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CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

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2022 CODE CYCLE:

Custom Cost Effectiveness Analysis: City of Glendale - Nonresidential

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SDGE A Sempra Energy utility
SOUTHERN CALIFORNIA EDISON Energy for What's Ahead
PG&E Pacific Gas and Electric Company

Legal Notice

Acronym List

B/C – Benefit-to-Cost Ratio

CBECC - California Building Energy Code Compliance

CBSC - California Building Standards Commission

CEC - California Energy Commission

CZ – Climate Zone

GHG - Greenhouse Gas

IOU – Investor-Owned Utility

POU – Publicly Owned Utility

PG&E – Pacific Gas & Electric (utility)

SCE – Southern California Edison (utility)

SCG – Southern California Gas (utility)

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

CPAU – City of Palo Alto Utilities

LADWP – Los Angeles Department of Water and Power

kWh – Kilowatt Hour

NPV – Net Present Value

PV - Solar Photovoltaic

TDV - Time Dependent Valuation

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

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1 Introduction

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

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

This report is an addendum to the **2022 Nonresidential New Construction Reach Code Cost Effectiveness Study** modified to accurately represent the City of Glendale, California. The study analyzes cost-effectiveness of measures and measure packages that exceed the minimum state requirements, the 2022 Building Energy Efficiency Standards, effective January 1, 2023, in newly constructed buildings. This report was developed in coordination with the California Statewide Investor Owned Utilities (IOUs) Codes and Standards Program, key consultants, and engaged cities - collectively known as the Reach Code Team (or “the Team” in short).

The prototype building designs analyzed in this study are newly constructed:

- Medium Office
- Medium Retail
- Quick-Service Restaurant
- Small Hotel

The methodology, prototype characteristics, and measure packages are retained from the main studies referenced above except for the energy costs are calculated using local City of Glendale utility rates. Measure packages include combinations of energy efficiency, electrification, solar photovoltaics (PV) with results evaluated for California Climate Zone 9 and 16.

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. Although a cost-effectiveness study is only required to amend Part 6 of the CA Building Code, it is important to understand the economic impacts of any policy decision. This study documents the estimated costs, benefits, energy impacts and greenhouse gas emission reductions that may result from implementing an ordinance based on the results to help residents, local leadership, and other stakeholders make informed policy decisions.

Model ordinance language and other resources are posted on the C&S Reach Codes Program website at LocalEnergyCodes.com. Local jurisdictions that are considering adopting an ordinance may contact the program for further technical support at info@localenergycodes.com.

2 Methodology and Assumptions

The Reach Codes Team analyzed four nonresidential prototypes to represent a variety of common building types using the cost-effectiveness methodology detailed in this section below. The general methodology is consistent with analyses of other prototypes, whereas some specifics such as utility rate selection are customized for the City of Glendale rates.

2.1 Reach Codes

This section describes the approach to calculate 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 30-year duration for residential and 15 years for nonresidential designs, accounting for a three percent discount rate and energy cost inflation per Appendix 6.2.3.

- 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 use 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.

The Reach Codes Team performed energy simulations using the most recent software available (June 8, 2022) for 2022 Title 24 code compliance analysis, California's Building Energy Code Compliance Software CBECC 2022.1.0 (1250).

2.1.2 Costs

The Reach Codes Team assessed the incremental costs and savings of the energy packages over the lifecycle of 15 years for the nonresidential buildings. 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.

2.1.3 Metrics

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

- NPV: The Reach Codes Team uses net savings (NPV benefits minus NPV costs) as the cost-effectiveness metric. If the net savings of a measure or package is positive, 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 costs to implement the measure are even more negative (i.e., construction and maintenance cost savings).

- 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 investment. 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. However, some packages result in initial construction cost savings (negative incremental cost), and either energy cost savings (positive benefits), or increased energy costs (negative benefits). In cases where both construction costs and energy-related savings are negative, the construction cost savings are treated as the benefit while the increased energy costs are the cost. In cases where a measure or package is cost-effective immediately (i.e., upfront construction cost savings and lifetime energy cost savings), B/C ratio cost-effectiveness is represented by ">1". Because of these situations, NPV savings are also reported, which, in these cases, are positive values.

2.1.4 Utility Rates

In coordination with the City of Glendale, the Reach Codes Team determined appropriate tariffs for each package, summarized in Table 1, based on the annual load profile of the prototype and the corresponding package, and the most prevalent rate for each building type.

For a more detailed breakdown of the rates selected refer to Appendix 6.2 Utility Rate Schedules.

Table 1. Utility Tariffs in City of Glendale

Electric / Gas Utility	Electricity	Natural Gas
Nonresidential Buildings		
City of Glendale / SCG	LD-2-B TOU	SCE

Utility rates are assumed to escalate over time, using assumptions detailed in Appendix 9.2 of the main report. Please see the main *2022 Nonresidential New Construction Reach Code Cost Effectiveness Study* for further details on methodology.

2.2 Greenhouse Gas Emissions

The analysis uses the greenhouse gas (GHG) emissions estimates built-in to CBECC software. There are 8,760 hourly multipliers accounting for time dependent energy use and carbon emissions based on source emissions, including RPS projections. There are 32 strings of multipliers, with a different string for each California CZ and each fuel type (metric tons of CO2 per kWh for electricity and metric tons of CO2 per therm for natural gas).

2.3 Nonresidential Occupancies

Table 2 describes the basic characteristics of each nonresidential prototype design.

Table 2: Nonresidential 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)
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
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 CZ 1, 16 < 65 kBtu/h: SZAC with gas furnace > 65 kBtu/h and < 240 kBtu/h: SZHP and gas furnace (i.e., dual fuel heat pump). VAV. > 240 kBtu/h: SZAC VAV with gas furnace CZ 2-15 < 65 kBtu/h: SZAC with gas furnace > 65 kBtu/h and < 240 kBtu/h: SZHP VAV > 240 kBtu/h: SZAC VAV with gas furnace	< 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

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

- **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 Quick Service Restaurant (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).

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.

3 Results

Results are presented as per the prototype-specific Measure Packages described in Section 4. Overarching factors impacting the results include:

- Designation of a **'benefit'** or a **'cost'** varies with the scenarios because both energy savings, and incremental construction costs may be negative depending on the package. Typically, utility bill savings are categorized as a 'benefit' while incremental construction costs are treated as 'costs.' In cases where both construction costs are negative and utility bill savings are negative, the construction cost savings are treated as the 'benefit' while the utility bill negative savings are the 'cost.'
- Most all-electric packages will have lower **GHG emissions** than equivalent mixed-fuel packages in all cases, due to the clean power sources currently available from California's power providers.
- The Reach Codes Team coordinated with the City of Glendale to select the most prevalent tariffs for each prototype given the annual energy demand profile. The Reach Codes Team **did not compare a variety of tariffs** to determine their impact on cost-effectiveness although utility rate changes or updates can affect on-bill cost-effectiveness results.

3.1 Nonresidential Occupancies

Table 3 through Table 6 shows results for the four nonresidential prototypes for all the evaluated packages for both climate zones 9 and 16. For climate zone 9, most packages are cost-effective based on On-Bill impacts due to lower electricity rates. For climate zone 16, there are limited possibilities to get cost-effective On-Bill impacts for all-electric packages in nonresidential buildings.

- Across all prototypes and climate zones, the Reach Code Team identified cost effective energy efficiency measures when added to the mixed-fuel baseline model.
- In Climate zone 9, the Team identified On-Bill cost effective packages for all-electric Medium Office and Medium Retail with Glendale rates. For Small Hotel, all-electric packages are On-Bill cost effective with added efficiency and/or solar PV measures. The Team could not identify any cost effective all-electric packages for Quick Service Restaurant.
- In Climate zone 16, the Team identified On-Bill cost effective package for All-Electric Medium Retail with added efficiency measures and Small Hotel with PTHP only.

Table 3. Medium Office Cost-Effectiveness Summary

Package	CZ	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Eff TDV Margin	Total Compliance Margin	Source kBtu Margin	Upfront Incremental Package Cost	Lifecycle Energy Cost Savings	Lifecycle $-TDV Savings	B/C Ratio (On-bill)	B/C Ratio (TDV)	NPV (On-bill)	NPV (TDV)
Mixed-Fuel + Efficiency Measures	cz09	10,560	(46)	0.9	3.8	5.2	0.28	$715	$19,659	$24,992	27.5	35.0	$18,944	$24,277
All Electric Code Minimum Efficiency	cz09	(23,780)	1,119	(0.3)	(21.6)	(8.3)	(0.07)	($39,415)	($1,126)	($39,789)	35.0	1.0	$38,289	($373)
All Electric Energy Efficiency	cz09	(14,205)	1,119	0.6	(18.4)	(3.4)	0.21	($38,700)	$21,306	($16,257)	>1	2.4	$60,006	$22,443
All-Electric Energy Efficiency and Load Flexibility	cz09	(6,098)	1,119	2.9	(9.5)	(1.1)	0.9	($38,700)	$72,583	$16,391	>1	>1	$111,283	$55,091
Mixed-Fuel + Efficiency Measures	cz16	9,204	(125)	0.4	3.6	3.5	0.11	$0	$20,976	$16,744	>1	>1	$20,976	$16,744
All Electric Code Minimum Efficiency	cz16	(130,271)	5,799	0.8	(66.5)	(63.6)	0.33	($52,070)	($247,907)	($303,371)	0.2	0.2	($195,836)	($251,301)
All Electric Energy Efficiency	cz16	(123,647)	5,799	1.4	(63.7)	(60.8)	0.50	($52,070)	($233,305)	($290,084)	0.2	0.2	($181,234)	($238,013)
All-Electric Energy Efficiency and Load Flexibility	cz16	(111,041)	5,799	5.0	(54.6)	(51.2)	1.61	($52,070)	($213,597)	($246,130)	0.2	0.2	($161,526)	($194,059)

Table 4. Medium Retail Cost-Effectiveness Summary

Package	CZ	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Eff TDV Margin	Total Compliance Margin	Source kBtu Margin	Upfront Incremental Package Cost	Lifecycle Energy Cost Savings	Lifecycle $-TDV Savings	B/C Ratio (On-bill)	B/C Ratio (TDV)	NPV (On-bill)	NPV (TDV)
Mixed-Fuel + Efficiency Measures	cz09	22,306	(88)	3.0	22.0	27.9	1.96	$12,800	$45,807	$61,052	3.6	4.8	$33,007	$48,252
All Electric Code Minimum Efficiency	cz09	(226)	495	2.1	1.1	5.9	1.41	($9,020)	$17,634	$12,981	>1	>1	$26,653	$22,000
All Electric Energy Efficiency	cz09	21,051	495	5.4	23.1	33.7	3.61	$3,780	$64,363	$73,717	17.0	19.5	$60,583	$69,937
Mixed-Fuel + Efficiency Measures	cz16	4,232	(86)	0.2	3.8	3.9	0.13	$0	$8,456	$8,480	>1	>1	$8,456	$8,480
All Electric Code Minimum Efficiency	cz16	(44,088)	3,537	11.4	(26.4)	(26.5)	7.67	($67,904)	($68,533)	($57,931)	1.0	1.2	($629)	$9,974
All Electric Energy Efficiency	cz16	(40,583)	3,537	12.0	(22.6)	(22.6)	8.04	($67,904)	($62,269)	($49,384)	1.1	1.4	$5,635	$18,521

Table 5. Quick-Service Restaurant Cost-Effectiveness Summary

Package	CZ	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Eff TDV Margin	Total Compliance Margin	Source kBtu Margin	Upfront Incremental Package Cost	Lifecycle Energy Cost Savings	Lifecycle $-TDV Savings	B/C Ratio (On-bill)	B/C Ratio (TDV)	NPV (On-bill)	NPV (TDV)
Mixed-Fuel + Efficiency Measures	cz09	3,764	444	3.1	197.8	96.3	28.90	$16,150	$17,681	$21,426	1.1	1.3	$1,531	$5,276
All Electric HS Energy Code Minimum Efficiency	cz09	(29,886)	2,233	6.2	(110.6)	(117.1)	77.9	$22,106	($3,979)	($26,069)	-0.2	-1.2	($26,086)	($48,176)
All-Electric HS Energy Efficiency	cz09	(20,124)	2,233	8.2	129.8	3.7	91.08	$38,256	$14,141	$820	0.4	0.0	($24,115)	($37,436)
All-Electric HS Energy Efficiency + Load Flexibility	cz09	(20,702)	2,233	9.0	174.3	15.9	96.23	$43,666	$11,028	$3,539	0.3	0.1	($32,637)	($40,126)
All-Electric HS Energy Efficiency + Solar PV	cz09	11,939	2,233	9.8	129.8	281.4	101.48	$88,664	$63,995	$62,638	0.7	0.7	($24,668)	($26,025)
All Electric Code Minimum Efficiency	cz09	(126,307)	9,687	28.7	(138.7)	(95.2)	77.99	$148,937	($100,206)	($113,479)	-0.7	-0.8	($249,143)	($262,415)
All Electric Energy Efficiency	cz09	(115,801)	9,687	30.9	104.5	33.4	91.89	$165,086	($81,033)	($84,863)	-0.5	-0.5	($246,119)	($249,950)
All-Electric Energy Efficiency + Load Flexibility	cz09	(116,494)	9,687	31.7	155.7	44.3	97.17	$170,496	($79,554)	($82,432)	-0.5	-0.5	($250,050)	($252,929)
Mixed-Fuel + Efficiency Measures	cz16	10,088	936	7.0	208.0	208.0	113.86	$22,540	$35,950	$46,308	1.6	2.1	$13,410	$23,768
All Electric HS Energy Code Minimum Efficiency	cz16	(57,545)	4,788	14.7	(315.2)	(315.2)	(11.34)	$23,206	($19,303)	($70,150)	-0.8	-3.0	($42,508)	($93,356)
All-Electric HS Energy Efficiency	cz16	(36,879)	4,788	18.6	(56.6)	(56.6)	14.5	$45,745	$20,561	($12,601)	0.4	-0.3	($25,184)	($58,346)
All-Electric HS Energy Efficiency + Load Flexibility	cz16	(36,807)	4,788	20.0	28.7	28.7	23.39	$51,155	$25,547	$6,395	0.5	0.1	($25,608)	($44,760)
All-Electric HS Energy Efficiency + Solar PV	cz16	(6,302)	4,788	20.1	(56.6)	177.8	23.90	$96,153	$64,479	$39,572	0.7	0.4	($31,674)	($56,581)
All Electric Code Minimum Efficiency	cz16	(160,672)	12,242	36.0	(395.8)	(395.8)	(18.97)	$143,959	($125,276)	($222,219)	-0.9	-1.5	($269,235)	($366,177)
All Electric Energy Efficiency	cz16	(138,982)	12,242	40.1	(123.7)	(123.7)	8.04	$166,498	($83,290)	($161,663)	-0.5	-1.0	($249,788)	($328,161)
All-Electric Energy Efficiency + Load Flexibility	cz16	(139,097)	12,242	41.7	(26.6)	(26.6)	18.17	$171,908	($71,895)	($140,052)	-0.4	-0.8	($243,804)	($311,960)

Table 6. Small Hotel Cost-Effectiveness Summary

Package	CZ	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Eff TDV Margin	Total Compliance Margin	Source kBtu Margin	Upfront Incremental Package Cost	Lifecycle Energy Cost Savings	Lifecycle $-TDV Savings	B/C Ratio (On-bill)	B/C Ratio (TDV)	NPV (On-bill)	NPV (TDV)
Mixed-Fuel + Efficiency Measures	cz09	9,535	1,661	10.5	19.9	21.8	3.7	$21,214	$71,107	$82,450	3.4	3.9	$49,893	$61,236
All Electric Code Minimum Efficiency	cz09	(170,301)	10,246	41.7	(12.2)	0.4	11.3	($178,858)	($203,701)	($47,270)	0.9	3.8	($24,844)	$131,587
All Electric Energy Efficiency	cz09	(145,720)	10,246	43.5	(0.3)	16.3	12.0	($157,644)	($111,027)	$13,998	1.4	>1	$46,617	$171,642
All Electric Code Energy Efficiency + Solar PV	cz09	(53,022)	10,246	47.4	(0.3)	62.0	13.5	($11,515)	$23,235	$187,360	>1	>1	$34,750	$198,876
All-Electric Code Minimum Efficiency with PTHP	cz09	(170,479)	10,246	41.6	(12.3)	0.6	11.3	($650,843)	($207,108)	($46,533)	3.1	14.0	$443,735	$604,309
Mixed-Fuel + Efficiency Measures	cz16	8,939	2,952	18.4	30.6	30.6	6.4	$21,214	$82,458	$116,017	3.9	5.5	$61,245	$94,804
All Electric Code Minimum Efficiency	cz16	(313,257)	17,363	61.4	(56.4)	(56.4)	17.4	($179,779)	($537,016)	($248,882)	0.3	0.7	($357,237)	($69,103)
All Electric Energy Efficiency	cz16	(271,171)	17,363	65.0	(35.4)	(35.4)	18.8	($158,565)	($351,844)	($167,773)	0.5	0.9	($193,278)	($9,207)
All Electric Code Energy Efficiency + Solar PV	cz16	(194,632)	17,363	67.9	(35.4)	(0.4)	19.9	($3,588)	($229,684)	($35,212)	0.0	0.1	($226,096)	($31,623)
All-Electric Code Minimum Efficiency with PTHP	cz16	(299,522)	17,363	64.5	(38.3)	(38.3)	18.6	($652,012)	($37,627)	($180,549)	17.3	3.6	$614,385	$471,464

4 Summary

The Reach Codes Team developed packages of energy efficiency measures as well as packages combining energy efficiency with solar PV generation, 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.

The combined result of cost effectiveness and code compliance across all packages are detailed in Table 7 through Table 10 below. The tables are formatted to show:

- "Both" with **green** highlight – for scenarios that are cost effective on both metrics and have positive compliance margin across all three compliance metrics.
- "TDV/On-Bill" with **yellow** highlight – for scenarios that are cost effective on either one of the metrics and has positive compliance margin across all three compliance metrics.
- "Comp" with **gray** highlight – for scenarios that are not cost effective on either metric but have positive compliance margin across all three compliance metrics.
- "-" with no color highlight – for scenarios that do not comply across any one code compliance metric and may or may not be cost effective.

The package names in table results columns are as follows:

- 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
- All-Electric – Code Min with PTHP: All-Electric Code Minimum Efficiency with PTHP

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.

Due to the greenhouse gas savings potential, the Reach Code Team advises jurisdictions to require All-Electric packages where there is **green** or **yellow** highlight (cost effective and compliant). Jurisdictions may also consider adopting all-electric requirements where packages are shown as **gray** highlight (compliant but may or may not be cost effective) if they are looking to require electrification based on energy code compliance alone and less concerned about cost impacts.

Table 7. Summary of Medium Office Packages

CZ	Utility	Mixed Fuel	All-Electric		
		EE	Code Min	EE	EE + LF
cz09	GWP	Both	-	-	-
cz16	GWP	Both	-	-	-

Table 8. Summary of Medium Retail Packages

CZ	Utility	Mixed Fuel	All-Electric	
		EE	Code Min	EE
cz09	GWP	Both	Both	Both
cz16	GWP	Both	-	-

Table 9. Summary of Quick Service Restaurant Packages

CZ	Utility	Mixed Fuel	All-electric			All-electric "HS" (HVAC+SHW)			
		EE	Code Min	EE	EE + LF	Code Min	EE	EE + LF	EE + PV
cz09	GWP	Both	-	Comp	Comp	-	Comp	Comp	Comp
cz16	GWP	Both	-	-	-	-	-	Comp	-

Table 10. Summary of Small Hotel Packages

CZ	Utility	Mixed Fuel	All-Electric			
		EE	Code Min	EE	EE + PV	Code Min + PTHP
cz09	GWP	Both	-	-	-	-
cz16	GWP	Both	-	-	-	-

LEGEND KEY

Both	Compliant & c/e on both metrics
On-bill/TDV	Compliant & c/e on one metric
Comp	Compliant not c/e
-	Not compliant

Please refer to the limitations of this study, described in *2022 Nonresidential New Construction Reach Code Cost Effectiveness Study* Section 3.5, while using these results to inform reach code policies. Medium Office All-Electric packages are cost effective, but not code compliant due to the use of electric resistance VAV reheat systems. The most likely all-electric replacement for a central has 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. 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 more efficient but may also be more costly than the electric resistance reheat systems currently analyzed.

Results support reach code adoption for energy efficiency measures over mixed fuel nonresidential building types for all four prototypes in both climate zones 9 and 16. The All-Electric packages indicate capability of achieving the greatest greenhouse savings as compared to mixed-fuel buildings. The Reach Codes Team found All-Electric code compliant new construction to be “cost-effective” based on Glendale electricity rates for Medium Retail and Small Hotel buildings in climate zone 9. The Team did not find all-electric restaurants to be cost effective but are compliant in climate zone 9 with added measures, and hence can be pursued for reach code with an exemption for cooking appliance. All-electric Small Hotel packages are cost effective in climate zone 9 but miss compliance by a small margin because its nonresidential areas have a similar limitation as Medium Office and will be re-evaluated in 2023.

5 References

California Public Utilities Commission. (2021a). *Utility Costs and Affordability of the Grid of the Future: An Evaluation of Electric Costs, Rates, and Equity Issues Pursuant to P.U. Code Section 913.1.* Retrieved from https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/office-of-governmental-affairs-division/reports/2021/senate-bill-695-report-2021-and-en-banc-whitepaper_final_04302021.pdf

E3. (2021). Retrieved from https://efiling.energy.ca.gov/GetDocument.aspx?tn=233260&DocumentContentId=65748

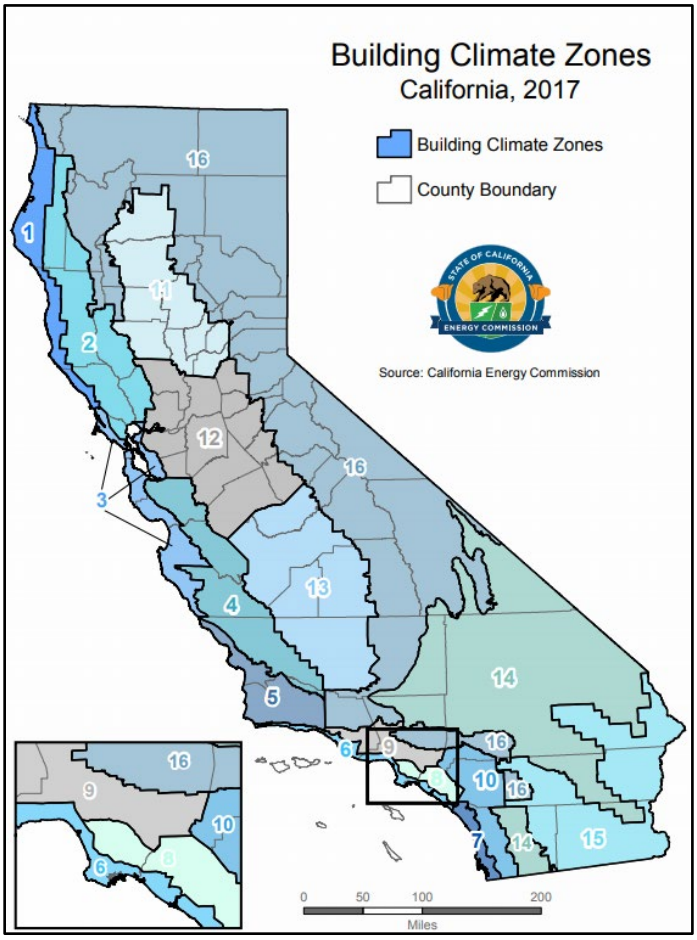
NORESCO. (2020). *Time Dependent Valuation of Energy for Developing Building Efficiency Standards.* Retrieved from https://efiling.energy.ca.gov/GetDocument.aspx?tn=233257&DocumentContentId=65743

6 Appendices

6.1 Map of California Climate Zones

Climate zone geographical boundaries are depicted in Figure 1. The map in Figure 1 along with a zip-code search directory is available at: https://ww2.energy.ca.gov/maps/renewable/building_climate_zones.html

Figure 1. Map of California climate zones.



6.2 Utility Rate Schedules

The Reach Codes Team used the City of Glendale tariffs detailed below to determine the On-Bill savings for each package.

6.2.1 City of Glendale

6.2.1.1 Nonresidential

Following are the City of Glendale electricity tariffs applied in this study. LD-2-B is applied based on the demands.

https://www.glendaleca.gov/government/departments/glendale-water-and-power/rates/medium-business-ld-2-electric-rates

LD-2-B Time-of-Use Service Rate

- The time-of-use (TOU) rate gives you the advantage of lower electric rates during the night and early morning hours, weekends, and the winter months.
- The highest rate time-period (peak period) is 8:00 AM through 7:59 PM Mondays through Fridays.
- The high-season rate is used for meters read *monthly* during the months of July through October. The low-season rate is used for meters read *monthly* during the months of November through June.
- This rate option may require a meter change. There will be no GWP charge for the installation of the new meter. However, if the electric panel for your service does not accommodate a socket meter, you will need to hire an electrician to upgrade the panel. Our Electric Meter Shop personnel will be able to evaluate this for you.

Customer Charge - per meter per day	$1.6700
Energy Charge - per kWh	
July through October (High Season)	
Base Period *	$0.0834
Peak Period **	$0.2434
Demand - Per kW (maximum kW reading for the last 12 months) per day	$0.5800

https://www.glendaleca.gov/government/departments/glendale-water-and-power/rates/medium-business-ld-2-electric-rates 1/4

3/17/22, 3:56 PM Medium Business (LD-2) Electric Rates | City of Glendale, CA

November through June (Low Season)	
Base Period *	$0.0834
Peak Period ***	$0.1469
Demand - Per KW (maximum kW reading for the last 12 months) per day	$0.4800

* Base Period: All other times, including all weekend hours and all Holidays
** High Season Peak Period: 2:00 p.m. - 7:59 p.m., Monday - Friday (excluding Holidays)
*** Low Season Peak Period: 12:00 p.m. - 8:59 p.m., Monday - Friday (excluding Holidays)

6.2.2 SCG

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

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	55.921¢	55.921¢	55.921¢
Transmission Charge:	GPT-10	106.047¢	60.635¢	30.186¢
Commodity Charge:	GN-10	161.968¢	116.556¢	86.107¢

[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.

6.2.3 Fuel Escalation Rates

6.2.3.1 Nonresidential Occupancies

Table 11 below documents the escalation rates used for nonresidential buildings.

Table 11: Real Utility Rate Escalation Rate Assumptions

	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%

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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