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CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Title 24, Parts 6 and 11
Local Energy Efficiency Ordinances

Cost-effectiveness Study: Low-Rise Residential

Prepared for:
Kelly Cunningham
Codes and Standards Program
Pacific Gas and Electric Company

Prepared by:
Frontier Energy, Inc.
Misti Bruceri & Associates, LLC

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Acronyms

ACH50	Air Changes per Hour at 50 pascals pressure differential
ACM	Alternative Calculation Method
AFUE	Annual Fuel Utilization Efficiency
B/C	Lifecycle Benefit-to-Cost Ratio
BEopt	Building Energy Optimization Tool
BSC	Buildings Standards Commission
CAHP	California Advanced Homes Program
CBECC-Res	Computer program developed by the California Energy Commission for use in demonstrating compliance with the California Residential Building Energy Efficiency Standards
CFI	California Flexible Installation
CFM	Cubic Feet per Minute
CMFNH	California Multifamily New Homes
CO_2	Carbon Dioxide
CPC	California Plumbing Code
CZ	California Climate Zone
DHW	Domestic Hot Water
DOE	Department of Energy
DWHR	Drain Water Heat Recovery
EDR	Energy Design Rating
EER	Energy Efficiency Ratio
EF	Energy Factor
GHG	Greenhouse Gas
HERS Rater	Home Energy Rating System Rater
HPA	High Performance Attic
HPWH	Heat Pump Water Heater
HSPF	Heating Seasonal Performance Factor
HVAC	Heating, Ventilation, and Air Conditioning
IECC	International Energy Conservation Code
IOU	Investor Owned Utility
kBtu	kilo-British thermal unit
kWh	Kilowatt Hour

LBNL	Lawrence Berkeley National Laboratory
LCC	Lifecycle Cost
LLAHU	Low Leakage Air Handler Unit
VLLDCS	Verified Low Leakage Ducts in Conditioned Space
MF	Multifamily
NAECA	National Appliance Energy Conservation Act
NEEA	Northwest Energy Efficiency Alliance
NEM	Net Energy Metering
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
PG&E	Pacific Gas and Electric Company
PV	Photovoltaic
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric
SEER	Seasonal Energy Efficiency Ratio
SF	Single Family
CASE	Codes and Standards Enhancement
TDV	Time Dependent Valuation
Therm	Unit for quantity of heat that equals 100,000 British thermal units
Title 24	Title 24, Part 6
TOU	Time-Of-Use
UEF	Uniform Energy Factor
ZNE	Zero-net Energy

1 Introduction

The California Building Energy Efficiency Standards Title 24, Part 6 (Title 24) (Energy Commission, 2018b) is maintained and updated every three years by two state agencies, the California Energy Commission (Energy Commission) and the Building Standards Commission (BSC). In addition to enforcing the code, local jurisdictions have the authority to adopt local energy efficiency ordinances, or reach codes, that exceed the minimum standards defined by Title 24 (as established by Public Resources Code Section 25402.1(h)2 and Section 10-106 of the Building Energy Efficiency Standards). Local jurisdictions must demonstrate that the requirements of the proposed ordinance are cost-effective and do not result in buildings consuming more energy than is permitted by Title 24. In addition, the jurisdiction must obtain approval from the Energy Commission and file the ordinance with the BSC for the ordinance to be legally enforceable.

This report documents cost-effective combinations of measures that exceed the minimum state requirements, the 2019 Building Energy Efficiency Standards, which become effective January 1, 2020, for new single family and low-rise (one- to three-story) multifamily residential construction. The analysis includes evaluation of both mixed fuel and all-electric homes, documenting that the performance requirements can be met by either type of building design. Compliance package options and cost-effectiveness analysis in all sixteen California climate zones (CZs) are presented. All proposed package options include a combination of efficiency measures and on-site renewable energy.

2 Methodology and Assumptions

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

- **Utility Bill Impacts (On-Bill)**: Customer-based Lifecycle Cost (LCC) approach that values energy based upon estimated site energy usage and customer on-bill savings using electricity and natural gas utility rate schedules over a 30-year duration accounting for discount rate and energy inflation.
- **Time Dependent Valuation (TDV)**: Energy Commission LCC methodology, which is intended to capture the "societal value or cost" of energy use including long-term projected costs such as the cost of providing energy during peak periods of demand and other societal costs such as projected costs for carbon emissions, as well as grid transmission and distribution impacts. This metric values energy use differently depending on the fuel source (gas, electricity, and propane), time of day, and season. Electricity used (or saved) during peak periods has a much higher value than electricity used (or saved) during off-peak periods (Horii et al, 2014). This is the methodology used by the Energy Commission in evaluating cost-effectiveness for efficiency measures in Title 24, Part 6.

2.1 Building Prototypes

The Energy Commission defines building prototypes which it uses to evaluate the cost-effectiveness of proposed changes to Title 24 requirements. There exist two single family prototypes and one low-rise multifamily prototype, all three of which are used in this analysis in development of the above-code efficiency packages. Table 1 describes the basic characteristics of each prototype. Additional details on the prototypes can be found in the Alternative Calculation Method (ACM) Approval Manual (Energy Commission, 2018a). The prototypes have equal geometry on all walls, windows and roof to be orientation neutral.

Table 1: Prototype Characteristics

	Single Family One-Story	Single Family Two-Story	Multifamily
Conditioned Floor Area	2,100 ft^2	2,700 ft^2	6,960 ft^2: (4) 780 ft^2 & (4) 960 ft^2 units
Num. of Stories	1	2	2
Num. of Bedrooms	3	3	(4) 1-bed & (4) 2-bed units
Window-to-Floor Area Ratio	20%	20%	15%

Source: 2019 Alternative Calculation Method Approval Manual.
https://www.energy.ca.gov/2018publications/CEC-400-2018-023/CEC-400-2018-023-CMF.pdf

The Energy Commission's protocol for single family prototypes is to weight the simulated energy impacts by a factor that represents the distribution of single-story and two-story homes being built statewide, assuming 45 percent single-story and 55 percent two-story. Simulation results in this study are therefore characterized according to this ratio, which is approximately equivalent to a 2,430-square foot (ft^2) house[1].

The methodology used in the analyses for each of the prototypical building types begins with a design that precisely meets the minimum 2019 prescriptive requirements (0% compliance margin). Table 150.1-A in the 2019 Standards (Energy Commission, 2018b) lists the prescriptive measures that determine the baseline design in each climate zone. Other features are defined consistent with the Standard Design in the ACM Reference Manual (Energy Commission, 2019), and are designed to meet, but not exceed, the minimum requirements. Each prototype building has the following features:

- Slab-on-grade foundation.
- Vented attic. High performance attic in climate zones where prescriptively required (CZ 4, 8-16) with insulation installed at the ceiling and below the roof deck per Option B. Refer to Table 150.1-A in the 2019 Standards.
- Ductwork located in the attic for single family and within conditioned space for multifamily.

Both mixed fuel and all-electric prototypes are evaluated in this study. While in past code cycles an all-electric home was compared to a home with gas for certain end-uses, in the 2019 code there are now separate prescriptive and performance paths for mixed-fuel and all-electric homes. The fuel specific characteristics of the mixed fuel and all-electric prototypes are defined according to the 2019 ACM Reference Manual and described in Table 2[2].

[1] 2,430 ft^2 = (45% x 2,100 ft^2) + (+ 55% x 2,700 ft^2)

[2] Standards Section 150.1(c)8.iv.a specifies that compact distribution and a drain water heat recover system are required when a heat pump water heater is installed prescriptively. The efficiency of the distribution and the drain water heat recovery systems as well as the location of the water heater applied in this analysis are based on the Standard Design assumptions in CBECC-Res which result in a 0% compliance margin for the 2019 basecase model.

Table 2: Characteristics of the Mixed Fuel vs All-Electric Prototype

	Mixed Fuel	All-Electric
Space Heating/Cooling[1]	Gas furnace 80 AFUE Split A/C 14 SEER, 11.7 EER	Split heat pump 8.2 HSPF, 14 SEER, 11.7 EER
Water Heater[1,2, 3, 4]	Gas tankless UEF = 0.81	50gal HPWH UEF = 2.0 SF: located in the garage MF CZ 2,4,6-16: located in living space MF CZ 1,3,5: located in exterior closet
Hot Water Distribution	Code minimum. All hot water lines insulated	Basic compact distribution credit, (CZ 6-8,15) Expanded compact distribution credit, compactness factor = 0.6 (CZ 1-5,9-14,16)
Drain Water Heat Recovery Efficiency	None	CZ 1: unequal flow to shower = 42% CZ 16: equal flow to shower & water heater = 65% None in other CZs
Cooking	Gas	Electric
Clothes Drying	Gas	Electric

[1]Equipment efficiencies comply with minimum federal appliance efficiency standards.
[2]The multifamily prototype is evaluated with individual water heaters. HPWHs located in the living space do not have ducting for either inlet or exhaust air; CBECC-Res does not have the capability to model ducted HPWHs.
[3]UEF = uniform energy factor. HPWH = heat pump water heater. SF = single family. MF = multifamily.
[4]CBECC-Res applies a 50gal water heater in all cases. Hot water draws differ between the prototypes based on number of bedrooms.

2.2 Measure Analysis

A research version of the California Building Energy Code Compliance simulation tool, CBECC-RES 2019.0.11 ALPHA[3], was used to evaluate energy impacts using the 2019 Title 24 prescriptive standards as the benchmark, and the 2019 TDV values. TDV is the energy metric used by the Energy Commission since the 2005 Title 24 energy code to evaluate compliance with the Title 24 standards.

Using the 2019 baseline as the starting point, prospective energy efficiency measures were identified and modeled in each of the prototypes to determine the projected energy (Therm and kWh) and compliance impacts. A large set of parametric runs were conducted to evaluate various options and develop packages of measures that exceed minimum code performance. The analysis utilizes a parametric tool based on Micropas[4] to automate and manage the generation of CBECC-Res input files. This allows for quick evaluation of various efficiency measures across multiple climate zones and prototypes and improves quality control. The batch process functionality of CBECC-Res is utilized to simulate large groups of input files at once. Annual utility costs were calculated using hourly data output from CBECC-Res and electricity and natural gas tariffs for each of the investor owned utilities (IOUs).

[3] The software is still in development and has not yet been approved by the Energy Commission for compliance purposes.

[4] Developed by Ken Nittler of Enercomp, Inc.

The Reach Codes Team selected packages and measures based on cost-effectiveness as well as decades of experience with residential architects, builders, and engineers along with general knowledge of the relative acceptance of many measures.

2.2.1 Federal Preemption

The Department of Energy (DOE) sets minimum efficiency standards for equipment and appliances that are federally regulated under the National Appliance Energy Conservation Act (NAECA), including heating, cooling, and water heating equipment. 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 equipment. While this study is limited by federal preemption, in practice builders may use any package of compliant measures to achieve the performance goals, including high efficiency appliances. Often, these measures are the simplest and most affordable measures to increase energy performance.

2.2.2 Energy Design Rating

The 2019 Title 24 code replaces the compliance margin with California's Energy Design Rating (EDR) as the primary metric to demonstrate compliance with the energy code. EDR is still based on TDV but it uses a building that is compliant with the 2006 International Energy Conservation Code (IECC) as the reference building. The reference building has an EDR score of 100 while a zero-net energy (ZNE) home has an EDR score of zero (Energy Commission, 2018d). See Figure 1 for a graphical representation of this. While the Reference Building is used to determine the rating, the Proposed Design is compared to the Standard Design based on the prescriptive baseline assumptions to determine compliance.

The EDR[5] is calculated by CBECC-Res and has two components:

1. An "Efficiency EDR" which represents the building's energy use without solar generation.[6]
2. A "Final EDR" that represents the final energy use of the building based on the combined impact of efficiency measures, PV generation and demand flexibility.

For a building to comply, two criteria are required:

(1) the proposed Efficiency EDR must be equal to or less than the Efficiency EDR of the Standard Design, and
(2) the proposed Final EDR must be equal to or less than the Final EDR of the Standard Design.

Single family prototypes used in this analysis that are minimally compliant with the 2019 Title 24 code achieve a Final EDR between 20 and 35 in most climates.

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

[5] During the analysis for this report, two issues were identified in the CBECC-Res software that result in a slight error in the EDR calculation for cases with certain water heating measures. As a result, the EDRs presented in this report are calculated externally to correct for this error and better reflect the EDRs that will be reported in the approved version of the software.

[6] While there is no compliance credit for solar PV as there is under the 2016 Standards, there is a credit for installing electric storage battery systems that meet minimum qualifications that is applied to the Efficiency EDR.

efficiency measures. Figure 1 graphically summarizes how both Efficiency EDR and PV / demand flexibility EDR are used to calculate the Total EDR used in the 2019 code and in this analysis.

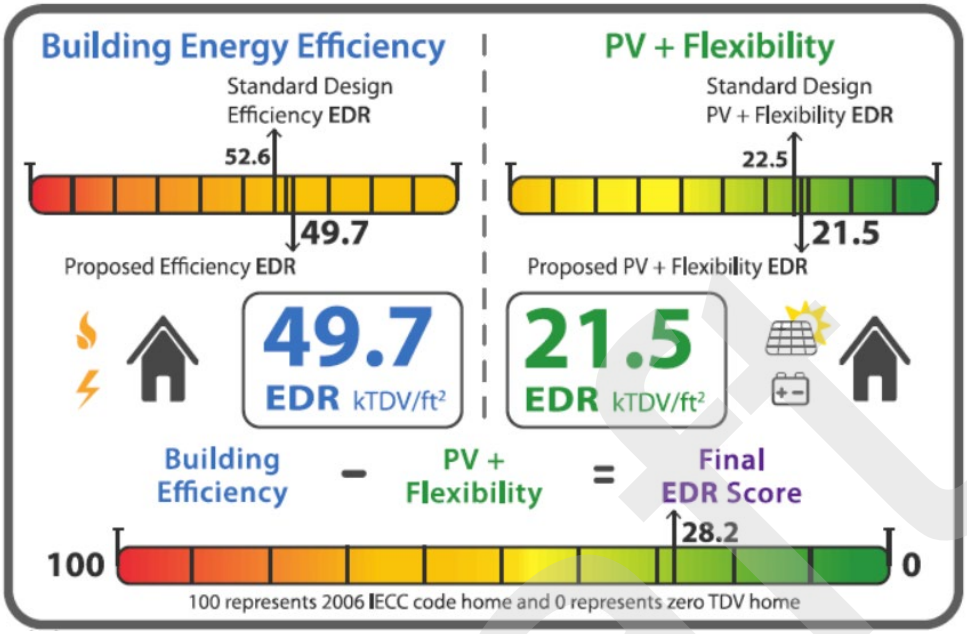

Figure 1: Graphical description of EDR scores (courtesy of Energy Code Ace[7])

Results from this analysis are presented as a reduction in the EDR score. EDR reduction is a better metric to use than absolute EDR in the context of a reach code because absolute values vary, based on the home design and characteristics such as size and orientation. This approach aligns with utility incentive programs, such as the California Advanced Homes Program (CAHP) & California Multifamily New Homes (CMFNH), which require minimum performance criteria based on an EDR reduction ("Delta EDR") for low-rise residential projects. The EDR reduction is calculated according to Equation 1 for the two efficiency packages and Equation 2 for the Efficiency & PV and Efficiency & PV/Battery packages (see Section 2.3).

Equation 1

$$EDR\ Reduction_{\boldsymbol{efficiency}} = Standard\ Design\ Efficiency\ EDR - Proposed\ Design\ Efficiency\ EDR$$

Equation 2

$$EDR\ Reduction_{\boldsymbol{efficiency\ \&\ PV}} = Standard\ Design\ Final\ EDR - Proposed\ Design\ Final\ EDR$$

2.2.3 Energy Efficiency Measures

Following are descriptions of each of the efficiency measures evaluated under this analysis. Because not all of the measures described below were found to be cost-effective and cost-effectiveness varied by climate zone, not all measures are included in all packages and some of the measures listed are not included in any final package. For a list of measures included in each efficiency package by climate zone, see Appendix C – Single Family Measure Summary and Appendix F – Multifamily Measure Summary

[7] https://energycodeace.com/

Reduced Infiltration (ACH50): Reduce infiltration in single family homes from the default infiltration assumption of five (5) air changes per hour at 50 Pascals (ACH50)[8] by 40 to 60 percent to either 3 ACH50 or 2 ACH50. HERS rater field verification and diagnostic testing of building air leakage according to the procedures outlined in the 2019 Reference Appendices RA3.8 (Energy Commission, 2018c). This measure was not applied to multifamily homes because CBECC-Res does not allow reduced infiltration credit for multifamily buildings.

Improved Fenestration: Reduce window U-factor to 0.24. The prescriptive U-factor is 0.30 in all climates. In climate zones 1, 3, 5, and 16 where heating loads dominate, an increase in solar heat gain coefficient (SHGC) from the default assumption of 0.35 to 0.50 was evaluated in addition to the reduction in U-factor.

Cool Roof: Install a roofing product that's rated by the Cool Roof Rating Council to have an aged solar reflectance (ASR) of 0.25. Steep-sloped roofs were assumed in all cases. Title 24 specifies a prescriptive ASR of 0.20 for Climate Zones 10 through 15 and assumes 0.10 in other climate zones.

Exterior Wall Insulation: Decrease wall U-factor in 2x6 walls to 0.043 from 0.048 by increasing exterior insulation from one-inch R-5 to 1-1/2 inch R-7.5. This was evaluated for single family buildings only in all climate zones except 6 and 7 where the prescriptive requirement is a U-factor of 0.065 and improving beyond that value has little impact.

High Performance Attics (HPA): HPA with R-38 ceiling insulation and R-30 insulation under the roof deck. In climates where HPA is already required prescriptively this measure requires an incremental increase in roof insulation from R-19 or R-13 to R-30. In climates where HPA is not currently required (Climate Zones 1 through 3, and 5 through 7), this measure adds roof insulation to an uninsulated roof as well as increasing ceiling insulation from R-30 to R-38 in Climate Zones 3, 5, 6 and 7.

Slab Insulation: Install R-10 perimeter slab insulation at a depth of 16-inches. For climate zone 16, where slab insulation is required, prescriptively this measure increases that insulation from R-7 to R-10.

Reduced Duct Leakage: Reduce duct leakage from 5% to 2% and install a low leakage air handler unit (LLAHU). This is only applicable to single family homes since the basecase for multifamily assumes ducts are within conditioned space and additional duct leakage credit is not available.

Ducts in Conditioned Space: Move the ductwork and equipment from the attic to inside the conditioned space in one of the three following ways.

1. Locate ductwork in conditioned space. The air handler may remain in the attic provided that 12 linear feet or less of duct is located outside the conditioned space including the air handler and plenum. Meet the requirements of 2019 Reference Appendices RA3.1.4.1.2. (Energy Commission, 2018c)
2. All ductwork located entirely in conditioned space meeting the requirements of 2019 Reference Appendices RA3.1.4.1.3. (Energy Commission, 2018c)
3. All ductwork located entirely in conditioned space with ducts tested to have less than or equal to 25 cfm leakage to outside. Meet the requirements of Verified Low Leakage Ducts in Conditioned Space (VLLDCS) in the 2019 Reference Appendices RA3.1.4.3.8. (Energy Commission, 2018c)

Option 1 and 2 above apply to single family only since the basecase for multifamily assumes ducts are within conditioned space. Option 3 applies to both single family and multifamily cases.

Low Pressure Drop Distribution System: Upgrade the duct distribution system to reduce external static pressure and meet a maximum fan efficacy of 0.35 Watts per cfm for gas furnaces and 0.45 Watts per cfm for heat pumps operating at full speed. This may involve upsizing ductwork, reducing the total effective length of ducts, and/or

[8] Whole house leakage tested at a pressure difference of 50 Pascals between indoors and outdoors.

selecting low pressure drop components such as filters. Fan watt draw is verified by a HERS rater according to the procedures outlined in the 2019 Reference Appendices RA3.3 (Energy Commission, 2018c). New federal regulations that went into effect July 3, 2019 require higher fan efficiency for gas furnaces than for heat pumps and air handlers, which is why the recommended specification is different for mixed fuel and all-electric homes.

HERS Verification of Hot Water Pipe Insulation: The California Plumbing Code (CPC) requires pipe insulation on all hot water lines. This measure provides credit for HERS rater verification of pipe insulation requirements according to the procedures outlined in the 2019 Reference Appendices RA3.6.3. (Energy Commission, 2018c)

Compact Hot Water Distribution: Two credits for compact hot water distribution were evaluated.

1. Basic Credit: Design the hot water distribution system to meet minimum requirements for the basic compact hot water distribution credit according to the procedures outlined in the 2019 Reference Appendices RA4.4.6 (Energy Commission, 2018c). In many single family homes this may require moving the water heater from an exterior to an interior garage wall. Multifamily homes with individual water heaters are expected to easily meet this credit with little or no alteration to plumbing design. CBECC-Res software assumes a 30% reduction in distribution losses for the basic credit.
2. Expanded Credit: Design the hot water distribution system to meet minimum requirements for the expanded compact hot water distribution credit according to the procedures outlined in the 2019 Reference Appendices RA3.6.5 (Energy Commission, 2018c). In addition to requiring HERS verification that the minimum requirements for the basic compact distribution credit are met, this credit also imposes limitations on pipe location, maximum pipe diameter, and recirculation system controls allowed.

Drain Water Heat Recovery (DWHR): For multifamily buildings add DWHR that serves the showers in an unequal flow configuration with 50% efficiency. This upgrade assumes all apartments are served by a DWHR with one unit serving four apartments based on the analysis conducted by the 2019 Statewide CASE Team (Statewide CASE Team, 2017a). For a slab-on-grade building this requires a horizontal unit for the first-floor apartments.

Federally Preempted Measures:

The following additional measures were evaluated. Because these measures involve upgrading appliances that are federally regulated, they cannot be used to show cost-effectiveness in a local ordinance. The measures and packages are presented here to show that there are several options for builders to meet the performance targets.

High Efficiency Furnace: For the mixed-fuel prototypes, upgrade natural gas furnace to one of two condensing furnace options with an efficiency of 92% or 96% AFUE. Heating capacity is not an input in CBECC-Res.

High Efficiency Air Conditioner: For the mixed-fuel prototypes, upgrade the air conditioner to either single-stage SEER 16 / EER 13 or two-stage SEER 18 / EER 14 equipment. Cooling capacity is not input in CBECC-Res.

High Efficiency Heat Pump: For the all-electric prototypes, upgrade the heat pump to either single-stage SEER 16 / EER 13 / HSPF 9 or two-stage SEER 18 / EER 14 / HSPF 10 equipment. The heating capacity is auto-sized for both the code compliant and high efficiency cases.

High Efficiency Tankless Water Heater: For the mixed-fuel prototype, upgrade tankless water heater to a condensing unit with a rated Uniform Energy Factor (UEF) of 0.96. Capacity is not an input in CBECC-Res.

High Efficiency Heat Pump Water Heater (HPWH): For the all-electric prototypes, upgrade the federal minimum heat pump water heater to a HPWH that meets the Northwest Energy Efficiency Alliance (NEEA)[9] Tier 3 rating. The code compliant case is a 50gal water heater. The evaluated NEEA water heater is an 80gal unit. Using the same water heater provides consistency in performance across all the equipment upgrade cases, even though hot water draws differ across the prototypes.

2.3 Package Development

Three to four packages were evaluated for each prototype and climate zone, as described below.

1) **Efficiency – Non-Preempted**: This package uses only efficiency measures that don't trigger federal preemption issues including envelope, and water heating and duct distribution efficiency measures.
2) **Efficiency – Equipment, Preempted**: This package shows an alternative design that applies HVAC and water heating equipment that are more efficient than federal standards.
3) **Efficiency & PV**: Using the Efficiency – Non-Preempted Package as a starting point[10], additional PV capacity is added to offset most of the estimated electricity use. This only applies to the all-electric case, since for the mixed fuel cases, 100% of the projected electricity use is already being offset in the efficiency only packages as required by 2019 Title 24, Part 6.
4) **Efficiency & PV/Battery**: Using the Efficiency & PV Package as a starting point, additional PV capacity is added as well as a battery system.

2.3.1 Solar Photovoltaics (PV)

Installation of on-site PV is required in the 2019 residential code. The PV sizing methodology in each package was developed to offset annual building electricity use and avoid oversizing which would violate net energy metering (NEM) rules. In all cases PV is evaluated in CBECC-Res according to the California Flexible Installation (CFI) assumptions.

The CBECC-Res software includes three options for sizing the PV system, described below. Analysis was conducted to determine the most appropriate sizing method for each package which is described in the Results.

- Standard Design PV – the same PV capacity as is required for the Standard Design case[11]
- Maximum PV for Compliance Credit – a PV system sized to offset 100% of the estimated electricity use of the Proposed Case. For the all-electric cases, the PV system would be sized larger than what is required by code. For a mixed fuel building that performs better than code, the PV system may be smaller than the size required in the Standard design.
- Specify PV System Scaling – a PV system sized to offset a specified percentage of the estimated electricity use of the Proposed Case

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

[10] In cases where there was no cost-effective Efficiency – Non-Preempted Package, the most cost-effective efficiency measures for that climate zone were also included in the Efficiency & PV Package in order to provide a combination of both efficiency and PV beyond code minimum.

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

2.3.2 Energy Storage (Batteries)

A battery system was evaluated in CBECC-Res with control type set to "Time of Use" and with default efficiencies of 95% for both charging and discharging. The "Time of Use" option assumes batteries are charged anytime PV generation is greater than the house load but controls when the battery storage system discharges to the electric grid, beginning during the highest priced time of use hours of the day. This control option is considered to be most reflective of the current products on the market. This control option requires an input for the "First Hour of the Summer Peak" and the Statewide CASE Team applied the default hour in CBECC-Res which differs by climate zone. The Self Utilization Credit was taken when the battery system was modeled.

2.4 Incremental Costs

Table 4 below summarizes the incremental cost assumptions for measures evaluated in this study. Incremental costs represent the equipment, installation, replacement, and maintenance costs of the proposed measures relative to the base case. Replacement costs are applied to HVAC and DHW equipment, PV inverters, and battery systems over the 30-year evaluation period. There is no assumed maintenance on the envelope, HVAC, or DHW measures since there should not be any additional maintenance cost for a more efficient version of the same system type as the baseline. Costs were estimated to reflect costs to the building owner. When costs were obtained from a source that didn't already include a builder overhead and profit markup a ten percent was added. All costs are provided as present value in 2020.

Equipment lifetimes applied in this analysis for the water heating and space conditioning measures are summarized in Table 3.

Table 3: Lifetime of Water Heating & Space Conditioning Equipment Measures

	Lifetime
Gas Furnace	20
Air Conditioner	20
Heat Pump	15
Gas Tankless Water Heater	20
Heat Pump Water Heater	15

Source: City of Palo Alto 2019 Title 24 Energy Reach Code Cost-effectiveness Analysis Draft (TRC, 2018) which is based on DEER

Table 4: Incremental Cost Assumptions

Measure	Performance Level	Incremental Cost (2020 PV$)		Source & Notes
		Single Family	Multifamily Per Unit	
Non-Pre-empted Measures				
Reduced Infiltration	3.0 vs 5.0 ACH50	$391	n/a	NREL's BEopt cost database ($0.115/ft^2 for 3 ACH50 & $0.207/ft^2 for 2 ACH50) + $100 HERS rater verification.
	2.0 vs 5.0 ACH50	$613	n/a	
Window U-factor	0.24 vs 0.30	$2,261	$607	$4.23/ft^2 window area based on analysis conducted for the 2019 and 2022 Title 24 cycles (Statewide CASE Team, 2018).
Window SHGC	0.50 vs 0.35	$0	$0	Data from CASE report along with direct feedback from Statewide CASE Team that higher SHGC does not necessarily have any incremental cost (Statewide CASE Team, 2017d). Applies to CZ 1,3,5,16.
Cool Roof - Aged Solar Reflectance	0.25 vs 0.20	$237	$58	Costs based on research by TRC for 2016 reach code analysis for 0.28 solar reflectance product. (Statewide Reach Codes Team, 2017b).
	0.20 vs 0.10	$0	$0	
Wall U-factor	0.043 vs 0.048	$818	n/a	Based on 2x6 wall and increasing exterior insulation from 1" R-5 to 1.5" R-7.5 (Statewide CASE Team, 2017c). Applies to single family only in all climates except CZ 6, 7.
Under-Deck Roof Insulation	R-13 vs R-0	$1,338	$334	Costs for R-13 ($0.64/ft^2), R-19 ($0.78/ft^2) and R-30 ($1.13/ft^2) based on data presented in the 2019 HPA CASE report (Statewide CASE Team, 2017b) along with data collected directly from builders during the 2019 CASE process. Costs for R-38 from NREL's BEopt cost database.
	R-19 vs R-13	$282	$70	
	R-30 vs R-19	$835	$209	
	R-38 vs R-30	$585	$146	
Attic Floor Insulation	R-38 vs R-30	$584	$146	NREL's BEopt cost database: $0.34/ft^2 ceiling area
Slab Edge Insulation	R-10 vs R-0	$553	$121	$4/linear foot of slab perimeter based on internet research. Assumes 16in depth.
	R-10 vs R-7	$157	$21	$1.58/linear foot of slab perimeter based on NREL's BEopt cost database. This applies to CZ 16 only where R-7 slab edge insulation is required prescriptively. Assumes 16in depth.
Duct Location	<12 feet in attic	$358	n/a	Costs based on a 2015 report on the Evaluation of Ducts in Conditioned Space for New California Homes (Davis Energy Group, 2015). HERS verification cost of $100 for the Verified Low Leakage Ducts in Conditioned Space credit.
	Ducts in Conditioned Space	$658	n/a	
	Verified Low Leakage Ducts in Conditioned Space	$768	$110	

Table 4: Incremental Cost Assumptions

Measure	Performance Level	Incremental Cost (2020 PV$)		Source & Notes
		Single Family	Multifamily Per Unit	
Distribution System Leakage	2% vs 5%	$96	n/a	1-hour labor. Labor rate of $96 per hour is from 2019 RSMeans for sheet metal workers and includes an average City Cost Index for labor for California cities & 10% for overhead and profit. Applies to single family only since ducts are assumed to be in conditioned space for multifamily
	Low Leakage Air Handler	$0	n/a	Negligible cost based on anecdotal information. There are more than 5,100 Energy Commission certified units.
Low Pressure Drop Ducts (Fan W/cfm)	0.35 vs 0.45	$96	$48	Costs assume one-hour labor for single family and half-hour per multifamily apartment. Labor rate of $96 per hour is from 2019 RSMeans for sheet metal workers and includes an average City Cost Index for labor for California cities.
	0.45 vs 0.58	$96	$48	
Hot water pipe insulation	HERS verified	$110	$83	Cost for HERS verification only, based on feedback from HERS raters. $100 per single family home and $75 per multifamily unit before markup.
Hot water compact distribution	Basic credit	$150	$0	For single family add 20-feet venting at $12/ft to locate water heater on interior garage wall, less 20-feet savings for less PEX and pipe insulation at $4.88/ft. Costs from online retailers. Many apartments are expected to meet this credit without any changes to distribution design.
	Expanded credit	n/a	$83	Cost for HERS verification only. $75 per multifamily unit before markup. This was only evaluated for multifamily buildings.
Drain water heat recovery	50% efficiency	n/a	$690	Cost from the 2019 DWHR CASE report assuming a 2-inch DWHR unit but with one unit per apartment since this analysis assumes individual water heaters per apartment (Statewide CASE Team, 2017a).
Federally Pre-empted Measures				
Furnace AFUE	92% vs 80%	$139	$139	Equipment costs from online retailers for 40-kBtu/h unit. Cost saving for 6-feet of venting at $26/foot due to lower cost venting requirements for condensing (PVC) vs non-condensing (stainless) furnaces. Replacement at year 20 assumes a 50% reduction in first cost. Value at year 30 based on remaining useful life is included.
	96% vs 80%	$244	$244	
Air Conditioner SEER/EER	16/13 vs 14/11.7	$111	$111	Costs from online retailers for 2-ton unit. Replacement at year 20 assumes a 50% reduction in first cost. Value at year 30 based on remaining useful life is included.
	18/14 vs 14/11.7	$1,148	$1,148	
Heat Pump SEER/EER /HSPF	16/13/9 vs 14/11.7/8.2	$411	$411	Costs from online retailers for 2-ton unit. Replacement at year 15 assumes a 50% reduction in first cost.
	18/14/10 vs 14/11.7/8.2	$1,511	$1,511	
Tankless water heater Energy Factor	0.96 vs 0.81	$249	$249	Equipment costs from online retailers for 40-kBtu/h unit. Cost saving for 6-feet of venting at $26/foot due to lower cost venting requirements for condensing (PVC) vs non-condensing (stainless) furnaces. Replacement at year 15 assumes a 50% reduction in first cost.

Table 4: Incremental Cost Assumptions

Measure	Performance Level	Incremental Cost (2020 PV$)		Source & Notes
		Single Family	Multifamily Per Unit	
HPWH	NEEA Tier 3 vs 2.0 EF	$294	$294	Equipment costs from online retailers. Replacement at year 15 assumes a 50% reduction in first cost.
PV + Battery				
PV System	System size varies	$3.72/W-DC	$3.18/W-DC	First costs are from LBNL's Tracking the Sun 2018 costs (Barbose et al, 2018) and represent costs for the first half of 2018 of $3.50/W-DC for residential system and $2.90/W-DC for non-residential system ≤500 kW-DC. These costs were reduced by 16% for the solar investment tax credit, which is the average credit over years 2020-2022. Inverter replacement cost of $0.14/W-DC present value includes replacements at year 11 at $0.15/W-DC (nominal) and at year 21 at $0.12/W-DC (nominal) per the 2019 PV CASE report (California Energy Commission, 2017). System maintenance costs of $0.31/W-DC present value assume $0.02/W-DC (nominal) annually per the 2019 PV CASE report (California Energy Commission, 2017). 10% overhead and profit added to all costs
Battery	System size varies by building type	$558/kWh	$558/kWh	$443/kWh first cost based on the Reach Code Team's report on batteries (Statewide Reach Codes Team, 2018). Cost was calculated as the average of the installed cost after the 30% tax credit for the three systems presented in the report. Replacement cost at year 15 of $100/kWh based on target price reductions (Penn, 2018).

2.5 Cost-effectiveness

Cost-effectiveness was evaluated for all sixteen climate zones and is presented based on both TDV energy, using the Energy Commission's LCC methodology, and on-bill customer lifecycle benefit-to-cost (B/C) ratio based on residential customer utility rates. Both methodologies require estimating and quantifying the value of the energy impact associated with energy efficiency measures over the life of the measures (30 years) as compared to the prescriptive Title 24 requirements.

2.5.1 On-Bill Customer Lifecycle Benefit-to-Cost Ratio

On-Bill benefit-to-cost (B/C) ratio is a net present value (NPV) metric which represents the cost-effectiveness of a measure over a 30-year lifetime taking into account discounting of future savings and costs, financing of incremental first costs, and energy escalation. A value of one indicates the NPV of the savings over the life of the measure is equivalent to the NPV of the lifetime incremental cost of that measure. A value greater than one represents a positive return on investment. The B/C ratio is calculated according to Equation 3.

Equation 3

$$On - Bill\ Benefit - to - Cost\ Ratio = \frac{Lifetime\ benefit\ NPV}{Lifetime\ cost\ NPV}$$

In most cases the benefit is represented by annual utility savings and the cost by incremental first cost and replacement costs. However, in some cases a measure may have incremental cost savings but with increased utility operational costs. In this case, the benefit is the lower first cost and the cost is the increase in utility bills. The lifetime costs or benefits are calculated according to Equation 4.

Equation 4

$$\boldsymbol{Lifetime\ cost/benefit = \sum_{t=1}^{n} Annual\ cost/benefit_t * (1 + r)^t}$$

Where:

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

The following summarizes the assumptions applied under this cost-effectiveness approach.

- Analysis term of 30-years
- Real discount rate of 3 percent
- Inflation rate of 2 percent
- First incremental costs are financed into a 30-year mortgage
- Mortgage interest rate of 4.5 percent
- Annual real utility tariff escalation rates of 0.7 percent for electricity (Energy & Environmental Economics, 2017)
- Annual real utility tariff escalation rates of 2.5 percent for natural gas (Energy & Environmental Economics, 2017)
- Average tax rate of 20 percent (to account for tax savings due to loan interest deductions)

Residential utility rates were used to calculate utility costs for all cases and determine customer cost-effectiveness for the proposed packages. The Reach Codes Team obtained the recommended utility rates from each IOU based on the assumption that the reach codes go into effect January of 2020. Annual utility costs were calculated using hourly electricity and gas output from CBECC-Res and applying the utility tariffs summarized in Table 5. Appendix A includes the utility rate schedules used for this study. The applicable residential time-of-use

(TOU) rate was applied to all cases. [12] Annual electricity production in excess of annual electricity consumption is credited to the utility account at the applicable wholesale rate based on the approved NEM2 tariffs for that utility, which is the second round of NEM tariffs now in effect, for that utility. Minimum daily use billing and mandatory non-bypassable charges have been applied. The net surplus compensation rates for the different utilities are as follows[13]:

- PG&E: $0.0287 / kWh
- SCE: $0.0301 / kWh
- SDG&E: $0.0355 / kWh

Utility rates were applied to each climate zone based on the predominant IOU serving the population of each zone. Climate zones 10 and 14 have been evaluated with both SCE/SoCalGas and SDG&E tariffs since each utility has customers within these climate zones.

Annual escalation rates of 0.7 percent for electricity and 2.5 percent for natural gas were applied statewide based on data from the development of the 2019 TDV multipliers (Energy & Environmental Economics, 2017).

Table 5: IOU Utility Tariffs used based on Climate Zone

Climate Zones	Electric / Gas Utility	Electricity (Time-of-use)	Natural Gas
1-5, 11-13, 16	PG&E	E-TOU, Option B	G1
6, 8-10, 14, 15	SCE / SoCal Gas	TOU-D-T	GR
7, 10, 14	SDG&E	TOU-DR1	GR

Source: Utility websites, See Appendix A for details on the tariffs applied.

2.5.2 TDV Lifecycle Cost

Cost-effectiveness was also assessed using the Energy Commission's TDV LCC methodology to calculate cost-effectiveness. The TDV methodology involves estimating and quantifying the energy savings associated with measures using TDV. TDV is a normalized monetary format developed and used by the Energy Commission for comparing electricity and natural gas savings, and it considers the cost of electricity and natural gas consumed during different times of the day and year. The 2019 TDV values are based on long term discounted costs of 30 years for all residential measures. The CBECC-Res simulation software outputs are in terms of TDV kBTUs. The present value of the energy cost savings in dollars is calculated by multiplying the TDV kBTU savings by a net present value (NPV) factor, also developed by the Energy Commission. The NPV factor is $0.173/TDV kBtu for residential buildings.

Like the customer B/C ratio, a TDV B/C ratio 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. The ratio is calculated according to Equation 5.

Equation 5

$$TDV\ Benefit - to - Cost\ Ratio = \frac{TDV\ energy\ savings\ *\ NPV\ factor}{Lifetime\ incremental\ cost}$$

[12] Under NEM rulings by the CPUC (D-16-01-144, 1/28/16), all new PV customers shall be in an approved TOU rate structure. As of March 2016, all new PG&E net energy metering (NEM) customers are enrolled in a time-of-use rate. (http://www.pge.com/en/myhome/saveenergymoney/plans/tou/index.page).

[13] Net surplus compensation rates based on 1-year average February 2018 – January 2019.

2.6 Electrification Evaluation

In addition to evaluating upgrades to mixed fuel and all-electric buildings independently that don't result in any fuel switching, the Reach Code Team also analyzed the impact on construction costs, utility costs, and TDV when a builder specifies and installs electric appliances instead of the gas appliances typically found in a mixed fuel building. This analysis compared the code compliant mixed fuel prototype, which uses gas for space heating, water heating, cooking, and clothes drying, with the code compliant all-electric prototype. It also compared the all-electric Efficiency & PV Package with the code compliance mixed fuel prototype. In these cases, the relative costs between natural gas and electric appliances, differences between in-house electricity and gas infrastructure and the associated infrastructure costs for providing gas to the building were also included.

A variety of sources were reviewed when determining incremental costs. The sources are listed below.

- SMUD All-Electric Homes Electrification Case Study (EPRI, 2016)
- City of Palo Alto 2019 Title 24 Energy Reach Code Cost-effectiveness Analysis (TRC, 2018)
- Building Electrification Market Assessment (E3, 2019)
- Decarbonization of Heating Energy Use in California Buildings (Hopkins et al, 2018)
- Analysis of the Role of Gas for a Low-Carbon California Future (Navigant, 2008)
- Rulemaking No. 15-03-010 An Order Instituting Rulemaking to Identify Disadvantaged Communities in the San Joaquin Valley and Analyze Economically Feasible Options to Increase Access to Affordable Energy in Those Disadvantages Communities (California Public Utilities Commission, 2016)
- 2010-2012 WO017 Ex Ante Measure Cost Study: Final Report (Itron, 2014)
- Natural gas infrastructure costs provided by utility staff through the Reach Code subprogram
- Costs obtained from builders, contractors and developers

Incremental costs are presented in Table 6. Values in parentheses represent a lower cost or cost reduction in the electric option relative to natural gas. The costs from the available sources varied widely making it difficult to develop narrow cost estimates for each component. For certain components data is provided with a low to high range as well as what were determined to be typical costs.

Table 6: Incremental Costs – All-Electric Compared to a Mixed Fuel Home

Measure	Incremental Cost (2020 PV$) Single Family			Incremental Cost (2020 PV$) Multifamily		
	Low	High	Typical	Low	High	Typical
Heat pump vs gas furnace/split AC	($2,770)	$620	($221)	N/A		Same as Single Family
Heat pump water heater vs gas tankless	($1,120)	$1,120	$0			
Electric vs gas clothes dryer[1]	($428)	$820	$0			
Electric vs gas cooking[1]	$0	$1,800	$0			
Electric service upgrade	$200	$800	$600	$150	$600	$600
In-house gas infrastructure	($1,670)	($550)	($800)	($600)	($150)	($600)
Site gas Infrastructure	($25,000)	($900)	($5,750)	($16,250)	($310)	($3,140)
Total First Cost	***($30,788)***	***$3,710***	***($6,171)***	***($20,918)***	***$4,500***	***($3,361)***
Present Value of Equipment Replacement Cost			***$1,266***			***$1,266***
Lifetime cost including replacement & financing of first cost			***($5,349)***			***($2,337)***

[1]The high range represents induction cooktops and heat pump clothes dryers. The typical costs assume electric resistance technology.

Typical incremental costs for switching from a mixed fuel design to an all-electric design are based on the following assumptions:

Appliances: The Reach Code Team determined that the typical first installed cost for electric appliances is very similar to that for natural gas appliances. This was based on information provided by HVAC contractors, plumbers and builders as well as a review of other studies. After review of various sources, the Reach Code Team concluded that the cost difference between gas and electric resistance options for clothes dryers and stoves is negligible and that the lifetimes of the two technologies are also similar.

HVAC: Typical HVAC incremental costs were based on the City of Palo Alto 2019 Title 24 Energy Reach Code Cost-effectiveness Analysis (TRC, 2018) which assumes approximately $200 first cost savings for the heat pump relative to the gas furnace and air conditioner. Table 6 also includes the present value of the incremental replacement costs for the heat pump based on a 15-year lifetime and a 20-year lifetime for the gas furnace in the mixed fuel home.

DHW: Typical costs for the water heating system were based on equivalent installed first costs for the HPWH and tankless gas water heater. This accounts for slightly higher equipment cost but lower installation labor due to the elimination of the gas flue. Incremental replacement costs for the HPWH are based on a 15-year lifetime and a 20-year lifetime for the tankless water heater.

For multifamily, less data was available and therefore a range of low and high costs is not provided. The typical first cost for multifamily similarly is expected to be close to the same for the mixed fuel and all-electric designs. However, there are additional considerations with multifamily such as greater complexity for venting of natural gas appliances as well as for locating the HPWH within the conditioned space (all climates except Climate Zones 1, 3, and 5, see Table 2) that may impact the total costs.

Electric service upgrade: The study assumes an incremental cost to run 220V service to each appliance of $200 per appliance for single family homes and $150 per appliance per multifamily apartment based on cost estimates from builders and contractors. The Reach Code Team reviewed production builder utility plans for mixed-fuel homes and consulted with contractors to estimate which electricity and/or natural gas services are usually provided to the dryer and oven. Typical practice varied, with some builders providing both gas and electric service to both appliances, others providing both services to only one of the appliances, and some only providing gas. For this study, the Reach Code Team determined that for single family homes the typical cost is best qualified by the practice of providing 220V service and gas to either the dryer and the oven and only gas service to the other. For multifamily buildings it's assumed that only gas is provided to the dryer and oven in the mixed fuel home.

It is assumed that no upgrades to the electrical panel are required and that a 200 Amp panel is typically installed for both mixed fuel and all-electric new construction homes. There are no incremental electrical site infrastructure requirements.

In-house gas infrastructure (from meter to appliances): Installation costs to run a gas line from the meter to the appliance location is $200 per appliance for single family and $150 per appliance per multifamily apartment based on cost estimates from builders and contractors. The cost estimate includes providing gas to the water heater, furnace, dryer and cooktop.

Site gas infrastructure: The components with the highest degree of variability are the costs for site gas infrastructure. These costs are very project dependent and may be significantly impacted by such factors as site characteristics, distance to the nearest gas main, joint trenching, whether work is conducted by the utility or a private contractor, and number of homes per development. The typical infrastructure costs for single family homes in Table 6 are based on input from the utilities involved in this study and reflect those for a new subdivision in an undeveloped area, requiring a new main, and assume $5,000 for extension of a gas main after

a 50% refund per Rule 15[14], $600 for a service lateral after deduction of allowances for gas appliances, and $150 for the meter. For multifamily homes the typical cost is based on TRC's City of Palo Alto 2019 Title 24 Energy Reach Code Cost-effectiveness Analysis (TRC, 2018). Cost assumptions for an infill development project provides yet another variable and can significantly affect costs depending on whether gas is already available at the site.

The Rule 15 50% refund and appliance allowance deduction is accounted for in the site gas infrastructure costs under the On-Bill cost-effectiveness methodology. However, because TDV cost savings impacts extend beyond the customer and account for societal impacts of energy use, these deductions were removed for this analysis to account for the full cost of the infrastructure upgrades when evaluating under the TDV methodology.

2.7 Greenhouse Gas Emissions

Equivalent CO_2 emission savings were calculated based on outputs from the CBECC-Res simulation software. Electricity emissions vary by region and by hour of the year. CBECC-Res applies two distinct hourly profiles, one for Climate Zones 1 through 5 and 11 through 13 and another for Climate Zones 6 through 10 and 14 through 16. For natural gas a fixed factor of 0.005307 metric tons/therm is used. In order to compare the mixed fuel and all-electric cases side-by-side, greenhouse gas (GHG) emissions are presented as CO_2-equivalent emissions per square foot of conditioned floor area.

[14] https://www.pge.com/tariffs/tm2/pdf/GAS_RULES_15.pdf

3 Results

The primary objective of the evaluation is to identify cost-effective, non-preempted performance targets for both single family and low-rise multifamily prototypes, under both mixed fuel and all-electric cases, to support the design of local ordinances requiring new low-rise residential buildings to exceed the minimum state requirements. The packages presented are representative examples of designs and measures that can be used to meet the requirements. In practice, a builder can use any combination of non-preempted or preempted compliant measures to meet the requirements.

This analysis covered all sixteen climate zones and evaluated two efficiency packages (a non-preempted package and a preempted package that includes upgrades to federally regulated equipment), an Efficiency & PV Package (for the all-electric scenario only) and an Efficiency & PV/Battery Package. For the efficiency-only packages, measures were refined to ensure that the non-preempted package was cost-effective based on one of the two metrics applied in this study, TDV or On-Bill. The preempted equipment package, which the Reach Code Team considers to be a package of upgrades most reflective of what builders commonly apply to exceed code requirements, was designed to be cost-effective based on the On-Bill cost-effectiveness approach.

Results are presented as EDR reduction instead of compliance margin, as EDR is the metric used to determine code compliance in the 2019 cycle. Target EDR reduction is based on taking the calculated EDR reduction for the case and rounding down to the next half of a whole number. Target EDR reduction for the Efficiency Package are defined based on the lower of the EDR reduction of the non-preempted package and the equipment, preempted package. For example, if for a particular case the cost-effective non-preempted package has an EDR reduction of 3 and the preempted package an EDR reduction of 4, the Target EDR reduction is set at 3.

For a package to qualify, a minimum EDR reduction of 0.5 was required. This is to say that a package that only achieved an EDR reduction of 0.4, for example, was not considered. An EDR reduction less than 0.5 generally corresponds to a compliance margin lower than 5% and was considered too small to ensure repeatable results. In certain cases, the Reach Code Team did not identify a cost-effective package that achieved the minimum EDR reduction of 0.5.

Although some of the efficiency measures evaluated were not cost-effective and were eliminated, the following measures are included in at least one package:

- Reduced infiltration
- Improved fenestration
- Improved cool roofs
- High performance attics
- Slab insulation
- Reduced duct leakage
- Verified low leakage ducts in conditioned space
- Low pressure-drop distribution system
- Compact hot water distribution system, basic and expanded
- High efficiency furnace, air conditioner & heat pump (*preempted*)
- High efficiency tankless water heater & heat pump water heater (*preempted*)

3.1 PV and Battery System Sizing

The approach to determining the size of the PV and battery systems varied based on each package and the source fuel. Table 7 describes the PV and battery sizing approaches applied to each of the four packages. For the **Efficiency Non-preempted and Efficiency – Equipment, Preempted packages** a different method was applied to each the two fuel scenarios. In all **mixed fuel cases**, the PV was sized to offset the estimated electrical load (Max PV) and any electricity savings from efficiency measures were traded off with a smaller PV system. Not

downsizing the PV system after adding efficiency measures runs the risk of producing more electricity than is consumed, reducing cost-effectiveness and violating NEM rules. While the impact of this in most cases is minor, analysis confirmed that cost-effectiveness improved when reducing the system size to offset 100% of the electricity usage as opposed to keeping the PV system the same size as the Standard Design.

In the **all-electric Efficiency cases**, the PV system size was left to match the Standard Design (Std Design PV), and the inclusion of energy efficiency measures was not traded off with a reduced capacity PV system. Because the PV system is sized to meet the electricity load of a mixed fuel home, it is cost-effective to keep the PV system the same size and offset a greater percentage of the electrical load.

For the **Efficiency & PV case on the all-electric home**, the Reach Code Team evaluated PV system sizing to offset 100%, 90% and 80% of the total calculated electricity use. Of these three, sizing to 90% proved to be the most cost-effective based on customer utility bills. This is a result of the impact of the annual minimum bill which is around $120 across all the utilities. The "sweet spot" is a PV system that reduces electricity bills just enough to match the annual minimum bill; increasing the PV size beyond this adds first cost but does not result in utility bill savings.

Table 7: PV & Battery Sizing Details by Package Type

Package	Mixed Fuel	All-Electric
Efficiency (Envelope & Equipment)	Max PV	Std Design PV
Efficiency & PV	n/a	PV Scaled @ 90%
Efficiency & PV/Battery	Max PV 5kWh / SF home 2.75kWh/ MF apt	PV Scaled @ 100% 5kWh / SF home 2.75kWh/ MF apt

A sensitivity analysis was conducted to determine the appropriate battery and PV capacity for the Efficiency & PV/Battery Packages using the 1-story 2,100 square foot prototype in Climate Zone 12. Results are shown in Figure 2. The current version of CBECC-Res requires a minimum battery size of 5 kWh to qualify for the self-utilization credit. CBECC-Res allows for PV oversizing up to 160% of the building's estimated electricity load when battery storage systems are installed; however, the Reach Code Team considered this high, potentially problematic from a grid perspective, and likely not acceptable to the utilities or customers. The Reach Code Team compared cost-effectiveness of 5kWh and 7.5kWh battery systems as well as of PV systems sized to offset 90%, 100%, or 120% of the estimated electrical load.

Results show that from an on-bill perspective a smaller battery size is more cost-effective. The sensitivity analysis also showed that increasing the PV capacity from 90% to 120% of the electricity use reduced cost-effectiveness. From the TDV perspective there was little difference in results across all the scenarios, with the larger battery size being marginally more cost-effective. Based on these results, the Reach Code Team applied to the Efficiency & PV/Battery Package a 5kWh battery system for single family homes with PV sized to offset 100% of the electricity load. Even though PV scaled to 90% was the most cost-effective, sizing was increased to 100% to evaluate greater generation beyond the Efficiency & PV Package and to achieve zero net electricity. These results also show that in isolation, the inclusion of a battery system reduces cost-effectiveness compared to the same size PV system without batteries.

For multifamily buildings the battery capacity was scaled to reflect the average ratio of battery size to PV system capacity (kWh/kW) for the single family Efficiency & PV Package. This resulted in a 22kWh battery for the multifamily building, or 2.75kWh per apartment.

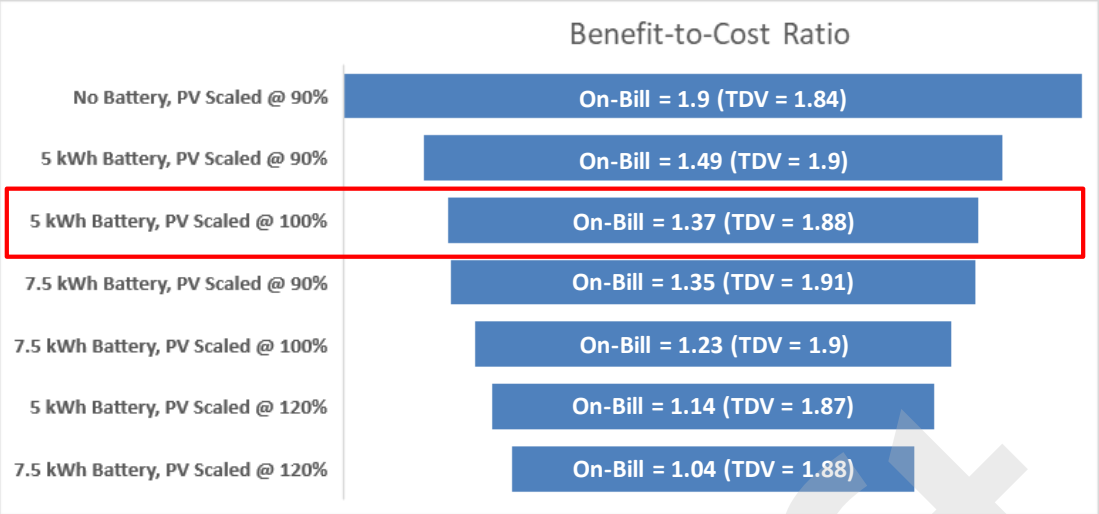

Figure 2: B/C ratio comparison for PV and battery sizing

3.2 Single Family Results

Table 8 and Table 9 present the B/C ratios for all the single family packages according to both the On-Bill and TDV methodologies for the mixed fuel and the all-electric cases, respectively. Results are cost-effective based on TDV for all cases except for Climate Zone 7 where there are no cost-effective combination of efficiency only measures that met the minimum 0.5 EDR reduction threshold. Cases where the B/C ratio is indicated as ">1" without a numerical value refer to instances where there are incremental cost savings in addition to annual utility bill savings. In these cases, there is no cost associated with the upgrade and benefits are realized immediately.

Figure 3 presents a comparison of Final EDRs for single family buildings and Figure 4 presents the EDR reduction results. Each graph compares the mixed fuel and all-electric cases as well as the various packages. The EDR reduction for the **Efficiency Package** for most climates is between 1.0 and 5.5 for mixed fuel cases and slightly higher, between 1.5 and 6.5, for the all-electric design. No cost-effective **mixed fuel Efficiency package** was found Climate Zone 7.

For the **mixed fuel case, the Efficiency & PV/Battery** package increased the EDR reduction to values between 7.0 and 10.5. Because of the limitations on oversizing PV systems to offset natural gas use it is not feasible to achieve higher EDR reductions by increasing PV system capacity.

For the **all-electric case, the Efficiency & PV** Package resulted in EDR reductions of 11.0 to 19.5 for most climates; adding a battery system increased this an additional 9 to 11 EDR reduction. Climate zones 1 and 16, which have high heating loads, have much higher EDR reductions for the Efficiency & PV package (27-32). The Standard Design PV, which is what is applied in the all-electric Efficiency Package, is not sized to offset any of the heating load. When the PV system is sized to offset 90% of the total electricity use, the increase is substantial as a result. In contrast, in Climate Zone 15 the Standard Design PV system is already sized to cover the cooling electricity load, which represents 40% of whole building electricity use. Therefore, increasing the PV size to offset 90% of the electric load in this climate only results in adding approximately 100 Watts of PV capacity and subsequently a negligible impact on the EDR.

Additional results details can be found in Appendix B – Single Family Detailed Results with summaries of measures included in each of the packages in Appendix C – Single Family Measure Summary and package costs in Appendix D – Single Family Package Costs. A summary of results by climate zone is presented in Appendix H – Results by Climate Zone.

Table 8: Single Family Package Cost-Effectiveness Results for the Mixed Fuel Case[1,2,3]

Climate Zone	Efficiency							Efficiency & PV/Battery			
	Non-Preempted			Equipment - Preempted			Target				
	Delta EDR	On-Bill B/C Ratio	TDV B/C Ratio	Delta EDR	On-Bill B/C Ratio	TDV B/C Ratio	EDR Red.	Delta EDR	On-Bill B/C Ratio	TDV B/C Ratio	Target Delta EDR
01	5.3	5.1	2.9	7.0	5.5	4.2	5.0	10.7	1.2	1.8	10.5
02	3.3	1.8	1.7	3.2	4.1	3.6	3.0	10.1	0.7	1.7	10.0
03	2.9	1.4	1.3	4.0	2.1	2.0	2.5	10.1	0.6	1.5	10.0
04	2.5	1.0	1.2	2.6	2.6	2.7	2.5	10.1	0.5	1.6	10.0
05	2.7	1.2	1.2	2.5	2.5	2.5	2.5	9.4	0.6	1.5	9.0
06	2.1	0.6	1.2	2.0	1.6	2.0	1.5	9.9	0.3	1.4	9.5
07	n/a	n/a	n/a	1.4	1.6	1.4	n/a	9.3	0.3	1.5	9.0
08	1.3	0.4	1.4	1.5	1.3	1.8	1.0	8.4	0.2	1.5	8.0
09	2.6	0.4	2.0	2.9	1.4	3.6	2.5	8.9	0.2	1.7	8.5
10-SCE/SoCalGas	3.2	0.4	1.4	3.2	1.5	4.0	3.0	10.0	0.1	1.7	9.5
10-SDGE	3.2	0.8	1.4	3.2	2.7	4.0	3.0	10.0	0.7	1.7	9.5
11	4.4	0.8	1.2	5.0	2.6	3.6	4.0	9.4	0.4	1.6	9.0
12	3.6	1.3	1.9	3.4	3.6	4.7	3.0	9.8	0.6	1.9	9.5
13	4.7	0.8	1.3	5.9	5.7	8.6	4.5	9.8	0.6	1.7	9.5
14-SCE/SoCalGas	4.9	1.0	2.4	5.8	2.7	6.2	4.5	9.1	0.5	1.9	9.0
14-SDGE	4.9	1.9	2.4	5.8	5.0	6.2	4.5	9.1	1.5	1.9	9.0
15	4.9	0.1	1.6	4.9	>1	>1	4.5	7.2	0.2	1.7	7.0
16	5.5	1.8	1.5	6.2	2.4	2.2	5.5	10.7	1.0	1.5	10.5

[1]">1" indicates cases where there are both first cost savings and annual utility bill savings.
[2]EDR Red. = EDR Reduction[3]Appendix C – Single Family Measure Summary

Table 9: Single Family Package Cost-Effectiveness Results for the All-Electric Case[1,2,3]

Climate Zone	Efficiency							Efficiency & PV				Efficiency & PV/Battery			
	Non-Preempted			Equipment - Preempted											
	Delta EDR	On-Bill B/C Ratio	TDV B/C Ratio	Delta EDR	On-Bill B/C Ratio	TDV B/C Ratio	Target Delta EDR	Delta EDR	On-Bill B/C Ratio	TDV B/C Ratio	Target Delta EDR	Delta EDR	On-Bill B/C Ratio	TDV B/C Ratio	Target Delta EDR
01	15.5	1.7	1.7	6.7	2.6	2.7	6.5	32.1	1.7	1.5	32.0	42.0	1.4	1.4	41.5
02	5.0	1.1	1.1	5.0	2.0	2.1	4.5	19.7	1.7	1.4	19.5	30.5	1.3	1.5	30.0
03	4.8	2.4	2.4	4.3	1.5	1.6	4.0	18.7	2.0	1.7	18.5	29.9	1.4	1.6	29.5
04	3.4	1.8	1.9	3.6	1.3	1.4	3.0	17.2	1.9	1.6	17.0	28.7	1.4	1.7	28.5
05	4.6	2.4	2.4	4.3	1.5	1.6	4.0	18.4	2.1	1.8	18.0	29.1	1.5	1.7	29.0
06	2.2	1.0	1.5	2.6	1.4	2.0	2.0	14.5	1.3	1.5	14.0	26.6	0.7	1.5	26.5
07	n/a	n/a	n/a	1.8	1.5	1.4	n/a	11.4	1.8	1.5	11.0	24.5	1.3	1.6	24.0
08	1.6	0.4	1.2	1.5	1.8	2.7	1.5	11.2	1.2	1.5	11.0	22.0	0.6	1.5	21.5
09	2.5	0.8	2.3	3.2	1.4	3.1	2.5	11.4	1.3	1.7	11.0	21.3	0.7	1.6	21.0
10-SCE/SoCalGas	3.2	0.7	1.5	3.6	1.6	3.2	3.0	11.3	1.3	1.5	11.0	21.5	0.7	1.6	21.0
10-SDGE	3.2	1.1	1.5	3.6	2.4	3.2	3.0	11.3	1.6	1.5	11.0	21.5	1.5	1.6	21.0
11	4.7	1.2	1.5	5.5	2.6	3.0	4.5	14.4	1.7	1.6	14.0	23.6	1.4	1.7	23.5
12	3.9	0.7	1.1	4.9	1.8	2.3	3.5	16.1	1.5	1.4	16.0	26.0	1.2	1.5	26.0
13	5.2	1.0	1.4	5.9	2.6	3.2	5.0	13.6	1.6	1.5	13.5	22.8	1.3	1.6	22.5
14-SCE/SoCalGas	5.7	0.9	1.5	6.1	2.1	3.1	5.5	15.7	1.5	1.6	15.5	24.2	1.0	1.7	24.0
14-SDGE	5.7	1.3	1.5	6.1	2.8	3.1	5.5	15.7	1.7	1.6	15.5	24.2	1.7	1.7	24.0
15	5.7	1.0	1.6	7.4	2.9	4.5	5.5	6.2	1.1	1.6	6.0	13.6	0.7	1.6	13.5
16	10.1	1.6	1.7	4.7	2.1	2.2	4.5	27.6	1.9	1.6	27.5	36.2	1.6	1.6	36.0

[1]">1" indicates cases where there are both first cost savings and annual utility bill savings.

[2]EDR Red. = EDR Reduction[3]Appendix C – Single Family Measure Summary

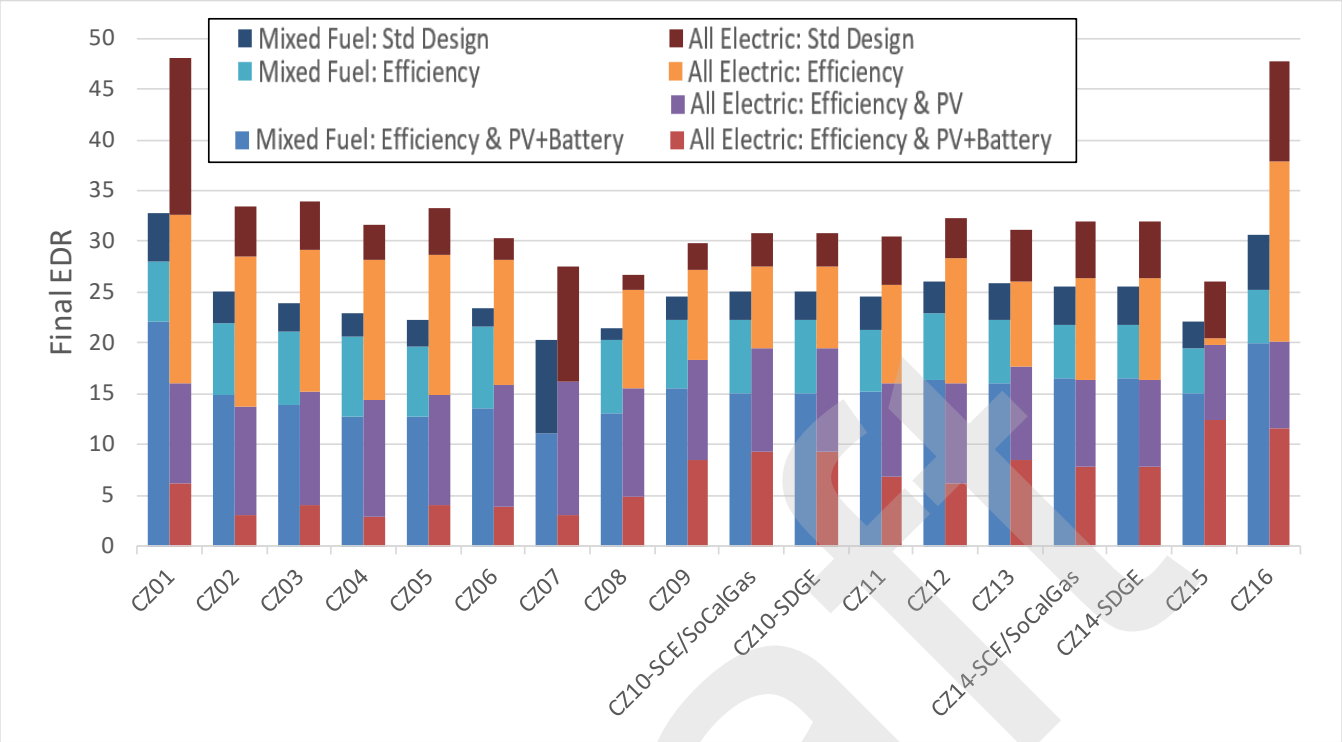

Figure 3: Single family Final EDR comparison

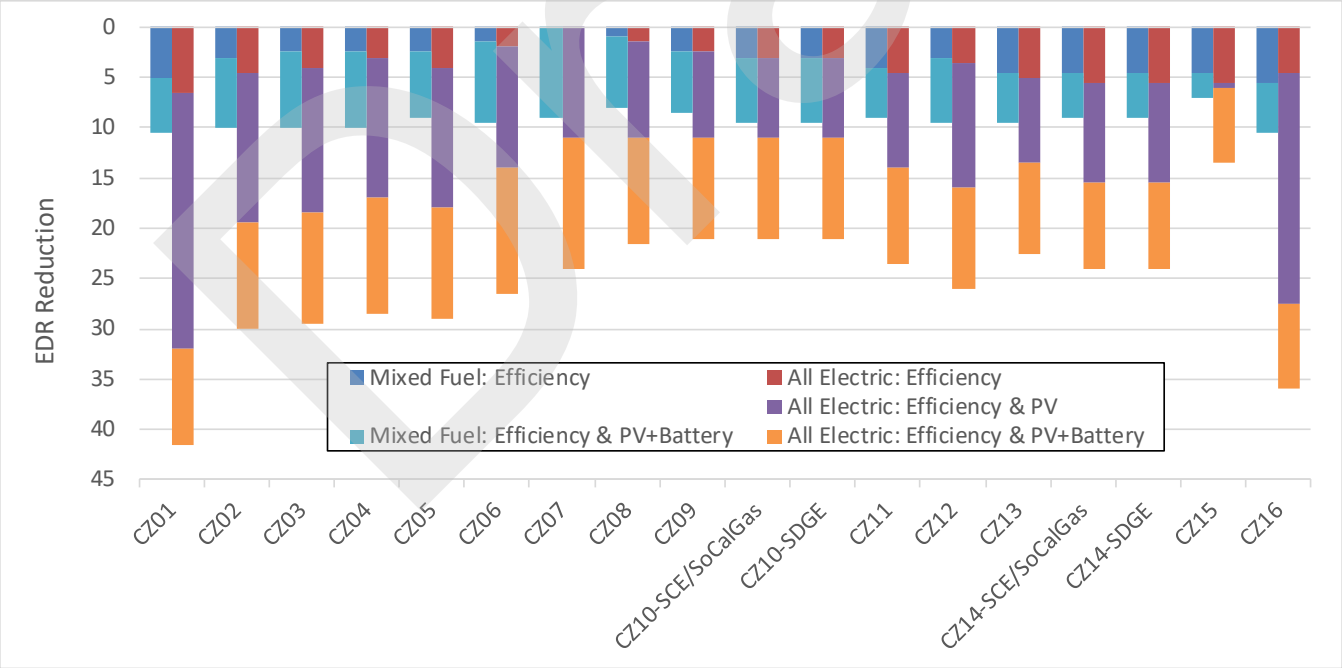

Figure 4: Single family EDR reduction comparison

3.2.1 GHG Emission Reductions

Figure 5 compares GHG emissions for both mixed fuel and all-electric single family 2019 code compliant cases with Efficiency, Efficiency & PV and Efficiency & PV/Battery packages. GHG emissions vary by climate but are consistently higher in mixed fuel cases than all-electric. Standard Design mixed fuel emissions range from 1.2 (CZ 7) to 3.3 (CZ 16) lbs CO2e/square foot of floor area, where all-electric Standard Design emissions range from 0.7 to 1.7 lbs CO2e/ ft^2. Adding efficiency, PV and batteries to the mixed fuel code compliant prototype reduces GHG emissions by 20% on average to between 1.0 and 1.8 lbs CO2e/ft^2, with the exception of Climate Zones 1 and 16. Adding efficiency, PV and batteries to the all-electric code compliant prototype reduces GHG emissions by 67% on average to 0.7 lbs CO2e/ft^2 or less with the exception of Climate Zones 14, 15 and 16. None of the cases completely eliminates GHG emissions. Because of the time value of emissions calculation for electricity in CBECC-Res, there is always some amount of GHG impacts with using electricity from the grid.

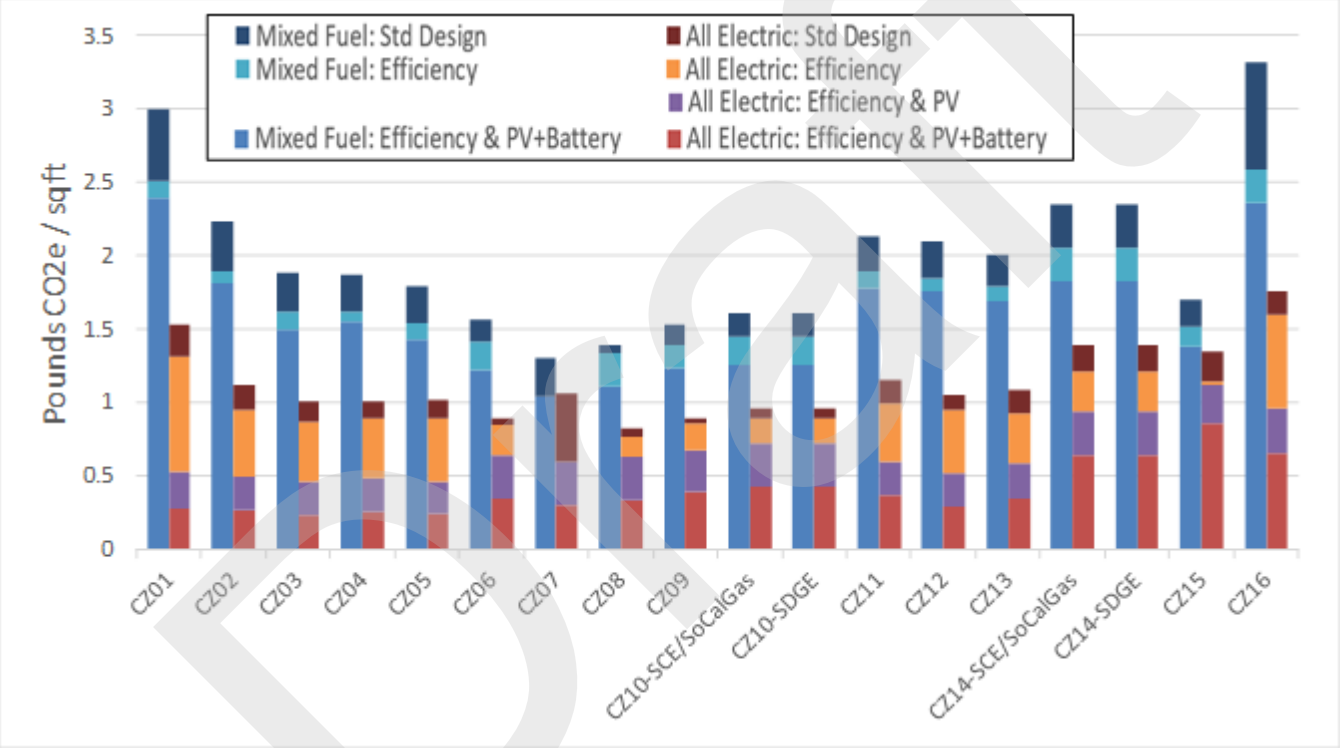

Figure 5: Single family greenhouse gas emissions comparison

3.3 Multifamily Results

Table 10 and Table 11 present the B/C ratios for all the packages according to both the On-Bill and TDV methodologies for the mixed fuel and the all-electric cases, respectively. All the packages are cost-effective based on TDV with the exception of Climate Zone 3 and 5 for the all-electric Efficiency – Non-Preempted Package. Cases where the B/C ratio is indicated as ">1" without a numerical value refer to instances where there are incremental cost savings in addition to annual utility bill savings. In these cases, there is no cost associated with this upgrade and benefits are realized immediately.

It is generally more challenging to achieve equivalent savings targets cost-effectively for the multifamily cases than for the single family cases. With less exterior surface area per floor area the impact of envelope measures

is diminished in multifamily buildings. Ducts are already assumed to be within conditioned space and therefore only one of the duct measures found to be cost-effective in single family homes can be applied.

Figure 6 presents a comparison of Final EDRs for the multifamily cases and Figure 7 presents the EDR reduction results. Each graph compares the mixed fuel and all-electric cases as well as the various packages. Cost-effective efficiency packages were found for all **mixed fuel cases**. The Target EDR reductions for the **mixed fuel Efficiency Package** are 0.5 for Climate Zones 3, 5 and 7, between 1.0 and 2.5 for Climate Zones 1, 2, 4, 6, and 8 through 12 and 16, and between 3.0 and 4.0 in Climate Zones 13 through 15. For the **all-electric case, no cost-effective efficiency packages** were found in Climate Zones 3 and 5. The Target EDR reductions are 0.5 for Climate Zone 7, between 1.0 and 2.5 for Climate Zones 2, 4, 6, 8 through 10, 12, and 16, and between 3.0 and 4.0 in Climate Zones 11 and 13 through 15.

For the **mixed fuel case, the Efficiency & PV/Battery Package** results in an EDR reduction of between 8.5 and 11.5 across all climate zones. None of these packages were found to be cost-effective based on utility bill savings alone, but they all are cost-effective based on TDV energy savings. For the **all-electric case, the Efficiency & PV Package** resulted in EDR reductions of 11 to 17.5 for most climates; adding a battery system increased this an additional 10 to 15 EDR reduction. Climate zones 1 and 16, which have high heating loads, have much higher EDR reductions for the **Efficiency & PV package** (20-23). The Standard Design PV, which is what is applied in the **Efficiency Package**, is not sized to offset any of the heating load. When the PV system is sized to offset 90% of the total electricity use, the increase is substantial as a result. In Climate Zone 15 the Standard Design PV system is already sized to cover the cooling electricity load, which represents 30% of whole building electricity use. Therefore, increasing the PV size to offset 90% of the electric load in this climate only results in adding approximately 230 Watts of PV capacity per apartment and subsequently a much smaller impact on the EDR than in other climate zones. Because of the limitations on oversizing PV systems to offset natural gas use it is not feasible to achieve comparable EDR reductions for the mixed fuel case as in the all-electric case.

Additional results details can be found in Appendix E – Multifamily Detailed Results with summaries of measures included in each of the packages in Appendix F – Multifamily Measure Summaryand package costs in Appendix G – Multifamily Package Costs. A summary of results by climate zone is presented in Appendix H – Results by Climate Zone.

Table 10: Multifamily Package Cost-Effectiveness Results for the Mixed Fuel Case[1,2,3]

Climate Zone	Efficiency							Efficiency & PV/Battery			
	Non-Preempted			Equipment - Preempted			Target				
	EDR Red.	On-Bill B/C Ratio	TDV B/C Ratio	EDR Red.	On-Bill B/C Ratio	TDV B/C Ratio	EDR Red.	EDR Red.	On-Bill B/C Ratio	TDV B/C Ratio	Target EDR Red.
01	3.4	1.2	1.2	2.3	1.4	1.4	2.0	11.6	0.4	1.4	11.5
02	1.8	1.1	1.8	2.3	1.2	1.5	1.5	10.9	0.2	1.8	10.5
03	0.7	1.1	1.1	1.6	1.2	1.2	0.5	10.3	0.1	1.6	10.0
04	1.3	0.8	1.2	2.2	1.0	1.4	1.0	11.1	0.2	1.8	11.0
05	0.6	1.1	1.0	1.6	1.2	1.2	0.5	10.1	0.2	1.6	10.0
06	1.2	0.3	1.5	1.5	1.5	2.1	1.0	10.7	0.0	1.6	10.5
07	0.8	0.8	2.1	1.9	1.1	1.4	0.5	11.0	0.0	1.6	11.0
08	1.5	0.3	1.4	1.6	1.6	2.4	1.5	9.8	0.0	1.5	9.5
09	1.8	0.4	3.4	2.8	1.1	2.9	1.5	9.5	0.0	1.7	9.5
10-SCE/SoCalGas	1.7	0.4	1.7	2.8	1.2	3.2	1.5	10.2	0.0	1.8	10.0
10-SDGE	1.7	1.0	1.7	2.8	2.5	3.2	1.5	10.2	0.3	1.8	10.0
11	2.9	0.7	1.2	3.2	2.0	3.3	2.5	10.5	0.4	1.8	10.5
12	1.9	1.2	2.2	2.8	1.3	2.2	1.5	10.3	0.3	2.0	10.0
13	3.1	0.7	1.3	3.4	2.1	3.7	3.0	10.8	0.4	1.8	10.5
14-SCE/SoCalGas	3.2	0.5	1.2	3.3	1.2	3.0	3.0	9.7	0.2	1.5	9.5
14-SDGE	3.2	0.9	1.2	3.3	2.5	3.0	3.0	9.7	0.6	1.5	9.5
15	4.2	0.1	2.3	4.4	>1	>1	4.0	8.8	0.0	1.9	8.5
16	2.4	1.2	1.2	2.9	1.9	2.2	2.0	9.9	0.6	1.4	9.5

[1]">1" indicates cases where there are both first cost savings and annual utility bill savings.

[2]EDR Red. = EDR Reduction

[3]Information about the measures included for each climate zone are described in Appendix F – Multifamily Measure Summary.

Table 11: Multifamily Package Cost-effectiveness Results for the All-Electric Case[1,2,3]

Climate Zone	Efficiency							Efficiency & PV				Efficiency & PV/Battery			
	Non-Preempted			Equipment - Preempted											
	EDR Red.	On-Bill B/C Ratio	TDV B/C Ratio	EDR Red.	On-Bill B/C Ratio	TDV B/C Ratio	Target EDR Red.	EDR Red.	On-Bill B/C Ratio	TDV B/C Ratio	Target EDR Red.	EDR Red.	On-Bill B/C Ratio	TDV B/C Ratio	Target EDR Red.
01	3.7	1.4	1.4	4.9	2.2	2.2	3.5	23.2	1.9	1.5	23.0	35.8	1.3	1.5	35.5
02	2.0	1.6	2.1	3.4	1.4	1.6	2.0	17.9	2.2	1.8	17.5	31.8	1.3	1.8	31.5
03	n/a	n/a	n/a	3.9	1.5	1.7	n/a	16.5	2.2	1.7	16.5	30.6	1.3	1.7	30.5
04	1.5	1.3	1.6	2.5	1.1	1.2	1.5	15.3	2.2	1.8	15.0	29.6	1.3	1.9	29.5
05	n/a	n/a	n/a	4.9	1.9	2.1	n/a	17.5	2.3	1.8	17.5	31.4	1.4	1.8	31.0
06	1.0	0.5	1.3	2.2	1.3	1.9	1.0	14.1	1.0	1.7	14.0	28.5	0.5	1.7	28.5
07	0.5	0.4	1.4	2.3	1.7	2.0	0.5	13.2	2.1	1.8	13.0	28.1	1.3	1.7	28.0
08	1.2	0.8	1.8	1.7	1.3	1.6	1.0	11.8	0.9	1.8	11.5	25.0	0.4	1.7	25.0
09	2.0	0.4	1.0	1.9	1.4	2.0	1.5	11.7	0.8	1.6	11.5	24.0	0.4	1.6	24.0
10-SCE/SoCalGas	1.8	1.0	1.9	2.0	1.5	2.1	1.5	11.0	1.1	1.8	11.0	23.8	0.5	1.8	23.5
10-SDGE	1.8	1.5	1.9	2.0	2.0	2.1	1.5	11.0	2.0	1.8	11.0	23.8	1.5	1.8	23.5
11	3.6	1.3	1.7	4.3	1.8	2.5	3.5	13.7	2.0	1.8	13.5	25.8	1.4	1.9	25.5
12	2.6	0.8	1.1	3.1	1.4	1.7	2.5	14.7	1.9	1.6	14.5	27.4	1.2	1.8	27.0
13	3.4	1.2	1.6	3.9	1.8	2.3	3.0	12.4	1.9	1.7	12.0	24.5	1.3	1.8	24.5
14-SCE/SoCalGas	3.8	1.1	1.6	3.7	1.4	2.1	3.5	14.2	1.4	1.9	14.0	25.4	0.8	1.9	25.0
14-SDGE	3.8	1.5	1.6	3.7	1.9	2.1	3.5	14.2	2.1	1.9	14.0	25.4	1.8	1.9	25.0
15	4.1	1.4	2.1	6.2	1.1	1.6	4.0	6.8	1.2	2.0	6.5	16.9	0.5	1.9	16.5
16	4.4	1.9	2.1	2.9	1.4	1.5	2.5	20.3	2.3	1.9	20.0	31.0	1.6	1.8	31.0

[1]">1" indicates cases where there are both first cost savings and annual utility bill savings.

[2]EDR Red. = EDR Reduction

[3]Information about the measures included for each climate zone are described in Appendix F – Multifamily Measure Summary.

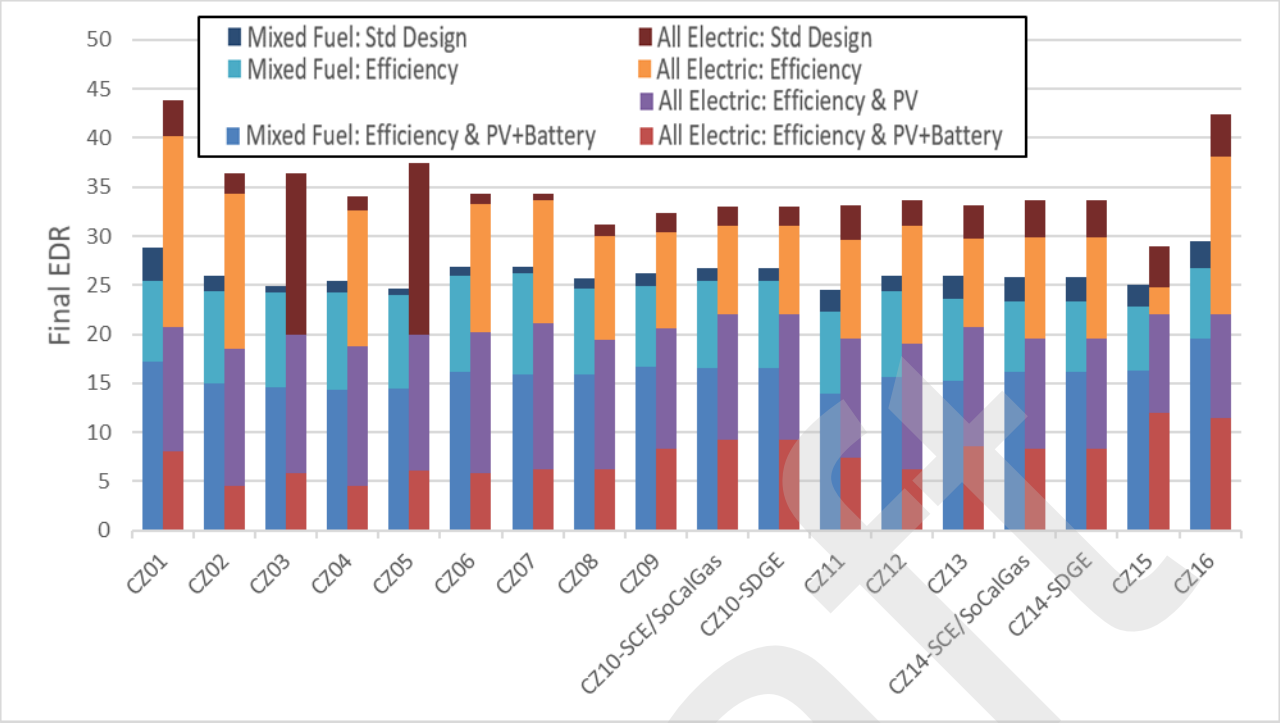

Figure 6: Multifamily Final EDR comparison

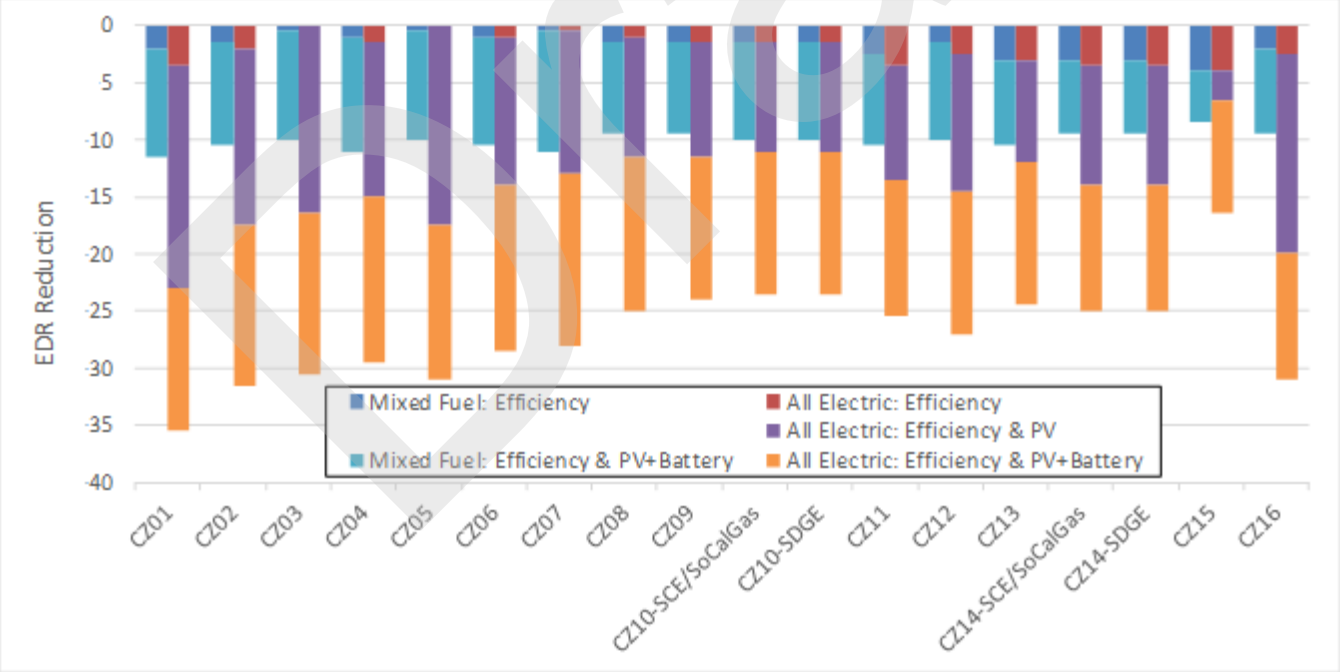

Figure 7: Multifamily EDR reduction comparison

3.3.1 GHG Emission Reductions

Figure 8 compares GHG emissions for both mixed fuel and all-electric multifamily 2019 code compliant cases with Efficiency, Efficiency & PV and Efficiency & PV/Battery packages. GHG emissions vary by climate but are consistently higher in mixed fuel cases than all-electric. Standard design mixed fuel emissions range from 2.1 to 3.5 lbs CO2e/square foot of floor area, where all-electric standard design emissions range from 1.3 to 1.9 lbs CO2e/ ft^2. Adding PV, batteries and efficiency to the mixed fuel code compliant prototype reduces GHG emissions by 17% on average to between 1.7 and 2.2 lbs CO2e/ft^2, with the exception of Climate Zone 16. Adding PV, batteries and efficiency to the all-electric code compliant prototype reduces GHG emissions by 63% on average to 0.7 lbs CO2e/ft^2 or less with the exception of Climate Zones 14, 15 and 16. As in the single family case, none of the cases completely eliminate GHG emissions because of the time value of emissions calculation for electricity in CBECC-Res.

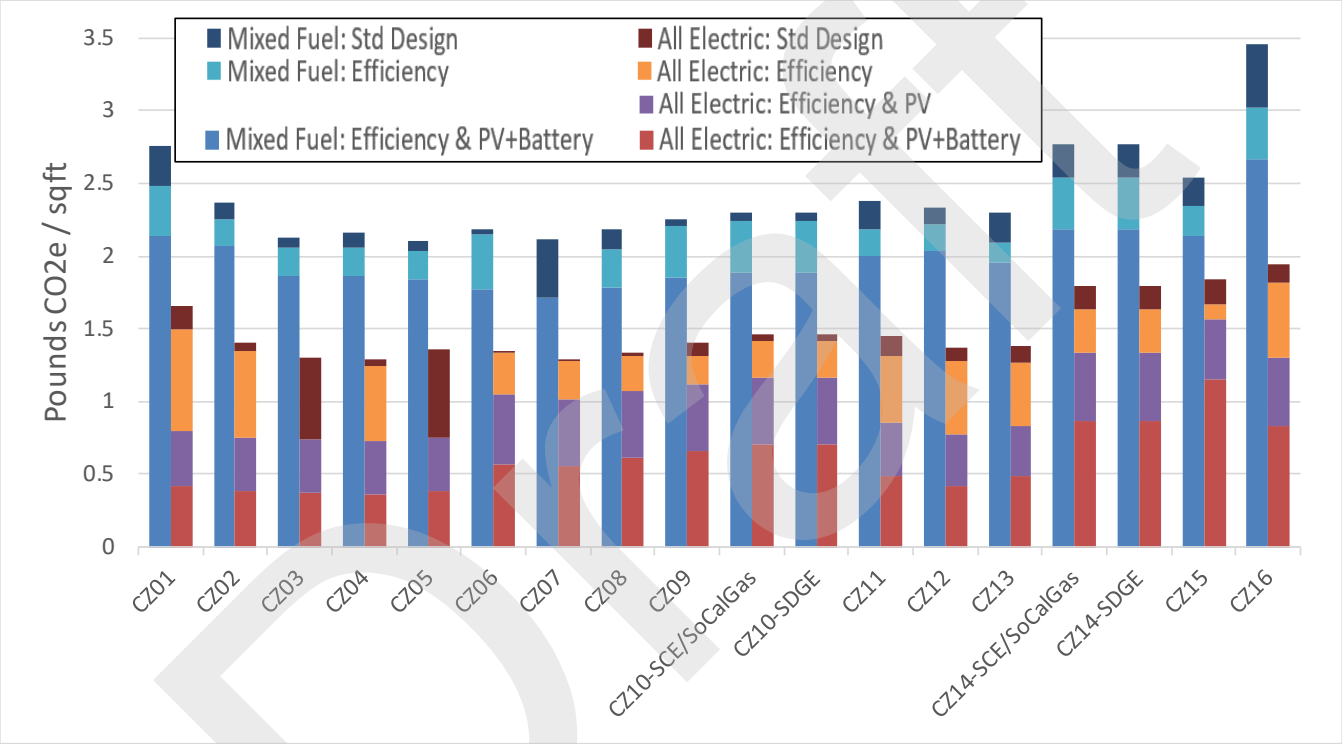

Figure 8: Multifamily greenhouse gas emissions comparison

3.4 Electrification Results

Cost-effectiveness results comparing mixed fuel and all-electric cases are summarized below. The tables show average annual utility bill impacts, lifetime utility bill impacts, which account for fuel escalation of 0.7% for electricity and 2.5% for natural gas (see Section 2.5), lifetime equipment cost savings, and both On-Bill and TDV cost-effectiveness (B/C ratio). Positive utility bill values indicate lower utility costs for the all-electric home relative to the mixed fuel case while negative values in red and parenthesis indicate higher utility costs for the all-electric case. Lifetime equipment cost savings include savings due to eliminating natural gas infrastructure and replacement costs for appliances based on equipment life. Positive values for the lifetime equipment cost savings indicate lower installed costs for the all-electric and negative values indicate higher costs. B/C ratios 1.0 or greater indicate positive cost-effectiveness. Cases where the B/C ratio is indicated as “>1” refer to instances where there was incremental cost savings in addition to annual utility bill savings. In these cases, there is no cost associated with this upgrade and benefits are realized immediately.

Two scenarios were evaluated:

1. 2019 Code Compliant: Compares a 2019 code compliant all-electric home with a 2019 code compliant mixed fuel home.
2. Efficiency & PV Package: Compares an all-electric home with efficiency and PV sized to 90% of the annual electricity use to a 2019 code compliant mixed fuel home. The first cost savings in the code compliant all-electric house is invested in above code efficiency and PV reflective of the Efficiency & PV packages described above.

3.4.1 Single Family

Table 12, Figure 9 and Figure 10 present results of cost-effectiveness analysis for electrification of single family buildings, according to both the On-Bill and TDV methodologies. Based on typical cost assumptions arrived at for this analysis, the lifetime equipment costs for the single family code compliant all-electric option are approximately $5,000 less than the mixed fuel code compliant option. Cost savings are primarily due to the elimination of gas infrastructure. When evaluating cost-effectiveness based on TDV, the Rule 15 50% refund and appliance allowance deduction are not applied and therefore the cost savings are twice as much.

Under the Efficiency & PV Package and the On-Bill analysis, the incremental cost of the efficiency and PV is typically more than the cost savings seen in the code compliant case, which results in a net cost increase in most climate zones for the all-electric case. In climates with small heating loads (7 and 15) there continues to be an incremental cost savings for the all-electric home. With the TDV analysis, there is still an incremental cost savings in all climates except 1 and 16 for single family.

Utility impacts differ by climate zone and utility, but utility costs are typically higher for the code compliant all-electric option while there are utility cost savings across all climates zones and building types for the all-electric Efficiency & PV Package.

The all-electric code compliant option is cost-effective based on the On-Bill approach for single family homes in Climate Zones 6 through 10, 12, 14 (SCE/SoCalGas territory only), and 15. The code compliant option is cost-effective based on the TDV methodology in all climate zones except 1 and 16. The Efficiency & PV all-electric option is cost-effective in all climate zones based on both the On-Bill and TDV methodologies. In many cases it is cost-effective immediately with lower equipment and utility costs.

3.4.2 Multifamily

Multifamily results are found in Table 13, Figure 11 and Figure 12. Lifetime costs for the multifamily code compliant all-electric option are approximately $2,300 less than the mixed fuel code compliant option, primarily due to the elimination of gas infrastructure. When evaluating cost-effectiveness based on TDV, the Rule 15 50% refund and appliance allowance deduction are not applied and therefore the cost savings are approximately 2.5 higher.

With the Efficiency & PV Package and the On-Bill analysis, due to the added cost of the efficiency and PV there is a net cost increase for the all-electric case in all climate zones for except 7, 8, and 15. With the TDV analysis, there is still an incremental cost savings in all climates. Like the single family results, utility costs are typically higher for the code compliant all-electric option but lower than the code compliant mixed fuel option with the Efficiency & PV Package.

The all-electric code compliant option is cost-effective based on the On-Bill approach for multifamily in Climate Zones 6 through 9, 10 and 14 (SCE/SoCalGas territory only), and 15. Based on the TDV methodology, the code compliant option for multifamily is cost-effective for all climate zones except 1. Like the single family cases, the Efficiency & PV all-electric option is cost-effective in all climate zones based on both the On-Bill and TDV methodologies.

Table 12: Single Family Electrification Results vs. a Code Compliant Mixed Fuel Home

	On-Bill Cost-effectiveness Approach[1]						TDV Cost-effectiveness Approach		
	Average Annual Utility Bill Savings			Lifetime	Lifetime		Lifetime	Lifetime	
Climate Zone	Electricity	Natural Gas	Net Utility Savings	Utility Bill Savings	Equipment Cost Savings	On-bill BCR[2]	TDV Cost Savings	Equipment Cost Savings	TDV BCR
2019 Code Compliant Home									
01	-($1,094)	+$782	-($312)	-($9,352)	+$5,349	0.6	-($13,301)	+$11,872	0.9
02	-($753)	+$532	-($222)	-($6,646)	+$5,349	0.8	-($7,589)	+$11,872	1.6
03	-($651)	+$426	-($224)	-($6,732)	+$5,349	0.8	-($7,938)	+$11,872	1.5
04	-($648)	+$424	-($224)	-($6,728)	+$5,349	0.8	-($7,669)	+$11,872	1.5
05	-($669)	+$401	-($268)	-($8,030)	+$5,349	0.7	-($9,061)	+$11,872	1.3
06	-($275)	+$298	+$23	+$683	+$5,349	>1	-($4,915)	+$11,872	2.4
07	-($414)	+$259	-($155)	-($4,655)	+$5,349	1.1	-($4,746)	+$11,872	2.5
08	-($211)	+$257	+$46	+$1,390	+$5,349	>1	-($4,150)	+$11,872	2.9
09	-($242)	+$279	+$38	+$1,128	+$5,349	>1	-($4,648)	+$11,872	2.6
10-SCE/SoCalGas	-($270)	+$289	+$19	+$574	+$5,349	>1	-($5,198)	+$11,872	2.3
10-SDGE	-($492)	+$317	-($175)	-($5,256)	+$5,349	1.0	-($5,198)	+$11,872	2.3
11	-($738)	+$488	-($250)	-($7,510)	+$5,349	0.7	-($7,413)	+$11,872	1.6
12	-($676)	+$498	-($177)	-($5,318)	+$5,349	1.0	-($6,648)	+$11,872	1.8
13	-($677)	+$452	-($226)	-($6,771)	+$5,349	0.8	-($6,586)	+$11,872	1.8
14-SCE/SoCalGas	-($512)	+$425	-($87)	-($2,613)	+$5,349	2.0	-($7,378)	+$11,872	1.6
14-SDGE	-($772)	+$499	-($273)	-($8,187)	+$5,349	0.7	-($7,378)	+$11,872	1.6
15	-($238)	+$200	-($38)	-($1,128)	+$5,349	4.7	-($5,324)	+$11,872	2.2
16	-($1,183)	+$781	-($401)	-($12,042)	+$5,349	0.4	-($17,753)	+$11,872	0.7
Efficiency & PV Package									
01	-($91)	+$782	+$691	+$20,731	-($12,799)	1.6	+$13,290	-($5,146)	2.6
02	-($82)	+$532	+$450	+$13,488	-($6,761)	2.0	+$9,198	+$506	>1
03	-($79)	+$426	+$347	+$10,408	-($3,101)	3.4	+$6,324	+$3,932	>1
04	-($79)	+$424	+$344	+$10,334	-($3,431)	3.0	+$6,607	+$3,621	>1
05	-($90)	+$401	+$311	+$9,332	-($2,867)	3.3	+$5,461	+$4,152	>1
06	-($0)	+$298	+$298	+$8,935	-($952)	9.4	+$4,501	+$5,950	>1
07	-($146)	+$259	+$112	+$3,366	+$908	>1	+$2,102	+$7,693	>1
08	-($0)	+$257	+$257	+$7,705	-($60)	128.7	+$3,840	+$6,789	>1
09	-($0)	+$279	+$279	+$8,381	-($165)	50.9	+$4,584	+$6,690	>1
10-SCE/SoCalGas	+$0	+$289	+$289	+$8,674	-($1,041)	8.3	+$4,399	+$5,873	>1
10-SDGE	-($148)	+$317	+$169	+$5,082	-($1,041)	4.9	+$4,399	+$5,873	>1
11	-($134)	+$488	+$354	+$10,607	-($5,424)	2.0	+$9,293	+$1,764	>1
12	-($85)	+$498	+$413	+$12,391	-($6,187)	2.0	+$9,573	+$1,045	>1
13	-($131)	+$452	+$320	+$9,607	-($5,172)	1.9	+$8,939	+$2,004	>1
14-SCE/SoCalGas	-($0)	+$425	+$425	+$12,742	-($5,116)	2.5	+$9,658	+$2,056	>1
14-SDGE	-($170)	+$499	+$329	+$9,871	-($5,116)	1.9	+$9,658	+$2,056	>1
15	-($54)	+$200	+$146	+$4,380	+$248	>1	+$2,721	+$7,109	>1
16	-($121)	+$781	+$660	+$19,813	-($11,279)	1.8	+$9,426	-($3,731)	2.5

[1]Red values in parentheses indicate an increase in utility bill costs or an incremental first cost for the all-electric home.

[2]">1" indicates cases where there are both first cost savings and annual utility bill savings.

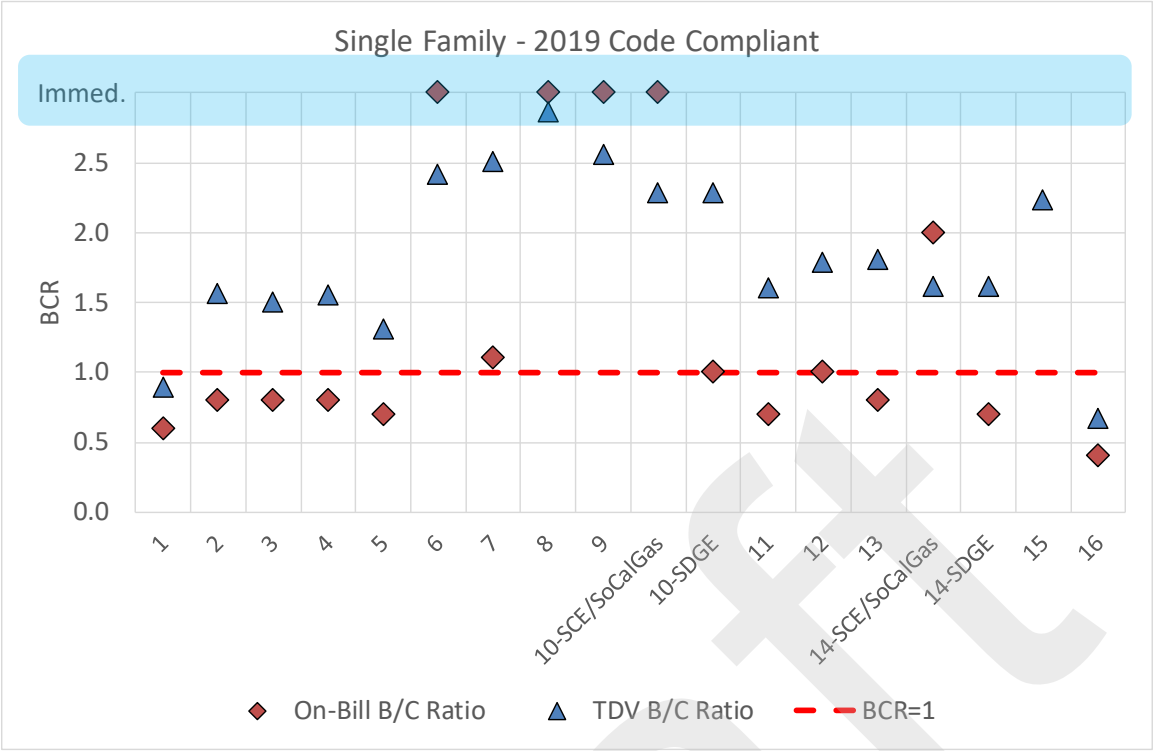

Figure 9: B/C ratio results for a single family all-electric code compliant home versus a mixed fuel code compliant home

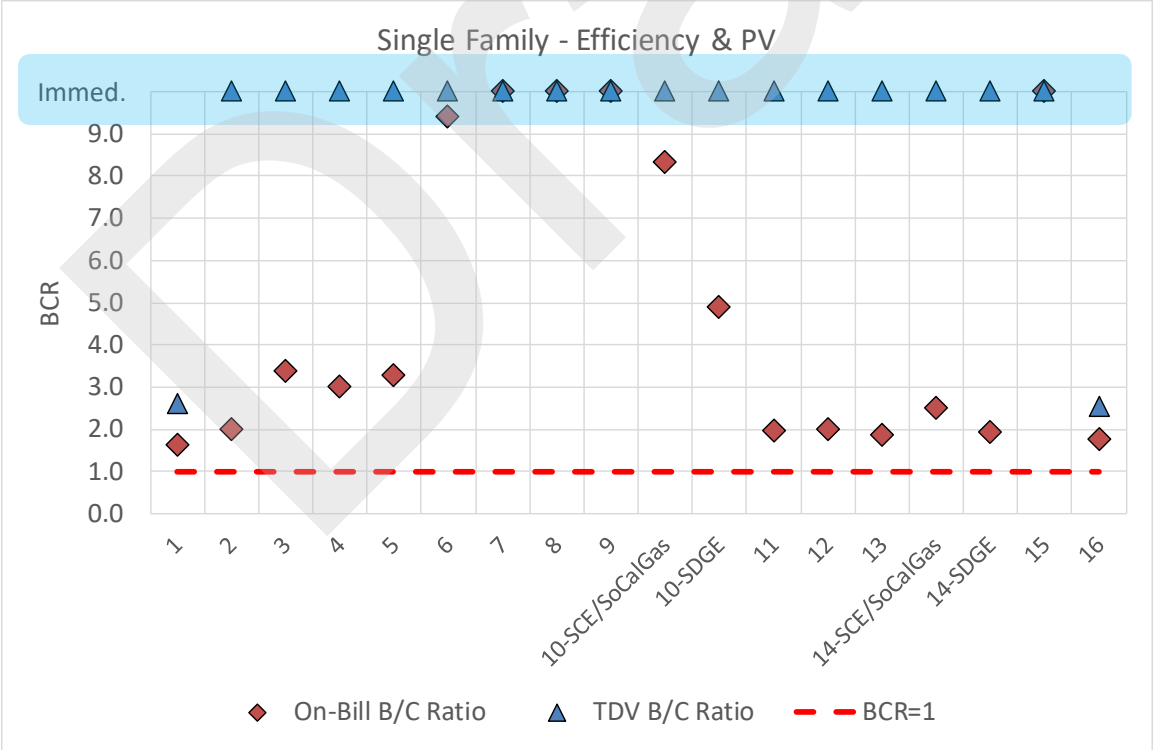

Figure 10: B/C ratio results for the single family Efficiency & PV all-electric home versus a mixed fuel code compliant home

Table 13: Multifamily Electrification Results vs. a Code Compliant Mixed Fuel Building

	On-Bill Cost-effectiveness Approach[1]						TDV Cost-effectiveness Approach		
	Average Annual Utility Bill Savings			Lifetime	Lifetime		Lifetime	Lifetime	
Climate Zone	Electricity	Natural Gas	Net Utility Savings	Utility Bill Savings	Equipment Cost Savings	On-bill BCR[2]	TDV Cost Savings	Equipment Cost Savings	TDV BCR
2019 Code Compliant Home									
01	-($362)	+$211	-($150)	-($4,509)	+$2,337	0.5	-($6,096)	+$5,899	0.97
02	-($281)	+$177	-($105)	-($3,135)	+$2,337	0.7	-($4,320)	+$5,899	1.4
03	-($252)	+$155	-($96)	-($2,883)	+$2,337	0.8	-($4,398)	+$5,899	1.3
04	-($240)	+$157	-($83)	-($2,490)	+$2,337	0.9	-($3,630)	+$5,899	1.6
05	-($270)	+$153	-($117)	-($3,519)	+$2,337	0.7	-($4,910)	+$5,899	1.2
06	-($83)	+$166	+$83	+$2,484	+$2,337	>1	-($2,768)	+$5,899	2.1
07	-($214)	+$145	-($69)	-($2,077)	+$2,337	1.1	-($2,687)	+$5,899	2.2
08	-($65)	+$162	+$96	+$2,891	+$2,337	>1	-($2,274)	+$5,899	2.6
09	-($76)	+$164	+$88	+$2,633	+$2,337	>1	-($2,657)	+$5,899	2.2
10-SCE/SoCalGas	-($84)	+$164	+$80	+$2,402	+$2,337	>1	-($2,816)	+$5,899	2.1
10-SDGE	-($244)	+$148	-($97)	-($2,898)	+$2,337	0.8	-($2,816)	+$5,899	2.1
11	-($265)	+$167	-($98)	-($2,928)	+$2,337	0.8	-($4,520)	+$5,899	1.3
12	-($252)	+$170	-($83)	-($2,483)	+$2,337	0.9	-($3,733)	+$5,899	1.6
13	-($246)	+$160	-($86)	-($2,568)	+$2,337	0.9	-($3,827)	+$5,899	1.5
14-SCE/SoCalGas	-($155)	+$192	+$38	+$1,126	+$2,337	>1	-($3,940)	+$5,899	1.5
14-SDGE	-($327)	+$186	-($142)	-($4,249)	+$2,337	0.5	-($3,940)	+$5,899	1.5
15	-($72)	+$146	+$74	+$2,218	+$2,337	>1	-($2,440)	+$5,899	2.4
16	-($369)	+$245	-($124)	-($3,725)	+$2,337	0.6	-($5,895)	+$5,899	1.0
Efficiency & PV Package									
01	-($21)	+$211	+$190	+$5,710	-($3,175)	1.8	+$2,131	+$713	>1
02	-($13)	+$177	+$164	+$4,924	-($1,320)	3.7	+$2,325	+$2,455	>1
03	-($14)	+$155	+$141	+$4,231	-($888)	4.8	+$1,174	+$2,861	>1
04	-($10)	+$157	+$147	+$4,401	-($786)	5.6	+$2,003	+$2,959	>1
05	-($21)	+$153	+$132	+$3,959	-($917)	4.3	+$1,002	+$2,835	>1
06	+$0	+$166	+$166	+$4,987	-($224)	22.3	+$1,595	+$3,487	>1
07	-($63)	+$145	+$81	+$2,442	+$157	>1	+$1,242	+$3,845	>1
08	-($0)	+$162	+$162	+$4,849	+$119	>1	+$1,666	+$3,811	>1
09	+$0	+$164	+$164	+$4,906	-($354)	13.9	+$1,622	+$3,370	>1
10-SCE/SoCalGas	+$0	+$164	+$164	+$4,928	-($13)	390.9	+$1,352	+$3,688	>1
10-SDGE	-($84)	+$148	+$63	+$1,899	-($13)	150.6	+$1,352	+$3,688	>1
11	-($26)	+$167	+$141	+$4,231	-($1,219)	3.5	+$1,893	+$2,557	>1
12	-($14)	+$170	+$156	+$4,677	-($1,454)	3.2	+$2,482	+$2,335	>1
13	-($27)	+$160	+$133	+$4,003	-($1,083)	3.7	+$1,991	+$2,685	>1
14-SCE/SoCalGas	-($0)	+$192	+$192	+$5,772	-($975)	5.9	+$2,354	+$2,787	>1
14-SDGE	-($97)	+$186	+$89	+$2,667	-($975)	2.7	+$2,354	+$2,787	>1
15	-($0)	+$146	+$146	+$4,385	+$539	>1	+$1,111	+$4,214	>1
16	-($25)	+$245	+$220	+$6,600	-($2,061)	3.2	+$2,437	+$1,762	>1

[1]Red values in parentheses indicate an increase in utility bill costs or an incremental first cost for the all-electric home.

[2]">1" indicates cases where there are both first cost savings and annual utility bill savings.

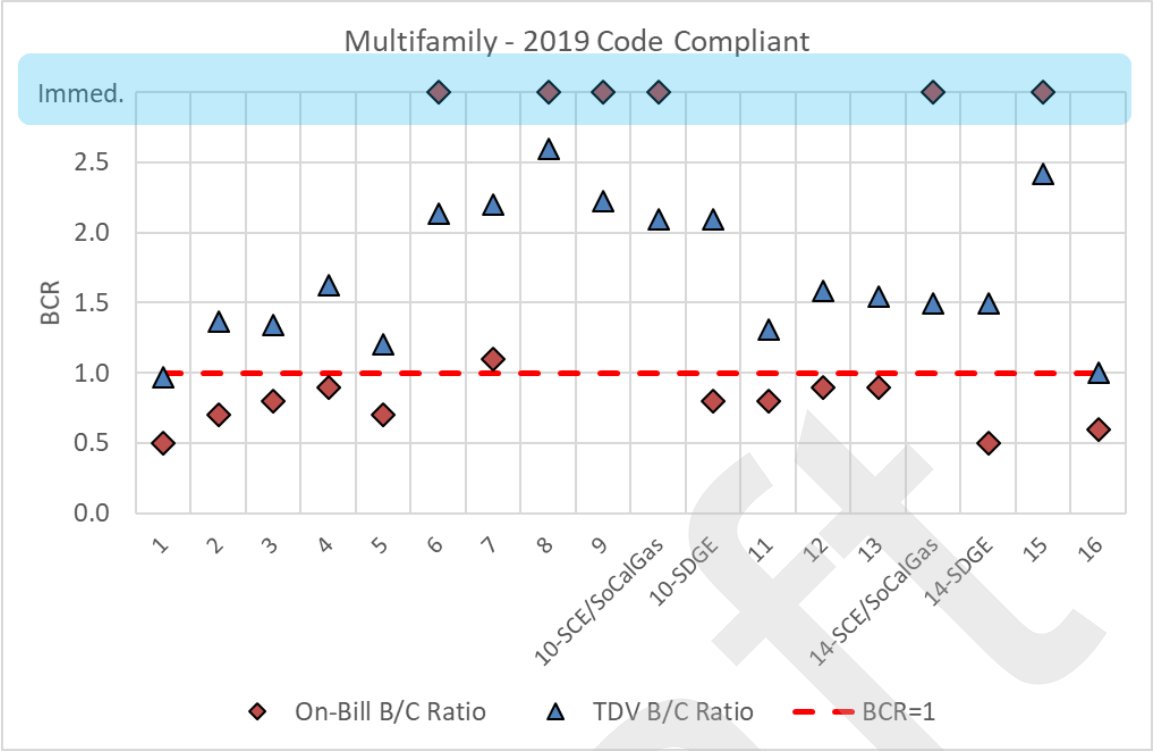

Figure 11: B/C ratio results for a multifamily all-electric code compliant home versus a mixed fuel code compliant home

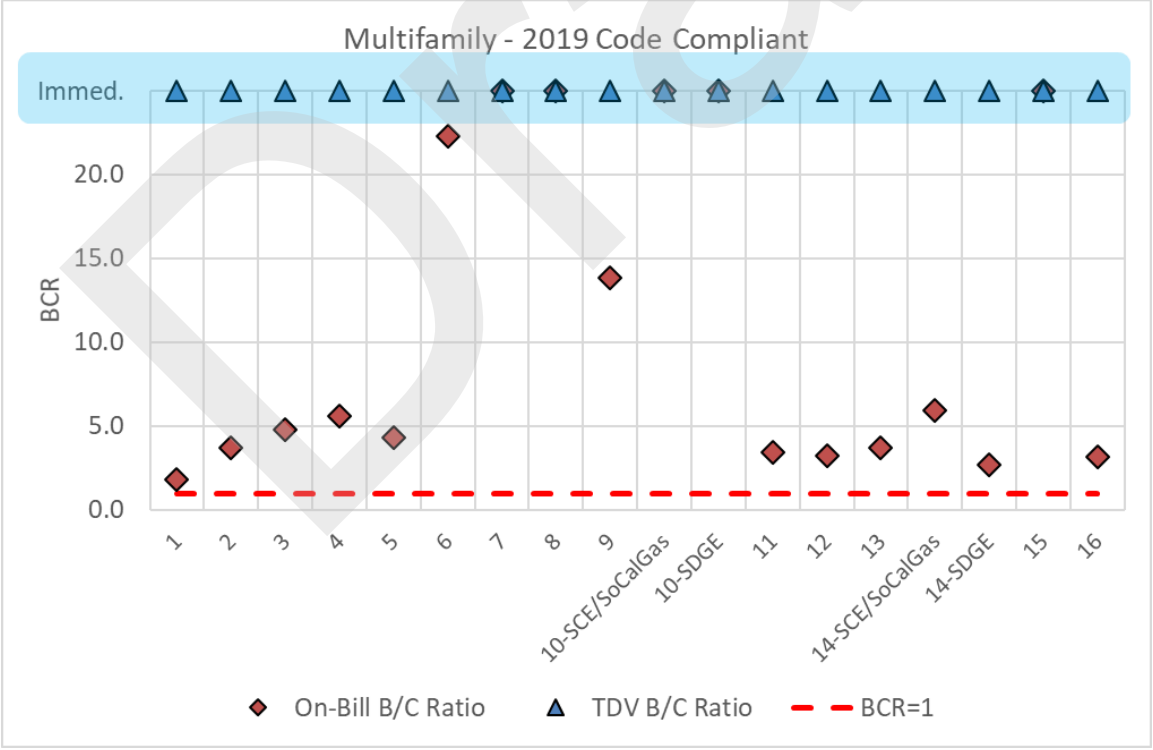

Figure 12: B/C ratio results for the multifamily Efficiency & PV all-electric home versus a mixed fuel code compliant home

4 Conclusions & Summary

This report evaluated the feasibility and cost-effectiveness of "above code" performance specifications through the application of efficiency measures, PV, and electric battery storage in all 16 California climate zones. The analysis found cost-effective packages across the state for both single family and low-rise multifamily buildings. For the building types and climate zones where cost-effective packages were identified, the results of this analysis can be used by local jurisdictions to support the adoption of reach codes. Cost-effectiveness was evaluated according to two metrics: On-Bill customer lifecycle benefit-to-cost and TDV lifecycle benefit-to-cost. While all the above code targets presented are based on packages that are cost-effective under at least one of these metrics, they are not all cost-effective under both metrics. Generally, the test for being cost-effective under the TDV methodology is less challenging than under the On-Bill methodology. Therefore, all packages presented are cost-effective based on TDV, and may or may not be cost-effective based on the On-Bill method. It is up to each jurisdiction to determine what metric is most appropriate for their application. A summary of results by climate zone are presented in Appendix H – Results by Climate Zone.

Above code targets are presented as a reduction in EDR. Target EDR reductions have been defined for each scenario where a cost-effective package was identified. For the Efficiency Package the Target EDR reduction was defined based on the lower EDR reduction of the Efficiency – Non-Preempted Package and the Efficiency – Equipment, Preempted Package. For example, if for a particular case the cost-effective Non-Preempted package has an EDR reduction of 3 and the Preempted package an EDR reduction of 4, the Target EDR reduction is set at 3.

For the mixed fuel Efficiency packages the average incremental cost for$2,900. Efficiency & PV Package average incremental cost is $8,600 and for the Efficiency & PV/Battery Package it is approximately $13,700. The incremental costs for each multifamily apartment are approximately 40% lower. See Appendix D – Single Family Package Costs and Appendix G – Multifamily Package Costs for a summary of package costs by case.

Table 14 and Table 15 summarize the maximum Target EDR reductions determined to be cost effective for each package for single family and multifamily, respectively. Cases labeled as “n/a” in the tables indicate where no cost-effective package was identified under either On-Bill or TDV methodology.

Table 14: Summary of Single-Family Target EDR Reductions

Climate Zone	Mixed Fuel		All-Electric		
	Efficiency	Efficiency & PV/Battery	Efficiency	Efficiency & PV	Efficiency & PV/Battery
01	**5.0**	**10.5**	**6.5**	**32.0**	**41.5**
02	**3.0**	**10.0**	**4.5**	**19.5**	**30.0**
03	**2.5**	**10.0**	**4.0**	**18.5**	**29.5**
04	**2.5**	**10.0**	**3.0**	**17.0**	**28.5**
05	**2.5**	**9.0**	**4.0**	**18.0**	**29.0**
06	**1.5**	**9.5**	**2.0**	**14.0**	**26.5**
07	**n/a**	**9.0**	**n/a**	**11.0**	**24.0**
08	**1.0**	**8.0**	**1.5**	**11.0**	**21.5**
09	**2.5**	**8.5**	**2.5**	**11.0**	**21.0**
10-SCE/SoCalGas	**3.0**	**9.5**	**3.0**	**11.0**	**21.0**
10-SDGE	**3.0**	**9.5**	**3.0**	**11.0**	**21.0**
11	**4.0**	**9.0**	**4.5**	**14.0**	**23.5**
12	**3.0**	**9.5**	**3.5**	**16.0**	**26.0**
13	**4.5**	**9.5**	**5.0**	**13.5**	**22.5**
14-SCE/SoCalGas	**4.5**	**9.0**	**5.5**	**15.5**	**24.0**
14-SDGE	**4.5**	**9.0**	**5.5**	**15.5**	**24.0**
15	**4.5**	**7.0**	**5.5**	**6.0**	**13.5**
16	**5.5**	**10.5**	**4.5**	**27.5**	**36.0**

Table 15: Summary of Multifamily Target EDR Reductions

Climate Zone	Mixed Fuel		All-Electric		
	Efficiency	Efficiency & PV/Battery	Efficiency	Efficiency & PV	Efficiency & PV/Battery
01	2.0	11.5	3.5	23.0	35.5
02	1.5	10.5	2.0	17.5	31.5
03	0.5	10.0	**n/a**	16.5	30.5
04	1.0	11.0	1.5	15.0	29.5
05	0.5	10.0	**n/a**	17.5	31.0
06	1.0	10.5	1.0	14.0	28.5
07	0.5	11.0	0.5	13.0	28.0
08	1.5	9.5	1.0	11.5	25.0
09	1.5	9.5	1.5	11.5	24.0
10-SCE/SoCalGas	1.5	10.0	1.5	11.0	23.5
10-SDGE	1.5	10.0	1.5	11.0	23.5
11	2.5	10.5	3.5	13.5	25.5
12	1.5	10.0	2.5	14.5	27.0
13	3.0	10.5	3.0	12.0	24.5
14-SCE/SoCalGas	3.0	9.5	3.5	14.0	25.0
14-SDGE	3.0	9.5	3.5	14.0	25.0
15	4.0	8.5	4.0	6.5	16.5
16	2.0	9.5	2.5	20.0	31.0

This analysis also looked at the GHG emissions impacts of the various packages. An all-electric design reduces GHG emissions 40-50% in most cases relative to a comparable mixed fuel design.

There is significant interest throughout California on electrification of new buildings. The Reach Code Team assembled data on the cost differences between a code compliant mixed fuel building and a code compliant all-electric building. Based on lifetime equipment cost savings (the difference in first cost for equipment and infrastructure combined with incremental replacement costs) of $5,349 for an all-electric home this analysis found that from a customer on-bill perspective, the all-electric code compliant option is cost-effective in Climates Zones 6 through 10, 12, 14 (SCE/SoCalGas territory only), and 15, and cost-effective in all climate zones except 1 and 16 based on TDV. For multifamily buildings, based on a cost savings of $2,337 per apartment, the code compliant option is cost-effective in Climates Zones 6 through 9, 10 & 14 (SCE/SoCalGas territory only), and 15, and cost-effective in all climates except Climate Zone 1 based on TDV.

Adding efficiency and PV to the code compliant all-electric buildings, the Efficiency & PV Package is cost-effective when compared to a mixed fuel code compliant building in all climate zones for both single family and multifamily buildings based on both the On-Bill and TDV methodologies. The Efficiency & PV package adds PV to offset 90% of the electricity use of the home. While this may result in higher installed costs for the package, the reduced lifetime utility costs are larger ($0 to $6,000 lifetime incremental equipment costs in many climates for single family homes and an associated $4,500 to $13,500 lifetime utility cost savings across the same cases), resulting in positive B/C ratios for all cases.

Other studies have shown that cost-effectiveness of electrification increases with high efficiency space conditioning and water heating equipment in the all-electric home. This was not directly evaluated in this analysis but based on the favorable cost-effectiveness results of the Equipment, Preempted package for the individual mixed fuel and all-electric upgrades it's expected that applying similar packages to the electrification analysis would result in increased cost-effectiveness.

The Reach Code Team found there can be substantial variability in first costs, particularly related to natural gas infrastructure. Costs are very project dependent and will be impacted by such factors as site characteristics, distance to the nearest gas main, joint trenching, whether work is conducted by the utility or a private contractor, and number of homes per development among other things. While the best cost data available to the Reach Code Team was applied in this analysis, it is recognized that individual projects may experience different costs, either higher or lower than the estimates presented here.

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Appendix A – Utility Tariff Details

Following are the PG&E electricity and natural gas tariffs applied in this study. The PG&E monthly gas rate in $/therm was applied on a monthly basis for the 12-month period ending January 2018.

Pacific Gas and Electric Company

U 39 San Francisco, California

Cancelling Revised Cal. P.U.C. Sheet No. 43533-E
Revised Cal. P.U.C. Sheet No. 42728-E

ELECTRIC SCHEDULE E-TOU Sheet 4
RESIDENTIAL TIME-OF-USE SERVICE

RATES:
(Cont'd.)

OPTION B TOTAL RATES

Total Energy Rates ($ per kWh)	PEAK		OFF-PEAK	
Summer (all usage)	$0.37188	(R)	$0.26882	(R)
Winter (all usage)	$0.23441	(R)	$0.21561	(R)

Delivery Minimum Bill Amount ($ per meter per day) $0.32854

California Climate Credit (per household, per semi-annual payment occurring in the April and October bill cycles) ($39.42)

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

UNBUNDLING OF OPTION B TOTAL RATES

Generation	PEAK	OFF-PEAK
Summer (all usage)	$0.21238	$0.10932
Winter (all usage)	$0.10554	$0.08674
Distribution**		
Summer (all usage)	$0.10716 (R)	$0.10716 (R)
Winter (all usage)	$0.07653 (R)	$0.07653 (R)

Transmission* (all usage)	$0.02469 (R)
Transmission Rate Adjustments* (all usage)	$0.00214
Reliability Services* (all usage)	$0.00260
Public Purpose Programs (all usage)	$0.01413
Nuclear Decommissioning (all usage)	$0.00020
Competition Transition Charges (all usage)	$0.00132
Energy Cost Recovery Amount (all usage)	($0.00005)
DWR Bond (all usage)	$0.00503 (R)
New System Generation Charge (all usage)**	$0.00228

* Transmission, Transmission Rate Adjustments and Reliability Service charges are combined for presentation on customer bills.
** Distribution and New System Generation Charges are combined for presentation on customer bills.
*** This same assignment of revenues applies to direct access and community choice aggregation customers.

(Continued)

Advice 5444-E | Issued by | Submitted December 18, 2018
Decision 18-08-013 | Robert S. Kenney, Vice President, Regulatory Affairs | Effective January 1, 2019
Resolution

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

Revised *Cal. P.U.C. Sheet No.* 34735-G
Cancelling Revised *Cal. P.U.C. Sheet No.* 34691-G

GAS SCHEDULE G-1 Sheet 1
RESIDENTIAL SERVICE

APPLICABILITY: This rate schedule[1] applies to natural gas service to Core End-Use Customers on PG&E's Transmission and/or Distribution Systems. To qualify, service must be to individually-metered single family premises for residential use, including those in a multifamily complex, and to separately-metered common areas in a multifamily complex where Schedules GM, GS, or GT are not applicable. Common area accounts that are separately metered by PG&E have an option of switching to a core commercial rate schedule. Common area accounts are those accounts that provide gas service to common use areas as defined in Rule 1.

Per D.15-10-032 and D.18-03-017, transportation rates include GHG Compliance Cost for non-covered entities. Customers who are directly billed by the Air Resources Board (ARB), i.e., covered entities, are exempt from paying AB 32 GHG Compliance Costs through PG&E's rates.[2] A "Cap-and-Trade Cost Exemption" credit for these costs will be shown as a line item on exempt customers' bills.[3, 4]

TERRITORY: Schedule G-1 applies everywhere within PG&E's natural gas Service Territory.

RATES: Customers on this schedule pay a Procurement Charge and a Transportation Charge, per meter, as shown below. The Transportation Charge will be no less than the Minimum Transportation Charge, as follows:

	Per Day			
Minimum Transportation Charge:[5]	$0.09863			
	Per Therm			
	Baseline		Excess	
Procurement:	$0.43394	(I)	$0.43394	(I)
Transportation Charge:	$0.99414	(I)	$1.59063	(I)
Total:	$1.42808	(I)	$2.02457	(I)
California Natural Gas Climate Credit (per Household, annual payment occurring in October 2018 bill cycle, and thereafter in the April bill cycle)	($25.45)	(I)		

Public Purpose Program Surcharge:
Customers served under this schedule are subject to a gas Public Purpose Program (PPP) Surcharge under Schedule G-PPPS.

See Preliminary Statement, Part B for the Default Tariff Rate Components.

The Procurement Charge on this schedule is equivalent to the rate shown on informational Schedule G-CP—Gas Procurement Service to Core End-Use Customers.

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1 PG&E's gas tariffs are available online at www.pge.com.
2 Covered entities are not exempt from paying costs associated with LUAF Gas and Gas used by Company Facilities.
3 The exemption credit will be equal to the effective non-exempt AB 32 GHG Compliance Cost Rate ($ per therm) included in Preliminary Statement – Part B, multiplied by the customer's billed volumes (therms) for each billing period.
4 PG&E will update its billing system annually to reflect newly exempt or newly excluded customers to conform with lists of Directly Billed Customers provided annually by the ARB.
5 The Minimum Transportation charge does not apply to submetered tenants of master-metered customers served under gas rate Schedules GS and GT.

(Continued)

Advice	4052-G	*Issued by*	*Submitted*	December 21, 2018
Decision	97-10-065 & 98-07-025	***Robert S. Kenney*** *Vice President, Regulatory Affairs*	*Effective* *Resolution*	January 1, 2019

Pacific Gas and Electric Company

Residential Non-CARE and CARE Gas Tariff Rates
January 1, 2018, to Present
($/therm)[1/]

Effective Date	Advice Letter Number	Minimum Transportation Charge[2/] (per day)	Procurement Charge	Transportation Charge[2/]		TOTAL Residential Non-CARE Schedules Charge[3/] (Non-CARE)	
				Baseline	Excess	Baseline	Excess
01/01/18	3918-G	$0.09863	$0.37310	$0.91828	$1.46925	$1.29138	$1.84235
02/01/18	3931-G	$0.09863	$0.40635	$0.91828	$1.46925	$1.32463	$1.87560
03/01/18	3941-G	$0.09863	$0.32103	$0.91828	$1.46925	$1.23931	$1.79028
04/01/18	3959-G	$0.09863	$0.34783	$0.91828	$1.46925	$1.26611	$1.81708
05/01/18	3969-G	$0.09863	$0.26995	$0.91828	$1.46925	$1.18823	$1.73920
06/01/18	3980-G	$0.09863	$0.21571	$0.91828	$1.46925	$1.13399	$1.68496
07/01/18	3984-G	$0.09863	$0.22488	$0.93438	$1.49502	$1.15926	$1.71990
08/01/18	3995-G	$0.09863	$0.28814	$0.93438	$1.49502	$1.22252	$1.78316
09/01/18	4008-G	$0.09863	$0.25597	$0.93438	$1.49502	$1.19035	$1.75099
10/01/18	4018-G	$0.09863	$0.27383	$0.93438	$1.49502	$1.20821	$1.76885
11/01/18	4034-G	$0.09863	$0.35368	$0.93438	$1.49502	$1.28806	$1.84870
12/01/18	4046-G	$0.09863	$0.42932	$0.93438	$1.49502	$1.36370	$1.92434
01/01/19	4052-G	$0.09863	$0.43394[7/]	$0.99414	$1.59063	$1.42808	$2.02457

[1/] Unless otherwise noted
[2/] Effective July 1, 2005, the Transportation Charge will be no less than the Minimum Transportation Charge of $0.09863 (per day). Applicable to Rate Schedule G-1 only and does not apply to submetered tenants of master-metered customers served under gas Rate Schedule GS and GT.
[3/] Schedule G-PPPS (Public Purpose Program Surcharge) needs to be added to the TOTAL Non-CARE Charge and TOTAL CARE Charge for bill calculation. See Schedule G-PPPS for details and exempt customers.
[4/] CARE Schedules include California Solar Initiative (CSI) Exemption in accordance with Advice Letter 3257-G-A.
[5/] Per dwelling unit per day (Multifamily Service)
[6/] Per installed space per day (Mobilehome Park Service)
[7/] This procurement rate includes a charge of $0.03686 per therm to reflect account balance amortizations in accordance with Advice Letter 3157-G.
[8/] **Residential bill credit of ($29.85) per household, annual bill credit occurring in the October 2018 bill cycle, thereafter in the April bill cycle.**
Seasons: **Winter** = Nov-Mar **Summer** = April-Oct

Following are the SCE electricity tariffs applied in this study.

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

Southern California Edison — Revised Cal. PUC Sheet No. 65364-E
Rosemead, California (U 338-E) — Cancelling Revised Cal. PUC Sheet No. 64934-E

Schedule TOU-D-T — Sheet 2
TIME-OF-USE TIERED DOMESTIC

(Continued)

RATES

	Delivery Service Total[1]	Generation[2] UG***	Generation[2] DWREC[3]
Energy Charge - $/kWh/Meter/Day			
Summer Season - On-Peak			
Level I (up to 130% of Baseline)	0.11830 (R)	0.25286	(0.00007) (R)
Level II (More than 130% of Baseline)	0.16030 (R)	0.25286	(0.00007) (R)
Summer Season - Off-Peak			
Level I (up to 130% of Baseline)	0.11830 (R)	0.06514	(0.00007) (R)
Level II (More than 130% of Baseline)	0.16030 (R)	0.06514	(0.00007) (R)
Winter Season - On-Peak			
Level I (up to 130% of Baseline)	0.11830 (R)	0.13286	(0.00007) (R)
Level II (More than 130% of Baseline)	0.16030 (R)	0.13286	(0.00007) (R)
Winter Season - Off-Peak			
Level I (up to 130% of Baseline)	0.11830 (R)	0.05805	(0.00007) (R)
Level II (More than 130% of Baseline)	0.16030 (R)	0.05805	(0.00007) (R)
Basic Charge - $/Meter/Day			
Single-Family Accommodation	0.031		
Multi-Family Accommodation	0.024		
Minimum Charge* - $/Meter/Day			
Single-Family Accommodation	0.346 (I)		
Multi-Family Accommodation	0.346 (I)		
Minimum Charge (Medical Baseline)* - $/Meter/Day			
Single-Family Accommodation	0.173 (I)		
Multi-Family Accommodation	0.173 (I)		
California Climate Credit[4]	(36.00)		
California Alternate Rates for Energy Discount - %	100.00**		

* The Minimum Charge is applicable when the Delivery Service Energy Charge, minus the DWRBC, plus the applicable Basic Charge is less than the Minimum Charge. The difference between these two amounts is the Balance of Minimum Charge and is included on a customer's bill.
** Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.
*** The ongoing Competition Transition Charge (CTC) of $0.00075 per kWh is recovered in the UG component of Generation.
1 Total = Total Delivery Service rates are applicable to Bundled Service, Direct Access (DA) and Community Choice Aggregation Service (CCA Service) Customers, except DA and CCA Service Customers are not subject to the DWRBC rate component of this Schedule but instead pay the DWRBC as provided by Schedule DA-CRS or Schedule CCA-CRS
2 Generation = The Gen rates are applicable only to Bundled Service Customers.
3 DWREC = Department of Water Resources (DWR) Energy Credit – For more information on the DWR Energy Credit, see the Billing Calculation Special Condition of this Schedule.
4 Applied on an equal basis, per household, semi-annually. See the Special Conditions of this Schedule for more information.

(Continued)

(To be inserted by utility)
Advice 3896-E-A
Decision
2C6

Issued by
Caroline Choi
Senior Vice President

(To be inserted by Cal. PUC)
Date Submitted Dec 17, 2018
Effective Jan 1, 2019
Resolution

Following are the SoCalGas natural gas tariffs applied in this study.

SOUTHERN CALIFORNIA GAS COMPANY Revised CAL. P.U.C. SHEET NO. 55854-G
LOS ANGELES, CALIFORNIA CANCELING Revised CAL. P.U.C. SHEET NO. 55828-G

Schedule No. GR Sheet 1
RESIDENTIAL SERVICE
(Includes GR, GR-C and GT-R Rates)

APPLICABILITY

The GR rate is applicable to natural gas procurement service to individually metered residential customers.

The GR-C, cross-over rate, is a core procurement option for individually metered residential core transportation customers with annual consumption over 50,000 therms, as set forth in Special Condition 10.

The GT-R rate is applicable to Core Aggregation Transportation (CAT) service to individually metered residential customers, as set forth in Special Condition 11.

The California Alternate Rates for Energy (CARE) discount of 20%, reflected as a separate line item on the bill, is applicable to income-qualified households that meet the requirements for the CARE program as set forth in Schedule No. G-CARE.

TERRITORY

Applicable throughout the service territory.

RATES	GR	GR-C	GT-R	
Customer Charge, per meter per day:	16.438¢	16.438¢	16.438¢	
For "Space Heating Only" customers, a daily Customer Charge applies during the winter period from November 1 through April 30[1/]:	33.149¢	33.149¢	33.149¢	
Baseline Rate, per therm (baseline usage defined in Special Conditions 3 and 4):				
Procurement Charge: [2/]	41.589¢	42.676¢	N/A	R
Transmission Charge:	63.566¢	63.566¢	63.566¢	
Total Baseline Charge:	105.155¢	106.242¢	63.566¢	R
Non-Baseline Rate, per therm (usage in excess of baseline usage):				
Procurement Charge: [2/]	41.589¢	42.676¢	N/A	R
Transmission Charge:	96.806¢	96.806¢	96.806¢	
Total Non-Baseline Charge:	138.395¢	139.482¢	96.806¢	R

[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.

(Footnotes continue next page.)

(Continued)

(TO BE INSERTED BY UTILITY)
ADVICE LETTER NO. 5410
DECISION NO.
1C5

ISSUED BY
Dan Skopec
Vice President
Regulatory Affairs

(TO BE INSERTED BY CAL. PUC)
SUBMITTED Jan 7, 2019
EFFECTIVE Jan 10, 2019
RESOLUTION NO. G-3351

Following are the SDG&E electricity and natural gas tariffs applied in this study.

SDGE

San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 31320-E

Canceling Revised Cal. P.U.C. Sheet No. 31103-E

Sheet 2

SCHEDULE TOU-DR1

RESIDENTIAL TIME-OF-USE

RATES

Total Rates:

Description – TOU DR1	UDC Total Rate		DWR-BC Rate		EECC Rate + DWR Credit		Total Rate	
Summer:								
On-Peak	0.29562	R	0.00503	R	0.35013	R	0.65078	R
Off-Peak	0.29562	R	0.00503	R	0.11235	R	0.41300	R
Super Off-Peak	0.29562	R	0.00503	R	0.05739	R	0.35804	R
Winter:								
On-Peak	0.32037	R	0.00503	R	0.07618	R	0.40158	R
Off-Peak	0.32037	R	0.00503	R	0.06762	R	0.39302	R
Super Off-Peak	0.32037	R	0.00503	R	0.05812	R	0.38352	R
Summer Baseline Adjustment Credit up to 130% of Baseline	(0.19921)	I					(0.19921)	I
Winter Baseline Adjustment Credit up to 130% of Baseline	(0.16853)	I					(0.16853)	I
Minimum Bill ($/day)	0.329						0.329	

Description – TOU DR1	UDC Total Rate		DWR-BC Rate		EECC Rate + DWR Credit		Total Rate		Total Effective Care Rate	
Summer – CARE Rates:										
On-Peak	0.29494	R	0.00000		0.35013	R	0.64507	R	0.41628	R
Off-Peak	0.29494	R	0.00000		0.11235	R	0.40729	R	0.26077	R
Super Off-Peak	0.29494	R	0.00000		0.05739	R	0.35233	R	0.22483	R
Winter – CARE Rates:										
On-Peak	0.31969	R	0.00000		0.07618	R	0.39587	R	0.25330	R
Off-Peak	0.31969	R	0.00000		0.06762	R	0.38731	R	0.24770	R
Super Off-Peak	0.31969	R	0.00000		0.05812	R	0.37781	R	0.24149	R
Summer Baseline Adjustment Credit up to 130% of Baseline	(0.19921)	I					(0.19921)	I	(0.13028)	I
Winter Baseline Adjustment Credit up to 130% of Baseline	(0.16853)	I					(0.16853)	I	(0.11022)	I
Minimum Bill ($/day)	0.164						0.164		0.164	

Note:
(1) Total Rates consist of UDC, Schedule DWR-BC (Department of Water Resources Bond Charge), and Schedule EECC (Electric Energy Commodity Cost) rates, with the EECC rates reflecting a DWR Credit.
(2) Total Rates presented are for customers that receive commodity supply and delivery service from Utility.
(3) DWR-BC charges do not apply to CARE customers.
(4) As identified in the rates tables, customer bills will also include line-item summer and winter credits for usage up to 130% of baseline to provide the rate capping benefits adopted by Assembly Bill 1X and Senate Bill 695.

(Continued)

2C11

Issued by
Dan Skopec
Vice President
Regulatory Affairs

Submitted Dec 28, 2018
Effective Jan 1, 2019
Resolution No.

Advice Ltr. No. 3326-E
Decision No.

SDGE
San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 23614-G
Canceling Revised Cal. P.U.C. Sheet No. 23601-G

Sheet 1

SCHEDULE GR

RESIDENTIAL NATURAL GAS SERVICE
(Includes Rates for GR, GR-C, GTC/GTCA)

APPLICABILITY

The GR rate is applicable to natural gas procurement service for individually metered residential customers.

The GR-C, cross-over rate, is a core procurement option for individually metered residential core transportation customers with annual consumption over 50,000 therms, as set forth in Special Condition 10.

The GTC/GTCA rate is applicable to intrastate gas transportation-only services to individually metered residential customers, as set forth in Special Condition 11.

Customers taking service under this schedule may be eligible for a 20% California Alternate Rate for Energy (CARE) program discount, reflected as a separate line item on the bill, if they qualify to receive service under the terms and conditions of Schedule G-CARE.

TERRITORY

Within the entire territory served natural gas by the utility.

RATES

	GR	GR-C		GTC/GTCA[1/]
Baseline Rate, per therm (baseline usage defined in Special Conditions 3 and 4):				
Procurement Charge:[2/]	$0.41614	$0.41614	R	N/A
Transmission Charge:	$1.01230	$1.01230		$1.01230
Total Baseline Charge:	$1.42844	$1.42844	R	$1.01230
Non-Baseline Rate, per therm (usage in excess of baseline usage):				
Procurement Charge: [2/]	$0.41614	$0.41614	R	N/A
Transmission Charge:	$1.19980	$1.19980		$1.19980
Total Non-Baseline Charge:	$1.61594	$1.61594	R	$1.19980
Minimum Bill, per day: [3/]				
Non-CARE customers:	$0.09863	$0.09863		$0.09863
CARE customers:	$0.07890	$0.07890		$0.07890

1/ The rates for core transportation-only customers, with the exception of customers taking service under Schedule GT-NGV, include any FERC Settlement Proceeds Memorandum Account (FSPMA) credit adjustments.
2/ This charge is applicable to Utility Procurement Customers and includes the GPC and GPC-A Procurement Charges shown in Schedule GPC which are subject to change monthly as set forth in Special Condition 7.
3/ Effective starting May 1, 2017, the minimum bill is calculated as the minimum bill charge of $0.09863 per day times the number of days in the billing cycle (approximately $3 per month) with a 20% discount applied for CARE customer resulting in a minimum bill charge of $0.07890 per day (approximately $2.40 per month).

(Continued)

1C5
Advice Ltr. No. 2735-G
Decision No.

Issued by
Dan Skopec
Vice President
Regulatory Affairs

Submitted Jan 7, 2019
Effective Jan 10, 2019
Resolution No.

Appendix B – Single Family Detailed Results

Table 16: Single Family Mixed Fuel Efficiency Package Cost-Effectiveness Results

Climate Zone	BASECASE					Non-Preempted								Equipment - Preempted							
	Final EDR	Efficiency EDR	CALGreen Tier 1 EDR Target	lbs CO2 per sqft	PV kW	Final EDR	Efficiency EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio	Final EDR	Efficiency EDR	EDR Red,	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio
01	32.8	54.6	23	3.0	3.3	28.1	49.3	5.3	19.2%	2.5	3.2	5.1	2.9	26.3	47.6	7.0	25.4%	2.3	3.2	5.5	4.2
02	25.0	45.9	12	2.2	2.8	22.0	42.6	3.3	16.6%	1.9	2.8	1.8	1.7	21.9	42.7	3.2	16.4%	1.9	2.8	4.1	3.6
03	24.0	46.8	10	1.9	2.7	21.2	43.9	2.9	17.0%	1.6	2.7	1.4	1.3	20.2	42.8	4.0	23.0%	1.5	2.7	2.1	2.0
04	22.9	44.4	8	1.9	2.7	20.6	41.9	2.5	14.2%	1.7	2.7	1.0	1.2	20.3	41.8	2.6	15.1%	1.6	2.7	2.6	2.7
05	22.2	44.3	10	1.8	2.6	19.7	41.6	2.7	17.0%	1.6	2.5	1.2	1.2	19.8	41.8	2.5	16.3%	1.5	2.5	2.5	2.5
06	23.5	50.1	10	1.6	2.7	21.6	48.0	2.1	12.5%	1.5	2.7	0.6	1.2	21.6	48.1	2.0	11.7%	1.4	2.7	1.6	2.0
07	20.4	49.2	5	1.3	2.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	19.0	47.8	1.4	12.4%	1.2	2.6	1.6	1.4
08	21.5	47.2	10	1.4	2.9	20.3	45.9	1.3	7.7%	1.3	2.9	0.4	1.4	20.0	45.7	1.5	9.3%	1.3	2.9	1.3	1.8
09	24.5	47.9	13	1.5	2.9	22.2	45.3	2.6	12.0%	1.5	2.9	0.4	2.0	21.9	45.0	2.9	13.4%	1.4	2.9	1.4	3.6
10-SCE/SCG	25.1	47.1	10	1.6	3.0	22.3	43.9	3.2	14.8%	1.5	3.0	0.4	1.4	22.3	43.9	3.2	14.6%	1.4	3.0	1.5	4.0
10-SDGE	25.1	47.1	10	1.6	3.0	22.3	43.9	3.2	14.8%	1.5	3.0	0.8	1.4	22.3	43.9	3.2	14.6%	1.4	3.0	2.7	4.0
11	24.6	45.1	11	2.1	3.6	21.3	40.7	4.4	16.7%	1.9	3.4	0.8	1.2	20.7	40.1	5.0	19.1%	1.8	3.4	2.6	3.6
12	26.1	45.5	12	2.1	3.0	22.9	41.9	3.6	15.1%	1.9	2.9	1.3	1.9	23.0	42.1	3.4	14.4%	1.9	3.0	3.6	4.7
13	25.9	46.7	11	2.0	3.8	22.3	42.0	4.7	17.2%	1.8	3.6	0.8	1.3	21.2	40.8	5.9	21.6%	1.7	3.6	5.7	8.6
14-SCE/SCG	25.6	46.5	15	2.3	3.2	21.8	41.6	4.9	18.2%	2.1	3.0	1.0	2.4	20.9	40.7	5.8	21.8%	2.0	3.0	2.7	6.2
14-SDGE	25.6	46.5	15	2.3	3.2	21.8	41.6	4.9	18.2%	2.1	3.0	1.9	2.4	20.9	40.7	5.8	21.8%	2.0	3.0	5.0	6.2
15	22.2	48.9	11	1.7	5.4	19.4	44.0	4.9	15.1%	1.6	5.0	0.1	1.6	19.4	44.0	4.9	15.2%	1.5	5.0	>1	>1
16	30.7	49.2	22	3.3	2.7	25.2	43.7	5.5	20.8%	2.6	2.7	1.8	1.5	25.0	43.0	6.2	23.7%	2.7	2.6	2.4	2.2

">1" = indicates cases where there is both first cost savings and annual utility bill savings.
EDR Red. = EDR Reduction.

Table 17: Single Family Mixed Fuel Efficiency & PV/Battery Package Cost-Effectiveness Results

Climate Zone	BASECASE				Efficiency & PV/Battery						
	Final EDR	CALGreen Tier 1 EDR Target	lbs CO2 per sqft	PV kW	Final EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio
01	32.8	23	3.0	3.3	22.1	10.7	32.2%	2.4	3.3	1.2	1.8
02	25.0	12	2.2	2.8	14.9	10.1	27.6%	1.8	2.9	0.7	1.7
03	24.0	10	1.9	2.7	13.9	10.1	29.0%	1.5	2.8	0.6	1.5
04	22.9	8	1.9	2.7	12.8	10.1	25.2%	1.5	2.8	0.5	1.6
05	22.2	10	1.8	2.6	12.8	9.4	30.0%	1.4	2.6	0.6	1.5
06	23.5	10	1.6	2.7	13.6	9.9	21.5%	1.2	2.8	0.3	1.4
07	20.4	5	1.3	2.6	11.1	9.3	9.0%	1.0	2.7	0.3	1.5
08	21.5	10	1.4	2.9	13.1	8.4	23.7%	1.1	3.0	0.2	1.5
09	24.5	13	1.5	2.9	15.6	8.9	25.0%	1.2	3.0	0.2	1.7
10-SCE/SoCalGas	25.1	10	1.6	3.0	15.1	10.0	26.8%	1.3	3.1	0.1	1.7
10-SDGE	25.1	10	1.6	3.0	15.1	10.0	26.8%	1.3	3.1	0.7	1.7
11	24.6	11	2.1	3.6	15.2	9.4	29.7%	1.8	3.5	0.4	1.6
12	26.1	12	2.1	3.0	16.3	9.8	29.1%	1.8	3.0	0.6	1.9
13	25.9	11	2.0	3.8	16.1	9.8	29.2%	1.7	3.7	0.6	1.7
14-SCE/SoCalGas	25.6	15	2.3	3.2	16.5	9.1	30.2%	1.8	3.1	0.5	1.9
14-SDGE	25.6	15	2.3	3.2	16.5	9.1	30.2%	1.8	3.1	1.5	1.9
15	22.2	11	1.7	5.4	15.0	7.2	25.5%	1.4	5.1	0.2	1.7
16	30.7	22	3.3	2.7	20.0	10.7	33.8%	2.4	2.8	1.0	1.5

">1" = indicates cases where there is both first cost savings and annual utility bill savings.
EDR Red. = EDR Reduction.

Table 18: Single Family All-Electric Efficiency Package Cost-Effectiveness Results

Climate Zone	BASECASE					Non-Preempted								Equipment - Preempted							
	Final EDR	Efficiency EDR	CALGreen Tier 1 EDR Target	lbs CO2 per sqft	PV kW	Final EDR	Efficiency EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio	Final EDR	Efficiency EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio
01	48.1	69.7	36	1.5	3.3	32.6	54.2	15.5	40.5%	1.0	3.3	1.7	1.7	41.3	63.0	6.7	17.9%	1.3	3.3	2.6	2.7
02	33.5	54.5	16	1.1	2.8	28.5	49.5	5.0	20.5%	0.9	2.8	1.1	1.1	28.4	49.5	5.0	20.8%	0.9	2.8	2.0	2.1
03	33.9	56.7	14	1.0	2.7	29.1	51.9	4.8	20.9%	0.8	2.7	2.4	2.4	29.5	52.4	4.3	19.1%	0.9	2.7	1.5	1.6
04	31.6	53.2	12	1.0	2.7	28.2	49.8	3.4	15.7%	0.9	2.7	1.8	1.9	28.0	49.6	3.6	16.4%	0.9	2.7	1.3	1.4
05	33.2	55.4	16	1.0	2.6	28.7	50.8	4.6	20.1%	0.9	2.6	2.4	2.4	28.9	51.1	4.3	19.2%	0.9	2.6	1.5	1.6
06	30.4	56.7	12	0.9	2.7	28.2	54.5	2.2	11.6%	0.8	2.7	1.0	1.5	27.8	54.1	2.6	13.8%	0.8	2.7	1.4	2.0
07	27.6	56.0	7	0.8	2.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	25.7	54.2	1.8	13.8%	0.7	2.6	1.5	1.4
08	26.8	52.4	10	0.8	2.9	25.2	50.8	1.6	9.0%	0.8	2.9	0.4	1.2	25.2	50.9	1.5	8.7%	0.8	2.9	1.8	2.7
09	29.8	53.0	13	0.9	2.9	27.2	50.5	2.5	11.5%	0.9	2.9	0.8	2.3	26.5	49.8	3.2	14.3%	0.8	2.9	1.4	3.1
10-SCE/SCG	30.8	53.0	11	1.0	3.0	27.6	49.8	3.2	13.6%	0.9	3.0	0.7	1.5	27.2	49.4	3.6	15.4%	0.9	3.0	1.6	3.2
10-SDGE	30.8	53.0	11	1.0	3.0	27.6	49.8	3.2	13.6%	0.9	3.0	1.1	1.5	27.2	49.4	3.6	15.4%	0.9	3.0	2.4	3.2
11	30.5	51.0	12	1.2	3.6	25.8	46.3	4.7	16.5%	1.0	3.6	1.2	1.5	25.0	45.5	5.5	19.4%	0.9	3.6	2.6	3.0
12	32.2	51.7	13	1.1	3.0	28.3	47.8	3.9	15.3%	0.9	3.0	0.7	1.1	27.3	46.8	4.9	19.0%	0.9	3.0	1.8	2.3
13	31.2	52.1	13	1.1	3.8	26.0	46.9	5.2	17.7%	0.9	3.8	1.0	1.4	25.3	46.2	5.9	20.2%	0.9	3.8	2.6	3.2
14-SCE/SCG	32.0	53.1	16	1.4	3.2	26.4	47.4	5.7	18.9%	1.2	3.2	0.9	1.5	25.9	47.0	6.1	20.3%	1.2	3.2	2.1	3.1
14-SDGE	32.0	53.1	16	1.4	3.2	26.4	47.4	5.7	18.9%	1.2	3.2	1.3	1.5	25.9	47.0	6.1	20.3%	1.2	3.2	2.8	3.1
15	26.0	52.8	8	1.3	5.4	20.4	47.1	5.7	17.0%	1.1	5.4	1.0	1.6	18.7	45.4	7.4	22.1%	1.1	5.4	2.9	4.5
16	47.8	66.1	39	1.8	2.7	37.8	56.0	10.1	25.5%	1.4	2.7	1.6	1.7	43.1	61.4	4.7	11.9%	1.6	2.7	2.1	2.2

">1" = indicates cases where there is both first cost savings and annual utility bill savings.
EDR Red. = EDR Reduction.

Table 19: Single Family All-Electric Efficiency & PV-PV/Battery Package Cost-Effectiveness Results

Climate Zone	BASECASE				Efficiency & PV							Efficiency & PV/Battery						
	Final EDR	CALGreen Tier 1 EDR Target	lbs CO2 per sqft	PV kW	Final EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio	Final EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio
01	48.1	36	1.5	3.3	16.0	32.1	40.5%	0.5	6.0	1.7	1.5	6.1	42.0	52.0%	0.3	6.75	1.4	1.4
02	33.5	16	1.1	2.8	13.8	19.7	20.5%	0.5	4.9	1.7	1.4	3.0	30.5	20.5%	0.3	5.52	1.3	1.5
03	33.9	14	1.0	2.7	15.2	18.7	20.9%	0.5	4.5	2.0	1.7	4.0	29.9	32.9%	0.2	5.08	1.4	1.6
04	31.6	12	1.0	2.7	14.4	17.2	15.7%	0.5	4.5	1.9	1.6	2.9	28.7	26.7%	0.3	5.15	1.4	1.7
05	33.2	16	1.0	2.6	14.8	18.4	20.1%	0.5	4.3	2.1	1.8	4.1	29.1	33.1%	0.2	4.82	1.5	1.7
06	30.4	12	0.9	2.7	15.9	14.5	11.6%	0.6	4.1	1.3	1.5	3.8	26.6	20.6%	0.3	4.66	0.7	1.5
07	27.6	7	0.8	2.6	16.2	11.4	0.6%	0.6	3.7	1.8	1.5	3.1	24.5	0.6%	0.3	4.21	1.3	1.6
08	26.8	10	0.8	2.9	15.6	11.2	9.0%	0.6	4.0	1.2	1.5	4.8	22.0	25.0%	0.3	4.56	0.6	1.5
09	29.8	13	0.9	2.9	18.4	11.4	11.5%	0.7	4.1	1.3	1.7	8.5	21.3	24.5%	0.4	4.66	0.7	1.6
10-SCE/SoCalGas	30.8	11	1.0	3.0	19.5	11.3	13.6%	0.7	4.2	1.3	1.5	9.3	21.5	13.6%	0.4	4.78	0.7	1.6
10-SDGE	30.8	11	1.0	3.0	19.5	11.3	13.6%	0.7	4.2	1.6	1.5	9.3	21.5	13.6%	0.4	4.78	1.5	1.6
11	30.5	12	1.2	3.6	16.1	14.4	16.5%	0.6	5.4	1.7	1.6	6.9	23.6	16.5%	0.4	6.10	1.4	1.7
12	32.2	13	1.1	3.0	16.1	16.1	15.3%	0.5	5.0	1.5	1.4	6.2	26.0	15.3%	0.3	5.63	1.2	1.5
13	31.2	13	1.1	3.8	17.6	13.6	17.7%	0.6	5.4	1.6	1.5	8.4	22.8	17.7%	0.3	6.15	1.3	1.6
14-SCE/SoCalGas	32.0	16	1.4	3.2	16.3	15.7	18.9%	0.9	4.8	1.5	1.6	7.8	24.2	18.9%	0.6	5.39	1.0	1.7
14-SDGE	32.0	16	1.4	3.2	16.3	15.7	18.9%	0.9	4.8	1.7	1.6	7.8	24.2	18.9%	0.6	5.39	1.7	1.7
15	26.0	8	1.3	5.4	19.8	6.2	17.0%	1.1	5.5	1.1	1.6	12.4	13.6	17.0%	0.9	6.26	0.7	1.6
16	47.8	39	1.8	2.7	20.2	27.6	25.5%	1.0	5.5	1.9	1.6	11.6	36.2	34.6%	0.7	6.19	1.6	1.6

">1" = indicates cases where there is both first cost savings and annual utility bill savings.
EDR Red. = EDR Reduction.

Appendix C – Single Family Measure Summary

Table 20: Single Family Mixed Fuel Efficiency – Non-Preempted Package Measure Summary

CZ	Duct	Infiltratio	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
2	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
3	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
4	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
5	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
6	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
7	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Max PV
8	< 12 ft ducts in attic	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
9	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
10	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
11	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
12	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
13	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
14	VLLDCS	3 ACH50	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
15	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
16	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	Max PV

VVLDCS – Verified Low Leakage Ducts in Conditioned Space

Table 21: Single Family Mixed Fuel Efficiency – Equipment, Preempted Package Measure Summary

CZ	Duct	Infiltratio	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	96 AFUE, 0.35W/cfm	Max PV
2	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	96 AFUE, 0.35W/cfm	Max PV
3	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	96 AFUE, 0.35W/cfm	Max PV
4	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	96 AFUE, 0.35W/cfm	Max PV
5	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	96 AFUE, 0.35W/cfm	Max PV
6	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	92 AFUE, 0.35W/cfm	Max PV
7	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	92 AFUE, 0.35W/cfm	Max PV
8	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	92 AFUE, 0.35W/cfm	Max PV
9	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
10	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
11	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	18 SEER, 96 AFUE, 0.35W/cfm	Max PV
12	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
13	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
14	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
15	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
16	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	18 SEER, 96 AFUE, 0.35W/cfm	Max PV

LLAHU - Low Leakage Air Handling Unit
VVLDCS – Verified Low Leakage Ducts in Conditioned Space

Table 22: Single Family Mixed Fuel Efficiency & PV/Battery Package Measure Summary

CZ	Duct	Infiltratio	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
2	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
3	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
4	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
5	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
6	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
7	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Basic CHW credit (0.7)	Code Min	1.0 PV scaling + 5 batt
8	< 12 ft ducts in attic	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
9	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
10	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
11	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
12	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
13	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
14	VLLDCS	3 ACH50	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
15	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt
16	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 5 batt

VVLDCS – Verified Low Leakage Ducts in Conditioned Space

Table 23: Single Family All-Electric Efficiency – Non-Preempted Package Measure Summary

CZ	Duct	Infiltratio	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	Code Min	0.24/0.50 windows	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
2	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
3	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
4	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
5	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
6	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	Std Design PV
7	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Std Design PV
8	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	Std Design PV
9	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	Std Design PV
10	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
11	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
12	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
13	VLLDCS	3 ACH50	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
14	VLLDCS	3 ACH50	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
15	VLLDCS	Code Min	0.043 wall	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
16	VLLDCS	3 ACH50	Code Min	R-38 + R-30 attic	Code Min	0.24/0.50 windows	Code Min	Code Min	0.45 W/cfm	Std Design PV

VVLDCS – Verified Low Leakage Ducts in Conditioned Space

Table 24: Single Family All-Electric Efficiency – Equipment, Preempted Package Measure Summary

CZ	Duct	Infiltratio	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
2	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
3	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
4	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
5	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
6	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
7	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
8	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	0.45 W/cfm	Std Design PV
9	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
10	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
11	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
12	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
13	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
14	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
15	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
16	LLAHU + 2% leakage	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV

LLAHU - Low Leakage Air Handling Unit

VVLDCS – Verified Low Leakage Ducts in Conditioned Space

Table 25: Single Family All-Electric Efficiency & PV Package Measure Summary

CZ	Duct	Infiltratio	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	Code Min	0.24/0.50 windows	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
2	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
3	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
4	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
5	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
6	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	0.9 PV scaling
7	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	0.9 PV scaling
8	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	0.9 PV scaling
9	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	0.9 PV scaling
10	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
11	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
12	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
13	VLLDCS	3 ACH50	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
14	VLLDCS	3 ACH50	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
15	VLLDCS	Code Min	0.043 wall (	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
16	VLLDCS	3 ACH50	Code Min	R-38 + R-30 attic	Code Min	0.24/0.50 windows	Code Min	Code Min	0.45 W/cfm	0.9 PV scaling

VVLDCS – Verified Low Leakage Ducts in Conditioned Space

Table 26: Single Family All-Electric Efficiency & PV/Battery Package Measure Summary

CZ	Duct	Infiltratio	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	Code Min	0.24/0.50 windows	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
2	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
3	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
4	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
5	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
6	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
7	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
8	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
9	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
10	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
11	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
12	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
13	VLLDCS	3 ACH50	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
14	VLLDCS	3 ACH50	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
15	VLLDCS	Code Min	0.043 wall	R-38 + R-30 attic	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt
16	VLLDCS	3 ACH50	Code Min	R-38 + R-30 attic	Code Min	0.24/0.50 windows	Code Min	Code Min	0.45 W/cfm	1.0 PV scaling + 5 batt

VVLDCS – Verified Low Leakage Ducts in Conditioned Space

Appendix D – Single Family Package Costs

Table 27: Single Family Package Cost Summary

Climate Zone	Mixed Fuel			All-Electric			
	Efficiency-Non-Preempted	Efficiency-Equipment, Preempted	Efficiency & PV/Battery	Efficiency-Non-Preempted	Efficiency-Equipment, Preempted	Efficiency & PV	Efficiency & PV/Battery
CZ01	+$1,259	+$1,197	+$4,489	+$7,130	+$1,996	+$17,018	+$22,711
CZ02	+$1,401	+$683	+$4,569	+$3,679	+$1,996	+$11,366	+$16,546
CZ03	+$1,448	+$1,358	+$4,612	+$1,417	+$1,996	+$7,940	+$12,959
CZ04	+$1,451	+$716	+$4,608	+$1,417	+$1,996	+$8,251	+$13,289
CZ05	+$1,465	+$728	+$4,608	+$1,417	+$1,996	+$7,720	+$12,622
CZ06	+$936	+$550	+$4,101	+$864	+$801	+$5,922	+$10,786
CZ07	n/a	+$573	+$3,298	n/a	+$801	+$4,179	+$8,863
CZ08	+$543	+$555	+$3,707	+$864	+$389	+$5,083	+$9,906
CZ09	+$845	+$542	+$3,998	+$864	+$801	+$5,182	+$10,032
CZ10-SCE/SoCalGas	+$1,535	+$559	+$4,689	+$1,654	+$897	+$5,999	+$10,894
CZ10-SDGE	+$1,535	+$559	+$4,689	+$1,654	+$897	+$5,999	+$10,894
CZ11	+$2,909	+$1,153	+$6,070	+$3,485	+$1,996	+$10,108	+$15,494
CZ12	+$1,565	+$618	+$4,732	+$3,485	+$1,996	+$10,827	+$16,046
CZ13	+$2,838	+$560	+$6,011	+$3,876	+$1,996	+$9,868	+$15,282
CZ14-SCE/SoCalGas	+$1,565	+$743	+$4,685	+$3,876	+$1,996	+$9,816	+$14,910
CZ14-SDGE	+$1,565	+$743	+$4,685	+$3,876	+$1,996	+$9,816	+$14,910
CZ15	+$1,993	-($875)	+$5,137	+$4,303	+$1,996	+$4,763	+$10,201
CZ16	+$3,301	+$2,290	+$6,439	+$5,347	+$1,996	+$15,603	+$21,005
Average	+$1,656	+$736	+$4,729	+$2,895	+$1,586	+$8,637	+$13,741
Min	+$3,301	+$2,290	+$6,439	+$7,130	+$1,996	+$17,018	+$22,711
Max	+$543	-($875)	+$3,298	+$864	+$389	+$4,179	+$8,863

Appendix E – Multifamily Detailed Results

Table 28: Multifamily Mixed Fuel Efficiency Package Cost-Effectiveness Results

Climate Zone	BASECASE					Non-Preempted								Equipment - Preempted							
	Final EDR	Efficiency EDR	CALGreen Tier 1 EDR Target	lbs CO2 per sqft	PV kW	Final EDR	Efficiency EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio	Final EDR	Efficiency EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio
01	28.8	60.7	23	2.8	15.9	25.4	57.3	3.4	19.2%	2.3	16.0	1.2	1.2	26.6	58.4	2.3	12.3%	2.5	15.9	1.4	1.4
02	25.9	56.5	12	2.4	13.9	24.4	54.7	1.8	10.0%	2.3	13.8	1.1	1.8	23.8	54.2	2.3	12.6%	2.2	13.9	1.2	1.5
03	24.9	57.9	10	2.1	13.5	24.3	57.2	0.7	4.7%	2.1	13.5	1.1	1.1	23.4	56.3	1.6	11.2%	1.9	13.5	1.2	1.2
04	25.4	56.4	8	2.2	13.6	24.3	55.1	1.3	7.6%	2.1	13.5	0.8	1.2	23.4	54.2	2.2	12.5%	2.0	13.5	1.0	1.4
05	24.6	57.8	10	2.1	12.6	24.0	57.2	0.6	4.4%	2.0	12.6	1.1	1.0	23.0	56.2	1.6	11.2%	1.9	12.6	1.2	1.2
06	26.9	63.0	10	2.2	13.9	25.9	61.8	1.2	7.0%	2.1	13.8	0.3	1.5	25.4	61.5	1.5	8.9%	2.0	13.9	1.5	2.1
07	26.9	64.3	5	2.1	13.2	26.2	63.5	0.8	5.1%	2.1	13.1	0.8	2.1	25.1	62.4	1.9	12.2%	2.0	13.2	1.1	1.4
08	25.7	61.5	10	2.2	14.6	24.6	60.0	1.5	7.3%	2.1	14.5	0.3	1.4	24.3	59.9	1.6	7.8%	2.0	14.6	1.6	2.4
09	26.2	59.1	13	2.2	14.7	24.9	57.3	1.8	8.3%	2.2	14.4	0.4	3.4	23.9	56.3	2.8	13.0%	2.1	14.4	1.1	2.9
10-SCE/SCG	26.7	58.1	10	2.3	15.1	25.4	56.4	1.7	7.7%	2.2	14.9	0.4	1.7	24.5	55.3	2.8	12.9%	2.1	14.8	1.2	3.2
10-SDGE	26.7	58.1	10	2.3	15.1	25.4	56.4	1.7	7.7%	2.2	14.9	1.0	1.7	24.5	55.3	2.8	12.9%	2.1	14.8	2.5	3.2
11	24.5	54.2	11	2.4	16.7	22.3	51.3	2.9	12.0%	2.2	16.3	0.7	1.2	22.2	51.0	3.2	13.2%	2.2	16.2	2.0	3.3
12	26.0	55.4	12	2.3	15.0	24.4	53.5	1.9	8.7%	2.2	14.8	1.2	2.2	23.6	52.6	2.8	12.8%	2.1	14.7	1.3	2.2
13	26.0	55.8	11	2.3	17.5	23.6	52.7	3.1	12.2%	2.1	17.1	0.7	1.3	23.6	52.4	3.4	13.2%	2.1	17.0	2.1	3.7
14-SCE/SCG	25.8	56.1	15	2.8	14.6	23.3	52.9	3.2	12.8%	2.5	14.3	0.5	1.2	23.4	52.8	3.3	13.2%	2.5	14.2	1.2	3.0
14-SDGE	25.8	56.1	15	2.8	14.6	23.3	52.9	3.2	12.8%	2.5	14.3	0.9	1.2	23.4	52.8	3.3	13.2%	2.5	14.2	2.5	3.0
15	25.1	59.2	11	2.5	21.7	22.8	55.0	4.2	12.9%	2.4	20.5	0.1	2.3	22.7	54.8	4.4	13.6%	2.3	20.4	>1	>1
16	29.5	57.2	22	3.5	13.4	26.7	54.8	2.4	11.3%	3.0	13.7	1.2	1.2	27.0	54.3	2.9	13.1%	3.1	13.3	1.9	2.2

">1" = indicates cases where there is both first cost savings and annual utility bill savings.
EDR Red. = EDR Reduction.

Table 29: Multifamily Mixed Fuel Efficiency & PV/Battery Package Cost-Effectiveness Results

Climate Zone	BASECASE				Efficiency & PV/Battery						
	Final EDR	CALGreen Tier 1 EDR Target	lbs CO2 per sqft	PV kW	Final EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio
01	28.8	23	2.8	15.9	17.2	11.6	28.2%	2.1	16.5	0.4	1.4
02	25.9	12	2.4	13.9	15.0	10.9	16.0%	2.1	14.3	0.2	1.8
03	24.9	10	2.1	13.5	14.6	10.3	9.7%	1.9	13.9	0.1	1.6
04	25.4	8	2.2	13.6	14.3	11.1	14.6%	1.9	13.9	0.2	1.8
05	24.6	10	2.1	12.6	14.5	10.1	8.4%	1.8	13.1	0.2	1.6
06	26.9	10	2.2	13.9	16.2	10.7	10.0%	1.8	14.2	0.0	1.6
07	26.9	5	2.1	13.2	15.9	11.0	7.1%	1.7	13.6	0.0	1.6
08	25.7	10	2.2	14.6	15.9	9.8	12.3%	1.8	14.9	0.0	1.5
09	26.2	13	2.2	14.7	16.7	9.5	14.3%	1.9	14.9	0.0	1.7
10-SCE/SoCalGas	26.7	10	2.3	15.1	16.5	10.2	12.7%	1.9	15.3	0.0	1.8
10-SDGE	26.7	10	2.3	15.1	16.5	10.2	12.7%	1.9	15.3	0.3	1.8
11	24.5	11	2.4	16.7	14.0	10.5	19.0%	2.0	16.7	0.4	1.8
12	26.0	12	2.3	15.0	15.7	10.3	16.7%	2.0	15.2	0.3	2.0
13	26.0	11	2.3	17.5	15.2	10.8	19.2%	2.0	17.5	0.4	1.8
14-SCE/SoCalGas	25.8	15	2.8	14.6	16.1	9.7	19.8%	2.2	14.7	0.2	1.5
14-SDGE	25.8	15	2.8	14.6	16.1	9.7	19.8%	2.2	14.7	0.6	1.5
15	25.1	11	2.5	21.7	16.3	8.8	18.9%	2.1	20.9	0.0	1.9
16	29.5	22	3.5	13.4	19.6	9.9	18.3%	2.7	14.1	0.6	1.4

"inf" = indicates cases where there is both first cost savings and annual utility bill savings.
EDR Red. = EDR Reduction.

Table 30: Multifamily All-Electric Efficiency Package Cost-Effectiveness Results

Climate Zone	BASECASE					Non-Preempted								Equipment - Preempted							
	Final EDR	Efficiency EDR	CALGreen Tier 1 EDR Target	lbs CO2 per sqft	PV kW	Final EDR	Efficiency EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio	Final EDR	Efficiency EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio
01	43.9	74.4	36	1.7	15.9	40.2	70.7	3.7	14.3%	1.5	15.9	1.4	1.4	38.9	69.5	4.9	17.7%	1.5	15.9	2.2	2.2
02	36.4	66.3	16	1.4	13.9	34.3	64.3	2.0	9.1%	1.3	13.9	1.6	2.1	32.9	62.9	3.4	15.3%	1.3	13.9	1.4	1.6
03	36.4	68.2	14	1.3	13.5	36.4	68.2	0.0	0.0%	1.3	13.5	-	-	32.5	64.3	3.9	20.1%	1.2	13.5	1.5	1.7
04	34.1	64.4	12	1.3	13.6	32.6	62.9	1.5	7.9%	1.2	13.6	1.3	1.6	31.6	61.9	2.5	12.9%	1.2	13.6	1.1	1.2
05	37.5	69.4	16	1.4	12.6	37.5	69.4	0.0	0.0%	1.4	12.6	-	-	32.6	64.5	4.9	23.5%	1.2	12.6	1.9	2.1
06	34.3	69.4	12	1.4	13.9	33.3	68.4	1.0	5.6%	1.3	13.9	0.5	1.3	32.1	67.2	2.2	12.4%	1.3	13.9	1.3	1.9
07	34.3	70.3	7	1.3	13.2	33.7	69.8	0.5	3.3%	1.3	13.2	0.4	1.4	31.9	68.0	2.3	14.8%	1.2	13.2	1.7	2.0
08	31.2	66.1	10	1.3	14.6	30.0	64.9	1.2	6.5%	1.3	14.6	0.8	1.8	29.5	64.4	1.7	9.2%	1.3	14.6	1.3	1.6
09	32.3	64.6	13	1.4	14.7	30.4	62.6	2.0	9.1%	1.4	14.7	0.4	1.0	30.4	62.7	1.9	9.0%	1.3	14.7	1.4	2.0
10-SCE/SCG	33.0	63.8	11	1.5	15.1	31.1	62.0	1.8	8.5%	1.4	15.1	1.0	1.9	30.9	61.8	2.0	9.3%	1.4	15.1	1.5	2.1
10-SDGE	33.0	63.8	11	1.5	15.1	31.1	62.0	1.8	8.5%	1.4	15.1	1.5	1.9	30.9	61.8	2.0	9.3%	1.4	15.1	2.0	2.1
11	33.2	62.4	12	1.5	16.7	29.6	58.8	3.6	13.0%	1.3	16.7	1.3	1.7	28.9	58.1	4.3	15.4%	1.3	16.7	1.8	2.5
12	33.7	62.4	13	1.4	15.0	31.0	59.8	2.6	11.3%	1.3	15.0	0.8	1.1	30.5	59.3	3.1	13.3%	1.2	15.0	1.4	1.7
13	33.1	62.3	13	1.4	17.5	29.7	58.9	3.4	12.7%	1.3	17.5	1.2	1.6	29.2	58.4	3.9	14.6%	1.2	17.5	1.8	2.3
14-SCE/SCG	33.7	63.5	16	1.8	14.6	29.9	59.7	3.8	13.8%	1.7	14.6	1.1	1.6	30.0	59.8	3.7	13.6%	1.6	14.6	1.4	2.1
14-SDGE	33.7	63.5	16	1.8	14.6	29.9	59.7	3.8	13.8%	1.7	14.6	1.5	1.6	30.0	59.8	3.7	13.6%	1.6	14.6	1.9	2.1
15	28.9	62.3	8	1.8	21.7	24.8	58.2	4.1	13.2%	1.7	21.7	1.4	2.1	22.8	56.1	6.2	19.7%	1.6	21.7	1.1	1.6
16	42.4	69.6	39	1.9	13.4	38.1	65.2	4.4	15.4%	1.8	13.4	1.9	2.1	39.6	66.7	2.9	10.1%	1.8	13.4	1.4	1.5

"1" = indicates cases where there is both first cost savings and annual utility bill savings.
EDR Red. = EDR Reduction.

Table 31: Multifamily All-Electric Efficiency & PV-PV/Battery Package Cost-Effectiveness Results

Climate Zone	BASECASE				Efficiency & PV							Efficiency & PV/Battery						
	Final EDR	CALGreen Tier 1 EDR Target	PV kW	lbs CO2 per sqft	Final EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio	Final EDR	EDR Red.	% Comp Margin	lbs CO2 per sqft	PV kW	On-Bill B/C Ratio	TDV B/C Ratio
01	43.9	36	1.7	15.9	20.7	23.2	14.3%	0.8	26.8	1.9	1.5	8.1	35.8	23.3%	0.4	30.3	1.3	1.5
02	36.4	16	1.4	13.9	18.5	17.9	9.1%	0.8	21.8	2.2	1.8	4.6	31.8	15.1%	0.4	24.6	1.3	1.8
03	36.4	14	1.3	13.5	19.9	16.5	2.6%	0.7	20.7	2.2	1.7	5.8	30.6	7.6%	0.4	23.5	1.3	1.7
04	34.1	12	1.3	13.6	18.8	15.3	7.9%	0.7	20.2	2.2	1.8	4.5	29.6	14.9%	0.4	22.8	1.3	1.9
05	37.5	16	1.4	12.6	20.0	17.5	3.3%	0.7	19.8	2.3	1.8	6.1	31.4	7.3%	0.4	22.4	1.4	1.8
06	34.3	12	1.4	13.9	20.2	14.1	5.6%	1.1	19.4	1.0	1.7	5.8	28.5	8.6%	0.6	22.0	0.5	1.7
07	34.3	7	1.3	13.2	21.1	13.2	3.3%	1.0	18.1	2.1	1.8	6.2	28.1	5.3%	0.6	20.6	1.3	1.7
08	31.2	10	1.3	14.6	19.4	11.8	6.5%	1.1	19.4	0.9	1.8	6.2	25.0	11.5%	0.6	22.0	0.4	1.7
09	32.3	13	1.4	14.7	20.6	11.7	9.1%	1.1	19.4	0.8	1.6	8.3	24.0	15.1%	0.7	21.9	0.4	1.6
10-SCE/SoCalGas	33.0	11	1.5	15.1	22.0	11.0	8.5%	1.2	19.8	1.1	1.8	9.2	23.8	13.5%	0.7	22.5	0.5	1.8
10-SDGE	33.0	11	1.5	15.1	22.0	11.0	8.5%	1.2	19.8	2.0	1.8	9.2	23.8	13.5%	0.7	22.5	1.5	1.8
11	33.2	12	1.5	16.7	19.5	13.7	13.0%	0.8	22.7	2.0	1.8	7.4	25.8	20.0%	0.5	25.7	1.4	1.9
12	33.7	13	1.4	15.0	19.0	14.7	11.3%	0.8	21.6	1.9	1.6	6.3	27.4	19.3%	0.4	24.4	1.2	1.8
13	33.1	13	1.4	17.5	20.7	12.4	12.7%	0.8	23.3	1.9	1.7	8.6	24.5	19.7%	0.5	26.3	1.3	1.8
14-SCE/SoCalGas	33.7	16	1.8	14.6	19.5	14.2	13.8%	1.3	20.1	1.4	1.9	8.3	25.4	20.8%	0.9	22.7	0.8	1.9
14-SDGE	33.7	16	1.8	14.6	19.5	14.2	13.8%	1.3	20.1	2.1	1.9	8.3	25.4	20.8%	0.9	22.7	1.8	1.9
15	28.9	8	1.8	21.7	22.1	6.8	13.2%	1.6	23.5	1.2	2.0	12.0	16.9	19.2%	1.1	26.6	0.5	1.9
16	42.4	39	1.9	13.4	22.1	20.3	15.4%	1.3	21.9	2.3	1.9	11.4	31.0	22.4%	0.8	24.7	1.6	1.8

">1" = indicates cases where there is both first cost savings and annual utility bill savings.
EDR Red. = EDR Reduction.

Appendix F – Multifamily Measure Summary

Table 32: Multifamily Mixed Fuel Efficiency – Non-Preempted Package Measure Summary

CZ	Duct	Infiltration	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
2	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
3	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
4	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
5	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
6	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
7	Code Min	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
8	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Enh CHW credit (0.6)	0.35 W/cfm	Max PV
9	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
10	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
11	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
12	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
13	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
14	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
15	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV
16	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	Max PV

VLLDCS – Verified Low-Leakage Ducts in Conditioned Space

Table 33: Multifamily Mixed Fuel Efficiency – Equipment, Preempted Package Measure Summary

CZ	Duct	Infiltration	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
2	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
3	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	92 AFUE, 0.35W/cfm	Max PV
4	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
5	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	92 AFUE, 0.35W/cfm	Max PV
6	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	Code Min	Max PV
7	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 0.35 W/cfm	Max PV
8	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	Code Min	Max PV
9	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 0.35 W/cfm	Max PV
10	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 0.35 W/cfm	Max PV
11	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
12	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
13	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
14	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV
15	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 0.35 W/cfm	Max PV
16	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	95 EF, compact dist.	16 SEER, 92 AFUE, 0.35W/cfm	Max PV

VLLDCS – Verified Low-Leakage Ducts in Conditioned Space

Table 34: Multifamily Mixed Fuel Efficiency & PV/Battery Package Measure Summary

CZ	Duct	Infiltration	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
2	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
3	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
4	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
5	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
6	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
7	Code Min	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
8	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Enh CHW credit (0.6)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
9	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
10	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
11	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
12	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
13	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
14	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
15	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF
16	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	R-10 slab insulation	Basic CHW credit (0.7)	0.35 W/cfm	1.0 PV scaling + 22 batt MF

VLLDCS – Verified Low-Leakage Ducts in Conditioned Space

Table 35: Multifamily All-Electric Efficiency – Non-Preempted Package Measure Summary

CZ	Duct	Infiltration	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
2	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
3	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Std Design PV
4	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
5	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Std Design PV
6	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	Std Design PV
7	Code Min	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	Std Design PV
8	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	Std Design PV
9	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	Std Design PV
10	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
11	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
12	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
13	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
14	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
15	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV
16	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	R-10 slab insulation	Code Min	0.45 W/cfm	Std Design PV

VLLDCS – Verified Low-Leakage Ducts in Conditioned Space

Table 36: Multifamily All-Electric Efficiency – Equipment, Preempted Package Measure Summary

CZ	Duct	Infiltration	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
2	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
3	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
4	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
5	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
6	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	0.45 W/cfm	Std Design PV
7	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	0.45 W/cfm	Std Design PV
8	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	0.45 W/cfm	Std Design PV
9	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	0.45 W/cfm	Std Design PV
10	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	0.45 W/cfm	Std Design PV
11	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
12	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
13	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
14	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV
15	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	18 SEER, 10 HSPF, 0.45W/cfm	Std Design PV
16	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	NEEA Tier 3 HPWH	16 SEER, 9 HSPF, 0.45W/cfm	Std Design PV

VLLDCS – Verified Low-Leakage Ducts in Conditioned Space

Table 37: Multifamily All-Electric Efficiency & PV Package Measure Summary

CZ	Duct	Infiltration	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
2	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
3	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
4	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
5	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	Code Min	0.9 PV scaling
6	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	0.9 PV scaling
7	Code Min	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	0.9 PV scaling
8	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	0.9 PV scaling
9	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	0.9 PV scaling
10	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
11	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
12	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
13	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
14	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
15	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling
16	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	R-10 slab insulation	Code Min	0.45 W/cfm	0.9 PV scaling

VLLDCS – Verified Low-Leakage Ducts in Conditioned Space

Table 38: Multifamily All-Electric Efficiency & PV/Battery Package Measure Summary

CZ	Duct	Infiltration	Wall	Attic	Roof	Glazing	Slab	DHW	HVAC	PV
1	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
2	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
3	Code Min	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
4	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
5	VLLDCS	Code Min	Code Min	Code Min	Code Min	Code Min	R-10 slab insulation	Code Min	Code Min	1.0 PV scaling + 22 batt MF
6	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
7	Code Min	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
8	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
9	VLLDCS	Code Min	Code Min	R-38 + R-30 attic	0.25 solar reflectance	Code Min	Code Min	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
10	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	Code Min	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
11	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
12	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
13	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
14	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
15	VLLDCS	Code Min	Code Min	Code Min	0.25 solar reflectance	0.24/0.23 windows	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF
16	VLLDCS	Code Min	Code Min	Code Min	Code Min	0.24/0.50 windows	R-10 slab insulation	Code Min	0.45 W/cfm	1.0 PV scaling + 22 batt MF

VLLDCS – Verified Low-Leakage Ducts in Conditioned Space

Appendix G – Multifamily Package Costs

Table 39: Multifamily Package Cost Summary

Climate Zone	Mixed Fuel			All-Electric			
	Efficiency-Non-Preempted	Efficiency-Equipment, Preempted	Efficiency & PV/Battery	Efficiency-Non-Preempted	Efficiency-Equipment, Preempted	Efficiency & PV	Efficiency & PV/Battery
CZ01	+$897	+$480	+$2,635	+$886	+$753	+$5,186	+$8,098
CZ02	+$287	+$471	+$1,997	+$336	+$753	+$3,444	+$6,108
CZ03	+$163	+$383	+$1,873	n/a	+$753	+$3,038	+$5,656
CZ04	+$306	+$471	+$2,012	+$336	+$753	+$2,940	+$5,530
CZ05	+$168	+$384	+$1,867	n/a	+$753	+$3,064	+$5,634
CZ06	+$176	+$193	+$1,886	+$216	+$341	+$2,412	+$4,975
CZ07	+$85	+$346	+$1,789	+$106	+$341	+$2,054	+$4,555
CZ08	+$231	+$180	+$1,940	+$216	+$341	+$2,088	+$4,649
CZ09	+$126	+$258	+$1,830	+$673	+$341	+$2,529	+$5,084
CZ10-SCE/SoCalGas	+$259	+$236	+$1,963	+$336	+$341	+$2,211	+$4,786
CZ10-SDGE	+$259	+$236	+$1,963	+$336	+$341	+$2,211	+$4,786
CZ11	+$791	+$301	+$2,497	+$944	+$753	+$3,342	+$6,043
CZ12	+$271	+$411	+$1,979	+$944	+$753	+$3,564	+$6,217
CZ13	+$773	+$276	+$2,484	+$944	+$753	+$3,214	+$5,942
CZ14-SCE/SoCalGas	+$814	+$330	+$2,503	+$944	+$753	+$3,112	+$5,686
CZ14-SDGE	+$814	+$330	+$2,503	+$944	+$753	+$3,112	+$5,686
CZ15	+$471	-($148)	+$2,171	+$944	+$1,853	+$1,685	+$4,420
CZ16	+$875	+$429	+$2,573	+$787	+$753	+$4,137	+$6,793
Average	+$431	+$309	+$2,137	+$618	+$677	+$2,964	+$5,591
Min	+$897	+$480	+$2,635	+$944	+$1,853	+$5,186	+$8,098
Max	+$85	-($148)	+$1,789	+$106	+$341	+$1,685	+$4,420

Appendix H – Results by Climate Zone

Climate Zone 1

Table 40: Single Family Climate Zone 1 Results Summary

Climate Zone 1 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	5.0	(0.1)	2.5	0.5	$1,259	5.1	2.9
	Efficiency-Equipment	6.5	(0.1)	2.3	0.7	$1,197	5.5	4.2
	Efficiency & PV/Battery	10.5	0.0	2.4	0.6	$4,489	1.2	1.8
All-Electric[2]	Efficiency-Non-Preempted	15.5	0.0	1.0	0.5	$7,130	1.7	1.7
	Efficiency-Equipment	6.5	0.0	1.3	0.2	$1,996	2.6	2.7
	Efficiency & PV	32.0	2.7	0.5	1.0	$17,018	1.7	1.5
	Efficiency & PV/Battery	41.5	3.4	0.3	1.2	$22,711	1.4	1.4
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.5	1.5	($5,349)	0.6	0.9
	Efficiency & PV	32.0	2.7	0.5	1.7	$12,799	1.6	2.6

Table 41: Multifamily Climate Zone 1 Results Summary

Climate Zone 1 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	3.0	0.0	2.3	0.4	$897	1.2	1.2
	Efficiency-Equipment	2.0	(0.1)	2.5	0.3	$480	1.4	1.4
	Efficiency & PV/Battery	11.5	0.5	2.1	0.6	$2,635	0.4	1.4
All-Electric[2]	Efficiency-Non-Preempted	3.5	0.0	1.5	0.2	$886	1.4	1.4
	Efficiency-Equipment	4.5	0.0	1.5	0.2	$753	2.2	2.2
	Efficiency & PV	23.0	10.9	0.8	0.9	$5,186	1.9	1.5
	Efficiency & PV/Battery	35.5	14.3	0.4	1.2	$8,098	1.3	1.5
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.7	1.1	($2,337)	0.5	1.0
	Efficiency & PV	23.0	10.9	0.8	1.6	$3,175	1.8	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 2

Table 42: Single Family Climate Zone 2 Results Summary

Climate Zone 2 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	3.0	(0.0)	1.9	0.3	$1,401	1.8	1.7
	Efficiency-Equipment	3.0	(0.0)	1.9	0.3	$683	4.1	3.6
	Efficiency & PV/Battery	10.0	0.1	1.8	0.4	$4,569	0.7	1.7
All-Electric[2]	Efficiency-Non-Preempted	4.5	0.0	0.9	0.2	$3,679	1.1	1.1
	Efficiency-Equipment	4.5	0.0	0.9	0.2	$1,996	2.0	2.1
	Efficiency & PV	19.5	2.1	0.5	0.6	$11,366	1.7	1.4
	Efficiency & PV/Battery	30.0	2.7	0.3	0.9	$16,546	1.3	1.5
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.1	1.1	($5,349)	0.8	1.6
	Efficiency & PV	19.5	2.1	0.5	1.4	$6,761	2.0	>1

Table 43: Multifamily Climate Zone 2 Results Summary

Climate Zone 2 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	1.5	(0.1)	2.3	0.1	$287	1.1	1.8
	Efficiency-Equipment	2.0	(0.1)	2.2	0.2	$471	1.2	1.5
	Efficiency & PV/Battery	10.5	0.3	2.1	0.3	$1,997	0.2	1.8
All-Electric[2]	Efficiency-Non-Preempted	2.0	0.0	1.3	0.1	$336	1.6	2.1
	Efficiency-Equipment	3.0	0.0	1.3	0.1	$753	1.4	1.6
	Efficiency & PV	17.5	7.9	0.8	0.7	$3,444	2.2	1.8
	Efficiency & PV/Battery	31.5	10.7	0.4	1.0	$6,108	1.3	1.8
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.4	1.0	($2,337)	0.7	1.4
	Efficiency & PV	17.5	7.9	0.8	1.4	$1,320	3.7	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 3

Table 44: Single Family Climate Zone 3 Results Summary

Climate Zone 3 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	2.5	(0.0)	1.6	0.3	$1,448	1.4	1.3
	Efficiency-Equipment	4.0	(0.0)	1.5	0.4	$1,358	2.1	2.0
	Efficiency & PV/Battery	10.0	0.1	1.5	0.4	$4,612	0.6	1.5
All-Electric[2]	Efficiency-Non-Preempted	4.5	0.0	0.8	0.2	$1,417	2.4	2.4
	Efficiency-Equipment	4.0	0.0	0.9	0.1	$1,996	1.5	1.6
	Efficiency & PV	18.5	1.8	0.5	0.5	$7,940	2.0	1.7
	Efficiency & PV/Battery	29.5	2.4	0.2	0.8	$12,959	1.4	1.6
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.0	0.9	($5,349)	0.8	1.5
	Efficiency & PV	18.5	1.8	0.5	1.4	$3,101	3.4	>1

Table 45: Multifamily Climate Zone 3 Results Summary

Climate Zone 3 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	0.5	(0.0)	2.1	0.1	$163	1.1	1.1
	Efficiency-Equipment	1.5	(0.0)	1.9	0.2	$383	1.2	1.2
	Efficiency & PV/Battery	10.0	0.4	1.9	0.3	$1,873	0.1	1.6
All-Electric[2]	Efficiency-Non-Preempted	0.0	0.0	1.3	0.0	n/a	-	-
	Efficiency-Equipment	3.5	0.0	1.2	0.1	$753	1.5	1.7
	Efficiency & PV	16.5	7.3	0.7	0.6	$3,038	2.2	1.7
	Efficiency & PV/Battery	30.5	10.0	0.4	0.9	$5,656	1.3	1.7
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.3	0.8	($2,337)	0.8	1.3
	Efficiency & PV	16.5	7.3	0.7	1.4	$888	4.8	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 4

Table 46: Single Family Climate Zone 4 Results Summary

Climate Zone 4 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	2.5	(0.0)	1.7	0.2	$1,451	1.0	1.2
	Efficiency-Equipment	2.5	(0.0)	1.6	0.3	$716	2.6	2.7
	Efficiency & PV/Battery	10.0	0.1	1.5	0.3	$4,608	0.5	1.6
All-Electric[2]	Efficiency-Non-Preempted	3.0	0.0	0.9	0.1	$1,417	1.8	1.9
	Efficiency-Equipment	3.5	0.0	0.9	0.1	$1,996	1.3	1.4
	Efficiency & PV	17.0	1.8	0.5	0.5	$8,251	1.9	1.6
	Efficiency & PV/Battery	28.5	2.4	0.3	0.8	$13,289	1.4	1.7
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.0	0.9	($5,349)	0.8	1.5
	Efficiency & PV	17.0	1.8	0.5	1.3	$3,431	3.0	>1

Table 47: Multifamily Climate Zone 4 Results Summary

Climate Zone 4 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	1.0	(0.1)	2.1	0.1	$306	0.8	1.2
	Efficiency-Equipment	2.0	(0.1)	2.0	0.2	$471	1.0	1.4
	Efficiency & PV/Battery	11.0	0.4	1.9	0.3	$2,012	0.2	1.8
All-Electric[2]	Efficiency-Non-Preempted	1.5	0.0	1.2	0.0	$336	1.3	1.6
	Efficiency-Equipment	2.5	0.0	1.2	0.1	$753	1.1	1.2
	Efficiency & PV	15.0	6.6	0.7	0.6	$2,940	2.2	1.8
	Efficiency & PV/Battery	29.5	9.2	0.4	0.9	$5,530	1.3	1.9
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.3	0.9	($2,337)	0.9	1.6
	Efficiency & PV	15.0	6.6	0.7	1.4	$786	5.6	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 5

Table 48: Single Family Climate Zone 5 Results Summary

Climate Zone 5 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	2.5	(0.0)	1.6	0.2	$1,465	1.2	1.2
	Efficiency-Equipment	2.5	(0.0)	1.5	0.2	$728	2.5	2.5
	Efficiency & PV/Battery	9.0	0.1	1.4	0.4	$4,608	0.6	1.5
All-Electric[2]	Efficiency-Non-Preempted	4.5	0.0	0.9	0.2	$1,417	2.4	2.4
	Efficiency-Equipment	4.0	0.0	0.9	0.1	$1,996	1.5	1.6
	Efficiency & PV	18.0	1.7	0.5	0.5	$7,720	2.1	1.8
	Efficiency & PV/Battery	29.0	2.3	0.2	0.8	$12,622	1.5	1.7
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.0	0.8	($5,349)	0.7	1.3
	Efficiency & PV	18.0	1.7	0.5	1.1	$2,867	3.3	>1

Table 49: Multifamily Climate Zone 5 Results Summary

Climate Zone 5 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	0.5	(0.0)	2.0	0.1	$168	1.1	1.0
	Efficiency-Equipment	1.5	(0.0)	1.9	0.2	$384	1.2	1.2
	Efficiency & PV/Battery	10.0	0.4	1.8	0.3	$1,867	0.2	1.6
All-Electric[2]	Efficiency-Non-Preempted	0.0	0.0	1.4	0.0	n/a	-	-
	Efficiency-Equipment	4.5	0.0	1.2	0.2	$753	1.9	2.1
	Efficiency & PV	17.5	7.2	0.7	0.6	$3,064	2.3	1.8
	Efficiency & PV/Battery	31.0	9.8	0.4	1.0	$5,634	1.4	1.8
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.4	0.7	($2,337)	0.7	1.2
	Efficiency & PV	17.5	7.2	0.7	1.4	$917	4.3	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 6

Table 50: Single Family Climate Zone 6 Results Summary

Climate Zone 6 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	2.0	(0.0)	1.5	0.1	$936	0.6	1.2
	Efficiency-Equipment	1.5	(0.0)	1.4	0.1	$550	1.6	2.0
	Efficiency & PV/Battery	9.5	0.1	1.2	0.3	$4,101	0.3	1.4
All-Electric[2]	Efficiency-Non-Preempted	2.0	0.0	0.8	0.0	$864	1.0	1.5
	Efficiency-Equipment	2.5	0.0	0.8	0.1	$801	1.4	2.0
	Efficiency & PV	14.0	1.4	0.6	0.2	$5,922	1.3	1.5
	Efficiency & PV/Battery	26.5	1.9	0.3	0.5	$10,786	0.7	1.5
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	0.9	0.7	($5,349)	>1	2.4
	Efficiency & PV	14.0	1.4	0.6	0.7	$952	9.4	>1

Table 51: Multifamily Climate Zone 6 Results Summary

Climate Zone 6 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	1.0	(0.1)	2.1	0.0	$176	0.3	1.5
	Efficiency-Equipment	1.5	(0.0)	2.0	0.1	$193	1.5	2.1
	Efficiency & PV/Battery	10.5	0.3	1.8	0.4	$1,886	0.0	1.6
All-Electric[2]	Efficiency-Non-Preempted	1.0	0.0	1.3	0.0	$216	0.5	1.3
	Efficiency-Equipment	2.0	0.0	1.3	0.1	$341	1.3	1.9
	Efficiency & PV	14.0	5.5	1.1	0.3	$2,412	1.0	1.7
	Efficiency & PV/Battery	28.5	8.1	0.6	0.8	$4,975	0.5	1.7
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.4	0.8	($2,337)	>1	2.1
	Efficiency & PV	14.0	5.5	1.1	1.1	$224	22.3	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 7

Table 52: Single Family Climate Zone 7 Results Summary

Climate Zone 7 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	0.0	0.0	1.3	0.0	n/a	-	-
	Efficiency-Equipment	1.0	(0.0)	1.2	0.1	$573	1.6	1.4
	Efficiency & PV/Battery	9.0	0.1	1.0	0.3	$3,298	0.3	1.5
All-Electric[2]	Efficiency-Non-Preempted	0.0	0.0	0.8	0.0	n/a	-	-
	Efficiency-Equipment	1.5	0.0	0.7	0.1	$801	1.5	1.4
	Efficiency & PV	11.0	1.1	0.6	0.2	$4,179	1.8	1.5
	Efficiency & PV/Battery	24.0	1.6	0.3	0.5	$8,863	1.3	1.6
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	0.8	0.5	($5,349)	1.1	2.5
	Efficiency & PV	11.0	1.1	0.6	0.8	($908)	>1	>1

Table 53: Multifamily Climate Zone 7 Results Summary

Climate Zone 7 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	0.5	(0.1)	2.1	0.0	$85	0.8	2.1
	Efficiency-Equipment	1.5	(0.0)	2.0	0.1	$346	1.1	1.4
	Efficiency & PV/Battery	11.0	0.4	1.7	0.4	$1,789	0.0	1.6
All-Electric[2]	Efficiency-Non-Preempted	0.5	0.0	1.3	0.0	$106	0.4	1.4
	Efficiency-Equipment	2.0	0.0	1.2	0.1	$341	1.7	2.0
	Efficiency & PV	13.0	4.9	1.0	0.3	$2,054	2.1	1.8
	Efficiency & PV/Battery	28.0	7.4	0.6	0.7	$4,555	1.3	1.7
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.3	0.8	($2,337)	1.1	2.2
	Efficiency & PV	13.0	4.9	1.0	1.2	($157)	>1	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 8

Table 54: Single Family Climate Zone 8 Results Summary

Climate Zone 8 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	1.0	(0.0)	1.3	0.1	$543	0.4	1.4
	Efficiency-Equipment	1.5	(0.0)	1.3	0.1	$555	1.3	1.8
	Efficiency & PV/Battery	8.0	0.1	1.1	0.3	$3,707	0.2	1.5
All-Electric[2]	Efficiency-Non-Preempted	1.5	0.0	0.8	0.0	$864	0.4	1.2
	Efficiency-Equipment	1.5	0.0	0.8	0.1	$389	1.8	2.7
	Efficiency & PV	11.0	1.1	0.6	0.2	$5,083	1.2	1.5
	Efficiency & PV/Battery	21.5	1.7	0.3	0.5	$9,906	0.6	1.5
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	0.8	0.6	($5,349)	>1	2.9
	Efficiency & PV	11.0	1.1	0.6	0.9	$60	128.7	>1

Table 55: Multifamily Climate Zone 8 Results Summary

Climate Zone 8 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	1.5	(0.2)	2.1	0.0	$231	0.3	1.4
	Efficiency-Equipment	1.5	(0.1)	2.0	0.1	$180	1.6	2.4
	Efficiency & PV/Battery	9.5	0.3	1.8	0.4	$1,940	0.0	1.5
All-Electric[2]	Efficiency-Non-Preempted	1.0	0.0	1.3	0.0	$216	0.8	1.8
	Efficiency-Equipment	1.5	0.0	1.3	0.1	$341	1.3	1.6
	Efficiency & PV	11.5	4.7	1.1	0.3	$2,088	0.9	1.8
	Efficiency & PV/Battery	25.0	7.3	0.6	0.7	$4,649	0.4	1.7
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.3	0.8	($2,337)	>1	2.6
	Efficiency & PV	11.5	4.7	1.1	1.2	($119)	>1	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 9

Table 56: Single Family Climate Zone 9 Results Summary

Climate Zone 9 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	2.5	(0.0)	1.5	0.1	$845	0.4	2.0
	Efficiency-Equipment	2.5	(0.0)	1.4	0.1	$542	1.4	3.6
	Efficiency & PV/Battery	8.5	0.1	1.2	0.3	$3,998	0.2	1.7
All-Electric[2]	Efficiency-Non-Preempted	2.5	0.0	0.9	0.0	$864	0.8	2.3
	Efficiency-Equipment	3.0	0.0	0.8	0.1	$801	1.4	3.1
	Efficiency & PV	11.0	1.2	0.7	0.2	$5,182	1.3	1.7
	Efficiency & PV/Battery	21.0	1.7	0.4	0.5	$10,032	0.7	1.6
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	0.9	0.6	($5,349)	>1	2.6
	Efficiency & PV	11.0	1.2	0.7	0.9	$165	50.9	>1

Table 57: Multifamily Climate Zone 9 Results Summary

Climate Zone 9 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	1.5	(0.2)	2.2	0.0	$126	0.4	3.4
	Efficiency-Equipment	2.5	(0.3)	2.1	0.2	$258	1.1	2.9
	Efficiency & PV/Battery	9.5	0.2	1.9	0.4	$1,830	0.0	1.7
All-Electric[2]	Efficiency-Non-Preempted	1.5	0.0	1.4	0.0	$673	0.4	1.0
	Efficiency-Equipment	1.5	0.0	1.3	0.1	$341	1.4	2.0
	Efficiency & PV	11.5	4.7	1.1	0.3	$2,529	0.8	1.6
	Efficiency & PV/Battery	24.0	7.3	0.7	0.7	$5,084	0.4	1.6
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.4	0.8	($2,337)	>1	2.2
	Efficiency & PV	11.5	4.7	1.1	1.2	$354	13.9	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 10 SCE/SoCalGas

Table 58: Single Family Climate Zone 10 SCE/SoCalGas Results Summary

Climate Zone 10 SCE/SoCalGas Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	3.0	(0.1)	1.5	0.1	$1,535	0.4	1.4
	Efficiency-Equipment	3.0	(0.1)	1.4	0.2	$559	1.5	4.0
	Efficiency & PV/Battery	9.5	0.0	1.3	0.4	$4,689	0.1	1.7
All-Electric[2]	Efficiency-Non-Preempted	3.0	0.0	0.9	0.1	$1,654	0.7	1.5
	Efficiency-Equipment	3.5	0.0	0.9	0.1	$897	1.6	3.2
	Efficiency & PV	11.0	1.2	0.7	0.2	$5,999	1.3	1.5
	Efficiency & PV/Battery	21.0	1.7	0.4	0.5	$10,894	0.7	1.6
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.0	0.7	($5,349)	>1	2.3
	Efficiency & PV	11.0	1.2	0.7	0.9	$1,041	8.3	>1

Table 59: Multifamily Climate Zone 10 SCE/SoCalGas Results Summary

Climate Zone 10 SCE/SoCalGas Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	1.5	(0.2)	2.2	0.1	$259	0.4	1.7
	Efficiency-Equipment	2.5	(0.3)	2.1	0.2	$236	1.2	3.2
	Efficiency & PV/Battery	10.0	0.2	1.9	0.4	$1,963	0.0	1.8
All-Electric[2]	Efficiency-Non-Preempted	1.5	0.0	1.4	0.1	$336	1.0	1.9
	Efficiency-Equipment	2.0	0.0	1.4	0.1	$341	1.5	2.1
	Efficiency & PV	11.0	4.7	1.2	0.3	$2,211	1.1	1.8
	Efficiency & PV/Battery	23.5	7.4	0.7	0.8	$4,786	0.5	1.8
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.5	0.8	($2,337)	>1	2.1
	Efficiency & PV	11.0	4.7	1.2	1.1	$13	390.9	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 10 SDGE

Table 60: Single Family Climate Zone 10 SDGE Results Summary

Climate Zone 10 SDGE Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	3.0	(0.1)	1.5	0.1	$1,535	0.8	1.4
	Efficiency-Equipment	3.0	(0.1)	1.4	0.2	$559	2.7	4.0
	Efficiency & PV/Battery	9.5	0.0	1.3	0.4	$4,689	0.7	1.7
All-Electric[2]	Efficiency-Non-Preempted	3.0	0.0	0.9	0.1	$1,654	1.1	1.5
	Efficiency-Equipment	3.5	0.0	0.9	0.1	$897	2.4	3.2
	Efficiency & PV	11.0	1.2	0.7	0.2	$5,999	1.6	1.5
	Efficiency & PV/Battery	21.0	1.7	0.4	0.5	$10,894	1.5	1.6
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.0	0.7	($5,349)	1.0	2.3
	Efficiency & PV	11.0	1.2	0.7	1.4	$1,041	4.9	>1

Table 61: Multifamily Climate Zone 10 SDGE Results Summary

Climate Zone 10 SDGE Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	1.5	(0.2)	2.2	0.1	$259	1.0	1.7
	Efficiency-Equipment	2.5	(0.3)	2.1	0.2	$236	2.5	3.2
	Efficiency & PV/Battery	10.0	0.2	1.9	0.4	$1,963	0.3	1.8
All-Electric[2]	Efficiency-Non-Preempted	1.5	0.0	1.4	0.1	$336	1.5	1.9
	Efficiency-Equipment	2.0	0.0	1.4	0.1	$341	2.0	2.1
	Efficiency & PV	11.0	4.7	1.2	0.3	$2,211	2.0	1.8
	Efficiency & PV/Battery	23.5	7.4	0.7	0.8	$4,786	1.5	1.8
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.5	0.8	($2,337)	0.8	2.1
	Efficiency & PV	11.0	4.7	1.2	1.2	$13	150.6	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 11

Table 62: Single Family Climate Zone 11 Results Summary

Climate Zone 11 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	4.0	(0.2)	1.9	0.2	$2,909	0.8	1.2
	Efficiency-Equipment	5.0	(0.2)	1.8	0.3	$1,153	2.6	3.6
	Efficiency & PV/Battery	9.0	(0.1)	1.8	0.4	$6,070	0.4	1.6
All-Electric[2]	Efficiency-Non-Preempted	4.5	0.0	1.0	0.2	$3,485	1.2	1.5
	Efficiency-Equipment	5.5	0.0	0.9	0.2	$1,996	2.6	3.0
	Efficiency & PV	14.0	1.8	0.6	0.6	$10,108	1.7	1.6
	Efficiency & PV/Battery	23.5	2.5	0.4	0.8	$15,494	1.4	1.7
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.2	1.0	($5,349)	0.7	1.6
	Efficiency & PV	14.0	1.8	0.6	1.5	$5,424	2.0	>1

Table 63: Multifamily Climate Zone 11 Results Summary

Climate Zone 11 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	2.5	(0.4)	2.2	0.2	$791	0.7	1.2
	Efficiency-Equipment	3.0	(0.5)	2.2	0.2	$301	2.0	3.3
	Efficiency & PV/Battery	10.5	0.0	2.0	0.4	$2,497	0.4	1.8
All-Electric[2]	Efficiency-Non-Preempted	3.5	0.0	1.3	0.1	$944	1.3	1.7
	Efficiency-Equipment	4.0	0.0	1.3	0.2	$753	1.8	2.5
	Efficiency & PV	13.5	6.1	0.8	0.6	$3,342	2.0	1.8
	Efficiency & PV/Battery	25.5	9.0	0.5	1.0	$6,043	1.4	1.9
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.5	0.9	($2,337)	0.8	1.3
	Efficiency & PV	13.5	6.1	0.8	1.5	$1,219	3.5	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 12

Table 64: Single Family Climate Zone 12 Results Summary

Climate Zone 12 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	3.5	(0.1)	1.9	0.2	$1,565	1.3	1.9
	Efficiency-Equipment	3.0	(0.0)	1.9	0.3	$618	3.6	4.7
	Efficiency & PV/Battery	9.5	0.0	1.8	0.3	$4,732	0.6	1.9
All-Electric[2]	Efficiency-Non-Preempted	3.5	0.0	0.9	0.1	$3,485	0.7	1.1
	Efficiency-Equipment	4.5	0.0	0.9	0.2	$1,996	1.8	2.3
	Efficiency & PV	16.0	2.0	0.5	0.5	$10,827	1.5	1.4
	Efficiency & PV/Battery	26.0	2.6	0.3	0.8	$16,046	1.2	1.5
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.1	1.0	($5,349)	1.0	1.8
	Efficiency & PV	16.0	2.0	0.5	1.5	$6,187	2.0	>1

Table 65: Multifamily Climate Zone 12 Results Summary

Climate Zone 12 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	1.5	(0.2)	2.2	0.1	$271	1.2	2.2
	Efficiency-Equipment	2.5	(0.2)	2.1	0.2	$411	1.3	2.2
	Efficiency & PV/Battery	10.0	0.3	2.0	0.3	$1,979	0.3	2.0
All-Electric[2]	Efficiency-Non-Preempted	2.5	0.0	1.3	0.1	$944	0.8	1.1
	Efficiency-Equipment	3.0	0.0	1.2	0.1	$753	1.4	1.7
	Efficiency & PV	14.5	6.6	0.8	0.6	$3,564	1.9	1.6
	Efficiency & PV/Battery	27.0	9.4	0.4	0.9	$6,217	1.2	1.8
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.4	1.0	($2,337)	0.9	1.6
	Efficiency & PV	14.5	6.6	0.8	1.5	$1,454	3.2	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 13

Table 66: Single Family Climate Zone 13 Results Summary

Climate Zone 13 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	4.5	(0.2)	1.8	0.2	$2,838	0.8	1.3
	Efficiency-Equipment	5.5	(0.2)	1.7	0.3	$560	5.7	8.6
	Efficiency & PV/Battery	9.5	(0.1)	1.7	0.3	$6,011	0.6	1.7
All-Electric[2]	Efficiency-Non-Preempted	5.0	0.0	0.9	0.2	$3,876	1.0	1.4
	Efficiency-Equipment	5.5	0.0	0.9	0.2	$1,996	2.6	3.2
	Efficiency & PV	13.5	1.6	0.6	0.5	$9,868	1.6	1.5
	Efficiency & PV/Battery	22.5	2.3	0.3	0.7	$15,282	1.3	1.6
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.1	0.9	($5,349)	0.8	1.8
	Efficiency & PV	13.5	1.6	0.6	1.8	$5,172	1.9	>1

Table 67: Multifamily Climate Zone 13 Results Summary

Climate Zone 13 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	3.0	(0.4)	2.1	0.2	$773	0.7	1.3
	Efficiency-Equipment	3.0	(0.6)	2.1	0.2	$276	2.1	3.7
	Efficiency & PV/Battery	10.5	0.0	2.0	0.3	$2,484	0.4	1.8
All-Electric[2]	Efficiency-Non-Preempted	3.0	0.0	1.3	0.1	$944	1.2	1.6
	Efficiency-Equipment	3.5	0.0	1.2	0.1	$753	1.8	2.3
	Efficiency & PV	12.0	5.7	0.8	0.6	$3,214	1.9	1.7
	Efficiency & PV/Battery	24.5	8.8	0.5	0.9	$5,942	1.3	1.8
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.4	0.9	($2,337)	0.9	1.5
	Efficiency & PV	12.0	5.7	0.8	1.9	$1,083	3.7	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 14 SCE/SoCalGas

Table 68: Single Family Climate Zone 14 SCE/SoCalGas Results Summary

Climate Zone 14 SCE/SoCalGas Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	4.5	(0.2)	2.1	0.3	$1,565	1.0	2.4
	Efficiency-Equipment	5.5	(0.2)	2.0	0.4	$743	2.7	6.2
	Efficiency & PV/Battery	9.0	(0.1)	1.8	0.5	$4,685	0.5	1.9
All-Electric[2]	Efficiency-Non-Preempted	5.5	0.0	1.2	0.2	$3,876	0.9	1.5
	Efficiency-Equipment	6.0	0.0	1.2	0.2	$1,996	2.1	3.1
	Efficiency & PV	15.5	1.6	0.9	0.5	$9,816	1.5	1.6
	Efficiency & PV/Battery	24.0	2.2	0.6	0.8	$14,910	1.0	1.7
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.4	1.0	($5,349)	2.0	1.6
	Efficiency & PV	15.5	1.6	0.9	1.4	$5,116	2.5	>1

Table 69: Multifamily Climate Zone 14 SCE/SoCalGas Results Summary

Climate Zone 14 SCE/SoCalGas Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	3.0	(0.3)	2.5	0.2	$814	0.5	1.2
	Efficiency-Equipment	3.0	(0.4)	2.5	0.2	$330	1.2	3.0
	Efficiency & PV/Battery	9.5	0.1	2.2	0.6	$2,503	0.2	1.5
All-Electric[2]	Efficiency-Non-Preempted	3.5	0.0	1.7	0.1	$944	1.1	1.6
	Efficiency-Equipment	3.5	0.0	1.6	0.2	$753	1.4	2.1
	Efficiency & PV	14.0	5.5	1.3	0.5	$3,112	1.4	1.9
	Efficiency & PV/Battery	25.0	8.1	0.9	0.9	$5,686	0.8	1.9
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.8	1.0	($2,337)	>1	1.5
	Efficiency & PV	14.0	5.5	1.3	1.4	$975	5.9	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 14 SDGE

Table 70: Single Family Climate Zone 14 SDGE Results Summary

Climate Zone 14 SDGE Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	4.5	(0.2)	2.1	0.3	$1,565	1.9	2.4
	Efficiency-Equipment	5.5	(0.2)	2.0	0.4	$743	5.0	6.2
	Efficiency & PV/Battery	9.0	(0.1)	1.8	0.5	$4,685	1.5	1.9
All-Electric[2]	Efficiency-Non-Preempted	5.5	0.0	1.2	0.2	$3,876	1.3	1.5
	Efficiency-Equipment	6.0	0.0	1.2	0.2	$1,996	2.8	3.1
	Efficiency & PV	15.5	1.6	0.9	0.5	$9,816	1.7	1.6
	Efficiency & PV/Battery	24.0	2.2	0.6	0.8	$14,910	1.7	1.7
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.4	1.0	($5,349)	0.7	1.6
	Efficiency & PV	15.5	1.6	0.9	0.8	$5,116	1.9	>1

Table 71: Multifamily Climate Zone 14 SDGE Results Summary

Climate Zone 14 SDGE Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	3.0	(0.3)	2.5	0.2	$814	0.9	1.2
	Efficiency-Equipment	3.0	(0.4)	2.5	0.2	$330	2.5	3.0
	Efficiency & PV/Battery	9.5	0.1	2.2	0.6	$2,503	0.6	1.5
All-Electric[2]	Efficiency-Non-Preempted	3.5	0.0	1.7	0.1	$944	1.5	1.6
	Efficiency-Equipment	3.5	0.0	1.6	0.2	$753	1.9	2.1
	Efficiency & PV	14.0	5.5	1.3	0.5	$3,112	2.1	1.9
	Efficiency & PV/Battery	25.0	8.1	0.9	0.9	$5,686	1.8	1.9
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.8	1.0	($2,337)	0.5	1.5
	Efficiency & PV	14.0	5.5	1.3	1.2	$975	2.7	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 15

Table 72: Single Family Climate Zone 15 Results Summary

Climate Zone 15 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	4.5	(0.4)	1.6	0.1	$1,993	0.1	1.6
	Efficiency-Equipment	4.5	(0.4)	1.5	0.2	($875)	>1	>1
	Efficiency & PV/Battery	7.0	(0.3)	1.4	0.3	$5,137	0.2	1.7
All-Electric[2]	Efficiency-Non-Preempted	5.5	0.0	1.1	0.2	$4,303	1.0	1.6
	Efficiency-Equipment	7.0	0.0	1.1	0.3	$1,996	2.9	4.5
	Efficiency & PV	6.0	0.1	1.1	0.2	$4,763	1.1	1.6
	Efficiency & PV/Battery	13.5	0.8	0.9	0.5	$10,201	0.7	1.6
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.3	0.4	($5,349)	4.7	2.2
	Efficiency & PV	6.0	0.1	1.1	2.2	($248)	>1	>1

Table 73: Multifamily Climate Zone 15 Results Summary

Climate Zone 15 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	4.0	(1.2)	2.4	0.1	$471	0.1	2.3
	Efficiency-Equipment	4.0	(1.3)	2.3	0.2	($148)	>1	>1
	Efficiency & PV/Battery	8.5	(0.8)	2.1	0.4	$2,171	0.0	1.9
All-Electric[2]	Efficiency-Non-Preempted	4.0	0.0	1.7	0.2	$944	1.4	2.1
	Efficiency-Equipment	6.0	0.0	1.6	0.3	$1,853	1.1	1.6
	Efficiency & PV	6.5	1.9	1.6	0.3	$1,685	1.2	2.0
	Efficiency & PV/Battery	16.5	4.9	1.1	0.7	$4,420	0.5	1.9
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.8	0.7	($2,337)	>1	2.4
	Efficiency & PV	6.5	1.9	1.6	1.9	($539)	>1	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.

Climate Zone 16

Table 74: Single Family Climate Zone 16 Results Summary

Climate Zone 16 Single Family		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	5.5	0.0	2.6	0.7	$3,301	1.8	1.5
	Efficiency-Equipment	6.0	(0.1)	2.7	0.7	$2,290	2.4	2.2
	Efficiency & PV/Battery	10.5	0.1	2.4	1.0	$6,439	1.0	1.5
All-Electric[2]	Efficiency-Non-Preempted	10.0	0.0	1.4	0.4	$5,347	1.6	1.7
	Efficiency-Equipment	4.5	0.0	1.6	0.2	$1,996	2.1	2.2
	Efficiency & PV	27.5	2.8	1.0	0.8	$15,603	1.9	1.6
	Efficiency & PV/Battery	36.0	3.5	0.7	1.1	$21,005	1.6	1.6
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.8	1.6	($5,349)	0.4	0.7
	Efficiency & PV	27.5	2.8	1.0	-1.0	$11,279	1.8	2.5

Table 75: Multifamily Climate Zone 16 Results Summary

Climate Zone 16 Multifamily		EDR Red.	PV Size Change (kW)[4]	CO_2-Equivalent Emissions (lb/sqft)		Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel[1]	Efficiency-Non-Preempted	2.0	0.2	3.0	0.4	$875	1.2	1.2
	Efficiency-Equipment	2.5	(0.2)	3.1	0.3	$429	1.9	2.2
	Efficiency & PV/Battery	9.5	0.6	2.7	0.8	$2,573	0.6	1.4
All-Electric[2]	Efficiency-Non-Preempted	4.0	0.0	1.8	0.2	$787	1.9	2.1
	Efficiency-Equipment	2.5	0.0	1.8	0.1	$753	1.4	1.5
	Efficiency & PV	20.0	8.5	1.3	0.6	$4,137	2.3	1.9
	Efficiency & PV/Battery	31.0	11.3	0.8	1.1	$6,793	1.6	1.8
Mixed Fuel to All-Electric[3]	Code Compliant	0.0	0.0	1.9	1.5	($2,337)	0.6	1.0
	Efficiency & PV	20.0	8.5	1.3	-1.3	$2,061	3.2	>1

[1]All reductions and incremental costs relative to the mixed fuel code compliant home.
[2]All reductions and incremental costs relative to the all-electric code compliant home.
[3]All reductions and incremental costs relative to the mixed fuel code compliant home except the EDR reductions are relative to the Standard Design for each case which is the all-electric code compliant home.
[4]Positive values indicate an increase in PV capacity relative to the Standard Design.