2019 New Construction Cost-Effectiveness Study Addendum:

2020 Analysis of Detached Accessory Dwelling Unit, Medium Office, Medium Retail and Small Hotel – City of Glendale

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LEGAL NOTICE

Acronym List

B/C – Benefit-to-Cost

CBECC - California Building Energy Code Compliance

CEC - California Energy Commission

CZ – Climate Zone

GHG - Greenhouse Gas

IOU - Investor Owned Utility

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 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 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. Local jurisdictions that are considering adopting ordinances may contact the program for support through its website, LocalEnergyCodes.com.

The California Building Energy Efficiency Standards or Title 24, Part 6 (Title 24) (California Energy Commission, 2018a) 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 result in buildings consuming less 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 *2019 Nonresidential New Construction Reach Code Cost Effectiveness Study* and *2020 New Construction Cost Effectiveness Analysis: Detached Accessory Dwelling Units* modified to accurately represent the city of Glendale, California. The study analyzes cost-effectiveness of measure packages 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 prototypes analyzed in this study are:

- Detached Accessory Dwelling Units (ADUs)
- Medium Office
- Medium Retail
- 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 Glendale utility rates and updated modeling software since the 2019 study. Measure packages include combinations of energy efficiency, electrification, solar photovoltaics (PV), and battery storage. The cost effectiveness is evaluated for California Climate Zone 9 (see Appendix 8.1) covering the City of Glendale.

2 Methodology and Assumptions

The Reach Code team analyzed four prototypes, with a common approach for the three nonresidential prototypes (medium office, medium retail, and small hotel) and a separate one for the residential detached ADU prototype. However, the general cost effectiveness methodology below applies commonly to all the prototypes.

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

Across all prototypes, this analysis used both *On-Bill* and *time dependent valuation* (TDV) 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 of On-Bill and TDV is how energy is valuated:

- **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 and 30-year duration for the detached ADU, accounting for a 3 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 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 (gas, electricity, and propane), time of day, and season (E3 2016).

The Reach Code team performed energy simulations using the most recent software available for 2019 Title 24 code compliance analysis, EnergyPro 8.2 (CBECC-Com 2019.1.3 ruleset engine) and CBECC-Res 2019.1.3 for nonresidential and residential prototypes respectively. The Team also used CBECC-Res 2022.0.1 RV for testing the impacts of updated weather files and 2022 TDV multipliers on cost-effectiveness. 2022 weather files have more cooling loads and less heating loads, and 2022 TDV multipliers increased significantly for fossil-fuel sources to reflect CO_2 price forecasts and emissions abatement, while comparatively reducing for electricity to reflect increased renewable generation penetration (California Energy Commission, 2019).

2.1.2 Costs

The Reach Code team assessed the incremental costs and savings of the energy packages over 15 years for nonresidential prototypes, and 30 years for the detached ADU. Incremental costs represent the equipment, installation, replacements, and maintenance costs of the proposed measure relative to the 2019 Title 24 Standards minimum requirements.

2.1.3 Cost Effectiveness Metrics

Cost effectiveness results are 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 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 or 30 years (NPV benefits *divided by* NPV costs). The criterion for cost effectiveness is a B/C ratio 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

Glendale Water & Power (GWP)[1] is the main electric utility with SoCalGas[2] as the gas utility in the City of Glendale. In coordination with the utilities in Glendale, the Reach Code team determined appropriate utility rates based on the annual load profile of each prototype, the corresponding ~~package~~package, and the most prevalent rate in each territory. L-1-A is the standard service rate for residential customers in Glendale. L-1-D rate is applied to customers with a self-generation source such as solar PV. The customer charge and energy charges are the same for L-1-A and L-1-D except L-1-D is applied on net energy usage for self-generation customers and used to identify Net Energy Metering (NEM) customers. The residential detached ADU prototype analyzed in this study has solar PV installed in all packages including the baseline, hence L-1-D is the selected rate.

Nonresidential GWP rates are based on small, medium, or large categories depending on their monthly peak loads. The peak loads of the nonresidential prototype packages are between 20 and 500kW, hence "medium" and "large" category rates are applied in this analysis. Mixed fuel and all-electric packages of medium office as well as all-electric small hotel packages fall under "large" category and medium retail and small hotel mixed fuel packages falls under "medium" category. Similar to residential, L-2-A and L-2-C have the same rate structure except that L-2-C is applied for solar PV customers.

[1] GWP: https://www.glendaleca.gov/government/city-departments/glendale-water-and-power/rates

[2] SoCal Gas: https://www2.socalgas.com/regulatory/tariffs/tariffs-rates.shtml

Figure 1~~Figure 1~~ below summarizes the utility rates that the Reach Codes Team used for this analysis.

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Figure 1. Utility Rate Tariffs in Glendale

Electric / Gas Utility	Electricity	Natural Gas
Residential (Detached ADU)		
GWP/SoCalGas	L-1-D	GM (GM-E)
Nonresidential		
GWP (Small 0-20kW)/SoCalGas	L-2-A/L-2-C	G-10 (GN-10)
GWP (Medium 20-150kW)/SoCalGas	LD-2-A/LD-2-C	G-10 (GN-10)
GWP (Large 150-500kW)/SoCalGas	PC-1A	G-10 (GN-10)

The cost-effectiveness methodology assumes utility rates escalating over time, using assumptions detailed in *Appendix 8.2.* Please see the main *2019 Nonresidential New Construction Reach Code Cost Effectiveness Study* for further details on methodology.

3 Measure Description

Detailed descriptions of the prototypes, measures and cost breakdowns are included in the two main studies referenced above. This section provides a summary of the package development and individual measure breakdown for each prototype.

3.1 Detached ADU

The Reach Code team evaluated two electrification packages against a prescriptively built mixed fuel baseline model:

- **All-Electric Prescriptive Minimum:** All-electric prescriptively built, including heat pump water heater located in conditioned space per 2019 Residential Alternate Calculation Method (ACM). The cost includes electric utility upgrade from the primary dwelling to the detached ADU and avoided cost of gas utility extension.
- **All-Electric Energy Efficiency + PV:** All-electric prescriptively built, heat pump water heater located in conditioned space per 2019 Residential ACM, plus energy efficiency measures, and additional solar PV to improve cost effectiveness based on prior reach code research.

The energy efficiency and solar PV measures for the Glendale region are detailed in Figure 2~~Figure 2~~ below. Please refer to the *2019 New Construction Detached Accessory Dwelling Unit Analysis* report for further details on measures, incremental cost and methodology.

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Figure 2. Measures for Detached ADU

Measure	Incremental Cost	Cost for ADU Prototype
Verified low leakage ducts in conditioned space (including HERS verification)	$0.31/ft^2 of floor area + $110 HERS test	$343
Low pressure drop ducts - 2% vs 5%	$96/hr labor for installation	$96
Reduced infiltration: 3ACH50 vs 5ACH50	$0.115/ft^2 + $100 HERS test	$186
High performance attics: R-38 attic floor + R-30 Under Deck	$0.34/ft^2 attic floor + $1.61/ft^2 roof	$1,563
Improved fenestration	$4.23/ft^2 of window	$381
Solar PV to offset 90% annual electricity use	$3.72/W-DC	$7,839
Total (Present Value $)		$9,722

The Reach Code team evaluated the electrification packages using 2022 TDV multipliers and updates in CBECC-Res 2022 software like the weather data and update in algorithms.

3.2 Nonresidential Prototypes

The Reach Code team evaluated cost effectiveness of the following measure packages over a 2019 mixed-fuel code compliant baseline for three nonresidential prototypes (medium office, medium retail and small hotel), summarized in Figure 3.~~Figure 3.~~

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- **Package 1A – Mixed-Fuel + EE:** Mixed-fuel design with energy efficiency measures and federal minimum appliance efficiencies.

- **Package 1B – Mixed-Fuel + EE + PV + B**: Same as Package 1A, plus solar PV and batteries.
- **Package 1C – Mixed-fuel + HE**: Alternative design with high efficiency appliances, triggering federal preemption. Federal preemption prohibits mandatory local reach codes from requiring high efficiency covered appliances. However, in practice, builders may install any package of compliant measures to achieve the performance requirements.
- **Package 2 – All-Electric Federal Code-Minimum Reference**: All-electric design with federal code minimum appliance efficiency. No solar PV or battery. Note that the office and hotel models in this package are included for reference only, as they do not meet minimum compliance requirements.
- **Package 3A – All-Electric + EE**: All-electric design with energy efficiency measures and federal minimum appliance efficiencies.
- **Package 3B – All-Electric + EE + PV + B**: Same as Package 3A, plus solar PV and batteries.
- **Package 3C – All-Electric + HE**: All-electric design with high efficiency appliances, triggering federal preemption.

Figure 3. Nonresidential Prototype – Measure Package Summary

Package	Fuel Type		Energy Efficiency Measures	PV & Battery (PV + B)	High Efficiency Appliances (HE)
	Mixed Fuel	All-Electric			
Mixed-Fuel Code Minimum Baseline	✓				
1A – Mixed-Fuel + EE	✓		✓		
1B – Mixed-Fuel + EE + PV + B	✓		✓	✓	
1C – Mixed-fuel + HE	✓				✓
2 – All-Electric Federal Code-Minimum Reference		✓			
3A – All-Electric + EE		✓	✓		
3B – All-Electric + EE + PV + B		✓	✓	✓	
3C – All-Electric + HE		✓			✓

See *2019 Nonresidential New Construction Reach Code Cost Effectiveness Study* for further details on measure descriptions and cost breakdowns for each package.

4 Results

In this section the Reach Code team presents results per the prototype-specific 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. 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 and utility bill savings are negative, the construction cost savings are treated as the 'benefit' and the utility bill negative savings as the 'cost.'

Overarching factors impacting the results include:

- All-electric packages will have lower GHG emissions than mixed-fuel packages in all cases, due to the cleaner power sources currently available from California's power providers.
- To pass the Energy Commission's application process, local reach codes amend Title 24, Part 6 must be both cost effective and have a positive compliance margin compared to the standard baseline model in the compliance software. To emphasize these requirements, the figures in this section highlight in green the positive compliance margin or cost-effective modeling results. This will allow readers to identify whether a scenario is fully or partially supportive of a reach code, and the opportunities/challenges that the scenario presents. *Section 5* highlights results that have **both** a positive compliance margin and are cost effective, identifying reach code-ready scenarios.
- In the performance modeling of residential buildings of three stories or less (including the Detached ADU), compliance software uses an electric Standard Design when the Proposed Design is electric, removing TDV-related penalties and associated negative compliance margins. This approach allows for a compliance pathway for all-electric residential buildings. Nonresidential buildings are not treated in the same way and are compared to a mixed-fuel standard design.
- The Energy Commission does not currently allow compliance credit for either solar PV or battery storage in nonresidential buildings. Thus, compliance margins are the same for nonresidential packages with and without these technologies. However, the Reach Code team did include the impact of solar PV and battery when calculating overall TDV cost-effectiveness.
- As a point of comparison, mixed-fuel baseline energy figures are provided in Section 0~~8.3~~.
- 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 software outputs for 2022 EDR margins as the 2022 Title 24 Part 6 code is still being developed.

4.1 Detached ADU

Figure 4~~Figure 4~~ shows results of the two all-electric packages modeled for detached ADU compared to a mixed-fuel baseline. The all-electric prescriptive minimum package with heat pump water heater located in conditioned space, federal-minimum efficiencies for mechanical equipment, and minimum PV system capacity is On-Bill cost effective under GWP rates. Furthermore, the all-electric prescriptive minimum with 1) the heat pump water heater located in conditioned space, 2) energy efficiency measures, and 3) additional solar PV is cost effective on both On-Bill and TDV basis.

The figure below also shows cost-effectiveness results for the TDV approach using 2022 Title24 compliance software. The TDV was calculated using 30-year residential TDV hourly multipliers for the detached ADU.[3] The all-electric detached ADU with additional measures is cost effective on both On-bill and TDV basis under both utility rates. The EDR margin for compliance is not shown for 2022 TDV scenarios because the 2022 Title 24 ruleset is not finalized yet.

Figure 4. Cost Effectiveness for ADU: All-Electric Packages

Package	Elec Savings (kWh)	Gas Savings (therms)	GHG Reductions (mtons)	Total EDR Margin	Incremental Package Cost	Lifecycle Utility Cost Savings	$TDV Savings	B/C Ratio (On-Bill)	B/C Ratio (TDV)	NPV (On-Bill)	NPV (TDV)
2019 TDV											
AE code min	(1,669)	128	0.6	0.20	(1,674)	(772)	(2,476)	2.2	0.7	$902	($803)
AE+EFF +PV	(439)	128	0.2	12.90	1,317	3,572	2,170	2.7	1.6	$2,256	$853
2022 TDV											
AE code min (2022)	(1,517)	119	0.4	-	(1,674)	(527)	239	3.2	>1	$1,146	$1,912
AE+EFF+PV (2022)	(434)	119	0.3	-	1,049	3,291	4,002	3.1	3.8	$2,243	$2,954

4.2 Nonresidential Prototypes

This section includes cost effectiveness results of the following mixed fuel and all-electric measure packages over a 2019 mixed-fuel code compliant baseline for the three nonresidential prototypes, medium office, medium retail and small hotel in subsections 4.2.1, 4.2.2 and 4.2.3 respectively:

- **Package 1A – Mixed-Fuel + EE:** Mixed-fuel design with energy efficiency measures and federal minimum appliance efficiencies.
- **Package 1B – Mixed-Fuel + EE + PV + B**: Same as Package 1A, plus solar PV and batteries.

[3] TDV multipliers can be found in the "2022 TDV CH4 20yr 15RA" workbook. https://www.energy.ca.gov/event/workshop/2020-03/staff-workshop-2022-energy-code-compliance-metrics

- **Package 1C – Mixed-fuel + HE**: Alternative design with high efficiency appliances, triggering federal preemption.
- **Package 2 – All-Electric Federal Code-Minimum Reference**: All-electric design with federal code minimum appliance efficiency. No solar PV or battery.
- **Package 3A – All-Electric + EE**: All-electric design with energy efficiency measures and federal minimum appliance efficiencies.
- **Package 3B – All-Electric + EE + PV + B**: Same as Package 3A, plus solar PV and batteries.
- **Package 3C – All-Electric + HE**: All-electric design with high efficiency appliances, triggering federal preemption.

Subsection 4.2.4 below presents the results of the PV-only and PV+Battery analysis.

4.2.1 Medium Office

Figure 5~~Figure 5~~ contains the cost-effectiveness findings for the Medium Office packages. Notable findings for each package include:

- Mixed fuel package with efficiency measures (package 1A) and with added PV and battery (package 1B) is cost effective on both an On-Bill and TDV basis.
- Mixed fuel package with high efficiency appliances (package 1C) is not cost-effective in Glendale.
- All of the all-electric packages are cost-effective in Glendale. However, Package 2 does not achieve a positive compliance margin.

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Figure 5. Cost Effectiveness for Medium Office Packages - Glendale

CZ	Utility	Elec Savings (kWh)	Gas Savings (therms)	GHG Reductions (mtons)	Comp-liance Margin (%)	Incremental Package Cost	Lifecycle Energy Cost Savings	$TDV Savings	B/C Ratio (On-Bill)	B/C Ratio (TDV)	NPV (On-Bill)	NPV (TDV)
Package 1A: Mixed Fuel + EE												
CZ09	GWP	42,568	-178	10.4	16%	$66,649	$98,775	$117,079	1.5	1.8	$32,125	$50,430
Package 1B: Mixed Fuel + EE + PV + B												
CZ09	GWP	265,661	-178	55.3	16%	$376,705	$488,674	$633,363	1.3	1.7	$111,969	$256,658
Package 1C: Mixed Fuel + HE												
CZ09	GWP	7,273	183	3.2	4%	$61,311	$25,637	$30,642	0.4	0.5	($35,674)	($30,669)
Package 2: All-Electric Federal Code Minimum												
CZ09	GWP	-16,462	1310	1.8	-2%	($63,102)	$5,250	($12,600)	>1	5.0	$68,352	$50,501
Package 3A: All-Electric + EE												
CZ09	GWP	27,281	1310	13.6	15%	$3,547	$108,625	$110,254	30.6	31.1	$105,077	$106,706
Package 3B: All-Electric + EE + PV + B												
CZ09	GWP	250,384	1310	58.6	15%	$313,603	$498,531	$626,585	1.6	2.0	$184,928	$312,982
Package 3C: All-Electric + HE												
CZ09	GWP	-9,192	1310	3.9	2%	($10,282)	$28,613	$14,796	>1	>1	$38,895	$25,078

4.2.2 Medium Retail

Figure 6~~Figure 6~~ contains the cost-effectiveness findings for the Medium Retail packages. Notable findings for each package include:

- All mixed fuel and all-electric packages are cost-effective on both an On-Bill and TDV basis.

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Figure 6. Cost Effectiveness for Medium Retail Packages - Glendale

CZ	Utility	Elec Savings (kWh)	Gas Savings (therms)	GHG Reductions (mtons)	Comp-liance Margin (%)	Incremental Package Cost	Lifecycle Energy Cost Savings	$TDV Savings	B/C Ratio (On-Bill)	B/C Ratio (TDV)	NPV (On-Bill)	NPV (TDV)
Package 1A: Mixed Fuel + EE												
CZ09	GWP	13,489	299	5.50	10%	$5,569	$36,282	$29,337	6.5	5.3	$30,713	$23,768
Package 1B: Mixed Fuel + EE + PV + B												
CZ09	GWP	194,310	299	42.94	10%	$263,374	$372,251	$467,716	1.4	1.8	$108,878	$204,342
Package 1C: Mixed Fuel + HE												
CZ09	GWP	4,221	87	1.72	4%	$10,446	$14,973	$17,602	1.4	1.7	$4,527	$7,156
Package 2: All-Electric Federal Code Minimum												
CZ09	GWP	-7,099	951	3.26	0.4%	($32,113)	$11,312	$1,714	>1	>1	$43,426	$33,827
Package 3A: All-Electric + EE												
CZ09	GWP	8,537	951	7.74	10%	($26,545)	$46,378	$30,479	>1	>1	$72,923	$57,024
Package 3B: All-Electric + EE + PV + B												
CZ09	GWP	189,375	951	45.32	10%	$231,260	$381,991	$469,034	1.7	2.0	$150,730	$237,774
Package 3C: All-Electric + HE												
CZ09	GWP	-1,953	951	4.77	4%	($8,268)	$26,422	$19,777	>1	>1	$34,690	$28,046

4.2.3 Small Hotel

The following issues must be considered when reviewing the Small Hotel results:

- The Small Hotel is a mix of residential and nonresidential space types, which results in different occupancy and load profiles than the office and retail prototypes.
- The Reach Code team modeled individual heat pump water heaters as an approximation for central heat pump water heating performance, but integrated costs associated with tank and controls for central heat pump water heating into cost effectiveness calculations.
- Assuming central heat pump water heating also enabled the inclusion of a solar hot water thermal collection system.

Figure 7~~Figure 7~~ contains the cost-effectiveness findings for the Small Hotel packages. Notable findings for each package include:

- Mixed fuel model with efficiency measures (package 1A) is cost effective on TDV basis only.
- Mixed fuel model with efficiency measures, PV and battery (package 1B) is cost effective on both On-Bill and TDV basis.
- All all-electric scenarios (packages 2, 3A and 3B) are cost effective on both On-Bill and TDV basis, and just achieve compliance for package 3A and 3B.

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Figure 7. Cost Effectiveness for Small Hotel Packages - Glendale

CZ	Utility	Elec Savings (kWh)	Gas Savings (therms)	GHG Reductions (mtons)	Comp-liance Margin (%)	Incremental Package Cost	Lifecycle Energy Cost Savings	$-TDV Savings	B/C Ratio (On-Bill)	B/C Ratio (TDV)	NPV (On-Bill)	NPV (TDV)
Package 1A: Mixed Fuel + EE												
CZ09	GWP	4,950	467	1.19	5%	$21,824	$17,173	$23,697	0.8	1.1	($4,650)	$1,874
Package 1B: Mixed Fuel + EE + PV + B												
CZ09	GWP	133,093	467	29.24	5%	$216,927	$252,233	$352,534	1.2	1.6	$35,306	$135,607
Package 1C: Mixed Fuel + HE												
CZ09	GWP	1,633	156	1.39	2%	$20,052	$8,491	$10,339	0.4	0.5	($11,561)	($9,714)
Package 2: All-Electric Federal Code Minimum												
CZ09	GWP	-89,780	9355	28.77	-12%	($1,298,174)	($179,228)	($54,194)	7.2	24.0	$1,118,947	$1,243,981
Package 3A: All-Electric + EE												
CZ09	GWP	-58,575	9355	30.26	0%	($1,266,302)	($153,684)	($150)	8.2	8457.8	$1,112,618	$1,266,152
Package 3B: All-Electric + EE + PV + B												
CZ09	GWP	69,841	9355	57.48	0%	($1,071,198)	$77,609	$328,232	>1	>1	$1,148,807	$1,399,431
Package 3C: All-Electric + HE												
CZ09	GWP	-85,363	9355	30.05	-9%	($1,285,139)	($168,064)	($38,439)	7.6	33.4	$1,117,075	$1,246,699

4.2.4 PV-only and PV+Battery

The Reach Code team also ran packages of PV-only and PV + Battery measures, without additional efficiency measures, to assess cost effectiveness for the mixed-fuel baseline and the all-electric federal code minimum reference building (Package 2 in Section 3.2).

Each of the following eight packages were evaluated against a mixed fuel baseline designed as per 2019 Title 24 Part 6 requirements.

- **Mixed-Fuel + 3 kW PV Only**
- **Mixed-Fuel + 3 kW PV + 5 kWh battery**
- **Mixed-Fuel + PV Only**: PV sized per the roof size of the building, or to offset the annual electricity consumption, whichever is smaller
- **Mixed-Fuel + PV + 50 kWh Battery:** PV sized per the roof size of the building, or to offset the annual electricity consumption, whichever is smaller, along with 50 kWh battery
- **All-Electric + 3 kW PV Only**
- **All-Electric + 3 kW PV + 5 kWh Battery**
- **All-Electric + PV Only**: PV sized per the roof size of the building, or to offset the annual electricity consumption, whichever is smaller
- **All-Electric + PV + 50 kWh Battery:** PV sized per the roof size of the building, or to offset the annual electricity consumption, whichever is smaller, along with 50 kWh battery

Figure 8~~Figure 8~~ summarize the On-Bill and TDV B/C ratios for each prototype for the two PV only packages and the two PV plus battery packages. The compliance margins are not impacted by renewables and battery storage measures and hence not shown in the tables. The figure is formatted in the following way:

Forma

- Cells highlighted in green have a B/C ratio greater than 1 and are cost-effective. The shade of green gets darker as cost effectiveness increases.
- Cells not highlighted have a B/C ratio less than one and are not cost effective.

Please see Appendix 8.4 for results in full detail. Generally, for mixed-fuel packages across all prototypes, PV-only measure is cost effective on both On-Bill and TDV basis, while the addition of a battery slightly reduces cost effectiveness.

In all-electric packages, the results for larger PV systems or larger PV+Battery systems are cost effective using both TDV and On-Bill approaches. The results for small 3 kW PV systems or small PV+Battery systems are also found to be cost effective using the On-Bill and TDV method. The addition of a battery slightly reduces the cost effectiveness for all-electric buildings with PV.

Figure 8. Cost Effectiveness PV and Battery only packages

		Mixed Fuel								All-Electric							
	PV	3kW		3kW		Large PV		Large PV		3kW		3kW		Large PV		Large PV	
	Battery	0		50kWh		0		50kWh		0		50kWh		0		50kWh	
Prototype	Utility	On-Bill	TDV	On-Bill	TDV	On-Bill	TDV	On-Bill	TDV	On-Bill	TDV	On-Bill	TDV	On-Bill	TDV	On-Bill	TDV
Medium Office	GWP	1.7	1.8	1.2	1.3	1.4	1.8	1.3	1.7	>1	49.6	>1	47.2	1.8	2.3	1.6	2.1
Medium Retail	GWP	1.9	1.8	1.3	1.3	1.4	1.9	1.3	1.7	>1	>1	>1	>1	1.7	2.2	1.5	1.9
Small Hotel	GWP	1.7	1.8	1.2	1.2	1.4	1.8	1.2	1.5	7.7	30.8	7.7	30.8	>1	>1	>1	>1

5 Summary of Results

Figure 9~~Figure 9~~ through Figure 12~~Figure 12~~ summarize results for each prototype showing the EDR margin (for detached ADUs) and compliance margin (nonresidential prototypes) percentages achieved for each measure package. Because local reach codes must both meet or 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 options 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, and do not support a reach code.

For more detail on the results in the Figures below, please refer to Section 4. As described in Section 4.2.4, PV-only and PV+Battery packages in the mixed-fuel building were found to be cost effective across all nonresidential prototypes using both On-Bill and TDV approach, and results are not reiterated in the following figures.

Figure 9. Detached ADU Summary of EDR Margin and Cost Effectiveness

Utility	All Electric, 2019 TDV		All Electric, 2022 TDV	
	Code Minimum	EE + PV	Code Minimum	EE + PV
GWP	0.2	12.9	0.5	9.8

Figure 10. Medium Office Summary of Compliance Margin and Cost Effectiveness

Utility	Mixed Fuel			All Electric			
	EE	EE + PV + B	HE	Fed Code	EE	EE + PV + B	HE
GWP	16%	16%	4%	-2%	15%	15%	2%

Figure 11. Medium Retail Summary of Compliance Margin and Cost Effectiveness

Utility	Mixed Fuel			All Electric			
	EE	EE + PV + B	HE	Fed Code	EE	EE + PV + B	HE
GWP	10%	10%	4%	0.4%	10%	10%	4%

Figure 12. Small Hotel Summary of Compliance Margin and Cost Effectiveness

Utility	Mixed Fuel			All Electric			
	EE	EE + PV + B	HE	Fed Code	EE	EE + PV + B	HE
GWP	5%	5%	2%	-12%	0%	0%	-9%

6 Conclusions

The Reach Code team developed packages of energy efficiency measures as well as packages combining energy efficiency with PV generation and/or battery storage systems, simulated them in building modeling software, 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.

The Reach Code team provides the following high-level takeaways from results:

- **Detached ADU:** All-electric detached ADUs have near zero or positive 'Total EDR Margins' implying that they comply with the code or exceed the 2019 Title 24 minimum requirements. They are cost effective in Glendale using the On-Bill metric.
- **Medium Office:** Both mixed fuel energy efficiency packages are cost effective and have positive compliance margins with and without solar PV and battery. All-electric packages are cost effective and compliant against the standard mixed fuel baseline model with efficiency measures and/or solar PV and battery. All-electric office is cost effective but requires additional efficiency measures to achieve compliance with federal minimum efficiency equipment and support an all-electric reach code.
- **Medium Retail:** All mixed fuel and all-electric energy efficiency packages are cost effective with positive compliance margins.
- **Small Hotel:** Mixed fuel efficiency and PV with battery packages are cost effective with positive compliance margin but not On-Bill cost effective with efficiency measures alone. Electrification packages are cost effective but require additional efficiency measures to achieve compliance with federal minimum efficiency equipment. Hence, an all-electric reach code can be required when combined with efficiency measures alone or with efficiency plus solar PV and/or battery.

Reach code policies requiring all-electric buildings with added efficiency and/or solar PV are feasible for detached ADUs, medium office, medium retail and small hotel building types. Electric-preferred policies, where a mixed-fuel prototype must achieve a higher compliance margin than an all-electric building, are supported for all building types. In addition, PV only and PV + Battery reach codes policies are feasible for nonresidential new construction building types. In practice system size must be optimized for the specific building.

7 References

Environmental Energy + Economics (E3). Time Dependent Valuation of Energy for Developing Building Efficiency Standards 2019 Time Dependent Valuation (TDV) Data Sources and Inputs. July 2016.
https://www.ethree.com/wp-content/uploads/2017/01/TN212524_20160801T120224_2019_TDV_Methodology_Report_7222016.pdf

Statewide Reach Code Team. 2019a. 2019 Nonresidential New Construction Reach Code Cost Effectiveness Study. Prepared for Southern California Edison. Prepared by TRC. July 2019.
https://localenergycodes.com/download/801/file_path/fieldList/2019%20NR%20NC%20Cost%20Effectiveness%20Study-2019-07-25.pdf

Statewide Reach Code Team. 2019b. 2019 Cost-effectiveness Study: Low-Rise Residential New Construction. Prepared for Pacific Gas and Electric Company. Prepared by Frontier Energy. August 2019.
https://localenergycodes.com/download/800/file_path/fieldList/2019%20Res%20NC%20Reach%20Codes

8 Appendices

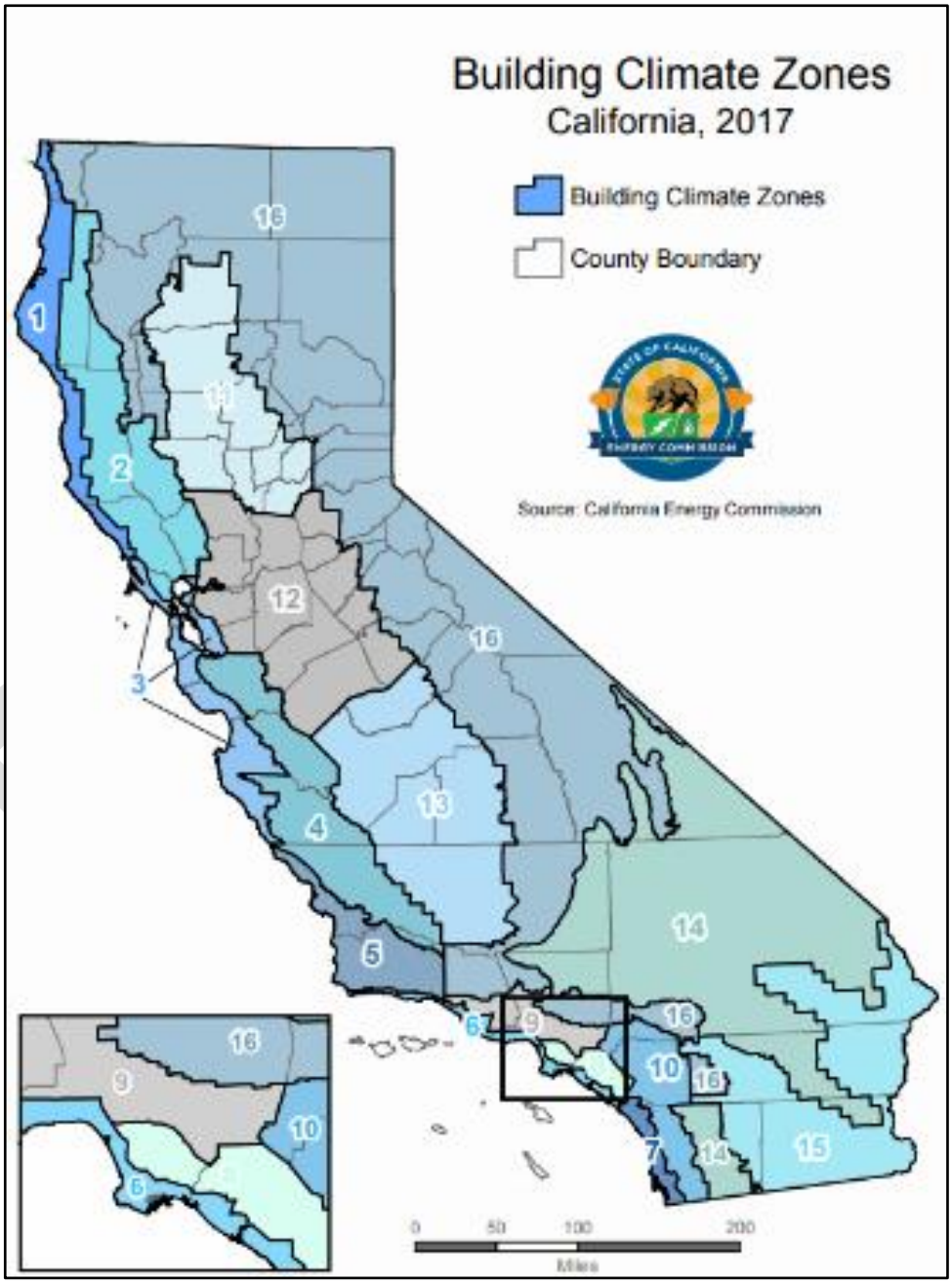
8.1 Map of California Climate Zones

Climate zone geographical boundaries are depicted in Figure 13~~Figure 13~~. The map in Figure 13~~Figure 13~~ along with a zip-code search directory is available at: https://ww2.energy.ca.gov/maps/renewable/building_climate_zones.html

Format

Format

Figure 13. Map of California Climate Zones



8.2 Utility Rate Schedules

8.2.1 GWP Utilities

8.2.1.1 Residential

L-1-D Customer Owned Generation Standard

Customer Charge - per meter per day	$0.4400
Energy Charges - perkWh	
July through October (High Season)	
First 10kWh per day	$0.1620
Next 10kWh per day	$0.2008
Remaining kWh	$0.2398
November through June (Low Season)	
First 10kWh per day	$0.1358
Next 10kWh per day	$0.1682
Remaining kWh	$0.2075

8.2.1.2 Nonresidential – Small

L-2-A Standard Service Rate

- This is the rate Glendale Water & Power uses for standard small business electric services. This is the rate your business account will be billed under unless you choose the time-of-use rate.
- Usage should not exceed 5,000 kWh per month or more than 20 KW for 3 months during 1 year.
- Accounts on the L-2 rate exceeding the above usage will be subjected to a rate change as appropriate.
- Time-of-Use option is available.

Customer Charge - per meter per day	$0.6200
Energy Charges	
July through October (High Season) Any Time	$0.1841
November through June (Low Season) Any Time	$0.1595

8.2.1.3 Nonresidential – Medium

LD-2-A Standard Service Rate

- This is the rate Glendale Water & Power uses for standard business demand electric services.
- This is the rate your business account will be billed under unless you choose the time-of-use rate.

Customer Charge - per meter per day	$2.5000
Energy Charges - per kWh	
July through October (High Season)	
Any Time	$0.1243
Demand - Per kW (maximum kW reading for last 12 months) per day	$0.6000
November through June (Low Season)	
Any Time	$0.1189
Demand - Per kW (maximum kW reading for last 12 months) per day	$0.4200

8.2.1.4 Nonresidential – Large

PC-1-A Standard Service Rate

- This rate is applicable to electric service at demands less than 500 kW.

Customer Charge - per meter per day	$22.5000
Energy Charges - per kWh	
July through October (High Season)	
Any Time	$0.1113
KVAR - Per kVar per day	$0.0040
Demand - Per kW (maximum kW reading for last 12 months) per day	$0.7000
November through June (Low Season)	
Any Time	$0.1006
KVAR - Per kVar per day	$0.0040
Demand - Per kW (maximum kW reading for last 12 months) per day	$0.4800

8.2.2 SoCalGas

8.2.2.1 Residential (GN-10)

SOUTHERN CALIFORNIA GAS COMPANY Revised CAL. P.U.C. SHEET NO. 57658-G
LOS ANGELES, CALIFORNIA CANCELING Revised CAL. P.U.C. SHEET NO. 57573-G

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¢	$16.357	
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/]	27.580¢	25.654¢	N/A	I
Transmission Charge:	77.909¢	77.909¢	77.909¢	
Total Baseline Charge (all usage):	105.489¢	103.563¢	77.909¢	I
Non-Baseline Rate, per therm (usage in excess of baseline usage):				
Procurement Charge:[2/]	27.580¢	25.654¢	N/A	I
Transmission Charge:	114.709¢	114.709¢	114.709¢	
Total Non Baseline Charge (all usage):	142.289¢	140.363¢	114.709¢	I

	GM-C	GM-CC[3/]	GT-MC	
Non-Baseline Rate, per therm (usage in excess of baseline usage):				
Procurement Charge:[2/]	27.580¢	25.654¢	N/A	I
Transmission Charge:	114.709¢	114.709¢	114.709¢	
Total Non Baseline Charge (all usage):	142.289¢	140.363¢	114.709¢	I

[1/] For the summer period beginning May 1 through October 31, with some exceptions, usage will be accumulated to at least 20 Ccf (100 cubic feet) before billing, or it will be included with the first bill of the heating season which may cover the entire duration since a last bill was generated for the current calendar year.
(Footnotes continue next page.)

(Continued)

(TO BE INSERTED BY UTILITY)
ADVICE LETTER NO. 5636
DECISION NO. 98-07-068
2C8

ISSUED BY
Dan Skopec
Vice President
Regulatory Affairs

(TO BE INSERTED BY CAL. PUC)
SUBMITTED May 29, 2020
EFFECTIVE Jun 1, 2020
RESOLUTION NO.

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)	0.473	0.473	0.473
Winter (Nov. 1-Apr.30)	1.691	1.823	2.950

* Climate Zones are described in the Preliminary Statement.

8.2.2.2 Nonresidential (GN-40)

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

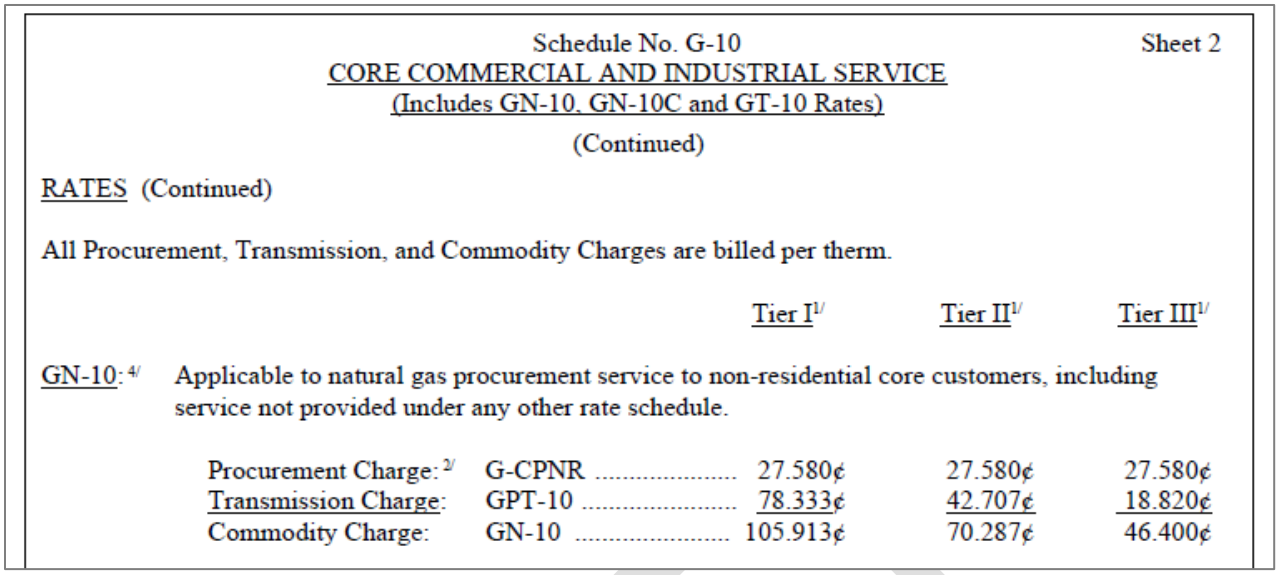
Applicable throughout the service territory.

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



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	27.580¢	27.580¢	27.580¢
Transmission Charge:	GPT-10	78.333¢	42.707¢	18.820¢
Commodity Charge:	GN-10	105.913¢	70.287¢	46.400¢

Escalation of natural gas rates between 2019 and 2022 is based on the currently filed General Rate Cases for PG&E, SoCalGas, and SDG&E. From 2023 through 2025, gas rates are assumed to escalate at 4 percent per year above inflation, which reflects historical rate increases between 2013 and 2018. Escalation of electricity rates from 2020 through 2025 is assumed to be 2 percent per year above inflation, based on electric utility estimates. After 2025, escalation rates for both natural gas and electric rates are assumed to drop to a more conservative 1 percent escalation per year above inflation for long-term rate trajectories beginning in 2026 through 2050. Figure 14~~Figure 14~~ and Figure 15~~Figure 15~~ below demonstrate the escalation rates used for nonresidential and residential (detached ADU and high-rise multifamily) buildings respectively.

Format

Format

Figure 14. Real Utility Rate Escalation Rate Assumptions - Nonresidential

Year	Statewide Electric Nonresidential Average Rate (%/year, real)	Natural Gas Nonresidential Core Rate (%/yr escalation, real)		
		PG&E	SoCalGas	SDG&E
2020	2.0%	0.67%	6.37%	5.00%
2021	2.0%	5.69%	4.12%	3.14%
2022	2.0%	1.11%	4.12%	2.94%
2023	2.0%	4.0%	4.0%	4.0%
2024	2.0%	4.0%	4.0%	4.0%
2025	2.0%	4.0%	4.0%	4.0%
2026	1.0%	1.0%	1.0%	1.0%
2027	1.0%	1.0%	1.0%	1.0%
2028	1.0%	1.0%	1.0%	1.0%
2029	1.0%	1.0%	1.0%	1.0%
2030	1.0%	1.0%	1.0%	1.0%
2031	1.0%	1.0%	1.0%	1.0%
2032	1.0%	1.0%	1.0%	1.0%
2033	1.0%	1.0%	1.0%	1.0%
2034	1.0%	1.0%	1.0%	1.0%

Figure 15. Real Utility Rate Escalation Rate Assumptions: Residential

Year	Statewide Electric Residential Average Rate (%/year, real)	Natural Gas Residential Core Rate (%/yr escalation, real)		
		PG&E	SoCalGas	SDG&E
2020	2.0%	1.48%	6.37%	5.00%
2021	2.0%	5.69%	4.12%	3.14%
2022	2.0%	1.11%	4.12%	2.94%
2023	2.0%	4.0%	4.0%	4.0%
2024	2.0%	4.0%	4.0%	4.0%
2025	2.0%	4.0%	4.0%	4.0%
2026	1.0%	1.0%	1.0%	1.0%
2027	1.0%	1.0%	1.0%	1.0%
2028	1.0%	1.0%	1.0%	1.0%
2029	1.0%	1.0%	1.0%	1.0%
2030	1.0%	1.0%	1.0%	1.0%
2031	1.0%	1.0%	1.0%	1.0%
2032	1.0%	1.0%	1.0%	1.0%
2033	1.0%	1.0%	1.0%	1.0%
2034	1.0%	1.0%	1.0%	1.0%
2035	1.0%	1.0%	1.0%	1.0%
2036	1.0%	1.0%	1.0%	1.0%
2037	1.0%	1.0%	1.0%	1.0%
2038	1.0%	1.0%	1.0%	1.0%
2039	1.0%	1.0%	1.0%	1.0%
2040	1.0%	1.0%	1.0%	1.0%
2041	1.0%	1.0%	1.0%	1.0%
2042	1.0%	1.0%	1.0%	1.0%
2043	1.0%	1.0%	1.0%	1.0%
2044	1.0%	1.0%	1.0%	1.0%
2045	1.0%	1.0%	1.0%	1.0%
2046	1.0%	1.0%	1.0%	1.0%
2047	1.0%	1.0%	1.0%	1.0%
2048	1.0%	1.0%	1.0%	1.0%
2049	1.0%	1.0%	1.0%	1.0%

8.3 Mixed Fuel Baseline Energy Figures

Figure 16~~Figure 16~~ through Figure 19~~Figure 19~~ show the annual electricity and natural gas consumption and cost, compliance TDV, and GHG emissions for each prototype under the mixed fuel design baseline. 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. Detached ADU: Mixed Fuel Baseline

Climate Zone	Utility	Electricity Consumption (kWh)	Natural Gas Consumption (Therms)	Electricity Cost	Natural Gas Cost	Total EDR Margin	GHG Emissions (mtons)
CZ09	GWP	0	128	$158	$193	0.1	1.1

Figure 17. Medium Office: Mixed Fuel Baseline

CZ	Utility	Electricity Consumption (kWh)	Natural Gas Consumption (Therms)	Electricity Cost	Natural Gas Cost	Compliance Margin TDV	GHG Emissions (mton)
CZ09	GWP	452,715	1,310	$90,326	$,1918	-1.92	127.8

Figure 18. Medium Retail: Mixed Fuel Baseline

CZ	Utility	Electricity Consumption (kWh)	Natural Gas Consumption (Therms)	Electricity Cost	Natural Gas Cost	Compliance Margin TDV	GHG Emissions (mton)
CZ09	GWP	232,374	951	$42,090	$1,540	18.13	67.7

Figure 19. Small Hotel: Mixed Fuel Baseline

CZ	Utility	Electricity Consumption (kWh)	Natural Gas Consumption (Therms)	Electricity Cost	Natural Gas Cost	Compliance Margin TDV	GHG Emissions (mton)
CZ09	GWP	214,047	9,355	$36,504	$8,776	-17.08	118.4

8.4 PV-only and PV+Battery-only Cost Effectiveness Results Details

8.4.1 Medium Office

Figure 20. PV-only and PV+Battery-only Results – Medium Office

CZ	IOU territory	Elec Savings (kWh)	Gas Savings (therms)	GHG savings (tons)	Comp-liance Margin (%)	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 + 3kW PV												
CZ09	GWP	4,968	0	1.0	0%	$6,270	$10,767	$11,455	1.7	1.8	$4,497	$5,185
Mixed Fuel + 3kW PV + Battery												
CZ09	GWP	4,968	0	1.0	0%	$9,060	$10,767	$11,455	1.2	1.3	$1,707	$2,395
Mixed Fuel + 135kW PV												
CZ09	GWP	223,561	0	44.0	0%	$282,156	$393,542	$515,281	1.4	1.8	$111,386	$233,126
Mixed Fuel + 135kW PV + Battery												
CZ09	GWP	223,115	0	45.0	0%	$310,056	$392,914	$516,379	1.3	1.7	$82,859	$206,323
All-Electric + 3kW PV												
CZ09	GWP	-11,494	1310	2.8	-2%	($56,832)	$16,575	($1,145)	>1	49.6	$73,406	$55,686
All-Electric + 3kWPV + Battery												
CZ09	GWP	-11,494	1310	2.8	-2%	($54,107)	$16,575	($1,145)	>1	47.2	$70,681	$52,961
All-Electric + 135kW PV												
CZ09	GWP	207,099	1310	45.8	-2%	$216,128	$399,360	$502,681	1.8	2.3	$183,232	$286,553
All-Electric + 135kW PV + Battery												
CZ09	GWP	206,660	1310	46.8	-2%	$244,028	$398,742	$503,779	1.6	2.1	$154,714	$259,750

8.4.2 Medium Retail

Figure 21. PV-only and PV+Battery-only Results – Medium Retail

CZ	IOU territory	Elec Savings (kWh)	Gas Savings (therms)	GHG savings (tons)	Comp-liance Margin (%)	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 + 3kW PV												
CZ09	GWP	4,968	0	0.98	0%	$6,270	$12,015	$11,449	1.9	1.8	$5,745	$5,179
Mixed Fuel + 3kW PV + Battery												
CZ09	GWP	4,968	0	0.98	0%	$9,060	$12,015	$11,449	1.3	1.3	$2,955	$2,389
Mixed Fuel + 135kW PV												
CZ09	GWP	182,161	0	35.83	0%	$229,905	$326,717	$430,204	1.4	1.9	$96,812	$200,300
Mixed Fuel + 135kW PV + Battery												
CZ09	GWP	180,860	0	37.36	0%	$257,805	$333,662	$430,204	1.3	1.7	$75,858	$172,400
All-Electric + 3kW PV												
CZ09	GWP	-2,131	951	4.23	0.4%	($25,843)	$23,327	$13,383	>1	>1	$49,171	$39,226
All-Electric + 3kWPV + Battery												
CZ09	GWP	-2,131	951	4.23	0.4%	($23,118)	$23,327	$13,383	>1	>1	$46,446	$36,501
All-Electric + 135kW PV												
CZ09	GWP	175,062	951	39.08	0.4%	$195,407	$338,029	$421,788	1.7	2.2	$142,622	$226,381
All-Electric + 135kW PV + Battery												
CZ09	GWP	173,784	951	40.77	0.4%	$223,307	$344,914	$432,314	1.5	1.9	$121,606	$209,007

8.4.3 Small Hotel

Figure 22. PV-only and PV+Battery-only Results – Small Hotel

CZ	IOU territory	Elec Savings (kWh)	Gas Savings (therms)	GHG savings (tons)	Comp-liance Margin (%)	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 + 3kW PV												
CZ09	GWP	4,852	0	0.9	0%	$6,270	$10,953	$11,013	1.7	1.8	$4,683	$4,743
Mixed Fuel + 3kW PV + Battery												
CZ09	GWP	4,852	0	0.9	0%	$9,060	$10,953	$11,013	1.2	1.2	$1,893	$1,953
Mixed Fuel + 135kW PV												
CZ09	GWP	129,378	0	25.3	0%	$167,203	$236,953	$293,750	1.4	1.8	$69,749	$126,546
Mixed Fuel + 135kW PV + Battery												
CZ09	GWP	128,249	0	27.9	0%	$195,103	$236,182	$296,058	1.2	1.5	$41,079	$100,955
All-Electric + 3kW PV												
CZ09	GWP	-84,415	9336	29.9	-12%	($1,291,904)	($168,127)	($41,894)	7.7	30.8	$1,123,777	$1,250,010
All-Electric + 3kWPV + Battery												
CZ09	GWP	-84,415	9336	29.9	-12%	($1,289,179)	($168,127)	($41,894)	7.7	30.8	$1,121,052	$1,247,285
All-Electric + 135kW PV												
CZ09	GWP	40,111	9336	54.3	-12%	($1,132,705)	$56,412	$240,843	>1	>1	$1,189,116	$1,373,548
All-Electric + 135kW PV + Battery												
CZ09	GWP	39,280	9336	56.0	-12%	($1,104,805)	$55,249	$242,130	>1	>1	$1,160,054	$1,346,934