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California Building Energy Efficiency Standards Title 24, Part 6
Local Energy Efficiency Ordinances

Existing Building Efficiency Upgrade Cost-Effectiveness Study

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1 Introduction

The California Building Energy Efficiency Standards Title 24, Part 6 (Title 24) (CEC, 2016b) 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 (also called reach codes) that exceed the minimum standards defined by Title 24 (as established by Public Resources Code Section 25402.1(h)2 and Section 10-106 of Title 24. 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 presents the results from analysis of the feasibility and cost-effectiveness of requiring existing single family and low-rise (3 stories or fewer) multifamily buildings to exceed the 2016 Title 24 code when a remodel is submitted for permit. This analysis does not apply to high-rise multifamily buildings (4 stories or greater), nor to common or nonresidential spaces within low-rise multifamily buildings. Each jurisdiction must establish the appropriate threshold for triggering the requirements, often based on the value of the project or percent of floor area impacted. Alternatively, a jurisdiction could require the upgrades described in this analysis at the time of sale of a home. The analysis includes scenarios of individual measures, as well as package upgrades, and identifies cost-effective options based on the existing conditions of the building within each California Climate Zone (CZ) as defined by the Energy Commission.[1]

This analysis does not evaluate the impact of retrofit measures on Title 24 compliance margins, as the proposed measures are required in addition to achieving compliance with all codes. The analysis uses a customer-based lifecycle cost approach for evaluating cost-effectiveness of the proposed upgrades, which requires estimating and quantifying incremental costs and the energy and utility cost savings for each energy efficiency measure. The applied approach establishes recommendations based on existing conditions and cost-effectiveness of each measure or package.

2 Methodology and Assumptions

The general approach applied in this analysis is to evaluate performance and determine cost-effectiveness of various energy retrofit measures, individually and as packages. Both single family and low-rise multifamily cases are considered, as well as three unique building vintages: pre-1978, 1978-1991, and 1992-2005. The vintages were defined based on review of historic Title 24 code requirements and selecting year ranges with distinguishing features.

The California Building Energy Code Compliance – Residential (CBECC-Res) 2016.3.0 (SP2 977) compliance simulation tool was used to evaluate energy savings for most measures, with the exception of those outside the code compliance scope. In these cases, the National Renewable Energy Laboratory's Building Energy Optimization (BEopt) v2.8 software and the EnergyPlus v8.8 simulation engine were used.

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. For the multifamily analysis, the Energy Commission eight-unit, two-story, multifamily new construction prototype was determined to be representative of low-rise multifamily buildings across the state within the vintages evaluated under this analysis. A single two-bedroom unit was extracted from the multifamily building model because CBECC-Res cannot evaluate building envelope air sealing for multifamily buildings. The two-bedroom unit was modified to be orientation neutral and represent the average properties of a lower floor and upper floor unit. Only individual, in-unit water heating and space

[1] http://www.energy.ca.gov/maps/renewable/BuildingClimateZonesMap.pdf

conditioning systems were evaluated. Additional details on the multifamily prototype can be found in the Alternative Calculation Method (ACM) Approval Manual (CEC, 2016a).

Average home size has steadily increased over time,[2] and the Energy Commission single family new construction prototypes are larger than many existing single family homes across California. For this analysis an existing home model developed for residential ACM testing[3] was used with the following revisions. The original model includes an existing 1,440 square foot space and a 225 square foot addition. For this analysis, the entire 1,665 square feet was evaluated as existing space and features (i.e., insulation levels, glazing) were applied consistently across the entire building consistent with the existing home specifications in Table 2. Additions are not addressed in this analysis as they are already addressed by the Title 24, Part 6 code.

Table 1 describes the basic characteristics of each prototype.

Table 1: Prototype Characteristics

	Single Family	Multifamily
Existing Conditioned Floor Area	1,665 ft^2	960 ft^2 unit
Num. of Stories	1	1
Num. of Bedrooms	3	2
Window-to-Floor Area Ratio	13%	15%

Three building vintages were evaluated to determine sensitivity of existing building performance on cost-effectiveness of upgrades. For example, it is widely recognized that adding attic insulation in an older home with no insulation is cost-effective, however, newer homes will likely have at least some existing insulation in the attic reducing the potential savings from the measure. The building characteristics for each vintage were determined based on either prescriptive requirements from the Title 24 code that was in effect or standard construction practice during that time period. Based on the vintages selected, this analysis covers homes built before 2006. Homes built between 2006 and 2012 are expected to be similar in envelope characteristics to the 1992-2005 era homes, but include higher performing HVAC. Table 2 summarizes the assumptions for each of the three vintages.

Additionally, the analysis assumed the following features when modeling the prototype buildings:

- Individual space conditioning and water heating systems, one per apartment or single family building. Multifamily buildings with central HVAC or water heating systems were not considered in this evaluation.
- Split-system air conditioner with gas furnace . Efficiency defined by year of the most recent equipment replacement (based on standard equipment lifetime).
- Small storage gas water heater. Efficiency defined by year of most recent equipment replacement (based on standard equipment lifetime).
- Gas cooktop, oven, and clothes dryer.

[2] https://www.census.gov/const/C25Ann/sftotalmedavgsqft.pdf

[3] Residential ACM test U12 can be accessed at the following website: http://www.bwilcox.com/BEES/cbecc2016.html

Table 2: Efficiency Characteristics for Three Vintage Cases

Building Component Efficiency Feature	Vintage Case		
	Pre-1978	1978-1991	1992-2005
Envelope			
Exterior Walls	2x4 16"oc wood frame, R-0	2x4 16"oc wood frame, R-11	2x4 16"oc wood frame, R-13
Foundation Type & Insulation	Raised floor, R-0	Uninsulated slab Raised floor, R-0 (CZ 1 & 16)	Uninsulated slab Raised floor, R-19 (CZ 16)
Ceiling Insulation & Attic Type	Vented attic, R-11 @ ceiling level Vented attic, R-5 @ ceiling level (CZ 6 & 7)	Vented attic, R-19 @ ceiling level	Vented attic, R-19 @ ceiling level
Roofing Material & Color	Asphalt shingles, dark	Asphalt shingles, dark	Asphalt shingles, dark
Radiant Barrier	No	No	No
Window Type: U-factor / SHGC[1]	Metal, single pane: 1.16 / 0.76	Metal, dual pane: 0.79 / 0.70	Vinyl, dual pane Low-E: 0.55 / 0.40
House Infiltration	10 ACH50	10 ACH50	7 ACH50
HVAC Equipment[2]			
Heating Efficiency	78 AFUE (assumes 1 replacement)	78 AFUE (assumes 1 replacement)	78 AFUE
Cooling Efficiency	9.7 SEER (assumes 1 replacement)	9.7 SEER (assumes 1 replacement)	9.7 SEER
Duct Location & Details	Attic, R-2.1, 30% leakage	Attic, R-2.1, 25% leakage	Attic, R-4.2, 25% leakage
Whole Building Mechanical Ventilation	None	None	None
Water Heating Equipment[2]			
Water Heater Efficiency	0.575 Energy Factor (assumes 2 replacements)	0.575 Energy Factor (assumes 1 replacement)	0.575 Energy Factor
Water Heater Tank	40gal uninsulated tank	40gal uninsulated tank	40gal uninsulated tank
Pipe Insulation	None	None	None
Hot Water Fixtures	Standard, non-low flow	Standard, non-low flow	Standard, non-low flow

[1] Window type selections were made based on conversations with window industry expert, Ken Nittler. If a technology was entering the market during the time period (e.g. Low-E during 1992-2005 or dual pane during 1978-1991) that technology was included in the analysis. This provides a conservative assumption for overall building performance and additional measures may be cost effective for buildings with lower performing windows, for example buildings with metal single pane windows in the 1978-1991 vintage.

[2] Multifamily analysis assumes one HVAC and water heating system per apartment.

2.2 Efficiency Measures

The methodology used in the analyses for each of the prototypical building types begins with a design that matches the specifications as described in Table 2 for each of the three vintages. Prospective energy efficiency measures were modeled in each of the prototypes to determine the projected electricity and natural gas energy savings relative to the baseline vintage. In some cases, where logical, measures were packaged together. Unless specified otherwise, all measures were evaluated using CBECC-Res.

All measures are evaluated based on work required above and beyond any work triggered by Title 24 code requirements. Measures apply regardless of the scope of the remodel and are evaluated assuming they are not otherwise required by Title 24. For example, duct sealing is required by code whenever heating and cooling equipment is altered. For this analysis duct sealing was evaluated for those projects where it is not already triggered by code (i.e. no changes to the heating or cooling equipment). Where appropriate, measure requirements align with those defined in Title 24. The one exception is the cool roof measure which applies when a building is already installing a new roof as part of the remodel. The minimum solar reflectance value is more stringent than that required in Title 24, Part 6.

Following are descriptions of each of the efficiency upgrade measures applied in this analysis.

Attic Insulation: Add attic insulation in buildings with vented attic spaces to meet R-38.

Air Sealing & Weather-stripping: Apply air sealing practices throughout all accessible areas of the building. For this study, it was assumed that older vintage buildings would be leakier than newer buildings and that approximately 30% improvement in air leakage was achievable through air sealing of all accessible areas. For modeling purposes, it was assumed that air sealing can reduce infiltration levels from 10 to 7 air changes per hour at 50 Pascals pressure difference (ACH50) in the two older vintages (pre-1992) and from 7 to 5 ACH50 in the newer vintage.

Cool Roof: For steep slope roofs, install a roofing product rated by the Cool Roof Rating Council (CRRC) with an aged solar reflectance of 0.25 or higher and thermal emittance of 0.75 or higher. This measure only applies to buildings that are installing a new roof as part of the scope of the remodel; therefore, the cost associated with this upgrade only reflects the incremental cost of a standard roofing product with one that is CRRC rated. This is similar to cool roof requirements in 2016 Title 24 Section 150.2(b)1Hi, but assumes a higher solar reflectance.

Window Replacement: Replace existing single pane windows with a dual pane product, which has a U-factor equal to 0.32 or lower and an Solar Heat Gain Coefficient (SHGC) equal to 0.25 or lower. This measure was only evaluated for the pre-1978 vintage, which is assumed to have single-pane, metal-frame windows.

Duct Sealing: Air seal all ductwork to meet the requirements of the 2016 Title 24 Section 150.2(b)1E. For this analysis, a final duct leakage value of 15 percent was applied, which corresponds to Option i in the Title 24 code section referenced.

Water Heater Blanket: Add R-6 insulation to the exterior of existing residential tank storage water heaters. For the analysis, the water heater was modeled within conditioned space, which is a typical configuration for older homes. This assumption is conservative since a water heater located in unconditioned space will tend to have higher tank losses and installing a water heater blanket in those situations will result in additional savings. The energy savings for this measure reflect only water heating energy savings only, and do not include any impacts to the space conditioning load, which reduces space cooling loads and increases space heating loads. In most climates, with the exception of heating dominated ones, the combination of these two impacts results in net energy savings. This measure was evaluated using EnergyPlus. This measure was evaluated for individual water heaters only and would not apply to central water heating systems.

Hot Water Pipe Insulation: Insulate all accessible hot water pipes with R-3 pipe insulation. In certain buildings which have slab on grade construction, and the majority of pipes located either underground or within the walls, most of the pipes will be inaccessible. For the purposes of this analysis a conservative assumption that only ten percent of the pipes could be insulated was applied. In buildings where pipes are located in the attic, crawlspace, or are otherwise more accessible, energy savings will be higher than those presented in this analysis. This measure was evaluated using BEopt and EnergyPlus.

Low Flow Fixtures: Upgrade sink and shower fittings to meet current CALGreen requirements, which require maximum flow rates of 1.8 gallons per minute (gpm) for showerheads and kitchen faucets, and 1.2 gpm for bathroom faucets. This measure

assumed the upgraded fixtures reduce flow rates by ten percent for showerheads and 20 percent for all faucets based on a 2010 water use study (ConSol, 2010). Baseline flow rates were based on BEopt assumptions. This measure was evaluated using BEopt and EnergyPlus.

LED Lighting: Replace screw-in incandescent lamps with screw-in light emitting diode (LED) lamps. This analysis was conducted external to the energy model assuming replacing a 45 W halogen or incandescent lamp with an 11 W LED lamp operating 620 hours annually. Annual hour estimates were based on whole building average hours of operation from a 2010 lighting study by KEMA (KEMA, 2010). Lifetime assumptions were 1,000 hours for incandescent lamps and 25,000 hours for LED lamps.

Lighting Vacancy Sensors: Install manual on - automatic off vacancy sensors that meet the requirements of Title 24 Section 110.9(b)4.C. This analysis was conducted external to the energy model assuming ten percent savings in operating hours for sensors installed on lights in bathrooms, bedrooms, offices, utility rooms, and garages. Energy savings assumed each sensor controls on average three 45 W halogen lamps operating 620 hours annually. Annual hour estimates were based on whole building average hours of operation from a 2010 lighting study by KEMA (KEMA, 2010).

2.3 Efficiency Packages

A few of the measures described above were also evaluated as part of a package. Three packages were developed as described below.

Envelope & Duct Package – R-38 Attic Insulation & Air Sealing & Duct Sealing: Air sealing and attic insulation are very often applied as a package in building retrofits. The boundary between the living space and vented attics is where a significant amount of building air leakage can occur, and sealing these areas as well as ducts prior to covering the attic floor with insulation is both practical and effective. Air sealing, duct sealing and insulation also directly address occupant comfort, as they reduce heat transfer, and result in more even temperatures within the building.

Water Heating Package – Water Heater Blanket, Hot Water Pipe Insulation, & Low-Flow Fixtures: These three water heating measures are all relatively low cost and work together to reduce building hot water energy use.

Lighting Package – LED Lamps & Vacancy Sensors: These two lighting measures reduce lighting energy use in rooms with existing low efficacy lighting and no lighting controls.

2.4 Measure Cost

Table 3 summarizes the cost assumptions for each of the measures evaluated. Costs were obtained from various sources, including local contractors, internet searches, past projects, and technical reports.

Table 3: Measure Descriptions & Cost Assumptions[1]

Measure	Performance Level	Incremental Cost – Single Family Building			Incremental Cost - Multifamily Residential Unit			Source	Notes (SF = single family; MF = multifamily)
		Pre 1978	1978 – 1991	1992 - 2005	Pre 1978	1978 – 1991	1992 - 2005		
Attic Insulation	R-38	$1,915	$1,548	$1,548	$500	$405	$405	Retrofit contractor[2]	$1.15/sqft ceiling area for full replacement (assume R-11 is removed in Pre-1978 case) $0.93/sqft to add insulation to existing R-19 insulation
Air sealing	7 ACH50	$959	$959	n/a	$341	$341	n/a	Retrofit contractor[2]	$173 materials & 19.5 hours labor ($40.30/hr common labor rate)[5] for SF. $67 materials and 6.8 hours labor for MF.
	5 ACH50	n/a	n/a	$959	n/a	n/a	$341		
Cool roof	Aged Reflectance ≥ 0.25	$577	$577	$577	$167	$167	$167	Research report[3]	Based on $0.32/sqft roof area incremental cost for cool asphalt shingle product, plus a 10% contractor markup. Higher reflectance values for lower cost are achievable for tile roof products
Window U-factor/ SHGC	0.32/0.25	$9,810	n/a	n/a	$5,873	n/a	n/a	Retrofit contractor[4]	Based on $45/sqft window area installed cost
Duct sealing	15% of nominal airflow	$240	$240	$240	$120	$120	$120	HVAC contractor	Assumes 4 hours of labor for SF and 2 hours per MF apartment with ducts in the attic ($54/hr HVAC labor rate)[5] + $24 material for SF and $12 material for MF (per unit).
Water heater blanket	R-6	$40	$40	$40	$40	$40	$40	Internet search	$20 blanket + ½-hr labor ($40.30/hr laborer rate)[5]
Hot water pipe insulation	3/4" (R-3)	$42	$42	$42	$42	$42	$42	Internet search	$0.20/ft of ¾" pipe insulation. 10ft total + 1-hr labor ($40.30/hr common labor rate)[5]
Low flow fixtures	CALGreen	$126	$126	$126	$86	$86	$86	Retrofit contractor[4]	Showerheads at $34.74 each + sink aerators at $5.37 each + 1-hr labor ($40.30/hr common labor rate)[5]. 2 showerheads & 3 aerators assumed for SF and 1 showerhead and 2 aerators for MF.
LED lamp	11W screw-in bulb	$4	$4	$4	$4	$4	$4	Internet search	$4 for LED dimmable A19 lamp 60W equivalent. $0.97 for an equivalent incandescent product which was used to estimate total replacement costs.
Vacancy Sensor	Manual on, auto off	$30	$30	$30	$30	$30	$30	Internet search	$20 per sensor + 1/4-hr labor ($40.30/hr common labor rate)[5].

[1] Costs include contractor overhead and profit
[2] Source: Retrofit contractor pricing, including labor, obtained by Davis Energy Group through the 2012 LA County Retrofit Program (DEG, 2017).
[3] Codes and Standards Enhancement Initiative: Residential Roof Envelope Measures. 2013 Title 24.
http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/current/Reports/Residential/Envelope/2013_CASE_R_Roof_Measures_Oct_2011.pdf
[4] Source: Retrofit contractor pricing obtained by Davis Energy Group through the Stockton Energy Challenge neighborhood retrofit program (DEG, 2017).
[5] Labor rates are estimated from RSMeans (RSMeans, 2014).

2.4.1 Cost-Effectiveness

A customer-based approach to evaluating cost-effectiveness was used based on past experience with reach code adoption by local governments. Residential utility rates at the time of the analysis were applied to calculate utility costs for all cases and determine cost-effectiveness for the proposed measures and packages. Annual utility costs were calculated using hourly electricity and gas output from CBECC-Res and applying the utility tariffs summarized in Table 4 and included in Appendix C. The standard residential rate was applied to all cases.

Climate zones have been applied according to the predominant investor owned utility (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.

Table 4: IOU Utility Tariffs Used Based on Climate Zone

Climate Zones	Electric/Gas Utility	Electricity (Standard)	Natural Gas
1-5, 11-13, 16	PG&E	E1	G1
6, 8-10, 14, 15	SCE/SoCalGas®	D	GR
7, 10, 14	SDG&E	DR	GR

Cost-effectiveness was evaluated for all 16 climate zones and is presented according to the lifecycle benefit-to-cost (B/C) ratio. This B/C ratio represents the cost-effectiveness of energy efficiency over a 30-year lifetime taking into account discounting of future savings and financing of incremental costs. A value of one indicates the savings over the life of the measure are equivalent to the incremental cost of that measure. A value greater than one represents a positive return on investment. The ratio is calculated as follows:

Equation 1

$$Lifecycle\ Benefit\ to\ Cost\ Ratio = \frac{(Annual\ utility\ cost\ savings\ *\ Lifecycle\ cost\ factor)}{(First\ incremental\ cost\ *\ Financing\ factor)}$$

The lifecycle cost factor is 19.6 and was calculated using Equation 2 as follows. No utility rate escalation is assumed which if observed would increase the B/C ratios found in this study. However, if peak TOU periods continue shifting into the evening and future NEM rates continue devaluing grid exports, both of which are likely, the B/C ratios presented here would decrease.

$$\boldsymbol{Lifecycle\ Cost\ Factor} = \frac{\mathbf{1} - (\mathbf{1} + \boldsymbol{disc})^{-\boldsymbol{n}}}{\boldsymbol{disc}} \quad \text{Equation 2}$$

Where:

- *n* = analysis term of 30 years
- *disc* = real discount rate of three percent

The financing factor is calculated as follows:

$$\boldsymbol{Financing\ Factor} = \frac{\boldsymbol{PV_{Mortgage\ Increase}} - \boldsymbol{PV_{Tax\ Savings}}}{\boldsymbol{L}} \quad \text{Equation 3}$$

Where:

- *L* = first incremental cost ($)
- $PV_{Mortgage\ Increase}$ = Present value of increased mortgage costs
- $PV_{Tax\ Savings}$ = Present value of tax savings from additional interest payments due to increased mortgage

$PV_{Mortgage\ Increase}$ is calculated using Equations 4 and 5.

$$P = L\frac{\left[\frac{c}{12} * \left(1+\frac{c}{12}\right)^{n_loan * 12}\right]}{\left[\left(1+\frac{c}{12}\right)^{n_loan * 12} - 1\right]} \qquad \text{Equation 4}$$

$$PV_{Mortgage\ Increase} = P * 12\frac{1-(1+disc)^{-n_loan}}{disc} \qquad \text{Equation 5}$$

Where:

- *P* = incremental monthly mortgage payment ($)
- *c* = loan interest rate
- *n_loan* = financing term

$PV_{Tax\ Savings}$ is calculated using Equations 6 and 7.

$$Annual\ Tax\ Savings = balance * c * taxrate \qquad \text{Equation 6}$$

$$PV_{Tax\ Savings} = \sum_{y=1}^{n} Annual\ Tax\ Savings * \frac{1}{(1+disc)^y} \qquad \text{Equation 7}$$

Where:

- *taxrate* = average tax rate of 20 percent (to account for tax savings due to loan interest deductions)
- *balance* = balance of mortgage at beginning of each year
- *y* = year

Simple payback is also presented and is calculated using the equation below.

$$Simple\ payback = First\ incremental\ cost / Annual\ customer\ utility\ cost\ savings \qquad \text{Equation 8}$$

Table 5 summarizes the financing assumptions and final terms that were applied in this analysis. The analysis term is 30 years in all cases.

Table 5: Final Financing Assumptions

	Loan Term	Loan Rate	Lifecycle Factor *(Equation 2)*	Financing Factor *(Equation 3)*
Single Family	30	5%	19.60	1.127
Multifamily	10	4%	19.60	0.998

The LED lighting and vacancy sensor upgrades are the only measures that are not assumed to be financed. The above equations and assumptions all still apply, except the financing factor is removed from Equation 1.

Simple payback is also presented and is calculated using the equation below.

$$Simple\ payback = First\ incremental\ cost\ /\ First\ year\ utility\ cost\ savings \qquad \text{Equation 9}$$

Maintenance costs were not included for any measures because there are no incremental maintenance costs expected for any of the measures evaluated. Any maintenance requirements that would apply are similar to both the upgrade and the base

case. LED lamp upgrade is the only measure with assumed replacement costs based on lifetime assumptions of LED and incandescent technologies and estimated operating hours. See the measures description in Section 2.2 for additional details.

3 Results

Cost-effectiveness analysis was completed for the three vintages and both single family and multifamily unit prototypes. Evaluations looked to identify cost-effective energy upgrades for existing buildings at the time of a remodel.

Results of cost-effectiveness analysis along with energy savings are presented in Appendix C in Table 8 through Table 43 for single family and multifamily buildings, by climate zone. Site energy savings, cost savings, measure cost, and cost-effectiveness including simple payback and lifecycle B/C ratio are provided. Results are presented for each of the three vintages. Shaded rows in the tables indicate that the measure is not cost-effective. The lifecycle B/C ratio threshold of one for the financed measures is roughly equivalent to a simple payback of 17 years for single family and 20 years for multifamily. For Climate Zones 10 and 14, cost-effectiveness results are separated out for buildings in both SCE and SDG&E territories, which differ based on applicable utility rates.

Some measure results do not differ between the vintages such as LED lamp replacement and water heating upgrades. The water heating and lighting measures are cost-effective for both single family and multifamily in all cases. Cost-effectiveness for the envelope and sealing measures is dependent on climate zone and building vintage. A summary of these results is provided below.

Envelope & Duct Package – R-38 Attic Insulation & Air Sealing & Duct Sealing: All of these measures were found to be cost-effective for all vintages in inland, cooling climates, as well as cold climates (Climate Zone 11-16 for single family and Climate Zone 10-16 for multifamily). Air sealing and attic insulation are less cost-effective in newer vintages in transitional and coastal climates, but all measures are also cost-effective in the following:

- Buildings built before 1992: Single family Climate Zone 1 and 10; and multifamily Climate Zone 1, 2, and 9
- Buildings built before 1978 only: Single family Climate Zone 2-5 and 8-9; and multifamily Climate Zone 3-6, and 8

Duct sealing is cost-effective in all cases except for single family homes in Climate Zone 6 and 7 built after 1977, and multifamily in Climate Zone 3, 5, 6 and 7 built after 1991.

Cost-effectiveness of the envelope and duct measures was better in SDG&E territory than SCE territory for both Climate Zone 10 and 14. In Climate Zone 10 the full package was cost-effective for single family in all vintages under the SDG&E scenario. Under the SCE scenario, only duct sealing was cost-effective for homes built after 1991 in Climate Zone 10.

Cool Roof: Cool roof is cost-effective for all vintages of single family and multifamily homes in Climate Zones 8 through 15. It is also cost-effective for all vintage multifamily homes in Climate Zone 4 and for older vintage multifamily buildings built before 1992 in Climate Zones 2, 6, 7, and 16.

Window Replacement: Window replacements are only cost-effective in buildings before 1978 in Climate Zones 11, 13, and 15, in addition to Climate Zones 10 and 14 in SDG&E territory.

4 Recommendations & Discussion

This analysis evaluated the feasibility and cost-effectiveness of retrofit measures in California existing homes built before 2006. A customer-based lifecycle cost approach to evaluating cost-effectiveness was applied quantifying the utility cost savings associated with energy efficiency measures compared to the costs associated with the measures.

4.1 Recommended Efficiency Measures

Based on the analysis, the cost-effective measures or packages of measures listed in Table 6 for single family and Table 7 for multifamily are recommended. The multifamily measures apply only to residential spaces in low-rise buildings (3 stories or fewer) and not to any common or non-residential spaces. Descriptions of each measure or package are provided below. In most cases, exceptions are defined which would exempt a particular project from a measure if certain conditions exist. These exceptions are based on existing on-site conditions and cost-effectiveness.

Attic Insulation: Add attic insulation to a minimum level of R-38 in vented attics. This measure applies to homes according to vintage, building type and climate zone as defined in Table 6 and Table 7.

Exception 1: Buildings without vented attic spaces and buildings with existing attic insulation levels greater than R-19 in Climate Zones 1-5 and 8-16 and greater than R-5 in Climate Zones 6 and 7.

Air Sealing: Seal all accessible cracks, holes and gaps in the building envelope at walls, floors, and ceilings. Pay special attention to penetrations including plumbing, electrical, and mechanical vents, recessed can light fixtures, and windows. Weather-strip doors if not already present. A blower door test is not required for verification. Verification shall be conducted by the building department following a prescriptive checklist (to be developed) which outlines what building aspects need to be addressed by the permit applicant and verified by an inspector. This measure applies to homes according to vintage, building type and climate zone as defined in Table 6 and Table 7.

Exception 1: Buildings that can demonstrate blower door test results showing 5 ACH50 or lower, a 30 percent reduction from pre-retrofit conditions, or can otherwise demonstrate that air sealing meeting the requirements of this ordinance was conducted within the last 12 months.

Cool Roof: When replacing a roof, install a roofing product rated by the Cool Roof Rating Council to have an aged solar reflectance equal to or greater than 0.25, and a thermal emittance equal to or greater than 0.75, regardless of the compliance approach (prescriptive or performance). This measure only applies to steep slope roofs (ratio of rise to run greater than 2:12) and to buildings that are installing a new roof as part of the scope of the remodel and where more than 50 percent of the roof is being replaced. This applies only to certain homes according to vintage, building type and climate zone as defined in Table 6 and Table 7. Low slope roofs (ratio of rise to run of 2:12 or less) shall meet the requirements of Section 150.2(b)1Hii of 2016 Title 24 Standards. See Appendix B for additional details on the requirements per Title 24.

Exception 1: Projects that are not installing a new roof as part of the scope. Only areas of roof that are to be re-roofed are subject to the cool roof upgrade.

Exception 2: All exceptions as stated in the 2016 Title 24 Section 150.2(b)1Hi for steep slope roofs and 150.2(b)1Hii for low slope roofs are allowed.

Windows: In a few climate zones, window upgrades were found to be cost-effective for the pre-1978 vintage buildings with existing single pane windows, but is not included as a recommended measure. The cost requirement for window replacement is significant and the margin for cost-effectiveness is lower than many other measures.

Duct Sealing: Air seal all ductwork to meet the requirements of the 2016 Title 24 Section 150.2(b)1E, with the exception that duct testing is not required to be verified by a HERS Rater. The contractor conducting the air sealing must test duct sealing and complete a self-certification form (to be developed) to provide to the building department. The form must be accompanied with a photograph of the contractor's gauge indicating the leakage results. See Appendix B for additional details on the requirements per Title 24. This measure applies to homes according to vintage, building type and climate zone as defined in Table 6 and Table 7.

Exception 1: All exceptions as stated in the 2016 Title 24 Section 150.2(b)1E are allowed.

Exception 2: Projects that require duct sealing as part of an HVAC alteration or replacement must meet the all of the requirements of Title 24, Part 6, including HERS Rater verification.

Water Heating Package: Add exterior insulation meeting a minimum of R-6 to storage water heaters. Insulate all accessible hot water pipes with pipe insulation a minimum of ¾" inch thick. This includes insulating the supply pipe leaving the water heater, piping to faucets underneath sinks, and accessible pipes in attic spaces or crawlspaces. Upgrade fittings in sinks and showers to meet current CALGreen requirements.

Exception 1: Water heater blanket is not required on water heaters less than 20 gallons.

Exception 2: Water heater blanket not required if application of a water heater blanket voids the warranty on the water heater.

Exception 3: Fixtures with rated flow rates no more than ten percent greater than current CALGreen requirements.

Exception 4: Water heater blanket is not required for multifamily buildings with central water heating systems.

Lighting Package:: Replace all interior and exterior screw-in (A-base) incandescent and halogen lamps with screw-in LED lamps. Install manual-on automatic-off vacancy sensors that meet the requirements in the Title 24 Section 110.9(b)4.C in all bathrooms, bedrooms, offices, laundry rooms, utility rooms, and garages.

Exception 1: Spaces which already include vacancy sensors, motions sensors, or dimmers.

Table 6: Summary of Single Family Results

CASE		CZ1-PGE	CZ2-PGE	CZ3-PGE	CZ4-PGE	CZ5-PGE	CZ6-SCE	CZ7-SDGE	CZ8-SCE	CZ9-SCE	CZ10-SCE	CZ10-SDGE	CZ11-PGE	CZ12-PGE	CZ13-PGE	CZ14-SCE	CZ14-SDGE	CZ15-SCE	CZ16-PGE
Envelope-Duct Package	Pre-1978	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38	Ducts/ R-38	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal
	1978-1991	Ducts/ R-38/ Air Seal	Ducts	Ducts	Ducts	Ducts	N/A	N/A	Ducts	Ducts	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal
	1992-2005	Ducts	Ducts	Ducts	Ducts	Ducts	N/A	N/A	Ducts	Ducts	Ducts	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal
Cool Roof	Pre-1978	N/A	N/A	N/A	Yes	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A
	1978-1991	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A
	1992-2005	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A
Windows	Pre-1978	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water Heating Package	All Vintages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lighting Package	All Vintages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 7: Summary of Multifamily Results

CASE		CZ1-PGE	CZ2-PGE	CZ3-PGE	CZ4-PGE	CZ5-PGE	CZ6-SCE	CZ7-SDGE	CZ8-SCE	CZ9-SCE	CZ10-SCE	CZ10-SDGE	CZ11-PGE	CZ12-PGE	CZ13-PGE	CZ14-SCE	CZ14-SDGE	CZ15-SCE	CZ16-PGE
Envelope-Duct Package	Pre-1978	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal
	1978-1991	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts	Ducts	Ducts	Ducts	Ducts	Ducts	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal
	1992-2005	Ducts	Ducts	N/A	Ducts	N/A	N/A	N/A	Ducts	Ducts	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal
Cool Roof	Pre-1978	N/A	Yes	N/A	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1978-1991	N/A	Yes	N/A	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1992-2005	N/A	N/A	N/A	Yes	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A
Windows	Pre-1978	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water Heating Package	All Vintages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lighting Package	All Vintages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4.2 Other Considerations

HERS Field Verification: HERS field verification is not required to meet any of the requirements for the recommended measures unless the measure is used to meet Title 24 compliance. Measure installation shall be verified by a city building inspector or another third party inspector deemed appropriate by the building department. While a HERS Rater is not required, one could be used as an alternative to inspections by the building department.

Combustion Appliance Safety and Indoor Air Quality: Implementation of some of the recommended measures will affect the pressure balance of the home which can subsequently impact the safe operation of existing combustion appliances as well as indoor air quality. Buildings with older gas appliances can present serious health and safety problems which may not be addressed in a remodel if the appliances are not being replaced. It is recommended that the building department inspect all combustion appliances after completion of the retrofit work. It's also recommended that jurisdictions consider requiring combustion safety testing by a certified professional whenever air sealing and insulation measures are applied and existing combustion appliances are located within the pressure boundary of the building.

Jurisdictions may also want to consider requiring mechanical ventilation in homes where air sealing has been conducted. In older buildings, outdoor air is typically introduced through leaks in the building envelope. After air sealing a building, it may be necessary to forcefully bring in fresh outdoor air using supply and/or exhaust fans to minimize issues associated with indoor air quality.

Required Measures Included in Title 24 Performance Simulation: If any of the measures above are included in a performance Title 24 compliance report, it's suggested that trade-offs be allowed as long as all minimum code requirements are met. For example, if a project is installing new windows and a new roof and insulating the attic and is demonstrating compliance with Title 24 with a performance simulation run, it would be acceptable if the installed roof did not meet the requirements listed above as long as this was traded off with either an increase in attic insulation or better performing windows. This would also allow trade-offs for projects that are installing high impact measures, such as solar water heating or whole house fans. This would require two simulation runs; however, it's not expected this approach would be utilized often. One run (#1) would evaluate the proposed building upgrades. This would also be the report submitted to the building department for the permit application demonstrating compliance with Title 24. A second run (#2) would also be completed with the minimum ordinance requirements modeled for each of the affected building components. The applicant would need to demonstrate that the proposed upgrades (#1) would result in annual time dependent valuation (TDV) energy use equal to or less than the annual TDV energy use of the case based on the ordinance requirements (#2)

5 References

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Appendix A – Utility Rate Tariffs

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 March 2018

Pacific Gas and Electric Company
U 39 San Francisco, California

	Revised	Cal. P.U.C. Sheet No.	41845-E
Cancelling	Revised	Cal. P.U.C. Sheet No.	41626-E

ELECTRIC SCHEDULE E-1
RESIDENTIAL SERVICES

Sheet 1

APPLICABILITY: This schedule is applicable to single-phase and polyphase residential service in single-family dwellings and in flats and apartments separately metered by PG&E; to single-phase and polyphase service in common areas in a multifamily complex (see Special Condition 8); and to all single-phase and polyphase farm service on the premises operated by the person whose residence is supplied through the same meter.

The provisions of Schedule S—Standby Service Special Conditions 1 through 6 shall also apply to customers whose premises are regularly supplied in part (but not in whole) by electric energy from a nonutility source of supply. These customers will pay monthly reservation charges as specified under Section 1 of Schedule S, in addition to all applicable Schedule E-1 charges. See Special Conditions 11 and 12 of this rate schedule for exemptions to standby charges.

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

RATES: Total bundled service charges are calculated using the total rates below. Customers on this schedule are subject to the delivery minimum bill amount shown below applied to the delivery portion of the bill (i.e. to all rate components other than the generation rate). In addition, total bundled charges will include applicable generation charges per kWh for all kWh usage.

Customers receiving a medical baseline allowance shall pay for all usage in excess of 200 percent of baseline at a rate $0.04000 per kWh less than the applicable rate for usage in excess of 200 percent of baseline. No portion of the rates paid by customers that receive a Medical Baseline allowance shall be used to pay the DWR Bond charge. For these customers, the Conservation Incentive Adjustment is calculated residually based on the total rate less the sum of: Transmission, Transmission Rate Adjustments, Reliability Services, Distribution, Generation, Public Purpose Programs, Nuclear Decommissioning, Competition Transition Charges (CTC), New System Generation Charges, and Energy Cost Recovery Amount. Customers receiving a medical baseline allowance shall also receive a 50 percent discount on the delivery minimum bill amount shown below.

Direct Access (DA) and Community Choice Aggregation (CCA) charges shall be calculated in accordance with the paragraph in this rate schedule titled Billing.

TOTAL RATES

Total Energy Rates ($ per kWh)	
Baseline Usage	$0.21169 (I)
101% - 400% of Baseline	$0.27993 (I)
High Usage Over 400% of Baseline	$0.43343 (I)
Delivery Minimum Bill Amount ($ 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) (R)

(Continued)

Advice	5231-E	*Issued by*	*Date Filed*	February 16, 2018
Decision		***Robert S. Kenney***	*Effective*	March 1, 2018
		Vice President, Regulatory Affairs	*Resolution*	

Pacific Gas and Electric Company
U 39 San Francisco, California

	Revised	*Cal. P.U.C. Sheet No.*	33319-G
Cancelling	Revised	*Cal. P.U.C. Sheet No.*	33280-G

GAS SCHEDULE G-1
RESIDENTIAL SERVICE

Sheet 1

APPLICABILITY: This rate schedule* 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.

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:

Minimum Transportation Charge:**	Per Day
	$0.09863

	Per Therm			
	Baseline		Excess	
Procurement:	$0.39848	(R)	$0.39848	(R)
Transportation Charge:	$0.88798		$1.42077	
Total:	$1.28646	(R)	$1.81925	(R)

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.

BASELINE QUANTITIES: The delivered quantities of gas shown below are billed at the rates for baseline use.

BASELINE QUANTITIES (Therms Per Day Per Dwelling Unit)

Baseline Territories***	Summer Effective Apr. 1, 2016	Winter Effective Nov. 1, 2015
P	0.46	2.15
Q	0.69	1.98
R	0.46	1.79
S	0.46	1.92
T	0.69	1.79
V	0.69	1.79
W	0.46	1.69
X	0.59	1.98
Y	0.85	2.55

* PG&E's gas tariff's are available online at www.pge.com.
** The Minimum Transportation charge does not apply to submetered tenants of master-metered customers served under gas rate Schedules GS and GT.
*** The applicable baseline territory is described in Preliminary Statement, Part A.

(Continued)

Advice	3836-G	*Issued by*	*Date Filed*	April 24, 2017
Decision	97-10-065 & 98-07-025	***Robert S. Kenney***	*Effective*	May 1, 2017
		Vice President, Regulatory Affairs	*Resolution*	

Pacific Gas and Electric Company

Residential Non-CARE and CARE Gas Tariff Rates
January 1, 2016, 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/]	
04/01/17	3827-G	$0.09863	$0.42225	$0.88798	$1.42077	$1.31023	$1.84302
05/01/17	3836-G	$0.09863	$0.39848	$0.88798	$1.42077	$1.28646	$1.81925
06/01/17	3844-G	$0.09863	$0.39102	$0.88798	$1.42077	$1.27900	$1.81179
07/01/17	3859-G	$0.09863	$0.31906	$0.88566	$1.41705	$1.20472	$1.73611
08/01/17	3870-G	$0.09863	$0.32821	$0.88566	$1.41705	$1.21387	$1.74526
09/01/17	3879-G	$0.09863	$0.27240[7/]	$0.88566	$1.41705	$1.15806	$1.68945
10/01/17	3886-G	$0.09863	$0.31496	$0.88566	$1.41705	$1.20062	$1.73201
11/01/17	3899-G	$0.09863	$0.34180	$0.88566	$1.41705	$1.22746	$1.75885
12/01/17	3913-G	$0.09863	$0.37595[7/]	$0.88566	$1.41705	$1.26161	$1.79300
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[7/]	$0.91828	$1.46925	$1.23931	$1.79028

[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 $0.02431 per therm to reflect account balance amortizations in accordance with Advice Letter 3157-G.
Seasons: **Winter** = Nov-Mar **Summer** = April-Oct

The following are the SCE electricity tariffs and SoCalGas natural gas tariff applied in this study.

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

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

Revised Cal. PUC Sheet No. 62848-E
Cancelling Revised Cal. PUC Sheet No. 62244-E

Schedule D
DOMESTIC SERVICE

Sheet 2

(Continued)

RATES

	Delivery Service Total[1]	Generation[2] UG***	Generation[2] DWREC[3]
Energy Charge- $/kWh/Meter/Day			
Baseline Service			
Summer	0.06675 (I)	0.06569 (I)	0.00000
Winter	0.06675 (I)	0.06569 (I)	0.00000
Nonbaseline Service*			
101% - 400% of Baseline - Summer	0.16034 (R)	0.06569 (I)	0.00000
Winter	0.16034 (R)	0.06569 (I)	0.00000
High Usage Charge			
(Over 400% of Baseline) - Summer	0.26072 (I)	0.06569 (I)	0.00000
- Winter	0.26072 (I)	0.06569 (I)	0.00000
Basic Charge - $/Meter/Day			
Single-Family Accommodation	0.031		
Multi-Family Accommodation	0.024		
Minimum Charge** - $/Meter/Day			
Single-Family Accommodation	0.335 (I)		
Multi-Family Accommodation	0.335 (I)		
Minimum Charge (Medical Baseline)** - $/Meter/Day			
Single-Family Accommodation	0.169 (I)		
Multi-Family Accommodation	0.169 (I)		
California Climate Credit[4]	(36.00) (R)		
Peak Time Rebate - $kWh		(0.75)	
Peak Time Rebate w/enabling technology - $/kWh		(1.25)	

* Nonbaseline Service includes all kWh in excess of applicable Baseline allocations as described in Preliminary Statement, Part H, Baseline Service.

** The Minimum Charge is applicable when the Delivery Service Energy Charge, plus the applicable Basic Charge is less than the Minimum Charge.

*** The ongoing Competition Transition Charge (CTC) of $(0.00075) per kWh is recovered in the UG component of Generation. (I)

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 Generation 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 3695-E-A
Decision

Issued by
Caroline Choi
Senior Vice President

(To be inserted by Cal. PUC)
Date Filed Dec 22, 2017
Effective Jan 1, 2018
Resolution

2C11

SOUTHERN CALIFORNIA GAS COMPANY Revised CAL. P.U.C. SHEET NO. 54800-G
LOS ANGELES, CALIFORNIA CANCELING Revised CAL. P.U.C. SHEET NO. 54771-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]	29.482¢	29.482¢	N/A
Transmission Charge: [3]	53.427¢	53.427¢	53.577¢
Total Baseline Charge:	82.909¢	82.909¢	53.577¢
Non-Baseline Rate, per therm (usage in excess of baseline usage):			
Procurement Charge: [2]	29.482¢	29.482¢	N/A
Transmission Charge: [3]	86.226¢	86.226¢	86.376¢
Total Non-Baseline Charge:	115.708¢	115.708¢	86.376¢

[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. 5266
DECISION NO.
1C5

ISSUED BY
Dan Skopec
Vice President
Regulatory Affairs

(TO BE INSERTED BY CAL. PUC)
DATE FILED Mar 8, 2018
EFFECTIVE Mar 10, 2018
RESOLUTION NO. G-3351

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

San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 29903-E
Canceling Revised Cal. P.U.C. Sheet No. 29682-E

Sheet 1

SCHEDULE DR

RESIDENTIAL SERVICE
(Includes Rates for DR-LI)

APPLICABILITY

Applicable to domestic service for lighting, heating, cooking, water heating, and power, or combination thereof, in single family dwellings, flats, and apartments, separately metered by the utility; to service used in common for residential purposes by tenants in multi-family dwellings under Special Condition 8; to any approved combination of residential and nonresidential service on the same meter; and to incidental farm service under Special Condition 7.

This schedule is also applicable to customers qualifying for the California Alternate Rates for Energy (CARE) Program and/or Medical Baseline, residing in single-family accommodations, separately metered by the Utility, and may include Non-profit Group Living Facilities and Qualified Agricultural Employee Housing Facilities, if such facilities qualify to receive service under the terms and conditions of Schedule E-CARE. The rates for CARE and Medical Baseline customers are identified in the rates tables below as DR-LI and DR-MB rates, respectively.

Customers on this schedule may also qualify for a semi-annual California Climate Credit $(33.50) per Schedule GHG-ARR.

TERRITORY

Within the entire territory served by the Utility.

RATES

Total Rates:

Description - DR Rates	UDC Total Rate		DWR-BC Rate		EECC Rate + DWR Credit		Total Rate	
Summer:								
Up to 130% of Baseline Energy ($/kWh)	0.09311	I	0.00549		0.17244	R	0.27104	I
131% - 400% of Baseline ($/kWh)	0.29722	I	0.00549		0.17244	R	0.47515	I
Above 400% of Baseline ($/kWh)	0.37566	I	0.00549		0.17244	R	0.55361	I
Winter:								
Up to 130% of Baseline Energy ($/kWh)	0.15406	I	0.00549		0.07075	R	0.23030	I
131% - 400% of Baseline ($/kWh)	0.32746	I	0.00549		0.07075	R	0.40372	I
Above 400% of Baseline ($/kWh)	0.39415	I	0.00549		0.07075	R	0.47039	I
Minimum Bill ($/day)	0.329						0.329	

Description -DR-LI Rates	UDC Total Rate		DWR-BC Rate		EECC Rate + DWR Credit		Total Rate		Total Effective CARE Rate	
Summer – CARE Rates:										
Up to 130% of Baseline Energy ($/kWh)	0.09246	I	0.00000		0.17244	R	0.26490	I	0.16772	I
131% - 400% of Baseline ($/kWh)	0.29657	I	0.00000		0.17244	R	0.46901	I	0.29912	I
Above 400% of Baseline ($/kWh)	0.37503	I	0.00000		0.17244	R	0.54747	I	0.34963	I
Winter – CARE Rates:										
Up to 130% of Baseline Energy ($/kWh)	0.15341	I	0.00000		0.07075	R	0.22416	I	0.14150	I
131% - 400% of Baseline ($/kWh)	0.32683	I	0.00000		0.07075	R	0.39758	I	0.25314	I
Above 400% of Baseline ($/kWh)	0.39350	I	0.00000		0.07075	R	0.46425	I	0.29606	I
Minimum Bill ($/day)	0.164						0.164		0.164	

(Continued)

1C7
Issued by
Dan Skopec
Vice President
Regulatory Affairs

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Resolution No.

Advice Ltr. No. 3167-E
Decision No.

San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 23019-G
Canceling Revised Cal. P.U.C. Sheet No. 23006-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/]	$0.34839	$0.34839 I	N/A
Transmission Charge:	$0.86581	$0.86581	$0.86581
Total Baseline Charge:	$1.21420	$1.21420 I	$0.86581
Non-Baseline Rate, per therm (usage in excess of baseline usage):			
Procurement Charge: [2/]	$0.34839	$0.34839 I	N/A
Transmission Charge:	$1.04206	$1.04206	$1.04206
Total Non-Baseline Charge:	$1.39045	$1.39045 I	$1.04206
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. 2649-G
Decision No.

Issued by
Dan Skopec
Vice President
Regulatory Affairs

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Resolution No.

Appendix B – Standards Sections

5.1.1 2016 Building Energy Efficiency Standards Section 150.2(b)1H

Roofs. Replacements of the exterior surface of existing roofs shall meet the requirements of Section 110.8 and the applicable requirements of Subsections i and ii where more than 50 percent of the roof is being replaced:

i. Low-rise residential buildings with steep-sloped roofs, in Climate Zones 10 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

EXCEPTION TO 150.2(b)1Hi: The following shall be considered equivalent to Subsection i:

a. Air-space of 1.0 inch (25 mm) is provided between the top of the roof deck to the bottom of the roofing product; or

b. The installed roofing product has a profile ratio of rise to width of 1 to 5 for 50 percent or greater of the width of the roofing product; or

c. Existing ducts in the attic are insulated and sealed according to Section 150.1(c)9; or

d. Buildings with at least R-38 ceiling insulation; or

e. Buildings with a radiant barrier in the attic meeting the requirements of Section 150.1(c)2; or

f. Buildings that have no ducts in the attic; or

g. In Climate Zones 10-15, R-2or greater insulation above the roof deck.

ii. ii. Low-sloped roofs in Climate Zones 13 and 15 shall have a 3-year aged solar reflectance equal or greater than 0.63 and a thermal emittance equal or greater than 0.75, or a minimum SRI of 75.

EXCEPTION 1 to Section 150.2(b)1Hii: Buildings with no ducts in the attic.

EXCEPTION 2 to Section 150.2(b)1Hii: The aged solar reflectance can be met by using insulation at the roof deck specified in TABLE 150.2-B.

5.1.2 2016 Building Energy Efficiency Standards Section 150.2(b)1E

Altered Space-Conditioning System - Duct Sealing: In all Climate Zones, when a space-conditioning system is altered by the installation or replacement of space-conditioning system equipment, including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil; the duct system that is connected to the altered space-conditioning system equipment shall be sealed, as confirmed through field verification and diagnostic testing in accordance with the applicable procedures for duct sealing of altered existing duct systems as specified in Reference Residential Appendix RA3.1 and the leakage compliance criteria specified in Reference Residential Appendix Table RA3.1-2, conforming to one of the following requirements:

iii. The measured duct sealing shall be equal to or less than 15 percent of system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

iv. The measured duct sealing to outside shall be equal to or less than 10 percent of system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4; or

v. If it is not possible to meet the duct sealing requirements of either Section 150.2(b)1Ei or Section 150.2(b)1Eii, then, all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified HERS Rater utilizing the methods specified in Reference Residential Appendix RA3.1.4.3.5.

EXCEPTION 1 to Section 150.2(b)1E: Duct Sealing. Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Reference Residential Appendix RA3.1.

EXCEPTION 2 to Section 150.2(b)1E: Duct Sealing. Duct systems with less than 40 linear feet as determined by visual inspection.

EXCEPTION 3 to Section 150.2(b)1E: Duct Sealing. Existing duct systems constructed, insulated or sealed with asbestos.

Appendix C – Measure Cost-effectiveness Tables

Climate Zone 1: The envelope and duct package is cost-effective for single family and multifamily homes built before 1992. For newer homes built before 2006 duct sealing alone is cost-effective. Cool roof upgrades and window replacements are not cost-effective.

Table 8: CZ 1 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	154	179	$3,114	$365	8.53	2.04
	1978-1991	80	93	$2,748	$189	14.53	1.20
	1992-2005	65	76	$2,748	$154	17.88	0.97
R-38 Attic Insulation	Pre-1978	50	57	$1,915	$117	16.30	1.07
	1978-1991	23	27	$1,548	$55	28.29	0.61
	1992-2005	23	26	$1,548	$53	28.97	0.60
Duct Sealing	Pre-1978	84	97	$240	$198	1.21	14.38
	1978-1991	37	43	$240	$88	2.72	6.38
	1992-2005	31	36	$240	$73	3.30	5.27
Cool Roof	Pre-1978	-28	-34	$635	-$68	-9.29	-1.87
	1978-1991	-21	-25	$635	-$50	-12.75	-1.36
	1992-2005	-22	-26	$635	-$52	-12.14	-1.43
Windows	Pre-1978	111	130	$9,810	$265	37.07	0.47
Water Heating Package	All Vintages	0	19	$208	$32	6.44	2.70
Lighting Package	All Vintages	23	0	$34	$5	6.47	3.92

Table 9: CZ 1 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	58	67	$961	$133	7.24	2.71
	1978-1991	28	33	$865	$55	15.83	1.24
	1992-2005	21	25	$865	$40	21.75	0.90
R-38 Attic Insulation	Pre-1978	15	16	$500	$33	15.26	1.29
	1978-1991	7	8	$405	$15	27.56	0.71
	1992-2005	7	8	$405	$13	31.23	0.63
Duct Sealing	Pre-1978	32	37	$120	$74	1.62	12.14
	1978-1991	12	13	$120	$23	5.13	3.82
	1992-2005	8	10	$120	$16	7.74	2.54
Cool Roof	Pre-1978	-7	-9	$184	-$17	-10.72	-1.83
	1978-1991	-4	-6	$184	-$10	-19.25	-1.02
	1992-2005	-4	-6	$184	-$9	-20.80	-0.94
Windows	Pre-1978	78	92	$5,873	$180	32.56	0.60
Water Heating Package	All Vintages	0	16	$168	$28	6.10	3.22
Lighting Package	All Vintages	23	0	$34	$5	6.47	3.92

Climate Zone 2: The envelope and duct package is cost-effective for single family homes built before 1978 and multifamily homes built before 1992. For newer homes built before 2006 duct sealing alone is cost-effective. Cool roof upgrades are cost-effective for multifamily homes built before 1992. Window replacements are not cost-effective.

Table 10: CZ 2 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	578	109	$3,114	$356	8.75	1.99
	1978-1991	194	51	$2,748	$140	19.56	0.89
	1992-2005	125	45	$2,748	$104	26.32	0.66
R-38 Attic Insulation	Pre-1978	385	38	$1,915	$175	10.94	1.59
	1978-1991	137	18	$1,548	$69	22.40	0.78
	1992-2005	91	17	$1,548	$51	30.58	0.57
Duct Sealing	Pre-1978	203	56	$240	$157	1.53	11.37
	1978-1991	52	21	$240	$51	4.68	3.72
	1992-2005	31	20	$240	$41	5.84	2.98
Cool Roof	Pre-1978	219	-20	$635	$25	25.39	0.68
	1978-1991	95	-15	$635	$1	764.31	0.02
	1992-2005	47	-15	$635	-$16	-40.59	-0.43
Windows	Pre-1978	529	39	$9,810	$216	45.45	0.38
Water Heating Package	All Vintages	0	19	$208	$33	6.40	2.72
Lighting Package	All Vintages	23	0	$34	$5	6.32	4.01

Table 11: CZ 2 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	224	40	$961	$123	7.83	2.51
	1978-1991	89	18	$865	$47	18.43	1.07
	1992-2005	69	15	$865	$34	25.25	0.78
R-38 Attic Insulation	Pre-1978	116	11	$500	$48	10.34	1.90
	1978-1991	51	5	$405	$21	19.55	1.00
	1992-2005	44	5	$405	$16	25.05	0.78
Duct Sealing	Pre-1978	112	22	$120	$65	1.85	10.60
	1978-1991	44	6	$120	$20	5.95	3.30
	1992-2005	26	5	$120	$13	9.41	2.09
Cool Roof	Pre-1978	94	-5	$184	$18	10.48	1.87
	1978-1991	65	-3	$184	$13	13.82	1.42
	1992-2005	45	-3	$184	$5	35.83	0.55
Windows	Pre-1978	409	29	$5,873	$156	37.57	0.52
Water Heating Package	All Vintages	0	16	$168	$27	6.25	3.14
Lighting Package	All Vintages	23	0	$34	$5	6.32	4.01

Climate Zone 3: The envelope and duct package is cost-effective for single family and multifamily homes built before 1978. For newer homes built before 2006 duct sealing alone is cost-effective, except for multifamily homes built before after 1991 where duct sealing is not cost effective. Cool roof upgrades and window replacements are not cost-effective.

Table 12: CZ 3 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	132	99	$3,114	$217	14.33	1.21
	1978-1991	41	46	$2,748	$90	30.64	0.57
	1992-2005	36	40	$2,748	$77	35.47	0.49
R-38 Attic Insulation	Pre-1978	74	37	$1,915	$88	21.87	0.79
	1978-1991	17	17	$1,548	$35	44.40	0.39
	1992-2005	16	17	$1,548	$33	47.49	0.37
Duct Sealing	Pre-1978	53	51	$240	$108	2.23	7.81
	1978-1991	15	17	$240	$34	6.97	2.49
	1992-2005	14	16	$240	$31	7.74	2.25
Cool Roof	Pre-1978	17	-18	$635	-$27	-23.23	-0.75
	1978-1991	-9	-13	$635	-$24	-25.97	-0.67
	1992-2005	-10	-13	$635	-$25	-25.87	-0.67
Windows	Pre-1978	92	72	$9,810	$156	62.78	0.28
Water Heating Package	All Vintages	0	19	$208	$32	6.47	2.69
Lighting Package	All Vintages	23	0	$34	$5	6.28	4.03

Table 13: CZ 3 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	54	35	$961	$70	13.82	1.42
	1978-1991	19	15	$865	$25	35.00	0.56
	1992-2005	14	12	$865	$20	44.35	0.44
R-38 Attic Insulation	Pre-1978	26	10	$500	$23	21.51	0.91
	1978-1991	10	5	$405	$9	44.14	0.44
	1992-2005	8	5	$405	$9	47.50	0.41
Duct Sealing	Pre-1978	25	18	$120	$35	3.39	5.80
	1978-1991	7	5	$120	$8	15.41	1.27
	1992-2005	4	4	$120	$6	20.05	0.98
Cool Roof	Pre-1978	12	-4	$184	-$3	-57.76	-0.34
	1978-1991	7	-3	$184	-$2	-110.12	-0.18
	1992-2005	3	-3	$184	-$3	-67.54	-0.29
Windows	Pre-1978	67	49	$5,873	$95	62.08	0.32
Water Heating Package	All Vintages	0	16	$168	$26	6.49	3.02
Lighting Package	All Vintages	23	0	$34	$5	6.28	4.03

Climate Zone 4: The envelope and duct package is cost-effective for single family and multifamily homes built before 1978. For newer homes built before 2006 duct sealing alone is cost-effective. Cool roof upgrades are cost-effective for single family homes built before 1978 and all multifamily homes. Window replacements are not cost-effective.

Table 14: CZ 4 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	560	93	$3,114	$324	9.60	1.81
	1978-1991	228	44	$2,748	$133	20.73	0.84
	1992-2005	158	38	$2,748	$102	27.03	0.64
R-38 Attic Insulation	Pre-1978	383	35	$1,915	$170	11.29	1.54
	1978-1991	172	17	$1,548	$73	21.15	0.82
	1992-2005	124	16	$1,548	$57	27.39	0.63
Duct Sealing	Pre-1978	185	46	$240	$135	1.78	9.79
	1978-1991	60	17	$240	$44	5.48	3.17
	1992-2005	34	15	$240	$34	6.99	2.49
Cool Roof	Pre-1978	240	-16	$635	$38	16.54	1.05
	1978-1991	147	-12	$635	$20	31.57	0.55
	1992-2005	87	-12	$635	$1	600.45	0.03
Windows	Pre-1978	567	28	$9,810	$208	47.19	0.37
Water Heating Package	All Vintages	0	19	$208	$32	6.42	2.71
Lighting Package	All Vintages	23	0	$34	$5	6.28	4.03

Table 15: CZ 4 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	214	33	$961	$107	8.98	2.19
	1978-1991	93	15	$865	$43	19.95	0.98
	1992-2005	75	12	$865	$34	25.26	0.78
R-38 Attic Insulation	Pre-1978	114	10	$500	$46	10.84	1.81
	1978-1991	53	5	$405	$20	20.42	0.96
	1992-2005	47	5	$405	$18	22.59	0.87
Duct Sealing	Pre-1978	107	17	$120	$56	2.14	9.16
	1978-1991	49	5	$120	$19	6.34	3.10
	1992-2005	33	4	$120	$14	8.79	2.23
Cool Roof	Pre-1978	101	-4	$184	$22	8.44	2.33
	1978-1991	75	-3	$184	$16	11.32	1.74
	1992-2005	57	-3	$184	$11	17.44	1.13
Windows	Pre-1978	438	21	$5,873	$149	39.42	0.50
Water Heating Package	All Vintages	0	16	$168	$26	6.51	3.02
Lighting Package	All Vintages	23	0	$34	$5	6.28	4.03

Climate Zone 5: The envelope and duct package is cost-effective for single family and multifamily homes built before 1978. For newer homes built before 2006 duct sealing alone is cost-effective, except for multifamily homes built before after 1991 where duct sealing is not cost effective. Cool roof upgrades and window replacements are not cost-effective.

Table 16: CZ 5 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	105	102	$3,114	$214	14.58	1.19
	1978-1991	42	48	$2,748	$92	29.98	0.58
	1992-2005	36	41	$2,748	$79	35.00	0.50
R-38 Attic Insulation	Pre-1978	49	36	$1,915	$78	24.51	0.71
	1978-1991	15	16	$1,548	$32	48.46	0.36
	1992-2005	14	15	$1,548	$29	54.01	0.32
Duct Sealing	Pre-1978	46	52	$240	$107	2.25	7.74
	1978-1991	16	18	$240	$36	6.73	2.58
	1992-2005	15	17	$240	$33	7.20	2.42
Cool Roof	Pre-1978	-5	-25	$635	-$46	-13.85	-1.26
	1978-1991	-14	-18	$635	-$36	-17.54	-0.99
	1992-2005	-15	-19	$635	-$36	-17.46	-1.00
Windows	Pre-1978	81	76	$9,810	$160	61.48	0.28
Water Heating Package	All Vintages	0	19	$208	$32	6.49	2.68
Lighting Package	All Vintages	23	0	$34	$5	6.31	4.02

Table 17: CZ 5 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	45	36	$961	$67	14.35	1.37
	1978-1991	13	15	$865	$23	37.25	0.53
	1992-2005	10	13	$865	$19	45.01	0.44
R-38 Attic Insulation	Pre-1978	22	10	$500	$22	22.24	0.88
	1978-1991	7	5	$405	$8	49.35	0.40
	1992-2005	5	5	$405	$8	53.90	0.36
Duct Sealing	Pre-1978	20	19	$120	$35	3.44	5.71
	1978-1991	5	4	$120	$7	17.41	1.13
	1992-2005	3	4	$120	$6	20.66	0.95
Cool Roof	Pre-1978	7	-6	$184	-$7	-24.95	-0.79
	1978-1991	3	-3	$184	-$4	-50.94	-0.39
	1992-2005	-1	-3	$184	-$5	-36.28	-0.54
Windows	Pre-1978	59	52	$5,873	$91	64.42	0.30
Water Heating Package	All Vintages	0	16	$168	$26	6.50	3.02
Lighting Package	All Vintages	23	0	$34	$5	6.31	4.02

Climate Zone 6: The envelope and duct package is cost-effective for multifamily homes built before 1978. Duct sealing coupled with R-38 attic insulation is cost-effective for single family homes built before 1978. Duct sealing alone is cost-effective for multifamily homes built before 1992 but after 1977. For newer single family and multifamily homes built before 2006 none of these measures were found to be cost-effective. Cool roof upgrades are cost-effective for multifamily homes built before 1992. Window replacements are not cost-effective.

Table 18: CZ 6 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	455	54	$3,114	$166	18.71	0.93
	1978-1991	144	22	$2,748	$51	53.74	0.32
	1992-2005	95	19	$2,748	$38	71.78	0.24
R-38 Attic Insulation	Pre-1978	373	25	$1,915	$117	16.36	1.06
	1978-1991	122	9	$1,548	$36	43.43	0.40
	1992-2005	80	9	$1,548	$27	58.41	0.30
Duct Sealing	Pre-1978	114	23	$240	$52	4.65	3.74
	1978-1991	33	6	$240	$13	18.02	0.96
	1992-2005	19	6	$240	$10	25.15	0.69
Cool Roof	Pre-1978	195	-15	$635	$32	19.66	0.88
	1978-1991	100	-9	$635	$15	42.53	0.41
	1992-2005	53	-10	$635	$5	135.96	0.13
Windows	Pre-1978	393	5	$9,810	$102	96.32	0.18
Water Heating Package	All Vintages	0	19	$208	$21	9.77	1.78
Lighting Package	All Vintages	23	0	$34	$4	7.66	3.31

Table 19: CZ 6 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	164	18	$961	$51	18.75	1.05
	1978-1991	58	5	$865	$17	49.63	0.40
	1992-2005	47	4	$865	$14	63.56	0.31
R-38 Attic Insulation	Pre-1978	107	7	$500	$30	16.83	1.17
	1978-1991	41	2	$405	$11	37.12	0.53
	1992-2005	35	2	$405	$9	43.89	0.45
Duct Sealing	Pre-1978	68	7	$120	$22	5.55	3.54
	1978-1991	32	1	$120	$8	14.32	1.37
	1992-2005	20	1	$120	$5	23.36	0.84
Cool Roof	Pre-1978	82	-3	$184	$16	11.53	1.70
	1978-1991	60	-1	$184	$13	14.37	1.37
	1992-2005	45	-1	$184	$9	20.73	0.95
Windows	Pre-1978	321	6	$5,873	$75	78.02	0.25
Water Heating Package	All Vintages	0	16	$168	$15	10.86	1.81
Lighting Package	All Vintages	23	0	$34	$4	7.66	3.31

Climate Zone 7: The envelope and duct package is not cost-effective for any cases. Duct sealing coupled with R-38 attic insulation is cost-effective for single family and multifamily homes built before 1978. Duct sealing alone is cost-effective for multifamily homes built before 1992 but after 1977. For newer single family and multifamily homes built before 2006 none of these measures were found to be cost-effective. Cool roof upgrades are cost-effective for single family homes built before 1978 and multifamily homes built before 1992. Window replacements are not cost-effective.

Table 20: CZ 7 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	314	31	$3,114	$161	19.34	0.90
	1978-1991	85	11	$2,748	$42	64.77	0.27
	1992-2005	64	10	$2,748	$29	93.38	0.19
R-38 Attic Insulation	Pre-1978	272	16	$1,915	$128	14.93	1.16
	1978-1991	76	6	$1,548	$33	47.13	0.37
	1992-2005	59	6	$1,548	$23	68.21	0.25
Duct Sealing	Pre-1978	66	11	$240	$41	5.89	2.95
	1978-1991	17	2	$240	$9	27.00	0.64
	1992-2005	9	2	$240	$5	45.36	0.38
Cool Roof	Pre-1978	150	-11	$635	$46	13.71	1.27
	1978-1991	65	-6	$635	$16	40.26	0.43
	1992-2005	41	-7	$635	$3	221.84	0.08
Windows	Pre-1978	293	-7	$9,810	$111	88.59	0.20
Water Heating Package	All Vintages	0	19	$208	$26	8.01	2.17
Lighting Package	All Vintages	23	0	$34	$6	5.64	4.50

Table 21: CZ 7 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	98	8	$961	$45	21.44	0.92
	1978-1991	40	1	$865	$14	59.95	0.33
	1992-2005	25	1	$865	$8	111.27	0.18
R-38 Attic Insulation	Pre-1978	66	3	$500	$29	17.32	1.13
	1978-1991	30	1	$405	$10	39.90	0.49
	1992-2005	20	1	$405	$6	67.41	0.29
Duct Sealing	Pre-1978	42	3	$120	$20	6.00	3.27
	1978-1991	21	0.13	$120	$7	16.58	1.18
	1992-2005	12	0.08	$120	$3	37.37	0.53
Cool Roof	Pre-1978	56	-2	$184	$20	9.21	2.13
	1978-1991	47	-0.35	$184	$15	12.50	1.57
	1992-2005	29	-0.35	$184	$7	24.53	0.80
Windows	Pre-1978	247	-1	$5,873	$78	75.58	0.26
Water Heating Package	All Vintages	0	16	$168	$21	8.13	2.42
Lighting Package	All Vintages	23	0	$34	$6	5.64	4.50

Climate Zone 8: The envelope and duct package is cost-effective for single family and multifamily homes built before 1978. For newer homes built before 2006 duct sealing alone is cost-effective. Cool roof upgrades are cost-effective for all single family and multifamily homes built before 2006. Window replacements are not cost-effective.

Table 22: CZ 8 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	850	39	$3,114	$249	12.50	1.39
	1978-1991	359	17	$2,748	$101	27.21	0.64
	1992-2005	311	15	$2,748	$85	32.18	0.54
R-38 Attic Insulation	Pre-1978	590	18	$1,915	$164	11.67	1.49
	1978-1991	266	8	$1,548	$71	21.73	0.80
	1992-2005	248	8	$1,548	$64	24.09	0.72
Duct Sealing	Pre-1978	307	17	$240	$93	2.59	6.71
	1978-1991	122	5	$240	$34	7.08	2.45
	1992-2005	84	4	$240	$24	10.06	1.73
Cool Roof	Pre-1978	389	-10	$635	$85	7.45	2.33
	1978-1991	266	-7	$635	$59	10.82	1.61
	1992-2005	219	-8	$635	$45	14.14	1.23
Windows	Pre-1978	723	4	$9,810	$183	53.65	0.32
Water Heating Package	All Vintages	0	19	$208	$21	9.89	1.76
Lighting Package	All Vintages	23	0	$34	$5	7.10	3.57

Table 23: CZ 8 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	312	13	$961	$85	11.37	1.73
	1978-1991	139	4	$865	$36	23.85	0.82
	1992-2005	123	3	$865	$30	28.38	0.69
R-38 Attic Insulation	Pre-1978	157	5	$500	$41	12.14	1.62
	1978-1991	73	2	$405	$18	21.88	0.90
	1992-2005	69	1	$405	$16	24.65	0.80
Duct Sealing	Pre-1978	171	5	$120	$46	2.63	7.48
	1978-1991	83	1	$120	$21	5.81	3.38
	1992-2005	64	1	$120	$16	7.72	2.54
Cool Roof	Pre-1978	149	-2	$184	$34	5.41	3.63
	1978-1991	115	-1	$184	$27	6.84	2.87
	1992-2005	99	-1	$184	$22	8.40	2.34
Windows	Pre-1978	519	5	$5,873	$128	45.86	0.43
Water Heating Package	All Vintages	0	16	$168	$16	10.47	1.88
Lighting Package	All Vintages	23	0	$34	$5	7.10	3.57

Climate Zone 9: The envelope and duct package is cost-effective for single family homes built before 1978 and multifamily homes built before 1992. For newer homes built before 2006 duct sealing alone is cost-effective. Cool roof upgrades are cost-effective for all single family and multifamily homes built before 2006. Window replacements are not cost-effective.

Table 24: CZ 9 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	1,101	51	$3,114	$323	9.64	1.80
	1978-1991	493	23	$2,748	$136	20.18	0.86
	1992-2005	432	20	$2,748	$115	23.99	0.72
R-38 Attic Insulation	Pre-1978	649	22	$1,915	$183	10.47	1.66
	1978-1991	305	11	$1,548	$82	18.86	0.92
	1992-2005	299	10	$1,548	$75	20.58	0.84
Duct Sealing	Pre-1978	466	23	$240	$139	1.73	10.05
	1978-1991	199	7	$240	$54	4.43	3.93
	1992-2005	142	6	$240	$39	6.20	2.80
Cool Roof	Pre-1978	457	-12	$635	$101	6.31	2.76
	1978-1991	319	-8	$635	$71	8.92	1.95
	1992-2005	267	-9	$635	$54	11.85	1.47
Windows	Pre-1978	941	9	$9,810	$240	40.81	0.43
Water Heating Package	All Vintages	0	19	$208	$21	9.88	1.76
Lighting Package	All Vintages	23	0	$34	$5	7.10	3.57

Table 25: CZ 9 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	418	17	$961	$115	8.38	2.34
	1978-1991	201	6	$865	$51	16.94	1.16
	1992-2005	168	5	$865	$42	20.43	0.96
R-38 Attic Insulation	Pre-1978	186	6	$500	$50	10.05	1.95
	1978-1991	89	3	$405	$22	18.52	1.06
	1992-2005	79	2	$405	$20	20.61	0.95
Duct Sealing	Pre-1978	245	8	$120	$66	1.82	10.79
	1978-1991	122	1	$120	$29	4.09	4.80
	1992-2005	95	1	$120	$23	5.26	3.73
Cool Roof	Pre-1978	179	-3	$184	$41	4.46	4.40
	1978-1991	138	-2	$184	$30	6.13	3.20
	1992-2005	111	-2	$184	$24	7.76	2.53
Windows	Pre-1978	673	8	$5,873	$165	35.64	0.55
Water Heating Package	All Vintages	0	16	$168	$15	10.89	1.80
Lighting Package	All Vintages	23	0	$34	$5	7.10	3.57

Climate Zone 10 – SCE/SCG: The envelope and duct package is cost-effective for single family homes built before 1992 and all multifamily homes built before 2006. For newer homes built before 2006 duct sealing alone is cost-effective. Cool roof upgrades are cost-effective for all single family and multifamily homes built before 2006. Window replacements are not cost-effective.

Table 26: CZ 10 SCE/SCG - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	1,354	57	$3,114	$393	7.92	2.20
	1978-1991	597	25	$2,748	$166	16.58	1.05
	1992-2005	516	22	$2,748	$137	20.12	0.86
R-38 Attic Insulation	Pre-1978	729	24	$1,915	$206	9.31	1.87
	1978-1991	338	11	$1,548	$91	16.96	1.03
	1992-2005	332	11	$1,548	$84	18.33	0.95
Duct Sealing	Pre-1978	617	25	$240	$179	1.34	12.97
	1978-1991	248	8	$240	$67	3.58	4.86
	1992-2005	186	7	$240	$51	4.70	3.70
Cool Roof	Pre-1978	555	-13	$635	$123	5.17	3.37
	1978-1991	377	-9	$635	$85	7.50	2.32
	1992-2005	315	-10	$635	$65	9.76	1.78
Windows	Pre-1978	1,178	11	$9,810	$301	32.61	0.53
Water Heating Package	All Vintages	0	19	$208	$21	9.92	1.75
Lighting Package	All Vintages	23	0	$34	$5	6.98	3.63

Table 27: CZ 10 SCE/SCG - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	526	19	$961	$143	6.72	2.92
	1978-1991	250	7	$865	$66	13.08	1.50
	1992-2005	207	6	$865	$51	16.84	1.17
R-38 Attic Insulation	Pre-1978	221	7	$500	$58	8.56	2.30
	1978-1991	106	3	$405	$28	14.52	1.35
	1992-2005	91	3	$405	$22	18.13	1.08
Duct Sealing	Pre-1978	317	9	$120	$85	1.42	13.84
	1978-1991	152	2	$120	$39	3.12	6.30
	1992-2005	119	1	$120	$28	4.23	4.64
Cool Roof	Pre-1978	215	-3	$184	$50	3.70	5.31
	1978-1991	163	-2	$184	$38	4.80	4.09
	1992-2005	129	-2	$184	$27	6.72	2.92
Windows	Pre-1978	840	10	$5,873	$211	27.80	0.71
Water Heating Package	All Vintages	0	16	$168	$16	10.54	1.86
Lighting Package	All Vintages	23	0	$34	$5	6.98	3.63

Climate Zone 10 – SDG&E: The envelope and duct package is cost-effective for all single family and multifamily homes built before 2006. Cool roof upgrades and window replacements are also cost-effective for all single family and multifamily homes built before 2006.

Table 28: CZ 10 SDG&E - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	1,354	57	$3,114	$747	4.17	4.17
	1978-1991	597	25	$2,748	$298	9.24	1.88
	1992-2005	516	22	$2,748	$254	10.83	1.61
R-38 Attic Insulation	Pre-1978	729	24	$1,915	$395	4.85	3.59
	1978-1991	338	11	$1,548	$165	9.38	1.85
	1992-2005	332	11	$1,548	$158	9.77	1.78
Duct Sealing	Pre-1978	617	25	$240	$351	0.68	25.46
	1978-1991	248	8	$240	$124	1.94	8.97
	1992-2005	186	7	$240	$93	2.58	6.73
Cool Roof	Pre-1978	555	-13	$635	$268	2.37	7.35
	1978-1991	377	-9	$635	$161	3.95	4.40
	1992-2005	315	-10	$635	$130	4.90	3.55
Windows	Pre-1978	1,178	11	$9,810	$607	16.16	1.08
Water Heating Package	All Vintages	0	19	$208	$26	7.98	2.18
Lighting Package	All Vintages	23	0	$34	$8	4.03	6.29

Table 29: CZ 10 SDG&E - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	526	19	$961	$258	3.73	5.26
	1978-1991	250	7	$865	$118	7.33	2.68
	1992-2005	207	6	$865	$92	9.38	2.09
R-38 Attic Insulation	Pre-1978	221	7	$500	$105	4.75	4.13
	1978-1991	106	3	$405	$49	8.33	2.36
	1992-2005	91	3	$405	$40	10.24	1.92
Duct Sealing	Pre-1978	317	9	$120	$153	0.78	25.10
	1978-1991	152	2	$120	$69	1.74	11.30
	1992-2005	119	1	$120	$52	2.31	8.51
Cool Roof	Pre-1978	215	-3	$184	$92	1.99	9.86
	1978-1991	163	-2	$184	$68	2.70	7.28
	1992-2005	129	-2	$184	$50	3.66	5.37
Windows	Pre-1978	840	10	$5,873	$377	15.59	1.26
Water Heating Package	All Vintages	0	16	$168	$21	7.93	2.48
Lighting Package	All Vintages	23	0	$34	$8	4.03	6.29

Climate Zone 11: The envelope and duct package is cost-effective for all single family and multifamily homes built before 2006. Cool roof upgrades and window replacements are also cost-effective for all single family and multifamily homes built before 2006.

Table 30: CZ 11 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	1,827	120	$3,114	$873	3.57	4.88
	1978-1991	858	55	$2,748	$327	8.40	2.07
	1992-2005	770	48	$2,748	$292	9.40	1.85
R-38 Attic Insulation	Pre-1978	795	47	$1,915	$379	5.05	3.44
	1978-1991	383	22	$1,548	$141	10.94	1.59
	1992-2005	396	22	$1,548	$145	10.70	1.62
Duct Sealing	Pre-1978	982	61	$240	$482	0.50	34.93
	1978-1991	434	20	$240	$155	1.55	11.21
	1992-2005	355	18	$240	$130	1.85	9.39
Cool Roof	Pre-1978	624	-14	$635	$215	2.95	5.89
	1978-1991	440	-10	$635	$103	6.15	2.83
	1992-2005	369	-10	$635	$85	7.47	2.33
Windows	Pre-1978	1,568	45	$9,810	$646	15.18	1.15
Water Heating Package	All Vintages	0	19	$208	$34	6.16	2.82
Lighting Package	All Vintages	23	0	$34	$6	5.40	4.69

Table 31: CZ 11 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	728	44	$961	$272	3.53	5.57
	1978-1991	363	19	$865	$126	6.89	2.85
	1992-2005	315	16	$865	$107	8.12	2.42
R-38 Attic Insulation	Pre-1978	268	13	$500	$94	5.29	3.71
	1978-1991	131	6	$405	$44	9.15	2.15
	1992-2005	118	6	$405	$40	10.23	1.92
Duct Sealing	Pre-1978	473	25	$120	$171	0.70	27.97
	1978-1991	231	7	$120	$73	1.64	11.98
	1992-2005	196	6	$120	$61	1.97	9.98
Cool Roof	Pre-1978	245	-4	$184	$61	2.99	6.56
	1978-1991	189	-2	$184	$48	3.83	5.12
	1992-2005	156	-2	$184	$39	4.67	4.21
Windows	Pre-1978	1,107	33	$5,873	$356	16.49	1.19
Water Heating Package	All Vintages	0	16	$168	$29	5.85	3.36
Lighting Package	All Vintages	23	0	$34	$6	5.40	4.69

Climate Zone 12: The envelope and duct package is cost-effective for all single family and multifamily homes built before 2006. Cool roof upgrades are also cost-effective for all single family and multifamily homes built before 2006. Window replacements are not cost-effective.

Table 32: CZ 12 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	1,209	109	$3,114	$534	5.83	2.98
	1978-1991	540	51	$2,748	$236	11.66	1.49
	1992-2005	471	45	$2,748	$203	13.51	1.29
R-38 Attic Insulation	Pre-1978	674	43	$1,915	$264	7.25	2.40
	1978-1991	318	20	$1,548	$122	12.73	1.37
	1992-2005	317	20	$1,548	$119	12.97	1.34
Duct Sealing	Pre-1978	532	55	$240	$249	0.96	18.03
	1978-1991	216	20	$240	$95	2.53	6.87
	1992-2005	155	18	$240	$74	3.26	5.34
Cool Roof	Pre-1978	479	-16	$635	$105	6.05	2.87
	1978-1991	332	-12	$635	$71	8.94	1.94
	1992-2005	273	-12	$635	$55	11.47	1.52
Windows	Pre-1978	1,090	43	$9,810	$381	25.76	0.67
Water Heating Package	All Vintages	0	19	$208	$34	6.15	2.83
Lighting Package	All Vintages	23	0	$34	$6	6.00	4.22

Table 33: CZ 12 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	465	40	$961	$190	5.06	3.88
	1978-1991	223	18	$865	$84	10.36	1.90
	1992-2005	187	15	$865	$68	12.74	1.54
R-38 Attic Insulation	Pre-1978	199	11	$500	$73	6.89	2.85
	1978-1991	97	6	$405	$33	12.10	1.62
	1992-2005	88	6	$405	$30	13.56	1.45
Duct Sealing	Pre-1978	276	22	$120	$110	1.09	18.06
	1978-1991	134	7	$120	$45	2.68	7.33
	1992-2005	103	5	$120	$34	3.52	5.58
Cool Roof	Pre-1978	188	-4	$184	$44	4.13	4.75
	1978-1991	146	-3	$184	$36	5.12	3.84
	1992-2005	117	-3	$184	$27	6.78	2.90
Windows	Pre-1978	785	31	$5,873	$263	22.33	0.88
Water Heating Package	All Vintages	0	16	$168	$27	6.17	3.19
Lighting Package	All Vintages	23	0	$34	$6	6.00	4.22

Climate Zone 13: The envelope and duct package is cost-effective for all single family and multifamily homes built before 2006. Cool roof upgrades and window replacements are also cost-effective for all single family and multifamily homes built before 2006.

Table 34: CZ 13 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	2,047	98	$3,114	$909	3.43	5.07
	1978-1991	964	45	$2,748	$347	7.91	2.20
	1992-2005	877	39	$2,748	$307	8.95	1.94
R-38 Attic Insulation	Pre-1978	940	37	$1,915	$396	4.84	3.59
	1978-1991	451	18	$1,548	$158	9.80	1.77
	1992-2005	463	17	$1,548	$156	9.93	1.75
Duct Sealing	Pre-1978	1,072	50	$240	$479	0.50	34.70
	1978-1991	480	17	$240	$167	1.44	12.12
	1992-2005	403	16	$240	$139	1.73	10.08
Cool Roof	Pre-1978	729	-15	$635	$232	2.73	6.36
	1978-1991	516	-11	$635	$130	4.90	3.55
	1992-2005	441	-11	$635	$104	6.13	2.84
Windows	Pre-1978	1,604	41	$9,810	$638	15.39	1.13
Water Heating Package	All Vintages	0	19	$208	$34	6.19	2.81
Lighting Package	All Vintages	23	0	$34	$6	5.35	4.74

Table 35: CZ 13 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	805	36	$961	$279	3.44	5.70
	1978-1991	407	16	$865	$132	6.56	2.99
	1992-2005	353	13	$865	$113	7.68	2.56
R-38 Attic Insulation	Pre-1978	317	10	$500	$103	4.86	4.04
	1978-1991	158	5	$405	$50	8.12	2.42
	1992-2005	141	5	$405	$44	9.17	2.14
Duct Sealing	Pre-1978	510	20	$120	$173	0.70	28.25
	1978-1991	254	6	$120	$78	1.55	12.70
	1992-2005	214	5	$120	$64	1.86	10.55
Cool Roof	Pre-1978	283	-4	$184	$72	2.56	7.67
	1978-1991	220	-3	$184	$57	3.22	6.10
	1992-2005	183	-3	$184	$46	4.00	4.91
Windows	Pre-1978	1,127	30	$5,873	$358	16.39	1.20
Water Heating Package	All Vintages	0	16	$168	$27	6.22	3.16
Lighting Package	All Vintages	23	0	$34	$6	5.35	4.74

Climate Zone 14 – SCE/SCG: The envelope and duct package is cost-effective for all single family and multifamily homes built before 2006. Cool roof upgrades are also cost-effective for all single family and multifamily homes built before 2006. Window replacements are not cost-effective.

Table 36: CZ 14 SCE/SCG - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	1,832	121	$3,114	$688	4.52	3.84
	1978-1991	844	55	$2,748	$265	10.38	1.67
	1992-2005	746	48	$2,748	$234	11.74	1.48
R-38 Attic Insulation	Pre-1978	816	43	$1,915	$290	6.60	2.63
	1978-1991	388	21	$1,548	$117	13.22	1.31
	1992-2005	394	20	$1,548	$118	13.08	1.33
Duct Sealing	Pre-1978	967	63	$240	$366	0.66	26.53
	1978-1991	417	21	$240	$125	1.93	9.03
	1992-2005	333	19	$240	$102	2.35	7.41
Cool Roof	Pre-1978	631	-19	$635	$167	3.81	4.57
	1978-1991	427	-14	$635	$90	7.04	2.47
	1992-2005	359	-14	$635	$74	8.58	2.03
Windows	Pre-1978	1,527	36	$9,810	$496	19.77	0.88
Water Heating Package	All Vintages	0	19	$208	$22	9.62	1.81
Lighting Package	All Vintages	21	0	$4	$5	0.82	4.00

Table 37: CZ 14 SCE/SCG - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	731	45	$961	$223	4.32	4.55
	1978-1991	364	19	$865	$104	8.30	2.36
	1992-2005	310	16	$865	$87	9.89	1.99
R-38 Attic Insulation	Pre-1978	273	12	$500	$79	6.36	3.09
	1978-1991	134	6	$405	$37	10.89	1.80
	1992-2005	118	6	$405	$33	12.13	1.62
Duct Sealing	Pre-1978	467	25	$120	$139	0.86	22.73
	1978-1991	227	7	$120	$61	1.98	9.93
	1992-2005	188	6	$120	$51	2.37	8.28
Cool Roof	Pre-1978	250	-5	$184	$56	3.31	5.94
	1978-1991	188	-3	$184	$43	4.27	4.60
	1992-2005	152	-3	$184	$35	5.32	3.69
Windows	Pre-1978	1,080	26	$5,873	$288	20.39	0.96
Water Heating Package	All Vintages	0	16	$168	$18	9.35	2.10
Lighting Package	All Vintages	23	0	$34	$5	6.34	4.00

Climate Zone 14 – SDG&E: The envelope and duct package is cost-effective for all single family and multifamily homes built before 2006. Cool roof upgrades and window replacements are also cost-effective for all single family and multifamily homes built before 2006.

Table 38: CZ 14 SDG&E - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	1,832	121	$3,114	$1,067	2.92	5.96
	1978-1991	844	55	$2,748	$466	5.90	2.95
	1992-2005	746	48	$2,748	$388	7.08	2.46
R-38 Attic Insulation	Pre-1978	816	43	$1,915	$455	4.21	4.13
	1978-1991	388	21	$1,548	$211	7.35	2.37
	1992-2005	394	20	$1,548	$198	7.82	2.22
Duct Sealing	Pre-1978	967	63	$240	$568	0.42	41.17
	1978-1991	417	21	$240	$228	1.05	16.52
	1992-2005	333	19	$240	$175	1.37	12.66
Cool Roof	Pre-1978	631	-19	$635	$293	2.17	8.02
	1978-1991	427	-14	$635	$190	3.34	5.21
	1992-2005	359	-14	$635	$143	4.44	3.92
Windows	Pre-1978	1,527	36	$9,810	$806	12.17	1.43
Water Heating Package	All Vintages	0	19	$208	$26	7.94	2.19
Lighting Package	All Vintages	23	0	$34	$9	3.85	6.57

Table 39: CZ 14 SDG&E - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	731	45	$961	$388	2.48	7.93
	1978-1991	364	19	$865	$182	4.75	4.14
	1992-2005	310	16	$865	$147	5.90	3.33
R-38 Attic Insulation	Pre-1978	273	12	$500	$139	3.60	5.46
	1978-1991	134	6	$405	$65	6.25	3.14
	1992-2005	118	6	$405	$54	7.48	2.63
Duct Sealing	Pre-1978	467	25	$120	$245	0.49	40.05
	1978-1991	227	7	$120	$108	1.11	17.73
	1992-2005	188	6	$120	$86	1.40	14.02
Cool Roof	Pre-1978	250	-5	$184	$108	1.71	11.51
	1978-1991	188	-3	$184	$78	2.36	8.32
	1992-2005	152	-3	$184	$58	3.16	6.22
Windows	Pre-1978	1,080	26	$5,873	$521	11.27	1.74
Water Heating Package	All Vintages	0	16	$168	$22	7.62	2.58
Lighting Package	All Vintages	23	0	$34	$9	3.85	6.57

Climate Zone 15: The envelope and duct package is cost-effective for all single family and multifamily homes built before 2006. Cool roof upgrades and window replacements are also cost-effective for all single family and multifamily homes built before 2006.

Table 40: CZ 15 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	4,141	23	$3,114	$1,132	2.75	6.32
	1978-1991	2,041	8	$2,748	$538	5.11	3.40
	1992-2005	1,877	7	$2,748	$489	5.62	3.09
R-38 Attic Insulation	Pre-1978	1,483	12	$1,915	$429	4.46	3.90
	1978-1991	740	5	$1,548	$199	7.78	2.24
	1992-2005	769	5	$1,548	$203	7.62	2.28
Duct Sealing	Pre-1978	2,494	9	$240	$686	0.35	49.71
	1978-1991	1,182	2	$240	$310	0.77	22.49
	1992-2005	1,039	1	$240	$267	0.90	19.34
Cool Roof	Pre-1978	1184	-5	$635	$336	1.89	9.19
	1978-1991	854	-3	$635	$224	2.83	6.15
	1992-2005	751	-3	$635	$192	3.31	5.25
Windows	Pre-1978	3,214	4	$9,810	$879	11.16	1.56
Water Heating Package	All Vintages	0	19	$208	$20	10.58	1.64
Lighting Package	All Vintages	23	0	$34	$5.42	6.27	4.04

Table 41: CZ 15 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	1,663	7	$961	$434	2.22	8.86
	1978-1991	863	2	$865	$214	4.04	4.86
	1992-2005	762	1	$865	$179	4.84	4.06
R-38 Attic Insulation	Pre-1978	574	3	$500	$150	3.33	5.90
	1978-1991	285	1	$405	$71	5.69	3.45
	1992-2005	254	1	$405	$61	6.64	2.96
Duct Sealing	Pre-1978	1,128	3	$120	$292	0.41	47.83
	1978-1991	565	0.34	$120	$139	0.86	22.81
	1992-2005	501	0.20	$120	$118	1.01	19.38
Cool Roof	Pre-1978	455	-1	$184	$117	1.58	12.47
	1978-1991	351	-0.49	$184	$86	2.14	9.17
	1992-2005	296	-0.45	$184	$70	2.62	7.48
Windows	Pre-1978	2,237	4	$5,873	$578	10.16	1.93
Water Heating Package	All Vintages	0	16	$168	$15	11.01	1.78
Lighting Package	All Vintages	23	0	$34	$5	6.27	4.04

Climate Zone 16: The envelope and duct package is cost-effective for all single family and multifamily homes built before 2006. Cool roof upgrades are cost-effective for multifamily homes built before 1992. Window replacements are not cost-effective.

Table 42: CZ 16 - Single Family Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	635	231	$3,114	$593	5.25	3.31
	1978-1991	286	119	$2,748	$291	9.43	1.84
	1992-2005	240	107	$2,748	$257	10.71	1.62
R-38 Attic Insulation	Pre-1978	407	76	$1,915	$250	7.66	2.27
	1978-1991	176	38	$1,548	$115	13.45	1.29
	1992-2005	155	36	$1,548	$107	14.52	1.20
Duct Sealing	Pre-1978	236	128	$240	$298	0.80	21.62
	1978-1991	103	60	$240	$136	1.77	9.84
	1992-2005	79	55	$240	$121	1.98	8.76
Cool Roof	Pre-1978	232	-31	$635	$9	72.47	0.24
	1978-1991	153	-23	$635	$0	2801.65	0.01
	1992-2005	107	-22	$635	-$12	-55.10	-0.32
Windows	Pre-1978	267	162	$9,810	$368	26.66	0.65
Water Heating Package	All Vintages	0	19	$208	$32	6.46	2.69
Lighting Package	All Vintages	23	0	$34	$5	6.31	4.01

Table 43: CZ 16 - Multifamily Unit Efficiency Upgrade Package Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Ducts Sealing + R-38 Attic Insulation + Air Sealing	Pre-1978	243	88	$961	$220	4.36	4.50
	1978-1991	119	45	$865	$97	8.96	2.19
	1992-2005	98	38	$865	$77	11.20	1.75
R-38 Attic Insulation	Pre-1978	115	22	$500	$69	7.28	2.70
	1978-1991	56	11	$405	$30	13.37	1.47
	1992-2005	49	10	$405	$27	15.03	1.31
Duct Sealing	Pre-1978	131	54	$120	$130	0.92	21.32
	1978-1991	63	22	$120	$50	2.38	8.24
	1992-2005	47	20	$120	$40	3.02	6.50
Cool Roof	Pre-1978	100	-9	$184	$10	17.55	1.12
	1978-1991	79	-6	$184	$10	17.72	1.11
	1992-2005	60	-6	$184	$7	27.80	0.71
Windows	Pre-1978	173	113	$5,873	$246	23.85	0.82
Water Heating Package	All Vintages	0	16	$168	$28	6.09	3.22
Lighting Package	All Vintages	23	0	$34	$5	6.31	4.01