Codes Team highlighted cells meeting these two requirements to help clarify the upper boundary for potential reach code policies. All results presented in this study have a positive compliance margin.

- Cells highlighted in **green** depict cases with a positive compliance margin and cost-effective results using both On-Bill and TDV approaches.
- Cells highlighted in **yellow** depict cases with a positive compliance margin and cost-effective results using either the On-Bill or TDV approach.
- Cells **not highlighted** depict cases with a positive compliance margin but that were not cost-effective using either the On-Bill or TDV approach.

Following are key takeaways and recommendations from the analysis.

- The Reach Codes Team found all-electric new construction to be feasible and cost-effective based on the California Energy Commission's Time Dependent Valuation (TDV) metric in all cases. In many cases all-electric prescriptive code construction results in an increase in utility costs and is not cost-effective On-Bill. Some exceptions include the SMUD and CPAU territories where lower electricity rates relative to gas rates result in lower overall utility bills.
- All-electric packages have lower GHG emissions than mixed fuel packages in all cases, due to the clean power sources currently available from California's power providers.
- The 2022 Energy Code's new source energy metric combined with the heat pump space heating baseline in most climate zones encourages all-electric construction. While the code does not include an electric baseline for water heating, the penalty for central electric water heating observed in the performance approach in past code cycles has been removed and a credit is provided for well-designed central heat pump water heaters in most cases.
- Electrification combined with increased PV capacity results in utility cost savings and was found to be On-Bill cost-effective in all cases.
- The results in this study are based on today's net energy metering (NEM 2.0) rules and do not account for recently approved changes to the NEM tariff (referred to as the net billing tariff). The net billing tariff decreases the value of PV to the consumer as compared to NEM 2.0. As a result, the cost-effectiveness of the packages that include above-code PV capacity is expected to be less under the net billing tariff. Conversely, the net billing tariff is expected to increase On-Bill cost-effectiveness of the all-electric prescriptive code scenario. An all-electric home has better on-site utilization of generated electricity from PV than a mixed fuel home with a similar sized PV system, and as a result exports less electricity to the grid. Since the net-billing tariff values exports less than under NEM 2.0, the relative impact on annual utility costs to the mixed fuel baseline is greater.
- This analysis does justify requiring a modest reach based on either efficiency TDV or source energy for all-electric buildings. However, this may be challenging for some projects given the recent changes to which the industry must adapt, including the efficiency updates and multifamily restructuring in the 2022 Title 24, Part 6 code. While project compliance margins using a CO_2 refrigerant heat pump water heating system are high, the Reach Code Team found lower compliance margins using other heat pump water heater system designs.

Focusing on supporting projects to electrify water heating is expected to support the market shift towards more central heat pump water heaters.

- For jurisdictions interested in a reach code that allows for mixed fuel buildings, a mixed fuel efficiency and PV package (and battery for the 3-story prototype) was found to be cost-effective based on TDV in all cases and cost-effective On-Bill in most climate zones. This path, referred to as “Electric-Preferred”, allows for mixed fuel buildings but requires a higher building performance than for all-electric buildings. The efficiency measures evaluated in this study did not provide significant compliance benefit. As a result, the Reach Codes Team recommends establishing a compliance margin target based on source energy or total TDV. This would allow for PV and battery above minimum code requirements to be used to meet the target.
- Jurisdictions interested in increasing affordable multifamily housing should know that applying the CARE rates has the overall impact of increasing utility cost savings for an all-electric building in most climate zones compared to a code compliant mixed fuel building, improving On-Bill cost-effectiveness.

Local jurisdictions may also adopt ordinances that amend different parts of the California Building Standards Code or may elect to amend other state or municipal codes. The decision regarding which code to amend will determine the specific requirements that must be followed for an ordinance to be legally enforceable. Reach codes that amend Part 6 of the California Building Code and require energy performance beyond state code minimums must demonstrate the proposed changes are cost-effective and obtain approval from the Energy Commission.

Table 22. Summary of Efficiency TDV Compliance Margins and Cost-Effectiveness

Climate Zone	Electric /Gas Utility	3-Story				5-Story			
		All-Electric Prescriptive Code	All-Electric + PV	Mixed Fuel Efficiency	Mixed Fuel Efficiency + PV + Battery	All-Electric Prescriptive Code	All-Electric + PV	Mixed Fuel Efficiency	Mixed Fuel Efficiency + PV
CZ01	PGE	26%	26%	1%	1%	14%	14%	0%	0%
CZ02	PGE	20%	20%	1%	1%	9%	9%	1%	1%
CZ03	PGE	21%	21%	1%	1%	11%	11%	0%	0%
CZ04	PGE	18%	18%	1%	1%	9%	9%	1%	1%
CZ04	CPAU	18%	18%	1%	1%	9%	9%	1%	1%
CZ05	PGE	23%	23%	1%	1%	12%	12%	0%	0%
CZ05	PGE/SCG	23%	23%	1%	1%	12%	12%	0%	0%
CZ06	SCE/SCG	18%	18%	1%	1%	9%	9%	0%	0%
CZ07	SDGE	20%	20%	0%	0%	11%	11%	0%	0%
CZ08	SCE/SCG	13%	13%	1%	1%	8%	8%	1%	1%
CZ09	SCE	13%	13%	1%	1%	7%	7%	1%	1%
CZ10	SCE/SCG	14%	14%	3%	3%	7%	7%	2%	2%
CZ10	SDGE	14%	14%	3%	3%	7%	7%	2%	2%
CZ11	PGE	14%	14%	3%	3%	8%	8%	2%	2%
CZ12	PGE	17%	17%	2%	2%	9%	9%	2%	2%
CZ12	SMUD/PGE	17%	17%	2%	2%	9%	9%	2%	2%
CZ13	PGE	13%	13%	4%	4%	7%	7%	2%	2%
CZ14	SCE/SCG	13%	13%	3%	3%	6%	6%	2%	2%
CZ14	SDGE	13%	13%	3%	3%	6%	6%	2%	2%
CZ15	SCE/SCG	5%	5%	5%	5%	3%	3%	3%	3%
CZ16	PG&E	24%	24%	5%	5%	9%	9%	2%	2%

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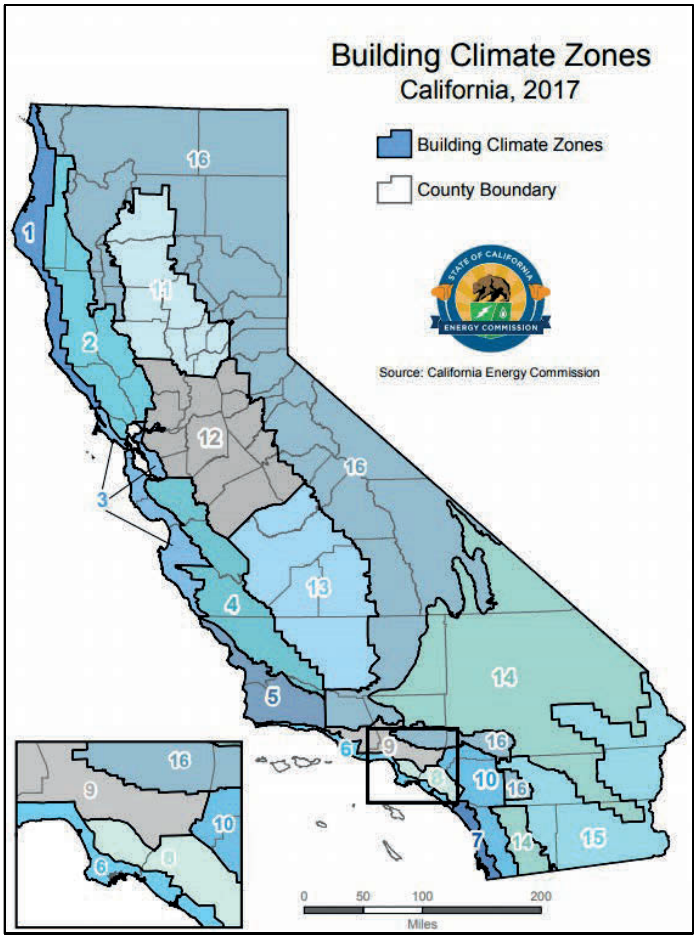
7 Appendices

7.1 Map of California Climate Zones

Climate zone geographical boundaries are depicted in Figure 3. The map in Figure 3 along with a zip-code search directory is available at: https://ww2.energy.ca.gov/maps/renewable/building_climate_zones.html

Figure 3. Map of California climate zones.



7.2 Utility Rate Schedules

The Reach Codes Team used the CA IOU and POU rate tariffs detailed below to determine the On-Bill savings for each package. The California Climate Credit was applied for both electricity and natural gas service for the IOUs using the 2022 credits shows below.[9] The credits were applied to reduce the total calculated annual bill, including any fixed fees or minimum bill amounts.

2022 Electric California Climate Credit Schedule

	April	May	June	July	Aug	Sept	Oct
PG&E	$39.30						$39.30
SCE	$59.00						$59.00
SDG&E					$64.17	$64.17	

Residential Natural Gas California Climate Credit

The 2022 Natural Gas California Climate Credit is distributed in April.

	2018‡	2019	2020	2021	2022	Total Value Received Per Household 2018-2022
PG&E	$30	$25	$27	$25	$47.83	**$154**
SDG&E	*	$34	$21	$18	$43.06	**$116**
Southwest Gas	$22	$25	$27	$28	$49.44	**$150**
SoCalGas	*	$50	$26	$22	$44.17	**$142**

Electricity rates reflect the most recent approved tariffs. Monthly gas rates were estimated based on the latest available gas rate (December 2022) and a curve to reflect how natural gas prices fluctuate with seasonal supply and demand. The seasonal curve was estimated from monthly residential tariffs between 2012 and 2022 (between 2020 and 2022 for CPAU). 12-month curves were created from monthly gas rates for each of the eleven years (three years for CPAU). These annual curves were then averaged to arrive at an average normalized annual curve. This was conducted separately for baseline and excess energy rates. Costs used in this analysis were then derived by establishing the most recent baseline and excess rate from the latest tariff as a reference point (December 2022), and then using the normalized curve to estimate the cost for the remaining months relative to the reference point rate.

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

7.2.1 Pacific Gas & Electric

The following pages provide details on the PG&E electricity and natural gas tariffs applied in this study. **Error! Reference source not found.** describes the baseline territories that were assumed for each climate zone. A net surplus compensation rate of $0.0474/ kWh was applied to any net annual electricity generation based on a one-year average of the rates between November 2021 and October 2022.

Table 23. PG&E Baseline Territory by Climate Zone

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

The PG&E monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in **Error! Reference source not found.**. These are applied to both the G-1 and GM rates. These rates are based on applying a normalization curve to the December 2022 tariff based on eleven years of historical gas data. See the beginning of Section **Error! Reference source not found. Error! Reference source not found.** for further details. The corresponding CARE rates are shown in **Error! Reference source not found.** and reflect the 20 percent discount per the GL-1 tariff. The GM master metered wather heating baseline quantity of 0.43 therms per dwelling unit per day in all baseline territories and in both seasons was applied to the centrally metered gas water heating.

Table 24. PG&E Monthly Gas Rate ($/therm)

Month	Total Charge	
	Baseline	Excess
January	$2.20579	$2.66008
February	$2.24291	$2.69637
March	$2.11750	$2.58278
April	$2.08101	$2.55500
May	$2.08062	$2.55844
June	$2.09104	$2.56928
July	$2.10404	$2.58189
August	$2.15162	$2.63251
September	$2.18718	$2.67910
October	$2.23153	$2.71934
November	$2.32121	$2.79158
December	$2.34123	$2.80922

Table 25. PG&E Monthly CARE (GL-1) Gas Rate ($/therm)

Month	Total CARE Charge	
	Baseline	Excess
January	$1.76463	$2.12806
February	$1.79433	$2.15710
March	$1.69400	$2.06622
April	$1.66480	$2.04400
May	$1.66449	$2.04675
June	$1.67283	$2.05543
July	$1.68323	$2.06551
August	$1.72129	$2.10601
September	$1.74974	$2.14328
October	$1.78523	$2.17547
November	$1.85697	$2.23327
December	$1.87298	$2.24738

Residential
GAS
Baseline Territories and Quantities 1/

Effective April 1, 2022 - Present

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

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

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

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

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

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U 39 San Francisco, California

	Revised	*Cal. P.U.C. Sheet No.*	53472-E
Cancelling	Revised	*Cal. P.U.C. Sheet No.*	52702-E

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

RATES: (Cont'd.) **E-TOU-C TOTAL BUNDLED RATES** (T)

Total Energy Rates ($ per kWh)	PEAK		OFF-PEAK	
Summer				
Total Usage	$0.48902	(I)	$0.42558	(I)
Baseline Credit (Applied to Baseline Usage Only)	($0.09054)	(R)	($0.09054)	(R)
Winter				
Total Usage	$0.39193	(I)	$0.37460	(I)
Baseline Credit (Applied to Baseline Usage Only)	($0.09054)	(R)	($0.09054)	(R)
Delivery Minimum Bill Amount ($ per meter per day)	$0.34810			
California Climate Credit (per household, per semi-annual payment occurring in the April and October bill cycles)	($39.30)			

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

(Continued)

Advice	6603-E-A	*Issued by*	*Submitted*	May 31, 2022
Decision		***Robert S. Kenney***	*Effective*	June 1, 2022
		Vice President, Regulatory Affairs	*Resolution*	

Pacific Gas and Electric Company
U 39 San Francisco, California

	Revised	Cal. P.U.C. Sheet No.	53474-E
Cancelling	Revised	Cal. P.U.C. Sheet No.	50175-E

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

SPECIAL CONDITIONS:

1. BASELINE (TIER 1) QUANTITIES: The following quantities of electricity are to be used to define usage eligible for the baseline credit:

BASELINE QUANTITIES (kWh PER DAY)

Baseline Territory*	Code B - Basic Quantities				Code H - All-Electric Quantities			
	Summer Tier 1		Winter Tier 1		Summer Tier 1		Winter Tier 1	
P	13.5	(R)	11.0	(R)	15.2	(R)	26.0	(R)
Q	9.8	(R)	11.0	(R)	8.5	(R)	26.0	(R)
R	17.7	(R)	10.4	(R)	19.9	(R)	26.7	(R)
S	15.0	(R)	10.2	(R)	17.8	(R)	23.7	(R)
T	6.5	(R)	7.5	(R)	7.1	(R)	12.9	(R)
V	7.1	(R)	8.1	(R)	10.4	(R)	19.1	(I)
W	19.2	(R)	9.8	(R)	22.4	(R)	19.0	(R)
X	9.8	(R)	9.7	(R)	8.5	(R)	14.6	(R)
Y	10.5	(R)	11.1	(R)	12.0	(R)	24.0	(R)
Z	5.9	(R)	7.8	(R)	6.7	(R)	15.7	(R)

2. TIME PERIODS FOR **E-TOU-C**: Times of the year and times of the day are defined as follows:

Summer (service from June 1 through September 30):

Peak:	4:00 p.m. to 9:00 p.m.	All days
Off-Peak:	All other times	

Winter (service from October 1 through May 31):

Peak:	4:00 p.m. to 9:00 p.m.	All days
Off-Peak:	All other times	

* The applicable baseline territory is described in Part A of the Preliminary Statement

(Continued)

Advice	6603-E-A	*Issued by*	*Submitted*	May 31, 2022
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		Vice President, Regulatory Affairs	*Resolution*	

Pacific Gas and Electric Company
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	Revised	Cal. P.U.C. Sheet No.	53424-E
Cancelling	Revised	Cal. P.U.C. Sheet No.	52653-E

ELECTRIC SCHEDULE D-CARE Sheet 1
LINE-ITEM DISCOUNT FOR CALIFORNIA ALTERNATE RATES FOR ENERGY (CARE) CUSTOMERS

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

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

RATES: Customers taking service on this rate schedule will receive a percentage discount ("A" below) on their total bundled charges on their otherwise applicable rate schedule (except for the California Climate Credit, which will not be discounted). In addition, customers will receive a percentage discount ("B" below) on the delivery minimum bill amount, if applicable. The CARE discount will be calculated for direct access and community choice aggregation customers based on the total charges as if they were subject to bundled service rates. Discounts will be applied as a residual reduction to distribution charges, after D-CARE customers are exempted from the Wildfire Fund Charge, Recovery Bond Charge, Recovery Bond (T)
Credit, and the CARE surcharge portion of the public purpose program charge (T)
used to fund the CARE discount. These conditions also apply to master-metered customers and to qualified sub-metered tenants where the master-meter customer is jointly served under PG&E's Rate Schedule D-CARE and either Schedule EM, ES, ESR, ET, or EM-TOU.

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

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

A.	D-CARE Discount:	34.947 % (Percent)	(I)
B.	Delivery Minimum Bill Discount:	50.000 % (Percent)	
C.	Master-Meter D-CARE Discount:	34.947 % (Percent)	(I)
D.	Master-Meter Delivery Minimum Bill Discount:	50.000 % (Percent)	

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

(Continued)

Advice	6603-E-A	*Issued by*	*Submitted*	May 31, 2022
Decision		***Robert S. Kenney***	*Effective*	June 1, 2022
		Vice President, Regulatory Affairs	*Resolution*	

7.2.2 Southern California Edison

The following pages provide details on are the SCE electricity tariffs applied in this study. **Error! Reference source not found.** describes the baseline territories that were assumed for each climate zone. A net surplus compensation rate of $ 0.04361/ kWh was applied to any net annual electricity generation based on a one-year average of the rates between November 2021 and October 2022

Table 26: SCE Baseline Territory by Climate Zone

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

Summer Daily Allocations (June through September)

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

Winter Daily Allocations (October through May)

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

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

Sheet 12 (T)

SPECIAL CONDITIONS

1. Applicable rate time periods are defined as follows:

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

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

EDISON

Southern California Edison		Revised	Cal. PUC Sheet No. 74502-E
Rosemead, California (U 338-E)	Cancelling	Revised	Cal. PUC Sheet No. 73968-E

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

Sheet 2

RATES

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

Option 4-9 PM / Option 4-9 PM-CPP	Delivery Service Total[1]	Generation[2] UG***	Generation[2] DWREC[3]
Energy Charge - $/kWh			
Summer Season - On-Peak	0.29820 (R)	0.23706 (I)	0.00000
Mid-Peak	0.29820 (R)	0.13648 (I)	0.00000
Off-Peak	0.25471 (I)	0.07939 (R)	0.00000
Winter Season - Mid-Peak	0.29820 (R)	0.17235 (I)	0.00000
Off-Peak	0.25471 (I)	0.10198 (R)	0.00000
Super-Off-Peak	0.23907 (I)	0.08508 (I)	0.00000
Baseline Credit**** - $/kWh	(0.09086) (I)	0.00000	
Fixed Recovery Charge - $/kWh	0.00117 (I)		
Basic Charge - $/day			
Single-Family Residence	0.031		
Multi-Family Residence	0.024		
Minimum Charge** - $/day			
Single Family Residence	0.346		
Multi-Family Residence	0.346		
Minimum Charge (Medical Baseline)** - $/day			
Single Family Residence	0.173		
Multi-Family Residence	0.173		
California Climate Credit[4]	(59.00)		
California Alternate Rates for Energy Discount - %	100.00*		
Family Electric Rate Assistance Discount -	100.00		
Option 4-9 PM-CPP			
CPP Event Energy Charge - $/kWh		0.80000	
Summer CPP Non-Event Credit On-Peak Energy Credit - $/kWh		(0.15170)	
Maximum Available Credit - $/kWh***** Summer Season		(0.50662) (I)	

* Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.
** The Minimum Charge is applicable when the Delivery Service Energy Charge, plus the applicable Basic Charge is less than the Minimum Charge.
*** The ongoing Competition Transition Charge CTC of ($0.00019) per kWh is recovered in the UG component of Generation. (R)
**** The Baseline Credit applies up to 100% of the Baseline Allocation, regardless of Time-of-Use time period. Additional Baseline Allocations apply for Customers with Heat Pump Water Heaters served under this Option. The Baseline Allocations are set forth in Preliminary Statement, Part H. (T) (T)
*****The Maximum Available Credit is the capped credit amount for CPP Customers dual participating in other demand response programs.
1 Total = Total Delivery Service rates are applicable to Bundled Service, Direct Access (DA) and Community Choice Aggregation Service (CCA Service) Customers, except DA and CCA Service Customers are not subject to the DWRBC rate component of this Schedule but instead pay the DWRBC as provided by Schedule DA-CRS or Schedule CCA-CRS.
2 Generation = The Gen rates are applicable only to Bundled Service Customers. See Special Condition below for PCIA recovery.
3 DWREC = Department of Water Resources (DWR) Energy Credit – For more information on the DWR Energy Credit, see the Billing Calculation Special Condition of this Schedule.
4 Applied on an equal basis, per household, semi-annually. See the Special Conditions of this Schedule for more information.

(Continued)

(To be inserted by utility)	Issued by	(To be inserted by Cal. PUC)
Advice 4864-E	Michael Backstrom	Date Submitted Sep 15, 2022
Decision 22-08-001	Vice President	Effective Oct 1, 2022
2C17		Resolution

Southern California Edison
Rosemead, California (U 338-E)

Revised Cal. PUC Sheet No. 74493-E
Cancelling Revised Cal. PUC Sheet No. 73964-E

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

APPLICABILITY

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

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

TERRITORY

Within the entire territory served.

RATES

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

CARE Discount:

A 28.9 percent discount is applied to a CARE Customer's bill prior to the application of the Public Utilities (R)
Commission Reimbursement Fee (PUCRF) and any applicable user fees, taxes, and late payment charges. CARE Customers are required to pay the PUCRF and any applicable user fees, taxes, and late payment charges in full. In addition, CARE Customers are exempt from paying the CARE Surcharge of $0.00931 per kWh and the Wildfire Fund Non-Bypassable Charge of $0.00652 per kWh. (I)
The 28.9 percent discount, in addition to these exemptions result in an average effective CARE Discount (R)
of 32.5 percent.

(Continued)

(To be inserted by utility)	Issued by	(To be inserted by Cal. PUC)
Advice 4864-E	Michael Backstrom	Date Submitted Sep 15, 2022
Decision 22-08-001	Vice President	Effective Oct 1, 2022
1C10		Resolution

7.2.3 Southern California Gas

Following are the SoCalGas natural gas tariffs applied in this study. **Error! Reference source not found.** describes the baseline territories that were assumed for each climate zone.

Table 27. SoCalGas Baseline Territory by Climate Zone

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

The SoCalGas monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in **Error! Reference source not found.**. These rates are based on applying a normalization curve to the December 2022 tariff based on eleven years of historical gas data. See the beginning of Section **Error! Reference source not found. Error! Reference source not found.** for further details. Long-term historical natural gas rate data was only available for SoCalGas' procurement charges.[10] The baseline and excess transmission charges were found to be consistent over the course of a year and applied for the entire year based on 2022 rates. CARE rates reflect the 20 percent discount per the GR tariff.

Table 28. SoCalGas Monthly Gas Rate ($/therm)

Month	Procurement Charge	Transportation Charge		Total Charge	
		Baseline	Excess	Baseline	Excess
January	$0.90581	$0.82487	$1.23877	$1.73068	$2.14458
February	$0.83669	$0.82487	$1.23877	$1.66156	$1.84967
March	$0.80596	$0.82487	$1.23877	$1.63083	$1.82938
April	$0.71941	$0.82487	$1.23877	$1.54428	$1.75890
May	$0.77049	$0.82487	$1.23877	$1.59536	$1.78548
June	$0.86253	$0.82487	$1.23877	$1.68740	$1.83337
July	$0.87687	$0.82487	$1.23877	$1.70174	$1.86833
August	$0.95391	$0.82487	$1.23877	$1.77878	$1.91089
September	$0.85896	$0.82487	$1.23877	$1.68383	$1.83611
October	$0.84147	$0.82487	$1.23877	$1.66634	$1.84936
November	$0.89018	$0.82487	$1.23877	$1.71505	$1.88836
December	$1.05329	$0.82487	$1.23877	$1.87816	$1.98294

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

Schedule No. GM Sheet 2
MULTI-FAMILY SERVICE
(Includes GM-E, GM-C, GM-EC, GM-CC, GT-ME, GT-MC and all GMB Rates)

(Continued)

APPLICABILITY (Continued)

Multi-family Accommodations built prior to December 15, 1981 and currently served under this schedule may also be eligible for service under Schedule No. GS. If an eligible Multi-family Accommodation served under this schedule converts to an applicable submetered tariff, the tenant rental charges shall be revised for the duration of the lease to reflect removal of the energy related charges.

Eligibility for service hereunder is subject to verification by the Utility.

TERRITORY

Applicable throughout the service territory.

RATES

	GM/GT-M	GMB/GT-MB
Customer Charge, per meter, per day:	16.438¢	$19.792
For "Space Heating Only" customers, a daily Customer Charge applies during the winter period from November 1 through April 30[1/]:	33.149¢	

GM

	GM-E	GM-EC[3/]	GT-ME
Baseline Rate, per therm (baseline usage defined per Special Conditions 3 and 4):			
Procurement Charge:[2/]	110.870¢	110.870¢	N/A
Transmission Charge:	90.256¢	90.256¢	90.256¢
Total Baseline Charge (all usage):	201.126¢	201.126¢	90.256¢
Non-Baseline Rate, per therm (usage in excess of baseline usage):			
Procurement Charge:[2/]	110.870¢	110.870¢	N/A
Transmission Charge:	135.367¢	135.367¢	135.367¢
Total Non Baseline Charge (all usage):	246.237¢	246.237¢	135.367¢

3. Baseline Usage: The following usage is to be billed at the Baseline rate for Multi-family Accommodation units. Usage in excess of applicable Baseline allowances will be billed at the Non-Baseline rate.

Per Residence	Daily Therm Allowance for Climate Zones*		
	1	2	3
Summer (May 1- Oct.31)	0.424	0.424	0.424
Winter On-Peak (Dec., Jan., and Feb.)	1.600	1.867	2.600
Winter Off-Peak (Nov., Mar., and Apr.)	0.874	0.923	1.714

7.2.4 San Diego Gas & Electric

Following are the SDG&E electricity and natural gas tariffs applied in this study. **Error! Reference source not found.** describes the baseline territories that were assumed for each climate zone. A net surplus compensation rate of $0.04174 / kWh was applied to any net annual electricity generation based on a one-year average of the rates between January 2022 and December 2022.

Table 29. SDG&E Baseline Territory by Climate Zone

Climate Zone	Baseline Territory
CZ07	Coastal
CZ10	Inland
CZ14	Mountain

The SDG&E monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in **Error! Reference source not found.**. These rates are based on applying a normalization curve to the December 2022 tariff based on eleven years of historical gas data. See the beginning of Section **Error! Reference source not found. Error! Reference source not found.** for further details. CARE rates reflect the 20 percent discount per the G-CARE tariff.

Table 30. SDG&E Monthly Gas Rate ($/therm)

Month	Total Charge	
	Baseline	Excess
January	$2.33762	$2.34748
February	$2.26751	$2.28440
March	$2.25119	$2.27016
April	$2.20192	$2.22744
May	$2.24252	$2.26403
June	$2.31819	$2.33060
July	$2.32406	$2.33630
August	$2.37527	$2.38090
September	$2.33542	$2.34971
October	$2.30366	$2.32151
November	$2.31722	$2.33381
December	$2.45653	$2.73517

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

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

SCHEDULE GM

Sheet 2

MULTI-FAMILY NATURAL GAS SERVICE
(Includes Rates for GM, GM-C and GTC/GTCA)

RATES

	GM	GM-C		GTC/GTCA[1]
Baseline Rate, per therm (baseline usage defined in Special Condition 4)				
Procurement Charge[2]............................	$1.05454	$1.42421	I	N/A
Transmission Charge	$1.40199	$1.40199		$1.40201
Total Baseline Charge.............................	$2.45653	$2.82620	I	$1.40201
Non-Baseline Rate (usage in excess of baseline usage)				
Procurement Charge[2]......................................	$1.05454	$1.42421	I	N/A
Transmission Charge......................................	$1.68063	$1.68063		$1.68065
Total Non-Baseline Charge................................	$2.73517	$3.10484	I	$1.68065
Minimum Bill, per day[3]				
Non-CARE customers......................................	$0.13151	$0.13151		$0.13151
CARE customers......................................	$0.10521	$0.10521		$0.10521

Franchise Fee Differential:

A Franchise Fee Differential of 1.03% will be applied to the monthly billings calculated under this schedule for all customers within the corporate limits of the City of San Diego. Such Franchise Fee Differential shall be so indicated and added as a separate item to bills rendered to such customers.

Additional Charges
Rates may be adjusted to reflect any applicable taxes, franchise fees or other fees, regulatory surcharges, and interstate or intrastate pipeline charges that may occur.

SPECIAL CONDITIONS

1. Definitions. The definitions of principal terms used in this schedule are found either herein or in Rule 1, Definitions.

2. Number of Therms. The number of therms to be billed shall be determined in accordance with Rule 2. The daily therm allowance in the Baseline Usage, shown in Special Condition 4, shall be multiplied by the number of qualified residential units. It is the responsibility of the customer to advise the Utility within 15 days following any change in the submetering arrangements or the number of dwelling units or Mobilehome Park spaces provided gas service. The number of qualifying units is subject to verification by the Utility.

3. Exclusions. Gas service for non-domestic enterprises such as rooming houses, boarding houses, dormitories, rest homes, military barracks, transient trailer parks, stores, restaurants, service stations, and other similar establishments will be separately metered and billed under the applicable schedules.

[1] The rates for core transportation-only customers, with the exception of customers taking service under Schedule GT-NGV, include any FERC Settlement Proceeds Memorandum Account (FSPMA) credit adjustments.
[2] This charge is applicable to Utility Procurement Customers and includes the GPC and GPC-A Procurement Charges shown in Schedule GPC which are subject to change monthly as set forth in Special Condition 7.
[3] Effective starting May 1, 2020, the minimum bill is calculated as the minimum bill charge of $0.13151 per day times the number of days in the billing cycle (approximately $4 per month) with a 20% discount applied for CARE customer resulting in a minimum bill charge of $0.10521 per day (approximately $3.20 per month).

(Continued)

2H7 Issued by Submitted Dec 9, 2022
Advice Ltr. No. 3145-G Effective Dec 10, 2022

SDG&E
San Diego Gas & Electric Company
San Diego, California

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

Canceling Revised Cal. P.U.C. Sheet No. 35747-E

SCHEDULE TOU-DR1

Sheet 2

RESIDENTIAL TIME-OF-USE

RATES

Total Rates:

Description – TOU DR1	UDC Total Rate		DWR BC + WF-NBC		EECC Rate + DWR Credit		Total Rate	
Summer:								
On-Peak	0.26467	I	0.00309	R	0.42232	R	0.69008	R
Off-Peak	0.26467	I	0.00309	R	0.19003	R	0.45779	I
Super Off-Peak	0.26467	I	0.00309	R	0.06802	R	0.33578	I
Winter:								
On-Peak	0.39848	I	0.00309	R	0.14268	R	0.54425	R
Off-Peak	0.39848	I	0.00309	R	0.08004	R	0.48161	I
Super Off-Peak	0.39848	I	0.00309	R	0.06187	R	0.46344	I
Summer Baseline Adjustment Credit up to 130% of Baseline	(0.10182)	R					(0.10182)	R
Winter Baseline Adjustment Credit up to 130% of Baseline	(0.10182)	R					(0.10182)	R
Minimum Bill ($/day)	0.350						0.350	

Note:

(1) Total Rates consist of UDC, Schedule DWR-BC (Department of Water Resources Bond Charge), Schedule WF-NBC (CA Wildfire Fund charge) and Schedule EECC (Electric Energy Commodity Cost) rates, with the EECC rates reflecting a DWR Credit. EECC rates are applicable to bundled customers only. See Special Condition 16 for PCIA (Power Charge Indifference Adjustment) recovery.

(2) Total Rates presented are for customers that receive commodity supply and delivery service from Utility.

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

(4) As identified in the rates tables, customer bills will also include line-item summer and winter credits for usage up to 130% of baseline to provide the rate capping benefits adopted by Assembly Bill 1X and Senate Bill 695. R

(5) WF-NBC rate is 0.00652 + DWR-BC Bond Charge is (0.00343).

(Continued)

2C10

Advice Ltr. No. 4004-E

Decision No. 22-03-003

Issued by
Dan Skopec
Vice President
Regulatory Affairs

Submitted May 16, 2022

Effective Jun 1, 2022

Resolution No.

Time Periods

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

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

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

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

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

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

(1) Total Rates consist of UDC, Schedule DWR-BC (Department of Water Resources Bond Charge), and Schedule EECC (Electric Energy Commodity Cost) rates, with the EECC rates reflecting a DWR Credit of $0.00000 that customers receive on their monthly bills.
(2) Total Rates presented are for customers that receive commodity supply and delivery service from Utility. Differences in total rates paid by Direct Access (DA) and Community Choice Aggregation (CCA) customers are identified in Schedule DA-CRS and CCA-CRS, respectively.
(3) DWR-BC charges do not apply to CARE or Medical Baseline customers.
(4) Total Effective CARE Rate is presented for illustrative purposes only, and reflects the average effective CARE discount CARE customers receive which consists of (a) exemptions from paying the CARE Surcharge, DWR-BC, California Solar Initiative (CSI) and Vehicle-Grid Integration (VGI) Costs; (b) a 50% minimum bill relative to Non-CARE; and (c) a separate line-item bill discount for all qualified residential CARE customers.
(5) Current DWR-BC as presented is now used for collecting the California Wildfire Fund Charge effective Oct 1, 2020 (See Schedule WF – NBC). DWR BC will be renamed at implementation of SDG&E's new customer information system.

San Diego Gas & Electric Company
San Diego, California

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

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

SCHEDULE E-CARE

Sheet 1

CALIFORNIA ALTERNATE RATES FOR ENERGY

APPLICABILITY

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

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

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

3) Non-profit group living facilities.

4) Agricultural employee housing facilities.

TERRITORY

Within the entire territory served by the Utility.

DISCOUNT

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

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

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

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

(Continued)

1C5

Advice Ltr. No. 3928-E

Issued by
Dan Skopec
Vice President

Submitted Dec 30, 2021
Effective Jan 1, 2022

7.2.5 City of Palo Alto Utilities

Following are the CPAU electricity and natural gas tariffs applied in this study. The CPAU monthly gas rate in $/therm was applied on a monthly basis according to the rates shown in **Error! Reference source not found.**. These rates are based on applying a normalization curve to the December 2022 tariff based on three years of historical gas data. See the beginning of Section **Error! Reference source not found. Error! Reference source not found.** for further details. The monthly service charge applied was $106.90 per month per the December 2022 G-2 tariff.

Table 31. CPAU Monthly Gas Rate ($/therm)

Month	G2 Volumetric Totals
January	$1.80964
February	$1.67009
March	$1.68480
April	$1.68698
May	$1.78478
June	$1.88288
July	$1.88355
August	$2.06943
September	$2.06798
October	$2.08553
November	$2.09681
December	$2.45700

RESIDENTIAL ELECTRIC SERVICE

UTILITY RATE SCHEDULE E-1

A. APPLICABILITY:

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

B. TERRITORY:

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

C. UNBUNDLED RATES:

Per kilowatt-hour (kWh)	Commodity	Distribution	Public Benefits	Total
Tier 1 usage	$0.08547	$0.05429	$0.00469	$0.14445
Tier 2 usage Any usage over Tier 1	0.11858	0.08008	0.00469	0.20335
Minimum Bill ($/day)				0.3447

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

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	$0.12151	$0.09276	$0.00469	$0.21896
Winter Period	0.08715	0.06171	0.00469	0.15355
Minimum Bill ($/day)				0.8777

EXPORT ELECTRICITY COMPENSATION

UTILITY RATE SCHEDULE E-EEC-1

A. APPLICABILITY:
This Rate Schedule applies in conjunction with the otherwise applicable Rate Schedules for each Customer class. This Rate Schedule may not apply in conjunction with any time-of-use Rate Schedule. This Rate Schedule applies to Customer-Generators as defined in Rule and Regulation 2 who are either not eligible for Net Energy Metering or who are eligible for Net Energy metering but elect to take Service under this Rate Schedule.

B. TERRITORY:
Applies to locations within the service area of the City of Palo Alto.

C. RATE:
The following buyback rate shall apply to all electricity exported to the grid.

	Per kWh
Export electricity compensation rate	$0.1045

7.2.6 Sacramento Municipal Utilities District (Electric Only)

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

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

II. Firm Service Rates

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

	Effective as of October 1, 2021	Effective as of March 1, 2022	Effective as of January 1, 2023
Time-of-Day (5-8 p.m.) Rate (RT02)			
Non-Summer Season (October - May)			
System Infrastructure Fixed Charge *per month per meter*	$22.70	$23.05	$23.50
Electricity Usage Charge			
Peak *$/kWh*	$0.1494	$0.1516	$0.1547
Off-Peak *$/kWh*	$0.1082	$0.1098	$0.1120
Summer Season (June - September)			
System Infrastructure Fixed Charge *per month per meter*	n/a	$23.05	$23.50
Electricity Usage Charge			
Peak *$/kWh*	n/a	$0.3215	$0.3279
Mid-Peak *$/kWh*	n/a	$0.1827	$0.1864
Off-Peak *$/kWh*	n/a	$0.1323	$0.1350

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

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

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

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

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

[1] See Section V. Conditions of Service

C. Master-Metered Multifamily Accommodation and Mobile Home Park Billing (Rate Category RSMM) Closed

	Effective as of October 1, 2021	Effective as of March 1, 2022	Effective as of January 1, 2023
Master Metered Multifamily and Mobile Home Park Billing (Closed)			
Non-Summer Season (October - May)			
System Infrastructure Fixed Charge *per month per meter*	$22.70	$23.05	$23.50
Electricity Usage Charge			
All kWh usage per month *$/kWh*	$0.1279	$0.1298	$0.1324
Summer Season (June - September)			
System Infrastructure Fixed Charge *per month per meter*	n/a	$23.05	$23.50
Electricity Usage Charge			
All kWh usage per month *$/kWh*	n/a	$0.1486	$0.1516

7.2.7 Fuel Escalation Assumptions

The average annual escalation rates in **Error! Reference source not found.** were used in this study. These are based on assumptions from the CPUC 2021 En Banc hearings on utility costs through 2030 (California Public Utilities Commission, 2021a). Escalation rates through the remainder of the 30-year evaluation period are based on the escalation rate assumptions within the 2022 TDV factors. No data was available to estimate electricity escalation rates for CPAU and SMUD, therefore electricity escalation rates for PG&E and statewide natural gas escalation rates were applied.

Table 32: Real Utility Rate Escalation Rate Assumptions

	Statewide Natural Gas Residential Average Rate (%/year, real)	Electric Residential Average Rate (%/year, real)		
		PG&E	SCE	SDG&E
2023	4.6%	1.8%	1.6%	2.8%
2024	4.6%	1.8%	1.6%	2.8%
2025	4.6%	1.8%	1.6%	2.8%
2026	4.6%	1.8%	1.6%	2.8%
2027	4.6%	1.8%	1.6%	2.8%
2028	4.6%	1.8%	1.6%	2.8%
2029	4.6%	1.8%	1.6%	2.8%
2030	4.6%	1.8%	1.6%	2.8%
2031	2.0%	0.6%	0.6%	0.6%
2032	2.4%	0.6%	0.6%	0.6%
2033	2.1%	0.6%	0.6%	0.6%
2034	1.9%	0.6%	0.6%	0.6%
2035	1.9%	0.6%	0.6%	0.6%
2036	1.8%	0.6%	0.6%	0.6%
2037	1.7%	0.6%	0.6%	0.6%
2038	1.6%	0.6%	0.6%	0.6%
2039	2.1%	0.6%	0.6%	0.6%
2040	1.6%	0.6%	0.6%	0.6%
2041	2.2%	0.6%	0.6%	0.6%
2042	2.2%	0.6%	0.6%	0.6%
2043	2.3%	0.6%	0.6%	0.6%
2044	2.4%	0.6%	0.6%	0.6%
2045	2.5%	0.6%	0.6%	0.6%
2046	1.5%	0.6%	0.6%	0.6%
2047	1.3%	0.6%	0.6%	0.6%
2048	1.6%	0.6%	0.6%	0.6%
2049	1.3%	0.6%	0.6%	0.6%
2050	1.5%	0.6%	0.6%	0.6%
2051	1.8%	0.6%	0.6%	0.6%
2052	1.8%	0.6%	0.6%	0.6%

7.3 Cost Details

Table 33 presents additional detail on the first cost assumptions for the central water heating systems. For the 5-story prototype costs are provided both for a CO_2 refrigerant Sanden-based and R-134a refrigerant Colmac-based heat pump water heater designs. The results presented in the main body of this report are based on the Sanden design. A sensitivity analysis was also conducted for a Colmac design (see Appendix 7.5 Central Heat Pump Water Heater Comparison) and the cost comparison is presented here. All costs are based on data from the 2022 Multifamily All-Electric CASE Report (Statewide CASE Team, 2020c).

Table 33. Heat Pump Water Heater First Costs per Building (Present Value (2023$))

Item	3-Story (36-units)			5-Story (88-units)			
	Gas Boiler (CZs 1-9)	Gas Boiler (CZs 10-16)	Heat Pump	Gas Boiler (CZs 1-9)	Gas Boiler (CZs 10-16)	Heat Pump (Sanden)	Heat Pump (Colmac)
Water Heating Equipment	$87,602	$87,602	$140,907	$135,146	$135,146	$244,742	$319,485
Solar Thermal Collector	$39,800	$46,888	n/a	$74,740	$91,776	n/a	n/a
Gas Piping	$8,890	$8,890	n/a	$9,065	$9,065	n/a	n/a
Electrical Circuits	n/a	n/a	$25,000	n/a	n/a	$25,000	$25,000
Overhead & Markup	$37,480	$39,430	$45,624	$60,212	$64,896	$74,179	$94,733
Total	**$173,772**	**$182,810**	**$211,531**	**$279,163**	**$300,883**	**$343,920**	**$439,218**

Table 34 presents additional detail on the first cost assumptions for the space hating systems.

Table 34. Heat Pump Space Heater First Costs per Dwelling Unit (Present Value (2023$)

Item	3-Story		5-Story		Source & Notes
	Furnace + Split AC	Heat Pump	Furnace + Split HP	Heat Pump	
Dwelling Unit HVAC	$5,651	$5,460	$6,109	$5,460	Gas system costs based on 2022 Multifamily All-Electric CASE Report. Heat pump costs based on online equipment research indicating a 2-ton HP is $191 less than a furnace/AC of the same size.
Refrigerant Piping	$563	$563	$423	$423	2022 Multifamily All-Electric CASE Report.
Gas Piping	$92	$0	$227	$0	
Electrical Circuits	$0	$150	$0	$150	
Labor	$9,904	$6,985	$9,904	$6,985	Based on the 2022 Multifamily All-Electric CASE Report with adjustments to align with updated equipment costs.
Overhead & Markup	$4,457	$3,618	$4,582	$3,579	Based on a 27% markup
Total	**$20,667**	**$16,776**	**$21,245**	**$16,597**	
Incremental Cost		**($3,891)**		**($4,647)**	

7.4 PG&E Gas Infrastructure Cost Memo

Pacific Gas and Electric Company

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Director – Grid Edge
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San Francisco, CA 94177-00001

December 5, 2019

Energy Commission Staff:

On March 2, 2018, PG&E provided gas extension cost estimates for residential existing and new subdivisions (see attached memo). We have recently updated our estimates and are therefore providing an updated memo.

In addition to mainline and service extension costs, we are also providing estimates of the cost of gas meters for different building types including both residential and commercial customers. These estimates are based on PG&E historical jobs.

Developing gas extension cost estimates is complex and the actual costs are project dependent. Costs vary widely with location, terrain, distance to the nearest main, joint trenching, materials, number of dwellings per development, and several other site and job-specific conditions. For these reasons, it is not practical to come up with estimates that represent every case. Instead we are including estimates based on historical averages taken from projects within PG&E's territory. It is not recommended to compare specific project costs to these estimates as any number of factors could lead to higher or lower costs than these averages are representing.

We are also including estimates for in-house gas infrastructure costs and specific plan review costs. These estimates are from external sources, and are not based on PG&E data, but have been provided for the sake of completeness and for use in energy efficiency analysis.

To further anchor the estimates, several assumptions have been made:

1. It is assumed that during new construction, gas infrastructure will likely be joint trenched with electric infrastructure. As a result, the incremental cost of trenching associated with the gas infrastructure alone is minimal. Therefore, all mainline cost estimates exclude trench costs. Service extension cost estimates include both estimates with and without trench costs. In the case where new construction would require overhead electric and underground gas infrastructure, the estimates with trench costs included for service extensions should be utilized.

2. It is assumed that new construction in an existing subdivision would not generally require a mainline extension. In cases where a mainline extension would be required to an existing subdivision, the costs are highly dependent on the location, terrain, and distance to the nearest main.

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3. These estimates are for total costs. The cost estimates have not been reduced to account for the portion of the costs paid by all customers due to application of Rule 15[1] and Rule 16[2] allowances. Hence, costs to the specific customer may be lower than the estimates below, as the specific customer benefits from the Rule 15 and Rule 16 allowances.

Table 1: PG&E Gas Infrastructure Cost Estimates

	Existing Subdivision/Development	New Greenfield Subdivision/Development
Mainline Extension	N/A[3]	Single-Family $17/ft[4] Multi-Family $11/ft[4]
Service Extension (Typically 1" pipe from mainline to the meter)	$6750 per service/building[4] (excludes trench costs) $9200 per service/building[4] (includes trench costs)	$1300 per service/building[4] (includes mainline extension costs within the subdivision; excludes trench costs) $1850 per service/building[4] (includes mainline extension costs within the subdivision; includes trench costs)
Meter	Residential Single Family $300 per meter[5] Residential Multi-Family $300 per meter + $300 per meter manifold outlet[5] Small/Medium Commercial $3600 per meter[6]	Residential Single Family $300 per meter[5] Residential Multi-Family $300 per meter + $300 per meter manifold outlet[5] Small/Medium Commercial $3600 per meter[6]

1 https://www.pge.com/tariffs/tm2/pdf/ELEC_RULES_15.pdf
2 https://www.pge.com/tariffs/tm2/pdf/ELEC_RULES_16.pdf
3 It is assumed that new construction in an existing subdivision would not require a main extension.
4 Estimates based on PG&E jobs from Jan 2016 - Dec 2017 from PG&E's Service Planning team.
5 Estimates from PG&E's Dedicated Estimating Team. For Multi-Family units, the costs of $300 per meter and $300 per meter manifold outlet should be combined for a total of $600 per meter.
6 PG&E Marginal Customer Access Cost Estimates presented in the 2018 Gas Cost Allocation Proceedings (GCAP), A.17-09-006, Exhibit PG&E-2, Appendix A, Section A, Table A-1. The Average Connection Cost per Customer values were included in the MCAC workpaper that accompanied the GCAP testimony

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	Large Commercial $32,000 per meter[6]	Large Commercial $32,000 per meter[6]

Note: Service extension cost estimates for New Greenfield Subdivisions include mainline extension costs as well. Therefore, mainline cost estimates can be ignored for the purpose of estimating total project costs.

Table 2: Gas Infrastructure Cost Estimates from Other Sources

	Existing Subdivision/Development	New Greenfield Subdivision/Development
In-House Infrastructure	Single-Family $800[7] Multi-Family $600 per unit[7] Medium Office $600-4500[7,8] Medium Retail $10,000[8]	Single-Family $800[7] Multi-Family $600 per unit[7] Medium Office $600-4500[7,8] Medium Retail $10,000[8]
Plan Review (Will vary by city and often not a fixed fee)	Residential Palo Alto - $850[9] Nonresidential Palo Alto - $2316[9]	Residential Palo Alto - $850[9] Nonresidential Palo Alto - $2316[9]

Please let us know if there are any follow-up questions or clarifications.

Best regards,

Janice Berman

[7] Frontier Energy, Inc., Misti Bruceri & Associates, LLC. 2019. "2019 Cost-effectiveness Study: Low Rise Residential New Construction." Available at: https://localenergycodes.com/content/performance-ordinances
[8] TRC, EnergySoft. 2019. "2019 Nonresidential New Construction Reach Code Cost Effectiveness Study." Available at: https://localenergycodes.com/content/performance-ordinances
[9] TRC. 2018. "City of Palo Alto 2019 Title 24 Energy Reach Code Cost Effectiveness Analysis Draft." Available at: http://cityofpaloalto.org/civicax/filebank/documents/66742

7.5 Central Heat Pump Water Heater Comparison

Table 35 presents energy and cost-effectiveness results for a R-134a refrigerant based system design using a Colmac central heat pump water heater in the 5-story prototype. This was only found to be cost-effective based on at least one of the two metrics in Climate Zones 1, 4 in CPAU territory, and 16.

Table 35. 5-Story Cost-Effectiveness: All-Electric Prescriptive Code with R-134a Heat Pump Water Heater

Climate Zone	Electric /Gas Utility	Efficiency TDV Comp Margin	Source Comp Margin	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Utility Cost Savings		Incremental Cost		On-Bill		TDV	
						First Year	Lifecycle (2022$)	First Year	Lifecycle (2022$)	B/C Ratio	NPV	B/C Ratio	NPV
CZ01	PGE	6%	6%	-1,496	147	($155)	($1,240)	($3,556)	($4,223)	3.4	$2,984	>1	$5,870
CZ02	PGE	4%	2%	-1,197	120	($145)	($1,513)	$1,691	$2,749	0.0	($4,262)	0.5	($1,287)
CZ03	PGE	6%	3%	-1,166	120	($138)	($1,360)	$1,691	$2,749	0.0	($4,109)	0.8	($523)
CZ04	PGE	4%	2%	-1,116	113	($76)	($49)	$1,691	$2,749	0.0	($2,798)	0.7	($949)
CZ04	CPAU	4%	2%	-1,116	113	$185	$7,144	$1,718	$2,776	2.6	$4,368	0.6	($976)
CZ05	PGE	5%	2%	-1,161	117	($137)	($1,391)	$1,691	$2,749	0.0	($4,140)	0.5	($1,412)
CZ05	PGE/SCG	5%	2%	-1,161	117	($189)	($3,016)	$1,691	$2,749	0.0	($5,765)	0.5	($1,412)
CZ06	SCE/SCG	4%	1%	-1,000	104	($92)	($879)	$1,691	$2,749	0.0	($3,628)	0.6	($1,013)
CZ07	SDGE	5%	2%	-996	106	($183)	($3,216)	$1,691	$2,749	0.0	($5,965)	0.7	($936)
CZ08	SCE/SCG	3%	1%	-948	100	($156)	($2,413)	$1,691	$2,749	0.0	($5,162)	0.7	($695)
CZ09	SCE	3%	0%	-966	100	($132)	($1,863)	$1,691	$2,749	0.0	($4,612)	0.7	($738)
CZ10	SCE/SCG	3%	1%	-962	84	($188)	($3,375)	$1,444	$2,395	0.0	($5,770)	0.3	($1,596)
CZ10	SDGE	3%	1%	-962	84	($239)	($4,959)	$1,444	$2,395	0.0	($7,354)	0.3	($1,596)
CZ11	PGE	4%	3%	-1,029	92	($165)	($2,487)	$1,444	$2,395	0.0	($4,882)	0.4	($1,367)
CZ12	PGE	4%	3%	-1,081	96	($172)	($2,591)	$1,444	$2,395	0.0	($4,986)	0.3	($1,667)
CZ12	SMUD/PGE	4%	3%	-1,081	96	$26	$1,988	$1,444	$2,395	0.8	($407)	0.3	($1,667)
CZ13	PGE	3%	2%	-976	88	($156)	($2,361)	$1,444	$2,395	0.0	($4,756)	0.4	($1,452)
CZ14	SCE/SCG	2%	-1%	-1,045	84	($210)	($3,880)	$1,444	$2,395	0.0	($6,275)	0.1	($2,056)
CZ14	SDGE	2%	-1%	-1,045	84	($270)	($5,725)	$1,444	$2,395	0.0	($8,120)	0.1	($2,056)
CZ15	SCE/SCG	2%	-1%	-718	65	($146)	($2,713)	$1,444	$2,395	0.0	($5,108)	0.3	($1,564)
CZ16	PG&E	-5%	6%	-1,913	142	($276)	($4,142)	($3,803)	($4,577)	1.1	$435	1.2	$746

7.6 Summary of Measures by Package

Table 36 provides the details of the measures in each of the efficiency package by climate zone. The measures are the same for the 3-story and 5-story prototypes. Table 37 presents the PV capacities per dwelling unit in the upgrade packages. In Climate Zone 6 for the mixed fuel case in the 5-story prototype there is no upgrade to the PV system capacity as the prescriptive PV system already offset all of the estimated electricity use.

Table 36. Mixed Fuel Efficiency Package Measures

Climate Zone	0.70 Roof Solar Reflectance	0.24 U-Factor Windows	0.35 W/cfm	Verified Low Leakage Ducts in Conditioned Space
1			X	X
2				X
3				X
4				X
5				X
6				X
7				X
8				X
9	X			X
10	X		X	X
11	X		X	X
12	X		X	X
13	X		X	X
14	X		X	X
15	X		X	X
16		X	X	X

Table 37. Upgrade Package PV Capacities (kW-DC)

Climate Zone	All-Electric + PV		Mixed Fuel + PV	
	3-Story	5-Story	3-Story	5-Story
CZ01	4.41	4.35	3.69	3.43
CZ02	3.56	3.58	3.02	2.98
CZ03	3.31	3.29	2.80	2.72
CZ04	3.21	3.27	2.73	2.75
CZ05	3.04	3.08	2.57	2.55
CZ06	2.91	3.04	2.49	2.68
CZ07	3.09	3.21	2.64	2.74
CZ08	3.18	3.30	2.76	2.86
CZ09	3.04	3.16	2.63	2.73
CZ10	3.20	3.30	2.79	2.86
CZ11	3.90	3.95	3.42	3.43
CZ12	3.53	3.60	3.05	3.08
CZ13	3.77	3.84	3.32	3.36
CZ14	3.20	3.23	2.79	2.79
CZ15	3.93	3.94	3.58	3.58
CZ16	3.79	3.76	2.60	2.90

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.

Visit LocalEnergyCodes.com to access our resources and sign up for newsletters.

Contact info@localenergycodes.com for no-charge assistance from expert Reach Code advisors

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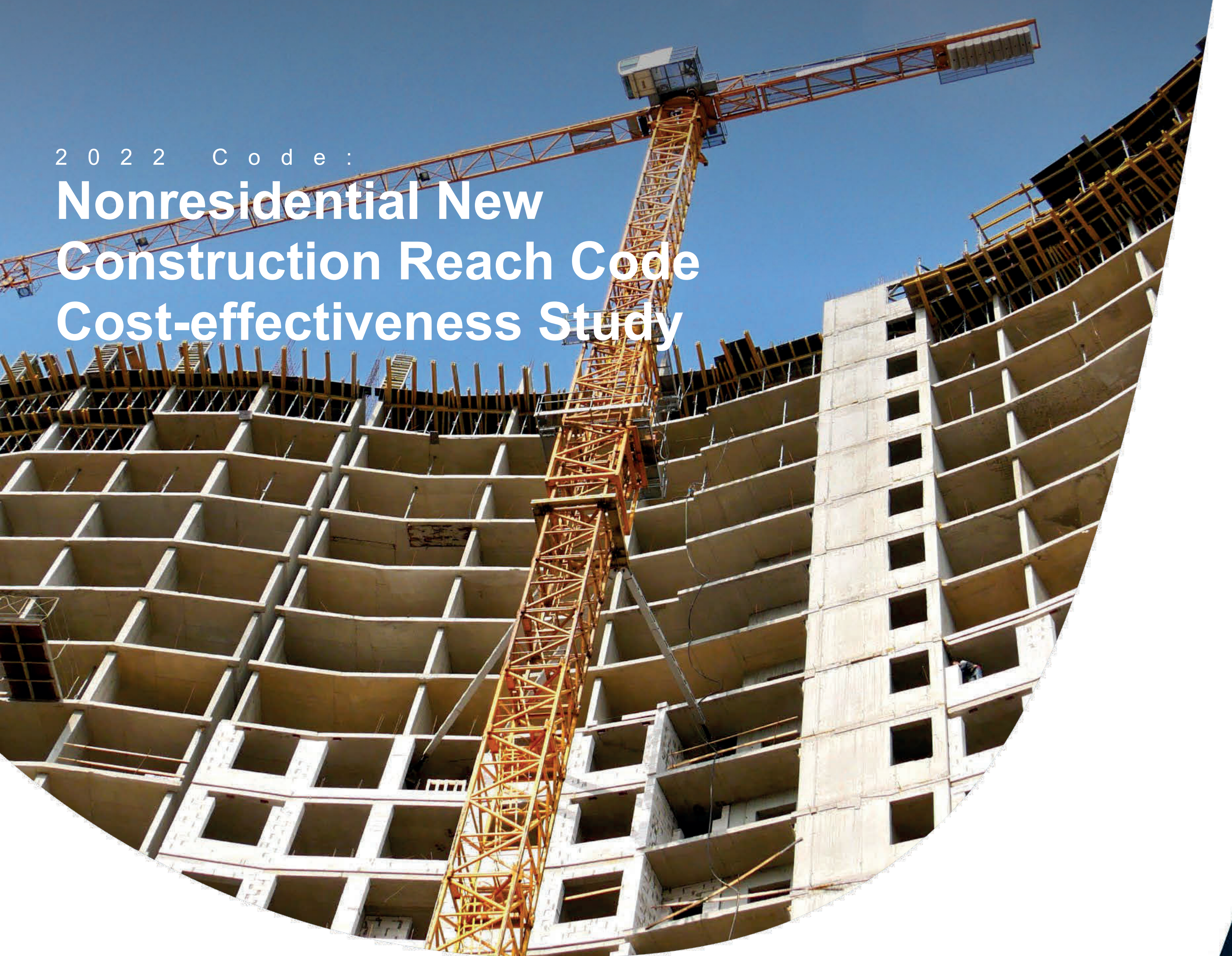
Last modified: 2023/03/24
Revision: 1.3

2022 Code:

Nonresidential New Construction Reach Code Cost-effectiveness Study



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Codes and Standards Program Southern California Edison

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This report was prepared by Southern California Edison Company and funded by the California utility customers under the auspices of the California Public Utilities Commission.

Acronym List

AC – Air Conditioner

ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers

B/C – Benefit-to-Cost Ratio

BOD – Basis of Design

BSC – Building Standards Commission

Btu – British thermal unit

CAV – Constant Air Volume

CBECC - California Building Energy Code Compliance

CBECS - Commercial Building Energy Consumption Survey

CBSC - California Building Standards Commission

CEC - California Energy Commission

CPAU – City of Palo Alto Utilities

CZ – Climate Zone

DCKV – Demand-Controlled Kitchen Ventilation

DHW – Domestic Hot Water

DEER – Database for Energy Efficient Resources

DOE – U.S. Department of Energy

E3 – Energy and Environmental Economics

EUI – Energy Use Index

FDD – Fault Detection and Diagnostics

GHG - Greenhouse Gas

GPM – Gallons Per Minute

HVAC – Heating, Ventilation, and Air Conditioning

IOU – Investor-Owned Utility

kWh – Kilowatt Hour

LADWP – Los Angeles Department of Water and Power

LBNL – Lawrence Berkeley National Lab

LPD – Lighting Power Density

NPV – Net Present Value

QSR – Quick-Service Restaurant

PNNL – Pacific Northwest National Laboratory

POU – Publicly Owned Utility

PTHP – Packaged Terminal Heat Pump

PG&E – Pacific Gas & Electric (utility)

PTAC – Packaged Terminal Air Conditioning

PV - Solar Photovoltaic

SCE – Southern California Edison (utility)

SCG – Southern California Gas (utility)

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

SHW – Service Hot Water

SMUD – Sacramento Municipal Utility District

SZ – Single Zone

TDV – Time Dependent Valuation

VAV – Variable Air Volume

TDV - Time Dependent Valuation

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

TOU – Time of Use

Summary of Revisions

Date	Description	Reference (page or section)
11/16/2022	Original Release	-
01/31/2023	Minor changes to reflect efficiency compliance margin calculation updates in workbook and report tables	Section 5
03/24/2023	Minor changes in narrative of quick service restaurant in reach code considerations	Section 5

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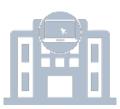
Executive Summary

The California Codes and Standards (C&S) Reach Codes program provides technical support to local governments considering adopting a local ordinance, also known as a reach code, intended to support meeting local and/or statewide energy efficiency and greenhouse gas (GHG) reduction goals. The program facilitates the adoption and implementation of reach codes 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 (the Team) provides this report and accompanying Reach Code Results Workbook to present measures and measure packages that local jurisdictions can adopt to achieve energy savings and emissions reductions beyond what will be accomplished by enforcing the minimum state requirements according to the 2022 Building Energy Efficiency Standards (Title 24, Part 6), effective January 1, 2023. This report documents a variety of above-code electrification, energy efficiency, load flexibility, and solar photovoltaic (PV) packages applied to a set of four nonresidential building prototypes: Medium Office, Standalone Retail, Quick-Service Restaurant, and Small Hotel.

The Team evaluated energy simulation results and code compliance using the CBECC v1.0 software version released in June 2022. Results may change with future software versions. Results across all prototypes indicate the efficiency measures included in the analysis, both On-Bill and TDV, are cost-effective across all climate zones when added to the prescriptive baseline prototype. In all cases all-electric packages are capable of achieving the greatest greenhouse gas emissions reductions as compared to mixed-fuel buildings.

These results, including the attached Reach Code Results Workbook, indicate that all-electric packages can achieve the greatest greenhouse gas emissions reductions as compared to mixed-fuel buildings. Results align with the decarbonization objectives set by California Energy Commission (Energy Commission), and several new construction new construction ordinances focusing on all-electric design. The results of this study by prototype are summarized below:



Medium Office: Due to the lack of a prescriptive compliance pathway and performance modeling approach in CBECC, all-electric space heating is simulated as electric-resistance variable-air-volume reheat. This system selection limits operational benefits, energy code compliance, and cost-effectiveness. All-electric packages are cost-effective with energy efficiency and load flexibility measures in many climate zones, but do not achieve code compliance across all three metrics—with efficiency TDV margin being the most challenging. Results will be updated in the first half of 2023 when central heat pump boilers can be simulated in CBECC. Jurisdictions may adopt reach codes that exempt building systems that do not have a prescriptive pathway in the energy code and cannot be modeled to comply using the performance approach. Efficiency packages over the mixed-fuel baseline are cost-effective and compliant across all climate zones.

Medium Retail: All-electric is prescriptively required in most scenarios in Retail buildings. The Team identified cost-effective and code compliant packages with energy efficiency measures over an all-electric baseline in most climate zones. This study analyzed mixed-fuel retail buildings with large (>240 kBtuh) gas furnace packaged units replacing the smaller (<240 kBtuh) packaged heat pumps. The mixed-fuel building is neither cost-effective nor code compliant in most climate zones.

Quick-Service Restaurant: The Team identified cost-effective, *nearly* cost-effective, and code compliant packages in several climate zones for all-electric space conditioning and service water heating when including energy efficiency and solar PV measures. The Team could not identify cost-effective packages including all-electric commercial cooking equipment except for City of Palo Alto Utility (CPAU) territory. Also, when including energy efficiency measures, restaurants with all-electric cooking achieve compliance and are *nearly* On-Bill cost-effective in Sacramento Municipal Utility District (SMUD) territory as well. Jurisdictions may adopt All-Electric reach codes that exempt commercial cooking equipment or require energy efficiency for either mixed-fuel and/or all-electric buildings, in many climate zones.

Small Hotel: All-electric packages are cost-effective and code-compliant in most climate zones. The remaining climate zones are very close to meeting the TDV Efficiency compliance criteria and may achieve compliance by re-evaluating nonresidential-area modeling using central heat pump boiler instead of electric resistance VAV systems. In addition to electrification packages that include single-zone packaged heat pumps, the Team analyzed an alternative scenario with packaged terminal heat pumps (PTHPs) that improved all-electric code minimum cost-effectiveness due to high first-cost savings, but PTHPs do not achieve TDV Efficiency compliance. Mixed-fuel plus energy efficiency is code compliant and cost-effective across all climate zones.

Jurisdictions may use these results for amending Part 6, Part 11, other parts of the California building code, or their municipal code as determined appropriate for the given jurisdiction. A cost-effectiveness study is required to amend Part 6 of the California building code or when adopting energy efficiency or energy conservation measures, including solar PV or batteries. The Energy Commission has previously concluded that all-electric requirements do not constitute an energy efficiency or energy conservation standard and are outside the scope of Public Resources Code section 25402.1(h)(2).[1] Jurisdictions may adopt an All-Electric reach code when amending Part 11 or their municipal code. Even reach code policies that only require electrification, and do not require energy efficiency or conservation, will benefit from findings in this study to inform potential economic impacts of a policy decision. This study documents the estimated costs, benefits, energy impacts and GHG 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 www.localenergycodes.com. Local jurisdictions that are considering adopting an ordinance are encouraged to contact the program for further technical support at info@localenergycodes.com.

[1] CEC Letter to South San Francisco 2021: https://bayareareachcodes.org/wp-content/uploads/2022/10/CEC-Letter-to-SSF-Signed.pdf

1 Introduction

This report documents cost-effective combinations of measures that exceed the minimum state requirements, the 2022 California Building Energy Efficiency Standards Title 24, Part 6 (Title 24) (CEC 2022), effective January 1, 2023, for newly constructed nonresidential buildings. This report was developed in coordination with the California Statewide Investor-Owned Utilities (CA IOUs) Codes and Standards Program, key consultants, and engaged cities—collectively known as the Reach Code Team (or "the Team" for short). The objectives of this report are to inform discourse for local reach code adoption and, where applicable, support approval of local energy code amendments from the California Energy Commission (the Energy Commission).

The Reach Code Team performed cost-effectiveness analysis for the following scenarios above prescriptive 2022 Title 24 code requirements in all 16 California climate zones (CZs):

- Fuel substitution with federal code-minimum efficiency appliances, compared to a prescriptive minimum design compliance pathway.
    - For the retail building type, the prescriptive code minimum is all-electric. Fuel substitution packages revert to mixed-fuel appliances.
    - For all other building types, the prescriptive code minimum is mixed-fuel. Fuel substitution packages switch to all-electric appliances.
- Energy efficiency measures
- Load flexibility measures
- Solar PV and Battery

The Reach Code Team analyzed four prototypes—Medium Office, Medium Retail, Quick-Service Restaurant, and Small Hotel—to represent common nonresidential new construction buildings in the California. The selected building types align with the requests received from dozens of jurisdictions seeking to adopt reach codes. The results of this cost-effectiveness study could potentially be extrapolated to other building types that have similar properties such as occupancy pattern, HVAC design and layout. These results were attained using the first version of California Building Energy Compliance Calculator (CBECC) software that is approved by CEC for 2022 code compliance. There are a few gaps in functionalities and standard design assumptions in this software version, described in Section 2.5, the Reach Code team has been actively coordinating with the CBECC software team to inform future software updates.

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

The Department of Energy (DOE) sets minimum efficiency standards for equipment and appliances that are federally regulated under the National Appliance Energy Conservation Act, including heating, cooling, and water heating equipment (E-CFR 2020). Since state and local governments are prohibited from adopting higher minimum equipment efficiencies than the federal standards require, the focus of this study is to identify and evaluate cost-effective packages that do not include high efficiency heating, cooling, and water heating equipment. High efficiency appliances are often the easiest and most affordable 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 the performance requirements.

This study references the statewide reach code study performed in 2019 for newly constructed nonresidential buildings as a starting point for additional measure definitions. Importantly, the current 2022 cost-effectiveness report introduced a new restaurant building type and updated the modeling and cost assumptions.

2 Methodology and Assumptions

The Reach Code Team analyzed four prototypes—Medium Office, Medium Retail, Quick-Service Restaurant, and Small Hotel—using the cost-effectiveness methodology detailed in this section below.

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 time dependent valuation (TDV) of energy-based approaches to evaluate cost-effectiveness. Both On-Bill and TDV require estimating and quantifying the energy savings and costs associated with energy measures. The primary difference between On-Bill and TDV is how energy is valued:

- **On-Bill:** Customer-based lifecycle cost approach that values energy based upon estimated site energy usage and customer On-Bill savings using electricity and natural gas utility rate schedules over a 15-year duration accounting for a three percent discount rate and energy cost inflation per Appendix 8.2.
- **TDV:** TDV was developed by the Energy Commission to reflect the time dependent value of energy, including long-term projected costs of energy such as the cost of providing energy during peak periods of demand and other societal costs including projected costs for carbon emissions and grid transmission impacts. This metric values energy uses differently depending on the fuel source (gas, electricity, and propane), time of day, and season. Electricity used (or saved) during peak periods has a much higher value than electricity used (or saved) during off-peak periods. This refers to the "Total TDV" that includes all the energy end uses such as space-conditioning, mechanical ventilation, service water heating indoor lighting, photovoltaic (PV) and battery storage systems, and covered process loads.

2.1.2 Costs

The Reach Code Team assessed the incremental costs and savings of the energy packages over a 15 year lifecycle. Incremental costs represent the equipment, installation, replacements, and maintenance costs of the proposed measure relative to the 2022 Title 24 standards minimum requirements or standard industry practices. The Reach Code Team obtained baseline and measure costs from manufacturer distributors, contractors, literature review, and online sources such as RS Means.

For heating, ventilation, and air conditioning (HVAC) and water heating baseline and measure costs, including gas and electrical infrastructure, the Reach Code Team contracted two different firms, one mechanical contractor (Western Allied Mechanical, based in Menlo Park) and one mechanical designer (P2S Engineering, based in Irvine) to provide cost data. The Reach Code Team developed a basis of design for all prototypes described in section 3.1 and worked with the mechanical contractor and designer to get cost estimates. The Reach Code Team determined HVAC design heating and cooling loads and capacities by climate zone from the energy models. For each HVAC system type, the Reach Code Team requested costs for the smallest capacity unit required and the largest capacity unit required and specified federal minimum equipment efficiency.

The mechanical contractor and mechanical designer collected equipment costs and labor assumptions from their vendors and manufacturers' representatives, as well as through their own recent projects. The mechanical contractor and designer provided material and labor cost estimates for the entire HVAC and DHW systems, disaggregated by the HVAC and DHW equipment itself; refrigerant piping; structural; electrical supply; gas supply; controls; commissioning and startup; general conditions and overhead; design and engineering; permit, testing, and inspection; and a contractor profit or market factor. The mechanical contractor and designer provided costs for each of the system capacities, based on which the Reach Code Team developed a relationship between HVAC system capacity and cost to calculate the cost for each building in each climate zone. In most cases, the analysis uses the average of the costs provided by the contractor and the costs provided by the designer. In some limited cases where costs provided by one source were unlikely to be representative of the measure, costs from only the other source were used. The Reach Code Team added taxes, contractor markups, maintenance costs, and replacement costs where needed, and adjusted material and labor costs for each climate zone based on weighting factors from RS Means (presented in Appendix 8.3).

Actual project costs vary widely based on a range of real-building considerations. The costs that the Reach Code Team determined through contractors are likely costs for the given prototypes and are not representative of all projects.

2.1.3 Metrics

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

- **NPV:** Net savings (NPV benefits minus NPV costs). If the net savings of a measure or package is positive over a lifetime of 15 years, it is considered cost-effective. Negative net savings represent net costs to the consumer. A measure that has negative energy cost benefits (energy cost increase) can still be cost-effective if the incremental costs to implement the measure (i.e., construction and maintenance cost savings) outweigh the negative energy cost impacts.
- **B/C Ratio:** Ratio of the present value of all benefits to the present value of all costs over 15 years (NPV benefits divided by NPV costs). The criterion for cost-effectiveness is a B/C greater than 1.0. A value of one indicates the savings over the life of the measure are equivalent to the incremental cost of that measure. A value greater than one represents a positive return on investment.

Improving the energy performance of a building often requires an initial capital investment, though in some cases an energy measure may be cost neutral or have a lower cost. In most cases the benefit is represented by annual On-Bill utility or TDV savings and the cost by incremental first cost and replacement costs. 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., shows positive 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 IOU and POU rate teams the Reach Code Team determined appropriate utility rates for each CZ and package as of October 2022. The utility tariffs, summarized in Table 1, were determined based on the annual load profile of each prototype and the corresponding package, the most prevalent rate in each utility territory, and information indicating that the rates were unlikely to be phased out during the code cycle.

A time-of-use (TOU) rate was applied to most cases, some POUs may not have TOU rates. In addition to energy consumption charges, there are kW demand charges for monthly peak loads. Utilities calculate the peak load by the highest kW of the 15-minute interval readings in the month. However, the energy modeling software produces results on hourly intervals; hence, the Team calculated the demand charges by multiplying the highest load of all hourly loads in a month with the corresponding demand charge per kW. The utility rates applicable to a prototype may vary by package and CZ especially between a mixed fuel and all-electric package if the monthly peak demand loads exceed the applicable threshold.

The Reach Code Team coordinated with utilities to select tariffs for each prototype given the annual energy demand profile of each specific prototype, climate zone, and measure package 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. For a more detailed breakdown of the rates selected, refer to Appendix 8.2.

For packages with PV generation, the approved Net Energy Metering (NEM) 2.0 tariffs were applied along with minimum daily use billing and mandatory non-bypassable charges. For the PV cases, annual electric production was always less than the modeled annual electricity consumption; therefore, no credits for surplus generation were necessary.

The analysis assumes that utility rates escalate over time for commercial buildings, as described in Appendix 8.2. 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 CZ (October 2022)

1A: Investor-Owned Utilities

CZs	Electric / Gas Utility	Electricity	Natural Gas
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 (SCG)	TOU-GS-1 / TOU-GS-2 /TOU-GS-3	G-10 (GN-10)
7, 10, 14	San Diego Gas and Electric Company (SDG&E)	AL-TOU + EECC (AL-TOU)	GN-3

1A: Publicly-Owned Utilities

CZs	Electric / Gas Utility	Electricity	Natural Gas
4	City of Palo Alto Utilities (CPAU)	E-2	G-2
12	Sacramento Municipal Utilities District (SMUD)	CI-TOD 1 (CITS-0 /CITS-1)	G-NR1

2.2 Energy Simulations

The Reach Code Team performed energy simulations using California's Building Energy Code Compliance Software CBECC 2022.1.0 (1250) with ruleset version BEMCmpMgr 2022.1.0 (7361) (California Building Energy Code Compliance 2022).[2] This is the first 2022 Title 24 code compliance software approved by Energy Commission for compliance of nonresidential buildings on June 8, 2022. The CBECC software combined the capabilities of CBECC-Com and CBECC-Res software into one to model both nonresidential and multifamily building prototypes in one interface.

The Reach Code Team set up parametric simulations using Modelkit software to run thousands of measure packages for each prototype in all California's CZs. Individual measures were simulated separately and combined into cost-effective measure packages for each CZ. Where necessary, the Reach Code Team employed minor ruleset changes, such as load flexibility measures that alter thermostat setpoint schedules, to improve the cost-effectiveness of measure packages. While these measures produce operational savings, they may not be used to achieve code compliance without further software upgrades.

[2] Prior to the CBECC software, the Reach Code Team used CBECC-Com 2022 and CBECC 2022.0.8 Beta to model nonresidential prototypes for the 2022 reach code analysis. The Reach Code Team noted the changes in results due to updates in functionalities and standard design assumptions.

2.3 2022 T24 Compliance Metrics

2022 Title 24 Section 140.1 defines the energy budget of the building based on source energy and TDV energy for space-conditioning, indoor lighting, mechanical ventilation, photovoltaic (PV) and battery storage systems, and service water heating and covered process loads. CEC has introduced two new compliance metrics in addition to Total Compliance TDV Margin for 2022 code cycle. A building needs to comply with all three compliance metrics below:

- **Efficiency TDV.** Efficiency TDV accounts for all regulated end-uses but does not include the impacts of PV and battery storage.
- **Total TDV**. Total TDV Compliance metric includes regulated end-uses accounting for PV and battery storage contributions.
- **Source Energy.** Source energy is based on fuel used for power generation, assuming utilities meet all Renewable Portfolio Standard (RPS) goals and other obligations projected over 15-year lifecycle.

2.4 GHG Emissions

The analysis uses the GHG emissions estimates built into CBECC. The GHG emission multipliers were developed by Energy + Environmental Economics (E3) to support development of compliance metrics for use in the 2022 California energy code (E3 2021). There are 8,760 hourly multipliers accounting for time dependent energy use and carbon emissions based on source emissions, including RPS projections. For the 2022 code cycle, the multipliers incorporate GHG from methane and refrigerant leakage, which are two significant sources of GHG emissions (NORESCO 2020). There are 32 strings of multipliers, with a different string for each California CZ and each fuel type (metric tons of CO_2 per kWh for electricity and metric tons of CO_2 per therm for natural gas).

2.5 Limitations and Further Considerations

The Team encountered some modeling limitations, outside of the Team’s control that should be noted while using these results to inform reach code policies,

- **CBECC Software:**
    - The Reach Code Team coordinated with the CBECC software development team on potential differences in our understanding of 2022 code requirements and its implementation in standard design such as battery controls. The version of 2022 CBECC software v1.0, described in Section 2.2, available to the Reach Code Team at the time of the analysis has limited functionalities and could not model heat pump hydronic system or other measures like drain water heat recovery. As the software evolves, some results may look different.
    - The most likely all-electric replacement for a central gas boiler serving a variable air volume reheat system would be a central heat pump boiler; however, this system cannot be modeled in CBECC at the time of the writing of this report. The Reach Code Team is treating this analysis as temporary until a compliance pathway is established for a central heat pump boiler in the Energy Code and results can be updated accordingly.
    - The team identified some apparent anomalies in software-reported compliance margins when they became available in June 2022. The Reach Code Team is in the midst of discussing outputs and ramifications with software development team specifically related to ventilation such as fan power and heat recovery, among other modeling methods. Results may change with future software versions. In the interim, the Reach Code Team manually calculated the compliance margins using the mixed fuel baseline model created in this study based on our best understanding.

- **Prototype Building:** The cost-effectiveness analysis is based on standard prototypical buildings, which may differ from actual buildings being constructed. Jurisdictions should keep this in mind while extrapolating to the buildings in their territory.
- **System Cost Assumptions:** The incremental electrification and additional measure costs are based on specific system selection and assumptions made by experienced professionals. These costs can vary based on contractor, system design and specifications, and regional variation.

The Team will re-evaluate packages with central heat pump boiler system in Medium Office and Small Hotel in early 2023. In addition to the packages assessed in the report, there are other future potential enhancements that can be considered for more cost-effective or compliant packages:

- Adding more solar PV than already analyzed if the building has more roof space to accommodate.
- Adding battery at higher levels than prescriptively required in 2022 Title 24 with more advanced controls.
- Adding energy efficiency measures as software capability evolves such as drain water heat recovery.
- Applying federally pre-emptive (high) efficiency energy systems or appliances.

3 Prototypes, Measure Packages, and Costs

This section describes the prototype characteristics and the scope of analysis including measures and their corresponding costs. The Reach Code Team used versions of the following four DOE building prototypes to evaluate cost-effectiveness of measure packages in the occupancy types listed below:

- Medium Office
- Medium Retail
- Quick-Service Restaurant (QSR)
- Small Hotel

The Reach Code Team designed the baseline prototypes to be mixed fuel based on 2022 Title 24 Final Express Terms requirements. The Reach Code Team reviewed the 2022 T24 ACM HVAC system map to ensure alignment as applicable for most cases, differences if any are discussed in subsequent sections. The Team built new construction prototypes to have compliance margins as close to zero as possible to reflect a prescriptively compliant new construction building in each CZ. The code compliance is based on the first publicly available CBECC v1.0 compliance software as described in Section 2.2. Misalignments have been reported back to the software team for future software iterations, as described in Section 2.5.

3.1 Prototype Characteristics

The DOE provides building prototype models which, when modified to comply with 2022 Title 24 requirements, can be used to evaluate the cost-effectiveness of efficiency measures (U.S. Department of Energy 2022 A). These prototypes have historically been used by the Energy Commission to assess potential code enhancements. The selection of four building types for this analysis is based on the priority suggested by a group of California cities. The cost-effectiveness results of this study could potentially be extrapolated to other building types that have similar properties such as occupancy pattern, HVAC design and layout.

Water heating includes both service hot water (SHW) for office and retail buildings and domestic hot water for hotel guest rooms. In this report, water heating or SHW is used to refer to both. The compliance software assumes a Standard Design, where HVAC and SHW systems are based on the system maps included in 2022 Nonresidential ACM Reference Manual. However, the Reach Code Team applied both 2022 Title 24 prescriptive requirements and 2022 ACM system map for baseline mixed fuel model, HVAC and SHW system characteristics as described below.

- **Medium Office**
  - The HVAC design is a variable air volume (VAV) reheat system with two gas hot water boilers, three packaged rooftop units (one serving each floor), and VAV terminal units with hot water reheat coils.
  - The SHW design includes one 8.7 kW electric resistance hot water heater with a 5-gallon storage tank.
- **Medium Retail**
  - For CZs 2 to 15, the 2022 Title 24 ACM System Map Standard Design informed the baseline model to have three packaged Single Zone Heat Pump (SZHP) systems for the smaller capacity (<240 kBtuh) thermal zones, in alignment with 2022 Title 24 prescriptive code requirements.[3] The large (>240 kBtuh) core thermal zone has two smaller (<240 kBtuh) SZHPs with VAV fans instead of one large SZHP, since larger rooftop packaged heat pumps are not available in the market. The 2022 Title24 ACM Standard Design assumes a large SZHP for larger zones as well, however this deviation does not impact the results considerably.[3]

[3] https://www.energy.ca.gov/publications/2022/2022-nonresidential-and-multifamily-alternative-calculation-method-reference

- For CZs 1 and 16, the baseline model assumed all-electric packaged single zone heat pumps similar to CZs 2-15. The assumption deviates from 2022 Title24 ACM System Map that suggests a single zone dual fuel heat pump. Presumably this will not impact results significantly because the dual fuel system will be in heat-pump mode most times.
- The SHW design includes one 8.7 kW electric resistance hot water heater with a 5-gallon storage tank.

- **Quick-Service Restaurant**
  - HVAC includes two SZAC (VAV or constant volume, depending on capacity) with gas furnace, one for kitchen and another for dining area. An exhaust fan is applied for kitchens in all climates based on prescriptive requirements in 2022 Title 24 code.
  - The SHW design includes a gas storage water heater with a 100-gallon storage tank.
- **Small Hotel**
  - The nonresidential HVAC design is a VAV reheat system with two gas hot water boilers, four packaged rooftop units (one serving each floor), and VAV terminal units with hot water reheat coils. The SHW design includes a small electric resistance water heater with 30-gallon storage tank.
  - The guest room HVAC design includes one packaged SZAC unit with gas furnace serving each guest room. The water heating design includes a central gas water heater with a 250-gallon storage tank and recirculation pump, serving all guest rooms.

Table 2 summarizes the baseline mixed-fuel prototype characteristics, based on prescriptive 2022 Title 24 new construction requirements.

Table 2. Baseline Prototype Characteristics

	Medium Office	Medium Retail	Quick-Service Restaurant	Small Hotel
Conditioned floor area (ft²)	53,628	24,563	2,501	42,554 (77 guest rooms) (Nonresidential area: 15,282 (36%))
Number of stories	3	1	1	4
Window-to-Wall Area ratio	0.33	0.07	0.11	0.14
Window U-factor/SHGC	U-factor: CZ 1-8, 10, 16 – 0.36 CZ 9, 11-15 – 0.34 SHGC: CZ 1-8, 10, 16 – 0.25 CZ 9, 11-15 – 0.22	U-factor: CZ 1-8, 10, 16 – 0.36 CZ 9, 11-15 – 0.34 SHGC: CZ 1-8, 10, 16 – 0.25 CZ 9, 11-15 – 0.22	U-factor: CZ 1-8, 10, 16 – 0.36 CZ 9, 11-15 – 0.34 SHGC: CZ 1-8, 10, 16 – 0.25 CZ 9, 11-15 – 0.22	Nonresidential: U-factor: CZ 1-8,10,16 – 0.36 CZ 9, 11-15 –0.34 SHGC: CZ 1-8,10,16 – 0.25 CZ 9, 11-15 – 0.22 Guest Rooms: U-factor: 0.36 SHGC: 0.25
Solar PV size	123 kW – 204 kW Depending on CZ	64 kW – 87 kW Depending on CZ	None	17 kW – 25 kW Depending on CZ
Battery Storage	217 kWh – 360 kWh Depending on CZ	70 kWh – 94 kWh Depending on CZ	None	16 kWh – 24 kWh Depending on CZ

	Medium Office	Medium Retail	Quick-Service Restaurant	Small Hotel
HVAC System	VAV reheat system with packaged rooftop units, gas boilers, VAV terminal units with hot water reheat	CZ 1 Heat recovery for Core Retail space only < 65 kBtu/h: SZHP > 65 kBtu/h and < 240 kBtu/h: SZHP VAV > 240 kBtu/h: SZHP VAV	< 65 kBtu/h: SZAC + gas furnace > 65 kBtu/h: SZAC VAV	Nonresidential and Laundry: VAV reheat system with packaged rooftop units, gas boilers, VAV terminal units with hot water reheat Guest Rooms: SZAC with gas furnaces
SHW System	5-gallon electric resistance water heater	5-gallon electric resistance water heater	100-gallon gas water heater	Nonresidential: 30-gallon electric resistance water heater Laundry Room: 120-gal gas storage water heater Guest rooms: Central gas water heater, 250 gallons storage, recirculation loop

3.2 Measure Definitions and Costs

The measures evaluated in the analysis fall into four different categories:

Fuel Substitution

- Heat pump or electric space heating or gas furnace
- Heat pump or electric water heaters
- Electric cooking
- Electric clothes dryer
- Electrical panel capacity
- Natural gas infrastructure

Energy Efficiency

- Envelope
- Mechanical equipment (HVAC and SHW)
- Lighting

Load Flexibility

- Peak Load shedding
- Load shift

Additional solar PV and/or battery storage.

These measures are detailed further in this section.

3.2.1 Fuel Substitution

The Reach Code Team investigated the cost and performance impacts and associated infrastructure costs associated with changing the mixed-fuel baseline HVAC and water heating systems to all-electric equipment for all prototypes except Medium Retail where the baseline is already an all-electric design.

For Medium Office, Quick Service Restaurant and Small Hotel, the fuel substitution measure entails electrification including heat pump space heating, electric resistance re-heat coils, electric water heaters with storage tank, heat pump water heating, increasing electrical capacity, and eliminating natural gas connections that would have been present in mixed-fuel new construction.

For Medium Retail with all-electric baseline, the fuel substitution measure entails mixed-fuel space conditioning system including single zone packaged AC with gas furnace, dual fuel heat pump, adding gas infrastructure costs and eliminating any additional electric infrastructure.

3.2.1.1 HVAC and Water Heating

The 2022 T24 nonresidential standards analysis uses a mixed-fuel baseline for most of the Standard Design mechanical equipment, primarily gas for space heating, except for some heat pump scenarios in Retail prototype (see Table 2). Quick-Service Restaurant has a gas storage water heater in baseline, and heat pump water heater in all-electric scenario. The Small Hotel has a central gas water heating system serving the guest rooms and a separate gas storage water heater for laundry room. In the all-electric scenario, gas equipment serving HVAC and water heating end-uses is replaced with electric equipment. Full details of HVAC and water heating systems in baseline and proposed fuel substitution measure package are described in Table 3.

Regions of California covered by the South Coast Air Quality Management District have emissions restrictions imposed on mechanical equipment. The Reach Code Team investigated the potential cost implications of meeting these requirements for gas furnaces and boilers but found that costs are minimal for mechanical systems under 2,000,000 Btu/h, and therefore did not include them. All gas-fired mechanical systems in this study are under 2,000,000 Btu/h and are subject to only an initial permitting fee, while larger systems require additional permitting costs and annual renewals.

Table 3. HVAC and Water Heating Characteristics Summary

		Medium Office	Medium Retail	Quick-Service Restaurant	Small Hotel
HVAC	Baseline	Packaged DX + VAV with hot water reheat. Central **gas** boilers.	All zones and CZs: Single zone packaged **heat pumps**	Packaged SZAC + **gas** furnace	Nonresidential: Packaged DX + VAV with hot water reheat. Central **gas** boilers. Guest Rooms: Packaged SZAC + **gas** furnaces
	Proposed – Fuel Substitution	Packaged DX + VAV with electric **resistance** reheat.	Core zone (>30 ton): Packaged SZAC + VAV + **gas** furnace Other small zones: SZHP, or dual fuel heat pump for CZ 1 and 16	Single zone packaged **heat pumps**	Nonresidential: Packaged DX + VAV with electric **resistance** reheat Guest Rooms: SZHPs
SHW	Baseline	Electric **resistance** with storage	Electric **resistance** with storage	**Gas** storage water heater	Nonresidential: Electric **resistance** storage Guest Rooms: Central **gas** storage with recirculation
	Proposed – Fuel Substitution			Unitary **heat pump** water heater	Nonresidential: Electric **resistance** storage Guest Rooms: Central **heat pump water heater** with recirculation

The Reach Code Team received cost data for mechanical equipment from two experienced mechanical design firms including equipment and material, labor, subcontractors (for example, HVAC and SHW control systems), and contractor overhead.

3.2.1.1.1 Medium Office

For the Medium Office all-electric HVAC design, the Reach Code Team investigated several potential all-electric design options, including variable refrigerant flow, packaged heat pumps, and variable volume and temperature systems. The most likely all-electric replacement for a central gas boiler serving a variable air volume reheat system would be a central heat pump boiler; however, this system cannot be modeled in CBECC at the time of writing of this report. As such, Reach Code Team is treating this analysis as temporary until a compliance pathway is established for a central heat pump boiler in the Energy Code and results can be updated accordingly. This modeling capability is anticipated by Q1 2023 according to discussions with the CBECC software development team, and the cost-effectiveness analysis should become available in the first half of 2023.

After seeking feedback from the design community and considering the software modeling constraints, the Reach Code Team determined that the most feasible all-electric HVAC system is a VAV system with an electric resistance reheat instead of hot water reheat coil. A parallel fan-powered box (PFPB) implementation of electric resistance reheat would further improve efficiency due to reducing ventilation requirements, but an accurate implementation of PFPBs is not currently available in compliance software.

The actual gas consumption for the VAV hot water reheat baseline may be higher than the current simulation results due to a combination of boiler and hot water distribution losses. A recent research study shows that the total losses can account for as high as 80 percent of the boiler energy use.[4] If these losses are considered savings for the electric resistance reheat (which has zero associated distribution loss), cost-effectiveness may be higher than presented.

The all-electric SHW system remains the same electric resistance water heater as the baseline and has no associated incremental costs. Cost data for Medium Office designs are presented in Table 4. The all-electric HVAC system presents cost savings compared to the hot water reheat system from elimination of the hot water boiler and associated hot water piping distribution. CZ10 and CZ15 all-electric design costs are slightly higher because they require larger size rooftop heat pumps than the other CZs.

Table 4. Medium Office Average Mechanical System Costs

Components (HVAC Only)	Baseline – Mixed Fuel	Proposed – All-electric	Incremental Cost
Description	Packaged units, boilers, hot water piping, VAV boxes, ductwork, grilles	Packaged units, electric resistance VAV boxes, electric circuitry, ductwork, grilles	VAV Boxes, electric infrastructure
Material	$491,630	$438,555	$(53,075)
Labor	$173,816	$102,120	$(71,696)
Electric Infrastructure	$0	$112,340	$112,340
Gas Infrastructure	$17,895	$0	$(17,895)
Overhead & CZ adjustment **	$267,052	$250,114	$(16,938)
TOTAL	**$950,393**	**$903,129**	**$(47,264)**

** The overhead and CZ adjustment factors are presented in Section 8.3.

3.2.1.1.2 Medium Retail

The baseline HVAC system includes five packaged single zone heat pumps. Based on fan control requirements in Section 140.4(m), units with cooling capacity ≥ 65,000 Btu/h have variable air volume fans, while smaller units have constant volume fans. For the Medium Retail proposed fuel substitution scenario, the Reach Code Team assumed one large Single Zone Packaged ACs with gas furnaces to replace the two smaller packaged heat pumps in the large core thermal zone. The all-electric SHW system remains the same electric resistance water heater as the baseline and has no associated incremental costs. In addition, according to the prescriptive requirement in Section 140.4 (q), the air system of Core Retail Zone in CZ1 meets the requirement in Table 140.4 J, which should include exhaust air heat recovery. Cost data for Medium Retail designs are presented in Table 5. Costs for rooftop air-conditioning systems are very similar to rooftop heat pump systems.

[4] Raftery, P., A. Geronazzo, H. Cheng, and G. Paliaga. 2018. Quantifying energy losses in hot water reheat systems. Energy and Buildings, 179: 183-199. November. https://doi.org/10.1016/j.enbuild.2018.09.020. Retrieved from https://escholarship.org/uc/item/3qs8f8qx

For climate zones 2 to 15, the proposed fuel substitution HVAC design includes three SZHP units (VAV or constant volume, depending on capacity) based on prescriptive requirements and one large SZAC that is between 35-45 tons for the core zone.

For climate zones 1 and 16, the smaller capacity (<240 kBtuh) thermal zones may have either of dual-fuel SZHPs or SZACs, depending on capacity. The core zone with 35-to-45-ton cooling capacity is assumed to have one large SZAC. CZ 1 also assumes an exhaust air heat recovery system for core zone based on prescriptive requirement in Title 24 Part 6 Section 140.4.

Table 5. Medium Retail Average Mechanical System Costs

Components (HVAC Only)	Baseline – All-electric	Proposed – Mixed Fuel	Incremental Cost
Description	SZHPs	Single zone AC + furnace, SZHP, or dual fuel SZHP, depending upon capacity and CZ	SZAC with gas furnace, Added gas infrastructure cost
HVAC – Material	$189,160	$183,157	$(6,003)
HVAC – Labor	$54,785	$52,886	$(1,899)
Electric Infrastructure	$0	$0	-
Gas Infrastructure	$0	$17,895	$17,895
Overhead & CZ adjustment **	$94,600	$98,519	$3,919
TOTAL	**$338,546**	**$352,458**	**$13,912**

** The overhead and CZ adjustment factors are presented in Section 8.3.

3.2.1.1.3 Quick-Service Restaurant

The baseline HVAC system includes two packaged single zone rooftop ACs with gas furnaces. Based on fan control requirements in Section 140.4(m), units with cooling capacity ≥ 65,000 Btu/h have variable air volume fans, while smaller units have constant volume fans. The SHW design includes one central gas storage water heater with 150 kBtu/h input capacity and a 100-gallon storage tank. For the QSR all-electric design, the Reach Code Team assumed packaged heat pumps and an A.O. Smith CHP-120 heat pump water heater with a 120-gallon storage tank. Cost data for the QSR designs are presented in Table 6, which shows the costs for full electrification of the HVAC and water heating equipment.

The Team has not included costs of electrifying the cooking equipment because of the negative impact on cost-effectiveness, as demonstrated in a 2021 Restaurants cost-effectiveness study (TRC, P2S Engineers, and Western Allied Mechanical 2022). The HVAC and SHW electrification packages are referred to as the HS package to reflect all-electric HVAC and SHW.

Table 6. Quick-Service Restaurant Average Mechanical System Costs - HS Package

Components	Baseline – Mixed Fuel	Proposed – All-electric	Incremental Cost
Description	Single zone AC + furnace, gas storage water heater	SZHP, heat pump water heater	HVAC +SHW electrification
HVAC Material	$50,065	$52,785	$2,719
HVAC Labor	$6,748	$6,249	$(499)
SHW – Material	$10,198	$13,720	$3,523
SHW – Labor	$2,650	$2,529	$(121)
Electric Infrastructure	$0	$12,960	$12,960

Gas Infrastructure	$17,895	$15,878	-$2,017
Overhead & CZ adjustment **	$41,633	$47,612	$5,979
TOTAL	**$150,838**	**$173,382**	**$22,544**

** The overhead and CZ adjustment factors are presented in Section 8.3.

3.2.1.1.4 Small Hotel

The Small Hotel has two different baseline equipment systems, one for the nonresidential spaces and one for the guest rooms. The nonresidential HVAC system includes two gas hot water boilers, four packaged rooftop units, and twenty-eight VAV terminal boxes with hot water reheat coil. The SHW design includes a small electric water heater with storage tank for nonresidential areas and gas storage water heater dedicated to laundry room. The guest rooms HVAC design includes one single-zone AC unit with gas furnace for each guest room, and the water heating design includes one central gas storage water heater with a recirculation pump for all guest rooms.

For the Small Hotel all-electric design, the Reach Code Team assumed the nonresidential HVAC system to be packaged heat pumps with electric resistance VAV terminal units, and the SHW system will remain a small electric resistance water heater. As described in Section 3.2.1.1.1 above, a central heat pump boiler may be the most commonly employed system type but was not evaluated in this study because of modeling limitations. For the guest room all-electric HVAC system, the Team assumed SZHPs and a central heat pump water heater serving all guest rooms. For the laundry room, all-electric HVAC system is same as other nonresidential areas and all-electric water heating is a split heat pump water heater. The central heat pump water heater includes a temperature maintenance loop with an electric resistance backup heater.

Cost data for Small Hotel designs are presented in Table 7. The all-electric design presents substantial cost savings because there is no hot water plant or piping distribution system serving the nonresidential spaces. The incremental cost savings are further enhanced considerably if packaged terminal heat pumps (PTHPs) are used instead of SZHPs in guest rooms compared to split DX/furnace systems with individual flues.

Table 7. Small Hotel HVAC and Water Heating System Costs

Components	Baseline – Mixed Fuel	Proposed – All-electric	Incremental Cost
Description	Non-residential spaces: Packaged units, boilers, hot water piping, VAV boxes, ductwork, grilles, gas water heater for laundry Guest rooms: SZAC + furnace, central gas water heater	Non-residential spaces: Packaged units, electric resistance VAV boxes, electric circuitry, ductwork, grilles, heat pump water heater for laundry Guest rooms: SZHP, central heat pump water heater	HVAC (NR and Guest Rooms) Electrification SHW (Laundry Room and Guest Rooms)
HVAC - Material	$802,004	$625,642	$(176,361)
HVAC - Labor	$366,733	$282,394	$(84,339)
SHW - Material	$55,829	$139,087	$83,258
SHW - Labor	$11,780	$15,080	$3,300
Electric Infrastructure	$-	$119,625	$119,625
Gas Infrastructure	$74,943	$-	$(74,943)
Overhead & CZ adjustment **	$518,741	$461,001	$(57,739)
TOTAL	**$1,830,029**	**$1,642,830**	**$(187,199)**
TOTAL HVAC (PTHP option)	**$1,830,029**	**$1,161,178**	**($668,851)**

** The overhead and CZ adjustment factors are presented in 8.3.

3.2.1.2 Commercial Cooking Equipment

For Quick-Service Restaurant prototype, the Reach Code Team evaluated electrification of commercial cooking equipment extensively in 2019 Restaurants Cost Effectiveness analysis and leveraged it for cost and other specifications for the this study. It assumes a Type I exhaust hood and shows high incremental cost affecting the cost-effectiveness of this measure. Table 8 summarizes the quick-service restaurant cooking equipment costs for both mixed-fuel and all-electric scenarios.

Table 8. Quick-Service Restaurant Cooking Equipment Costs

Components	Baseline – Mixed Fuel	Proposed – All-electric (non "HS" scenario)	Incremental Cost
Description	Gas based appliances	Electric cooking appliance	Cooking appliance electrification
Cooking equipment cost	$21,649	$43,534	$21,886
TOTAL	**$21,649**	**$43,534**	**$21,886**

This measure also adds electric infrastructure cost as detailed in Table 10 below.

3.2.1.3 Commercial Clothes Dryer

For the all-electric measure, the Reach Code Team assumed electric resistance clothes dryers for Small Hotel prototype. Commercial-scale heat pump clothes dryers take significantly longer time to dry compared to a conventional gas or electric dryer and are not common in the United States On-Premise Laundry (OPL) market, where labor is relatively expensive and use of heat pump dryers implies hotels may need to require more than one shift to perform laundry duties. Most commercial clothes dryers are available in models that use either gas or electricity as the fuel source, so there is negligible incremental cost for electric resistance dryers. Table 9 summarizes the Small Hotel construction costs for both mixed-fuel and all-electric OPL scenarios.

Table 9. Small Hotel Clothes Dryer Costs

Components	Baseline – Mixed Fuel	Proposed – All-electric	Incremental Cost
Description	Gas clothes dryer	Electric resistance clothes dryer	-
Clothes Dryer cost	$29,342	$29,342	$0
TOTAL	**$29,342**	**$29,342**	**$(0)**

This measure also adds electric infrastructure cost as detailed in Table 10 below.

3.2.1.4 Infrastructure Impacts

3.2.1.4.1 Electrical infrastructure

Electric heating appliances and equipment often require a larger electrical connection than an equivalent gas appliance because of the higher voltage and amperage necessary to electrically generate heat. Thus, many buildings may require larger electrical capacity than a comparable building with natural gas appliances. This includes:

- Electric resistance VAV space heating in the medium office and common area spaces of the small hotel.
- Heat pump water heating for the guest room spaces of the small hotel.

Table 10 details the cost impact of additional electrical panel sizing and wiring required for all-electric scenarios as compared to their corresponding mixed-fuel scenario The costs are based on estimates from one contractor. The Reach Code Team excluded costs associated with electrical service connection upgrades because these costs are very often rate-based and highly complex.

Table 10. Electrical Infrastructure Costs

	Mixed-Fuel Equipment	All-electric Equipment	Electrical Infrastructure Impact	Incremental Cost
Medium Office	Hot water reheat system with gas boiler plant and VAV boxes with hot water reheat coils	VAV boxes with electric resistance reheat coils	Upgraded transformers, transformer feeders, switchboards, and branch circuits	$ 112,340
Medium Retail	Mix of SZHPs and single zone AC plus furnace serving all zones	SZHPs serving all zones	Electrical requirements are driven by cooling capacity, so no impact.	$0
Quick-Service Restaurant	Gas water heater	Heat pump water heater	Upgraded switchboard, transformer feeder, and branch circuits	$12,960
	Gas Water heater, Gas cooking	Heat pump water heater, Electric cooking	Upgraded switchboard, transformer feeder, and branch circuits	$95,260
Small Hotel	Guest rooms HVAC: Single zone AC plus furnace Non-residential spaces HVAC: Hot water reheat system with gas boiler plant and VAV boxes with hot water reheat coils. Water heating: Gas water heating serving both laundry and guest rooms. Process: Gas dryers.	Guest rooms HVAC: SZHPs Non-residential spaces HVAC: VAV boxes with electric resistance reheat coils. Water heating: Heat pump water heating serving both laundry and guest rooms. Process: Electric resistance dryers.	Upgraded transformers, transformer feeders, switchboards, and branch circuits	$119,625

3.2.1.4.2 Gas Piping

The Reach Code Team assumes that gas would not be supplied to the site in an all-electric new construction scenario. Eliminating natural gas in new construction would save costs associated with connecting a service line from the street main to the building, piping distribution within the building, and monthly connection charges by the utility.

The Reach Code Team determined that for a new construction building with natural gas piping, there is a service line (branch connection) from the natural gas main to the building meter. Table 11 gives a summary of the gas infrastructure costs by component, assuming 1-inch corrugated stainless-steel tubing (CSST) material is used for the plumbing distribution. The Reach Code Team assumes that the gas meter costs vary depending on the gas load. Based on typical space heating loads for all building types, the Reach Code Team categorized CZs 1 and 16 as ‘High-load CZs’ and CZs 2-15 as ‘Low-load CZs’. The Reach Code Team assumed an interior plumbing distribution length based on the expected layout. Table 12 gives the total gas infrastructure cost by building type. The costs are based on estimates from one contractor.

Table 11. Gas Infrastructure Costs by Component

Component	Details	Cost
Meter, including Pressure Regulator, and Earthquake Valve	Low load CZ (CZ 2-15)	$11,056
	High load CZ (CZ 1,16)	$15,756
Gas lateral	Cost per linear foot of 1" CSST	$40
Connection charges	Includes street cut and plan review	$1,015
Interior plumbing distribution	Cost per linear foot of 1" CSST	$40

Table 12. Total Gas Infrastructure Cost Estimates by Building Type

		Total gas infrastructure cost	
Building Prototype	**Interior plumbing distribution length (ft)**	**Low load CZ**	**High load CZ**
Medium Office	100	$17,307	$22,007
Medium Retail	100	$17,307	$22,007
Quick-Service Restaurant	100	$2,017*	
Small Hotel	1,412	$70,243	$74,943

*The Quick-Service Restaurant package includes gas cooking appliances, which will require a gas lateral and meter. These costs represent only the interior plumbing distribution costs that would have served the HVAC and SHW systems.

3.2.2 Efficiency

The Reach Code Team started with a potential list of energy efficiency measures proposed for the 2025 Title 24 energy code update by the Statewide Building Codes Advocacy program (CASE Team)[5], which initially included over 500 options. Other options originated in previous energy code cycles or were drawn from other codes or standards (examples: ASHRAE 90.1 and International Energy Conservation Code [IECC]), literature reviews, or expert recommendations. The Reach Code Team leveraged the CASE Team's assessment tools for the 2025 Cycle, focusing on measures prioritized by the CASE Team. The Reach Code Team filtered the list of potential measures based on building type (to remove measures that applied to building types not covered in this study), measure category (to remove end-uses and loads that are not relevant to the prototypes) and impacts to new construction. Based on this filtering, the Team was left with around 100 measures to consider. The Reach Code Team ranked this list of potential measures based on applicability to the prototypes in this study, ability to model in simulation software, demonstrated energy savings potential, and market readiness.

Please note that the **measures requiring a ruleset update cannot currently be modeled for compliance purposes**. The modeling method for each efficiency measure is defined in their respective measure descriptions in Section 3.2.2.1 and if the ruleset amendment was applied. Please refer to Section 2.5 for further details.

The subsections below describe the energy efficiency measures that the Team analyzed, including description, modeling approach, and specification.

3.2.2.1 Envelope

1. **Cool Roof:** Requires higher reflectance and emittance values for the Medium Office building only. This measure was not shown to produce substantial savings in the other prototypes.

[5] https://title24stakeholders.com/

Modeling: Modeled cool roof measure in efficiency measures package by updating Aged Solar Reflectance (ASR) and/or Thermal Emittance (TE) in CBECC software.
Specification: Increased ASR from 0.63 to 0.70 with a TE of 0.85 in CZs 4 and 6-15.

2. **Efficient Vertical Fenestration:** Requires lower U-factor and Solar Heat Gain Coefficient (SHGC) for windows in select climate zones for three building types (Medium Office, Retail, and Small Hotel). The measure details and the climate zone selection are based on the proposition of 2022 NR CASE Report (Statewide CASE Team 2020 B).

   Modeling: Modeled high performance windows in efficiency measures package by updating U-factor and SHGC inputs in CBECC software.
   Specification: Reduced U-factor from 0.36 to 0.34 and SHGC from 0.25 to 0.22 in CZs 2, 6, 7 and 8 for Medium Office and Retail, Reduced U-factor from 0.36 to 0.34 and SHGC from 0.25 to 0.22 in all CZs for Small Hotel.

3. **Vertical Fenestration as a Function of Orientation:** Limit the amount of fenestration area as a function of orientation for the Medium Office. East-facing and west-facing windows are each limited to one-half of the average amount of north-facing and south-facing windows.

   Modeling: Change z-coordinate input of windows in CBECC software for Medium Office to increase or decrease fenestration area for the Medium Office.
   Specification: Decreased east-facing and west-facing fenestration area from 468 to 390 square feet. Increased north-facing and south-facing fenestration area from 703 to 781 square feet.

3.2.2.2 Mechanical Equipment (SHW and HVAC)

4. **Water Efficient Fixtures in Kitchen:** Specifies commercial dishwashers that use 20% less water than ENERGY STAR® specifications. In addition, the dishwasher includes heat recovery function such that it only needs connection to cold water and reduces hot water demand and central SHW system capacity. For QSRs, which typically specify a three-compartment sink for dishwashing, this measure would replace or add a dishwasher to reduce total hot water load. The measure also adds 1.0 gallon per minute (GPM) faucet aerators to hand-washing sinks in the kitchen to reduce water usage. Title 20 requires kitchen sinks to have a flow rate of 1.8 GPM at most. The reduced hot water load from the water efficient fixtures above allows the heat pump water heater (HPWH) to operate without an electric resistance back-up.

   Modeling: Reduced water usage in the ruleset based on calculations of expected water usage from literature review and fixture specifications. HPWH coefficient of performance (COP) is increased since there is no electric resistance back-up.
   Specification: Decreased hot water usage by 26% in the software ruleset (13.4 gallons per person to 9.9 gallons per person) and increased HPWH COP from 3.1 to 4.2.

5. **Ozone Washing Machines:** Adds an ozone system to the large on-premises washing machines. The ozone laundry system generates ozone, which helps clean fabrics by chemically reacting with soils in cold water. This measure saves energy by reducing hot water usage and by reducing cycle time for laundry systems. Refer to DEER Deemed measure SWAP005-01 for more information (California Public Utilites Commission 2022).

   Modeling: Reduced the total runtime of each cycle and hot water hourly usage per person (gallons per hour per person) for laundry area in software ruleset.
   Specification: Reduced hot water usage by 85%, from 48.4 to 7.3 gal/hour-person based on the deemed measure data from the California electronic Technical Reference Manual (California Technical Forum 2022).

6. **Efficient Hot Water Distribution:** Reduces domestic hot water (DHW) distribution system pipe heat losses in two ways. First, the Team used pipe sizing requirements in Appendix M of the California Plumbing Code instead of Appendix A. Appendix M reduces pipe diameters for the cold and hot water supply lines based on advancements made in water efficiency standards for plumbing fixtures found in hotel bathrooms. Second, the Team added more stringent pipe insulation thickness requirements for hotels to match that of single and multifamily dwellings using Title 24 Table 160.4-A *Pipe Insulation Thickness Requirements for Multifamily DHW Systems* instead of Table 120.3-A.

   Modeling*:* The Team calculated the pipe heat loss savings for the Small Hotel prototype by following the modelling methodology applied to the low-rise loaded corridor multi-family building prototype in the *2022 CASE Multifamily Domestic Hot Water Distribution* report (Statewide CASE Team 2020 A). The Team designed a riser distribution system for the Small Hotel prototype building using the baseline Appendix A and modern Appendix M pipe sizing tables. The pipe design and total pipe surface area of the supply and return lines for the Small Hotel closely matched the Low-Rise Loader Corridor Building prototype. The hotel insulated pipe heat loss for both Appendix A and M was approximated from the multifamily building heat loss modelling results for the 16 CZs and water heater energy savings calculated for the two sub-measures.

   Specification*:* (a) Pipe diameter decreased from Appendix A requirements to Appendix M multifamily plumbing requirements (b) For pipe diameters at or above 1.5 inches, increase the insulation thickness from 1.5 to two inches thick for fluids operating in the 105-140ºF temperature range. . The Team reduced the DHW energy consumption by 0.4 – 0.7% depending on CZ in a post-processing of the model.

7. **Demand Control Ventilation (DCV) and Transfer Air:** The California Energy Code requires kitchen exhaust to have DCV if the exhaust rate is greater than 5,000 cfm. This measure expands this requirement and applies DCV regardless of the exhaust rate for the QSR. Additionally, the kitchen makeup air supply is decreased by requiring at least 15% of replacement air to come from the transfer air in the dining space that would otherwise be exhausted.

   Modeling: Changed exhaust fan from constant speed fan to variable speed and reduce kitchen ventilation airflow rate for the QSR.

   Specification: Changed Kitchen Exhaust Fan Control Method to Variable Flow Variable Speed Drive, reduced kitchen ventilation from 2,730 cfm to 2,293 cfm.

8. **Guest Room Ventilation and Fan Power:** Uses the 2021 IECC fan power limitation requirements for ventilation fans under 1/12 horsepower, and approximates the ASHRAE 90.1 Small Hotel guestroom control requirements, which require shutting off ventilation within five minutes of all occupants leaving the room and changing the cooling setpoint to at least 80ºF and heating setpoint to at most 60ºF.

   Modeling*:* Since variable occupancy cannot be modeled in CBECC, the Reach Code Team revised the software ruleset ventilation schedule and setpoints from 8:00 AM to 7:00 PM—the time range where the CBECC software assumed occupancy to be less than half for all guestrooms.

   Specification: Heating setpoint reduced from 68°F to 66°F, cooling setpoint increased from 78°F to 80°F PM, and ventilation shut off from 8:00 AM to 7:00 PM. Guestroom ventilation fans have fan efficacy of 0.263 W/cfm.

9. **Variable speed Fans:** Require variable speed fans at lower capacities than required by Title 24 Part 6 Section 140.4(m), currently at 65,000 Btu/hr. This measure is based on the 2022 Title 24 Part 6, Section 140.4(m),

where direct expansion units greater than 65,000 Btu/hr that control the capacity of the mechanical cooling directly shall have a minimum of two stages of mechanical cooling capacity and variable speed fan control.

Modeling: Reduced the cooling capacity threshold from 65,000 Btu/hr to 48,000 Btu/hr. Changed the supply fan control from constant speed to variable speed for zones that have cooling capacity > 48,000 Btu/hr and < 65,000 Btu/hr in the Medium Retail and QSR.

Specification: Changed the supply fan control from Constant Volume to Variable Speed Drive for the Front Retail and Point-of-Sale thermal zones in Medium Retail prototype and the Dining Zone in the QSR prototype.

3.2.2.3 Lighting

10. **Interior lighting reduced lighting power density:** Update lighting power densities (LPD, measured as Watts/ft^2) requirements based on technology advances (e.g., optical efficiency, thermal management, and improved bandgap materials). Identify spaces with opportunities for more savings from lowered LPDs—not all spaces are subject to LPD reductions. Take into consideration IES recommended practices and biological effectiveness metrics (such as WELL) when developing the proposed LPD values (WELL 2022).

The 2022 Indoor Lighting CASE Study (Statewide CASE Team 2021 D) provided a survey of 2x2 troffer products available in the Design Lights Consortium Qualified Products List (DLC-QPL) and the efficacy level each measured. This study indicated that at the time of the report approximately 20% of available DLC-QPL products exceeded the performance level of the ‘Standard’ DLC-QPL listing by approximately 15%, meeting the ‘Premium’ listing criteria. The Title 24 2022 CASE Report uses the ‘Standard’ designation performance level as the design baseline for all the LPD calculations in the code. This document proposes using the ‘Premium’ designation performance as the basis of the LPD allowances.

A DOE study on solid-state light sources (LEDs) provides projections of efficacy improvement for LED light sources that are in the range of 2.5 to 3% per year, continuing for the next five or ten years (U.S. Department of Energy 2019 B). So, the products offered for sale by the luminaire manufacturers are improving as older products are discontinued and newer ones are introduced. Even in just three years, the overall performance of the products available can improve by 7 to 9%.

A recent Navigant LED pricing study shows a slightly negative cost to efficacy correlation, indicating that higher performing products may be slightly lower in cost (Navigant Consulting 2018). This is likely to be in part caused by the decreasing cost of the LED chips with each subsequent generation produced. There is likely to be no cost associated with employing higher performing LED luminaires.

Modeling: Reduce LPDs by approximately 13% in each space listed below under regulated lighting below Title 24 prescriptive requirements.

Specification*:* Medium Office

- All spaces: 0.52 W/ft^2

Medium Retail

- Storage: 0.36 W/ft^2
- Retail sales: 0.86 W/ft^2
- Main entry lobby: 0.63 W/ft^2

QSR

- Dining: 0.41 W/ft^2
- Kitchen: 0.86 W/ft^2

Small Hotel

Stairs: 0.54 W/ft^2
Corridor: 0.36 W/ft^2
Lounge: 0.50 W/ft^2

The measures are summarized below by building type, including measure costs, in Table 13.

Table 13. Efficiency Measures Applicability, Costs, and Sources

Measure Applicability

- • Included in packages with energy efficiency measures
- \- Not Applicable

Measure	Baseline T24 Requirement	Proposed Measure	Med Office	Med Retail	Quick-Service Restaurant	Small Hotel: *Guest Rooms*	Small Hotel: *Nonresidential*	Incremental Cost	Sources & Notes
Envelope									
1. Cool Roof	For low slope roofs: ASR = 0.63 TE = 0.75	For low slope roofs: ASR = 0.7 TE = 0.85	•	–	–	–	–	$0.04/ft^2	Final Nonresidential High Performance Envelope Case Report (Statewide CASE Team 2020 B)
2. Efficient Vertical Fenestration	U-factor = 0.36 SHGC = 0.25	U-factor = 0.34 SHGC = 0.22	•	•	–	•	•	$1.75/ft^2	Final Nonresidential High Performance Envelope Case Report (Statewide CASE Team 2020 B)
3. Vertical Fenestration as a Function of Orientation	40% window-to-wall ratio in each orientation per Title 24 Table 140.3-B.	Redistribute window areas by orientation	•	–	–	–	–	$0	No additional cost. This measure is a design consideration.
HVAC and SHW									
4. Water Efficient Fixtures in Kitchen	Kitchen faucet max flow rate is 1.8 GPM (Title 20)	Kitchen faucet flow rate is 1 GPM	–	–	•	–	–	High efficiency, door-type, high temperature dishwasher: $7,633/unit Faucet aerator: $8/unit	Combination of literature review, online sources such as Home Depot and manufacturer websites
5.Ozone Washing Machine	Not required	Reduced hot water use	–	–	–	–	•	$25,469/unit	DEER Deemed measure SWAP005-01 (California Public Utilites Commission 2022)

Measure Applicability • Included in packages with energy efficiency measures - Not Applicable									
Measure	**Baseline T24 Requirement**	**Proposed Measure**	**Med Office**	**Med Retail**	**Quick-Service Restaurant**	**Small Hotel: *Guest Rooms***	**Small Hotel: *Nonresidential***	**Incremental Cost**	**Sources & Notes**
6. Efficient Hot Water Distribution	Appendix A Pipe Sizing with standard pipe insulation thickness 1.5''	Appendix M pipe sizing with 2" pipe insulation thickness	–	–	–	•	–	$5,819	Multifamily Domestic Hot Water Final CASE Report
7. DCV & Transfer Air	DCV required in kitchen for exhaust air rate > 5000 cfm	DCV for all exhaust fans	–	–	•	–	–	$8,500	Mechanical contractor cost estimate
8. Guest Room Ventilation, Temperature Setback, and Fan Power	Guest rooms required to have occupancy sensing zone controls, but no ventilation fan power requirement.	Updated fan power and HVAC schedules	–	–	–	•	–	$0	No cost increase, as guest rooms already have controls.
9. Variable Speed Fans	Variable speed required if cooling capacity is greater than 65,000 Btu/h	Variable speed control for smaller capacity systems	–	•	•	–	–	$6,390/unit	Mechanical contractor cost estimate
Lighting									
10. Interior Lighting Reduced LPD	Per Area Category Method, varies by Primary Function Area.	Top 20% of market products	•	•	•	–	•	$0	Industry report on LED pricing analysis shows that costs are not correlated with efficacy. (Navigant Consulting 2018)

3.2.3 Load Flexibility

The Reach Code Team investigated a range of high-impact demand flexibility strategies potentially applicable to the four prototypes. The list of strategies is informed by DOE's Grid-interactive Efficient Buildings efforts and the 2022 Nonresidential Grid Integration CASE report (U.S. Department of Energy 2021, Statewide CASE Team 2020). The Team selected the three measures based on their load flexibility potential, cost, compliance software modeling capabilities, savings potential and the ease of project implementation and field verification:

Please note that these measures require a ruleset update and cannot be modeled currently for compliance purposes.

11. **Temperature Setback using Smart Thermostat:** This measure leverages the existing mandatory requirement for HVAC zone thermostatic controls to pre-condition spaces prior to, and to shed demand during, peak period. This measure introduces a setback in temperature setpoint during peak period and incurs no additional cost because Occupant-Controlled Smart Thermostats (OCSTs) are already required for buildings similar to the Medium Office prototype.

    Modeling: Instead of utilizing the demand responsive features, OCST would be used to change temperature setpoints and setpoint schedules. These changes were integrated by altering the setpoint schedules directly in the backend ruleset files of CBECC software.

    Specification: In the base case, the Medium Office prototype HVAC equipment schedules dictate "on" hours (at desired temperature) from 6:00 AM through 12:00 AM on weekdays and 6:00 AM – 7:00 PM on Saturdays. All Sunday hours are "off." Cooling setpoints are 75°F during "on" and 85°F when "off" hours; heat setpoints are 70°F during "on" and 60°F during "off" hours. The Team modified this schedule such that the "on" setpoints are stepped back by 2°F from 4:00 PM through 12:00 AM on weekdays; and from 4:00 PM – 7:00 PM on Saturdays.

12. **Demand Response Capable HPWH:** The Reach Code Team modeled a measure intended to reduce the peak demand of the significant hot water loads in the QSR prototype. The measure increases costs due to adding a 100-gallon storage tank and plumbing hardware. The additional hot water storage enables pre-heating water ahead of demand by effectively increasing the HPWH's thermal storage capacity. The extra plumbing hardware is needed to keep the stored hot water stratified to maintain efficient HPWH operations. The Team did not directly address the issue of storage tank location but assumed floor plan design would be able to accommodate it.

    Modeling: The measure uses the HPWH and additional storage tank capacity to produce and store hot water ahead of actual use during evening peak period. QSR hot water baseline schedule exhibits a low morning load (6:00 AM – 8:00 AM), moderate load near lunch time (11:00 AM), and a peak evening load (4:00 PM – 11:00 PM). These changes were made by changing the hot water load fraction in the ruleset.

    Specification: Implements an early pre-heat that starts at 12:00 PM and finishes by 7:00 PM, avoiding the super peak hours of 7:00 PM – 9:00 PM.

13. **Demand Response Lighting:** This measure extends existing Title 24 mandatory requirements for demand responsive lighting by shedding demand during peak hours. There are no additional measure costs because demand responsive control capability is already required for nonresidential buildings with more than 4kW of total lighting load. This measure does not require additional commissioning.

    Modeling: The baseline lighting schedule exhibits a plateau of 0.65 load fraction from 8:00 AM – 8:00 PM and trails off after 8:00 PM through the end of the day for weekdays. The Team altered the ruleset to reduce the load fraction during 4:00 PM – 9:00 PM.

    Specification: The Team implemented a 10% setback during the 4-9pm peak hours.

The load flexibility measure applications to each prototype are summarized in Table 14.

Table 14. Load Flexibility Measure Summary

Measure	Med Office	Med Retail	QSR	Small Hotel	Incremental Cost	Other Notes
11. Smart Thermostat	●	-	-	-	$0	Capability already required
12. Demand Control HPWH	-	-	●	-	$5,400	An additional 100-gallon tank, plumbing hardware, and related labor hours
13. Demand Response Lighting	●	-	-	-	$0	Capability already required

None of the measures apply to the Medium Retail or Small Hotel prototypes. While the Small Hotel contains some office space and common areas, the Medium Office load flexibility measures were not applied to the Small Hotel spaces because of the potential for unpopular impacts, varying occupancy schedules, difficult field maintenance, and limited energy impacts. Team also explored the impact of load flexibility in all-electric clothes dryer scenario but did not see enough savings impact, hence the measure was not included in the package.

3.2.4 Additional Solar PV and Battery Storage

The Reach Code Team considered additional solar PV and battery storage measures that exceed the 2022 Title 24 prescriptive requirements to improve the cost-effectiveness of proposed scenarios. For Medium Office and Retail, the prescriptive solar PV sizes are large enough to occupy the entirety of the available roof space. Additional rooftop solar PV could not be considered for the two prototypes. For the Quick-Service Restaurant, solar PV is not prescriptively required since the prototype qualifies for the exception and the Reach Code Team considered adding solar PV to improve cost-effectiveness. For Small Hotel, the required PV size in the code-compliant models did not occupy the entire available roof space. Additional PV system capacity was considered as a measure to improve cost-effectiveness.

For the cost-effectiveness analysis, the Team evaluated additional solar PV for all-electric scenarios for the two building types, Quick Service Restaurant and Small Hotel. The additional PV size is calculated based on available roof space, assuming the maximum available space is 50% of total roof space and 15 Watt per square foot panel size.

Modeling: Updated PV capacity (kW) input in CBECC software.
Specification: Baseline requirement is 0 kW and 22-32.6 (depending on climate zone) kW for Quick-Service Restaurant and Small Hotel respectively. Proposed measure specification is 18.8 kW and 79.8 kW for Quick-Service Restaurant and Small Hotel respectively.

The costs for PV include first cost to purchase and install the system, inverter replacement costs, and annual maintenance costs. A summary of incremental costs and sources is given in Table 15 below.

Table 15. Additional Solar PV Measure Summary

Measure	Med Office	Med Retail	QSR	Small Hotel	Incremental Cost	Cost Source
Solar PV	-	-	•	•	First Cost: $3.20/W Inverter replacement cost at 10-yr: $0.15/W Annual Maintenance Cost: $0.02/W ITC Federal Incentive: 30%	National Renewable Energy Laboratory (NREL) Q1 2016 (National Renewable Energy Laboratory 2016) E3 Rooftop Solar PV System Report (Energy and Environmental Economics, Inc. 2017)

Upfront solar PV system costs are lowered because of the federal income tax credit (ITC)—approximately 30 percent based on the passage of Inflation Reduction Act. PV energy output is built into CBECC and is based on NREL's PVWatts calculator, which includes long term performance degradation estimates.

A battery storage system is prescriptively required for three prototypes: Medium Office, Medium Retail, and Small Hotel. The current software, CBECC v1.0, applies the appropriate prescriptive battery size (kWh) and capacity (kW) in the standard design. However, the control assumed in standard design is "Basic Control", which does not function for optimum battery use. The Team did not evaluate additional battery measures because the compliance software does not apply the "Time of Use" battery control method in standard design, which impacts the incremental energy costs and TDV benefits.

3.3 Measure Packages

The Reach Code Team compared a baseline Title 24 prescriptive package to mixed-fuel packages and two to four electrification packages depending on applicability of building type. Note that *most* QSR all-electric packages exclude kitchen electrification, while the Small Hotel all-electric package does include electric laundry cost and energy impacts.

- **Mixed Fuel Code Minimum:** Mixed-fuel prescriptive building per 2022 Title 24 requirements.
- **Mixed Fuel + Efficiency Measures**: Mixed-fuel prescriptive building per 2022 Title 24 requirements, including additional efficiency measures.
- **All-electric Code Minimum Efficiency:** All-electric building to minimum Title 24 prescriptive standards and *federal* minimum efficiency standards. This package has the same PV size as mixed-fuel prescriptive baseline.
- **All-electric Energy Efficiency:** All-electric building with added energy efficiency measures related to HVAC, SHW, lighting or envelope.
- **All-electric Energy Efficiency + Load Flexibility:** All-electric building with added energy efficiency and load flexibility measures.
- **All-electric Energy Efficiency + Solar PV:** All-electric building with added energy efficiency and additional Solar PV. The added PV size is larger than prescriptive 2022 Title 24 code requirements and accounts for roof space availability.

For QSR, the Reach Code Team has analyzed two scenarios for all-electric packages, one with electric cooking and the one with gas cooking (the latter of which is referred to as the "HS" package to reflect all-electric HVAC and SHW). The results section includes results for both scenarios since all-electric package with electric cooking appliance can be cost-effective in POU territories. This study did not evaluate pre-empted package with all-electric HVAC and SHW to have higher efficiency than required by federal regulations, that will potentially enhance cost-effectiveness and/or compliance margins.

For Small Hotel, the Reach Code Team also analyzed an alternative scenario with PTHP instead of SZHP in all-electric scenario. It is denoted by the “PTHP” in parenthesis in package name.

4 Cost-Effectiveness Results

Cost-effectiveness results are presented in this section and the attached workbook per prototype and measure packages described in Section 3. The TDV and On-Bill based cost-effectiveness results are presented in terms of B/C ratio and NPV.

In the following figures, the result **Both** (shown in green shading) indicates that the result is cost-effective on both On-Bill and (Total) TDV basis. The result ***On-Bill*** or ***TDV*** (shown in yellow shading) indicates that the result is either cost-effective on On-Bill or (Total) TDV basis, respectively. The result " - " (results with no shading) indicates that the result is not cost-effective on either an On-Bill basis or (Total) TDV basis.

Across all prototypes and climate zones, efficiency measures improve cost-effectiveness when added to the mixed-fuel baseline prototype and all-electric federal code minimum designs.

All-electric cost-effectiveness results by prototype can be summarized as:

Medium Office (Figure 1): All-electric space heating is predominantly achieved through electric resistance due to modeling limitations, which limits operational benefits. Efficiency measures yield some On-Bill cost-effective all-electric packages in milder climate zones. Adding load flexibility measures increases the cost-effectiveness to most climates.

Medium Retail (Figure 2): All-electric packages are cost-effective in all climate zones with added efficiency measures over all-electric baseline. Proposed mixed-fuel packages are cost-effective too with added efficiency measures in most climate zones primarily driven by cost-equivalency in the all-electric package compared to a mixed-fuel package.

Quick-Service Restaurant (

Figure 3)**:** All-electric package with and without cooking electrification is cost-effective in CPAU and SMUD territories only, On-Bill. All-electric HVAC and SHW package with added efficiency measures is On-Bill cost-effective in CZs 1, 3-5 and 12. Adding efficiency and solar PV is On-Bill cost-effective in CZs 1-5, 11-13, and 16. While not depicted in

Figure 3, the Results Workbook indicates that all-electric HVAC and SHW plus efficiency packages are *nearly* cost-effective (greater than
-$350/month) in all climate zones using On-Bill Net Present Values.

Small Hotel (Error! Reference source not found.)**:** The all-electric hotel has tremendous cost savings compared to a mixed-fuel package, primarily due to the avoidance of gas infrastructure to each guest room. All-electric packages achieve TDV cost-effectiveness in all CZs except 16. On-Bill cost-effectiveness is limited to CZs 2-5, 12 and 15 with single zone ducted heat pumps, but nearly all CZs with a packaged terminal heat pump.

4.1 Medium Office

In the all-electric Medium Office building, the upfront cost savings associated with avoiding boiler and gas infrastructure supports cost-effective packages in several climate zones, particularly with additional efficiency and load flexibility measures.

- Adding energy efficiency measures over mixed fuel code minimum is On-Bill cost-effective in all climate zones.
- The all-electric code minimum efficiency package is cost-effective for CZs 4 (CPAU), 6-10, 12 (SMUD) and 15.
- Adding energy efficiency measures to the all-electric code minimum package extends On-Bill cost-effectiveness to CZ 3 as well.
- All-electric energy efficiency along with load flexibility measure package is On-Bill cost-effective in most climate zones except 1, 11 and 16.

Figure 1. Medium Office Cost-Effectiveness Summary

Climate Zone		CZ1	CZ2	CZ3	CZ4		CZ5		CZ6	CZ7	CZ8	CZ9	CZ10		CZ11	CZ12		CZ13	CZ14		CZ15	CZ16
	Utility	PG&E	PG&E	PG&E	PG&E	CPAU	PG&E	SCG	SCE	SDG&E	PG&E	SCE	SDG&E	SCE	PG&E	PG&E	SMUD	PG&E	SDG&E	SCE	SCE	PG&E
Prototype	Package																					
Medium Office (MO)	Mixed Fuel + Efficiency Measures	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
	All Electric Code Minimum Efficiency	–	–	–	On-Bill	On-Bill	–	–	Both	Both	Both	On-Bill	On-Bill	On-Bill	–	–	On-Bill	–	–	–	Both	–
	All Electric Energy Efficiency	–	–	On-Bill	Both	Both	–	–	Both	Both	Both	Both	Both	Both	–	–	On-Bill	–	–	–	Both	–
	All-Electric Energy Efficiency + Load Flexibility	–	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	On-Bill	Both	Both	Both	On-Bill	On-Bill	Both	–

4.2 Medium Retail

2022 Title 24 code prescriptively requires heat pumps in most scenarios already. This report evaluates added energy efficiency measures over the baseline all-electric scenario and proposed mixed-fuel packages.

- The mixed-fuel code minimum is not cost-effective by itself in most climate zones.
- Adding energy efficiency measures to the mixed-fuel code minimum package is On-Bill and/or TDV cost-effective in most climate zones.
- Adding energy efficiency measures over prescriptive all-electric package is also cost-effective in most climate zones except CZ16 using TDV.

Figure 2. Medium Retail Cost-effectiveness Summary

Climate Zone		CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
	Utility	PG&E	PG&E	PG&E	PG&E CPAU	PG&E SCG	SCE	SDG&E	PG&E	SCE	SDG&E SCE	PG&E	PG&E SMUD	PG&E	SDG&E SCE	SCE	PG&E
Prototype	Package																
Retail (RE)	Mixed Fuel Code Minimum	Both	–	–	– –	– –	–	–	–	–	– –	–	– –	–	On-Bill On-Bill	–	On-Bill
	Mixed Fuel + Efficiency Measures	Both	Both	Both	Both TDV	Both Both	Both	Both	Both	TDV	On-Bill –	On-Bill	Both TDV	Both	Both Both	Both	On-Bill
	All Electric Energy Efficiency	Both	Both	Both	Both Both	Both Both	Both	Both	Both	Both	Both Both	Both	Both Both	Both	Both Both	Both	On-Bill

4.3 Quick-Service Restaurant (QSR)

High incremental cost for HVAC and SHW electrification (“HS” package) makes restaurant electrification challenging. Because cooking electrification packages are very expensive – both upfront and operationally in IOU territories – the Team evaluated HS packages that do not consider cooking equipment electrification. This affects cost-effectiveness as gas infrastructure cost savings do not materialize.

- Adding energy efficiency measures over mixed fuel code minimum is On-Bill cost-effective in all climate zones.
- All-electric HVAC and SHW “HS” package is On-Bill cost-effective in CZ4 (CPAU) and CZ12 (SMUD) territory only.
- Adding energy efficiency and load flexibility measures extends On-Bill cost-effectiveness to CZs 1, 3 and 5.
- All-electric HVAC and SHW “HS” package with energy efficiency and solar PV measure is On-Bill cost-effective in climate zones 1-5, 11-13 and 16.
- All-electric package including cooking electrification is On-Bill cost-effective in CZ 4 (CPAU) territory only.
- The Results Workbook indicates that all-electric HVAC and SHW plus efficiency packages are nearly cost-effective (greater than -$350/month) in all climate zones using On-Bill Net Present Values.

Figure 3. QSR Cost-effectiveness Summary

Climate Zone		CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
	Utility	PG&E	PG&E	PG&E	PG&E CPAU	PG&E SCG	SCE	SDG&E	PG&E	SCE	SDG&E SCE	PG&E	PG&E SMUD	PG&E	SDG&E SCE	SCE	PG&E
Prototype	Package																
Quick-Service Restaurant (QSR)	Mixed Fuel + Efficiency Measures	Both	Both	Both	Both Both	Both Both	Both	Both	Both	Both	Both Both	Both	Both Both	Both	Both Both	Both	Both
	All Electric HS Code Minimum Efficiency	–	–	–	– On-Bill	– –	–	–	–	–	– –	–	– On-Bill	–	– –	–	–
	All Electric HS Energy Efficiency	On-Bill	–	On-Bill	– On-Bill	On-Bill –	–	–	–	–	– –	–	– On-Bill	–	– –	–	–
	All-Electric HS Energy Efficiency + Load Flexibility	On-Bill	–	On-Bill	– On-Bill	– –	–	–	–	–	– –	–	– On-Bill	–	– –	–	–
	All Electric HS Energy Efficiency + Solar PV	On-Bill	On-Bill	On-Bill	On-Bill On-Bill	On-Bill On-Bill	–	–	–	–	– –	On-Bill	On-Bill On-Bill	On-Bill	– –	–	On-Bill
	All Electric Code Minimum Efficiency	–	–	–	– On-Bill	– –	–	–	–	–	– –	–	– –	–	– –	–	–
	All Electric Energy Efficiency	–	–	–	– On-Bill	– –	–	–	–	–	– –	–	– –	–	– –	–	–

4.4 Small Hotel

The all-electric hotel has cost savings compared to a mixed-fuel package, primarily due to the avoidance of boilers and gas infrastructure to each guest room. The analysis assumes single zone ducted heat pump for all all-electric scenarios; however, the Team analyzed a Packaged Terminal Heat Pump (PTHP) scenario as well. PTHP shows higher incremental cost *savings* as compared to a baseline of mixed fuel single zone packaged system and hence are cost-effective in many climate zones.

- Adding energy efficiency measures over mixed fuel code minimum is On-Bill cost-effective in all climate zones.
- All-electric code minimum packages with or without energy efficiency measure packages are TDV cost-effective in all climate zones except 16, and On-Bill cost-effective in CZ4 (CPAU) and CZ12 (SMUD) due to relatively lower electricity costs.
- Additional solar PV over all-electric energy efficiency package extends On-Bill cost-effectiveness to CZs 2, 3, 4 (PG&E), 5 and 15.
- The alternative all-electric scenario with PTHP is cost-effective in all climates, On-Bill in most CZs except 7,10 and 14 SDG&E territories.

Figure 4. Small Hotel Cost-effectiveness Summary

Climate Zone		CZ1	CZ2	CZ3	CZ4	CZ4	CZ5	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ10	CZ11	CZ12	CZ12	CZ13	CZ14	CZ14	CZ15	CZ16
Prototype	Utility / Package	PG&E	PG&E	PG&E	PG&E	CPAU	PG&E	SCG	SCE	SDG&E	PG&E	SCE	SDG&E	SCE	PG&E	PG&E	SMUD	PG&E	SDG&E	SCE	SCE	PG&E
Small Hotel (SH)	Mixed Fuel + Efficiency Measures	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both
Small Hotel (SH)	All Electric Code Minimum Efficiency	TDV	TDV	TDV	TDV	Both	TDV	TDV	TDV	TDV	TDV	TDV	TDV	TDV	TDV	TDV	Both	TDV	TDV	TDV	TDV	–
Small Hotel (SH)	All Electric Energy Efficiency	TDV	TDV	TDV	Both	Both	TDV	TDV	TDV	TDV	TDV	TDV	TDV	TDV	TDV	TDV	Both	TDV	TDV	TDV	TDV	–
Small Hotel (SH)	All Electric Energy Efficiency + Solar PV	TDV	Both	Both	Both	Both	Both	TDV	TDV	TDV	TDV	TDV	TDV	TDV	TDV	TDV	Both	TDV	TDV	TDV	Both	–
Small Hotel (SH)	All Electric Code Minimum Efficiency (PTHP)	Both	Both	Both	Both	Both	Both	Both	Both	TDV	Both	Both	TDV	Both	Both	Both	Both	Both	TDV	Both	Both	Both

5 Energy Code Compliance Results and Reach Code Considerations

This section combines the cost-effectiveness and 2022 Title 24 energy code compliance metric results — efficiency TDV, total TDV, and source energy, described in Section 2.3 — to highlight the viable reach code options for local jurisdictions. The Reach Code Team calculated metrics using both:

1. Software outputs using the ACM standard design and
2. Manually by subtraction against the baseline model because of software limitations that are beyond the Reach Code Team's control.[6]

All Efficiency TDV margins presented in this section are the lower of the two approaches, Software output and Manual, to be conservative and inform the minimum compliance margins that can be met by a typical modeler. Full details of compliance margins and cost-effectiveness results are presented in the Final Results Workbook for reference.

Importantly, the workbook shows that for all prototypes, all-electric packages are capable of achieving greater greenhouse savings as compared to mixed-fuel buildings. Below is a summary of how compliance results as well as cost-effectiveness for each prototype and package could influence reach code options. The Reach Code Team outlines recommendations using the following framework, based on reach codes that were adopted across California under the 2019 building code cycle:

- **Mixed fuel buildings are allowed, with efficiency.** Local amendments governing efficiency and conservation must be performed in the Title 24 Part 6 Building Energy Efficiency Standards and be approved by the Energy Commission.
  - *Energy Efficiency* — Require energy efficiency for buildings regardless of fuel type. A jurisdiction can require different compliance thresholds for all-electric and/or mixed-fuel. The thresholds should be set considering how they may affect mixed-fuel or all-electric buildings.
  - *Electric-Preferred* — Allow mixed-fuel appliances but require a higher building performance via efficiency, total, or source compliance metric (for example, (Milpitas 2019), section 140.1).[7] Applies only to mixed-fuel buildings.
- **Mixed fuel buildings are not allowed.** Local amendments governing green building requirements may be performed in the Title 24 Part 11 Green Building Standards Code and must be filed with the Building Standards Commission. Alternatively, the local amendment may be performed in a municipal code chapter of their respective jurisdictions.
  - *All-Electric* — Require certain all-electric only appliances, with exceptions (for example (Menlo Park 2019). Does not involve efficiency or conservation measures, and cost-effectiveness is a not a legal requirement.[8] Local amendments may be performed through other building code sections, such as Part 11. See discussion on Exceptions below.
  - *All-Electric + Efficiency* — Require certain all-electric appliances, but with a higher building performance via efficiency, total, or source compliance metric. Also requires amendment to Title 24 Part 6 and approval by the Energy Commission.

[6] The difference between the two methods of calculating TDV margins occurs due to various software limitations. The Team had challenges modeling a baseline showing zero-percent (exactly compliant) compliance margin, and differing interpretations of 2022 Title 24 code regarding fan power, exhaust fan, heat recovery, battery control, and other aspects. Most scenarios show similar trends between software calculated compliance margin and the Team's manual subtraction against baseline model, with a difference in magnitude. For example, if the Total TDV Compliance margin as shown by software directly is negative, it is typically negative per manual calculation as well. Nonetheless, modeling limitations introduce error into the calculations, which may affect results. Many scenarios have very low negative compliance margin and are very close to being zero. While this uncertainty in error may lead to imprecision in results, relative performance across packages can yield information helpful for decision-making.
[7] Note Milpitas has since adopted an All-electric with Exceptions code for the 2022 code cycle.
[8] See letter from CEC to South San Francisco for reference.

Exceptions enable reach codes to broadly require electrification except for specific building systems. These systems may have uncertainty on energy code compliance, building industry electrification approaches, or other related impacts on economic development. During the 2019 code cycle, cities developed exemptions based on discussions with local stakeholders, resulting in a wide array of exemption types.[9] For the four prototypes in this study, the Team has determined two exemptions that may be necessary for cities passing All-Electric reach codes.

- **Building systems without a prescriptive compliance pathway in the energy code.** This exemption considers that all-electric central space heating does not have a prescriptive pathway in Title 24, and central heat pump boilers cannot be currently modeled, which has impacted compliance results for the Medium Office and Small Hotel. This exemption has broad precedence and can apply to other large nonresidential buildings (e.g., (Berkeley 2019), section 12.80.040.A Exception 1). These exemptions typically state that the building is also not able to comply via the performance approach using commercially available technology.
- **Commercial cooking**. Cooking electrification does not considerably impact code compliance but is not nearly cost-effective against a mixed-fuel baseline. To account for this challenge, cities may wish to adopt reach codes that exempt commercial kitchen cooking appliances (e.g., (Menlo Park 2019) 100.0(e)2.A Exception 4).

[9] See list of exemptions on Bay Area Reach Codes.

Table 16. Reach Code Pathway Considerations

Prototype	Compliance and Cost-Effectiveness Results Summary	Energy Efficiency	Electric-Preferred	All-Electric	All-Electric + Efficiency
Medium Office	The Team could not identify any all-electric package that complies with all three compliance metrics, with the Efficiency TDV Compliance margin being the most challenging. Future iterations of this study will re-evaluate the Medium Office with a central heat pump boiler, an anticipated compliance software capability in early 2023, instead of electric resistance VAVs.	To Be Determined. Modeling constraints impacted achievable compliance margins for all-electric packages.	All CZs.	Exempt building systems without a prescriptive pathway in the energy code.	To Be Determined. Modeling constraints impacted achievable compliance margins for all-electric packages
Medium Retail	The Team identified cost-effective and code compliant packages of all-electric + energy efficiency measures across most CZs. Mixed-fuel + efficiency was cost-effective but not code compliant in most CZs.	CZs 7 and 9.	CZs 7 and 9.	CZs 2-15. 2022 T24 prescriptive baseline	CZs 1-10, 12-14.
Quick-Service Restaurant	The Mixed-fuel + efficiency package is cost-effective and compliant in many climate zones. Code compliance and cost-effectiveness results support reach code adoption for all-electric space conditioning and service water heating when adding efficiency and solar PV for CZs 1 and 3-5, many others are likely to be compliant with future modeling input updates. Cost-effectiveness is achieved or *nearly* achieved (Net Present Value is greater than -$350/month) On-Bill in all CZs. Cooking electrification does not impact code compliance but is not cost-effective against a mixed-fuel baseline except for CPAU territory.	CZs 1, 3-7.	CZs 1-7, 13.	CZs 1, 3-7. Exempt commercial kitchen appliances, except CZ4 (CPAU). Nearly all remaining CZs have a *nearly* cost-effective and/or nearly compliant pathway for HVAC and SHW only.	CZs 1, 3-5.
Small Hotel	Results support Electric-Preferred reach code for all CZs. The all-electric packages are *near* compliant and TDV cost-effective for most CZs when including energy efficiency measures and additional solar PV. They are *likely* to be compliant with future modeling iterations. Future iterations of this study will re-evaluate the nonresidential areas of the hotel with a central heat pump boiler, as mentioned for the Medium Office, which can potentially improve code compliance.	To Be Determined. Modeling constraints impacted achievable compliance margins for all-electric packages.	All CZs.	Exempt building systems without a prescriptive pathway in the energy code.	To Be Determined. Modeling constraints impacted achievable compliance margins for all-electric packages.

The combined result of cost-effectiveness and code compliance across all climate zones and packages are detailed in Section 0 through 5.4 below. The tables are formatted to show:

- Cost-effectiveness results with color highlight:
  - **Green** highlight — for scenarios that are cost-effective on both On-Bill and TDV metrics, may or may not be compliant.
  - **Yellow** highlight — for scenarios that are cost-effective on either one of the On-Bill/TDV metrics, may or may not be compliant.
  - **Gray** highlight — for scenarios that are not cost-effective on either metric, either compliant currently or likely to be compliant in future.
  - White highlight — for scenarios that are not cost-effective on either metric and are not compliant.
- Compliance results with cell values:
  - “EffTDV Margin” percentages — for scenarios that are compliant, across both Manual and CBECC software output, the reported value is the minimum of the two.
  - “-” for scenarios that do not comply across any one code compliance metric.

“TBD” – for scenarios that are likely to be compliant with modeling updates or software versions in future, maybe compliant across either one of the Manual or CBECC software output approach or has a system type modeling limitation such as central heat pump boiler for Medium Office and Small Hotel. The package names in table results columns are as follows, as defined in Section 3.3:

- **Mixed fuel — Code Min**: Mixed Fuel Code Minimum Efficiency
- **Mixed fuel — EE**: Mixed Fuel + Efficiency Measures
- **All-electric — Code Min**: All-electric Code Minimum Efficiency
- **All-electric — EE**: All-electric Energy Efficiency
- **All-electric — EE + LF**: All-electric Energy Efficiency and Load Flexibility
- **All-electric — EE + PV**: All-electric Energy Efficiency and Solar PV

The QSR has two electrification scenarios, with and without cooking appliance electrification, which is denoted by “HS” prefix.

The Small Hotel has an extra package that evaluates a different HVAC type in the all-electric Code Minimum Efficiency package, a Packaged Terminal Heat Pump (PTHP) instead of a Single Zone Heat Pump.

5.1 Medium Office

For Medium Office, the Reach Code Team analyzed EE measures over mixed fuel baseline model and three electrification packages: 1) Code Min, 2) EE and 3) EE + LF packages, results shown in Table 17.

The most likely all-electric replacement for a central gas boiler serving a VAV reheat system would be a central heat pump boiler; however, this system cannot be modeled in CBECC at the time of the writing of this report. As such, the Reach Code Team is treating this analysis as temporary until a compliance pathway is established for a central heat pump boiler in the Energy Code and results can be updated accordingly. This modeling capability is anticipated in early 2023 according to discussions with the CBECC software development team, and the cost-effectiveness analysis should become available in the first half of 2023. Heat pump systems are multiple times more efficient, but may also be multiple times more costly, than the electric resistance reheat systems currently analyzed.

- Results support reach code adoption for energy efficiency measures over mixed fuel baseline, also known as the "Electric-Preferred". A compliance margin of 4–5% is achievable depending on the climate zone.
- No all-electric package complies with all three-compliance metrics, with the efficiency compliance TDV margin being the most challenging. The Reach Code Team explored other efficiency measures that reduce the efficiency compliance TDV margin, but not enough to make the TDV margin positive. The compliance values are labeled as "TBD" for all-electric packages, as they are likely to be compliant with future modeling and/or software updates. Some climate zones are compliant currently on either one of the Software output or Manual compliance approaches.

Table 17. Cost-effectiveness and Compliance Summary – Medium Office

CZ	Utility	Mixed Fuel	All-electric		
		EE	Code Min	EE	EE + LF
cz01	PG&E	4%	TBD	TBD	TBD
cz02	PG&E	5%	TBD	TBD	TBD
cz03	PG&E	5%	TBD	TBD	TBD
cz04	PG&E	4%	TBD	TBD	TBD
cz04-2	CPAU	4%	TBD	TBD	TBD
cz05	PG&E	5%	TBD	TBD	TBD
cz05-2	SCG	5%	TBD	TBD	TBD
cz06	SCE	6%	TBD	TBD	TBD
cz07	SDG&E	7%	TBD	TBD	TBD
cz08	SCE	6%	TBD	TBD	TBD
cz09	SCE	4%	TBD	TBD	TBD
cz10	SDG&E	4%	TBD	TBD	TBD
cz10-2	SCE	4%	TBD	TBD	TBD
cz11	PG&E	3%	TBD	TBD	TBD
cz12	PG&E	4%	TBD	TBD	TBD
cz12-2	SMUD	4%	TBD	TBD	TBD
cz13	PG&E	4%	TBD	TBD	TBD
cz14	SDG&E	4%	TBD	TBD	TBD
cz14-2	SCE	4%	TBD	TBD	TBD
cz15	SCE	3%	TBD	TBD	TBD
cz16	PG&E	4%	TBD	TBD	TBD

* These results will be re-evaluated with central heat pump boiler system instead of electric resistance VAV systems, which largely are unable to achieve energy code compliance.

KEY

Cell Color	
(green)	Cost effective on both TDV/On-Bill metrics
(yellow)	Cost effective on either TDV/On-Bill metrics
(gray)	Compliant, not cost effective
	Not compliant nor cost effective
Cell Value	
X%	EffTDV Compliance Margin percentages (Lowest common) Compliant on both Manual and Software output approaches
TBD	Likely to comply with future modeling updates or software versions, maybe compliant on either Manual or Software output approach presently
-	Not compliant on either approach

5.2 Medium Retail

For Medium Retail, the Team analyzed EE measure package over an all-electric baseline model and two mixed fuel packages — Code Min and EE, with results in Table 18.

- Results support reach code adoption for energy efficiency measures over mixed fuel code minimum package, also known as “Electric-Preferred” or “Energy Efficiency” reach code pathways in climate zones 7 and 9.
- Results also support “All-Electric + Efficiency” reach code option, with compliance margins of 4-14% above the all-electric code minimum baseline in climate zones 1-10 and 12-14.
- For some scenarios in climate zone 6, 8, 11, 15 and 16, labeled as “TBD”, the package is cost-effective and likely to be compliant in future with modeling input and/or software version updates.

Table 18. Cost-effectiveness and Compliance Summary – Medium Retail

CZ	Utility	Mixed Fuel		All-electric
		Code Min	EE	EE
cz01	PG&E	-	-	6%
cz02	PG&E	-	-	4%
cz03	PG&E	-	-	12%
cz04	PG&E	-	-	11%
cz04-2	CPAU	-	-	11%
cz05	PG&E	-	-	12%
cz05-2	SCG	-	-	12%
cz06	SCE	-	TBD	9%
cz07	SDG&E	-	12%	14%
cz08	SCE	-	TBD	8%
cz09	SCE	-	11%	12%
cz10	SDG&E	-	-	3%
cz10-2	SCE	-	-	3%
cz11	PG&E	-	-	TBD
cz12	PG&E	-	-	10%
cz12-2	SMUD	-	-	10%
cz13	PG&E	-	-	4%
cz14	SDG&E	-	-	7%
cz14-2	SCE	-	-	7%
cz15	SCE	-	-	TBD
cz16	PG&E	-	-	TBD

KEY

Cell Color	
(green)	Cost effective on both TDV/On-Bill metrics
(yellow)	Cost effective on either TDV/On-Bill metrics
(gray)	Compliant, not cost effective
	Not compliant nor cost effective

Cell Value	
X%	EffTDV Compliance Margin percentages (Lowest common) Compliant on both Manual and Software output approaches
TBD	Likely to comply with future modeling updates or software versions, maybe compliant on either Manual or Software output approach presently
-	Not compliant on either approach

5.3 Quick-Service Restaurant (QSR)

The Team analyzed efficiency measures over a mixed fuel baseline and electrification packages, with and without cooking appliance electrification. For the “HS” scenario including HVAC and SHW electrification only, packages with EE, EE + LF and EE + PV were analyzed, with results in Table 19.

- Results support reach code adoption for energy efficiency measures over a mixed fuel baseline, also known as “Electric-Preferred” in climate zones 1 to 7 and 13, or “Energy Efficiency” in CZs 1 and 3 to 7.
- All-electric “HS” HVAC and SHW electrification can be adopted in CZs 1 and 3-7 since it is code compliant and *nearly* cost effective on at least one metric when energy efficiency measures and/or load flexibility or solar PV measure is added, demonstrated by yellow or gray cells.
- All-electric “HS” HVAC and SHW option with additional efficiency measures can be adopted in CZs 1 and 3-5. Adding solar PV makes the package on-bill cost-effective on at least one metric marked as yellow cells..
- Packages labeled as “TBD” may or may not be cost-effective but are likely to be compliant in the future with modeling input and/or software updates.

Table 19. Cost-effectiveness and Compliance Summary – Quick-Service Restaurant (without cooking electrification)

CZ	Utility	Mixed Fuel	All-electric "HS" (HVAC+SHW)			
		EE	Code Min	EE	EE + LF	EE + PV
cz01	PG&E	16%	-	6%	16%	6%
cz02	PG&E	6%	-	TBD	TBD	TBD
cz03	PG&E	18%	-	8%	13%	8%
cz04	PG&E	16%	-	5%	8%	5%
cz04-2	CPAU	16%	-	5%	8%	5%
cz05	PG&E	18%	-	8%	15%	8%
cz05-2	SCG	18%	-	8%	15%	8%
cz06	SCE	16%	-	3%	6%	3%
cz07	SDG&E	21%	-	9%	13%	9%
cz08	SCE	TBD	-	-	-	-
cz09	SCE	TBD	-	TBD	TBD	TBD
cz10	SDG&E	TBD	-	-	-	-
cz10-2	SCE	TBD	-	-	-	-
cz11	PG&E	TBD	-	TBD	TBD	TBD
cz12	PG&E	TBD	-	TBD	TBD	TBD
cz12-2	SMUD	TBD	-	TBD	TBD	TBD
cz13	PG&E	7%	-	TBD	TBD	TBD
cz14	SDG&E	TBD	-	TBD	TBD	TBD
cz14-2	SCE	TBD	-	TBD	TBD	TBD
cz15	SCE	TBD	-	TBD	TBD	TBD
cz16	PG&E	TBD	-	-	TBD	-

KEY

Cell Color	
	Cost effective on both TDV/On-Bill metrics
	Cost effective on either TDV/On-Bill metrics
	Compliant, not cost effective
	Not compliant nor cost effective
Cell Value	
X%	EffTDV Compliance Margin percentages (Lowest common) Compliant on both Manual and Software output approaches
TBD	Likely to comply with future modeling updates or software versions, maybe compliant on either Manual or Software output approach presently
-	Not compliant on either approach

The Reach Code Team analyzed a completely all-electric package including cooking appliances, results shown in Table 20, which show compliance in many climate zones with added efficiency and load flexibility. Remaining CZs are “TBD”, except climate zone 16, which comply on either one of the Manual or Software output approaches currently and are likely to show compliance with future modeling updates. However, the all-electric package is cost-effective in CZ4 CPAU territory only and very close to being cost-effective in SMUD territory. Cooking electrification is expensive and challenging to show cost-effective.

Table 20. Cost-effectiveness and Compliance Summary – Quick-Service Restaurant (with cooking electrification)

CZ	Utility	All-electric		
		Code Min	EE	EE + LF
cz01	PG&E	-	6%	15%
cz02	PG&E	-	TBD	2%
cz03	PG&E	-	10%	14%
cz04	PG&E	-	8%	10%
cz04-2	CPAU	-	8%	10%
cz05	PG&E	-	10%	17%
cz05-2	SCG	-	10%	17%
cz06	SCE	-	6%	10%
cz07	SDG&E	-	11%	14%
cz08	SCE	-	TBD	TBD
cz09	SCE	-	TBD	TBD
cz10	SDG&E	-	TBD	TBD
cz10-2	SCE	-	TBD	TBD
cz11	PG&E	-	TBD	0%
cz12	PG&E	-	TBD	TBD
cz12-2	SMUD	-	TBD	TBD
cz13	PG&E	-	TBD	TBD
cz14	SDG&E	-	TBD	TBD
cz14-2	SCE	-	TBD	TBD
cz15	SCE	-	TBD	2%
cz16	PG&E	-	-	-

KEY

Cell Color	
	Cost effective on both TDV/On-Bill metrics
	Cost effective on either TDV/On-Bill metrics
	Compliant, not cost effective
	Not compliant nor cost effective
Cell Value	
X%	EffTDV Compliance Margin percentages (Lowest common) Compliant on both Manual and Software output approaches
TBD	Likely to comply with future modeling updates or software versions, maybe compliant on either Manual or Software output approach presently
-	Not compliant on either approach

5.4 Small Hotel

The Team analyzed EE package over mixed fuel baseline and three electrification packages - Code Min, EE, EE+PV, with results in Table 21.

- Results support reach code adoption for energy efficiency measures over mixed fuel baseline, also known as "Electric-Preferred" reach code pathway with 2-5% compliance margin.
- All-electric packages with efficiency measures and/or solar PV in most CZs are cost-effective and likely to be compliant in future with modeling and/or software version updates. Some climate zones are compliant currently across either one of the Manual or Software output approaches.
- All all-electric scenarios are labeled as "TBD" because 36% of conditioned floor area is nonresidential space and has the same system type limitation as Medium Office (see Section 5.1). Hence, the Small Hotel will be re-evaluated as well with a central heat pump boiler system instead of electric resistance VAV system in early 2023. The current results show compliance on either one of the Manual or Software output approaches in some climate zones with efficiency measures and solar PV, still labeled as "TBD" until the software inconsistencies are resolved.

Table 21. Cost-effectiveness and Compliance Summary – Small Hotel.

CZ	Utility	Mixed Fuel	All-electric		
		EE	Code Min	EE	EE + PV
cz01	PG&E	5%	TBD	TBD	TBD
cz02	PG&E	4%	TBD	TBD	TBD
cz03	PG&E	5%	TBD	TBD	TBD
cz04	PG&E	5%	TBD	TBD	TBD
cz04-2	CPAU	5%	TBD	TBD	TBD
cz05	PG&E	5%	TBD	TBD	TBD
cz05-2	SCG	5%	TBD	TBD	TBD
cz06	SCE	5%	TBD	TBD	TBD
cz07	SDG&E	4%	TBD	TBD	TBD
cz08	SCE	5%	TBD	TBD	TBD
cz09	SCE	5%	TBD	TBD	TBD
cz10	SDG&E	5%	TBD	TBD	TBD
cz10-2	SCE	5%	TBD	TBD	TBD
cz11	PG&E	3%	TBD	TBD	TBD
cz12	PG&E	4%	TBD	TBD	TBD
cz12-2	SMUD	4%	TBD	TBD	TBD
cz13	PG&E	3%	TBD	TBD	TBD
cz14	SDG&E	4%	TBD	TBD	TBD
cz14-2	SCE	4%	TBD	TBD	TBD
cz15	SCE	5%	TBD	TBD	TBD
cz16	PG&E	2%	TBD	TBD	TBD

KEY

Cell Color	
(green)	Cost effective on both TDV/On-Bill metrics
(yellow)	Cost effective on either TDV/On-Bill metrics
(gray)	Compliant, not cost effective

	Not compliant nor cost effective
Cell Value	
X%	EffTDV Compliance Margin percentages (Lowest common) Compliant on both Manual and Software output approaches
TBD	Likely to comply with future modeling updates or software versions, maybe compliant on either Manual or Software output approach presently
-	Not compliant on either approach

The Team analyzed an additional scenario that proposes PTHP compared to the same SZAC mixed fuel baseline model, results shown in Table 22. Though PTHP is a much cheaper alternative than SZHP, it is not compliant by itself.

Table 22. Cost-effectiveness and Compliance Summary – Small Hotel (PTHP)

CZ	Utility	All-electric Code Min (PTHP)
cz01	PG&E	-
cz02	PG&E	-
cz03	PG&E	-
cz04	PG&E	-
cz04-2	CPAU	-
cz05	PG&E	-
cz05-2	SCG	-
cz06	SCE	-
cz07	SDG&E	TBD
cz08	SCE	TBD
cz09	SCE	TBD
cz10	SDG&E	-
cz10-2	SCE	-
cz11	PG&E	-
cz12	PG&E	-
cz12-2	SMUD	-
cz13	PG&E	-
cz14	SDG&E	-
cz14-2	SCE	-
cz15	SCE	-
cz16	PG&E	-

KEY

Cell Color	
(green)	Cost effective on both TDV/On-Bill metrics
(yellow)	Cost effective on either TDV/On-Bill metrics
(gray)	Compliant, not cost effective
	Not compliant nor cost effective
Cell Value	
X%	EffTDV Compliance Margin percentages (Lowest common) Compliant on both Manual and Software output approaches

TBD	Likely to comply with future modelling updates or software versions, maybe compliant on either Manual or Software output approach presently
-	Not compliant on either approach

6 Conclusions

The Reach Code Team developed a variety of packages involving fuel substitution, energy efficiency, load flexibility, and solar PV, simulated them in building modeling software, and gathered costs to determine the cost-effectiveness of multiple scenarios. The 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, fuel costs, other costs, energy escalation rates, software or utility tariffs may change the results.

These results, including the attached Reach Code Results Workbook, indicate all-electric packages are capable of achieving the greatest GHG savings as compared to mixed-fuel buildings, see Appendix 8.5. Jurisdictions may adopt a variety of reach codes such as “Energy Efficiency”, “Electric-Preferred”, “All-Electric” or “All-Electric + Efficiency.” In summary:

- The Reach Code Team has identified a cost-effective and code compliant energy efficiency measure package for most prototypes and climate zones analyzed, which supports an “Electric-Preferred” and/or “Energy Efficiency” reach code pathways for jurisdictions.
- “All-Electric” reach codes are feasible for all building types and climate zones when Part 11 is modified, including some exceptions.
  - All-electric HVAC consisting of packaged single zone systems, including rooftop units in the Medium Retail and Quick-Service Restaurant, and single zone heat pumps in the Small Hotel guest rooms, are widely shown to be cost-effective and energy code compliant, with exceptions in CZs 1 and 16.
  - All-electric SHW systems have a prescriptive pathway for all building types and have not been shown to be an impediment to cost-effectiveness or energy code compliance of all-electric packages in this study.
  - All-electric laundry in the Small Hotel can be cost-effective with added energy efficiency and additional solar PV than required prescriptively by 2022 Title 24 code.
  - Medium Office all-electric packages are cost-effective with energy efficiency and load flexibility measures, but not code compliant due to the use of electric resistance VAV reheat systems. The Small Hotel faces a similar issue for its smaller nonresidential area HVAC systems in some climate zones. This indicates that further efficiency measures would need to be added to achieve energy code compliance which may not be cost-effective. As described in Sections 5.1 and 5.4, modeling limitations impacted the code compliance results for the medium office and nonresidential portion of the small hotel. These prototypes will be re-evaluated using a more appropriate central heat pump boiler HVAC system, likely available in compliance software in early 2023. In the meantime, jurisdictions can choose to exempt building systems that do not have a prescriptive compliance pathway in the energy code. See Berkeley’s all-electric ordinance (Berkeley 2019) section 12.80.040.A Exception 1 for an example.
- Commercial kitchen electrification is challenging to design cost-effectively currently. These results align with a previous study focusing on restaurants (Statewide IOU Team 2022). Jurisdictions may choose to exempt cooking appliances until cost-effectiveness factors improve. See Menlo Park's ordinance (Menlo Park 2019) 100.0(e)2.A Exception 4 for an example.
- For the Medium Retail prototype in CZs 2 to 15, there is already a prescriptive pathway to comply with packaged single zone heat pumps in smaller (<240 kBtuh) thermal zones. This study supports an “All-Electric + Efficiency” reach code pathway for many climates. However, mixed-fuel scenarios with SZAC and gas furnaces for larger (>240 kBtuh) thermal zones are challenging to show cost-effectiveness and/or code compliance, except for climate zones 7 and 9, when including efficiency measures.

Further discussion is required at the jurisdiction and community members to review results and determine appropriate reach code pathways. Please refer to the limitations of this study, described in Section 2.5, while using them to inform reach code policies. Of note:

- The Team employed several CBECC ruleset modifications to support achieving cost-effective packages, especially load flexibility measures. Ruleset modifications cannot be used by the building industry for code compliance without supporting justification or alternate methods. Where jurisdictions want to encourage the adoption of Load Flexibility measures through modeling estimates, the Reach Code Team can support cities and building applicants by providing modeling approximations that may achieve similar energy and compliance total impacts, in coordination with the Energy Commission. For example, for the Demand Response Lighting measure, the Team may be able to share a TDV/ft^2 impact of the measure in that climate zone or provide guidance to the building applicant's energy consultant on appropriate modeling and documentation.
- Results are predominantly based on the code compliance metrics that are manually calculated based on the mixed fuel baseline model and not the standard design model assumed by the current software version. The Team also provided software reported compliance metrics in the workbook for reference. The Team is in communication with software development team to resolve differences in future iterations of this study and the software and improve code compliance reporting.

Even considering the limitations, this study has identified a set of reach code pathways for all climate zones, and jurisdictions have broad discretion on how to interpret the study's findings. Jurisdictions can adopt reach codes requiring energy efficiency via a Title 24 Part 6 local amendment, or electrification via a Title 24 Part 11 (or municipal code) amendment, or both. Jurisdictions may choose to except particular building systems from certain reach codes pathways.

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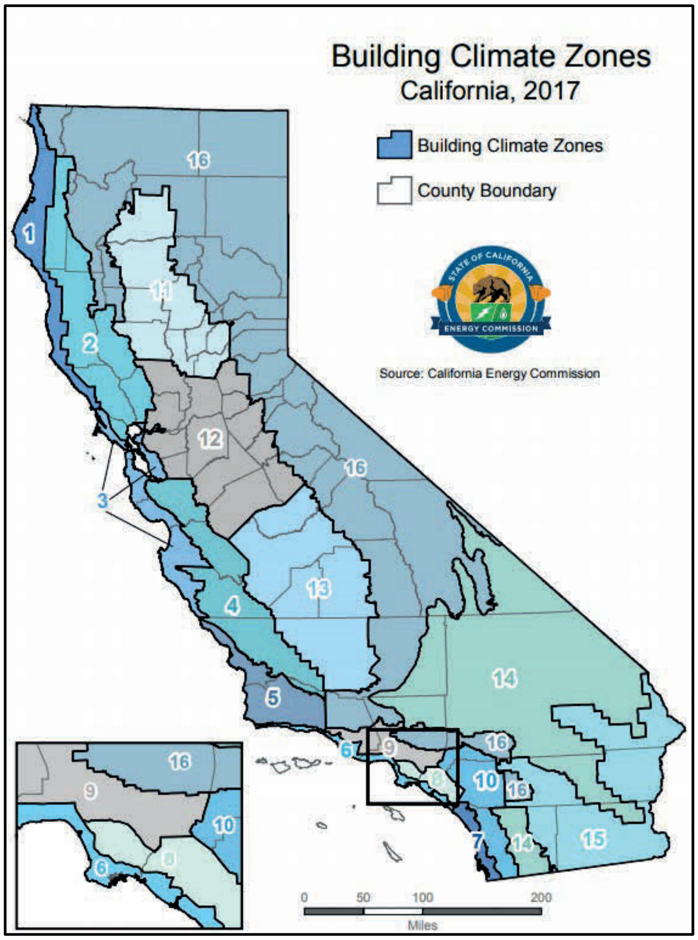
8 Appendices

8.1 Map of California CZs

Climate Zone geographical boundaries are depicted in Figure 5 below. An interactive GIS location based map and zip-code based search directory is available at: Climate Zone tool, maps, and information supporting the California Energy Code

Figure 5. Map of California CZs



8.2 Utility Rate Schedules

The Reach Codes Team used the IOU and POU rates depicted in to determine the On-Bill savings for each prototype.

Table 23. Utility Tariffs Analyzed Based on CZ – Detailed View

CZs	Utility	Electric Rate (Time of Use)				Gas Rate
		Medium Office	Medium Retail	QSR	Small Hotel	All Prototypes
CZ01	**PG&E**	B-10	B-1	B-1	B-1 or B-10	G-NR1
CZ02	**PG&E**	B-10	B-1 or B-10	B-1 or B-10	B-1 or B-10	G-NR1
CZ03	**PG&E**	B-10	B-1	B-1	B-1 or B-10	G-NR1
CZ04	**PG&E**	B-10	B-1 or B-10	B-1 or B-10	B-1 or B-10	G-NR1
CZ04-2	**CPAU**	E-2	E-2	E-2	E-2	G-2
CZ05	**PG&E**	B-10	B-1	B-1	B-1 or B-10	G-NR1
CZ05-2	**SCG**	B-10	B-1	B-1	B-1 or B-10	G-10 (GN-10)
CZ06	**SCE**	TOU-GS-2	TOU-GS-2	TOU-GS-2	TOU-GS-2	G-10 (GN-10)
CZ07	**SDG&E**	AL-TOU+EECC (AL-TOU)	AL-TOU+EECC (AL-TOU)	AL-TOU+EECC (AL-TOU)	AL-TOU+EECC (AL-TOU)	GN-3
CZ08	**SCE**	TOU-GS-2	TOU-GS-2	TOU-GS-2	TOU-GS-2	G-10 (GN-10)
CZ09	**SCE**	TOU-GS-2	TOU-GS-2	TOU-GS-2	TOU-GS-2	G-10 (GN-10)
CZ10	**SDG&E**	AL-TOU+EECC (AL-TOU)	AL-TOU+EECC (AL-TOU)	AL-TOU+EECC (AL-TOU)	AL-TOU+EECC (AL-TOU)	G-10 (GN-10)
CZ10-2	**SCE**	TOU-GS-2	TOU-GS-2	TOU-GS-2	TOU-GS-2	GN-3
CZ11	**PG&E**	B-10	B-10	B-1 or B-10	B-10	G-NR1
CZ12	**PG&E**	B-10	B-1 or B-10	B-1 or B-10	B-10	G-NR1
CZ12-2	**SMUD**	CITS-1 (CI-TOD 1)	CITS-1 (CI-TOD 1)	CITS-1 (CI-TOD 1)	CITS-1	G-NR1
CZ13	**PG&E**	B-10	B-10	B-1 or B-10	B-10	G-NR1
CZ14	**SDG&E**	AL-TOU+EECC (AL-TOU)	AL-TOU+EECC (AL-TOU)	AL-TOU+EECC (AL-TOU)	AL-TOU+EECC (AL-TOU)	G-10 (GN-10)
CZ14-2	**SCE**	TOU-GS-2	TOU-GS-2	TOU-GS-2	TOU-GS-2 or TOU-GS-3	GN-3
CZ15	**SCE**	TOU-GS-2	TOU-GS-2	TOU-GS-2	TOU-GS-2	G-10 (GN-10)
CZ16	**PG&E**	B-10	B-1 or B-10	B-1 or B-10	B-1 or B-10	G-NR1

8.2.1 PG&E

Figure 6. PG&E Electric Schedule - B-1

Pacific Gas and Electric Company
U 39 San Francisco, California

	Revised	*Cal. P.U.C. Sheet No.*	53377-E
Cancelling	Revised	*Cal. P.U.C. Sheet No.*	52618-E

ELECTRIC SCHEDULE B-1
SMALL GENERAL SERVICE
Sheet 3

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	(T)
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	---		$4.75	(I)
Winter	---		$4.75	(I)
Total TOU Energy Rates ($ per kWh)				
Peak Summer	$0.38827	(I)	$0.44884	(I)
Part-Peak Summer	$0.33904	(I)	$0.30754	(I)
Off-Peak Summer	$0.31824	(I)	$0.26021	(I)
Peak Winter	$0.31285	(I)	$0.35089	(I)
Partial-Peak Winter (for B1-ST only)	---		$0.32139	(I)
Off-Peak Winter	$0.29674	(I)	$0.23234	(I)
Super Off-Peak Winter	$0.28032	(I)	$0.21592	(I)
PDP Rates (Consecutive Day and Five-Hour Event Option)*				
PDP Charges ($ per kWh)				
All Usage During PDP Event	$0.60			
PDP Credits				
Energy ($ per kWh)				
Peak Summer	($0.05667)			
Part-Peak Summer	($0.01683)			

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

(Continued)

Advice	6603-E-A	*Issued by*	*Submitted*	May 31, 2022
Decision		***Robert S. Kenney***	*Effective*	June 1, 2022
		Vice President, Regulatory Affairs	*Resolution*	

Figure 7. PG&E Electric Schedule - B-10

Pacific Gas and Electric Company
U 39
San Francisco, California

	Revised	Cal. P.U.C. Sheet No.	53381-E
Cancelling	Revised	Cal. P.U.C. Sheet No.	52969-E

ELECTRIC SCHEDULE B-10
MEDIUM GENERAL DEMAND-METERED SERVICE

Sheet 3

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 (T)

	Secondary Voltage		Primary Voltage		Transmission Voltage	
Total Customer Charge Rates						
Customer Charge ($ per meter per day)	$6.42016	(I)	$6.42016	(I)	$6.42016	(I)
Total Demand Rates ($ per kW)						
Summer	$17.47	(I)	$17.19	(I)	$13.66	(I)
Winter	$17.47	(I)	$17.19	(I)	$13.66	(I)
Total Energy Rates ($ per kWh)						
Peak Summer	$0.31411	(I)	$0.29823	(I)	$0.23025	(I)
Part-Peak Summer	$0.25242	(I)	$0.23993	(I)	$0.17351	(I)
Off-Peak Summer	$0.21985	(I)	$0.20909	(I)	$0.14344	(I)
Peak Winter	$0.23784	(I)	$0.22538	(I)	$0.17720	(I)
Off-Peak Winter	$0.20236	(I)	$0.19174	(I)	$0.14436	(I)
Super Off-Peak Winter	$0.16602	(I)	$0.15540	(I)	$0.10802	(I)
PDP Rates (Consecutive Day and Five-Hour Event Option						
PDP Charges ($ per kWh)						
All Usage During PDP Event	$0.90		$0.90		$0.90	
PDP Credits						
Energy ($ per kWh)						
Peak Summer	($0.07825)		($0.07825)		($0.07825)	
Part-Peak Summer	($0.02710)		($0.02710)		($0.02710)	

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

(Continued)

Advice	6603-E-A	*Issued by*	*Submitted*	May 31, 2022
Decision		***Robert S. Kenney***	*Effective*	June 1, 2022
		Vice President, Regulatory Affairs	*Resolution*	

Figure 8. PG&E Gas Schedule – G-NR1

Core Commercial Gas Rates

Rates below are effective October 1, 2022, through October 31, 2022.

Small Commercial: Schedule G-NR1 (Usage less than 20,800 therms per month)*

	Highest Average Daily Usage**				
	0 - 5.0 Therms	5.1 - 16.0 Therms	16.1 - 41.0 Therms	41.1 - 123.0 Therms	123.1 & Up Therms
Customer Charge (per day)	$0.27048	$0.52106	$0.95482	$1.66489	$2.14936
		Per Therm			
		Summer		Winter	
		First 4,000 Therms	Excess Therms	First 4,000 Therms	Excess Therms
Procurement Charge (per therm)		$0.87890	$0.87890	$0.87890	$0.87890
Transportation Charge (per therm)		$0.93090	$0.58273	$1.09498	$0.68545
Total G-NR1 Schedule Charge 1/		$1.80980	$1.46163	$1.97388	$1.56435
Cap-and-Trade Cost Exemption Credit 2/		$0.10235			
Schedule G-PPPS (Public Purpose Program Surcharge)1/ (per therm)		$0.06237	$0.06237	$0.06237	$0.06237

*Excluding months during which usage is less than 200 therms.
**Based on customer's highest Average Daily Usage (ADU) determined from among the billing periods occurring within the last twelve months, including current billing period. PG&E calculates the ADU for each billing period by dividing the total usage by the number of days in the billing period.

8.2.2 SCE

Figure 9. SCE Electric Schedule – TOU-GS-1

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

Southern California Edison — Revised — Cal. PUC Sheet No. 74535-E
Rosemead, California (U 338-E) — Cancelling Revised — Cal. PUC Sheet No. 73990-E

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

RATES (Continued)

Option D	Delivery Service: Trans[1]	Distrbtn[2]	NSGC[3]	NDC[4]	PPPC[5]	WFC[6]	DWRA[11]	PUCRF[7]	Total[8]	Generation[9]: UG**	DWREC[10]
Energy Charge - $/kWh											
Summer Season On-Peak	(0.00039)	0.03268 (R)	0.00967 (R)	0.00010	0.01845 (R)	0.00652	(0.00208)	0.00130	0.06825 (R)	0.11330 (I)	0.00000
Mid-Peak	(0.00039)	0.03268 (R)	0.00967 (R)	0.00010	0.01845 (R)	0.00652	(0.00208)	0.00130	0.06825 (R)	0.10231 (I)	0.00000
Off-Peak	(0.00039)	0.01374 (I)	0.00967 (R)	0.00010	0.01845 (R)	0.00652	(0.00208)	0.00130	0.04731 (I)	0.06705 (I)	0.00000
Winter Season											
Mid-Peak	(0.00039)	0.03268 (R)	0.00967 (R)	0.00010	0.01845 (R)	0.00652	(0.00208)	0.00130	0.06825 (R)	0.10668 (I)	0.00000
Off-Peak	(0.00039)	0.01374 (I)	0.00967 (R)	0.00010	0.01845 (R)	0.00652	(0.00208)	0.00130	0.04731 (I)	0.07531 (R)	0.00000
Super-Off-Peak	(0.00039)	0.00520 (R)	0.00967 (R)	0.00010	0.01845 (R)	0.00652	(0.00208)	0.00130	0.03877 (R)	0.05634 (R)	0.00000
Fixed Recovery Charge - $/kWh									0.00086 (I)		
Customer Charge - $/day		0.488 (R)							0.488 (R)		
Facilities Related Demand Charge - $/kW	3.81	13.16 (I)							16.97 (I)		
Time Related Demand Charge - $/kW											
Summer Season On-Peak		3.80 (R)							3.80 (R)	15.97 (R)	
Winter Season Mid-peak - Weekdays (4-9pm)		0.00							0.00	4.90 (I)	
Three-Phase Service - $/day		0.046 (I)							0.046 (I)		
Voltage Discount, Energy - $/kWh											
From 2 kV to 50 kV	0.00000	0.00000 (R)							0.00000 (R)	(0.00045) (R)	
From 51 kV to 219 kV	0.00000	0.00000 (R)							0.00000 (R)	(0.00089) (R)	
220 kV and above	0.00000	(0.01843) (R)							(0.01843) (R)	(0.00092) (R)	
Voltage Discount, Demand - $/kW											
Facilities Related From 2 kV to 50 kV	0.00	(0.26) (I)							(0.26) (I)		
Above 50 kV but below 220 kV	0.00	(5.78) (R)							(5.78) (R)		
At 220 kV	0.00	(13.16) (I)							(13.16) (I)		
Voltage Discount, Summer On Peak Demand - $/kW											
From 2 kV to 50 kV		(0.08) (I)							(0.08) (I)	(0.20)	
Above 50 kV but below 220 kV		(1.44) (I)							(1.44) (I)	(0.47)	
At 220 kV		(1.44) (R)							(1.44) (R)	(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		(59.00)							(59.00)		

* Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.
** The ongoing Competition Transition Charge (CTC) of $(0.00015) 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 $(0.00141) per kWh, Reliability Services Balancing Account Adjustment (RSBAA) of $(0.00087) per kWh, and Transmission Access Charge Balancing Account Adjustment (TACBAA) of $0.00189 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.

(Continued)

(To be inserted by utility) — Issued by — (To be inserted by Cal. PUC)
Advice 4864-E — Michael Backstrom — Date Submitted Sep 15, 2022
Decision 22-08-001 — Vice President — Effective Oct 1, 2022
5C11 — Resolution

Figure 10. SCE Electric Schedule – TOU-GS-2

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

Southern California Edison Revised Cal. PUC Sheet No. 74551-E
Rosemead, California (U 338-E) Cancelling Revised Cal. PUC Sheet No. 74003-E

Schedule TOU-GS-2 Sheet 4
TIME-OF-USE - GENERAL SERVICE - DEMAND METERED

(Continued)

RATES (Continued)

Option D / Option D-CPP		Delivery Service: Trans[1]	Distrbtn[2]	NSGC[3]	NDC[4]	PPPC[5]	WFC[6]	DWRA[11]	PUCRF[7]	Total[8]	Generation[9]: UG**	DWREC[10]
TOU Pricing												
Energy Charge - $/kWh												
	Summer Season - On-Peak	(0.00012)	0.01503 (I)	0.00940 (R)	0.00010	0.01919 (R)	0.00652	(0.00208)	0.00130	0.04994 (I)	0.10801 (R)	0.00000
	Mid-Peak	(0.00012)	0.01433 (I)	0.00940 (R)	0.00010	0.01919 (R)	0.00652	(0.00208)	0.00130	0.04864 (I)	0.09821 (R)	0.00000
	Off-Peak	(0.00012)	0.01403 (I)	0.00940 (R)	0.00010	0.01919 (R)	0.00652	(0.00208)	0.00130	0.04834 (I)	0.06365 (R)	0.00000
	Winter Season - Mid-Peak	(0.00012)	0.01503 (I)	0.00940 (R)	0.00010	0.01919 (R)	0.00652	(0.00208)	0.00130	0.04994 (I)	0.07345 (R)	0.00000
	Off-Peak	(0.00012)	0.01433 (I)	0.00940 (R)	0.00010	0.01919 (R)	0.00652	(0.00208)	0.00130	0.04864 (I)	0.07389 (I)	0.00000
	Super-Off-Peak	(0.00012)	0.01359 (I)	0.00940 (R)	0.00010	0.01919 (R)	0.00652	(0.00208)	0.00130	0.04790 (I)	0.03879 (R)	0.00000
Fixed Recovery Charge - $/kWh										0.00089 (I)		
Customer Charge - $/Meter/Month			189.75 (R)							189.75 (R)		
Facilities Related Demand Charge - $/kW		5.14	16.48 (I)							21.62 (I)		
Time Related Demand Charge - Summer Season - $/kW												
	On-Peak		13.63 (R)							13.63 (R)	20.20 (R)	
Winter Season - $/kW												
	Mid-peak - Weekdays (4-9pm)		2.20 (R)							2.20 (R)	5.30 (I)	
Single Phase Service - $/Month			(6.58) (I)							(6.58) (I)		
Voltage Discount, Demand - $/kW												
	Facilities Related											
	From 2 kV to 50 kV	0.00	(0.33) (I)							(0.33) (I)	0.00	
	Above 50 kV but below 220 kV	0.00	(7.24) (I)							(7.24) (I)	0.00	
	At 220 kV	0.00	(16.48) (I)							(16.48) (I)	0.00	
Voltage Discount, Summer On Peak - $/kW												
	From 2 kV to 50 kV	0.00	(0.27) (I)							(0.27) (I)	(0.48) (I)	
	Above 50 kV but below 220 kV	0.00	(5.15) (I)							(5.15) (I)	(1.06) (I)	
	At 220 kV	0.00	(13.63) (I)							(13.63) (I)	(1.07) (I)	
Voltage Discount, Winter Weekday Mid-Peak - $/kW												
	From 2 kV to 50 kV	0.00	(0.04) (R)							(0.04) (R)	(0.12) (R)	
	Above 50 kV but below 220 kV	0.00	(0.83) (R)							(0.83) (R)	(0.28) (R)	
	At 220 kV	0.00	(2.20) (R)							(2.20) (R)	(0.28) (R)	
Voltage Discount, Energy - $/kWh												
	From 2 kV to 50 kV	0.00000	(0.00026) (I)							(0.00026) (I)	(0.00091) (R)	
	Above 50 kV but below 220 kV	0.00000	(0.00494) (I)							(0.00494) (I)	(0.00197) (R)	
	At 220 kV	0.00000	(0.01314) (I)							(0.01314) (I)	(0.00199) (R)	
California Alternate Rates for Energy Discount - %			100.00*							100.00*		
TOU Option	$/Meter/Month											
	RTEM		26.83							26.83		
California Climate Credit - $/meter			(59.00)							(59.00)		
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)										(20.20) (R)	

* Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.
** The ongoing Competition Transition Charge (CTC) of $(0.00015) per kWh is recovered in the UG component of Generation. (R)
*** 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 $(.00141) per kWh, Reliability Services Balancing Account Adjustment (RSBAA) of $(0.00060) per kWh, and Transmission Access Charge Balancing Account Adjustment (TACBAA) of $0.00189 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.

(Continued)

(To be inserted by utility)		Issued by	(To be inserted by Cal. PUC)	
Advice	4864-E	Michael Backstrom	Date Submitted	Sep 15, 2022
Decision	22-08-001	Vice President	Effective	Oct 1, 2022
4C11			Resolution	

Figure 11. SCE Electric Schedule – TOU-GS-3

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

Southern California Edison Revised Cal. PUC Sheet No. 73208-E
Rosemead, California (U 338-E) Cancelling Revised Cal. PUC Sheet No. 72721-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]	DWRBC[6]	PUCRF[7]	Total[8]	UG**	DWREC[10]
Option D / Option D-CPP										
Energy Charge - $/kWh/Meter/Month										
Summer Season - On-Peak	0.00095	0.00996 (I)	0.00886 (R)	0.00010	0.01771 (R)	0.00652	0.00130	0.04540 (R)	0.10353 (I)	0.00000
Mid-Peak	0.00095	0.00996 (I)	0.00886 (R)	0.00010	0.01771 (R)	0.00652	0.00130	0.04540 (R)	0.09309 (I)	0.00000
Off-Peak	0.00095	0.00996 (I)	0.00886 (R)	0.00010	0.01771 (R)	0.00652	0.00130	0.04540 (R)	0.08120 (I)	0.00000
Winter Season										
Mid-Peak	0.00095	0.00996 (I)	0.00886 (R)	0.00010	0.01771 (R)	0.00652	0.00130	0.04540 (R)	0.08038 (I)	0.00000
Off-Peak	0.00095	0.00996 (I)	0.00886 (R)	0.00010	0.01771 (R)	0.00652	0.00130	0.04540 (R)	0.06747 (I)	0.00000
Super-Off-Peak	0.00095	0.00996 (I)	0.00886 (R)	0.00010	0.01771 (R)	0.00652	0.00130	0.04540 (R)	0.04329 (I)	0.00000
Customer Charge - $/Meter/Month		496.98 (I)						496.98 (I)		
Demand Charge - $/kW of Billing Demand/Meter/Month										
Facilities Related	5.65	13.29 (I)						18.94 (I)		
Time Related										
Summer Season - On-Peak		16.14 (I)						16.14 (I)	22.38 (I)	
Winter Season - Mid-Peak - Weekdays (4-9pm)		5.47 (I)						5.47 (I)	4.06 (I)	
Voltage Discount, Demand - $/kW										
Facilities Related										
From 2 kV to 50 kV	0.00	(0.19) (I)						(0.19) (I)		
Above 50 kV but below 220 kV	0.00	(8.13) (I)						(8.13) (I)		
At 220 kV	0.00	(13.29) (I)						(13.29) (I)		
Voltage Discount, Summer On Peak and Winter Weekdays (4-9pm) Demand - $/kW										
From 2 kV to 50 kV	0.00	(0.13)						(0.13)	(0.18) (I)	
Above 50 kV but below 220 kV	0.00	(3.93) (I)						(3.93) (I)	(0.47) (I)	
At 220 kV	0.00	(9.31) (I)						(9.31) (I)	(0.47) (I)	
Voltage Discount, Energy - $/kWh										
From 2 kV to 50 kV	0.00000	(0.00013)						(0.00013)	(0.00104) (I)	
Above 50 kV but below 220 kV	0.00000	(0.00364) (I)						(0.00364) (I)	(0.00229) (I)	
At 220 kV	0.00000	(0.00870) (I)						(0.00870) (I)	(0.00230) (I)	
Power Factor Adjustment - $/kVAR										
Greater than 50 kV		0.54						0.54		
50 kV or less		0.60						0.60		
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 Weekdays (4-9pm)									(22.38) (I)	

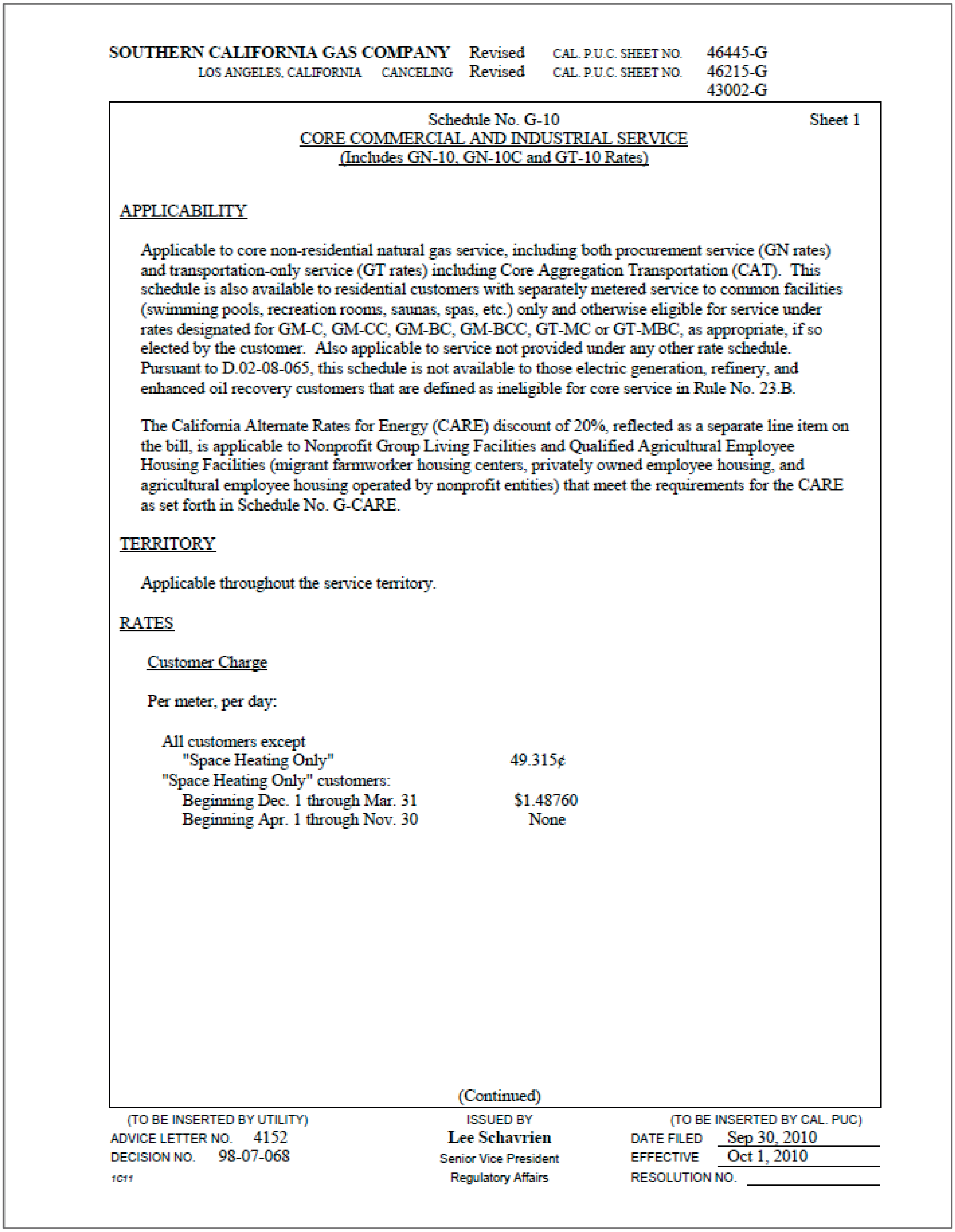
* Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.
** The ongoing Competition Transition Charge (CTC) of $(0.00015) per kWh is recovered in the UG component of Generation. (R)
*** The Maximum Available Credit is the capped credit amount for CPP 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 $(0.00141) per kWh, Reliability Services Balancing Account Adjustment (RSBAA) of $(0.00079) per kWh, and Transmission Access Charge Balancing Account Adjustment (TACBAA) of $0.00315 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 DWRBC = Department of Water Resources (DWR) Bond Charge. The DWR Bond Charge is the Wildfire Fund Non-Bypassable Charge which 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.

(Continued)

(To be inserted by utility) Issued by (To be inserted by Cal. PUC)
Advice 4719-E Michael Backstrom Date Submitted Feb 15, 2022
Decision Vice President Effective Mar 1, 2022
3C7 Resolution

8.2.3 SCG

Figure 12. SCG Gas Schedule – G-10



SOUTHERN CALIFORNIA GAS COMPANY Revised CAL. P.U.C. SHEET NO. 46445-G
LOS ANGELES, CALIFORNIA CANCELING Revised CAL. P.U.C. SHEET NO. 46215-G
43002-G

Schedule No. G-10 Sheet 1
CORE COMMERCIAL AND INDUSTRIAL SERVICE
(Includes GN-10, GN-10C and GT-10 Rates)

APPLICABILITY

Applicable to core non-residential natural gas service, including both procurement service (GN rates) and transportation-only service (GT rates) including Core Aggregation Transportation (CAT). This schedule is also available to residential customers with separately metered service to common facilities (swimming pools, recreation rooms, saunas, spas, etc.) only and otherwise eligible for service under rates designated for GM-C, GM-CC, GM-BC, GM-BCC, GT-MC or GT-MBC, as appropriate, if so elected by the customer. Also applicable to service not provided under any other rate schedule. Pursuant to D.02-08-065, this schedule is not available to those electric generation, refinery, and enhanced oil recovery customers that are defined as ineligible for core service in Rule No. 23.B.

The California Alternate Rates for Energy (CARE) discount of 20%, reflected as a separate line item on the bill, is applicable to Nonprofit Group Living Facilities and Qualified Agricultural Employee Housing Facilities (migrant farmworker housing centers, privately owned employee housing, and agricultural employee housing operated by nonprofit entities) that meet the requirements for the CARE as set forth in Schedule No. G-CARE.

TERRITORY

Applicable throughout the service territory.

RATES

Customer Charge

Per meter, per day:

All customers except "Space Heating Only"	49.315¢
"Space Heating Only" customers:	
Beginning Dec. 1 through Mar. 31	$1.48760
Beginning Apr. 1 through Nov. 30	None

(Continued)

(TO BE INSERTED BY UTILITY)
ADVICE LETTER NO. 4152
DECISION NO. 98-07-068
1C11

ISSUED BY
Lee Schavrien
Senior Vice President
Regulatory Affairs

(TO BE INSERTED BY CAL. PUC)
DATE FILED Sep 30, 2010
EFFECTIVE Oct 1, 2010
RESOLUTION NO.

SOUTHERN CALIFORNIA GAS COMPANY Revised CAL. P.U.C. SHEET NO. 60204-G
LOS ANGELES, CALIFORNIA CANCELING Revised CAL. P.U.C. SHEET NO. 60169-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.

			Tier I[1/]	Tier II[1/]	Tier III[1/]	
GN-10:[4/]	Applicable to natural gas procurement service to non-residential core customers, including service not provided under any other rate schedule.					
	Procurement Charge:[2/]	G-CPNR	64.959¢	64.959¢	64.959¢	R,R,R
	Transmission Charge:	GPT-10	106.047¢	60.635¢	30.186¢	
	Commodity Charge:	GN-10	171.006¢	125.594¢	95.145¢	R,R,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.					
	Procurement Charge:[2/]	G-CPNRC	72.898¢	72.898¢	72.898¢	
	Transmission Charge:	GPT-10	106.047¢	60.635¢	30.186¢	
	Commodity Charge:	GN-10C	178.945¢	133.533¢	103.084¢	
GT-10[4/]:	Applicable to non-residential transportation-only service including CAT service, as set forth in Special Condition 13.					
	Transmission Charge:	GT-10	106.047¢[3/]	60.635¢[3/]	30.186¢[3/]	

[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. 6051	Dan Skopec	SUBMITTED Oct 31, 2022
DECISION NO. 98-07-068	Senior Vice President	EFFECTIVE Nov 1, 2022
2C8	Regulatory Affairs	RESOLUTION NO.

8.2.4 SDG&E

Figure 13. SDG&E Electric Schedule – AL-TOU

San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 35374-E

Canceling Revised Cal. P.U.C. Sheet No. 31333-E

SCHEDULE AL-TOU

Sheet 2

GENERAL SERVICE - TIME METERED

RATES*

Description – AL-TOU	Transm	Distr	PPP	ND	CTC	LGC	RS	TRAC	UDC Total
Basic Service Fees ($/month)									
0-500 kW									
Secondary		199.35 I							199.35 I
Primary		53.75 I							53.75 I
Secondary Substation		18,717.35 I							18,717.35 I
Primary Substation		18,717.35 I							18,717.35 I
Transmission		289.91 I							289.91 I
> 500 kW									
Secondary		766.91 I							766.91 I
Primary		63.95 I							63.95 I
Secondary Substation		18,717.35 I							18,717.35 I
Primary Substation		18,717.35 I							18,717.35 I
Transmission		1,159.95 I							1,159.95 I
> 12 MW									
Secondary Substation		31,585.50 I							31,585.50 I
Primary Substation		31,644.17 I							31,644.17 I
Trans. Multiple Bus		3,000.00							3,000.00
Distance Adjust. Fee									
Secondary - OH		1.23							1.23
Secondary - UG		3.17							3.17
Primary - OH		1.22							1.22
Primary - UG		3.13							3.13

(Continued)

2C7

Advice Ltr. No. 3855-E

Decision No. 21-07-010

Issued by
Dan Skopec
Vice President
Regulatory Affairs

Submitted Sep 30, 2021
Effective Nov 1, 2021
Resolution No.

SDGE
San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 36350-E

Canceling Revised Cal. P.U.C. Sheet No. 35768-E

Sheet 3

SCHEDULE AL-TOU

GENERAL SERVICE - TIME METERED

RATES* (Continued)

Description – AL-TOU	Transm	Distr	PPP	ND	CTC	LGC	RS	TRAC	UDC Total
Demand Charges ($/kW)									
Non-Coincident									
Secondary	18.63	12.69 I			0.00		0.00		31.32 I
Primary	18.00	12.62 I			0.00		0.00		30.62 I
Secondary Substation	18.63	0.23 I	0.52		0.37 I		0.00		19.75 I
Primary Substation	18.00	0.23 I	0.52		0.37 I		0.00		19.12 I
Transmission	17.93	0.23 I	0.52		0.37 I		0.00		19.05 I
Maximum On-Peak									
Summer									
Secondary	3.90	23.90 I							27.80 I
Primary	3.77	23.77 I							27.54 I
Secondary Substation	3.90	0.00							3.90
Primary Substation	3.77	0.00							3.77
Transmission	3.75	0.00							3.75
Winter									
Secondary	0.82	27.92 I							28.74 I
Primary	0.79	27.77 I							28.56 I
Secondary Substation	0.82	0.00							0.82
Primary Substation	0.79	0.00							0.79
Transmission	0.79	0.00							0.79
Power Factor ($/kvar)									
Secondary		0.25							0.25
Primary		0.25							0.25
Secondary Substation		0.25							0.25
Primary Substation		0.25							0.25
Transmission		0.00							0.00

(Continued)

3C9

Advice Ltr. No. 4004-E

Decision No. 22-03-003

Issued by
Dan Skopec
Vice President
Regulatory Affairs

Submitted May 16, 2022

Effective Jun 1, 2022

Resolution No.

SDGE
San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 36351-E

Canceling Revised Cal. P.U.C. Sheet No. 35769-E

Sheet 4

SCHEDULE AL-TOU

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	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Primary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Secondary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Primary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Transmission	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Off-Peak – Summer									
Secondary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Primary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Secondary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Primary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Transmission	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Super Off-Peak									
Secondary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Primary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Secondary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Primary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Transmission	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
On-Peak – Winter									
Secondary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Primary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Secondary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Primary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Transmission	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Off-Peak – Winter									
Secondary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Primary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Secondary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Primary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Transmission	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Super Off-Peak									
Secondary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Primary	(0.01745)	0.00132 I	0.01979	0.00007	0.00106 I	0.00289 I	0.00001		0.00769 I
Secondary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Primary Substation	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I
Transmission	(0.01745)	0.00068 I	0.01837	0.00007		0.00289 I	0.00001		0.00457 I

Notes: Transmission Energy charges include the Transmission Revenue Balancing Account Adjustment (TRBAA) of $(0.00130) per kWh and the Transmission Access Charge Balancing Account Adjustment (TACBAA) of $(0.01615) 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) $0.01060/kWh, Non-low Income PPP rate (Non-LI-PPP) $0.00300/kWh (pursuant to PU Code Section 399.8, the Non-LI-PPP rate may not exceed January 1, 2000 levels), Procurement Energy Efficiency Surcharge Rate of $0.00477/kWh. For Secondary and Primary voltage levels, the PPP Energy charge also includes California Solar Initiative rate (CSI) of $0.00000/kWh and Self-Generation Incentive Program rate (SGIP) $ 0.00142 /kWh. For Secondary Substation, Primary Substation and Transmission voltage levels, the PPP rate includes Demand charges for CSI of $0.00 /kW and SGIP of $0.52 /kW.

*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. 4004-E	Issued by **Dan Skopec**	Submitted	May 16, 2022
		Effective	Jun 1, 2022
Decision No. 22-03-003	Vice President Regulatory Affairs	Resolution No.	

Figure 14. SDG&E Electric Schedule - EECC

San Diego Gas & Electric Company
San Diego, California

	Revised	Cal. P.U.C. Sheet No.	36409-E
Canceling	Revised	Cal. P.U.C. Sheet No.	35858-E

SCHEDULE EECC Sheet 5

ELECTRIC ENERGY COMMODITY COST

Commodity Rates (Continued)

Schedule A-TC	($/kWh)	
Summer	0.08147	R
Winter	0.08147	R
Schedule TOU-M		
Summer		
On-Peak Energy	0.34164	R
Off-Peak Energy	0.11656	R
Super Off-Peak Energy	0.06544	R
Winter		
On-Peak Energy	0.13581	R
Off-Peak Energy	0.07640	R
Super Off-Peak Energy	0.05903	R
Schedule OL-TOU		
Summer		
On-Peak Energy	0.40931	R
Off-Peak Energy	0.13921	R
Super Off-Peak Energy	0.07661	R
Winter		
On-Peak Energy	0.16089	R
Off-Peak Energy	0.09017	R
Super Off-Peak Energy	0.06966	R
Schedule AL-TOU	($/kW)	
Maximum On-Peak Demand: Summer		
Secondary	12.18	R
Primary	12.12	R
Secondary Substation	12.18	R
Primary Substation	12.12	R
Transmission	11.60	R
Maximum On-Peak Demand: Winter		
Secondary		
Primary		
Secondary Substation		
Primary Substation		
Transmission		
On-Peak Energy: Summer	($/kWh)	
Secondary	0.17868	R
Primary	0.17782	R
Secondary Substation	0.17868	R
Primary Substation	0.17782	R
Transmission	0.17021	R
Off-Peak Energy: Summer		
Secondary	0.10423	R
Primary	0.10375	R
Secondary Substation	0.10423	R
Primary Substation	0.10375	R
Transmission	0.09933	R
Super Off-Peak Energy: Summer		
Secondary	0.09960	R
Primary	0.09927	R
Secondary Substation	0.09960	R
Primary Substation	0.09927	R
Transmission	0.09526	R

(Continued)

5C8

Advice Ltr. No.	4004-E	Issued by	Submitted	May 16, 2022
		Dan Skopec	Effective	Jun 1, 2022
Decision No.	22-03-003	Vice President Regulatory Affairs	Resolution No.	

Figure 15. SDG&E Gas Schedule – GN-3

San Diego Gas & Electric Company
San Diego, California

	Revised	Cal. P.U.C. Sheet No.	18445-G
Canceling	Revised	Cal. P.U.C. Sheet No.	18058-G

SCHEDULE GN-3

Sheet 1

NATURAL GAS SERVICE FOR CORE NON-RESIDENTIAL CUSTOMERS
(Includes Rates for GN-3, GN-3C, GN-3/GTC and GN-3/GTCA)

APPLICABILITY

Applicable to core nonresidential natural gas service, including both procurement service and transportation-only service including Core Aggregation Transportation (CAT). Also applicable to service not provided under any other rate schedule. This schedule is not available to electric generation customers who generator's rated capacity exceeds one megawatt, refinery customers, and enhanced oil recovery customers, whose gas consumption exceeds 250,000 therms per year.

The GN-3 rate is applicable to natural gas procurement and transportation service to nonresidential core customers and to separately metered, common area use service to residential detached homes. This schedule is optionally available to customers with separately metered, common area use service to residential, multi-family accommodations, as defined in Rule 1.

The GN-3C cross-over rate is a core procurement service for previous transportation-only customers returning to core procurement service customers with annual consumption over 50,000 therms, as set forth in Special Condition 8. T

The GN-3/GTC (GTC) and GN-3/GTCA (GTCA) rates are applicable to intrastate gas transportation-only services as set forth in Special Conditions 9-14. N T

Non-profit group living facilities taking service under this schedule may be eligible for a 20% low-income rate discount on their bill, if such facilities qualify to receive service under the terms and conditions of Schedule G-CARE.

Agricultural Employee Housing Facilities, as defined in Schedule G-CARE, may qualify for a 20% CARE discount on the bill if all eligibility criteria set forth in Form 142-4032 or Form 142-4035 is met.

TERRITORY

Within the entire territory served natural gas by the Utility.

RATES	GN-3	GN-3-C	GTC/GTCA
Customer charges, $ per meter per month:	$10.00	$10.00	$10.00

D

(Continued)

1C11

Advice Ltr. No. 1980-G	Issued by Lee Schavrien	Date Filed	Oct 15, 2010
	Senior Vice President	Effective	Nov 14, 2010
Decision No.	Regulatory Affairs	Resolution No.	

SDGE
San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 26223-G
Canceling Revised Cal. P.U.C. Sheet No. 26210-G

SCHEDULE GN-3

Sheet 2

NATURAL GAS SERVICE FOR CORE NON-RESIDENTIAL CUSTOMERS
(Includes Rates for GN-3, GN-3C, GN-3/GTC and GN-3/GTCA)

RATES (continued)

Volumetric charges, $ per therm:

	GN-3	GN-3C		GTC/GTCA[2]
Procurement Charge (0 to 1,000)	$0.65036	$0.71790	R	N/A
Transportation Charge	$0.72856	$0.72856		$0.72858
Total Charge	$1.37892	$1.44646	R	$0.72858
Procurement Charge (1,001 to 21,000	$0.65036	$0.71790	R	N/A
Transportation Charge	$0.48510	$0.48510		$0.48512
Total Charge	$1.13546	$1.20300	R	$0.48512
Procurement Charge (Over 21,000	$0.65036	$0.71790	R	N/A
Transportation Charge	$0.41632	$0.41632		$0.41634
Total Charge	$1.06668	$1.13422	R	$0.41634

[2] The rates for core transportation-only customers, with the exception of customers taking service under Schedule GT-NGV, include any FERC Settlement Proceeds Memorandum Account (FSPMA) credit adjustments.

Standby Service Fee for GTC/GTCA Customers

Per decatherm $10

This fee shall be assessed to customers only during curtailments of transportation services to firm noncore customers. This fee will apply only to the difference between the customer's nominations and their confirmed deliveries.

The customer's storage volumes, if available, may be used to offset the standby service fee. Revenues collected from this fee shall be credited to the Utility's Non-Margin Fixed Cost Account (NMFCA). Curtailments of standby services provided to core customers are described in Rule 14.

GTC/GTCA customers who receive service under this schedule shall also be eligible for standby services ahead of such services offered to noncore customers, including core subscription customers.

Billing adjustments may be necessary to reflect changes in volumes used in developing prior periods' transportation charges.

(Continued)

2C6	Issued by	Submitted	Nov 7, 2022
Advice Ltr. No. 3138-G	Dan Skopec	Effective	Nov 10, 2022
	Senior Vice President		
Decision No.	Regulatory Affairs	Resolution No.	

8.2.5 CPAU

Figure 16. CPAU Electric Schedule – E-2

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

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	$0.12151	$0.09276	$0.00469	$0.21896
Winter Period	0.08715	0.06171	0.00469	0.15355
Minimum Bill ($/day)				0.8777

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

Supersedes Sheet No E-2-1
dated 7-1-2019

CITY OF PALO ALTO UTILITIES

Sheet No **E-2-1**
Effective 7-1-2022

Figure 17. CPAU Gas Schedule – G-2

CITY OF
PALO ALTO
UTILITIES

Monthly Gas
Commodity & Volumetric Rates

Your gas bill includes two charge types: 1) a service charge, and 2) a volumetric charge. The service charge for your gas service can be found on the appropriate rate schedule, which you can find in the following locations: Residential Rate Schedules, and Business Rate Schedules.

The volumetric charge depends on your consumption, and the rate varies monthly based on the current price of gas. The following tables show the volumetric rates ($/Therm) for each gas rate schedule. The volumetric rates include a) a Commodity charge, which represents the cost of the gas, b) a Distribution rate, c) a Cap and Trade Compliance charge, a d) Carbon Offset Charge and e) a Transportation Charge. The Cap and Trade charge covers the cost of acquiring compliance instruments in California's Cap and Trade program, and will change in response to market conditions, sales volumes, and the quantity of allowances required. The Transportation Charge is based on the current PG&E G-WSL rate for Palo Alto, accounting for delivery losses to the Customer's Meter. Prior to November 1, 2016, it was included within the Distribution rate.

On September 15, 2014, Council adopted Resolution #9451 authorizing the City's participation in a natural gas purchase from Municipal Gas Acquisition and Supply Corporation (MuniGas) for the City's entire retail gas load for a period of at least 10 years. The MuniGas transaction includes a mechanism for municipal utilities to utilize their tax-exempt status to achieve a discount on the market price of gas. As of November 1, 2018, gas will begin flowing under this program, reducing the City's gas commodity cost by about $1 Million per year and saving gas customers approximately $0.03 per Therm on the commodity portion of their bills.

These charges are shown on the left-hand side of the table below for information purposes, while the total volumetric rate (Commodity+ Distribution+ Cap and Trade Compliance+ Carbon Offset+ Transportation) is shown on the right-hand side of the table. To calculate your variable gas costs, apply the total rate to your consumption for each month. If you are a resident, note that your gas rate varies based on how much you consume (Tier 1 and Tier 2). For information on consumption tiers please refer to the G-1 Residential Gas Service Rate Schedule.

If you have questions on your bill, please call the City of Palo Alto Utilities Customer Service Center at 650-329-2161.

Effective Date	Commodity Rate	Cap and Trade Compliance Charge	Transportation Charge	Carbon Offset Charge	Total Volumetric Rate			
					G-1 (Residential)		G-2 (Master Metered Multi-Family and Small Commercial)	G-3 (Large Commercial)
					Tier 1	Tier 2		
	per Therm	per Therm	per Therm	per Therm	per Therm	per Therm	per Therm	per Therm
3/1/22	0.5370	0.0486	0.15000	0.040	1.30460	2.12820	1.47040	1.46350
2/1/22	0.5360	0.0486	0.15000	0.040	1.30360	2.12720	1.46940	1.46250
1/1/22	0.7714	0.0486	0.15000	0.040	1.53900	2.36260	1.70480	1.69790
12/1/21	0.6321	0.0486	0.12274	0.040	1.37244	2.19604	1.53824	1.53134
11/1/21	0.7505	0.0486	0.12274	0.040	1.49084	2.31444	1.65664	1.64974
10/1/21	0.7175	0.0486	0.12274	0.040	1.45784	2.28144	1.62364	1.61674
9/1/21	0.5217	0.0486	0.12274	0.040	1.26204	2.08564	1.42784	1.42094
8/1/21	0.5492	0.0486	0.12274	0.040	1.28954	2.11314	1.45534	1.44844
7/1/21	0.4800	0.0486	0.12274	0.040	1.22034	2.04394	1.38614	1.37924
6/1/21	0.3982	0.0486	0.12214	0.040	1.11274	1.89714	1.27064	1.26404
5/1/21	0.3901	0.0486	0.12200	0.040	1.10450	1.88890	1.26240	1.25580
4/1/21	0.3375	0.0486	0.12200	0.040	1.05190	1.83630	1.20980	1.20320
3/1/21	0.3577	0.0486	0.12200	0.040	1.07210	1.85650	1.23000	1.22340

8.2.6 SMUD (Electric Only)

Figure 18. SMUD Electric Schedule – CITS-0/CITS-1

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

C. **Restructured Commercial & Industrial Time-of-Day Rates**

	Effective as of October 1, 2021	Effective as of March 1, 2022	Effective as of January 1, 2023
CITS-0: C&I Secondary 0-20 kW			
Non-Summer Season (October - May)			
System Infrastructure Fixed Charge *per month per meter*	$28.40	$28.85	$35.15
Maximum Demand Charge *$ per monthly max kW*	$0.000	$0.000	$0.000
Electricity Usage Charge			
Peak *$/kWh*	$0.1430	$0.1451	$0.1440
Off-Peak *$/kWh*	$0.1393	$0.1414	$0.1364
Off-Peak Saver *$/kWh*	$0.1373	$0.1394	$0.1323
Summer Season (June - September)			
System Infrastructure Fixed Charge *per month per meter*	$28.40	$28.85	$35.15
Maximum Demand Charge *$ per monthly max kW*	$0.000	$0.000	$0.000
Electricity Usage Charge			
Peak *$/kWh*	$0.2355	$0.2390	$0.2554
Off-Peak *$/kWh*	$0.1331	$0.1351	$0.1349
CITS-1: C&I Secondary 21-299 kW			
Non-Summer Season (October - May)			
System Infrastructure Fixed Charge *per month per meter*	$88.05	$89.35	$158.30
Site Infrastructure Charge *per 12 months max kW or contract capacity*	$7.930	$8.049	$7.568
Electricity Usage Charge			
Peak *$/kWh*	$0.1169	$0.1187	$0.1230
Off-Peak *$/kWh*	$0.1136	$0.1153	$0.1158
Off-Peak Saver *$/kWh*	$0.1078	$0.1094	$0.1030
Summer Season (June - September)			
System Infrastructure Fixed Charge *per month per meter*	$88.05	$89.35	$158.30
Site Infrastructure Charge *per 12 months max kW or contract capacity*	$7.930	$8.049	$7.568
Summer Peak Demand Charge *$ per monthly Peak max kW*	$1.680	$1.705	$3.468
Electricity Usage Charge			
Peak *$/kWh*	$0.1897	$0.1925	$0.1983
Off-Peak *$/kWh*	$0.1102	$0.1119	$0.1119

New restructured commercial rates beyond 2023 are effective as shown in Section IX. Transition Schedule.

IV. Electricity Usage Surcharges

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

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

V. Rate Option Menu

A. **Energy Assistance Program for Nonprofit Agencies.** Refer to Rate Schedule EAPR.

B. **Campus Rates.** Refer to Rate Schedule CB.

C. **Implementation of Energy Efficiency Program or Installation of New Solar/Photovoltaic or Storage Systems**

Customers who implement a SMUD-sponsored Energy Efficiency program or who install a SMUD-approved solar/photovoltaic or storage system to offset their on-site energy usage may request, in writing, within 30 days of the project completion and commissioning, an adjustment to their twelve month maximum demand based on the anticipated reduction in kW from the Energy Efficiency Project Worksheet. The adjusted twelve month maximum demand is valid for 12 months or until it is exceeded by actual maximum demand.

SACRAMENTO MUNICIPAL UTILITY DISTRICT Sheet No. **CI-TOD1-3**
Resolution No. 21-09-06 adopted September 16, 2021 Effective: **September 17, 2021**
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8.2.7 Escalation Rates

Utility rates are assumed to escalate over time, using assumptions from research conducted by Energy and Environmental Economics (E3) in Appendix 8.2. The 2019 *study Residential Building Electrification in California* (Energy + Environmental Economics 2019a) and escalation rates used in the development of the 2022 TDV multipliers

Table 24 below demonstrate the escalation rates used for nonresidential buildings. 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 24. Real Utility Rate Escalation Rate Assumptions Above Inflation

	Source	Statewide Electric Nonresidential Average Rate (%/year, real)	Statewide Natural Gas Nonresidential Core Rate (%/year, real)
2023	E3 2019	2.0%	4.0%
2024	2022 TDV	0.7%	7.7%
2025	2022 TDV	0.5%	5.5%
2026	2022 TDV	0.7%	5.6%
2027	2022 TDV	0.2%	5.6%
2028	2022 TDV	0.6%	5.7%
2029	2022 TDV	0.7%	5.7%
2030	2022 TDV	0.6%	5.8%
2031	2022 TDV	0.6%	3.3%
2032	2022 TDV	0.6%	3.6%
2033	2022 TDV	0.6%	3.4%
2034	2022 TDV	0.6%	3.4%
2035	2022 TDV	0.6%	3.2%
2036	2022 TDV	0.6%	3.2%
2037	2022 TDV	0.6%	3.1%

8.3 HVAC and SHW System Cost Scalers

Table 25 shows the material and labor adjustment factors used to determine the costs.

Table 25. Materials and Labor Adjustment Factors by Climate Zone

	Materials	Labor
CZ 01	0.963	0.994
CZ 02	0.963	1.387
CZ 03	1.001	1.291
CZ 04	0.998	1.298
CZ 05	0.964	0.997
CZ 06	0.960	0.997
CZ 07	0.999	0.985
CZ 08	0.998	0.996
CZ 09	0.964	0.996
CZ 10	0.998	0.996
CZ 11	1.002	0.990
CZ 12	1.000	1.000

CZ 13	1.000	0.990
CZ 14	0.964	0.980
CZ 15	0.963	0.996
CZ 16	0.967	0.990

Table 26 shows the contractor markup values used to determine the costs.

Table 26. Contractor Markup Values

	Contractor 1	Contractor 2
General Conditions and Overhead	15%	20%
Design and Engineering	5%	10%
Permit, testing and inspection	5%	3%
Contractor Profit/Market Factor	10%	10%

8.4 Mixed Fuel Baseline Figures

Table 27. Mixed Fuel Baseline Model – Medium Office

Climate zone	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (therms)	Total kTDV/ft2	Total TDV Compliance kTDV/ft2	Efficiency TDV Compliance kTDV/ft2	GHG Emissions tons/yr	Total TDV Compliance Margin	Proposed Elec Utility Cost	Proposed Gas Utility Cost
CZ01	**PG&E**	186,894	5,331	130	10	72	63	1	$67,234	$10,377
CZ02	**PG&E**	163,979	3,253	142	12	107	52	2	$67,798	$6,493
CZ03	**PG&E**	176,640	2,672	131	5	83	48	1	$67,999	$5,352
CZ04	**PG&E**	163,768	2,003	125	-2	107	46	1	$68,366	$4,093
CZ04-2	**CPAU**	163,768	2,003	125	-2	107	46	1	$30,988	$6,966
CZ05	**PG&E**	170,544	2,575	113	-8	76	46	1	$66,040	$5,156
CZ05-2	**SCG**	170,544	2,575	113	-8	76	46	1	$66,040	$4,242
CZ06	**SCE**	163,722	1,066	122	-7	76	39	0	$76,817	$1,980
CZ07	**SDG&E**	169,611	747	114	-9	76	38	0	$120,127	$1,150
CZ08	**SCE**	191,703	941	130	-2	76	41	1	$83,752	$1,763
CZ09	**SCE**	169,514	1,119	135	0	76	41	1	$82,274	$2,046
CZ10	**SDG&E**	185,682	1,445	141	10	76	45	2	$134,646	$2,113
CZ10-2	**SCE**	185,682	1,445	141	10	76	45	2	$86,338	$2,474
CZ11	**PG&E**	209,343	3,309	166	40	136	59	2	$81,001	$6,669
CZ12	**PG&E**	178,461	2,864	145	19	118	53	2	$72,381	$5,784
CZ12-2	**SMUD**	178,461	2,864	145	19	118	53	2	$26,576	$5,784
CZ13	**PG&E**	211,193	2,377	165	37	139	55	2	$81,491	$4,852
CZ14	**SDG&E**	156,689	3,058	147	13	139	52	3	$128,390	$4,337
CZ14-2	**SCE**	156,689	3,058	147	13	139	52	3	$83,690	$4,756
CZ15	**SCE**	209,720	662	161	32	139	47	2	$101,041	$1,311
CZ16	**PG&E**	177,562	5,799	127	9	94	67	4	$68,281	$11,409

Table 28. All-electric Baseline Model – Medium Retail

Climate zone	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (therms)	Total kTDV/ft2	Total TDV Compliance kTDV/ft2	Efficiency TDV Compliance kTDV/ft2	GHG Emissions tons/yr	Total TDV Compliance Margin	Proposed Elec Utility Cost	Proposed Gas Utility Cost
CZ01	PG&E	138,367	0	192	110	162	28	-8	$43,917	$0
CZ02	PG&E	131,521	0	211	125	198	28	-15	$50,499	$0
CZ03	PG&E	112,237	0	176	91	156	25	-1	$36,206	$0
CZ04	PG&E	122,256	0	197	111	193	27	-5	$47,522	$0
CZ04-2	CPAU	122,256	0	197	111	193	27	-5	$22,961	$0
CZ05	PG&E	108,753	0	159	76	146	24	-8	$35,179	$0
CZ05-2	SCG	108,753	0	159	76	146	24	-8	$35,179	$0
CZ06	SCE	111,442	0	175	89	146	24	-8	$42,572	$0
CZ07	SDG&E	109,079	0	172	87	146	23	0	$71,108	$0
CZ08	SCE	129,105	0	196	107	146	26	-10	$47,404	$0
CZ09	SCE	123,673	0	193	105	146	26	-3	$46,830	$0
CZ10	SDG&E	114,235	0	174	87	146	25	4	$77,903	$0
CZ10-2	SCE	114,235	0	174	87	146	25	4	$45,763	$0
CZ11	PG&E	144,411	0	229	144	218	30	-6	$54,592	$0
CZ12	PG&E	141,639	0	221	136	211	30	-4	$53,798	$0
CZ12-2	SMUD	141,639	0	221	136	211	30	-4	$21,079	$0
CZ13	PG&E	153,371	0	244	158	236	32	-15	$56,701	$0
CZ14	SDG&E	145,499	0	223	135	236	31	-8	$86,177	$0
CZ14-2	SCE	145,499	0	223	135	236	31	-8	$52,840	$0
CZ15	SCE	146,092	0	244	158	236	29	-24	$56,750	$0
CZ16	PG&E	157,944	0	224	144	214	34	-31	$57,190	$0

Table 29. Mixed Fuel Baseline Model – Quick-Service Restaurant

Climate zone	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (therms)	Total kTDV/ft2	Total TDV Compliance kTDV/ft2	Efficiency TDV Compliance kTDV/ft2	GHG Emissions tons/yr	Total TDV Compliance Margin	Proposed Elec Utility Cost	Proposed Gas Utility Cost
CZ01	PG&E	63,187	12,237	1,974	820	820	80	5	$20,126	$23,401
CZ02	PG&E	66,343	11,170	1,989	839	839	74	20	$21,332	$21,422
CZ03	PG&E	67,877	10,605	1,922	769	769	71	1	$21,657	$20,336
CZ04	PG&E	77,615	10,277	2,062	910	910	71	-4	$24,931	$19,725
CZ04-2	CPAU	77,615	10,277	2,062	910	910	71	-4	$15,041	$30,442
CZ05	PG&E	69,442	10,655	1,898	744	744	71	-2	$22,105	$20,416
CZ05-2	SCG	69,442	10,655	1,898	744	744	71	-2	$22,105	$14,924
CZ06	SCE	78,813	9,600	1,934	778	744	67	-1	$19,698	$13,599
CZ07	SDG&E	76,653	9,425	1,898	739	744	66	18	$26,903	$13,116
CZ08	SCE	77,418	9,554	1,948	792	744	66	28	$20,356	$13,542
CZ09	SCE	77,625	9,687	1,993	837	744	67	7	$20,405	$13,709
CZ10	SDG&E	81,897	9,907	2,032	877	744	69	26	$31,166	$13,782
CZ10-2	SCE	81,897	9,907	2,032	877	744	69	26	$21,407	$13,986
CZ11	PG&E	85,725	10,748	2,259	1,109	1,109	75	-12	$27,885	$20,664
CZ12	PG&E	74,131	10,726	2,080	928	928	72	2	$24,000	$20,605
CZ12-2	SMUD	74,131	10,726	2,080	928	928	72	2	$11,272	$20,605
CZ13	PG&E	88,060	10,441	2,240	1,089	1,089	73	-2	$28,620	$20,070
CZ14	SDG&E	87,498	10,655	2,251	1,097	1,089	74	-31	$30,692	$14,728
CZ14-2	SCE	87,498	10,655	2,251	1,097	1,089	74	-31	$22,471	$14,925
CZ15	SCE	118,353	9,194	2,444	1,289	1,089	71	-13	$28,746	$13,090
CZ16	PG&E	75,373	12,242	2,143	983	983	82	2	$24,194	$23,494

Table 30. Mixed Fuel Baseline Model – Small Hotel

Climate zone	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (therms)	Total kTDV/ft2	Total TDV Compliance kTDV/ft2	Efficiency TDV Compliance kTDV/ft2	GHG Emissions tons/yr	Total TDV Compliance Margin	Proposed Elec Utility Cost	Proposed Gas Utility Cost
CZ01	PG&E	230,187	16,824	299	161	173	137	7	$72,520	$32,208
CZ02	PG&E	243,164	13,161	287	152	169	117	5	$77,188	$25,351
CZ03	PG&E	232,511	12,725	272	136	151	113	6	$73,496	$24,461
CZ04	PG&E	251,386	11,608	280	146	165	109	5	$80,034	$22,342
CZ04-2	CPAU	251,386	11,608	280	146	165	109	5	$48,175	$34,218
CZ05	PG&E	232,585	12,375	264	127	143	111	6	$73,479	$23,746
CZ05-2	SCG	232,585	12,375	264	127	143	111	6	$73,479	$17,084
CZ06	SCE	251,627	10,100	260	124	143	100	4	$53,976	$14,227
CZ07	SDG&E	250,625	9,977	257	120	143	100	3	$77,312	$13,878
CZ08	SCE	271,204	9,874	269	136	143	101	3	$60,488	$13,943
CZ09	SCE	265,607	10,246	273	140	143	103	4	$60,896	$14,411
CZ10	SDG&E	276,218	9,903	276	142	143	102	3	$91,917	$13,642
CZ10-2	SCE	276,218	9,903	276	142	143	102	3	$63,534	$13,980
CZ11	PG&E	285,482	12,457	315	179	197	118	4	$82,170	$24,172
CZ12	PG&E	263,561	11,890	293	158	176	112	2	$76,104	$23,029
CZ12-2	SMUD	263,561	11,890	293	158	176	112	2	$34,853	$23,029
CZ13	PG&E	293,124	11,309	310	175	193	113	1	$84,632	$21,924
CZ14	SDG&E	276,292	12,071	298	166	193	115	2	$89,492	$16,232
CZ14-2	SCE	276,292	12,071	298	166	193	115	2	$63,611	$16,703
CZ15	SCE	349,319	7,895	309	174	193	98	-4	$78,507	$11,458
CZ16	PG&E	228,611	17,363	310	170	195	142	9	$72,664	$33,471

8.5 GHG Savings Summary

This section shows the percent GHG savings for each package. GHG multipliers in CBECC software have utility emissions multipliers assigned only to each of the California's sixteen climate zones, does not vary by utility within each zone. Individual utility assumptions may vary widely. In the Medium Office, the GHG emissions increases in all-electric package because the proposed all-electric system is electric resistance VAV system instead of a more efficient heat pump boiler system.

Figure 19. Percentage GHG Savings – Medium Office

CZ	Mixed Fuel	All-Electric		
	EE	Code Min	EE	EE + LF
cz01	0%	3%	4%	12%
cz02	1%	0%	1%	8%
cz03	1%	0%	1%	8%
cz04	2%	-1%	1%	7%
cz04-2	2%	-1%	1%	7%
cz05	1%	0%	2%	9%
cz05-2	1%	0%	2%	9%
cz06	2%	0%	2%	8%
cz07	3%	0%	3%	8%
cz08	3%	0%	2%	8%
cz09	2%	-1%	2%	7%
cz10	2%	-2%	0%	6%
cz11	1%	-3%	-1%	5%
cz12	1%	-2%	-1%	5%
cz13	2%	-3%	-1%	5%
cz14	2%	-4%	-2%	5%
cz15	3%	-1%	2%	7%
cz16	1%	1%	2%	7%

Figure 20. Percentage GHG Savings – Medium Retail

CZ	Utility	Mixed Fuel		All-Electric
		Code Min	EE	EE
cz01	PG&E	-4%	-2%	9%
cz02	PG&E	-21%	-13%	10%
cz03	PG&E	-18%	-8%	11%
cz04	PG&E	-14%	-5%	10%
cz05	PG&E	-15%	-5%	12%
cz06	SCE	-7%	4%	13%
cz07	SDG&E	-5%	7%	14%
cz08	SCE	-7%	4%	12%
cz09	SCE	-8%	3%	13%
cz10	SDG&E	-12%	-9%	3%
cz11	PG&E	-23%	-21%	2%

cz12	PG&E	-19%	-11%	9%
cz13	PG&E	-17%	-8%	10%
cz14	SDG&E	-15%	-5%	10%
cz15	SCE	-3%	0%	3%
cz16	PG&E	-34%	-33%	2%

Figure 21. Percentage GHG Savings – Quick Service Restaurant

CZ	Utility	Mixed Fuel	All-electric "HS" (HVAC+SHW)				All-electric	
		EE	Code Min	EE	EE + LF	EE + PV	Code Min	EE
cz01	PG&E	10%	21%	26%	28%	27%	47%	52%
cz02	PG&E	7%	16%	19%	21%	21%	45%	49%
cz03	PG&E	8%	14%	20%	22%	22%	45%	51%
cz04	PG&E	7%	12%	17%	19%	19%	43%	49%
cz05	PG&E	8%	14%	20%	22%	22%	45%	51%
cz06	SCE	7%	9%	15%	16%	17%	43%	48%
cz07	SDG&E	6%	8%	14%	15%	16%	43%	48%
cz08	SCE	4%	9%	12%	13%	14%	43%	46%
cz09	SCE	5%	9%	12%	13%	15%	43%	46%
cz10	SDG&E	5%	10%	13%	14%	15%	42%	46%
cz11	PG&E	6%	13%	17%	18%	18%	43%	46%
cz12	PG&E	6%	14%	17%	18%	19%	44%	48%
cz13	PG&E	6%	12%	15%	16%	17%	43%	46%
cz14	SDG&E	6%	13%	16%	17%	18%	42%	46%
cz15	SCE	4%	7%	9%	11%	12%	40%	42%
cz16	PG&E	8%	18%	23%	24%	24%	44%	49%

Figure 22. Percentage GHG Savings – Small Hotel

CZ	Utility	Mixed Fuel	All-Electric			All-Electric
		EE	Code Min	EE	EE + PV	Code Min (PTHP)
cz01	PG&E	13%	47%	48%	50%	47%
cz02	PG&E	11%	42%	44%	47%	43%
cz03	PG&E	12%	43%	45%	48%	43%
cz04	PG&E	11%	41%	44%	46%	42%
cz05	PG&E	11%	43%	45%	48%	43%
cz06	SCE	10%	41%	43%	46%	41%
cz07	SDG&E	10%	41%	43%	47%	41%

cz08	SCE	10%	40%	42%	46%	40%
cz09	SCE	10%	40%	42%	46%	40%
cz10	SDG&E	11%	37%	39%	43%	37%
cz11	PG&E	12%	39%	41%	43%	39%
cz12	PG&E	12%	38%	41%	43%	39%
cz13	PG&E	11%	37%	39%	42%	37%
cz14	SDG&E	12%	38%	40%	44%	38%
cz15	SCE	10%	33%	35%	40%	33%
cz16	PG&E	13%	43%	46%	48%	45%

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 Code Team stands ready to assist jurisdictions at any stage of a reach code project.

Visit LocalEnergyCodes.com to access our resources and sign up for newsletters.

Contact info@localenergycodes.com for no-charge assistance from expert Reach Code advisors

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