DOCKETED	DOCKETED					
Docket Number:	16-BSTD-07					
Project Title:	Local Ordinance Applications - 2016 Standards					
TN #:	217558					
Document Title:	Healdsburg Cost Effectiveness Study					
Description:	N/A					
Filer:	Ingrid Neumann					
Organization:	City of Healdsburg					
Submitter Role:	Applicant					
Submission Date:	5/11/2017 3:56:03 PM					
Docketed Date:	5/11/2017					

CA Statewide Codes and Standards Program

Title 24, Part 11 Local Energy Efficiency Ordinances

CALGreen Cost Effectiveness Study

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Last Modified: September 2, 2016

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Introduction 1

The California Building Energy Efficiency Standards Title 24, Part 6 (Title 24) (CEC, 2016b) is maintained and updated every three years by two state agencies, the California Energy Commission (CEC) 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 CEC and file the ordinance with the BSC for the ordinance to be legally enforceable.

This report presents the results from analysis of the feasibility and cost-effectiveness of requiring new low-rise single family and multifamily residential construction to exceed the 2016 Building Energy Efficiency Standards, which become effective January 1, 2017. The analysis includes scenarios of compliance packages options and cost effectiveness analysis for all sixteen California climate zones. Four levels of building energy performance were examined:

- (1) exceeding the minimum requirements by at least 15%, consistent with the voluntary Tier 1 Performance Standard in Title 24, Part 11 (CALGreen),
- (2) exceeding minimum requirement by at least 30%, consistent with the voluntary Tier 2 Performance Standard in CALGreen,
- (3) meeting minimum Title 24 efficiency performance targets plus on-site renewable energy generation sufficient to achieve an Energy Design Rating of zero (TDV-Zero), consistent with the voluntary Zero Net Energy Design tier in CALGreen,
- (4) meeting minimum Title 24 efficiency performance targets plus on-site renewable energy generation sized to offset a portion of the total TDV loads of the building without risking sizing of the PV system larger than the estimated electrical energy use of the building.

Methodology and Assumptions 2

2.1 **Building Prototypes**

The CEC defines building prototypes which it uses to evaluate the cost-effectiveness of proposed changes to Title 24 requirements. There exist two single family prototypes and one multifamily prototype, all three of which are used in this analysis in development of the above-code efficiency packages. Table 1 describes the basic characteristics of each prototype. Additional details on the prototypes can be found in the ACM Approval Manual (CEC, 2016a).

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

1 uvic 1.1 ivivijv c characteristic	1	Table	1:	Prot	otype	Charac	teristic
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Additionally, each prototype building has the following features:

- Slab-on-grade foundation
- Vented attic. High performance attic in climates where prescriptively assigned (CZ 4, 8-16) with insulation installed below roof deck. Refer to Table 150.1-A in Appendix A.
- Ductwork located in the attic for single family homes and in conditioned space for multifamily.
- Split-system gas furnace with air conditioner that meet the minimum federal guidelines for efficiency
- Tankless gas water heater that meets the minimum federal guidelines for efficiency; individual water heaters in each multifamily apartment.

Other features are defined consistent with the Standard Design in the Alternative Calculation Method Reference Manual (CEC, 2016d), designed to meet, but not exceed, the minimum requirements.

The CEC's standard protocol for the single family prototypes is to weight the simulated energy impacts by a factor that represents the distribution of single-story and two-story homes being built statewide, assuming 45% single-story homes and 55% two-story homes. Simulation results in this study are therefore characterized according to this ratio, which is approximately equivalent to a 2,430 ft² house¹.

2.2 Efficiency Measures & Package Development

The CBECC-RES 2016.2.0 ALPHA2² (833) compliance simulation tool was used to evaluate energy impacts using the 2016 prescriptive standards as the benchmark and the 2016 time dependent valuation (TDV) values. TDV is the energy metric used by the CEC since the 2005 Title 24 energy code to evaluate compliance with the Title 24 standards. TDV values energy use differently depending on the fuel source (gas, electricity, and propane), time of day, and season. TDV was developed to reflect the "societal value or cost" of energy including long-term projected costs of energy such as the cost of providing energy during peak periods of demand and other societal costs such as projected costs for carbon emissions. Electricity used (or saved) during peak periods of the summer has a much higher value than electricity used (or saved) during off-peak periods (Horii et al, 2014).

The methodology used in the analyses for each of the prototypical building types begins with a design that precisely meets the minimum 2016 prescriptive requirements (0% compliance margin). A table of prescriptive measures used in each base design by climate zone is located in Appendix A. Using the 2016 baseline as the starting point, prospective energy efficiency measures were identified and modeled in each of the prototypes to determine the projected energy (Therm and kWh) and compliance impacts. A large set of parametric runs³ were conducted to develop packages of measures that exceed the minimum code performance level by 15% (CALGreen Tier 1), and 30% (Tier 2). The consultants authoring this study selected packages and measures based on decades of experience with residential architects, builders, and engineers along with general knowledge of the relative acceptance and preferences of many measures, as well as their incremental costs.

³ Using the "quick" simulation speed option.

 $^{^{1}}$ 2,430 ft² = 45% * 2,100 ft² + 55% * 2,700 ft²

 $^{^{2}}$ On June 14, 2016 the CEC approved CBECC-Res 2016.2.0 Version of the software. The version used for this study is nearly identical to the approved version with the exception of minor changes that do not affect the cost effective analysis of the measures evaluated.

Evaluation results for the selected packages show that meeting the performance targets for both single family and multifamily prototypes is feasible in most climate zones. In climates where it was not feasible, targets were relaxed to an appropriate level. It is important to note that the packages contained in this report are examples only; any project meeting requirements of a local ordinance, both single family and multifamily, must independently evaluate and identify the most cost effective approach based on project-specific factors.

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

<u>Ouality Insulation Installation (OII)</u>: HERS rater verification of insulation quality according to the procedures outlined in the 2016 Reference Appendices RA3.5 (CEC, 2016c). QII is included in all cases since it is a pre-requisite for all the voluntary tiers in 2016 CALGreen.

Reduced Infiltration (ACH50): HERS rater field verification and diagnostic testing of building air leakage according to the procedures outlined in the 2016 Reference Appendices RA3.8 (CEC, 2016c). The default infiltration assumption for single family homes is 5 air changes per hour at 50 Pascals (ACH50)⁴ and the reduced level applied in this analysis is 3 ACH50. This measure was not applied to multifamily homes because the modeling software does not allow this credit unless each unit is modeled individually, which is not typical in the compliance process for multifamily buildings.

<u>Window Performance</u>: Reduce window U-value from the prescriptive value of 0.32 to 0.30 in all climates and reduce the solar heat gain coefficient (SHGC) from the prescriptive value of 0.25 to 0.23 in climate zone 2, 4, 6 through 16. In climate zones 1, 3, and 5 there is no prescriptive SHGC requirement and the default value of 0.50 is left as is.

Door Performance: Install insulated doors that meet a U-value of 0.20 at the front entry and doors between the house and garage. It's assumed there is a single 3' x 6'8" entry door per single family home and multifamily unit as well as a second 3' x 6'8" door to the garage per single family home.

<u>Cool Roof</u>: Install a roofing product that's rated by the Cool Roof Rating Council to have an aged solar reflectance of 0.20. This measure only applies to climates zones where this is not already required prescriptively.

Exterior Wall Insulation: Increase wall cavity insulation from R-19 to R-21 in 2x6 walls.

<u>High Performance Attics (HPA)</u>: For climates where HPA is not already prescriptive under the 2016 code (CZ 1-3, 5-7), increase attic ceiling insulation to R-38 and add insulation under the roof deck between framing (R-13 for roof with air space, R-18 for roof without air space).

High Efficiency Furnace: Upgrade furnace to a condensing unit with an efficiency of 92% AFUE.

<u>High Efficiency Air Conditioner</u>: Upgrade air conditioner efficiency beyond federal efficiency minimum to either SEER 15 / EER 12.5 or SEER 16 / EER 13.

High Efficacy Fan: Upgrade the fan in the furnace or air handler using an electronically commutated motor (ECM) that meets an efficacy of 0.3 Watts / cfm or lower operating at full speed. Fan watt draw is verified by a HERS rater according to the procedures outlined in the 2016 Reference Appendices RA3.3 (CEC, 2016c). New federal regulations that go into effect July 3, 2019 are expected to result in equivalent performance for all newly manufactured furnaces provided that the ducts are sized properly.

⁴ Whole house leakage tested at a pressure difference of 50 Pascals between indoors and outdoors.

<u>Refrigerant Charge Verification</u>: HERS rater verification of proper air conditioner refrigerant charge according to the procedures outlined in the 2016 Reference Appendices RA3.2 (CEC, 2016c). This measure only applies to climates zones where this is not already required prescriptively.

<u>R-8 Duct Insulation</u>: Increase duct insulation to R-8. This measure only applies to climates zones where R-8 ducts are not already required prescriptively.

<u>High Efficiency Water Heater</u>: Upgrade tankless water heater to a condensing unit with a rated Energy Factor (EF) of either 0.94 or 0.96.

Hot Water Pipe Insulation: Beginning in January 1, 2017 the 2016 California Plumbing Code will require pipe insulation levels that are close to that required if taking the Title-24 pipe insulation credit. This credit will be obsolete under the 2016 energy code, however, the HERS-Verified Pipe Insulation Credit, as defined in the 2016 Reference Appendices RA3.6.3 (CEC, 2016c), will remain. While CBECC-Res has not yet been updated to reflect this, for this analysis it was assumed that the revised HERS verified credit would be equivalent to the current credit for pipe insulation without HERS verification. This was determined based on simulations that demonstrated the HERS credit to be valued at roughly twice that for pipe insulation without verification in terms of TDV energy. This credit was only applied to single family residences. For costing purposes, 120 linear feet of 1/2in insulated pipe is assumed to be insulated.

Hot Water Compact Distribution: HERS rater verification of compact distribution system requirements according to the procedures outlined in the 2016 Reference Appendices RA3.6.5 (CEC, 2016c). This measure was applied to multifamily buildings only. Many multifamily buildings with individual water heaters are expected to easily meet this credit with little or no alteration to plumbing design. This measure also requires verification of pipe insulation per the HERS-Verified Pipe Insulation Credit. Assumption is 60 linear feet per dwelling unit of 1/2in insulated pipe.

PV Compliance Credit: To be eligible for this compliance credit a PV system with a minimum capacity of 2 kW DC per single family home with no more than 2,000 ft² of conditioned floor area and 1 kW DC per multifamily unit with no more than 1,000 ft² of conditioned floor area is required. For the single family 2,430 ft² prototype the minimum capacity as calculated by CBECC-Res is 2.0 kW to 2.4 kW depending on the climate zone. The multifamily apartment units in the prototype are all under 1,000 ft² and therefore require a 1 kW system. The credit was developed to give builders an option with which to trade-off High Performance Attics and Walls, and to begin preparing for ZNE requirements.

Table 2 below summarizes the measures evaluated along with cost assumptions.

		Increm	ental Cost				
	Performance	Single	MF - Per				
Measure	Level	Family	Unit	Source & Notes			
011	N. C.	AC 10	6100	City of Palo Alto 2016 Reach Code Ordinance:			
QII	Yes	\$519	\$133	http://www.cityofpaloalto.org/civicax/filebank/documents/52054			
4 01160	to a statistica.	60.50	10 11 11	NREL measure cost database (\$0.115/ft ² for sealing) + HERS rater			
ACH50	3.0	\$379	n/a	verification (\$100).			
Wall	D.A.	A1.44		2016 CASE Report: Residential High Performance Walls and QII,			
Insulation	R-21	\$164	n/a	2016-RES-ENV2-F			
G 15 4	Aged Reflect			\$0-\$0.50 / ft ² of roof area per local industry expert at LBNL. Used			
Cool Root	= 0.20	\$523	\$131	average of \$0.25/ft ² .			
Window U-	0.00/0.00	AAA					
factor/ SHGC	0.30/0.23	\$73	\$20	EnerComp (\$0.15/ft ² of window area)			
Doors	0.20 U-factor	\$210	\$140	NREL measure cost database $($3.50/ft^2)$ for doors between house and garage. Double cost $($7/ft^2)$ for front door assuming a premium product.			
High Performance Attics (HPA)	R-15 under roof deck	\$878	\$219	For climate zones 1-3, & 5-7 only where HPA is not prescriptive. 2016 CASE Report: Residential Ducts in Conditioned Space / High Performance Attics, 2016-RES-ENV1-F			
Furnace	92%	\$389	\$351	Local HVAC contractor, MF reduction for smaller capacity.			
Air	15/12.5	\$78	\$46	Local HVAC contractor, MF reduction for smaller capacity.			
Conditioning	16/13	\$839	\$699	Average of local HVAC contractor & NREL database costs. MF reduction for smaller capacity.			
Fan Efficacy	0.3 Watts/cfm	\$143	\$104	Local HVAC contractor, MF reduction for smaller capacity.			
Refrigerant	HERS	1 1 1	and the second				
Charge	verified	n/a	\$75	Local HERS rater.			
Duct Insulation	R-8	\$164	n/a	For climate zones 3, 6, & 7 where not prescriptive. 2016 CASE Report: Residential Ducts in Conditioned Space / High Performance Attics, 2016-RES-ENV1-F			
	0.94 EF	\$0	\$0	Internet pricing and plumbing contractor input. Minimal			
Water heater	0.96 EF	\$100	\$100	incremental equip cost and lower cost to install PVC venting (condensing) vs stainless venting (standard). Slight premium going from 0.94 to 0.96.			
Hot water pipe insulation	HERS verified	\$146	n/a	Roughly equivalent to code requirements effective Jan. 2017. 10% of \$3.87 per ft (2013 SF DHW CASE study) for additional labor to pass HERS inspection. \$100 for HERS verification per local HERS raters.			
Hot water compact distribution	HERS verified	n/a	\$112	Assume compact design already or easily achieved in MF units – no added cost. \$100 HERS verification fee per local HERS rater. Pipe insulation cost per the pipe insulation measure assumptions.			
PV	System size varies	\$3.53 / kW DC	\$3.21 / kW DC	Avg. system cost for systems < 10kW (for the last 12 months) of \$5.29/Watt for single family (http://www.gosolarcalifornia.ca.gov/). For multi-family systems, an average of the < 10 kW and > 10kW system cost (\$4.37/Watt) was used; systems are expected to be typically greater than 10 kW, although not as large as some commercial systems reported on in the database. In both cases cost was reduced by \$0.25/Watt for the NSHP incentive & 30% for the solar investment tax credit.			

 Table 2: Measure Descriptions & Cost Assumptions

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2.3 Efficiency Packages

Three efficiency packages were developed for each climate zone where feasible, as described below. Since the federal government does not allow local or state government agencies to require the use of federally-regulated equipment that exceeds the minimum standard requirement, this analysis includes at least one package for each climate zone that does not require installing equipment with higher efficiencies, than federally mandated. In climates where the PV Compliance Credit (PVCC) is available (all climates except 6 and 7) a package that includes the PVCC in addition to efficiency measures was evaluated to achieve Tier 2 performance levels.

- Envelope: These packages focus on building envelope measures but also include efficient hot
 water pipe distribution and cooling fan efficiency measures that don't trigger federal preemption
 issues.
- 2) **Equipment**: Use of HVAC and water heating equipment that are more efficient than federal standards combined with efficient envelope measures if necessary.
- 3) **<u>PV Credit</u>**: Utilize the PV compliance credit (PVCC) available in all climate zones except 6 and 7.

2.4 PV Performance Packages

Using the Tier 2 efficiency package (or Tier 1 in cases where reaching Tier 2 wasn't feasible), the PV system was evaluated and sized to offset TDV loads for the following two conditions:

- <u>PV-Plus</u>: Install a PV system sized to offset a portion of the total household energy use based on TDV energy. PV sizing is consistent with the methodology included in the California Energy Commission's proposed Solar PV Ordinance being developed by the CEC, and PV sizing calculations were developed such that PV size is to be equivalent to offsetting approximately 80% of total estimated building electricity use for a gas/electric home built to the 2016 Title 24. Table 3 summarizes the prescriptive PV sizing based on Climate Zone and home size.
- <u>TDV-Zero</u>: Install a PV system sized to offset 100% of building energy use based on TDV energy, including appliances and plug loads. This is consistent with the requirements of the CALGreen Zero Net Energy Design tier.

In both these cases PV is evaluated in CBECC-Res according to the California Flexible Installation (CFI).

Conditioned Space (ft2)	CZI	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZII	CZ12	CZ13	CZ14	CZ15	CZ16
Less than 1000	1.6	1.4	1.5	1.3	1.4	1.5	1.3	1.5	1.4	1.4	1.7	1.5	1.8	1.3	2.1	1.3
1000 - 1499	2.0	1.7	1.7	1.5	1.6	1.7	1.5	1.8	1.7	1.7	2.2	1.9	2.3	1.6	2.8	1.6
1500 - 1999	2.4	2.0	2.1	1.8	1.9	2.0	1.8	2.1	2.0	2.0	2.7	2.3	2.8	2.0	3.5	1.9
2000 - 2499	2.8	2.3	2.4	2.1	2.1	2.3	2.0	2.4	2.3	2.3	3.2	2.7	3.4	2.3	4.2	2.3
2500 - 2999	3.2	2.6	2.7	2.4	2.4	2.6	2.3	2.7	2.6	2.7	3.7	3.1	3.9	2.7	4.9	2.6
3000 - 3499	3.6	2.9	3.0	2.6	2.7	2.9	2.5	3.0	2.9	3.0	4.2	3.4	4.4	3.0	5.6	3.0
3500 - 3999	3.9	3.2	3.2	2.9	2.9	3.2	2.7	3.3	3.2	3.3	4.7	3.8	4.9	3.4	6.3	3.3
4000 - 4499	4.3	3.5	3.5	3.2	3.1	3.4	2.9	3.6	3.5	3.6	5.1	4.2	5.4	3.7	7.0	3.6

Table 3: Minimum PV System Size (kW_{DC}) required to meet Solar PV Ordinance by Climate Zone

2.5 Cost Effectiveness

A customer based approach to evaluating cost effectiveness was used based on past experience with Reach Code adoption by local governments. The current residential utility rates at the time of the analysis were used to calculate utility costs for all cases and determine cost effectiveness for the proposed packages. Annual utility costs were calculated using hourly electricity and gas output from CBECC-Res and applying the utility tariffs summarized in Table 4. Appendix C includes the utility rate schedules used for this study. The standard residential rate (E1 in PG&E territory, D in SCE territory, & DR in SDG&E) was applied to the base case and all cases without PV systems. The applicable residential time-of-use (TOU) rate was applied to all cases with PV systems.³ Any annual electricity production in excess of annual electricity consumption is credited to the utility account at the applicable wholesale rate based on the approved NEM tariffs for that utility. The net surplus compensation rates for the different utilities are as follows:

- PG&E: \$0.043 / kWh
- SCE: \$0.0298 / kWh⁶
- SDG&E: \$0.0321 / kWh⁷

Climate Zones	Electric / Gas ' Utility	Electricity (Standard)	Electricity (Time-of-use)	Natural Gas		
1-5, 11-13, 16	PG&E	E1	E-TOU, Option A	G1 G1		
6, 8-10, 14, 15	SCE / SoCal Gas	D	TOU-D-T	GR		
	SDG&E	DR	DR-SES	GR		

Table 4: IOU Utility Tariffs used based on Climate Zone

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

Lifecycle Customer Benefit-Cost Ratio =

(Annual utility cost savings * Lifecycle cost factor) / (First incremental cost * Financing factor)

The lifecycle cost factor is 19.6 and includes the following assumptions:

- 30-year measure life & utility cost savings
- 3% real discount rate
- No utility rate escalation (conservative assumption)

(http://www.pge.com/en/myhome/saveenergymoney/plans/tou/index.page?).

⁶ SCE net surplus compensation rate based on 1-year average September 2015 – August 2016.

⁷ SDG&E net surplus compensation rate based on 1-year average August 2015 – July 2016.

⁵ Under NEM rulings by the CPUC (D-16-01-144, 1/28/16), all new PV customers shall be in an approved TOU rate structure. As of March 2016, all new PG&E net energy metering (NEM) customers are enrolled in a time-of-use rate.

The financing factor is 1.068 and includes the following assumptions:

- 30-year financing term
- 4.5% loan interest rate
- 3% real discount rate
- 20% average tax rate (to account for tax savings due to loan interest deductions)

Simple payback is also presented and is calculated using the equation below. Based on the terms described above the lifecycle cost-to-benefit ratio threshold of one is roughly equivalent to a simple payback of 18 years.

Simple payback = First incremental cost / Annual customer utility cost savings

2.6 Greenhouse Gas Emissions

Equivalent CO_2 emission savings were calculated using the following emission factors. Electricity factors are specific to California electricity production.

		Source
Electricity	0.724 lb. CO ₂ -e / kWh	U.S. Environmental Protection agency's 2007 eGRID
		data. ⁸
Natural Gas	11.7 lb. CO ₂ -e / Therm	Emission rates for natural gas combustion as reported by
		the U.S. Environmental Protection agency's GHG
		Equivalencies Calculator.9

Table 5: Equivalent CO₂ Emissions Factors

⁸ https://www.epa.gov/energy/ghg-equivalencies-calculator-calculations-and-references

⁹ https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

3 **Results**

Cost effective analysis including evaluating three efficiency packages and two PV performance packages was completed for all sixteen climate zones. Evaluations looked to identify cost effective Tier 1 and Tier 2 packages for both single family and multifamily prototypes at the CALGreen performance targets of 15% and 30%. When initial proposed packages were found to not be cost effective, multiple iterations were conducted to identify a cost effective package. In certain climates it was not feasible, and targets were subsequently relaxed to something more appropriate. In other climates no cost effective package could be identified. In almost every climate there was no cost effective way to achieve Tier 2 efficiency levels without the PV compliance credit, therefore all Tier 2 packages include PV. Because the PVCC is not available in climate zones 6 and 7, no Tier 2 packages were developed for those climates.

Since the results from this analysis are intended to support mandatory energy efficiency requirements, the authors intentionally selected proven cost-effective measures with wide market acceptance in typical residential construction. Achieving greater performance is feasible using advanced design strategies and measures.

3.1 Single Family Results

3.1.1 Single Family Cost Effectiveness Analysis

A comparison of cost effectiveness for each climate zone and five cases is presented in Figure 1. Table 6 and Table 7 provide the results in tabular form along with energy and greenhouse gas (GHG) savings for each efficiency and PV performance tier. Cost effectiveness results are presented for all three efficiency packages described previously (Envelope, Equipment, and PV Credit) as well as for the two PV performance packages (PV-Plus and TDV-Zero). A summary of measures included in each package is listed in Appendix B.1. The lifecycle benefit-to-cost ratio threshold of one is roughly equivalent to a simple payback of 18 years. Shaded rows in the tables reflect those cases which are not cost effective. While using high efficiency equipment is shown to result in the highest return on investment in many climates, it was necessary to find cost effective packages that do not require specification of equipment with efficiencies better than federally mandated values to avoid federal preemption prohibitions.

Tier 1 Envelope packages were found to be cost effective in climate zones 1 through 5 and 9 through 16. The Tier 1 threshold in climate zone 4 was reduced to 10% to meet the cost effectiveness criteria without installing equipment more efficient than federally mandated. No cost effective Tier 1 efficiency packages were identified in climate zones 6 through 8.

Table 7 presents results for the two PV performance packages including the PV capacity necessary to offset the specified TDV energy. The PV system capacity for the PV-Plus packages is sized based upon the values in Table 3 to provide approximately 80% of estimated annual kWh consumption. The required TDV-Zero PV capacity (as required to generate a TDV=0 compliance simulation result) ranges from 3.1 kW DC in the mild climates (CZ5 and 7) to 7.7 kW DC in hot climates (CZ15). In all cases the measures in these packages reflect those in the Tier 2 package, with the exception of climate zones 6 & 7 where they are based on the Tier 1 envelope package.

The PV-Plus cases demonstrate cost effectiveness with a benefit-to-cost ratio ranging from 1.08 to 1.49. Adding PV beyond the amount needed to offset electricity use reduces cost effectiveness in all cases. The Zero-TDV cases are cost effective in only four climate zones and benefit-cost ratios are consistently lower in all climates. This is impacted by the fact that the compliance model is based upon a home with natural gas space and water heating, thus when sizing PV to offset total house TDV, PV electricity generation is offsetting natural gas consumption. The customer is paid for excess electricity generation beyond what is consumed by the dwelling but only at the wholesale rate which is substantially lower than the retail rate. Greenhouse gas (GHG) savings range from 4.1% to 12.7% for the envelope and equipment Tier 1 packages. Including the PV compliance credit increases GHG reductions to 39% on average. GHG reductions for the two PV packages average 50% and 77% for the PV-Plus and TDV-ZERO cases, respectively.



Figure 1: Single family cost effectiveness comparison

Climate Zone	T-24 Comp. Margin	Elec Savings (kWh)	Gas Savings (therms)	% GHG Savings ²	Package Cost ³	Utility Cost Savings	Simple	Lifecycle Benefit-Cost Ratio
Tier 1, En	velope Case	IS IS			10.00			
CZ1	16.1%	67	83.7	10.7%	\$1,043	\$146	7.2	2.56
CZ2	15,8%	146	49.1	8.2%	\$1,617	\$105	15.4	1.20
CZ3	15.5%	32	43.6	7.7%	\$1,043	\$64	16.3	1.13
CZ4	12.0%	114	18.8	4.1%	, \$808	\$53	15.3	1.20
CZ5	15.2%	27	39.3	7.3%	\$812	\$54	15.1	1.22
CZ6	8.7%	20	17.1	3.6%	\$571	\$20	28.4	0.65
CZ7	7.0%	9	9.7	2.3%	\$571	\$15	39.3	0.47
CZ8	8.9%	37	10.2	2.6%	\$571	\$18	32.1	0.57
CZ9	17.2%	1,69	11.1	4.1%	\$808	\$47	17.2	1.07
CZ10	17.2%	213	12.9	4.7%	\$808	\$57	14.2	1.29
CZ11	16.9%	460	25.9	7.1%	\$808	\$156	5.2	3.55
CZ12	16.4%	222	24.2	5.4%	\$808	\$87	9.3	1.98
CZ13	17.4%	485	22.1	7.0%	\$808	\$157	5.2	3.56
CZ14	16.4%	441	24.4	6.9%	\$808	\$127	6.4	2.88
CZ15	15.2%	896	4.7	8.1%	\$728	\$209	3.5	5.26
CZ16	15.8%	296	80.4	9.8%	\$1,456	\$195	7.5	2.46
Tier 1, Eq	uipment Ca	ses						
CZ1	19.3%	47	101.7	12.7%	\$999	\$169	5.9	3.10
CZ2	16.8%	34	67.0	9.7%	\$999	\$103	9.7	1.89
CZ3	15.3%	23	45.4	8.0%	\$681	\$63	10.8	1.69
CZ4	17.0%	103	45.4	8.3%	\$1,156	\$82	14.2	1.30
CZ5	16.9%	22	46.0	8.4%	\$681	\$60	11.3	1.62
CZ6	15.5%	20	36.2	7.3%	\$842	\$38	22.2	0.83
CZ7	15.6%	9	25.7	5.8%	\$681	\$35	19.6	0.94
CZ8	17.4%	68	25.1	6.0%	\$838	\$39	21.6	0.85
CZ9	16.9%	159	12.2	4.2%	\$1,650	\$46	35.8	0.51
CZ10	16.6%	203	14.2	4.9%	\$1,650	\$56	29.4	0.62
CZ11	17.3%	473	26.0	7.2%	\$1,650	\$160	10.3	1.78
CZ12	16.0%	247	22.7	5.4%	\$1,650	\$92	18.0	1.02
CZ13	17.9%	507	21.5	7.1%	\$1,650	\$161	10.2	1.79
CZ14	17.1%	458	26.4	7.3%	\$1,650	\$133	12.4	1.48
CZ15	15.2%	896	4.7	8.1%	\$728	\$209	3.5	5.26
CZ16	17.6%	58	123.7	12.6%	\$999	\$207	4.8	3.80

Table 6: Single Family Efficiency Package Cost Effectiveness Results¹

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Climate Zone	T-24 Elec G Comp. Savings S Margin (kWh) (r		Gas Savings (therms)	ngs % GHG P rms) Savings ² C		Utility Package Cost Cost ³ Savings		Lifecycle Benefit-Cost Ratio					
Tier 2, Cas	es with PV	Credit				的特定证的	1996						
CZ1	32.2%	2,947	111.8	35.7%	\$10,576	\$781	13.5	1.36					
CZ2	31.4%	3,227	132.7	46.9%	\$10,158	\$809	12.6	1.46					
CZ3	21.8%	3,190	40.1	40.3%	\$8,644	\$731	11.8	1.55					
CZ4	30.4%	3,353	21.8	36.6%	\$8,801	\$677	13.0	1.41					
CZ5	22.0%	3,392	35.6	43.7%	\$8,413	\$737	11,4	1.61					
CZ6		N/A - No PV Credit											
CZ7				N/A - 1	No PV Credit		1.4	λ					
CZ8	36.4%	3,290	10.2	44.0%	\$8,721	\$617	14.1	1.30					
CZ9	35.0%	3,333	13.2	41.5%	\$8,333	\$595	14.0	1.31					
CZ10	32.2%	3,517	15.4	42.3%	\$8,721	\$612	14.2	1.29					
CZ11	31.2%	3,698	35.8	34.7%	\$9,420	\$752	12.5	1.47					
CZ12	32.4%	3,386	27.9	33.8%	\$8,721	\$684	12.8	1.44					
CZ13	31.3%	3,584	25.4	33.2%	\$9,189	\$715	12.9	1.43					
CZ14	30.9%	4,366	26.4	39.4%	\$9,265	\$801	11.6	1.59					
CZ15	32.2%	4,610	4.7	39.0%	\$9,265	\$767	12.1	1.52					
CZ16	31.5%	3,881	80.4	31.8%	\$9,606	\$852	11.3	1.63					

 ¹ Shaded rows reflect those cases which are not cost effective.
 ² Based on CA electricity production and equivalent CO₂ emission rates of 0.724 lbCO₂e / kWh & 11.7 lb-CO2e / therm.

³ Includes 10% markup for builder profit and overhead.

Climate Zone	Compliance Capacity Margin (kW)		Elec Savings (kWh)	Gas Savings (therms)	GHG % Savings ²	Package Cost ³	Utility Cost Savings	Simple Payback	Lifecycle Benefit- Cost Ratio
PV-Plus P	ackage								
CZ1	32.2%	3.0	4,178	111.8	45.0%	\$14,146	\$889	15.9	1.15
CZ2	31.4%	2.5	3,798	132.7	51.9%	\$11,575	\$872	13.3	1.38
CZ3	21.8%	2.6	4,082	40.1	49.7%	\$10,836	\$784	13.8	1.33
CZ4	30.4%	2.3	3,619	21.8	39.2%	\$9,441	\$716	13.2	1.39
CZ5	22.0%	2.3	3,838	35.6	48.6%	\$9,441	\$768	12.3	1.49
CZ6	10.8%	2.5	3,912	17.1	48.9%	\$10,294	\$604	17.0	1.08
CZ7	10.6%	2.2	3,556	9.7 51.5%		\$9,602	\$655	14.7	1.25
CZ8	36.4%	2.6	4,026	10.2	53.4%	\$10,525	\$693	15.2	1.21
CZ9	35.0%	2.5	4,092	13.2	50.3%	\$10,137	\$713	14.2	1.29
CZ10	32.2%	2.5	4,202	15.4	50.0%	\$10,351	\$733	14.1	1.30
CZ11	31.2%	3.5	5,728	35.8	51.1%	\$14,368	\$1,097	13.1	1.40
CZ12	32.4%	2.9	4,673	27.9	45.2%	\$11,903	\$799	14.9	1.23
CZ13	,31.3%	3.7	5,863	25.4	52.1%	\$14,913	\$1,111	13.4	1.37
CZ14	30.9%	2.5	4,941	26.4	44.1%	\$10,507	\$900	11.7	1.57
CZ15	32.2%	4.6	8,600	4.7	72.2%	\$18,521	\$1,497	12.4	1.48
CZ16	31.5%	2.5	4,501	80.4	35.6%	\$11,022	\$866	12.7	1.44
Zero-TDV	Package								
CZ1	32.2%	4.8	6,560	111.8	62.9%	\$21,054	\$987	21.3	0.86
CZ2	31.4%	4.0	6,200	132.7	72.9%	\$17,532	\$960	18.3	1.01
CZ3	21.8%	3.5	5,557	40.1	65.2%	\$14,465	\$845	17.1	1.07
CZ4	30.4%	3.9	6,252	21.8	65.3%	\$15,786	\$808	19.5	0.94
CZ5	22.0%	3.2	5,411	35.6	65.9%	\$13,070	\$821	15.9	1.15
CZ6	10.8%	3.5	5,530	17.1	68.3%	\$14,271	\$644	22.2	0.83
CZ7	10.6%	3.1	5,083	9.7	72.4%	\$13,221	\$686	19.3	0.95
CZ8	36.4%	3.7	5,821	10.2	76.3%	\$14,930	\$705	21.2	0.87
CZ9	35.0%	4.3	7,090	13.2	85.4%	\$17,258	\$756	22.8	0.80
CZ10	32.2%	4.3	7,103	15.4	82.5%	\$17,258	\$776	22.2	0.83
CZ11	31.2%	6.1	9,908	35.8	85.0%	\$24,555	\$1,269	19.3	0.95
CZ12	32.4%	5.1	8,094	27.9	75.4%	\$20,363	\$944	21.6	0.85
CZ13	31.3%	6.4	10,075	25.4	87.1%	\$25,488	\$1,299	19.6	0.94
CZ14	30.9%	5.5	10,295	26.4	88.0%	\$22,072	\$1,068	20.7	0.89
CZ15	32.2%	7.7	13,811	4.7	115.5%	\$30,610	\$1,762	17.4	1.06
CZ16	31.5%	5.2	9,147	80.4	64.2%	\$21,636	\$1,061	20.4	0.90

Table 7: Single Family PV Performance Package Cost Effectiveness Results¹

Shaded rows reflect those cases which are not cost effective.

² Based on CA electricity production and equivalent CO₂ emission rates of 0.724 lbCO₂e / kWh & 11.7 lb-CO₂e / therm. ³ Includes 10% markup for builder profit and overhead.

3.1.2 Single Family Package Recommendations

in all

Based on the single family cost effective analysis, two reach code packages were developed, an efficiency package and a PV package as described below. Table 8 and Table 9 summarize the measures used to cost effectively meet the performance targets for each package.

<u>Tier 1 Efficiency only:</u> Where cost effective packages were identified, the 15% compliance margin target, consistent with CALGreen Tier 1 were used. As stated earlier, a cost effective 15% package was not identified for climate zone 4, so a 10% compliance margin target was used. No cost effective efficiency only packages were identified for climate zones 6 through 8.

Climate Zone	Compliance Margin Target	ß	ACH50	Window U-value / SHGC	Door U- value	AH Fan W/cfm	HW Pipe Insul.
CZ1	15%	Y		.30/.50	0.20		Y
CZ2	15%	Y	3	.30/.23	0.20	0.30	Y
CZ3	15%	Y		.30/.50	0.20		Y
CZ4	10%	Y		.30/.23		0.30	
CZ5	15%	Y		.30/.50			Ŷ
CZ6	barry services	and a second	1	No package			
CZ7		5546	1	No package	1-1-1-1		
CZ8	- and the state		1	No package	Sector Sec.	She walk	S State
CZ9	15%	Y		.30/.23		0.30	
CZ10	15%	Υ		.30/.23		0.30	
CZ11	15%	Y		.30/.23		0.30	
CZ12	15%	Y		.30/.23		0.30	
CZ13	15%	Y	~	.30/.23		0.30	_
CZ14	15%	Y		.30/.23	0.000	0.30	
CZ15	15%	Y				0.30	
CZ16	15%	Ŷ	3	.30/.23	0.20	0.3	1

Table 8: Single Family Efficiency Only: Cost Effective Measures Summary

PV-Plus: Cost effective packages with efficiency and PV were identified in all 16 climate zones, but the compliance margin targets were lowered to 20% for climates 3 and 5, and to 10% for 6 and 7. Table 9 summarizes the measures used in each climate zone to cost effectively meet the targets. It is assumed that the PV compliance credit can be used to meet all these targets, except in climate zones 6 and 7. It is also assumed that a PV system is installed per the methodology described in Table 3 and consistent with the CEC Solar PV Ordinance.

Climate Zone	Compliance Margin Target	ē	ACH50	Window U- value / SHGC	Door U- value	НРА	AH Fan W/cfm	HW Pipe Insul.	PV Capacity (kW)
CZ1	30%	Y	3	.30/.50	0.20	Y	1.212.2010	Y	3.0
CZ2	30%	Y	a 10	.30/.50	0.20	Y	41 42	Ŷ	2.5
CZ3	20%	Y		.30/.50	0.20	S. Sciences 194	1.9.1	1.000	2.6
CZ4	30%	Y	V (6)	.30/.23				- 10 Alba - 10 	2.3
CZ5	20%	Y		.30/.50	1.1.2	· · · ·		1	2.3
CZ6	10%	Y	95 - 18b	- 191 - AL 1		7 - Q7, 4 P	0.30	- Sterio	2.5
ĊZ7	10%	Y	4 I. M.	.30/.23	0.20	11 N 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0.30	· · γ · · ·	2.2
CZ8	30%	Y	120 1 1 42	11 - 2 ¹ 4	75, 5	115 - 5	· · · · ·	1.2.5	2.6
CZ9	30%	Y						*	2.5
CZ10	30%	Y	- 41-11-12	an an ta St		A Second	L. and	St. 3	2.5
CZ11	30%	Y	and the se	.30/.23	0.20	and with	30.9. 17	Y: Transfer	3.5
CZ12	30%	br to Y au 1	2 12 and	10. 1 W. W.	e St. 1	e marci del	bullsma V	1 1642 421	2.9
CZ13	30%	Y		.30/.23					3.7
CZ14	30%	Y					0.30		2.5
CZ15	30%	Yanna	Institution of	1	laine -	A post of	0.30	1	4.6
CZ16	30%	Y	* 3 et	.30/.23	0.20	1.26	0.30		2.5

Table 9: Single Family PV-Plus: Cost Effective Measures Summary

3.2 Multifamily Results

It is generally more challenging to achieve equivalent savings targets for the multifamily cases than for the single family cases. With less exterior surface area per floor area the impact of envelope measures is diminished in multifamily buildings. The PV credit is also much smaller because it is offsetting only high performance walls; high performance attic is not applied to the multifamily prescriptive design because ducts are already assumed to be within conditioned space. Shaded rows in the tables below indicate cases that don't meet the 15% target for Tier 1 or don't have feasible Tier 2 packages.

3.2.1 Multifamily Cost Effectiveness Analysis

A comparison of cost effectiveness for the multi-family prototype is presented in Figure 2. Table 10 and Table 11 provide the results in tabular form, along with energy and greenhouse gas savings for the efficiency and PV performance tiers, respectively. *All multifamily results are presented on a per dwelling unit basis.* Cost effectiveness results are presented for all of the three efficiency packages described previously (envelope, equipment, and PV compliance credit) as well as for the two PV performance packages (PV-Plus and TDV-Zero). A summary of measures included in each package is listed in Appendix B.2. The lifecycle benefit-to-cost ratio threshold of one is roughly equivalent to a simple payback of 18 years. Shaded rows in the tables reflect those cases which aren't cost effective. While using high efficiency equipment is shown to result in an improved return on investment in many climates, it was necessary to find cost effective packages that do not require specification of equipment with efficiencies better than federally mandated values. It can be noted that since rental rates are determined primarily by location, tenants may not experience increased rents due to the cost of efficiency measures. If this is the case, the tenants have no costs and only the benefit of lower energy utility costs.

Tier 1, Envelope packages were found to be cost effective in climate zones 1, and 10 through 16, although the threshold for climate zone 10 was lowered to 10% to meet the cost effectiveness criteria. QII alone was found to be cost effective in climate zone 2 but a cost effective 10% package requires using the PV

compliance credit. No cost effective Tier 1, Envelope efficiency packages were identified in climate zones 3 through 9 without the addition of high efficiency equipment or PV.

Table 11 summarizes the cost effectiveness of the PV performance packages. PV capacity required to meet the required TDV energy offset for each case is also included. The PV capacity for the PV-Plus packages are sized the same as for the single family analysis and based upon the values in Table 3. The required TDV-Zero PV capacity per apartment ranges from 1.9 kW DC in the mild climates to 3.7 kW DC in hot climates (CZ15). For the multifamily prototype 8-unit apartment building, this is equivalent to 15.2 to 29.6 kW for the building. In all cases the measures in these packages reflect those in the Tier 2 package, with the exception of climate zones 6 & 7 where they are based on the Tier 1 envelope package.

The PV-Plus cases demonstrate cost effectiveness with a benefit-to-cost ratio ranging from 1.01 to 1.66. Similar to the single family analysis, while PV is cost effective in offsetting electricity use, adding PV to meet a zero TDV design reduces cost effectiveness in all cases with only two climates having a value greater than 1.

Greenhouse gas (GHG) savings range from 2.2% to 8.6% for the envelope and equipment Tier 1 packages. Including the PV compliance credit increases GHG reductions to 34% on average. GHG reductions for the two PV packages average 49% and 78% for the PV-Plus and ZN-TDV cases, respectively.



Figure 2: Multifamily cost effectiveness comparison

Climate Zone	T-24 Comp. Margin	Elec Savings (kWh)	Gas Savings (therms)	% GHG Savings ²	Package Cost ³	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio	
Tier 1, En	velope Case	S							
CZ1	16.5%	31	28.0	8.0%	\$559	\$37	15.0	1.22	
CZ2	4.8%	7	7.3	2.2%	\$146	\$10	15.0	1.22	
CZ3	10.9%	-3	14.3	4.5%	\$444	\$16	28.1	0.65	
CZ4	10.9%	45	4.6	2.3%	\$364	\$14	26.9	0.68	
C25	10.2%	-4	13.3	4.2%	\$641	\$14	45.1	0.41	
CZ6	11.7%	19	7.7	3.0%	\$559	\$10	55.7	0.33	
CZ7	10.2%	10	4.3	1.7%	\$641	\$7	87.3	0.21	
CZ8	10.5%	55	1.2	1.5%	\$282	\$10	29.0	0.63	
CZ9	12.3%	79	2.0	2.2%	\$282	\$14	19.7	0.93	
CZ10	10.1%	92	2.5	2.6%	\$282	\$17	16.9	1.08	
CZ11	17.7%	186	13.2	6.5%	\$436	\$49	8.9	2.07	
CZ12	17.1%	103	12.6	5.4%	\$436	\$33	13.1	1.41	
(213	18.1%	200	11.3	6.3%	\$436	\$50	8.8	2.09	
CZ14	17.8%	176	12.9	6.3%	\$436	\$39 ,	11.1	1.66	
CZ15	17.7%	426	0.6	6.8%	\$436	\$73	5.9	3.09	
CZ16	16.3%	91	29.9	8.0%	\$559	\$52	10.7	1.71	
Tier 1, Eq	ulpment Ca	ses							
CZ1	16.7%	8	31.7	8.6%	\$290	\$37	7.8	2.35	
CZ2	15.0%	7	27.3	8.0%	\$642	\$32	19.8	0.93	
CZ3	12.4%	1	16.9	5.4%	\$146	\$19	7.6	2.42	
CZ4	16.3%	11	25.5	8.0%	\$765	\$31	24.8	0.74	
CZ5	11.8%	-3	16.6	5.3%	\$146	\$18	8.1	2.28	
CZ6	12.1%	1	16.4	5.6%	\$269	\$15	17.8	1.03	
CZ7	12.5%	-1	15.9	5.5%	\$379	\$20	19.3	0.95	
CZ8	15.2%	83	1.2	2.1%	\$1,133	\$14	80.4	0.23	
CZ9	15.7%	106	2.0	2.8%	\$1,029	\$19	55.4	0.33	
CZ10	15.5%	124	2.5	3.2%	\$1,029	\$22	47.2	0.39	
CZ11	16.5%	202	6.3	5.0%	\$333	\$44	7.5	2.43	
CZ12	15.0%	109	6.1	3.6%	\$333	\$27	12.4	1.48	
CZ13	15.4%	199	5.1	4.6%	\$311	\$42	7.4	2.48	
CZ14	16.5%	201	6.1	4.9%	\$1,029	\$37	27.7	0.66	
CZ15	20.4%	515	0.4	8.2%	\$1,029	\$89	11.6	1.58	
CZ16	15.7%	86	. 29.8	7.9%	\$668	\$51	13.0	1.41	

 Table 10: Multifamily Efficiency Cost Effectiveness Results¹

Climate Zone	T-24 Comp. Margin	Elec Sávings (kWh)	Gas Savings (therms)	% GHG Savings ²	Package Cost ³	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
Tier 2, Ca	ses with PV	Credit		山北につい	R WELLER		and the st	PART CARLES
CZ1	21.0%	1,370	28.0	30.2%	\$4,085	\$291	14.1	1.31
CZ2	20.4%	1,608	17.2	33.7%	\$4,085	\$318	12.8	1.43
CZ3	15.3%	1,585	14.1	35.7%	\$4,085	\$315	13.0	1.41
CZ4	26.9%	1,654	13.6	35.6%	\$4,085	\$321	12.7	1.44
CZ5	12.4%	1,677	13.3	37.7%	\$4,085	\$326	12.5	1.46
CZ6		The local		N/A - 1	No PV credit	Carley.		
CZ7				N/A -	No PV credit			
CZ8	21.0%	1,622	5.7	35.3%	\$4,085	\$260	15.7	1.17
CZ9	26.8%	1,719	4.0	35.4%	\$3,963	\$270	14.7	1.25
CZ10	26.2%	1,734	4.9	35.2%	\$3,963	\$269	14.7	1.25
CZ11	26.5%	1,778	13.2	32.6%	\$3,963	\$311	12.7	1.44
CZ12	26.5%	1,673	12.6	32.8%	\$3,963	\$312	12.7	1.44
CZ13	27.3%	1,746	11.3	31.8%	\$3,963	\$301	13.2	1.39
CZ14	26.0%	1,973	12.9	36.0%	\$3,963	\$307	12.9	1.42
CZ15	25.4%	2,100	0.6	33.0%	\$3,963	\$281	14.1	1.30
CZ16	25.7%	1,734	42.4	33.8%	\$3,848	\$369	10.4	1.76

¹Shaded rows reflect those cases which are not cost effective.

 2 Based on CA electricity production and equivalent CO_2 emission rates of 0.724 lbCO_2e / kWh & 11.7 lb-CO_2e / therm.

³ Includes 10% markup for builder profit and overhead.

Climate Zone	ate Compliance Capacit Margin (kW)		Elec Savings (kWh)	Gas Savings (therms)	Gas Savings GHG % (therms) Savings ²		Utility Cost Savings	Simple Payback	Lifecycle Benefit- Cost Ratio	
PV-Plus P	ackage									
CZ1	21.0%	1.6	2,172	28.0	43.5%	\$6,201	\$393	15.8	1.16	
CZ2	20.4%	1.4	2,234	17.2	44.9%	\$5,496	\$393	14.0	1.31	
CZ3	15.3%	1.5	2,374	14.1	51.2%	\$5,849	\$377	15.5	1.18	
CZ4	26.9%	1.3	2,137	13.6	44.8%	\$5,143	\$391	13.1	1.40	
CZ5	12.4%	1.4	2,350	13,3	51.1%	\$5,496	\$375	14.7	1.25	
CZ6	11.7%	1.5	2,388	7.7	52.5%	\$5,849	\$322	18.1	1.01	
CZ7	10.2%	1.3	2,139	4.3 48.0% \$5,226		\$5,226	\$369	14.2	1.30	
CZ8	21.0%	1.5	2,413	5.7	51.6%	\$5,849	\$350	16.7	1.10	
CZ9	26.8%	1.4	2,372	4.0	48.4%	\$5,373	\$369	14.6	1.26	
CZ10	26.2%	1.4	2,386	4:9	47.9%	\$5,373	\$383	14.0	1.31	
CZ11	26.5%	1.7	2,893	13.2	50.8%	\$6,431	\$514	12.5	1.47	
CZ12	26.5%	1.5	2,457	12.6	46.5%	\$5,726	\$437	13.1	1.40	
CZ13	27.3%	1.8	2,982	11.3	52.2%	\$6,784	\$525	12.9	1.42	
CZ14	26.0%	1.3	2,512	12.9	44.9%	\$5,021	\$406	12.4	1.49	
CZ15	25.4%	2.1	3,940	0.6	61.8%	\$7,842	\$618	12.7	1.45	
CZ16	25.7%	1.3	2,244	42.4	40.9%	\$4,906	\$444	11.1	1.66	
Żero-TDV	Package									
CZ1	21.0%	2.5	3,415	28.0	64.2%	\$9,476	\$424	22.3	0.82	
CZ2	20.4%	2.3	3,674	17.2	70.7%	\$8,741	\$433	20.2	0.91	
CZ3	15.3%	2.0	3,233	14.1	68.1%	\$7,767	\$400	19.4	0.94	
CZ4	26.9%	2.2	3,587	13.6	72.4%	\$8,320	\$429	19.4	0.95	
CZ5	12.4%	1.9	3,189	13.3	67.8%	\$7,254	\$399	18.2	1.01	
CZ6	11.7%	2.1	3,356	8.0	72.7%	\$8,011	\$341	23.5	0.78	
CZ7	10.2%	2.1	3,383	4.0	75.0%	\$7,903	\$394	20.0	0.92	
CZ8	21.0%	2.4	3,768	5.7	79.6%	\$8,869	\$379	23.4	0.78	
CZ9	26.8%	2.5	4,124	4.0	83.1%	\$9,154	\$403	22.7	0.81	
CZ10	26.2%	2.5	4,115	4.9	81.5%	\$9,115	\$415	22.0	0.84	
CZ11	26.5%	3.0	4,979	13.2	84.9%	\$11,052	\$586	18.9	0.97	
CZ12	26.5%	2.8	4,509	12.6	82.3%	\$10,336	\$503	20.6	0.89	
CZ13	27.3%	3.2	5,129	11.3	87.6%	\$11,681	\$603	19.4	0.95	
CZ14	26.0%	2.7	5,056	12.9	86.8%	\$10,014	\$482	20.8	0.88	
CZ15	25.4%	3.7	6,571	0.6	102.9%	\$13,389	\$726	18.4	0.99	
CZ16	25.7%	2.6	4,398	42.4	71.0%	\$9,379	\$514	18.2	1.01	

 Table 11: Multifamily PV Performance Cost Effectiveness Results¹

¹Shaded rows reflect those cases which are not cost effective.

² Based on CA electricity production and equivalent CO₂ emission rates of 0.724 lbCO₂e / kWh & 11.7 lb-CO₂e / therm. ³ Includes 10% markup for builder profit and overhead.

3.2.2 Multifamily Package Recommendations

Based on the multifamily cost effective analysis, two reach code packages were developed, similar to the single family packages. Table 12 and Table 13 summarize the measures used to cost effectively meet the performance targets for each multifamily package.

Tier 1 Efficiency only: Where cost effective packages were identified, the 15% compliance margin target, consistent with CALGreen Tier 1 were used. As stated earlier, a cost effective 15% package was not identified for climate zone 10, so a 10% compliance margin target was used, and only QII was cost effective in climate zone 2. Additionally, no cost effective efficiency only packages were identified for climate zones 3 through 9.

Climate Zone	Compliance Margin Target	ē	Window U- value / SHGC	Window U- value / SHGC Door U- value		Refrigerant Charge	HW Comp. Dist.
CZ1	15%	Y	0.30/0.50	0.20	0.3	1	Y
CZ2	QII Only	Y					
CZ3		1 A Street	N	o package			
CZ4			N	o package			
CZ5			N	o package			
CZ6			N	o package			
CZ7	Contract Carel Brown		N	o package			
CZ8	and the second second		N	o package			
CZ9	and the second second		N	o package			
CZ10	10%	Y	0.30/0.23		0.3		
CZ11	15%	Y	.0.30/0.23	0.20	0.3		
CZ12	15%	Y	0.30/0.23	0.20	0.3		
CZ13	15%	Y	0.30/0.23	0.20	0.3		
CZ14	15%	Y	0.30/0.23	0.20	0.3		
CZ15	15%	Y	0.30/0.23	0.20	0.3		
CZ16	15%	Y	0.30/0.23	0.20	0.3		Y

Table 12: Multifamily Efficiency Only: Cost Effective Measures Summary

PV-Plus: Cost effective packages with efficiency and PV were identified in all 16 climate zones, but the compliance margin targets in all climates were lowered below 30% in all cases to be cost effective. Table 13 summarizes the compliance margin targets in each climate zone and the measures used to cost effectively meet the targets. As with the single family packages, with the exception of climate zones 6 and 7, it is assumed that the PV compliance credit can be used to meet these targets. It is also assumed that a PV system is installed per the methodology developed for the proposed Solar PV ordinance (Table 3).

Climate Zone	Compliance Margin Target	ē	Window U-value / SHGC	Door U- value	AH Fan W/cfm	HW Comp. Dist.	PV Capadity (kW)
CZ1	20%	Ŷ	0.30/0.50	0.20	0.3	Y	1.6
CZ2	20%	Y	0.30/0.23	0.20	0.3	Y	1.4
CZ3	15%	Y	0.30/0.50	0.20	0.3	Y	1.5
CZ4	25%	Y	0.30/0.23	0.20	0.3	Y	1.3
CZ5	10%	Y	0.30/0.50	0.20	0.3	Y	1.4
CZ6	10%	110 Y 11	0.30/0.23	0.20	1. 范围 (市)	1. C. B	1.5
CZ7	10%	Y	0.30/0.23	0.20	al l'	$t = -2 \frac{1}{2} t_{10} t_{10} t_{10}$	1.3
CZ8	20%	Y	0.30/0.23	0.20	0.3	Y	1.5
CZ9	25%	Y	0.30/0.23	0.20	0.3		1.4
ČZ10	25%	Y	0.30/0.23	0.20	0.3	1.01	1.4
CŽ11	25%	Y	0.30/0.23	0.20	0.3	 Contraction 	1.7
CZ12	25%	Y	0.30/0.23	0.20	0.3	int fait (i	1.5
CZ13	25%	Y	0.30/0.23	0.20	0.3	THE BUL	1.8
CZ14	25%	Y	0.30/0.23	0.20	0.3	1 1 1 1 1 4 4 1 4 1 4 1 1 1 1 1 1 1 1 1	1.3
CZ15	25%	Y	0.30/0.23	0.20	0.3	in the second second	2.1
CZ16	25%	Y	0.30/0.23	0.20			1.3

2016 Energy Efficiency Ordinance Cost Effectiveness Study

Table 13: Multifamily PV-Plus: Cost Effective Measures Summary

4 Conclusions & Summary

This report evaluated the feasibility and cost effectiveness of "above code" ordinance performance tiers through the application of both efficiency measures and PV in all 16 California climates zones. For this analysis, PG&E rates were used for gas and electricity in climate zones 1 through 5, 11 through 13, and 16. SCE electricity rates and Southern California Gas rates were used for climate zones 6, 8 through 10, 14 and 15. SDG&E rates were used for electricity and gas for climate zone 7.

The following describes the recommended performance levels for the above-code ordinance packages. The original intent was to develop packages that align with the tiers as defined in the 2016 CALGreen code. Based on the analysis results, performance thresholds were reduced in some climates and eliminated altogether in other climates. Identifying cost effective efficiency (only) packages was particularly challenging in multifamily buildings. Table 14 and Table 15 summarize recommended cost effective ordinance criteria by climate zone for single family and multifamily buildings, respectively. Where cost effective packages exist, there is both a Tier 1 efficiency only package and the efficiency with PV (PV-Plus) package. The tables include the Title 24 compliance target needed to meet the criteria for each package. Tier 1 compliance targets are compliance margins for efficiency measures only and are designed to be met without using the PV Compliance Credit. The PV-Plus compliance targets are for projects that include PV. The efficiency targets are set higher, but assume that the PV compliance credit (PVCC) is used to meet the performance targets. The efficiency targets are set lower for climate zones 6 and 7 because projects built in these climate zones are not eligible to take the PVCC.

Following is a summary of the differences between the two packages defined in this analysis and the tiers defined in CALGreen.

Tier 1 Packages: CALGreen defines Tier 1 as showing a 15% or greater Title 24 compliance margin compared to the Standard Design. The intent of the Efficiency tier in this study was to find cost effective packages of measures that meet the CALGreen Tier 1 criteria without mandating the installation of PV or high efficiency equipment that exceed federal minimum levels. To encourage adoption of efficiency measures in preparation for the 2019 Title-24 code, the authors recommend that PV not be allowed as a means to meet the Tier 1 compliance requirements. Based on the lifecycle benefit-to-cost ratio metric applied in this analysis, cost effective packages to meet Tier 1. There are several climates where the compliance margin targets are lowered to maintain the cost effectiveness criteria and other climates where no cost effective efficiency packages were identified.

PV-Plus Packages: CALGreen defines both Tier 2 and ZNE Tier performance levels. The ZNE Tier requires that the building meet the required efficiency targets as defined in Section A4.203.1.2.3 of 2016 CALGreen and size a PV system to offset 100% of the TDV energy of the building (achieve an Energy Design Rating of 0). The results of this work, based on dwellings with gas and electricity, found that sizing the PV system to meet the ZNE Tier criteria was generally not cost effective or in some limited cases, marginally cost effective. Instead a PV and efficiency package (PV-Plus) was developed that limited the size of the PV system to no larger than the annual estimated electricity use of the building and combine it with efficiency measures that are cost effective in all climate zones. Lifecycle benefit-to-cost ratio for the PV-Plus cases for both the single family and multifamily prototypes are all above one. In cases where PV capacity in the PV-Plus package is less than the minimum to meet the PV compliance credit, it's recommended that jurisdictions allow the smaller PV capacity be installed and still qualify for the PVCC to avoid sizing the PV systems larger than the estimated electricity use.

Packages	Climate Zones	T-24 Compliance Target	PVCC Allowed	PV
Tier 1 Efficiency	1-3, 5, 9-16	15%	No	n/a
Only Package	4	10%	No	n/a
-CO ^N modil 1995.0	1,2,4, 8-16	30%	Yes	Yes
PV-Plus Package	3,5	20%	Yes	Yes
	6-7	10%	n/a	Yes

Table 14: Single Family Reach Code Package Recommendations

Packages	Climate Zones	T-24 Compliance Target	PVCC Allowed	PV
	1, 11-16	15%	No	n/a
	10	10%	No	n/a
Unity Fackage	2	QII	No	n/a
	4, 9-16	25%	Yes	Yes
	1-2, 8	20%	Yes	Yes
PV-Plus Package	3	15%	Yes	Yes
	5	10%	Yes	Yes
	6-7	10%	n/a	Yes

Table 15: Multifamily Reach Code Package Recommendations

Consistent with CALGreen, a pre-requisite for all packages includes HERS verification of Quality Insulation Installation (QII).

The recommended packages do not include a TDV-Zero option because these packages were generally not found to be cost effective. Lifecycle benefit-to-cost ratios for the single family TDV-Zero packages are 0.78 to 1.07. Limited cost effectiveness is largely a result of oversizing the PV systems relative to the house electricity load. With mixed fuel homes, PV electricity generation offsets natural gas consumption when sizing relative to zero TDV. The consumer is compensated by the utility for electricity generation in excess of annual consumption, but only at the wholesale rate which is substantially lower than the retail rate. Consideration of dwellings without gas was not in the scope of this study.

In conclusion, this report has identified cost effective options to meet above-code performance levels for dwellings using natural gas and electricity which can be adopted by cities and counties within investorowned utility territories across California. Including PV to the level of offsetting electricity loads was found to be cost effective in all sixteen climate zones evaluated as summarized above.

5 <u>References</u>

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<u>Appendix A – Prescriptive Package</u>

The following presents the residential prescriptive package as printed in the 2016 Building Energy Efficiency Standards (CEC, 2016b).

1.1									in the				(C ·							
- law				-		1 .	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	I	(¥6(s Insulation oof Rafter	ug Type	No Air Space ¹	NR	NR	NR	R 8	NR	NR	NR	R 8	R 8	R 8	R 8	R 8	R 8	R 8	R 8	R 8
		ets §150.1(c	Continuou Above R	Roofir	With Air Space ²	NR	NR	NR	R 6	NR	NR	NR	R 6	R 6	R 6	R 6	R 6	R 6	R 6	R 6	R 6
1024		Option A (m		Ceiling Insulation		R 38	R 38	R 30	R 38	R 30	R 30	R 30	R 38								
ıg Envelope sulation				Radiant Barrier		NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
	oofs/ lings	c)9A)	acets §150.1(c)9A) Below Roof Deck	Roofin g Type	No Air Space	NR	NR	NR	R 18	NR	NR	NR	R 18								
Building Insu	R. C. R	seets §150.1(With Air	NR	NR	NR	R 13	NR	NR	NR	R 13								
1		Option B (n		Ceiling Insulation	1	R 38	R 38	R 30	R 38	R 30	R 30	R 30	R 38								
				Radiant Barrier	- 10 - 11	NR	REQ	REQ	NR	REQ	REQ	REQ	NR								
		C (meets		Cerling Insulation		R 38	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 38					
		Option		Radiant		NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR

TABLE 150.1-A COMPONENT PACKAGE-A STANDARD BUILDING DESIGN

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												Clima	te Zone							
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
				Framed	U 0.051	U 0.065	U 0.065	U 0.051	U 0.051	U 0.051										
lation			Above Grade	Mass Wall Interior S	U 0.070 R 13	U 0.070 R 13	U 0.059 R 17													
avelope Inst		Walls		Mass Wall Exterior ⁶	U 0.125 R 8.0	U 0.1025 R 8.0	U 0.125 R 8.0	U 0.070 R 13												
Building E			Grade	Below Grade Interior	U 0.070 R 13	U 0.070 R 13	U 0.066 R 15													
			Below	Below Grade Exterior	U 0.200 R 5.0	U 0.100 R 10	U 0.100 R 10	U 0.053 R 19												
			Slab F	Perimeter	NR	NR	U 0.58													
	FI	oors	R	aised	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19													
			Concre	te Raised	U 0.092 R 8.0	U 0.092 R 8.0	U 0.269 R 0	U 0.269 R 0	U0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.092 R 8.0	U 0.138 R 4.0	U 0.092 R 8.0	U 0.092 R 8.0	U 0.138 .R 4.0	U 0.092 R 8.0
	5		Age	d Solar	NR	0.63	NR	0.63	NR											
ing	roduc	sloped	Th	ermal	NR	0.75	NR	0.75	NR											
Build Envel	fing P	Steen	Age	d Solar ectance	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR								
	Roo	Sloped	Th Em	ermal ittance	NR	0. 75	0.75	0.75	0.75	0.75	0.75	NR								
×		Max	simum U	-factor	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
veloj	00	Ma	kimum S	HGC	NR	0.25	NR	0.25	NR	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
E	strat	Maxi	num To	tal Area	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Buildin	Fene	Maxin	aum We Area	st Facing	NR	5%	NR	5%	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

TABLE 150.1-A COMPONENT PACKAGE-A STANDARD BUILDING DESIGN (CONTINUED)

2016 Energy Efficiency Ordinance Cost Effectiveness Study

								9. c.	ĵ.		Climat	e Zone						1	
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	.=	Electric-R	esistance Allowed	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
ž.	Spac	If	gas, AFUE	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
10	*	If Heat	Pump, HSPF ⁹	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
			SEER	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
	Space cooling	Refrig Verification	gerant Charge n or Fault Indicator Display	NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
		Whole	e House Fan ¹⁰	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR	NR
HVAC SYSTEM	Central System Air Handlers	Central Ventila	l Fan Integrated tion System Fan Efficacy	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
		eiling A & B	Duct Insulation	R-8	R-8	R-6	R-8	R-6	R-6	R-6	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8
č.	12 12	RooffC	§150.1(c)9A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Å	8	Duct Insulation	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6
		RooffCeili	§150.1(c)9B	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Water Heating	1	All Buildi	ngs				4	and a state of	A THE	System	Shall mee	Section 1	50 l(c)8				ł		

TABLE 150.1-A COMPONENT PACKAGE-A STANDARD BUILDING DESIGN (CONTINUED)

Footnote requirements to TABLE 150.1-A:¹⁰

- 1. Install the specified R-value with no air space present between the roofing and the roof deck.
- 2. Install the specified R-value with an air space present between the roofing and the roof deck. Such as standard installation of concrete or clay tile.
- 3. R-values shown for below roof deck insulation are for wood-frame construction with insulation installed between the framing members.
- 4. Assembly U-factors can be met with cavity insulation alone or with continuous insulation alone, or with both cavity and continuous insulation that results in an assembly U-factor equal to or less than the U-factor shown. Use Reference Joint Appendices JA4 Table 4.3.1, 4.3.1(a), or Table 4.3.4 to determine alternative insulation products to meet the required maximum U-factor.
- 5. Mass wall has a thermal heat capacity greater than or equal to 7.0 Btu/h-ft². "Interior" denotes insulation installed on the inside surface of the wall.
- 6. Mass wall has a thermal heat capacity greater than or equal to 7.0 Btu/h-ft². "Exterior" denotes insulation installed on the exterior surface of the wall.
- 7. Below grade "interior" denotes insulation installed on the inside surface of the wall.
- 8. Below grade "exterior" denotes insulation installed on the outside surface of the wall.
- 9. HSPF means "heating seasonal performance factor."
- 10. When whole house fans are required (REQ), only those whole house fans that are listed in the Appliance Efficiency Directory may be installed. Compliance requires installation of one or more WHFs whose total airflow CFM is capable of meeting or exceeding a minimum 1.5 cfm/square foot of conditioned floor area as specified by Section 150.1(c)12.
- 11. A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kilowatts or 7,000 Btu/hr and is controlled by a timelimiting device not exceeding 30 minutes.
- 12. For duct and air handler location: REQ denotes location in conditioned space. When the table indicates ducts and air handlers are in conditioned space, a HERS verification is required as specified by Reference Residential Appendix RA3.1.4.3.8.

¹⁰ Single family buildings are modeled with Option B and multifamily buildings are modeled with Option C.

Climate Zone	5	ACHSO	Mindow J-value / BHGC	Door J-value	APA	urnace	AC GER/EER	N/cfm	OHW EF	tW Pipe nsul.	V Credit lize (kW)	T-24 Comp. Margin
Tier 1, En	velop	e Cas	ies				~ ~	States and	100			
CZ1	Y		.30/.50	0.20					1	Y		16.1%
CZ2	Y	3	.30/.23	0.20				0.30		Y	_	15.8%
CZ3	Y		.30/.50	0.20				-		Y		15.5%
CZ4	Y		.30/.23					0.30				12.0%
CZ5	Y	5	.30/.50							Y		15.2%
CZ6	Y		5 CT .									8.7%
CZ7	Y					4	11.115	-		6		7.0%
CZ8	Y	1		14 - A.Y.			n	100		4Y4	100 A 100	8.9%
CZ9	Y		.30/.23	90 A			-	0.30	1	Vez	- 250 j	17.2%
CZ10	Y		.30/.23	(a) (a) (a) (b) (b) (b) (b) (b) (b) (b) (b) (b) (b		1		0.30	The second second	1.4.1.4		17.2%
CZ11	Y	Contrast 1	.30/.23		10.1			0.30				16.9%
CZ12	Y	1.11	.30/.23					0.30	- garage	- 11-r	- 1977 - - 8	16.4%
CZ13	Y		.30/.23	-				0.30				17.4%
CZ14	Y		.30/.23					0.30		2.5		16.4%
CZ15	Y	- 57						0.30				15.2%
CZ16	Y	3	.30/.23	0.20				0.30				15.8%
Tier 1. Ea	uipm	ent C	ases	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1								
CZ1	Y			Contract of the second	Rold-office	0.92	an Barradan da Garrad					19.3%
C72	Y					0.92	-					16.8%
CZ3	Y								0.94			15.3%
CZ4	Y					0.92		0.30				17.0%
CZ5	Y								0.94			16.9%
CZ6	Y							100	0.94	Y		15.5%
CZ7	Y								0.94			15.6%
CZ8	Y							0.30	0.94			17.4%
CZ9	Y	_					15/12.5	0.30				16.9%
CZ10	Y	-					15/12.5	0.30				16.6%
CZ11	Y						15/12.5	0.30				17.3%
CZ12	Y	. 5					15/12.5	0.30				16.0%
CZ13	Y	1					15/12.5	0.30				17.9%
CZ14	Y						15/12.5	0.30				17.1%
CZ15	Y						-,	0.30				15.2%
CZ16	Y					0.92						17.6%

Appendix B.1 – Single Family Package Summaries

Climate Zone	ßII	ACH50	Window U-value / SHGC	Door U-value	НРА	Furnace AFUE	AC SEER/EER	AH Fan W/cfm	DHW EF	HW Pipe Insul.	PV Credit Size (kW)	T-24 Comp. Margin
Tier 2, Ca	ses w	ith P\	/ Credit							1		
CZ1	Y	3	.30/.50	0.20	Y					Y	2.1	32.2%
CZ2	Y		.30/.50	0.20	Y					Y	2.1	31.4%
CZ3	Y		.30/.50	0.20							2.0	21.8%
CZ4	Y		.30/.23								2.1	30.4%
CZ5	Y		.30/.50								2.0	22.0%
CZ6					N/	A - No P	V Credit				-	1
CZ7					N/	A - No F	V Credit					
CZ8	Y										2.1	36.4%
CZ9	Y										2.0	35.0%
CZ10	Y										2.1	32.2%
CZ11	Y		.30/.23	0.20			W0				2.2	31.2%
CZ12	Y					11.11					2.1	32.4%
CZ13	Y		.30/.23							97	2.2	31.3%
CZ14	Y							0.30			2.2	30.9%
CZ15	Y							0.30			2.2	32.2%
CZ16	Y	3	.30/.23	0.20				0.30			2.1	31.5%

52 1942			Table	: 17: N	Iultifamil	ly Tier	1 Pack	ages		ĝ.	
Climate Zone	ā	Window U- value / SHGC	Door U-value	Furnace	AC SEER/EER	AH Fan W/cfm	Refrigerant Charge	DHW EF	HW Camp. Dist.	PV Credit Size (kW)	T-24 Comp. Margin
Tier 1, En	velo	be Cases									
CZ1	Y	0.30/0.50	0.20		5 27	0.3		S. A.K.	Y	12 1	16.5%
CZ2	Y	£			1.0		1050-1050	4.	at iso'	£1. 8	4.8%
CZ3	Y	0.30/0.50	0.20		3.0 m A.	10 21			Y		10.9%
CZ4	Y	0.30/0.23			and a set of the	0.3	Y				10.9%
CZ5	Y	0.30/0.50	0.20			0.3	Y	in a	Y	. N.	10.2%
CZ6	Y	0.30/0.23	0.20	-	in the second second	0.3		r.	Y	54 1	11.7%
CZ7	Y	0.30/0.23	0.20		12	0.3	Y	5.5	Yest		10.2%
CZ8	Y	0.30/0.23			1.2	0.3		19.57	1.1.52-6	0.0	10.5%
CZ9	Y	0.30/0.23			1.1	0.3	1 44 - 1 1 1	2.5	EL.JW	č. 6	12.3%
CZ10	Y	0.30/0.23	- 198 av 10		1.1.1	0.3		my A	100		10.1%
CZ11	Y	0.30/0.23	0.20		2.5	0.3	2 N - N	15.0	Stat.		17.7%
CZ12	Y	0.30/0.23	0.20		14	0.3			6. 65.3	- 14 - 14	17.1%
CZ13	Y	0.30/0.23	0.20	1.000		0.3		35.6	1.1.1.	and a second	18.1%
CZ14	Y	0.30/0.23	0.20	1		0.3					17.8%
CZ15	Y	0.30/0.23	0.20			0.3					17.7%
CZ16	Y	0.30/0.23	0.20			0.3			Y		16.3%
Tier 1, Eq	uipm	ent Cases					1				
CZ1	Y	0.30/0.50						94	Y		16.7%
CZ2	Y			92				96			15.0%
CZ3	Y				5 10 (P (1))			94			12.4%
CZ4	Y			92		1.		96	Y		16.3%
CZ5	Y		10000		a la sectoria da construcción de la sectoria da sectoria da sectoria da sectoria da sectoria da sectoria da sec			94			11.8%
CZ6	Y							94	Y		12.1%
CZ7	Y							96	Y		12.5%
CZ8	Y	0.30/0.23		2.101	16/13	0.3	Y				15.2%
CZ9	Y				16/13	0.3					15.7%
CZ10	Y				16/13	0.3					15.5%
CZ11	Y	0.30/0.23			15/12.5	0.3			N-010-000		16.5%
CZ12	Y	0.30/0.23			15/12.5	0.3					15.0%
CZ13	Y				15/12.5	0.3					15.4%
CZ14	Ŷ				16/13	0.3					16.5%
CZ15	Y				16/13	0.3					20.4%
CZ16	Y	0.30/0.23		92		0.3				-	15.7%

Appendix B.2 – Multifamily Package Summaries

Climate Zone	ال ال	Window U- value / SHGC	Door U-value	Furnace AFUE	AC SEER/EER	AH Fan W/cfm	Refrigerant Charge	DHW EF	HW Comp. Dist.	PV Credit Size (kW)	T-24 Comp. Margin
Tier 2, Ca	ses w	vith PV Credit	10-10-5					50 B.			1
CZ1	Y	0.30/0.50	0.20			0.3			Y	1.0	21.0%
CZ2	Y	0.30/0.23	0.20			0.3			Y	1.0	20.4%
CZ3	Y	0.30/0.50	0.20			0.3			Y	1.0	15.3%
CZ4	Y	0.30/0.23	0.20			0.3			Y	1.0	26.9%
CZ5	Y	0.30/0.50	0.20			0.3			Y	1.0	12.4%
CZ6		-		N	I/A – No F	V Credit					
CZ7	-			N	I/A - No F	V Credit					
CZ8	Y	0.30/0.23	0.20		_	0.3			Y	1.0	21.0%
CZ9	Y	0.30/0.23	0.20			0.3				1.0	26.8%
CZ10	Y	0.30/0.23	0.20			0.3				1.0	26.2%
CZ11	Y	0.30/0.23	0.20			0.3				1.0	26.5%
CZ12	Y	0.30/0.23	0.20			0.3				1.0	26.5%
CZ13	Y	0.30/0.23	0.20			0.3				1.0	27.3%
CZ14	Y	0.30/0.23	0.20			0.3				1.0	26.0%
CZ15	Y	0.30/0.23	0.20			0.3				1.0	25.4%
CZ16	Y	0.30/0.23	0.20							1.0	25.7%

Appendix C - Utility Rate Tariffs

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Following are the PG&E electricity, both standard and time-of-use, and natural gas tariffs applied in this study. The PG&E monthly gas rate in \$/therm was applied on a monthly basis for the 12-month period ending March 2016.

Pacific C San Fran U 39	Sas and Electric Company Icisco, California	Cancelling	Revised Revised	Cal. P.U.C. Sheet No. Cal. P.U.C. Sheet No.	36706-E 36470-E
	EL R	ECTRIC SCHEDUL ESIDENTIAL SERV	EE-1 ICES	8	heet 1
Applicability:	This so out is applicable single-family dwellings an phase and polyphase sen Condition 63; and to all sin by the person whose resid	s to single-phase and po d in Italis and apartments rice in common areas in Igle-phase and polyphas tense is supplied through	lyphase resid separately m a multifamity a farm service h the same m	lential service in lebred by PG&E to sing complex (see Special e on the premises operations, special eter.	ja- ad
	The provisions of Schedul apply to customers whose electric energy from a nar- reservation charges as ap applicable Scheduls 5-1 of for exemptions to standby	le S—Standby Service S premises are regularly to utility source of supply. ecified under Section 1 4 charges. See Special Co charges.	peciel Condit supplied in pa These custor of Schedule S inditions 11 a	ions 1 through 6 shall als nt (but <u>not</u> in whole) by ners will pay monthly , in addition to all nd 12 of this rate schedu	10
ERRITORY:	This rate schedule applied	everywhere PG&E prov	ides electric :	service.	心的 植生物
RATES:	Total bundled service cha this schedule are subject i delivery portion of the bill addition, total bundled che kWh usaga.	rges are calculated using to the delivery minimum (i.e. to all rela componer rges will include applica	g the lotal rata bill ernount sh tis other than blei generation	es below. Customers on own below applied to the the generation rate). In a charges per kWh for al	
	percent of baseline at a re excess of 200 percent of J. Medical Baseline allowant customers, the Conserval total rate less the sum of: Services, Distribution, Ger Competition Transition Ch Cost Recovery Amount. C receive a 50 percent disco Direct Access (DA) and C in accordance with the part	to \$0:04000 per kWh las baseline. No portion of (ion Insertive Adjustment Transmission, Transmissio	is than the ap he rates paid he DWR Bonn is calculated ation Rate Adj Programs, N im Generation edical basetim num bill amor gation (OCA) dule litted Bill	plicable rate for usage in by customers that receiv 5 charge. For three rescluelly based on the ustments, Reilability uclear Decommissioning o Charges, and Energy a filowance shall also unt shown below. charges shall be calculat ng.	e a
		TOTAL RAT	ES.		
	Tabul Courses Datas /R and	LANDA			1
	101% - 130% of Basel 101% - 130% of Basel 131% - 200% of Basel 201% - 300% of Basel Over 300% of Baselin	ine ine ine	61, 195, 1 	\$0.18212 \$0.24090 (I) \$0.24090 (R) \$0.39999 (I) \$0.39999 (I)	
	Delivery Minimum Bill Am	n mi fR nar makar nar da	-t	ST 22854	
	California Climate Credit (payment occurring in the /	per household, per semi April and October bill cyc	-annual les)	(\$28.14)	
	The second				
	· · · · · · · · · · · · · · · · · · ·				
	and the second second second second				
	¹ Per Decision 11-12-031,	New System Generation	Charges are	effective 1/1/2012.	
					(Continued)
tvice Letter No:	4810-E-A	Issued by		Date Filed	May 31, 2016
ncision No. 28	15-07-001 and E-4782	Steven Mainight Senior Vice President Reculatory Alfairs		Effective Resolution No.	June 1, 2016

Pacifi San F U 39	ic Gas and Electric Company Francisco, California	Cancelling	Revised Revised	Cal. P.U.C. She Cal. P.U.C. She	et No. et No.	36713-0 36500-0
	ELEC Residen	TRIC SCHEDULI TIAL TIME-OF-U	E E-TOU SE SERVIC	E	Shee	t2
RATES (Cont'd.):						
		OPT		L RATES		
Total Ene	rgy Rates (\$ per kWh)	PEAK		OFF-PEAK		
Summer Total L	Jsage	\$0.40327	(1)	\$0.32769	(1)	
Baseli Usagi	ne Credit (Applied to Baseline e Only)	(\$0.11709)	(R)	(\$0.11709)	(R)	
Winter Total L	Jaace	\$0,28530	(I)	\$0.27100	(I)	
Basel	ine Credit (Applied to Baseline e Only)	(\$0.11709)	(R)	(\$0.11709)	(R)	
Delivery M per day)	Ainimum Bill Amount (\$ per me	ter \$0.32854				
California per semi- April and	Climate Credit (per household annual payment occurring in th October bill cycles)	l. le (\$28.14)				
Total bundle rates shown the sum of (' times the nu minimum bill Reliability Sc Charges, En on kWh user revenue ass	d service charges shown on c below. Where the delivery mi 1) the delivery minimum bill am mber of kWh used. For revent amount will be assigned to the anvices. Public Purpose Progra lergy Cost Recovery Amount, (ge times the corresponding unl igned to Distribution.*	ustomer's bills are o nimum bill amount iount plus (2) for bu ue accounting purp e Transmission, Tra ms, Nuclear Decor DWR Bond, and Ne bundled rate compo	unbundled ac applies, the c indled service oses, the revi ansmission R nmissioning, w System Ge anent per kW	cording to the co ustomer's bill will a, the generation enues from the d ate Adjustments, Competition Trai eneration Charge h, with any resid	mp& Ant I equal rate belivery nsition rs ¹ based ual	
¹ Per Decisik * This same customers.	on 11-12-031, New System Ge assignment of revenues apple	meration Charges a as to direct access	are effective 1 and commun	1/1/2012. ity choice aggree	ation	ntine and
dvice Letter No	a: 4810-E-A	Issued by		Data Filad	(Ca	lay 31, 201
ecizion No. C9	15-07-001 and E-4782	Steven Malnight Senior Vice Presider Regulatory Affairs	at .	Effective Resolution No.	j	une 1, 2010

								11 2
		GAS SCHEDU	RERVICE	a se		Shee	:t1	
Pplicability:	This rate achedule' appli Transmission end/or Dist matered single family pre and to separately-matere GS, or GT are not applict have an option of switchis those accounts that provi	es lo natural gas sa tíbulion Systems. T mises for residentia d common areas in able. Common area ng to a core comme da gas servica to co	rvice to Core Ex o quality, service I use, including t a multifamily cor accounts that e- rolel rate schedu mmon use area	Hise Custor e musit de la l hase in e mu nplex where i re separately le. Common s so defined i	ners on PGAI Individually- Itifamily comp Schedules Gi metered by F area account in Rule 1.	E's lex, A, G&E 1 are		
ERRITORY:	Schedule G-1 applies evi	erywhere within PGI	LE's natural gas	Service Terri	tory.			
ATES	Customers on this sched meter, as shown below. Transportation Charge, a	ule pisy a Producem The Transportation a follows:	ent Charge and i Charge will be n	a Transportal o less than th	ion Charge, p le Minimum	er	- P	8
	Minimum Transportation	Charge.48	- E	Per Day \$0.09863			e	
		<u>አ</u> መ	14,31	Per Then	m		2411	
	Propurament;	×7	\$0.20960	(R)	50.20950	(R)	· · · · ·	
	Transportation Charge:		\$0.81592		81.30547	6.042		
	Totat		\$1,02552	(R)	\$1,51507	R	199 × 1	
	Public Purpose Procram	Surcharon-		44				
	Surcharge under Schedu See Preliminary Stateme	le G-PPPS. ni. Part 8 for the De	fault Teriff Rate	Components	an ang sanah Tang sanah	. ¹⁵	- 64	
	The Procurement Charge	an this schedule is	equivalent to the	e rate shown	on informatio	nal lan		
ASELINE	The Procurement Charge Schedule G-CP—Gas Pr The desvered quantities (e on this schedule is ocurement Service I of gas shown below	equivalent to the b Core End-Use are billed at the	e rate shown Oustomers. rates for base	on informatio	nat	10-10 10-10 10-10 10-10	
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Following are the SCE electricity tariffs, both standard and time-of-use, and SoCalGas natural gas tariffs applied in this study.

(To be inserted by utility) Advice <u>3401-E</u> Declaion <u>16-03-030</u> 2011	 Narbasetra Barvica Incluida al UVIn In escena of apullad Excelha Device. The Altoinam Charge B explicatio when the Beherry Barvin Minnum, Charge Dempetition Thanallon Charge (CTC) of \$0.0 That = Tabl Devicer State are applicable to the Sameras (CAC Service) Conformation are applicable only the DWBC as previded by the Sameras the Time Constituent in the are applicable only to the Constituent on applicable only the DWBC a constraint in the are applicable only the DWBC as previded by the Sameras the Time Constituent of the Defensive Service for the Defensive Service on applicable only the DWBC a constituent of Value Resources (DWBC) Escence Service S	Peak Time Rebate - Scotn Peak Time Rebate womabling technology - Shiwh	California Climate Gredit ⁴	PATER RATER Bareny Chargo Skylin Addust Cay Barenito Stanton Watte National Stanton Watte Cours 200% of Barenito Stanton National Course - Sector Stanton Cours 200% of Barenito Stanton Watte Cours 200% of Barenito Stanton Ones 200% of Barenito Stanton Watte Course 200% of Barenito Stanton Watte Barenic Chargio - Yamity Accommodation Matternam Chargio Medicant Barenito Maternam Chargio Medicant Barenito Matternam Chargio Medicant Barenito Maternam Chargio Medicant Barenito	Southern California Edison Rosemaad, California (V 338-E)
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September, 2016

Kosemead, Cain	nia Edison Iomia (U 338-E)	Cancelling	Revised Revised	Cal. FUC Cal. FUC	C Sheet No. C Sheet No.	59059-6 58249-6
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		Taba	NIGen .	DOWNES'	10 N N	
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	Leveril I (up to 150%) of Baseline)	0.50523 (0)	0.21560 (8)	(0.00025)		
	Level II (Moto than 130% of Baselino)	0.18352 (R)	0.21550 (R)	(0.00022)		
	Gummer Season - OR-Peak	R	in the second second			
	Level 3 (up to 12275 of Baseline)	0.10523(1)	0.02311(0)	(0.00022)		
	Level II (Mote than 130%) of Baseline)	0.18352 (R)	0.03311 (0)	(0.00022)		
	Winter Gemon - On Firsh					
	Level I (up to 120% of Baseline)	0.10523 (I)	6.00600 ORA	0.0000		
	Level II (More than \$30% of Baseline)	Q. 16332 (R)	0.03000 (9)	(0.00022)		
	Winter Gezon - Off-Peak					
	Level 1 (up to 130% of Baseline) Level 8 (More Non 130% of Baseline)	0.10523 (I) 0.15352 (R)	0.04749 (I) 0.04749 (I)	(0.00022) (0.00022)		
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(To be inserted by utility).

3401-E

16-03-030

Advice

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Decision

Issued by (7 B.Q.Nichula Di Senior Vice President El

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(To be inserted by Cal. PUC) Date Filed May 2, 2016 Effective Jun 1, 2018 Resolution

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SOUTHERN CALIFORNIA GAS COMPANY Revised CAL. P.U.C. SHEET NO. 52782-G LOS ANGELES, CALIFORNIA CANCELING Revised CAL. P.U.C. SHEET NO. 52751-G

(loc)	Schedule No. GR RESIDENTIAL SERVICE	ates)	Sheet 1
2000-0	and one on y and of the	and a start of the	
APPLICABILITY	SUP		
The GR rate is applicable to natural g	as procurement service to inc	dividually meter	ed residential customers.
The GR-C, cross-over rate, is a core p transportation customers with annual	rocurement option for indivi consumption over 50,000 the	dually metered	residential core h in Special Condition 10.
The GT-R rate is applicable to Core A residential customers, as set forth in S	Aggregation Transportation (pocial Condition 11.	CAT) service to	individually metered
The California Alternate Rates for En the bill, is applicable to income-qualif as set forth in Schedule No. G-CARE.	ergy (CARE) discount of 20 fied households that meet the	%, reflected as a requirements for	a separate line item on or the CARE program
TERRITORY			
Applicable throughout the service terr	ritory.		
RATES Customer Charge, per meter per day:	<u>GR</u> 16.438¢	GR-C 16.438¢	<u>GT-R</u> 16.438¢
For "Space Heating Only" customers, Customer Charge applies during the w	a daily vinter period		
from November 1 through April 30":		33.149¢	33.149¢
Baseline Rate, per therm (baseline usa	age defined in Special Condi	tions 3 and 4):	
Procurement Charge: "		34.536¢	N/A
Transmission Charge	<u>56.280d</u>	56.280¢	55.758e
Total Baseline Charge:	90.816d	90.816¢	55.758¢
Non-Baseline Rate, per therm (usage	in excess of baseline usage):		
Procurement Charge: 2/	34.536¢	34.536¢	N/A
Transmission Charge	<u>82.280d</u>	82.280¢	81.758¢
Total Non-Baseline Charge:	116.816¢	116.816¢	81.758¢
¹⁷ For the summer period beginning 1 accumulated to at least 20 Ccf (100	May 1 through October 31, v 0 oubic feet) before billing.	with some except	tions, usage will be
(Footnotes continue next page.)			
	(Continued)		
OD BE INSERTED BY UTILITY	ISSUED BY	(70)	E INSERTED BY CAL PUC
ADVICE LETTER NO. 4989	Dan Skopec	DATE FILED	Jul 7, 2016
DECISION NO.	Vice President	EFFECTIVE	Jul 10, 2016
102	Requisiony Allers	REBOLUTIO	IN NO. G-3351

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Following are the SDG&E electricity, both standard and time-of-use, and natural gas tariffs applied in this study.

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San Diego Gas & Electric Con San Diego, California	Car	waling Ren	vised Cal F	U.C. Sheet N	la	e Gelaakte k	.26948-E	ł.
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his schedule is also appl rogram and/or Medical B nd may include Non-prol Joh facilitias qualify to re ARE and Medical Baseli rspectively.	icable to custor assiina, reakting It Group Living caive service u ine customers o	mens qualify g in single-fi Facilities a nder the ter are identifier	ing for the Cu amity account and Qualified rms and conc d in the rates	alifornia Alter nodations, se Agricultural I litions of Sof stables belo	nste Ri parstel Employ redule i w as D	ates for Energy metered b are Housing E-CARE. T IR-LI and D	argy (CARE) by the Utility, Facilities, if The rates for R-MB rates,	
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1.02943	1 0.00307 8	PERAMAA -	U.UO032	1 0.00100	1 0.00036	1 0.00013	K 0.00000 1	10.12020
102943 102943 102943	I 0.08367 R	0.01241 [0.00052	1 0.00160	1	1 0.00012	p 0.00000 1	0.12695
1.02943 1.02943 1.02943 1.02943	I 0.08367 R I 0.08367 R I 0.08367 R	0.01241 [0.00052	I 0.00160	1 0.00033	I 0.00013	R 0.00000 1	0.12535 1
	Rates	hedule is available stams. Service in domestic service in single family dw re eligible for servic inchedule may also the served by the Rates UDC Total Rates 0.12835 0.12835 0.12855 0.12855 0.12855 0.12855 0.12855 0.12855 0.12855 0.12855 0.12855 0.128555	hedule is available on a voluptame. Service is limited to homestic service for light in single family dwellings an re eligible for service on this achedule may also qualify for the service on this achedule may also qualify for the service on this achedule may also qualify for the service on this achedule may also qualify for the service on this achedule may also qualify for the service on this achedule may also qualify for the service on this achedule may also qualify for the service on the service of the service on the service on the service on the service on the service of the servi	And the service is limited to individ a domestic service for lighting, he in single family dwellings and flats. re eligible for service on this schedul achedule may also qualify for a ser	hedule is available on a voluntary basis for indi- stams. Service is limited to individually mete- h domestic service for lighting, heating, cool- in single family dwellings and flats. Qualifying re eligible for service on this schedule, as further schedule may also qualify for a semi-annual of S ^(h) . achedule may also qualify for a semi-annual of S ^(h) . achedule may also qualify for a semi-annual of S ^(h) . achedule may also qualify for a semi-annual of S ^(h) . achedule may also qualify for a semi-annual of S ^(h) . active active served by the Utility. active active served by the Utility. a.12835 I 0.00539 I 0.33023 0.12835 I 0.00639 I 0.33023 0.12835 I 0.00639 I 0.09530 0.12835 I 0.00639 I 0.09530 0.12835 I 0.00639 I 0.09530 0.00639 I 0.095159 0.12835 I 0.00639 I 0.095159 0.12835 I 0.00639 I 0.09528 0.00639 I 0.00628 0.00639 I 0.00628 0.00628 0.00639 I 0.00629 0.00639 I 0.00628 1 0.00628 0.00628 0.00639 I 0.00628 1 0.006	Interview Service is limited to individually metered residend of comestic service for lighting, heating, cooking, we in single family dwellings and flats. Qualifying California celigible for service on this schedule, as further described Interview Service is further described to individually metered resident Inchedule may also qualify for a semi-annual California Service is further described to individually metered resident Service Service on this schedule, as further described to individually metered resident Service Service on this schedule, as further described to individually metered resident Service Service on this schedule, as further described to individually metered resident Service Service on this schedule, as further described to individually metered resident Service Service on this schedule, as further described to individually metered resident Service Service on this schedule, as further described to individually metered resident Service Service Service Service Rates UDC Tetal DWR-BC Service Service Service A:1253 I 0.00539 I 0.03030 R 0.221 O:1253 I 0.00539 I 0.0519 R 0.221 O:259 I	hedule is available on a voluntary basis for individually metered residential cust in domestic service for lighting, heating, cooking, water heating in single family dwellings and flats. Qualifying California Alternative re eligible for service on this schedule, as further described under inchedule may also qualify for a semi-annual California Climate (hedule is available on a voluntary basis for individually metered residential customers with h domestic service is limited to individually metered residential customers with h domestic service on this schedule, cooking, water heating, and point is single family dwellings and flats. Qualifying California Alternative Rates for re eligible for service on this schedule, as further described under Special Con- schedule may also qualify for a semi-annual California Climate Credit \$(17. \sqrt{n}) tory served by the Utility.

SOGE			
Ban Dingo Gas & Electric Company	Neveena Cal. P.U.C. 8	AMERICIALD.	211/21-9
San Dago, Celifornia	Canceling <u>Revised</u> Cal. P.U.C. 8	iheet No.	21908-G
	SCHEDULE GR		Sheet 1
<u>ins</u>	Suden Rates for GR. GR.C. GTC/GT	CA)	
AFFLICABILITY			
The GR rate is applicable to natural	gas procurement service for individu	ally metered resident	lial customere.
The GR-C, cross-over rate, is a transportation customers with annual	a core procutement option for in: al consumption over 50,000 therms, a	lividually metered (is set forth in Special	residential core Condition 10.
The GTC/GTCA rate is applicable residential customers, as set forth in	e to intrastate gas transportation-or Special Condition 11.	lly services to indiv	idually metered
Customers taking service under the (CARE) program discount, reflected the terms and conditions of Schedul	e schedule may be eligible for a 20% I as a separate line item on the bill, if Is G-CARE.	California Alternate they qualify to receiv	Rate for Energy re service under
TERRITORY			
Within the entire territory served nat	ural gas by the utility.		
RATES		60 G	ana ana ti
Baseline, Sate, per therm (baseline a	usage defined in Special Conditions 8	<u>GR-C.</u> 3 and 4);	GIEGICA
Procurement Charge."	\$0.34561	\$0.34561 I	NA
Total Baseline Charge:	St 25369	\$1.25366 I	\$0.90805
Procurement Charge: <u>Transmission Charge</u> Total Non-Baseline Charge ⁹ The rates for core transportation-onth NGV, include any FERC Settlement ⁹ This charge is applicable to Utility Pr chown in Schedule GPC which are a	\$0.34561 <u>\$1.08354</u> \$1.42915 recently a set for the exception of custor records Memorandum Account (FSPM) ocurement Customers and Includes the C ubject to change monthly as set forth in S	\$0.34501 I <u>\$1.08354</u> \$1.42915 I ners taking service un U credit adjustments. PC and GPC-A Procu pecial Condition 7.	N/A <u>\$1.08354</u> der Schedule GT- rement Chargen
and the second	(Continued)		
103 Advice Line No. College Co.	baund by	Date Filed	A17.2016
Advide LD. No. 2459-43	Vice President	Effective	#4 10, Z018
Desision No.	Regulatory Affairs	Resolution No.	3