CITY OF OAKLAND

AGENDA REPORT

TO:	Jestin D. Johnson City Administrator	**FROM:**	William A. Gilchrist Director, Planning and Building Department
SUBJECT:	Adoption of Local Amendments For Energy and Green Building Codes Related to Decarbonization, Energy Efficiency, and Public Health	**DATE:**	September 8, 2025

City Administrator Approval Jestin Johnson (Sep 11, 2025 15:19:24 PDT) Date: Sep 11, 2025

RECOMMENDATION

The City Administration Recommends That, After Conducting A Public Hearing And Upon Conclusion, The City Council Adopt The Following Pieces of Legislation:

(1) An Ordinance: (1) Adding Oakland Municipal Code ("O.M.C.") Chapter 15.06, "Oakland Amendments to the California Energy and Green Building Codes," Related To Building Decarbonization, Energy Efficiency, And Public Health To Meet the City of Oakland's Resource Conservation and Climate Goals; (2) Repealing The City Of Oakland's Local Amendments To The 2022 Edition Of The California Energy Code (Title 24, Part 6) And The 2022 California Green Building Code (Title 24, Part 11) at O.M.C. Chapter 15.04, Part 6 and Part 11 Administrative and Technical Amendments; And (3) Adopting Appropriate California Environmental Quality Act Findings; And

(2) A Resolution Of Findings Supporting The Adoption Of An Ordinance: (1) Adding Oakland Municipal Code ("O.M.C.") Chapter 15.06, "Oakland Amendments to the California Energy and Green Building Codes" To O.M.C. Title 15, "Buildings and Construction;" (2) Repealing The City Of Oakland's Local Amendments To The 2022 Edition Of The California Energy Code (Title 24, Part 6) And The 2022 California Green Building Code (Title 24, Part 11); And (3) Adopting Appropriate California Environmental Quality Act Exemption Findings.

EXECUTIVE SUMMARY

The proposed legislation would adopt new City of Oakland (City) amendments to the 2025 California Energy Code and Green Building Standards Code (CALGreen) to implement the City's 2030 Equitable Climate Action Plan (ECAP) (CMS 88267) and General Plan

Environmental Justice (EJ) Element goals (CMS 89907). The proposed amendments establish a comprehensive framework to reduce greenhouse gas (GHG) emissions and improve public health in both new and existing buildings.

The City Council adopted the EJ Element as part of Phase One of the City's General Plan Update on June 21, 2023. The EJ Element serves to equitably advance the health and safety of the City's residents and businesses. and explicitly references and integrates the goals and strategies of the City's ECAP. In alignment with the City's adopted greenhouse gas emissions reduction strategy, the EJ Element supports the transition to all-electric buildings.

The proposed Ordinance is exempt from the California Environmental Quality Act (CEQA) on the grounds that its regulatory standards are more stringent than those in the State Building Standards Code (Building Code) and is a regulatory action for the protection of the environment. As a result, there is no reasonably foreseeable adverse impacts associated with these higher standards. The findings supporting the proposed Ordinance are set forth in the proposed Resolution.

BACKGROUND / LEGISLATIVE HISTORY

The City has been a leader in ambitious and equity-driven climate action for decades, frequently surpassing California statewide goals. Resolution No. 82129 C.M.S. (2009) directed staff to develop the City's first climate strategy - the 2020 Energy and Climate Action Plan - with a GHG emission reduction target of 36 percent below 2005 levels; it also established a long-term GHG reduction target of 83 percent by 2050. In 2015, as a signatory to the Under2 Memorandum of Understanding and the Global Covenant of Mayors, the City declared its commitment to reducing its GHG emissions to levels consistent with the targets established in the 2015 Paris Climate Accord.

In 2016, California enacted Senate Bill (SB) 32, which built on the 2006 California Global Warming Solutions Act by requiring Statewide GHG emissions be reduced to 40 percent below 1990 levels by 2030. In 2018, the Oakland City Council adopted Resolution No. 87183 C.M.S., establishing a GHG emissions reduction target of 56 percent below 2005 levels by 2030. The City Council also adopted Resolution No. 87397 C.M.S. in 2018, declaring a climate emergency and calling for regional collaboration and a "citywide just transition and urgent climate mobilization effort to reverse global warming … as quickly as possible towards zero net emissions."

In July 2020, the City Council adopted the 2030 ECAP, a comprehensive plan responsive to the abovementioned Resolutions. The ECAP addresses both GHG mitigation and climate resilience through an equity lens, leveraging the tools and policy levers available through the City's regulatory and legal spheres of control to reduce local GHG emissions on a path projected to exceed Council's adopted 2030 and 2050 reduction targets.
Alongside the 2030 ECAP, the City Council also adopted a Carbon Neutrality Target of 2045 (Resolution No. 88268 C.M.S.). Achieving carbon neutrality will require complete decarbonization (ensuring that all mechanical systems run on clean electricity) of Oakland's building sector.

Action B-2 (Plan for All Existing Buildings to be Efficient and All- Electric by 2040) in the 2030 ECAP directs staff to develop a policy roadmap to achieve decarbonization of the existing building stock by 2040, without additional cost burden or displacement risk to frontline communities. The roadmap must address:

- Equitable process and outcomes, including avoiding bill increases, ensuring benefits flow to renters, and local green jobs;
- Incentives and requirements;
- Regulatory obstacles;
- Phasing of implementation;
- Financial assistance for low-income residents and businesses, including on-bill financing;
- Opportunities for integration of distributed renewable energy generation and energy storage; and
- Opportunities and needs for energy efficiency and building envelope upgrades, taking into account local, state, and regional energy efficiency incentive programs and focusing particularly on renters, low-income populations, and populations with a disproportionate risk of housing and business displacement.

The local building code is an important tool for cities to further local climate goals, including those set forth in Oakland's ECAP. Local jurisdictions are required to enforce the California Building Standards Code, codified as Title 24 of the California Code of Regulations (hereafter, Title 24), whether or not the jurisdiction formally adopts the Code. Title 24, Part 6, governs energy and energy efficiency in residential and nonresidential buildings and Title 24, Part 11, governs green buildings measures.

Local jurisdictions are permitted to adopt local amendments that exceed the State building code to address local conditions. Local jurisdictions may not adopt or implement less stringent standards. California Health & Safety Code Section 17958.7 provides that before making any modifications to the California Green Building Standards Code or any other applicable provisions published by the State Building Standards Commission, a governing body must make an express finding that each such change or modification is reasonably necessary because of specified local conditions. The findings must be filed with the State Building Standards Commission before the local changes or modifications go into effect. The recommended findings are set forth in the proposed Resolution.

ANALYSIS AND POLICY ALTERNATIVES

The City's 2017 Climate Action for Urban Sustainability (CURB) analysis indicated the City would not achieve its GHG emission reduction targets without eliminating natural gas combustion in buildings. However, the recent Ninth Circuit decision in *California Restaurant Association v. City of Berkeley* held that local legislation requiring buildings be all-electric, as opposed to incentivizing electrification, is preempted by the federal Energy Policy and Conservation Act ("EPCA").[1] As such, the City is not proposing an all-electric requirement for

[1] *See* Docket No. 21-16278, 89 F.4th 1094 (9th Cir. January 2, 2024).

new or existing buildings within the City. Instead, the City's local amendments focus on preparing buildings for future electrification that results in actual cost reductions.

In 2017, the most recent year for which data is available, 25.8 percent of Oakland's local GHG emissions originated from buildings, of which more than 70 percent came from natural gas combustion. That same analysis listed electrification of building space- heating systems as one of the top five strategic actions necessary to achieve those goals.

Oakland's primary source of electricity is East Bay Community Energy (EBCE), a local joint powers authority electricity supplier in Alameda County that prioritizes local renewable generation and local green jobs and development. EBCE's electricity generation was 85 percent renewable in 2019 and likely to be fully renewable and carbon free well before 2030. Increases in Oakland's consumption of electricity therefore draw from a clean and equitable electric grid, one that supports local economic development.

Failure to address and significantly reduce GHG emissions will result in continued increases in sea level rise that could put Oakland homes and businesses, public facilities, and portions of major local and regional transportation infrastructure at risk. Additional direct impacts of an unmitigated climate crisis likely to affect Oakland, as described in the Intergovernmental Panel on Climate Change (IPCC) reports and the 2030 ECAP, include severe weather events, increasing droughts, more frequent heat events and wildfires, smoke inundation from regional fires, erosion, flooding, and landslides.

Impacts of Natural Gas

Natural Gas and the Climate Crisis – Natural gas is primarily comprised of methane, a short-lived climate pollutant whose contribution to climate change ("global warming potential") is 86 times greater than carbon dioxide. Stopping methane pollution is necessary to keep global warming below the 1.5 degree-Celsius target identified in the Paris Climate Accord and in the subsequent agreements to which Oakland is a signatory. Methane pollution happens throughout the natural gas system, from leakages at the point of extraction and along the distribution system, to incidental leakage within homes and buildings. Additional climate emissions occur when natural gas is burned in home and building appliances, including for cooking, clothes drying, water heating, and space heating.

The City cannot meet its climate goals without shifting away from predominantly natural gas use without preparing buildings for future electrification that results in actual cost reductions. State policies and lower prices of renewable energy mean that substituting natural gas with electricity is one of the quickest, safest, and least expensive pathways to eliminating GHG emissions from buildings.

Natural Gas and Public Health – Indoor natural gas use, particularly for cooking, worsens indoor air quality, which disproportionately harms frontline communities, i.e., communities that experience the first and worst consequences of climate change. Burning natural gas creates indoor air pollutants including carbon monoxide, formaldehyde, and nitrogen dioxide, all of which contribute to respiratory ailments. These impacts are compounded in small, poorly-ventilated spaces like older apartments. Children living in homes with gas cooking are 42 percent more likely to have asthma.

Natural Gas and Public Safety – Natural gas presents combustion risk for buildings, especially during and after major earthquakes. It is well known that gas pipelines can cause catastrophic disasters, with perhaps the most infamous example being the 2010 San Bruno explosion. In 2017, the U.S. Geological Survey conducted its “HayWired Scenario,” simulating a 7.0 quake on the Hayward fault line with the epicenter in Oakland. The agency’s report predicted that “about 450 large fires could result in a loss of residential and commercial building floor area equivalent to more than 52,000 single-family homes and cause property (building and content) losses approaching $30 billion.” The report identified ruptured gas lines as a key fire risk factor. This finding mirrors the reality of the destructive gas fires resulting from the 1989 Loma Prieta and 1994 Northridge earthquakes.

Natural Gas and Resilience – Gas lines are also more difficult to repair following disasters than electric infrastructure, and as such reduce a city’s resilience. In times of disaster, the fossil fuel supply chain will likely be disrupted. Conversely, preparing buildings for future electrification that results in actual cost reductions can increase resilience. Electric appliances in conjunction with battery storage technology and renewable energy generation (such as rooftop solar) can operate absent the grid’s electric supply chain. Moreover, newer gas appliances, such as stoves and water heaters, require electricity to start. Thus, in times of power outages, gas appliances in new buildings will not provide the resilience that many people desire.

Natural Gas and Disproportionate Pollution Burdens and Severe Health Disparities – the City’s,topography and history have created concentrated zones of severe air pollution, disproportionately impacting communities in West and East Oakland.

- Statewide Pollution Hotspots: Four Oakland census tracts rank in the top 10th percentile in California for their cumulative pollution burden.
- Health Crisis: This pollution burden translates into devastating health outcomes. Residents of West and Downtown Oakland experience significantly higher rates of asthma-related emergency room visits, and there is a nearly 20-year gap in life expectancy between the Oakland hills and the flatlands of West and East Oakland.
- Indoor Air Quality: The ECAP and EJ Element highlight the contribution of indoor sources to these health crises, noting that "children who live in homes with gas stoves have a 42% increased chance of developing asthma" and that burning natural gas creates indoor pollutants like nitrogen dioxide (NO2) and carbon monoxide (CO).

A Comprehensive Approach for New and Existing Buildings
The proposed ordinance combines amendments to both the Energy Code and CALGreen to create a holistic strategy:

- Energy Code (Part 6): Amendments will establish high-performance standards for new construction, using energy modeling metrics (EDR/Source Energy) to strongly incentivize all-electric designs in a legally durable manner.
- Energy Code (Part 6): Amendments will apply to existing residential building alterations with a permit valuation over $25,000, requiring the implementation of practical, cost-effective electrification and efficiency measures from a flexible menu of options.
- CALGreen (Part 11): Amendments will apply to existing residential building alterations with a permit valuation over $25,000, requiring the implementation of all Mandatory Measures regardless of if a project is adding conditioned space, volume or size.

- CALGreen (Part 11): Amendments will require new construction to utilize concrete mixes that do not exceed a specified maximum Global Warming Potential (GWP) limit

The Amendments are set forth in full in the proposed Ordinance. This dual approach ensures that the City is addressing emissions from all construction activities, accelerating progress toward its 2030 ECAP and 2040 existing building decarbonization goals.

The adoption of this ordinance and findings aims to meet the following citywide priorities of addressing climate resilience, holistic community safety and supporting vibrant sustainable infrastructure.

FISCAL IMPACT

There is no fiscal impact to the City. Resources from existing budgeted staff will continue to enforce the Model Construction Codes as amended by the City.

The cost implications for residents are as follows:

- Cost-Effectiveness of High-Performance New Construction

Multiple analyses have concluded that all-electric new construction is cost-effective, often resulting in lower upfront costs due to the avoidance of gas infrastructure, which can cost between $7,050 and $9,500 for a single-family home. The performance standards in this ordinance are designed to make all-electric construction the most economically advantageous compliance pathway for developers.

- Cost-Effectiveness of Alteration Requirements

Requiring electrification-readiness and efficiency upgrades during a significant remodel is the most cost-effective time to undertake such work. The marginal cost of adding a 240-volt circuit or upgrading an electrical panel is significantly lower when walls are already open and electricians are on-site for other work. The ordinance provides a flexible menu of options, allowing property owners to choose the most practical and affordable measures for their specific project, thereby avoiding undue financial burden while preparing the home for a fossil-fuel-free future.

PUBLIC OUTREACH / INTEREST

The City engaged in extensive community and stakeholder outreach regarding building energy efficiency, electrification, and associated workforce implications through the ECAP and Phase 1 of the General Plan development process, development of the City's 2020 building code update, and other targeted outreach led by the City and partners. This specifically included:

- 4,000+ Oaklanders weighing in on development of the ECAP, with a consensus that there be full electrification of the entire inventory of Oakland's buildings, provided that it is predicated on efficiency and equitable implementation to ensure implementation does not exacerbate energy insecurity or housing displacement;
- ECAP ad-hoc Community Advisory Committee voted explicitly to advocate for equitable full electrification of all Oakland residential buildings;

• Targeted in-person and virtual events, documented on the City's Building Electrification webpage, including:

o a 3-part virtual town hall series addressing workforce needs and opportunities from electrification (50-70 participants per workshop);
o Building Electrification Clubhouse, a monthly networking and learning event co-convened by the City, Building Industry Gathering Oakland, and the Association of Energy Affordability; and
o Pop-up community education at farmers markets, community centers, Oakland Roots soccer games, neighborhood meetings, and other events.

For new construction electrification specifically, the City convened workshops on June 13, 2019 and September 12, 2019, with stakeholders consisting of developers, heating, ventilation and air conditioning (HVAC) designers, contractors, architects, engineers, business leaders, and City staff. Individual interviews with stakeholders were also conducted between workshops.

For electrification of existing buildings, insights came from the online Electrification Workforce workshop series that Sustainability & Resilience Division, Economic & Workforce Development, and Department of Transportation staff convened in 2021, and the extensive community outreach mentioned above and listed partially at the following link: https://www.oaklandca.gov/Government/Oakland-Improvement-Projects/Building-Electrification/Building-Electrification-Public-Engagement.

The City also published public notice of this action in the Alameda Times-Star on September 5, 2025 and September 12, 2025 and the Oakland Tribune on September 12, 2025 in compliance with Government Code section 6066.

COORDINATION

The Sustainability and Resilience Division of the City Administrator's Office, the Building Bureau of the Planning and Building Department, the Office of the City Attorney, the Department of Race and Equity, and the Budget Office have reviewed this report and proposed legislation.

SUSTAINABLE OPPORTUNITIES

Economic: These proposed amendments to the Model Construction Codes support housing and commercial development opportunities for new and remodeled building construction.

Cost-Effectiveness of High-Performance New Construction
Multiple analyses have concluded that all-electric new construction is cost-effective, often resulting in lower upfront costs due to the avoidance of gas infrastructure, which can cost between $7,050 and $9,500 for a single-family home. The performance standards in this ordinance are designed to make all-electric construction the most economically advantageous compliance pathway for developers.

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***Environmental**:* Natural gas, or methane, is a Short-Lived Climate Pollutant, with 86 times the global warming potential of carbon dioxide over a 20-year period. There is broad consensus among climate scientists that the world cannot limit global warming to 1.5 degrees Celsius without drastically limiting methane emissions, including from buildings. The reduction of greenhouse gas emissions by preparing buildings for future electrification that results in actual cost reductions will help mitigate climate change and its negative effects such as extreme heat events, droughts, intense storms, flooding, and displacement. This ordinance would fulfill Action B-1 in the 2030 ECAP, Eliminate Natural Gas in New Buildings, and prime the market for a smoother transition to full electrification for Oakland's existing buildings—the subject of 2030 ECAP Action B-2, Plan for All Existing Buildings to be Efficient and All-Electric by 2040.

***Race & Equity**:* Ensuring that new buildings are constructed without fossil fuel infrastructure and instead with local, carbon-free renewable energy sources will bring health and economic benefits to low-income communities. Modern electric systems and appliances are more efficient than older gas technologies, and in some cases offer lower overall installation costs and utility bills. They also offer improved air quality and less exposure to pollutants known to exacerbate asthma and other pulmonary diseases, which disproportionately impact vulnerable populations like children and seniors. Heat pumps add air conditioning capacity in areas with heat stress, and induction cooking is safer with lower exposure to hot surfaces and no open flames. Eliminating natural gas in buildings can lower the risk of fire after earthquakes, and reduce the likelihood of childhood asthma. All of these benefits disproportionately improve wellbeing in frontline communities, who face higher baseline levels of pollution exposure and pay a higher proportion of income for energy. These recommendations are also in alignment with O.M.C. 2.29.17.B.10 which direct departments to support "housing for all people that is safe, affordable, high quality and healthy. "
While new construction standards are vital, according to Census data over 40% of Oakland's building stock was built before 1940. Older, poorer-quality housing is concentrated in EJ communities, and these homes are more likely to contain inefficient, polluting gas appliances. The proposed amendment to the Energy Code and CALGreen addresses this directly by requiring upgrades during significant renovations. This ensures that as investment occurs, existing homes are made healthier by preparing them for the transition away from fossil fuels, directly improving indoor air quality and implementing ECAP Action B-2 and EJ Element Policy EJ-1.11.

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

The Health and Safety Code Section 18941.5, with reference to Section 17958.7, allows more restrictive local amendments to the Building Code that are reasonably necessary due to local climatic, geologic, or topographical conditions. This ordinance is exempt from CEQA under

CEQA Guidelines sections15061(b)(3) and 15308 due to the fact it is a regulatory action for the protection of the environment and that there are no reasonably foreseeable adverse impacts that would result from this action. As a result, there is no possibility that the activity in question would have a significant effect on the environment.

ACTION REQUESTED OF THE CITY COUNCIL

The City Administration Recommends That, After Conducting A Public Hearing And Upon Conclusion, The City Council Adopt The Following Pieces Of Legislation:

(1) An Ordinance: (1) Adding Oakland Municipal Code ("O.M.C.") Chapter 15.06, "Oakland Amendments to the California Energy and Green Building Codes," Related To Building Decarbonization, Energy Efficiency, And Public Health To Meet the City of Oakland's Resource Conservation and Climate Goals; (2) Repealing The City Of Oakland's Local Amendments To The 2022 Edition Of The California Energy Code (Title 24, Part 6) And The 2022 California Green Building Code (Title 24, Part 11) at O.M.C. Chapter 15.04, Part 6 and Part 11 Administrative and Technical Amendments; And (3) Adopting Appropriate California Environmental Quality Act Findings; And

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For questions regarding this report, please contact: Cecilia Muela, Interim Deputy Director Building Bureau/Chief Building Official, 510-238-6315.

Respectfully submitted,

William Gilchrist (Sep 11, 2025 10:07:21 PDT)

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Attachments:

1) Reach Codes 2019 Cost-effectiveness Study: Low-Rise Residential New Construction

Attachment 1

CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Title 24, Parts 6 and 11
Local Energy Efficiency Ordinances

2019 Cost-Effectiveness Study: Existing Low-rise Residential Building Efficiency Upgrade

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Last Modified: December 19, 2019

SDGE SoCalGas Southern California Edison Pacific Gas and Electric Company

LEGAL NOTICE

This report was prepared by Pacific Gas and Electric Company and funded by the California utility customers under the auspices of the California Public Utilities Commission.

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Acronyms

ACH50	Air Changes per Hour at 50 pascals pressure differential
ACM	Alternative Calculation Method
AFUE	Annual Fuel Utilization Efficiency
B/C	Lifecycle Benefit-to-Cost Ratio
BEopt	Building Energy Optimization Tool
BSC	Building Standards Commission
CBECC-Res	Computer program developed by the California Energy Commission for use in demonstrating compliance with the California Residential Building Energy Efficiency Standards
CFI	California Flexible Installation
CZ	California Climate Zone
EDR	Energy Design Rating
EER	Energy Efficiency Ratio
HERS Rater	Home Energy Rating System Rater
HVAC	Heating, Ventilation, and Air Conditioning
IOU	Investor Owned Utility
kWh	Kilowatt Hour
MF	Multifamily
NPV	Net Present Value
PG&E	Pacific Gas and Electric Company
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric
SEER	Seasonal Energy Efficiency Ratio
SF	Single Family
CASE	Codes and Standards Enhancement
TDV	Time Dependent Valuation
Title 24	Title 24, Part 6
TOU	Time-Of-Use

1 Overview

The California Codes and Standards Reach Codes team has completed a preliminary cost-effectiveness study for existing building upgrades. 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. This preliminary study updated a cost-effectiveness study completed in June 2018 (Statewide Reach Codes Team, 2018). The focus of this study was to revisit the recommended retrofit efficiency measure and package cost-effectiveness based on current utility rates and updated measure costs. Additional efforts have been identified that will be evaluated and released in an updated Existing Building Efficiency Upgrade Cost-Effectiveness Study in 2020. These include:

- Revisit base case assumptions for different vintages
- Additional HVAC upgrade options including:
    - High efficiency equipment replacement as alternative to non-preempted upgrade
    - Air sealing and attic insulation at time of HVAC replacement
    - Improved duct insulation, tighter ducts, buried ducts
- Additional building envelope improvements
    - Higher ceiling insulation requirements
    - Address low-slope roof replacements
- Lighting luminaire replacements in addition to lamp replacements
- Evaluation of electrification measures at equipment change-out and electrification-ready
- Additions: Installation of PV system when building an addition, and
- PV System Installation: Additional efficiency upgrade requirements when installing PV

2 Introduction

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

This report documents cost-effective combinations of measures that exceed the minimum state requirements, the 2019 Building Energy Efficiency Standards, effective January 1, 2020, for existing single family and low-rise (one- to three-habitable story) multifamily buildings when a remodel is submitted for permit. This analysis does not apply to high-rise multifamily buildings (four habitable stories or greater), nor to common areas categorized as 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 or listing 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 in all sixteen California Climate Zones (CZ) (see Appendix A – California Climate Zone Map for a graphical depiction of Climate Zone locations).

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.

3 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, for 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.

This analysis builds on the work completed for the 2016 Title 24 code (Statewide Reach Codes Team, 2018) and has been updated to reflect changes in measure costs over time as well as current utility tariffs. Energy simulations were not re-evaluated in CBECC-Res 2019 because there have been minimal updates to the software that impact the energy use results. This was validated by evaluating the pre-1978 basecase model in climate zone 12 with the version of the CBECC-Res software for the 2019 code, and comparing annual energy use with that from the 2016 version of software. Both total electricity and natural gas use differed between the two version by less than one percent. Therefore, this analysis can support ordinances adopted under either the 2016 or 2019 Title 24 code.

3.1 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 conditioning systems were evaluated. Additional details on the multifamily prototype can be found in the Alternative Calculation Method (ACM) Approval Manual (Energy Commission, 2018a).

Average home size has steadily increased over time,[1] 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

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

model developed by the Energy Commission for residential ACM testing[2] 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] 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 (CZ 2-15) Raised floor, R-0 (CZ 1 & 16)	Uninsulated slab (CZ 1-15) 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.

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

3.2 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; the cost and energy savings associated with this upgrade reflects the incremental step between a standard roofing product with one that is CRRC rated with an aged solar reflectance of 0.25. This is similar to cool roof requirements in 2019 Title 24 Section 150.2(b)1Ii 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 a 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 2019 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. The impact on space conditioning energy used would be minimal. 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. Baseline whole house hot water use was based on BEopt assumptions and 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). This measure was evaluated using BEopt and EnergyPlus.

LED Lighting: Replace screw-in incandescent lamps and compact fluorescent lamps (CFLs) with screw-in light emitting diode (LED) lamps. This analysis was conducted external to the energy model and evaluated replacement of both a single 45 W incandescent lamp and a 13W CFL 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, 10,000 hours for CFLs 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. This analysis was conducted external to the energy model, assuming ten percent savings in operating hours for a single vacancy sensor installed on a switch controlling three lamps. Energy savings were calculated assuming both 45 W incandescent lamps and 11 W LED 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).

3.3 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.

3.4 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]	$1.37/sqft ceiling area to add insulation to existing R-11 insulation $1.21/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. Cost based on a single lamp replacement
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).

3.4.1 Cost-Effectiveness

A customer-based approach to evaluating cost-effectiveness was used based on 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. First year utility costs were calculated using hourly electricity and gas output from CBECC-Res and applying the utility tariffs summarized in Table 4. The applicable residential time-of-use (TOU) 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 are evaluated with both SCE/SoCalGas and SDG&E tariffs since each utility has customers within these climate zones. Climate Zone 5 is evaluated under both PG&E and SoCalGas natural gas rates.

Table 4: IOU Utility Tariffs Applied Based on Climate Zone

Climate Zones	Electric/Gas Utility	Electricity (Standard)	Natural Gas
1-5, 11-13, 16	PG&E	E-TOU, Option B	G1
5	PG&E / SoCalGas	E-TOU, Option B	GR
6, 8-10, 14, 15	SCE/SoCalGas	TOU-D-4-9	GR
7, 10, 14	SDG&E	D TOU-DR1	GR

Source: Utility websites, see Appendix B – Utility Rate Tariffs for details on the tariffs applied.

Utility rates are assumed to escalate over time, using assumptions from research conducted by Energy and Environmental Economics (E3) in the 2019 study Residential Building Electrification in California study (Energy & Environmental Economics, 2019). Escalation of natural gas rates between 2019 and 2022 is based on the currently filed General Rate Cases (GRCs) for PG&E, SoCalGas and SDG&E. From 2023 through 2025, gas rates are assumed to escalate at 4% per year above inflation, which reflects historical rate increases between 2013 and 2018. Escalation of electricity rates from 2019 through 2025 is assumed to be 2% per year above inflation, based on electric utility estimates. After 2025, escalation rates for both natural gas and electric rates are assumed to drop to a more conservative 1% escalation per year above inflation for long-term rate trajectories beginning in 2026 through 2050. See Appendix B – Utility Rate Tariffs for additional details.

Cost-effectiveness was evaluated for all 16 climate zones and results are presented as a lifecycle benefit-to-cost (B/C) ratio, a net present value (NPV) metric which represents the cost-effectiveness of a measure over a 30-year lifetime taking into account discounting of future savings and costs and financing of incremental first costs. A value of one indicates the NPV of the savings over the life of the measure is equivalent to the NPV of the lifetime incremental cost of that measure. A value greater than one represents a positive return on investment. The B/C ratio is calculated according to Equation 1.

Equation 1

$$Benefit - to - Cost\ Ratio = \frac{NPV\ of\ lifetime\ benefit}{NPV\ of\ lifetime\ cost}$$

The benefit is represented by annual utility savings and the cost by incremental first cost and replacement costs. The lifetime costs or benefits are calculated according to Equation 2.

Equation 2

$$NPV\ of\ lifetime\ cost\ or\ benefit = \sum_{t=0}^{n} \frac{(Annual\ cost\ or\ benefit)_t}{(1+r)^t}$$

Where:

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

The following summarizes the assumptions applied in this analysis to both methodologies.

- Analysis term of 30-years
- Real discount rate of 3 percent
- First incremental costs are financed into a mortgage or loan

Table 5 summarizes the financing assumptions and terms that were applied in this analysis. The analysis term is 30 years in all cases. The LED lighting and vacancy sensor upgrades are the only measures that are not assumed to be financed.

Table 5: Final Financing Assumptions

	Loan Term	Loan Rate
Single Family	30	5%
Multifamily	10	4%

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

Simple payback = First incremental cost / First year utility cost savings **Equation 3**

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.

4 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 are summarized below as well as in Table 6 for single family and Table 7 for multifamily.

Results of cost-effectiveness analysis along with energy savings are presented in Appendix D – Measure Cost-effectiveness Tables in Table 13 through Table 50 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 20 years for single family and 24 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 LED 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 three of these measures are cost-effective for all vintages in inland, cooling climates, as well as cold climates (Climate Zone 1, and 9-16 for single family and Climate Zone 1, 2, 4, and 8-16 for multifamily).

Duct sealing is cost-effective in all cases except for single family homes in Climate Zone 6 built after 1991 and Climate Zone 7 built after 1977; and multifamily in Climate Zone 5 PG&E territory and Climate Zone 7 built after 1991.

Air sealing and attic insulation are less cost-effective in newer vintages in transitional and coastal climates. This package of measures is cost-effective in the following cases:

- Buildings built between 1992 and 2005: Single family Climate Zones 1 and 9-16; and multifamily Climate Zones 1, 2, 4, and 8-16.
- Buildings built between 1978 and 1991: Single family Climate Zones 1, 4 and 8-16; and multifamily Climate Zones 1, 2, 4 and 8-16.
- Buildings built before 1978: Single family and multifamily in Climate Zones 1-16.

Cost-effectiveness of the envelope and duct measures was better in SDG&E territory than SCE territory for both Climate Zone 10 and 14.

Cool Roof: Cool roof is cost-effective for all vintages of single family homes in Climate Zones 8 through 15 and multifamily homes in Climate Zones 2, 4, and 6 through 16. It is also cost-effective for homes built before 1978 for single family in Climate Zone 2, 4, 6, and 7 and for multifamily buildings in Climate Zone 5.

Window Replacement: Window replacements are only cost-effective in buildings built before 1978 in single family homes in Climate Zones 10 in SDG&E territory only and 13 through 15; and in multifamily homes in Climate Zones 5 in PG&E territory only, 10 in SDG&E territory only, and 11-16.

Water Heating Package – Water Heater Blanket, Hot Water Pipe Insulation, & Low-Flow Fixtures: The package including these three water heating measures is cost-effective in all climate zones.

Lighting – LED Lamps: Replacing either an existing CFL or incandescent lamp with an LED lamp is cost-effective in all climate zones. The lighting results in Appendix D report cost-effectiveness for replacement of CLFs with LED lamps. Replacement of incandescent with LED lamps result in simple paybacks of less than one year. While vacancy sensors are cost-effective when incandescent lamps are assumed, once lamps are replaced with LED luminaires, most of the savings disappear and vacancy sensors are not cost-effective. In 2020, industry standard practice will be 45 lumens per Watt or greater for all lamps, which make the vacancy sensor measure not cost-effective.

Table 6: Summary of Single Family Results

CASE		CZ1-PGE	CZ2-PGE	CZ3-PGE	CZ4-PGE	CZ5-PGE	CZ5-SCG	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[1]/ R-38[2]/ Air Seal[3]	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	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	Ducts/ R-38/ Air Seal
	1978-1991	Ducts/ R-38/ Air Seal	Ducts	Ducts	Ducts	Ducts	Ducts	N/A	N/A	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	Ducts/ R-38/ Air Seal
	1992-2005	Ducts	Ducts	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	Ducts/ R-38/ Air Seal
Cool Roof	Pre-1978	N/A	Yes	N/A	Yes	N/A	N/A	N/A	Yes	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	N/A	Yes	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	N/A	Yes	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	Yes	Yes	N/A	Yes	N/A	Yes	Yes	Yes	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	Yes	Yes
LED Lamps	All Vintages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] Ducts refers to the Duct Sealing upgrade, which calls for the air seal of all ductwork to meet the requirements of the 2019 Title 24 Section 150.2(b)1E.

[2] R-38 refers to the Attic Insulation upgrade, which calls for the addition of attic insulation to a minimum level of R-38 in vented attics.

[3] Air Seal refers to the Air Sealing upgrade, which calls for the sealing of all accessible cracks, holes and gaps in the building envelope at walls, floors, and ceilings.

Table 7: Summary of Multifamily Results

CASE		CZ1-PGE	CZ2-PGE	CZ3-PGE	CZ4-PGE	CZ5-PGE	CZ5-SCG	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	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/ R-38/ Air Seal	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	Ducts/ R-38/ Air Seal
	1992-2005	Ducts/ R-38/ Air Seal	Ducts/ R-38/ Air Seal	Ducts	Ducts	N/A	N/A	N/A	N/A	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
Cool Roof	Pre-1978	N/A	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1978-1991	N/A	Yes	N/A	Yes	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1992-2005	N/A	Yes	N/A	Yes	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Windows	Pre-1978	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Water Heating Package	All Vintages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LED Lamps	All Vintages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] Ducts refers to the Duct Sealing upgrade, which calls for the air seal of all ductwork to meet the requirements of the 2019 Title 24 Section 150.2(b)1E.

[2] R-38 refers to the Attic Insulation upgrade, which calls for the addition of attic insulation to a minimum level of R-38 in vented attics.

[3] Air Seal refers to the Air Sealing upgrade, which calls for the sealing of all accessible cracks, holes and gaps in the building envelope at walls, floors, and ceilings.

5 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.

5.1 Recommended Efficiency Measures

Based on the analysis, the following cost-effective measures or packages of measures 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. Verification shall be conducted 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. Compliance can also be demonstrated with blower door testing showing at least a 30% reduction from pre-retrofit conditions. 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 or can otherwise demonstrate that air sealing meeting the requirements of this ordinance was conducted within the last 12 months.

Duct Sealing: Air seal all ductwork to meet the requirements of the 2019 Title 24 Section 150.2(b)1E, with the exception that duct testing is not required to be verified by a HERS Rater. The duct system must be tested to confirm that the requirements have been met. The building department may allow the contractor to self-certify, may request to be present at the time of leakage testing, or may engage another third-party consultant to verify the duct sealing. See Appendix C – Standards Sections 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 2019 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 all of the requirements of Title 24, Part 6, including HERS Rater verification.

Envelope & Duct Package: This is the combination of the Attic Insulation, Air Sealing, and Duct Sealing upgrades listed above.

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)1Iii of 2019 Title 24 Standards. See Appendix C – Standards Sections 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 2019 Title 24 Section 150.2(b)1Ii for steep slope roofs and 150.2(b)1Iii 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.

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 or measured 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 – LED Lamps: Replace all interior and exterior screw-in (A-base) incandescent, halogen, and compact fluorescent lamps with screw-in LED lamps.

5.2 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 require inspection and testing of all combustion appliances after completion of the retrofit work. It's also recommended that jurisdictions require 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. 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. Run #2 would also be completed with the minimum ordinance requirements modeled for each of the affected building components. In order to show compliance with the ordinance 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).

5.3 Next Steps

The focus of this study was to update the existing building upgrade cost-effectiveness study completed in June 2018 (Statewide Reach Codes Team, 2018), based on current utility rates and updated upgrade costs. Additional efforts have been identified that will be evaluated and released in an updated Existing Building Efficiency Upgrade Cost-Effectiveness Study in 2020. These include:

- Revisit base case assumptions for different vintages
- Additional HVAC upgrade options including:
    - High efficiency equipment replacement as alternative to non-preempted upgrade
    - Air sealing and attic insulation at time of HVAC replacement
    - Improved duct insulation, tighter ducts, buried ducts
- Additional building envelope improvements

  - Higher ceiling insulation requirements
  - Address low-slope roof replacements
- Lighting luminaire replacements in addition to lamp replacements
- Evaluation of electrification measures at equipment change-out and electrification-ready
- PV requirements at time of addition, and
- Additional efficiency upgrade requirements when installing PV

6 References

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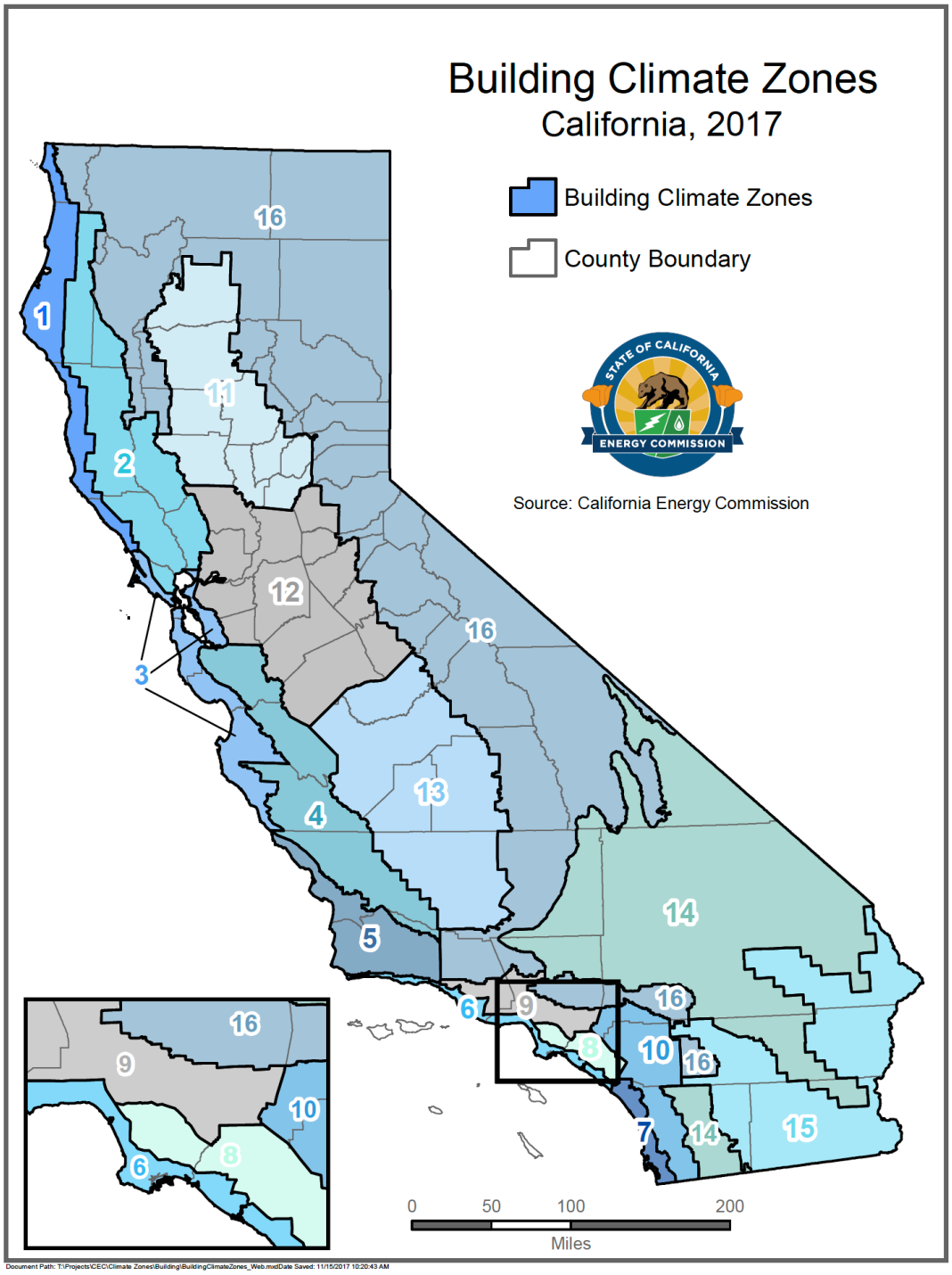
Appendix A – California Climate Zone Map



Appendix B – Utility Rate Tariffs

PG&E

The following pages provide details on the PG&E electricity and natural gas tariffs applied in this study. Table 8 describes the baseline territories that were assumed for each climate zone.

Table 8: PG&E Baseline Territory by Climate Zone

	Baseline Territory
CZ01	V
CZ02	X
CZ03	T
CZ04	X
CZ05	T
CZ11	R
CZ12	S
CZ13	R
CZ16	Y

The PG&E monthly gas rate in $/therm was applied on a monthly basis for the 12-month period ending January 2019 according to the rates shown below.

Pacific Gas and Electric Company

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

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

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

Pacific Gas and Electric Company
U 39 San Francisco, California

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

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

RATES:
(Cont'd.)

OPTION B TOTAL RATES

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

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

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

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

UNBUNDLING OF OPTION B TOTAL RATES

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

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

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

(Continued)

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

Pacific Gas and Electric Company

U 39 San Francisco, California

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

GAS SCHEDULE G-1 Sheet 1
RESIDENTIAL SERVICE

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

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

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

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

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

Public Purpose Program Surcharge:

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

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

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

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1 PG&E's gas tariffs are available online at www.pge.com.

2 Covered entities are not exempt from paying costs associated with LUAF Gas and Gas used by Company Facilities.

3 The exemption credit will be equal to the effective non-exempt AB 32 GHG Compliance Cost Rate ($ per therm) included in Preliminary Statement – Part B, multiplied by the customer's billed volumes (therms) for each billing period.

4 PG&E will update its billing system annually to reflect newly exempt or newly excluded customers to conform with lists of Directly Billed Customers provided annually by the ARB.

5 The Minimum Transportation charge does not apply to submetered tenants of master-metered customers served under gas rate Schedules GS and GT.

(Continued)

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

SCE

The following pages provide details on are the SCE electricity tariffs applied in this study. Table 9 describes the baseline territories that were assumed for each climate zone.

Table 9: SCE Baseline Territory by Climate Zone

	Baseline Territory
CZ06	6
CZ08	8
CZ09	9
CZ10	10
CZ14	14
CZ15	15

	Delivery	Generation	Total Rate
TOU-Default-Rate-1 (On-Peak 4:00 pm - 9:00 pm)			
Energy Charge - $/kWh			
Summer Season - On-Peak	0.19880	0.20072	0.39952
Mid-Peak	0.19880	0.05948	0.25828
Off-Peak	0.15574	0.06023	0.21597
Winter Season - Mid-Peak	0.19880	0.08308	0.28188
Off-Peak	0.15574	0.11309	0.26883
Super-Off-Peak	0.15062	0.01344	0.16406
Basic Charge - $/day			
Single-Family Residence	0.031	0.000	0.031
Multi-Family Residence	0.024	0.000	0.024
Minimum Charge - $/day			
Single Family Residence	0.338	0.000	0.338
Multi-Family Residence	0.338	0.000	0.338
Baseline Credit - $/kWh	(0.06512)	0.00000	(0.06512)

	Delivery	Generation	Total Rate
TOU-D-Rate PRIME			
Energy Charge - $/kWh			
Summer Season - On-Peak	0.15926	0.19811	0.35737
Mid-Peak	0.15926	0.10092	0.26018
Off-Peak	0.08308	0.04687	0.12995
Winter Season - Mid-Peak	0.16268	0.16761	0.33029
Off-Peak	0.08081	0.04331	0.12412
Super-Off-Peak	0.08081	0.04331	0.12412
Customer Charge - $/day	0.395	0.000	0.395

TOU Period	Weekdays		Weekends and Holidays	
	Summer	Winter	Summer	Winter
On-Peak	4 p.m. - 9 p.m.			
Mid-Peak		4 p.m. - 9 p.m.	4 p.m. - 9 p.m.	4 p.m. - 9 p.m.
Off-Peak	All other hours	9 p.m. - 8 a.m.	All other hours	9 p.m. - 8 a.m.
Super-Off-Peak		8 a.m. - 4 p.m.		8 a.m. - 4 p.m.

PROPOSED
(7 Year Average 2010-2016)

Summer kWh per Day			Winter kWh per Day		
Baseline Region	**Basic**	**All Electric**	**Baseline Region**	**Basic**	**All Electric**
05	17.2	17.9	05	18.7	29.1
06	11.4	8.8	06	11.3	13.0
08	12.6	9.8	08	10.6	12.7
09	16.5	12.4	09	12.3	14.3
10	18.9	15.8	10	12.5	17.0
13	22.0	24.6	13	12.6	24.3
14	18.7	18.3	14	12.0	21.3
15	46.4	24.1	15	9.9	18.2
16	14.4	13.5	16	12.6	23.1

SoCalGas

Following are the SoCalGas natural gas tariffs applied in this study. Table 10 describes the baseline territories that were assumed for each climate zone.

Table 10: SoCalGas Baseline Territory by Climate Zone

	Baseline Territory
CZ05	2
CZ06	1
CZ08	1
CZ09	1
CZ10	1
CZ14	2
CZ15	1

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

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

APPLICABILITY

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

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

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

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

TERRITORY

Applicable throughout the service territory.

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

[1/] For the summer period beginning May 1 through October 31, with some exceptions, usage will be accumulated to at least 20 Ccf (100 cubic feet) before billing.

(Footnotes continue next page.)

(Continued)

(TO BE INSERTED BY UTILITY)
ADVICE LETTER NO. 5410
DECISION NO.
1C6

ISSUED BY
Dan Skopec
Vice President
Regulatory Affairs

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

SDG&E

Following are the SDG&E electricity and natural gas tariffs applied in this study. Table 11 describes the baseline territories that were assumed for each climate zone.

Table 11: SDG&E Baseline Territory by Climate Zone

	Baseline Territory
CZ07	Coastal
CZ10	Inland
CZ14	Mountain

SDGE

San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 31320-E
Canceling Revised Cal. P.U.C. Sheet No. 31103-E

SCHEDULE TOU-DR1 Sheet 2
RESIDENTIAL TIME-OF-USE

RATES

Total Rates:

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

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

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

(Continued)

2C11
Advice Ltr. No. 3326-E
Decision No.

Issued by
Dan Skopec
Vice President
Regulatory Affairs

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

SDGE
San Diego Gas & Electric Company
San Diego, California

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

Sheet 1

SCHEDULE GR

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

APPLICABILITY

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

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

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

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

TERRITORY

Within the entire territory served natural gas by the utility.

RATES

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

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

(Continued)

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

Issued by
Dan Skopec
Vice President
Regulatory Affairs

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

Escalation Assumptions

The average annual escalation rates in the following table were used in this study and are from E3's 2019 study Residential Building Electrification in California (Energy & Environmental Economics, 2019). These rates are applied to the 2019 rate schedules over a thirty-year period beginning in 2020. SDG&E was not covered in the E3 study. The Reach Code Team reviewed SDG&E's GRC filing and applied the same approach that E3 applied for PG&E and SoCalGas to arrive at average escalation rates between 2020 and 2022.

Table 12: Real Utility Rate Escalation Rate Assumptions

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

Appendix C – Standards Sections

6.1.1 2019 Building Energy Efficiency Standards Section 150.2(b)1I

Roofs. Replacements of the exterior surface of existing roofs, including adding a new surface layer on top of the existing exterior surface, 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)1Ii: 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. 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)1Iii: Buildings with no ducts in the attic.

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

6.1.2 2019 Building Energy Efficiency Standards Section 150.2(b)1E

Altered Space-Conditioning System - Duct Sealing: In all Climate Zones, when a space-conditioning system serving a single family or multifamily dwelling 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 subsection i, ii, or iii below. Additionally, when altered ducts, air-handling units, cooling or heating coils, or plenums are located in garage spaces, the system shall comply with Section 150.2(b)1Diic regardless of the length of any new or replacement space-conditioning ducts installed in the garage space.

i. The measured duct leakage 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

ii. The measured duct leakage 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

iii. 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.

6.1.3 2019 Building Energy Efficiency Standards Section 110.9(b)4

Occupant Sensing Controls. Occupant sensing controls include occupant sensors, motion sensors, and vacancy sensors, including those with a Partial-ON or Partial-OFF function. Occupant sensing controls shall:

A. Be capable of automatically turning the controlled lights in the area either off or down no more than 20 minutes after the area has been vacated;

B. For manual-on controls, have a grace period of no less than 15 seconds and no more than 30 seconds to turn on lighting automatically after the sensor has timed out; and

C. Provide a visible status signal that indicates that the device is operating properly, or that it has failed or malfunctioned. The visible status signal may have an override that turns off the signal**.**

EXCEPTION to Section 110.9(b)4: Occupant Sensing Control systems may consist of a combination of single or multi-level Occupant, Motion, or Vacancy Sensor Controls, provided that components installed to comply with manual-on requirements shall not be capable of conversion by occupants from manual-on to automatic-on functionality

Appendix D – Measure Cost-effectiveness Tables

Climate Zone 1: The envelope and duct package is cost-effective for single family built before 1992 and multifamily homes built before 2006. For single family homes built between 1992 and 2005 duct sealing alone is cost-effective. Cool roof upgrades and window replacements are not cost-effective.

Note: Grey rows indicate option is not cost effective.

Table 13: CZ 1 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	154	179	$3,472	$366	9.49	2.10
	1978-1991	80	93	$3,212	$190	16.95	1.18
	1992-2005	65	76	$3,212	$155	20.73	0.96
R-38 Attic Insulation	Pre-1978	50	57	$2,273	$119	19.17	1.04
	1978-1991	23	27	$2,013	$55	36.46	0.55
	1992-2005	23	26	$2,013	$54	37.14	0.54
Duct Sealing	Pre-1978	84	97	$240	$198	1.21	16.51
	1978-1991	37	43	$240	$88	2.72	7.34
	1992-2005	31	36	$240	$73	3.28	6.09
Cool Roof	Pre-1978	-28	-34	$635	-$68	-9.41	-2.12
	1978-1991	-21	-25	$635	-$49	-12.88	-1.55
	1992-2005	-22	-26	$635	-$52	-12.19	-1.64
Windows	Pre-1978	111	130	$9,810	$265	37.08	0.54
Water Heating Package	All Vintages	0	19	$208	$33	6.35	3.16
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.96	4.45

Table 14: CZ 1 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	58	67	$1,054	$137	7.72	3.15
	1978-1991	28	33	$987	$56	17.59	1.38
	1992-2005	21	25	$987	$41	24.21	1.00
R-38 Attic Insulation	Pre-1978	15	16	$594	$34	17.48	1.39
	1978-1991	7	8	$526	$15	34.59	0.70
	1992-2005	7	8	$526	$13	39.30	0.62
Duct Sealing	Pre-1978	32	37	$120	$76	1.57	15.47
	1978-1991	12	13	$120	$24	4.99	4.88
	1992-2005	8	10	$120	$16	7.55	3.22
Cool Roof	Pre-1978	-7	-9	$184	-$17	-10.60	-2.30
	1978-1991	-4	-6	$184	-$10	-19.10	-1.27
	1992-2005	-4	-6	$184	-$9	-20.78	-1.17
Windows	Pre-1978	78	92	$5,873	$185	31.71	0.77
Water Heating Package	All Vintages	0	16	$168	$28	6.02	4.07
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.96	4.45

Climate Zone 2: The envelope and duct package is cost-effective for single family homes built before 1978 and multifamily homes built before 2006. For single family homes built between 1978 and 2005 duct sealing alone is cost-effective. Cool roof upgrades are cost-effective for single family homes built before 1978 and multifamily homes built before 2006. Window replacements are not cost-effective.

Note: Grey rows indicate option is not cost effective.

Table 15: CZ 2 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	578	109	$3,472	$387	8.97	2.17
	1978-1991	194	51	$3,212	$154	20.80	0.94
	1992-2005	125	45	$3,212	$117	27.47	0.72
R-38 Attic Insulation	Pre-1978	385	38	$2,273	$195	11.67	1.65
	1978-1991	137	18	$2,013	$79	25.47	0.76
	1992-2005	91	17	$2,013	$60	33.30	0.58
Duct Sealing	Pre-1978	203	56	$240	$169	1.42	13.77
	1978-1991	52	21	$240	$55	4.39	4.50
	1992-2005	31	20	$240	$44	5.50	3.60
Cool Roof	Pre-1978	219	-20	$635	$37	17.12	1.02
	1978-1991	95	-15	$635	$8	76.43	0.19
	1992-2005	47	-15	$635	-$9	-69.12	-0.33
Windows	Pre-1978	529	39	$9,810	$246	39.93	0.48
Water Heating Package	All Vintages	0	19	$208	$33	6.31	3.19
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.32	12.62	4.92

Table 16: CZ 2 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	224	40	$1,054	$136	7.76	3.05
	1978-1991	89	18	$987	$52	18.83	1.25
	1992-2005	69	15	$987	$42	23.26	1.02
R-38 Attic Insulation	Pre-1978	116	11	$594	$55	10.89	2.15
	1978-1991	51	5	$526	$23	22.40	1.04
	1992-2005	44	5	$526	$21	24.65	0.95
Duct Sealing	Pre-1978	112	22	$120	$72	1.67	14.16
	1978-1991	44	6	$120	$23	5.22	4.50
	1992-2005	26	5	$120	$16	7.49	3.15
Cool Roof	Pre-1978	94	-5	$184	$22	8.31	2.67
	1978-1991	65	-3	$184	$17	10.98	2.04
	1992-2005	45	-3	$184	$11	16.88	1.31
Windows	Pre-1978	409	29	$5,873	$179	32.85	0.71
Water Heating Package	All Vintages	0	16	$168	$27	6.16	3.98
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.32	12.62	4.92

Climate Zone 3: The envelope and duct package is cost-effective for single family and multifamily homes built before 1978. For single family and multifamily homes built between 1978 and 2005 duct sealing alone is cost-effective. Cool roof upgrades and window replacements are not cost-effective.

Note: Grey rows indicate option is not cost effective.

Table 17: CZ 3 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	132	99	$3,472	$222	15.61	1.28
	1978-1991	41	46	$3,212	$91	35.39	0.56
	1992-2005	36	40	$3,212	$78	40.97	0.49
R-38 Attic Insulation	Pre-1978	74	37	$2,273	$91	24.87	0.80
	1978-1991	17	17	$2,013	$36	56.57	0.35
	1992-2005	16	17	$2,013	$33	60.55	0.33
Duct Sealing	Pre-1978	53	51	$240	$110	2.19	9.11
	1978-1991	15	17	$240	$35	6.88	2.91
	1992-2005	14	16	$240	$31	7.65	2.61
Cool Roof	Pre-1978	17	-18	$635	-$25	-25.51	-0.80
	1978-1991	-9	-13	$635	-$24	-26.20	-0.76
	1992-2005	-10	-13	$635	-$24	-26.17	-0.76
Windows	Pre-1978	92	72	$9,810	$159	61.51	0.32
Water Heating Package	All Vintages	0	19	$208	$33	6.39	3.15
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.75	4.52

Table 18: CZ 3 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	54	35	$1,054	$72	14.60	1.66
	1978-1991	19	15	$987	$26	38.21	0.63
	1992-2005	14	12	$987	$20	48.42	0.50
R-38 Attic Insulation	Pre-1978	26	10	$594	$25	24.16	0.99
	1978-1991	10	5	$526	$10	53.48	0.45
	1992-2005	8	5	$526	$9	57.71	0.42
Duct Sealing	Pre-1978	25	18	$120	$37	3.27	7.41
	1978-1991	7	5	$120	$8	14.65	1.65
	1992-2005	4	4	$120	$6	19.37	1.25
Cool Roof	Pre-1978	12	-4	$184	-$2	-78.18	-0.35
	1978-1991	7	-3	$184	-$1	-167.26	-0.17
	1992-2005	3	-3	$184	-$2	-76.88	-0.33
Windows	Pre-1978	67	49	$5,873	$98	60.05	0.40
Water Heating Package	All Vintages	0	16	$168	$26	6.41	3.82
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.75	4.52

Climate Zone 4: The envelope and duct package is cost-effective for single family homes built before 1978 and multifamily homes built before 1992. For single family homes built between 1978 and 2005 and multifamily homes built between 1992 and 2005 duct sealing alone is cost-effective. Cool roof upgrades are cost-effective for single family homes built before 1978 and multifamily homes built before 2006. Window replacements are not cost-effective.

Note: Grey rows indicate option is not cost effective.

Table 19: CZ 4 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	560	93	$3,472	$349	9.95	1.95
	1978-1991	228	44	$3,212	$146	21.94	0.89
	1992-2005	158	38	$3,212	$116	27.80	0.70
R-38 Attic Insulation	Pre-1978	383	35	$2,273	$186	12.23	1.57
	1978-1991	172	17	$2,013	$84	24.10	0.80
	1992-2005	124	16	$2,013	$68	29.55	0.65
Duct Sealing	Pre-1978	185	46	$240	$144	1.67	11.73
	1978-1991	60	17	$240	$48	5.04	3.88
	1992-2005	34	15	$240	$37	6.53	3.02
Cool Roof	Pre-1978	240	-16	$635	$49	13.00	1.38
	1978-1991	147	-12	$635	$29	21.69	0.82
	1992-2005	87	-12	$635	$10	64.71	0.25
Windows	Pre-1978	567	28	$9,810	$234	41.95	0.45
Water Heating Package	All Vintages	0	19	$208	$33	6.33	3.18
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.32	12.63	4.92

Table 20: CZ 4 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	214	33	$1,054	$118	8.93	2.64
	1978-1991	93	15	$987	$49	20.05	1.17
	1992-2005	75	12	$987	$40	24.65	0.95
R-38 Attic Insulation	Pre-1978	114	10	$594	$51	11.61	2.01
	1978-1991	53	5	$526	$23	22.89	1.02
	1992-2005	47	5	$526	$21	24.91	0.94
Duct Sealing	Pre-1978	107	17	$120	$61	1.96	12.06
	1978-1991	49	5	$120	$22	5.47	4.27
	1992-2005	33	4	$120	$16	7.61	3.08
Cool Roof	Pre-1978	101	-4	$184	$26	7.19	3.12
	1978-1991	75	-3	$184	$21	8.94	2.52
	1992-2005	57	-3	$184	$15	12.49	1.80
Windows	Pre-1978	438	21	$5,873	$173	34.01	0.68
Water Heating Package	All Vintages	0	16	$168	$26	6.43	3.81
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.32	12.63	4.92

Climate Zone 5 PG&E/PG&E: The envelope and duct package is cost-effective for single family and multifamily homes built before 1978. For single family homes built between 1978 and 2005 and multifamily homes built between 1978 and 1991 duct sealing alone is cost-effective. Cool roof upgrades are cost-effective for multifamily homes built before 1978 but are not cost-effective for single family homes. Window replacements are cost-effective for multifamily homes built before 1978 but are not cost-effective for single family homes.

Note: Grey rows indicate option is not cost effective.

Table 21: CZ 5 PG&E/PG&E - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	105	102	$3,472	$215	16.12	1.24
	1978-1991	42	48	$3,212	$92	34.85	0.57
	1992-2005	36	41	$3,212	$79	40.63	0.49
R-38 Attic Insulation	Pre-1978	49	36	$2,273	$80	28.54	0.70
	1978-1991	15	16	$2,013	$32	62.07	0.32
	1992-2005	14	15	$2,013	$29	68.90	0.29
Duct Sealing	Pre-1978	46	52	$240	$107	2.24	8.93
	1978-1991	16	18	$240	$36	6.70	2.98
	1992-2005	15	17	$240	$33	7.17	2.79
Cool Roof	Pre-1978	-5	-25	$635	-$45	-14.14	-1.42
	1978-1991	-14	-18	$635	-$36	-17.72	-1.13
	1992-2005	-15	-19	$635	-$36	-17.70	-1.13
Windows	Pre-1978	81	76	$9,810	$160	61.19	0.33
Water Heating Package	All Vintages	0	19	$208	$33	6.40	3.14
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.88	4.48

Table 22: CZ 5 PG&E/PG&E - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	45	36	$1,054	$260	4.06	5.76
	1978-1991	13	15	$987	$19	53.03	0.46
	1992-2005	10	13	$987	$15	64.74	0.38
R-38 Attic Insulation	Pre-1978	22	10	$594	$226	2.63	8.85
	1978-1991	7	5	$526	$7	76.62	0.31
	1992-2005	5	5	$526	$6	87.62	0.28
Duct Sealing	Pre-1978	20	19	$120	$234	0.51	45.53
	1978-1991	5	4	$120	$5	21.88	1.11
	1992-2005	3	4	$120	$5	26.51	0.92
Cool Roof	Pre-1978	7	-6	$184	$203	0.91	25.55
	1978-1991	3	-3	$184	-$2	-75.95	-0.33
	1992-2005	-1	-3	$184	-$4	-45.73	-0.53
Windows	Pre-1978	59	52	$5,873	$280	20.98	1.12
Water Heating Package	All Vintages	0	16	$168	$21	8.07	3.04
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.88	4.48

Climate Zone 5 – PG&E/SoCalGas: The envelope and duct package is cost-effective for multifamily homes built before 1978. For single family homes built before 2006 and multifamily homes built between 1978 and 1991 duct sealing alone is cost-effective. Cool roof upgrades are cost-effective for multifamily homes built before 1978 but are not cost-effective for single family homes. Window replacements are not cost-effective.

Note: Grey rows indicate option is not cost effective.

Table 23: CZ 5 PG&E/SoCalGas - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	105	102	$3,472	$165	20.98	1.00
	1978-1991	42	48	$3,212	$69	46.38	0.45
	1992-2005	36	41	$3,212	$60	53.86	0.39
R-38 Attic Insulation	Pre-1978	49	36	$2,273	$61	37.07	0.56
	1978-1991	15	16	$2,013	$24	83.94	0.25
	1992-2005	14	15	$2,013	$22	92.44	0.23
Duct Sealing	Pre-1978	46	52	$240	$82	2.92	7.20
	1978-1991	16	18	$240	$27	9.04	2.32
	1992-2005	15	17	$240	$25	9.51	2.21
Cool Roof	Pre-1978	-5	-25	$635	-$34	-18.44	-1.16
	1978-1991	-14	-18	$635	-$28	-22.95	-0.92
	1992-2005	-15	-19	$635	-$28	-22.62	-0.93
Windows	Pre-1978	81	76	$9,810	$125	78.62	0.27
Water Heating Package	All Vintages	0	19	$208	$26	7.95	2.69
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.88	4.48

Table 24: CZ 5 PG&E/SoCalGas - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	45	36	$1,054	$216	4.89	4.80
	1978-1991	13	15	$987	$19	53.03	0.48
	1992-2005	10	13	$987	$15	64.74	0.40
R-38 Attic Insulation	Pre-1978	22	10	$594	$182	3.26	7.07
	1978-1991	7	5	$526	$7	76.62	0.33
	1992-2005	5	5	$526	$6	87.62	0.29
Duct Sealing	Pre-1978	20	19	$120	$191	0.63	36.87
	1978-1991	5	4	$120	$5	21.88	1.16
	1992-2005	3	4	$120	$5	26.51	0.97
Cool Roof	Pre-1978	7	-6	$184	$159	1.16	19.64
	1978-1991	3	-3	$184	-$2	-75.95	-0.36
	1992-2005	-1	-3	$184	-$4	-45.73	-0.56
Windows	Pre-1978	59	52	$5,873	$236	24.87	0.95
Water Heating Package	All Vintages	0	16	$168	$21	8.07	3.22
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.88	4.48

Climate Zone 6: The envelope and duct package is not cost-effective for single family or multifamily homes. For single family homes built before 1978 and multifamily homes built before 1992 duct sealing alone is cost-effective. Cool roof upgrades are cost-effective for multifamily homes built before 1992 but are not cost-effective for single family homes. Window replacements are not cost-effective.

Note: Grey rows indicate option is not cost effective.

Table 25: CZ 6 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	455	54	$3,472	$211	19.98	0.78
	1978-1991	144	22	$3,212	$69	56.35	0.28
	1992-2005	95	19	$3,212	$47	81.42	0.19
R-38 Attic Insulation	Pre-1978	373	25	$2,273	$150	18.68	0.83
	1978-1991	122	9	$2,013	$50	49.70	0.31
	1992-2005	80	9	$2,013	$33	73.83	0.21
Duct Sealing	Pre-1978	114	23	$240	$65	4.38	3.54
	1978-1991	33	6	$240	$18	16.35	0.95
	1992-2005	19	6	$240	$12	23.93	0.65
Cool Roof	Pre-1978	195	-15	$635	$44	19.31	0.80
	1978-1991	100	-9	$635	$25	34.16	0.45
	1992-2005	53	-10	$635	$7	134.99	0.11
Windows	Pre-1978	393	5	$9,810	$132	93.50	0.17
Water Heating Package	All Vintages	0	19	$208	$26	9.05	1.72
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.25	15.73	3.95

Table 26: CZ 6 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	164	18	$1,054	$67	19.24	0.98
	1978-1991	58	5	$987	$24	51.43	0.37
	1992-2005	47	4	$987	$18	68.16	0.28
R-38 Attic Insulation	Pre-1978	107	7	$594	$39	18.98	1.00
	1978-1991	41	2	$526	$14	45.11	0.42
	1992-2005	35	2	$526	$12	53.10	0.36
Duct Sealing	Pre-1978	68	7	$120	$29	5.12	3.69
	1978-1991	32	1	$120	$12	13.00	1.46
	1992-2005	20	1	$120	$7	22.40	0.84
Cool Roof	Pre-1978	82	-3	$184	$21	11.31	1.67
	1978-1991	60	-1	$184	$17	13.54	1.40
	1992-2005	45	-1	$184	$12	20.06	0.94
Windows	Pre-1978	321	6	$5,873	$101	73.32	0.26
Water Heating Package	All Vintages	0	16	$168	$19	9.78	1.93
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.25	15.73	3.95

Climate Zone 7: The envelope and duct package is not cost-effective for single family or multifamily homes. For multifamily homes built before 1978 a combination of the duct sealing and R-38 attic insulation upgrades are cost effective. For single family homes built before 1978 and multifamily homes built between 1978 and 1991 duct sealing alone is 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.

Note: Grey rows indicate option is not cost effective.

Table 27: CZ 7 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	314	31	$3,472	$209	20.63	0.75
	1978-1991	85	11	$3,212	$57	68.80	0.23
	1992-2005	64	10	$3,212	$41	96.06	0.16
R-38 Attic Insulation	Pre-1978	272	16	$2,273	$168	16.91	0.92
	1978-1991	76	6	$2,013	$46	54.75	0.28
	1992-2005	59	6	$2,013	$33	75.36	0.21
Duct Sealing	Pre-1978	66	11	$240	$52	5.68	2.74
	1978-1991	17	2	$240	$12	24.50	0.63
	1992-2005	9	2	$240	$7	41.18	0.38
Cool Roof	Pre-1978	150	-11	$635	$66	12.43	1.25
	1978-1991	65	-6	$635	$26	32.16	0.48
	1992-2005	41	-7	$635	$9	100.28	0.15
Windows	Pre-1978	293	-7	$9,810	$151	82.91	0.19
Water Heating Package	All Vintages	0	19	$208	$30	7.92	1.96
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.33	12.01	5.17

Table 28: CZ 7 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	98	8	$1,054	$68	19.21	0.98
	1978-1991	40	1	$987	$10	59.54	0.32
	1992-2005	25	1	$987	$5	101.52	0.19
R-38 Attic Insulation	Pre-1978	66	3	$594	$47	15.72	1.20
	1978-1991	30	1	$526	$0	44.99	0.42
	1992-2005	20	1	$526	$0	71.64	0.26
Duct Sealing	Pre-1978	28	2	$120	$27	5.54	3.41
	1978-1991	21	0.13	$120	$21	14.56	1.30
	1992-2005	12	0.08	$120	$12	29.36	0.64
Cool Roof	Pre-1978	46	-3	$184	$29	8.01	2.36
	1978-1991	47	-0.35	$184	$15	10.96	1.73
	1992-2005	29	-0.35	$184	$9	20.10	0.94
Windows	Pre-1978	235	-1	$5,873	$114	65.55	0.29
Water Heating Package	All Vintages	0	16	$168	$24	7.98	2.37
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.33	12.01	5.17

Climate Zone 8: The envelope and duct package is cost-effective for single family built before 1978 and multifamily homes built before 1992. For single family homes built between 1978 and 2005 and multifamily homes built between 1992 and 2005 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.

Note: Grey rows indicate option is not cost effective.

Table 29: CZ 8 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	850	39	$3,472	$312	11.14	1.72
	1978-1991	359	17	$3,212	$132	24.30	0.79
	1992-2005	311	15	$3,212	$119	26.98	0.71
R-38 Attic Insulation	Pre-1978	590	18	$2,273	$201	11.28	1.69
	1978-1991	266	8	$2,013	$92	21.90	0.87
	1992-2005	248	8	$2,013	$90	22.33	0.85
Duct Sealing	Pre-1978	307	17	$240	$120	2.00	9.60
	1978-1991	122	5	$240	$46	5.21	3.65
	1992-2005	84	4	$240	$34	7.14	2.68
Cool Roof	Pre-1978	389	-10	$635	$108	5.89	3.13
	1978-1991	266	-7	$635	$78	8.12	2.28
	1992-2005	219	-8	$635	$66	9.67	1.90
Windows	Pre-1978	723	4	$9,810	$222	44.12	0.43
Water Heating Package	All Vintages	0	19	$208	$25	8.22	2.60
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.83	4.49

Table 30: CZ 8 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	312	13	$1,054	$103	10.21	2.28
	1978-1991	139	4	$987	$46	21.31	1.08
	1992-2005	123	3	$987	$42	23.65	0.98
R-38 Attic Insulation	Pre-1978	157	5	$594	$48	12.29	1.89
	1978-1991	73	2	$526	$23	23.28	0.99
	1992-2005	69	1	$526	$22	23.73	0.97
Duct Sealing	Pre-1978	171	5	$120	$57	2.10	11.02
	1978-1991	83	1	$120	$27	4.45	5.15
	1992-2005	64	1	$120	$22	5.56	4.12
Cool Roof	Pre-1978	149	-2	$184	$40	4.64	4.88
	1978-1991	115	-1	$184	$33	5.56	4.10
	1992-2005	99	-1	$184	$29	6.29	3.62
Windows	Pre-1978	519	5	$5,873	$149	39.50	0.58
Water Heating Package	All Vintages	0	16	$168	$20	8.54	3.04
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.83	4.49

Climate Zone 9: The envelope and duct package is cost-effective for single family built before 1992 and multifamily homes built before 2006. For single family homes built between 1992 and 2005 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.

Note: Grey rows indicate option is not cost effective.

Table 31: CZ 9 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	1,101	51	$3,472	$392	8.86	2.17
	1978-1991	493	23	$3,212	$171	18.77	1.02
	1992-2005	432	20	$3,212	$156	20.55	0.93
R-38 Attic Insulation	Pre-1978	649	22	$2,273	$215	10.55	1.81
	1978-1991	305	11	$2,013	$98	20.45	0.93
	1992-2005	299	10	$2,013	$102	19.74	0.96
Duct Sealing	Pre-1978	466	23	$240	$174	1.38	13.91
	1978-1991	199	7	$240	$70	3.41	5.57
	1992-2005	142	6	$240	$54	4.44	4.30
Cool Roof	Pre-1978	457	-12	$635	$122	5.22	3.53
	1978-1991	319	-8	$635	$87	7.30	2.53
	1992-2005	267	-9	$635	$75	8.44	2.19
Windows	Pre-1978	941	9	$9,810	$285	34.43	0.55
Water Heating Package	All Vintages	0	19	$208	$25	8.21	2.60
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.60	4.57

Table 32: CZ 9 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	418	17	$1,054	$135	7.84	2.97
	1978-1991	201	6	$987	$65	15.12	1.53
	1992-2005	168	5	$987	$54	18.23	1.27
R-38 Attic Insulation	Pre-1978	186	6	$594	$57	10.46	2.22
	1978-1991	89	3	$526	$27	19.15	1.21
	1992-2005	79	2	$526	$24	21.48	1.08
Duct Sealing	Pre-1978	245	8	$120	$78	1.53	15.13
	1978-1991	122	1	$120	$38	3.17	7.24
	1992-2005	95	1	$120	$30	4.04	5.68
Cool Roof	Pre-1978	179	-3	$184	$45	4.06	5.58
	1978-1991	138	-2	$184	$37	4.96	4.58
	1992-2005	111	-2	$184	$30	6.20	3.66
Windows	Pre-1978	673	8	$5,873	$188	31.28	0.74
Water Heating Package	All Vintages	0	16	$168	$19	8.81	2.95
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.29	13.60	4.57

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

Note: Grey rows indicate option is not cost effective.

Table 33: CZ 10 SCE/SoCalGas - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	1,354	57	$3,472	$470	7.39	2.59
	1978-1991	597	25	$3,212	$206	15.62	1.22
	1992-2005	516	22	$3,212	$180	17.81	1.07
R-38 Attic Insulation	Pre-1978	729	24	$2,273	$235	9.66	1.98
	1978-1991	338	11	$2,013	$110	18.29	1.04
	1992-2005	332	11	$2,013	$109	18.53	1.03
Duct Sealing	Pre-1978	617	25	$240	$221	1.09	17.63
	1978-1991	248	8	$240	$89	2.69	7.06
	1992-2005	186	7	$240	$69	3.50	5.44
Cool Roof	Pre-1978	555	-13	$635	$143	4.43	4.16
	1978-1991	377	-9	$635	$105	6.05	3.06
	1992-2005	315	-10	$635	$86	7.41	2.49
Windows	Pre-1978	1,178	11	$9,810	$349	28.07	0.67
Water Heating Package	All Vintages	0	19	$208	$25	8.24	2.59
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.30	13.28	4.68

Table 34: CZ 10 SCE/SoCalGas - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	526	19	$1,054	$170	6.20	3.75
	1978-1991	250	7	$987	$79	12.49	1.85
	1992-2005	207	6	$987	$66	14.90	1.55
R-38 Attic Insulation	Pre-1978	221	7	$594	$70	8.52	2.72
	1978-1991	106	3	$526	$32	16.44	1.41
	1992-2005	91	3	$526	$29	18.31	1.26
Duct Sealing	Pre-1978	317	9	$120	$103	1.16	19.88
	1978-1991	152	2	$120	$46	2.61	8.82
	1992-2005	119	1	$120	$39	3.11	7.38
Cool Roof	Pre-1978	215	-3	$184	$57	3.22	7.03
	1978-1991	163	-2	$184	$43	4.31	5.27
	1992-2005	129	-2	$184	$35	5.21	4.36
Windows	Pre-1978	840	10	$5,873	$235	24.97	0.92
Water Heating Package	All Vintages	0	16	$168	$20	8.59	3.03
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.30	13.28	4.68

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 are cost-effective for all single family and multifamily homes built before 2006. Window replacements are cost-effective for single family and multifamily homes built before 1978.

Note: Grey rows indicate option is not cost effective.

Table 35: CZ 10 SDG&E - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	1,354	57	$3,472	$800	4.34	4.37
	1978-1991	597	25	$3,212	$359	8.95	2.12
	1992-2005	516	22	$3,212	$317	10.13	1.87
R-38 Attic Insulation	Pre-1978	729	24	$2,273	$405	5.61	3.38
	1978-1991	338	11	$2,013	$193	10.40	1.82
	1992-2005	332	11	$2,013	$195	10.31	1.83
Duct Sealing	Pre-1978	617	25	$240	$377	0.64	29.78
	1978-1991	248	8	$240	$155	1.55	12.20
	1992-2005	186	7	$240	$120	2.00	9.47
Cool Roof	Pre-1978	555	-13	$635	$272	2.33	7.98
	1978-1991	377	-9	$635	$195	3.26	5.71
	1992-2005	315	-10	$635	$164	3.87	4.80
Windows	Pre-1978	1,178	11	$9,810	$631	15.56	1.21
Water Heating Package	All Vintages	0	19	$208	$30	6.87	3.01
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.50	8.02	7.75

Table 36: CZ 10 SDG&E - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	526	19	$1,054	$298	3.54	6.52
	1978-1991	250	7	$987	$141	6.98	3.30
	1992-2005	207	6	$987	$116	8.54	2.70
R-38 Attic Insulation	Pre-1978	221	7	$594	$120	4.95	4.65
	1978-1991	106	3	$526	$57	9.21	2.50
	1992-2005	91	3	$526	$48	10.89	2.11
Duct Sealing	Pre-1978	317	9	$120	$180	0.67	34.43
	1978-1991	152	2	$120	$84	1.43	16.04
	1992-2005	119	1	$120	$67	1.79	12.77
Cool Roof	Pre-1978	215	-3	$184	$103	1.78	12.79
	1978-1991	163	-2	$184	$80	2.30	9.91
	1992-2005	129	-2	$184	$62	2.95	7.72
Windows	Pre-1978	840	10	$5,873	$427	13.76	1.67
Water Heating Package	All Vintages	0	16	$168	$25	6.79	3.71
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.50	8.02	7.75

Climate Zone 11: 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 all single family and multifamily homes built before 2006. Window replacements are cost-effective for single family and multifamily homes built before 1978.

Note: Grey rows indicate option is not cost effective.

Table 37: CZ 11 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	1,827	120	$3,472	$774	4.48	4.27
	1978-1991	858	55	$3,212	$358	8.96	2.13
	1992-2005	770	48	$3,212	$324	9.93	1.92
R-38 Attic Insulation	Pre-1978	795	47	$2,273	$318	7.15	2.68
	1978-1991	383	22	$2,013	$152	13.24	1.44
	1992-2005	396	22	$2,013	$158	12.76	1.50
Duct Sealing	Pre-1978	982	61	$240	$415	0.58	33.10
	1978-1991	434	20	$240	$174	1.38	13.77
	1992-2005	355	18	$240	$147	1.64	11.65
Cool Roof	Pre-1978	624	-14	$635	$161	3.93	4.71
	1978-1991	440	-10	$635	$118	5.40	3.44
	1992-2005	369	-10	$635	$99	6.41	2.89
Windows	Pre-1978	1,568	45	$9,810	$554	17.71	1.07
Water Heating Package	All Vintages	0	19	$208	$34	6.06	3.32
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.35	11.53	5.39

Table 38: CZ 11 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	728	44	$1,054	$296	3.57	6.53
	1978-1991	363	19	$987	$139	7.09	3.27
	1992-2005	315	16	$987	$119	8.29	2.79
R-38 Attic Insulation	Pre-1978	268	13	$594	$102	5.80	4.00
	1978-1991	131	6	$526	$49	10.75	2.15
	1992-2005	118	6	$526	$43	12.10	1.91
Duct Sealing	Pre-1978	473	25	$120	$186	0.65	36.02
	1978-1991	231	7	$120	$82	1.47	15.72
	1992-2005	196	6	$120	$69	1.74	13.25
Cool Roof	Pre-1978	245	-4	$184	$66	2.76	8.21
	1978-1991	189	-2	$184	$53	3.44	6.61
	1992-2005	156	-2	$184	$45	4.13	5.51
Windows	Pre-1978	1,107	33	$5,873	$387	15.19	1.52
Water Heating Package	All Vintages	0	16	$168	$29	5.76	4.26
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.35	11.53	5.39

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 cost-effective for all single family and multifamily homes built before 2006. Window replacements are cost-effective for multifamily homes built before 1978 but are not cost-effective for single family homes.

Note: Grey rows indicate option is not cost effective.

Table 39: CZ 12 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	1,209	109	$3,472	$579	6.00	3.21
	1978-1991	540	51	$3,212	$263	12.23	1.57
	1992-2005	471	45	$3,212	$229	14.02	1.37
R-38 Attic Insulation	Pre-1978	674	43	$2,273	$285	7.97	2.40
	1978-1991	318	20	$2,013	$136	14.78	1.29
	1992-2005	317	20	$2,013	$135	14.88	1.28
Duct Sealing	Pre-1978	532	55	$240	$272	0.88	21.82
	1978-1991	216	20	$240	$107	2.24	8.57
	1992-2005	155	18	$240	$83	2.89	6.67
Cool Roof	Pre-1978	479	-16	$635	$121	5.26	3.50
	1978-1991	332	-12	$635	$87	7.33	2.51
	1992-2005	273	-12	$635	$69	9.17	2.00
Windows	Pre-1978	1,090	43	$9,810	$420	23.34	0.81
Water Heating Package	All Vintages	0	19	$208	$34	6.05	3.32
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.34	11.80	5.26

Table 40: CZ 12 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	465	40	$1,054	$211	5.01	4.67
	1978-1991	223	18	$987	$94	10.50	2.22
	1992-2005	187	15	$987	$79	12.45	1.87
R-38 Attic Insulation	Pre-1978	199	11	$594	$80	7.40	3.14
	1978-1991	97	6	$526	$37	14.03	1.65
	1992-2005	88	6	$526	$35	15.14	1.53
Duct Sealing	Pre-1978	276	22	$120	$123	0.98	23.87
	1978-1991	134	7	$120	$51	2.34	9.87
	1992-2005	103	5	$120	$40	2.96	7.81
Cool Roof	Pre-1978	188	-4	$184	$51	3.63	6.23
	1978-1991	146	-3	$184	$42	4.42	5.13
	1992-2005	117	-3	$184	$33	5.49	4.13
Windows	Pre-1978	785	31	$5,873	$294	19.96	1.16
Water Heating Package	All Vintages	0	16	$168	$28	6.08	4.03
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.34	11.80	5.26

Climate Zone 13: 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 all single family and multifamily homes built before 2006. Window replacements are cost-effective for single family and multifamily homes built before 1978.

Note: Grey rows indicate option is not cost effective.

Table 41: CZ 13 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	2,047	98	$3,472	$790	4.39	4.34
	1978-1991	964	45	$3,212	$370	8.68	2.20
	1992-2005	877	39	$3,212	$339	9.48	2.01
R-38 Attic Insulation	Pre-1978	940	37	$2,273	$338	6.72	2.83
	1978-1991	451	18	$2,013	$162	12.43	1.53
	1992-2005	463	17	$2,013	$168	11.97	1.59
Duct Sealing	Pre-1978	1,072	50	$240	$418	0.57	33.16
	1978-1991	480	17	$240	$181	1.33	14.29
	1992-2005	403	16	$240	$156	1.54	12.32
Cool Roof	Pre-1978	729	-15	$635	$186	3.41	5.45
	1978-1991	516	-11	$635	$138	4.60	4.04
	1992-2005	441	-11	$635	$117	5.41	3.43
Windows	Pre-1978	1,604	41	$9,810	$547	17.94	1.06
Water Heating Package	All Vintages	0	19	$208	$34	6.09	3.30
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.34	11.60	5.35

Table 42: CZ 13 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	805	36	$1,054	$298	3.54	6.55
	1978-1991	407	16	$987	$144	6.85	3.37
	1992-2005	353	13	$987	$126	7.85	2.94
R-38 Attic Insulation	Pre-1978	317	10	$594	$110	5.42	4.26
	1978-1991	158	5	$526	$54	9.82	2.35
	1992-2005	141	5	$526	$49	10.77	2.14
Duct Sealing	Pre-1978	510	20	$120	$185	0.65	35.73
	1978-1991	254	6	$120	$85	1.42	16.22
	1992-2005	214	5	$120	$73	1.64	13.98
Cool Roof	Pre-1978	283	-4	$184	$76	2.42	9.37
	1978-1991	220	-3	$184	$62	2.99	7.62
	1992-2005	183	-3	$184	$52	3.54	6.42
Windows	Pre-1978	1,127	30	$5,873	$380	15.47	1.49
Water Heating Package	All Vintages	0	16	$168	$27	6.13	4.00
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.34	11.60	5.35

Climate Zone 14 – SCE/SoCalGas: 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 all single family and multifamily homes built before 2006. Window replacements are cost-effective for multifamily homes built before 1978 but are not cost-effective for single family homes.

Note: Grey rows indicate option is not cost effective.

Table 43: CZ 14 SCE/SoCalGas - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	1,832	121	$3,472	$680	5.10	3.80
	1978-1991	844	55	$3,212	$316	10.18	1.90
	1992-2005	746	48	$3,212	$285	11.28	1.71
R-38 Attic Insulation	Pre-1978	816	43	$2,273	$276	8.22	2.35
	1978-1991	388	21	$2,013	$134	15.07	1.28
	1992-2005	394	20	$2,013	$140	14.36	1.34
Duct Sealing	Pre-1978	967	63	$240	$366	0.66	29.52
	1978-1991	417	21	$240	$154	1.56	12.34
	1992-2005	333	19	$240	$130	1.84	10.44
Cool Roof	Pre-1978	631	-19	$635	$147	4.32	4.23
	1978-1991	427	-14	$635	$108	5.88	3.12
	1992-2005	359	-14	$635	$94	6.79	2.69
Windows	Pre-1978	1,527	36	$9,810	$475	20.66	0.92
Water Heating Package	All Vintages	0	19	$208	$26	8.02	2.66
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.31	13.03	4.77

Table 44: CZ 14 SCE/SoCalGas - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	731	45	$1,054	$259	4.07	5.78
	1978-1991	364	19	$987	$125	7.90	2.96
	1992-2005	310	16	$987	$107	9.23	2.53
R-38 Attic Insulation	Pre-1978	273	12	$594	$91	6.52	3.59
	1978-1991	134	6	$526	$44	11.94	1.95
	1992-2005	118	6	$526	$39	13.41	1.74
Duct Sealing	Pre-1978	467	25	$120	$162	0.74	31.67
	1978-1991	227	7	$120	$73	1.64	14.14
	1992-2005	188	6	$120	$62	1.93	11.99
Cool Roof	Pre-1978	250	-5	$184	$61	3.02	7.46
	1978-1991	188	-3	$184	$50	3.71	6.11
	1992-2005	152	-3	$184	$40	4.56	4.95
Windows	Pre-1978	1,080	26	$5,873	$329	17.86	1.30
Water Heating Package	All Vintages	0	16	$168	$22	7.76	3.35
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.31	13.03	4.77

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 are cost-effective for all single family and multifamily homes built before 2006. Window replacements are cost-effective for single family and multifamily homes built before 1978.

Note: Grey rows indicate option is not cost effective.

Table 45: CZ 14 SDG&E - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	1,832	121	$3,472	$1,098	3.16	6.04
	1978-1991	844	55	$3,212	$523	6.14	3.11
	1992-2005	746	48	$3,212	$460	6.98	2.73
R-38 Attic Insulation	Pre-1978	816	43	$2,273	$452	5.03	3.79
	1978-1991	388	21	$2,013	$223	9.04	2.11
	1992-2005	394	20	$2,013	$228	8.85	2.15
Duct Sealing	Pre-1978	967	63	$240	$593	0.40	47.14
	1978-1991	417	21	$240	$259	0.93	20.51
	1992-2005	333	19	$240	$213	1.12	16.92
Cool Roof	Pre-1978	631	-19	$635	$285	2.23	8.31
	1978-1991	427	-14	$635	$206	3.09	6.01
	1992-2005	359	-14	$635	$170	3.72	4.97
Windows	Pre-1978	1,527	36	$9,810	$815	12.04	1.57
Water Heating Package	All Vintages	0	19	$208	$30	6.83	3.03
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.50	7.98	7.78

Table 46: CZ 14 SDG&E - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	731	45	$1,054	$431	2.45	9.49
	1978-1991	364	19	$987	$209	4.72	4.90
	1992-2005	310	16	$987	$174	5.66	4.09
R-38 Attic Insulation	Pre-1978	273	12	$594	$154	3.87	5.99
	1978-1991	134	6	$526	$73	7.18	3.22
	1992-2005	118	6	$526	$63	8.36	2.77
Duct Sealing	Pre-1978	467	25	$120	$272	0.44	52.62
	1978-1991	227	7	$120	$125	0.96	23.98
	1992-2005	188	6	$120	$103	1.16	19.86
Cool Roof	Pre-1978	250	-5	$184	$114	1.61	14.12
	1978-1991	188	-3	$184	$87	2.12	10.73
	1992-2005	152	-3	$184	$69	2.68	8.47
Windows	Pre-1978	1,080	26	$5,873	$570	10.30	2.24
Water Heating Package	All Vintages	0	16	$168	$26	6.54	3.85
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.50	7.98	7.78

Climate Zone 15: 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 all single family and multifamily homes built before 2006. Window replacements are cost-effective for single family and multifamily homes built before 1978.

Note: Grey rows indicate option is not cost effective.

Table 47: CZ 15 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	4,141	23	$3,472	$1,116	3.11	6.04
	1978-1991	2,041	8	$3,212	$559	5.75	3.27
	1992-2005	1,877	7	$3,212	$526	6.10	3.08
R-38 Attic Insulation	Pre-1978	1,483	12	$2,273	$386	5.89	3.20
	1978-1991	740	5	$2,013	$192	10.49	1.79
	1992-2005	769	5	$2,013	$204	9.88	1.90
Duct Sealing	Pre-1978	2,494	9	$240	$680	0.35	53.24
	1978-1991	1,182	2	$240	$331	0.73	25.86
	1992-2005	1,039	1	$240	$299	0.80	23.41
Cool Roof	Pre-1978	1184	-5	$635	$296	2.15	8.72
	1978-1991	854	-3	$635	$223	2.84	6.59
	1992-2005	751	-3	$635	$201	3.15	5.93
Windows	Pre-1978	3,214	4	$9,810	$840	11.68	1.61
Water Heating Package	All Vintages	0	19	$208	$24	8.71	2.45
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.30	13.26	4.68

Table 48: CZ 15 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	1,663	7	$1,054	$445	2.37	9.67
	1978-1991	863	2	$987	$227	4.35	5.26
	1992-2005	762	1	$987	$195	5.07	4.51
R-38 Attic Insulation	Pre-1978	574	3	$594	$156	3.82	6.00
	1978-1991	285	1	$526	$77	6.87	3.33
	1992-2005	254	1	$526	$64	8.20	2.79
Duct Sealing	Pre-1978	1,128	3	$120	$299	0.40	57.10
	1978-1991	565	0.34	$120	$148	0.81	28.15
	1992-2005	501	0.20	$120	$129	0.93	24.54
Cool Roof	Pre-1978	455	-1	$184	$113	1.63	14.00
	1978-1991	351	-0.49	$184	$88	2.09	10.92
	1992-2005	296	-0.45	$184	$72	2.54	9.00
Windows	Pre-1978	2,237	4	$5,873	$581	10.11	2.26
Water Heating Package	All Vintages	0	16	$168	$19	8.91	2.92
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.30	13.26	4.68

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 2006 but are not cost-effective for single family homes. Window replacements are cost-effective for multifamily homes built before 1978 but are not cost-effective for single family homes.
Note: Grey rows indicate option is not cost effective.

Table 49: CZ 16 - Single Family Efficiency Upgrade Cost-effectiveness Results

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	635	231	$3,472	$620	5.60	3.52
	1978-1991	286	119	$3,212	$307	10.46	1.89
	1992-2005	240	107	$3,212	$271	11.87	1.66
R-38 Attic Insulation	Pre-1978	407	76	$2,273	$269	8.43	2.31
	1978-1991	176	38	$2,013	$126	15.97	1.22
	1992-2005	155	36	$2,013	$117	17.22	1.14
Duct Sealing	Pre-1978	236	128	$240	$307	0.78	25.32
	1978-1991	103	60	$240	$141	1.70	11.65
	1992-2005	79	55	$240	$125	1.92	10.34
Cool Roof	Pre-1978	232	-31	$635	$21	29.70	0.51
	1978-1991	153	-23	$635	$11	56.27	0.24
	1992-2005	107	-22	$635	-$3	-213.69	-0.18
Windows	Pre-1978	267	162	$9,810	$376	26.11	0.76
Water Heating Package	All Vintages	0	19	$208	$33	6.37	3.15
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.31	12.94	4.80

Table 50: CZ 16 - Multifamily Efficiency Upgrade Cost-effectiveness Results (Per Unit)

Measure	Vintage	Electricity Savings (kWh)	Gas Savings (therms)	Measure Cost	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Envelope & Duct Package	Pre-1978	243	88	$1,054	$236	4.48	5.36
	1978-1991	119	45	$987	$104	9.45	2.53
	1992-2005	98	38	$987	$84	11.80	2.03
R-38 Attic Insulation	Pre-1978	115	22	$594	$76	7.81	3.04
	1978-1991	56	11	$526	$34	15.48	1.53
	1992-2005	49	10	$526	$30	17.31	1.37
Duct Sealing	Pre-1978	131	54	$120	$138	0.87	27.75
	1978-1991	63	22	$120	$55	2.20	10.87
	1992-2005	47	20	$120	$43	2.80	8.56
Cool Roof	Pre-1978	100	-9	$184	$16	11.57	1.83
	1978-1991	79	-6	$184	$15	11.88	1.83
	1992-2005	60	-6	$184	$11	16.92	1.27
Windows	Pre-1978	173	113	$5,873	$257	22.83	1.06
Water Heating Package	All Vintages	0	16	$168	$28	6.01	4.08
LED Lamp vs. CFL	All Vintages	1.2	0	$3.99	$0.31	12.94	4.80