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2020 Reach Code Cost-Effectiveness Analysis

Large Office

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Acronym/Abbreviation List

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

B/C – Benefit-to-Cost (ratio)

CBECC - California Building Energy Code Compliance

BSC - California Building Standards Commission

CPAU – City of Palo Alto Utilities (utility)

CZ – Climate Zone

DOE – United States Department of Energy

E3 - Energy and Environmental Economics

Energy Commission - California Energy Commission

ft^2 – square foot

gal – gallon

GHG - Greenhouse Gas

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

IOU – Investor-Owned Utility

kBtu – kilo British thermal unit

kBtu/hr – kilo British thermal unit per hour

kW – kilowatt

kWh – kilowatt-Hour

LADWP – Los Angeles Department of Water and Power (utility)

mtons – metric tons

NPV – Net Present Value

POU – Publicly-Owned Utility

PG&E – Pacific Gas & Electric (utility)

PV - Photovoltaic (solar)

SCE – Southern California Edison (utility)

SoCalGas – Southern California Gas (utility)

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

SHW – Service Hot Water (equipment)

SMUD – Sacramento Municipal Utility District (utility)

TDV - Time Dependent Valuation

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

W – watt(s)

Wdc – direct current watt(s)

VAV – Variable Air Volume

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1 Introduction

The California Building Energy Efficiency Standards Title 24, Part 6 (Title 24) 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 Title 24, Part 6). Local jurisdictions that adopt energy conservation amendments or ordinances as the term is used in PRC 25402.1(h2) must demonstrate that the requirements of the proposed ordinance are cost-effective according to the local jurisdiction criteria and do not result in buildings consuming more energy than is permitted by Title 24. For energy conservation amendments, 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 documents cost-effective combinations of measures that exceed the minimum state requirements, the 2019 Building Energy Efficiency Standards, effective January 1, 2020, for design 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.

The Reach Code Team published nonresidential new construction studies in 2019 that documented the cost-effectiveness of energy measure packages for Medium Office, Medium Retail, and Small Hotel prototypes (Statewide Utility Team, 2020). Based on stakeholder requests, this report extends that analysis to the Large Office new construction prototype.

The United States 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.

2 Methodology and Assumptions

The Reach Code Team analyzed the large office prototype using the general cost-effectiveness methodology described in this section.

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 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 for nonresidential buildings, accounting for a three percent discount rate and energy cost inflation per Appendix 7.2.
- **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. With the TDV approach, electricity used (or saved) during peak periods has a much higher value than electricity used (or saved) during off-peak periods. This metric values energy use differently depending on the fuel source (natural gas, electricity, and propane), time of day, and season.

The Reach Code Team performed energy simulations using the most recent software available for 2019 Title 24 code compliance analysis, California Building Energy Code Compliance for Commercial/Nonresidential Buildings (CBECC-Com) 2019.1.3. The Reach Code Team also tested the 2022 weather files and 2022 TDV multipliers using CBECC-Com 2022 software for most results to understand potential impacts on cost-effectiveness.

2.1.2 Costs

The Reach Code Team assessed the incremental costs and savings of the energy packages over the 15 years for nonresidential prototypes. Incremental costs represent the equipment, installation, replacements, and maintenance costs of the proposed measure relative to the 2019 Title 24 Standards minimum requirements or standard industry practices. The Reach Code Team obtained measure costs from manufacturer distributors, contractors, literature review, and online sources, such as Home Depot and RS Means. Taxes and contractor markups were added as appropriate. Maintenance and replacement costs are included.

2.1.3 Metrics

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

- **NPV**: The Reach Code 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 savings represent net costs. 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**: The 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 criteria for cost-effectiveness is a B/C ratio greater than 1.0. A value of 1.0 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 incremental construction cost 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 rate specialists at each IOU, and the publicly available information for several Publicly-Owned Utilities (POUs), the Reach Code Team determined appropriate utility rate for each measure package (see Appendix 7.2 for details). The utility tariffs were determined based on the annual load profile of each prototype and the corresponding package, the most prevalent rate in each territory, and information assuring that the rate was not planned to be phased out. For some prototypes there are multiple options for rates because of the varying load profiles of mixed-fuel buildings versus all-electric buildings. If more than one rate schedule is applicable for a particular load profile, the Reach Code Team did not attempt to compare or test a variety of tariffs to determine their impact on cost-effectiveness. Utility rates were applied to each climate zone (CZ) based on the predominant IOU serving the population of each zone according to Figure 1.

A time-of-use (TOU) rate was applied to all cases. 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 TRC calculated the demand charges by multiplying the highest load of all hourly loads in a month with the corresponding demand charge per kW. For cases with PV generation, the approved NEM2 (Net Energy Metering) 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 annual electricity consumption; and therefore, no credits for surplus generation were necessary.

Figure 1. Utility Tariffs used based on CZ

CZ	Electric/Gas Utility	Electricity (TOU)	Natural Gas
IOUs			
1-5,11-13,16	Pacific Gas and Electric Company (PG&E)	B-1/B-10	G-NR1
5	PG&E/Southern California Gas Company (SoCalGas)	B-1/B-10	G-10 (GN-10)
6, 8-10, 14, 15	Southern California Edison (SCE)/SoCalGas	TOU-GS-1/TOU-GS-2/TOU-GS-3	G-10 (GN-10)
7, 10, 14	San Diego Gas & Electric Company (SDG&E)	TOU-A+EECC/AL-TOU+EECC	GN-3
POUs			
4	City of Palo Alto (CPAU)	E-2/E-4 TOU	G-2
12	Sacramento Municipal Utility District (SMUD)/PG&E	GSN/GSS	G-NR1
6, 8, 9, 16	Los Angeles Department of Water and Power (LADWP)/SoCalGas	A-1/A-2	G-10 (GN-10)

Utility rates are assumed to escalate over time, using assumptions from research conducted by Energy and Environmental Economics (E3) in the 2019 study Residential Building Electrification in California (Energy & Environmental Economics, 2019) and escalation rates used in the development of the 2022 TDV multipliers (Energy & Environmental Economics, 2021). See Appendix 7.2 Utility Rate Schedules for additional details.

2.2 Greenhouse Gas Emissions

The analysis uses the greenhouse gas (GHG) emissions multipliers developed by E3 (Energy & Environmental Economics, 2021). E3 developed the multipliers to support development of compliance metrics for use in the 2022 Title 24. There are 8,760 hourly multipliers accounting for GHG source emissions, including Renewable Portfolio Standards, methane leakage, and refrigerant leakage. There are 32 strings of multipliers, with a different string for each California Climate Zone and each fuel type (electricity and natural gas). The Reach Code Team used the multipliers to calculate emissions from both the 2019 and 2022 simulation results.

3 Prototype Description, Measure Packages, and Costs

This section describes the prototype and analysis method, drawing from previous 2019 Reach Code research where necessary. The Reach Code Team used a modified version of the DOE building prototype to evaluate cost-effectiveness of measure packages, after initializing the prototypes to comply with 2019 Title 24 new construction requirements, to reflect a prescriptively compliant new construction building in each CZ.

The 2019 Nonresidential Reach Code Cost-Effectiveness Study (Statewide Utility Team, 2020) examined the Medium Office prototype for mixed-fuel plus efficiency, all-electric plus efficiency, and demand flexibility measure packages (Statewide Reach Code Team 2019a). The Medium Office was a 53,000 ft^2 building, and representatives from jurisdictions planning to use the results to inform the development of local ordinances were unsure whether findings would apply to larger office buildings. In response, the Reach Code Team builds on the 2019 study by examining a Large Office prototype in this report.

3.1 Prototype Characteristics

Figure 2 summarizes the basic geometry and features of the Large Office. For the purposes of this study, the number of above-grade floors were reduced from the DOE prototype from ten to five at the request of jurisdictions to more accurately represent their building stock, which also reduces the total conditioned floor area. The Reach Code Team would not expect results to vary significantly compared to a ten-story office due to similar building characteristics and systems, just at a larger scale.

The baseline HVAC system includes two natural gas hot water boilers, two chillers and two cooling towers, one built up rooftop unit per floor, and variable air volume (VAV) hot water reheat boxes. The SHW design includes one 20.12 kW electric resistance hot water heater with a 70-gal storage tank.

Figure 2. Large Office Prototype Characteristics

	Large Office
Conditioned Floor Area (ft^2)	191,765
Number of Stories	5 (1 below grade)
Window-to-Wall Area Ratio	0.38
Baseline HVAC System	Built-up VAV hot water reheat system. Central gas hot water boilers (2), chillers (2), and cooling towers (2)
Baseline Water Heating System	70 gal of electric resistance water heating

3.2 Measure Definition and Costs

3.2.1 All-Electric

For the Large Office all-electric HVAC design, as with the Medium Office, the Reach Code Team selected a VAV system with an electric resistance reheat instead of hot water reheat coil. An alternative all-electric design that is designed frequently in large offices is a central heat recovery chiller and water heater serving hot water reheat coils. While this system can perform very efficiently, as of October 2021 it cannot be modeled in CBECC-Com (though the Energy Commission intends on adding this functionality in the near term). Actual energy consumption for the VAV hot water reheat baseline may be higher than the current simulation results show due to a combination of boiler and hot water distribution losses. A recent research study shows that the total losses can account for as much as 80 percent of the boiler energy use (Raftery, Geronazzo, Cheng, and Paliaga, 2018). If these losses are considered savings for the electric resistance reheat (which has no associated distribution losses) compared to the mixed-fuel baseline, the savings may be higher.

Cost data for the Large Office prototype are presented in Figure 3. 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. Chiller, chilled-water piping, and controls cost are not presented as they are assumed to be the same for both the mixed-fuel and all-electric scenarios. The all-electric SHW system remains the same electric resistance water heater as the baseline and has no associated incremental costs.

Figure 3. Large Office All-Electric Heating System Costs

Mixed-Fuel Measure	Mixed-Fuel Cost	All-Electric Measure	All-Electric Cost	All-Electric Incremental Cost	Source
Boilers (2) and heating hot water piping	$876,616	n/a	$0	($876,616)	Cost estimator
Hydronic VAV reheat terminal units	$2,041,460	Electric resistance VAV reheat terminal units	$2,322,839	$281,379	Cost estimator
Gas plumbing distribution	$6,843	Electrical upgrades, such as wiring, distribution boards, and transformers	$478,656	$471,813	RSMeans
Natural gas plan review, service extension, meter	$18,316	n/a	$0	($18,316)	2019 Nonresidential New Construction Reach Code Study (Statewide Reach Code Team 2019a)
Total	**$2,943,235**		**$2,801,495**	($141,740)	

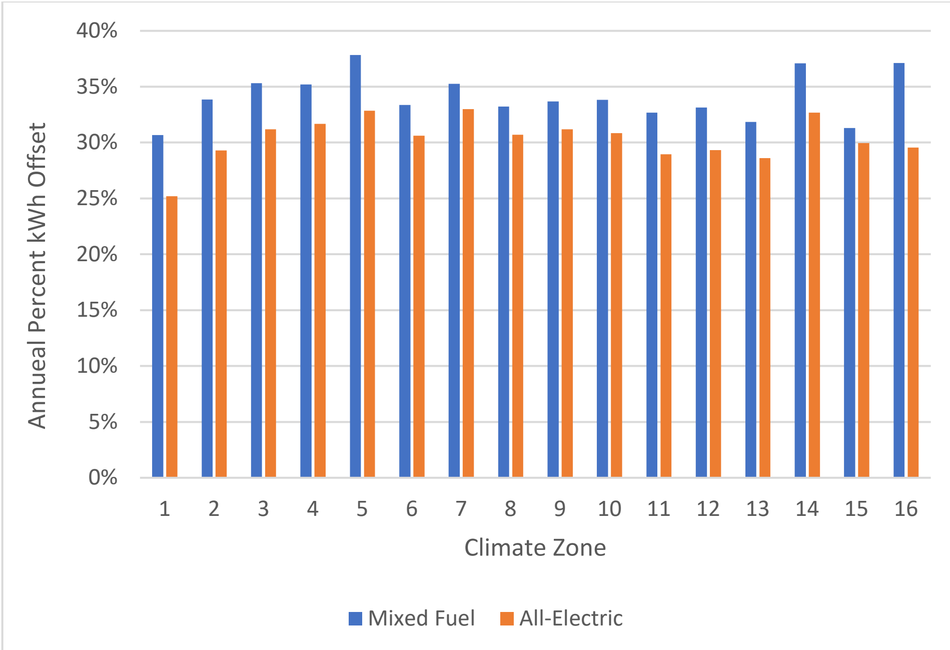
3.2.2 Efficiency

Efficiency measures are the same as those from the 2019 Nonresidential Reach Code Cost-Effectiveness Study (Statewide Reach Codes Team 2019a) for the Medium Office, which are primarily lighting measures but also include envelope and HVAC measures. Please refer to Appendix 7.3 Efficiency Measures for Large Office for cost information reproduced from the 2019 study.

3.2.3 Solar PV

The Reach Code Team estimated a large PV system size at 15 W/ft^2 covering 50 percent of the roof area. This approach assumes that the other 50 percent of the roof is for skylights, mechanical equipment, and walking paths. Figure 4 shows the percent of electricity offset by PV for both mixed-fuel and all-electric buildings over their respective federal minimum design package.

Figure 4. Annual Percent kWh Offset with 285 kW Array



3.2.4 Measure Packages

The Reach Code Team examined the following packages:

- Large Office Baseline Package: Mixed-fuel prescriptively built building.
- All-Electric (AE): Including electric appliances that meet federal minimum efficiency criteria, as well as electrical upgrades, such as on-site secondary transformers. All other aspects of the building are prescriptively built.
- All-Electric + Efficiency (AE Eff): All-electric, including efficiency measures. See Appendix 7.3 Efficiency Measures for Large Office for details.
- All-Electric + Efficiency + Solar PV (AE Eff PV): All-electric, including efficiency measures and a solar PV array.

4 Results

TDV and on-bill based cost-effectiveness results are presented in terms of B/C ratio and NPV savings. What constitutes a ‘benefit’ or a ‘cost’ varies with the scenarios because both energy savings and incremental construction costs may be negative depending on the package. Typically, on-bill savings are categorized as a ‘benefit’ while incremental construction costs are treated as ‘costs.’ In cases where both construction costs and on-bill savings are negative; the construction cost savings are treated as the ‘benefit’ while the on-bill negative savings are the ‘cost.’

Overarching factors to keep in mind when reviewing the results include:

- All-electric packages will have lower **GHG emissions** than mixed-fuel packages in all cases, due to the clean power sources currently available from California’s power providers.
- To be approved by the Energy Commission’s application process, local reach codes that amend the energy code must **both be cost-effective** compared to the mixed-fuel baseline package **and exceed the energy performance budget** using TDV (i.e., have a positive compliance margin) compared to the standard design in the compliance software. To emphasize these two important factors, the figures in this section highlight in green the modeling results that have **either** a positive compliance margin or are cost-effective. This will allow readers to identify whether a scenario is fully or partially supportive of a reach code. When a modeling result is not cost-effective, it is highlighted in red. Section 5 highlights only results that have **both** a positive compliance margin and are cost-effective, to allow readers to identify reach code-ready scenarios.
- Nonresidential buildings **do not have an all-electric prescriptive design pathway** and are compared to a mixed-fuel standard design for most occupancies. Because of current policy metrics, this comparison typically results in TDV-related penalties and associated negative compliance margins. These negative compliance margins are reflected in the ‘baseline’ all-electric packages, and must be overcome with the addition of building energy efficiency measures.
- The Energy Commission **does not currently allow compliance credit for solar PV** in nonresidential buildings. Thus, compliance margins for nonresidential packages containing these technologies are the same as packages without. However, the Reach Code Team did include the impact of solar PV when calculating overall TDV cost-effectiveness.
- As mentioned in Section 2.1.4, The Reach Code Team coordinated with utilities to select tariffs given the annual energy demand profile and the most prevalent rates in each utility territory. The Reach Code Team **did not compare a variety of tariffs** to determine their impact on cost-effectiveness although utility rate changes or updates can effect on-bill cost-effectiveness results.
- As a point of comparison, **mixed-fuel baseline** energy figures are provided in Appendix 7.4 Mixed-Fuel Baseline Energy Figures.
- The cost-effectiveness results for 2022 analysis differs from 2019 mainly in TDV savings, but also differs slightly in energy consumption which translates in minor difference in on-bill energy savings. The Reach Code Team **has not reported the 2022 Energy Code compliance margin outputs** as the compliance software has not yet been updated to reflect the 2022 Energy Code.

Because there is no all-electric prescriptive pathway for nonresidential buildings under the 2019 Energy Code, Figure 5 shows negative compliance margins in all CZs when replacing natural gas HVAC equipment with all-electric. The addition of cost-effective energy efficiency measures—with lighting delivering the most savings—yields positive compliance margins in all CZs except the coldest (CZs 1 and 16). The construction cost savings of using electric HVAC results in cost-effective all-electric efficiency packages in most CZs, and efficiency + solar PV packages in all CZs, as shown in Figure 6 and Figure 7, respectively.

Figure 5. Cost-effectiveness for Large Office: All-Electric

CZ	Utility	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG Reductions (tons)	Comp-liance Margin	Upfront Incremental Package Cost	Lifecycle Utility Cost Savings	Lifecycle $TDV Savings	B/C Ratio (On-bill)	B/C Ratio (TDV)	NPV (On-bill)	NPV (TDV)
CZ01	PG&E	(262,847)	16,395	28.5	-29.8%	$(141,740)	$(359,716)	$(371,473)	0.4	0.4	$(217,976)	$(229,733)
CZ02	PG&E	(206,143)	12,600	19.7	-11.5%	$(141,740)	$(290,124)	$(233,027)	0.5	0.6	$(148,385)	$(91,287)
CZ03	PG&E	(166,467)	9,905	13.6	-16.6%	$(141,740)	$(227,387)	$(206,276)	0.6	0.7	$(85,647)	$(64,536)
CZ04	PG&E	(147,048)	8,778	12.1	-11.0%	$(141,740)	$(186,234)	$(170,819)	0.7	0.8	$(44,494)	$(29,079)
CZ04-2	CPAU	(147,048)	8,778	12.1	-11.0%	$(141,740)	$(81,699)	$(170,819)	0.8	0.8	$60,041	$(29,079)
CZ05	PG&E	(194,316)	11,756	17.1	-18.1%	$(141,740)	$(226,399)	$(241,369)	0.6	0.6	$(84,659)	$(99,629)
CZ05-2	SoCalGas	(194,316)	11,756	17.1	-18.1%	$(141,740)	$(288,893)	$(241,369)	0.5	0.6	$(147,154)	$(99,629)
CZ06	SCE	(123,271)	7,088	7.5	-7.7%	$(141,740)	$(45,293)	$(146,660)	3.2	0.97	$96,447	$(4,920)
CZ06-2	LADWP	(123,271)	7,088	7.5	-7.7%	$(141,740)	$33,031	$(146,660)	>1	0.97	$174,771	$(4,920)
CZ07	SDG&E	(93,327)	5,092	4.7	-7.9%	$(141,740)	$(36,592)	$(116,624)	3.9	1.2	$105,148	$25,116
CZ08	SCE	(112,492)	6,371	6.4	-5.1%	$(141,740)	$(34,679)	$(134,973)	4.1	1.1	$107,061	$6,767
CZ08-2	LADWP	(112,492)	6,371	6.4	-5.1%	$(141,740)	$34,202	$(134,973)	>1	1.1	$175,942	$6,767
CZ09	SCE	(112,134)	6,444	7.1	-2.6%	$(141,740)	$(35,382)	$(131,390)	4.1	1.1	$106,358	$10,350
CZ09-2	LADWP	(112,134)	6,444	7.1	-2.6%	$(141,740)	$33,011	$(131,390)	>1	1.1	$174,751	$10,350
CZ10	SDG&E	(134,491)	7,574	7.8	-4.8%	$(141,740)	$(61,938)	$(160,839)	2.3	0.9	$79,802	$(19,099)
CZ10-2	SCE	(134,491)	7,574	7.8	-4.8%	$(141,740)	$(54,157)	$(160,839)	2.7	0.9	$87,583	$(19,099)
CZ11	PG&E	(179,689)	10,792	13.9	-5.9%	$(141,740)	$(244,543)	$(200,734)	0.6	0.7	$(102,803)	$(58,994)
CZ12	PG&E	(177,729)	10,678	14.0	-7.3%	$(141,740)	$(258,118)	$(200,865)	0.5	0.7	$(116,378)	$(59,126)
CZ12-2	SMUD	(177,729)	10,678	14.0	-7.3%	$(141,740)	$(102,625)	$(200,865)	1.3	0.7	$39,115	$(59,126)
CZ13	PG&E	(159,727)	9,590	11.5	-5.8%	$(141,740)	$(220,348)	$(183,952)	0.6	0.8	$(78,608)	$(42,212)
CZ14	SDG&E	(190,360)	10,986	10.4	-7.4%	$(141,740)	$(216,220)	$(221,327)	0.7	0.6	$(74,480)	$(79,587)
CZ14-2	SCE	(190,360)	10,986	10.4	-7.4%	$(141,740)	$(138,030)	$(221,327)	1.05	0.6	$3,710	$(79,587)
CZ15	SCE	(71,444)	3,890	1.9	2.1%	$(141,740)	$(22,684)	$(86,001)	6.4	1.6	$119,056	$55,739
CZ16	PG&E	(336,846)	18,599	23.5	-37.8%	$(141,740)	$(536,715)	$(576,006)	0.3	0.2	$(394,975)	$(434,266)
CZ16-2	LADWP	(336,846)	18,599	23.5	-37.8%	$(141,740)	$(56,676)	$(576,006)	2.5	0.2	$85,064	$(434,266)

Figure 6. Cost-effectiveness for Large Office: All-Electric + Eff

CZ	Utility	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG Reductions (tons)	Comp-liance Margin	Upfront Incremental Package Cost	Lifecycle Utility Cost Savings	Lifecycle $TDV Savings	B/C Ratio (On-bill)	B/C Ratio (TDV)	NPV (On-bill)	NPV (TDV)
CZ01	PG&E	(164,077)	16,395	44.3	-11.3%	$58,676	$(109,969)	$(145,177)	-1.9	-2.5	$(168,645)	$(203,854)
CZ02	PG&E	(91,089)	12,600	38.4	6.1%	$58,676	$15,651	$57,472	0.3	0.98	$(43,025)	$(1,205)
CZ03	PG&E	(47,376)	9,905	33.3	5.5%	$58,676	$89,927	$84,923	1.5	1.4	$31,251	$26,246
CZ04	PG&E	(23,199)	8,778	32.7	9.2%	$84,515	$143,442	$137,608	1.7	1.6	$58,927	$53,094
CZ04-2	CPAU	(23,199)	8,778	32.7	9.2%	$84,515	$195,263	$137,608	2.3	1.6	$110,748	$53,094
CZ05	PG&E	(80,683)	11,756	35.2	2.2%	$58,676	$75,708	$34,757	1.29	0.6	$17,031	$(23,919)
CZ05-2	SoCalGas	(80,683)	11,756	35.2	2.2%	$58,676	$13,213	$34,757	0.2	0.6	$(45,463)	$(23,919)
CZ06	SCE	10,223	7,088	30.5	12.6%	$84,515	$151,619	$192,519	1.8	2.3	$67,105	$108,004
CZ06-2	LADWP	10,223	7,088	30.5	12.6%	$84,515	$164,918	$192,519	1.95	2.3	$80,403	$108,004
CZ07	SDG&E	42,211	5,092	28.5	14.1%	$84,515	$349,658	$232,184	4.1	2.7	$265,144	$147,670
CZ08	SCE	21,755	6,371	29.9	13.6%	$84,515	$158,816	$207,746	1.9	2.5	$74,302	$123,231
CZ08-2	LADWP	21,755	6,371	29.9	13.6%	$84,515	$161,890	$207,746	1.9	2.5	$77,376	$123,231
CZ09	SCE	18,792	6,444	29.4	13.8%	$84,515	$156,638	$202,843	1.9	2.4	$72,123	$118,328
CZ09-2	LADWP	18,792	6,444	29.4	13.8%	$84,515	$161,996	$202,843	1.9	2.4	$77,482	$118,328
CZ10	SDG&E	4,572	7,574	32.1	13.0%	$84,515	$300,594	$184,670	3.6	2.2	$216,079	$100,155
CZ10-2	SCE	4,572	7,574	32.1	13.0%	$84,515	$140,138	$184,670	1.7	2.2	$55,624	$100,155
CZ11	PG&E	(58,308)	10,792	33.9	9.1%	$84,515	$86,028	$102,806	1.0	1.2	$1,513	$18,291
CZ12	PG&E	(58,409)	10,678	33.4	8.8%	$84,515	$53,554	$102,291	0.6	1.2	$(30,961)	$17,777
CZ12-2	SMUD	(58,409)	10,678	33.4	8.8%	$84,515	$110,597	$102,291	1.3	1.2	$26,082	$17,777
CZ13	PG&E	(43,265)	9,590	30.5	9.5%	$84,515	$84,765	$104,812	1.0	1.2	$250	$20,297
CZ14	SDG&E	(70,979)	10,986	30.0	7.7%	$84,515	$88,727	$80,053	1.0	0.9	$4,213	$(4,462)
CZ14-2	SCE	(70,979)	10,986	30.0	7.7%	$84,515	$18,453	$80,053	0.2	0.9	$(66,062)	$(4,462)
CZ15	SCE	55,545	3,890	23.4	15.6%	$84,515	$167,981	$235,297	2.0	2.8	$83,466	$150,782
CZ16	PG&E	(217,178)	18,599	45.5	-18.9%	$58,676	$(263,234)	$(289,187)	-4.5	-4.9	$(321,910)	$(347,863)
CZ16-2	LADWP	(217,178)	18,599	45.5	-18.9%	$58,676	$18,637	$(289,187)	0.3	-4.9	$(40,040)	$(347,863)

Figure 7. Cost-effectiveness for Large Office: All-Electric + Eff + PV

CZ	Utility	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG Reductions (tons)	Comp-liance Margin	Upfront Incremental Package Cost	Lifecycle Utility Cost Savings	Lifecycle $TDV Savings	B/C Ratio (On-bill)	B/C Ratio (TDV)	NPV (On-bill)	NPV (TDV)
CZ01	PG&E	208,501	16,395	61.2	-11.3%	$669,506	$793,703	$652,657	1.2	0.97	$124,197	$(16,848)
CZ02	PG&E	355,791	12,600	58.7	6.1%	$669,506	$1,091,002	$1,033,622	1.6	1.5	$421,496	$364,116
CZ03	PG&E	399,620	9,905	53.8	5.5%	$669,506	$1,168,136	$1,041,892	1.7	1.6	$498,630	$372,386
CZ04	PG&E	440,513	8,778	54.6	9.2%	$695,344	$1,265,593	$1,150,898	1.8	1.7	$570,248	$455,553
CZ04-2	CPAU	440,513	8,778	54.6	9.2%	$695,344	$1,252,581	$1,150,898	1.8	1.7	$557,237	$455,553
CZ05	PG&E	401,653	11,756	59.1	2.2%	$669,506	$1,239,738	$1,068,395	1.9	1.6	$570,232	$398,889
CZ05-2	SoCalGas	401,653	11,756	59.1	2.2%	$669,506	$1,177,244	$1,068,395	1.8	1.6	$507,738	$398,889
CZ06	SCE	465,400	7,088	54.1	12.6%	$695,344	$680,649	$1,210,243	0.98	1.7	$(14,695)	$514,899
CZ06-2	LADWP	465,400	7,088	54.1	12.6%	$695,344	$579,838	$1,210,243	0.8	1.7	$(115,506)	$514,899
CZ07	SDG&E	517,218	5,092	54.0	14.1%	$695,344	$1,360,957	$1,282,704	2.0	1.8	$665,612	$587,360
CZ08	SCE	481,259	6,371	53.4	13.6%	$695,344	$685,891	$1,274,010	0.99	1.8	$(9,453)	$578,665
CZ08-2	LADWP	481,259	6,371	53.4	13.6%	$695,344	$575,703	$1,274,010	0.8	1.8	$(119,642)	$578,665
CZ09	SCE	492,757	6,444	53.9	13.8%	$695,344	$692,836	$1,283,827	0.99	1.8	$(2,508)	$588,483
CZ09-2	LADWP	492,757	6,444	53.9	13.8%	$695,344	$582,237	$1,283,827	0.8	1.8	$(113,108)	$588,483
CZ10	SDG&E	478,753	7,574	56.7	13.0%	$695,344	$1,296,256	$1,229,995	1.9	1.8	$600,912	$534,651
CZ10-2	SCE	478,753	7,574	56.7	13.0%	$695,344	$674,381	$1,229,995	0.97	1.8	$(20,964)	$534,651
CZ11	PG&E	399,585	10,792	55.4	9.1%	$695,344	$1,162,457	$1,129,930	1.7	1.6	$467,113	$434,585
CZ12	PG&E	392,978	10,678	54.0	8.8%	$695,344	$1,131,755	$1,115,934	1.6	1.6	$436,411	$420,590
CZ12-2	SMUD	392,978	10,678	54.0	8.8%	$695,344	$904,425	$1,115,934	1.3	1.6	$209,080	$420,590
CZ13	PG&E	404,328	9,590	50.6	9.5%	$695,344	$1,150,674	$1,095,498	1.7	1.6	$455,329	$400,153
CZ14	SDG&E	449,987	10,986	57.4	7.7%	$695,344	$1,231,844	$1,289,059	1.8	1.9	$536,499	$593,715
CZ14-2	SCE	449,987	10,986	57.4	7.7%	$695,344	$631,960	$1,289,059	0.91	1.9	$(63,384)	$593,715
CZ15	SCE	544,152	3,890	49.3	15.6%	$695,344	$692,819	$1,335,246	0.99	1.9	$(2,526)	$639,902
CZ16	PG&E	269,671	18,599	69.9	-18.9%	$669,506	$846,748	$748,403	1.3	1.1	$177,242	$78,897
CZ16-2	LADWP	269,671	18,599	69.9	-18.9%	$669,506	$418,341	$748,403	0.6	1.1	$(251,165)	$78,897

The Reach Code Team tested the All-Electric + Efficiency package in 2022 software to ascertain potential improvements in cost-effectiveness resulting from 2022 weather files and TDV, because the TDV intensity of electricity usage is lower in 2022 versus 2019 TDV (i.e., electricity usage has become less valuable, and thus electrification may be less penalized in the compliance software). Figure 8 depicts the growing TDV intensity of gas and the lower intensity of electricity for the Large Office when comparing the 2022 annual TDV consumption of the mixed-fuel baseline to the 2019 annual TDV consumption. The overall 2022 TDV energy consumption is lower than 2019.

Figure 8. Annual TDV Energy Consumption Mixed-Fuel Baseline, 2019 and 2022

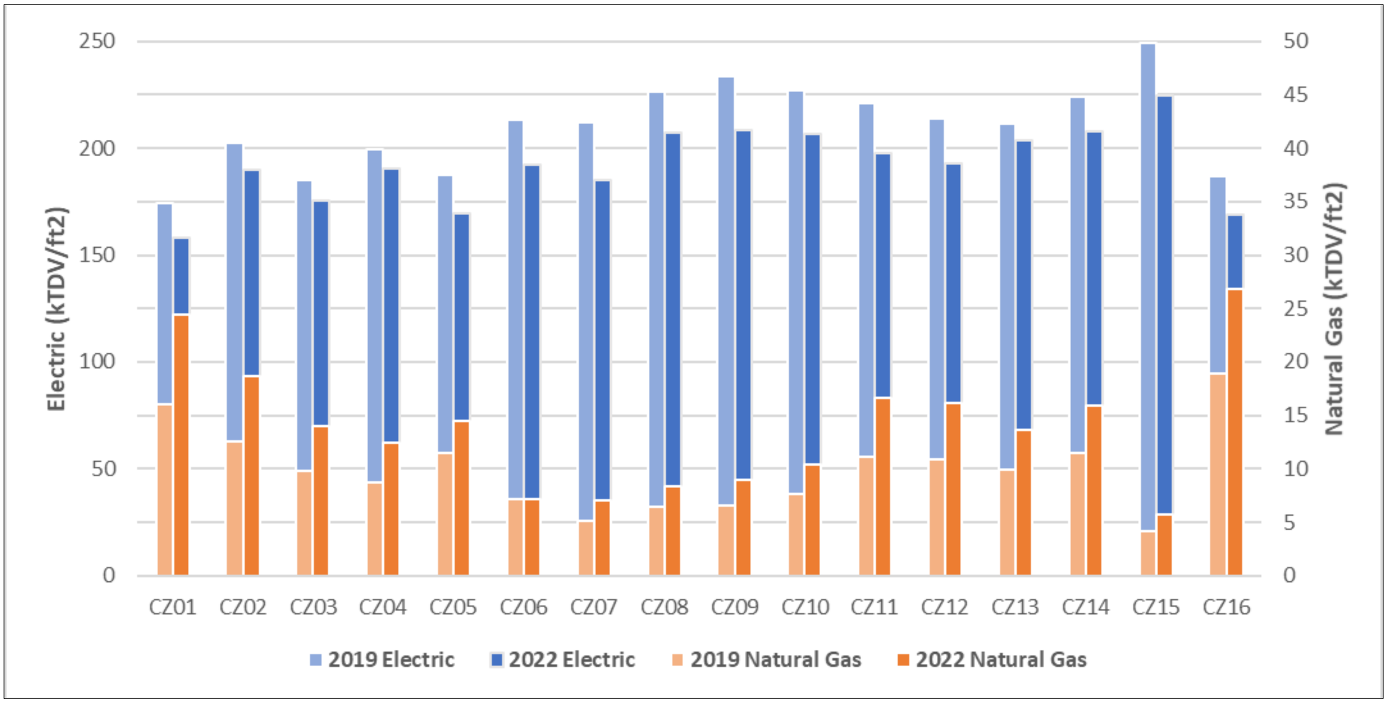
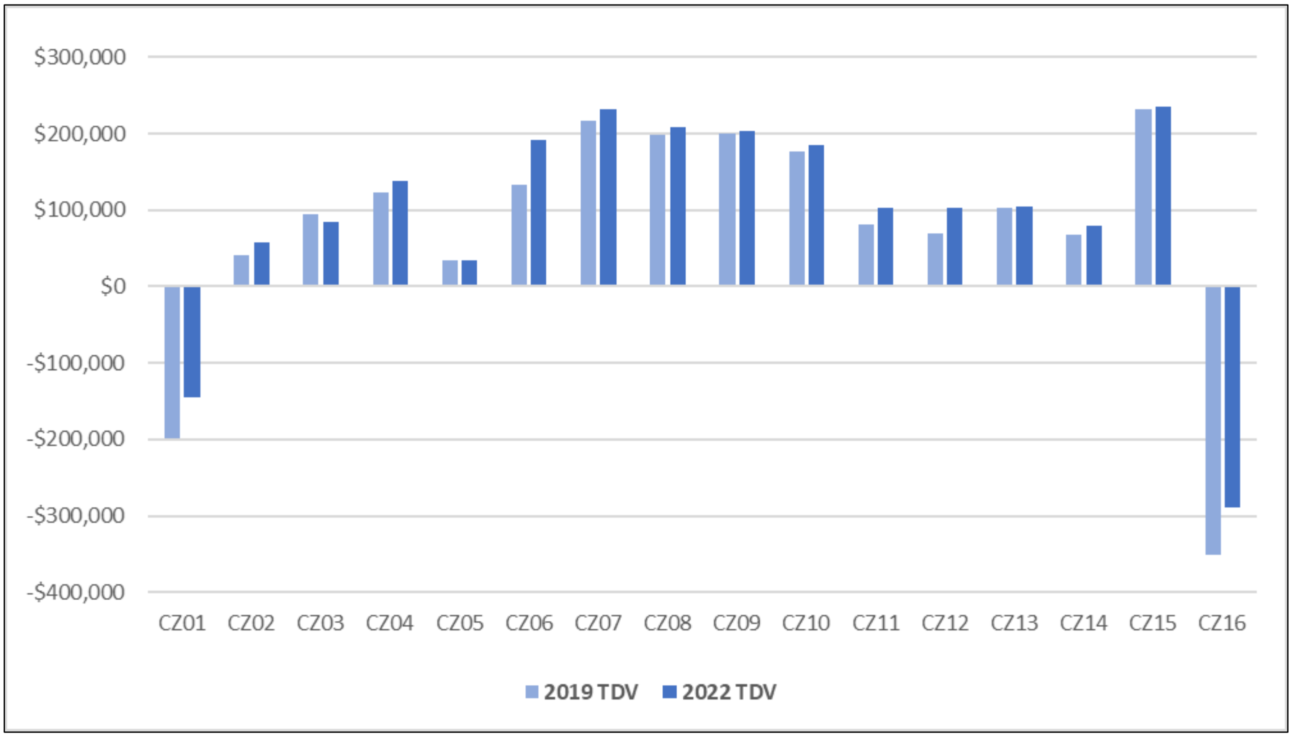


Figure 9 shows that the 2022 TDV savings of the All-Electric + Eff packages are lower than 2019 for all CZs except CZ3. This may be because the 1) overall TDV consumption of the mixed-fuel baseline is lower in 2022, as shown above, and thus the available savings are also smaller, and 2) the largest energy efficiency gains are resulting from lighting measure electricity savings, and these savings are less valued under 2022 TDV.

Figure 9. TDV Savings for All-Electric + Eff Packages, 2019 vs 2022



Cost-effectiveness does not show significant improvement in Figure 10. Note that the software outputs for 2022 compliance margins are not reported. The 2022 Energy Code compliance software is still in development.

Figure 10. Cost-effectiveness for Large Office: All-Electric + Eff 2022

CZ	Utility	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG Reductions (tons)	Comp-liance Margin	Upfront Incremental Package Cost	Lifecycle Utility Cost Savings	Lifecycle $TDV Savings	B/C Ratio (On-bill)	B/C Ratio (TDV)	NPV (On-bill)	NPV (TDV)
CZ01	PG&E	(187,142)	18,821	36.4	<0	$58,676	$(107,652)	$(197,805)	-1.8	-3.4	$(166,328)	$(256,481)
CZ02	PG&E	(106,635)	14,094	39.2	>0	$58,676	$40,368	$41,623	0.7	0.7	$(18,308)	$(17,054)
CZ03	PG&E	(50,653)	10,650	38.2	>0	$58,676	$132,079	$95,007	2.3	1.6	$73,402	$36,331
CZ04	PG&E	(26,266)	9,368	40.1	>0	$84,515	$177,292	$122,821	2.1	1.5	$92,777	$38,306
CZ04-2	CPAU	(26,266)	9,368	40.1	>0	$84,515	$229,143	$122,821	2.7	1.5	$144,628	$38,306
CZ05	PG&E	(62,776)	11,028	36.7	>0	$58,676	$123,433	$33,729	2.1	0.6	$64,757	$(24,948)
CZ05-2	SoCalGas	(62,776)	11,028	36.7	>0	$58,676	$64,558	$33,729	1.1	0.6	$5,882	$(24,948)
CZ06	SCE	14,532	5,151	41.7	>0	$84,515	$117,536	$133,269	1.4	1.6	$33,021	$48,754
CZ06-2	LADWP	14,532	5,151	41.7	>0	$84,515	$120,465	$133,269	1.4	1.6	$35,951	$48,754
CZ07	SDG&E	42,566	5,313	42.0	>0	$84,515	$330,250	$217,762	3.9	2.6	$245,735	$133,248
CZ08	SCE	30,239	6,218	41.9	>0	$84,515	$161,511	$198,882	1.9	2.4	$76,997	$114,367
CZ08-2	LADWP	30,239	6,218	41.9	>0	$84,515	$162,228	$198,882	1.9	2.4	$77,714	$114,367
CZ09	SCE	24,495	6,646	41.2	>0	$84,515	$158,352	$201,004	1.9	2.4	$73,838	$116,490
CZ09-2	LADWP	24,495	6,646	41.2	>0	$84,515	$162,958	$201,004	1.9	2.4	$78,444	$116,490
CZ10	SDG&E	5,973	7,669	42.9	>0	$84,515	$315,200	$176,958	3.7	2.1	$230,686	$92,443
CZ10-2	SCE	5,973	7,669	42.9	>0	$84,515	$146,716	$176,958	1.7	2.1	$62,202	$92,443
CZ11	PG&E	(69,606)	12,156	40.1	>0	$84,515	$108,111	$81,549	1.3	0.96	$23,596	$(2,966)
CZ12	PG&E	(67,837)	11,933	38.4	>0	$84,515	$101,811	$70,264	1.2	0.8	$17,297	$(14,251)
CZ12-2	SMUD	(67,837)	11,933	38.4	>0	$84,515	$118,718	$70,264	1.4	0.8	$34,204	$(14,251)
CZ13	PG&E	(39,003)	9,930	37.3	>0	$84,515	$127,205	$102,422	1.5	1.2	$42,691	$17,908
CZ14	SDG&E	(66,480)	11,529	35.5	>0	$84,515	$190,690	$67,444	2.3	0.8	$106,175	$(17,071)
CZ14-2	SCE	(66,480)	11,529	35.5	>0	$84,515	$74,832	$67,444	0.89	0.8	$(9,683)	$(17,071)
CZ15	SCE	60,850	4,137	38.4	>0	$84,515	$167,823	$231,422	2.0	2.7	$83,309	$146,907
CZ16	PG&E	(233,692)	20,003	37.1	<0	$58,676	$(250,720)	$(350,853)	-4.3	-6.0	$(309,396)	$(409,529)
CZ16-2	LADWP	(233,692)	20,003	37.1	<0	$58,676	$43,985	$(350,853)	0.7	-6.0	$(14,691)	$(409,529)

5 Summary of Results

The Reach Code Team developed packages of energy efficiency measures as well as packages combining energy efficiency with PV generation and battery storage systems, simulated them in CBECC-Com, and gathered costs to determine the cost-effectiveness of multiple scenarios. The Reach Code Team coordinated assumptions 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.

Figure 11 summarizes results for the Large Office prototype and depicts the compliance margins achieved for each CZ 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 Code Team highlighted cells meeting these two requirements to help clarify the upper boundary for potential reach code policies:

- 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 either depict a negative compliance margin or a package that was not cost-effective using either the on-bill or TDV approach.

The Reach Code Team found that electrifying Large Office HVAC and adding efficiency measures is generally cost-effective. The all-electric plus energy efficiency packages are cost-effective in all CZs except 1, 2, 5-2 (SoCalGas), 14-2 (SCE), and 16. Adding solar PV makes the efficiency packages cost-effective in all CZs, though do not achieve positive compliance margins in CZs 1 and 16. Reach codes may require all-electric large offices in all CZs except 1 and 16, but must include solar PV requirements in CZs 2, 5-2, and 14-2.

Figure 11. Large Office Summary of Compliance Margin and Cost-effectiveness

CZ	Utility	All Electric (2019 TDV)			All Electric (2022 TDV)
		AE	AE + Eff	AE + Eff + PV	AE + Eff
CZ01	PG&E	-30%	-11%	-11%	<0
CZ02	PG&E	-12%	6%	6%	>0
CZ03	PG&E	-17%	5%	5%	>0
CZ04	PG&E	-11%	9%	9%	>0
CZ04-2	CPAU	-11%	9%	9%	>0
CZ05	PG&E	-18%	2%	2%	>0
CZ05-2	SoCalGas	-18%	2%	2%	>0
CZ06	SCE	-8%	13%	13%	>0
CZ06-2	LADWP	-8%	13%	13%	>0
CZ07	SDG&E	-8%	14%	14%	>0
CZ08	SCE	-5%	14%	14%	>0
CZ08-2	LADWP	-5%	14%	14%	>0
CZ09	SCE	-3%	14%	14%	>0
CZ09-2	LADWP	-3%	14%	14%	>0
CZ10	SDG&E	-5%	13%	13%	>0
CZ10-2	SCE	-5%	13%	13%	>0
CZ11	PG&E	-6%	9%	9%	>0
CZ12	PG&E	-7%	9%	9%	>0
CZ12-2	SMUD	-7%	9%	9%	>0
CZ13	PG&E	-6%	10%	10%	>0
CZ14	SDG&E	-7%	8%	8%	>0
CZ14-2	SCE	-7%	8%	8%	>0
CZ15	SCE	2%	16%	16%	>0
CZ16	PG&E	-38%	-19%	-19%	<0
CZ16-2	LADWP	-38%	-19%	-19%	<0

6 References

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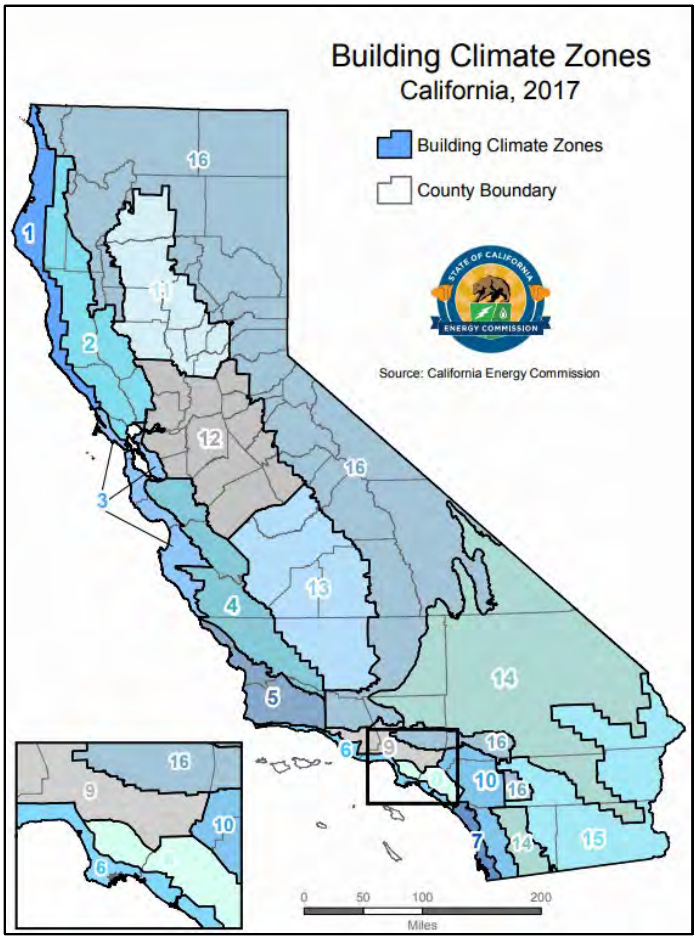
7 Appendices

7.1 Map of California CZs

CZ geographical boundaries are depicted in Figure 12. The map in Figure 12 along with a zip-code search directory is available at: https://ww2.energy.ca.gov/maps/renewable/building_climate_zones.html

Figure 12. Map of California CZs



7.2 Utility Rate Schedules

The Reach Code Team used the IOU rate tariffs listed in to determine the on-bill savings for each prototype.

Figure 13. Utility Tariffs Analyzed Based on CZ: Detailed View

CZ	Electric/Gas Utility	Electricity (TOU)	Natural Gas
CZ01	PG&E	B-10	G-NR1
CZ02	PG&E	B-10	G-NR1
CZ03	PG&E	B-10	G-NR1
CZ04	PG&E	B-10	G-NR1
CZ04-2	CPAU	E-2	G-2
CZ05	PG&E	B-10	G-NR1
CZ05-2	PG&E/SoCalGas	B-10	G-10 (GN-10)
CZ06	SCE/SoCalGas	TOU-GS-3	G-10 (GN-10)
CZ06-2	LADWP/SoCalGas	A-2	G-10 (GN-10)
CZ07	SDG&E	AL-TOU+EECC	GN-3
CZ08	SCE/SoCalGas	TOU-GS-3	G-10 (GN-10)
CZ08-2	LADWP/SoCalGas	A-2	G-10 (GN-10)
CZ09	SCE/SoCalGas	TOU-GS-3	G-10 (GN-10)
CZ09-2	LADWP/SoCalGas	A-2	G-10 (GN-10)
CZ10	SDG&E	AL-TOU+EECC	GN-3
CZ10-2	SCE/SoCalGas	TOU-GS-3	G-10 (GN-10)
CZ11	PG&E	B-10	G-NR1
CZ12	PG&E	B-10	G-NR1
CZ12-2	SMUD/PG&E	GSS	G-NR1
CZ13	PG&E	B-10	G-NR1
CZ14	SDG&E	AL-TOU+EECC	GN-3
CZ14-2	SCE/SoCalGas	TOU-GS-3	G-10 (GN-10)
CZ15	SCE/SoCalGas	TOU-GS-3	G-10 (GN-10)
CZ16	PG&E	B-10	G-NR1
CZ16-2	LADWP/PG&E	A-2	G-NR1

Utility rates are assumed to escalate over time, using assumptions from research conducted by Energy and Environmental Economics (E3) in the 2019 study Residential Building Electrification in California (Energy & Environmental Economics, 2019) and escalation rates used in the development of the 2022 TDV multipliers (Energy & Environmental Economics, 2021). Figure 14 demonstrates the escalation rates used for nonresidential buildings above inflation.

Figure 14. Real Utility Rate Escalation Rate Assumptions Above Inflation

Year	Source	Statewide Electric Nonresidential Average Rate (%/year, real)	Natural Gas Nonresidential Core Rate (%/year, real)
2020	E3 2019	2.0%	4.3%
2021	E3 2019	2.0%	4.3%
2022	E3 2019	2.0%	2.7%
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%

7.3 Efficiency Measures for Large Office

The Reach Code Team applied the efficiency measures from the 2019 Nonresidential Reach Code Cost-Effectiveness Study to the Large Office. These measures are listed below. Refer to Figure 15 for cost information reproduced from the 2019 study.

- **Modify SHGC fenestration**: In all CZs, Reduce window SHGC from the prescriptive value of 0.25 to 0.22. The fenestration visible transmittance and U-factor remain at prescriptive values.
- **Fenestration as a function of orientation**: Limit the amount of fenestration area as a function of orientation. East-facing and west-facing windows are each limited to one-half of the average amount of north-facing and south-facing windows.
- **VAV box minimum flow**: Reduce VAV box minimum airflows from the current T24 prescriptive requirement of 20 percent of maximum (design) airflow to the T24 zone ventilation minimums.[1]
- **Interior lighting reduced LPD**: Reduce LPD by 15 percent.
- **Institutional tuning**: Limit the maximum output or maximum power draw of lighting to 85 percent of full light output or full power draw.
- **Daylight dimming plus off**: Turn daylight-controlled lights completely off when the daylight available in the daylit zone is greater than 150 percent of the illuminance received from the general lighting system at full power. There is no associated cost with this measure, as the 2019 T24 Standards already require multilevel lighting and daylight sensors in primary and secondary daylit spaces. This measure is simply a revised control strategy, and does not increase the number of sensors required or labor to install and program a sensor
- **Occupant sensing in open plan offices**: In an open plan office area greater than 250 ft^2, control lighting based on occupant sensing controls. Two workstations per occupancy sensor.

Figure 15. Energy Efficiency Measures for Large Office

Measure	Baseline T24 Requirement	Incremental Cost	Sources & Notes
Modify SHGC Fenestration	SHGC of 0.25	\$1.60 /ft^2 window for SHGC decreases, \$0/ft^2 for SHGC increases	Costs from major U.S. manufacturer.
Fenestration as a Function of Orientation	Limit on total window area and west-facing window area as a function of wall area.	\$0	No additional cost associated with the measure; measure is a design consideration not an equipment cost.
VAV Box Minimum Flow	20 percent of maximum (design) airflow	\$0	No additional cost associated with the measure; measure is a design consideration not an equipment cost.
Interior Lighting Reduced LPD	Per Area Category Method, varies by Primary Function Area. Office area 0.60 – 0.70 W/ft^2 depending on area of space.	\$0	Industry report on LED pricing analysis shows that costs are not correlated with efficacy (Navigant, 2018)
Institutional Tuning	No requirement, but Power Adjustment Factor (PAF) credit of 0.10 available for luminaires in non-daylit areas and 0.05 for luminaires in daylit areas[2]	\$0.06/ft^2	Industry report on institutional tuning (Seventhwave, 2015)
Daylight Dimming Plus Off	No requirement, but PAF credit of 0.10 available.	\$0	Given the amount of lighting controls already required, this measure is no additional cost.
Occupant Sensing in Open Plan Offices	No requirement, but PAF credit of 0.30 available.	\$189 /sensor; \$74 /powered relay; \$108 /secondary relay	2 workstations per sensor; 1 fixture per workstation; 4 workstations per master relay; 120 ft^2/workstation in open office area, which is 53% of total floor area of the office

[2] Power Adjustment Factors allow designers to tradeoff increased lighting power densities for more efficient designs. In this study, PAF-related measures assume that the more efficient design is incorporated without a tradeoff for increased lighting power density.

7.4 Mixed-Fuel Baseline Energy Figures

Figure 16 show the annual electricity and natural gas consumption and cost, compliance TDV, and GHG emissions for the mixed-fuel design baseline Large Office. The compliance margins are non-zero in some cases and represent typical baseline compliance margins with prescriptive prototypes. The non-zero compliance margins are largely a result of compliance software complexities, and they are not expected to significantly impact the proposed case results or nature of recommendations.

Figure 16. Large Office: Mixed-Fuel Baseline

CZ	Utility	Annual Electricity Consumption (kWh)	Annual Natural Gas Consumption (therms)	Annual Electricity Cost	Annual Natural Gas Cost	Compliance Margin	Annual GHG Emissions (mton)
CZ01	PG&E	1,215,150	16,395	$285,639	$18,373	-0.2%	234
CZ02	PG&E	1,319,740	12,600	$319,306	$14,117	2.5%	223
CZ03	PG&E	1,266,120	9,905	$301,581	$11,148	-1.0%	202
CZ04	PG&E	1,317,420	8,779	$315,439	$9,962	0.3%	202
CZ04-2	CPAU	1,317,420	8,779	$300,066	$11,493	0.3%	202
CZ05	PG&E	1,274,340	11,756	$304,572	$13,106	-0.4%	212
CZ05-2	SoCalGas	1,274,340	11,756	$304,572	$9,512	-0.4%	212
CZ06	SCE	1,363,960	7,088	$181,861	$6,093	1.1%	196
CZ06-2	LADWP	1,363,960	7,088	$138,338	$6,093	1.1%	196
CZ07	SDG&E	1,346,930	5,092	$411,744	$4,401	-0.5%	186
CZ08	SCE	1,383,530	6,371	$185,083	$5,308	2.4%	195
CZ08-2	LADWP	1,383,530	6,371	$140,976	$5,308	2.4%	195
CZ09	SCE	1,407,310	6,444	$190,030	$5,259	4.0%	200
CZ09-2	LADWP	1,407,310	6,444	$145,758	$5,259	4.0%	200
CZ10	SDG&E	1,402,250	7,574	$430,610	$6,419	3.5%	205
CZ10-2	SCE	1,402,250	7,574	$186,796	$6,018	3.5%	205
CZ11	PG&E	1,401,560	10,792	$336,954	$12,362	4.2%	224
CZ12	PG&E	1,361,920	10,678	$327,386	$12,186	3.6%	218
CZ12-2	SMUD	1,361,920	10,678	$190,932	$12,186	3.6%	218
CZ13	PG&E	1,405,300	9,590	$336,926	$11,074	4.1%	217
CZ14	SDG&E	1,404,070	10,986	$430,133	$8,626	3.8%	224
CZ14-2	SCE	1,404,070	10,986	$186,646	$8,527	3.8%	224
CZ15	SCE	1,560,390	3,890	$204,763	$3,365	5.8%	204
CZ16	PG&E	1,311,220	18,599	$307,718	$21,068	-0.4%	258
CZ16-2	LADWP	1,311,220	18,599	$127,503	$14,046	-0.4%	258