

# Single Family New Construction Cost-Effectiveness Study

Building Energy Efficiency Standards: January 1, 2023

 [Complete Report](#)



## Introduction

This new Cost-Effectiveness Study on Single Family New Construction documents cost-effectiveness analysis results for traditional new detached single family and detached accessory dwelling unit (ADUs) building types. This report presents measures or measure packages that local jurisdictions may consider adopting to achieve energy savings and emissions reductions beyond what will be accomplished by enforcing minimum state requirements, i.e., the 2022 Building Energy Efficiency Standards (Title 24, Part 6), effective January 1, 2023.

It evaluates mixed fuel and all-electric package options in all sixteen California climate zones (CZs). Packages include combinations of efficiency measures, on-site renewable energy, and battery energy storage. The report calculates utility costs by applying tariffs from each investor-owned utility (IOU) and two publicly owned utilities (POU) based on the climate zones served by the respective utility.

The report also includes definitions of metrics, such as On-Bill, TDV (Time-Dependent Valuation), EDR (Energy Design Rating), and the new carbon-based source energy metric for code compliance, as well as detailed information about calculation methodology and assumptions.

### Prototypes:

For this analysis, two single-family prototypes and one ADU prototype were used. The single-family structures were a 3-bedroom, 2,100 ft<sup>2</sup> 1-story home and a 4-bedroom, 2,700 ft<sup>2</sup> 2-story home. The ADU prototype is a detached, 1-bedroom 625 ft<sup>2</sup> structure.

**Climate Zones:** All 16

## Packages

### All-Electric Code Minimum (Code Min):

This package meets all the prescriptive requirements of the 2022 Title 24 Code. In some instances, the prescriptive minimum package did not comply with code, so efficiency measures were added to meet minimum compliance requirements.

### Efficiency + PV (EE+PV):

Using the Efficiency Only Package as a starting point, PV capacity was added to offset the total estimated annual electricity use.

### Efficiency Only (EE):

This package uses only efficiency measures (including envelope and water heating or duct distribution efficiency measures) that don't trigger federal preemption issues.

### Efficiency + PV + Battery (EE+PV/B):

Using the Efficiency & PV package as a starting point, a battery system was added. For mixed-fuel homes the package of efficiency measures differed from the Efficiency Package in some climate zones to arrive at a cost-effective solution.

### Efficiency + NEEA Heat Pump Water Heater (Preempted):

This package was evaluated for the all-electric homes only and shows an alternative design that applies water heating equipment that is more efficient than federal standards meeting the NEEA Tier 3 rating. The Reach Codes Team considers this more reflective of how builders meet above code requirements in practice.

## Study Results

The following summarizes key results from the study:

- All-electric packages have lower GHG emissions than mixed-fuel packages in all cases, due to the clean power sources currently available from California's power providers.
- The Reach Codes Team found all-electric new construction to be feasible and cost effective based on TDV in all cases. In many cases all-electric code minimum construction results in an increase in utility costs and is not cost-effective On-Bill. Some exceptions include the SMUD (Sacramento Municipal Utility District) and CPAU (City of Palo Alto Utilities) territories where lower electricity rates relative to natural gas rates result in lower overall utility bills.
- The 2022 Title 24 Code's new source energy metric combined with the heat pump baseline encourage all-electric construction, providing an incentive that allows for some amount of prescriptively required building efficiency to be traded off. This compliance benefit for all-electric homes highlights a unique opportunity for jurisdictions to incorporate efficiency into all-electric reach codes. Efficiency and electrification have symbiotic benefits and are both critical for decarbonization of buildings. As demand on the electric grid is increased through electrification, efficiency can reduce the negative impacts of additional electricity demand on the grid, reducing

the need for increased generation and storage capacity, as well as the need to upgrade upstream transmission and distribution equipment. The Reach Codes Team recommends that jurisdictions adopting an all-electric reach code for single family buildings also include an efficiency requirement with above code EDR2 margins consistent with the All-Electric Code Minimum package.

- The code compliance margins for the ADU All-Electric Code Minimum package are lower than for the single-family prototype, and code compliance can be more challenging for smaller dwelling units. As a result, the Reach Codes Team does not recommend an additional efficiency requirement for all-electric ADU ordinances.
- Electrification combined with increased PV capacity results in utility cost savings and was found to be On-Bill cost effective in all cases. These results were based on net energy metering rules current at the date of this publication and do not account for future changes to utility agreements, which are expected to decrease the value of PV to the consumer.
- For jurisdictions interested in a reach code that allows for mixed fuel buildings, the mixed fuel efficiency, PV, and battery package was found to be cost effective based on TDV in all cases. Cost effectiveness was marginal because of the high cost of the battery system. EDR2eff margins ranged from 7 to 30 for the cost-effective packages. (For more information on EDR2-eff, EDR2-Total, and TDV, please review the [2022 CALGreen and Single Family Fact Sheet](#).)
- Applying the IOUs' California Alternate Rates for Energy (CARE) Program rates has the overall impact to increase utility cost savings for an all-electric building compared to a code compliant mixed fuel building, improving On-Bill cost-effectiveness.

The following tables summarize the results of the analysis results and present the Efficiency EDR2 above-code margins for the evaluated packages.

Cells highlighted in **green** indicate a positive compliance margin and cost-effective results using both On-Bill and TDV approaches. Cells highlighted in **yellow** depict a positive compliance and cost-effective results using either the On-Bill or TDV approach. Cells **not highlighted** depict a package that was not cost effective using either the On-Bill or TDV approach.

Table 1. Summary of All-Electric Efficiency EDR2 Margins and Cost-Effectiveness

Climate Zone	Electric /Gas Utility	Single Family				ADU			
		Code Min	EE	EE+PV	EE+PV/B	Code Min	EE	EE+PV	EE+PV/B
CZ01	PGE	8.3	18.8	18.8	29.6	0.0	15.1	15.1	24.6
CZ02	PGE	5.7	13.5	13.5	19.1	0.4	9.5	9.5	14.6
CZ03	PGE	4.7	10.5	10.5	15.8	0.0	5.7	5.7	10.5
CZ04	PGE	3.7	8.6	8.6	13.5	0.2	6.3	6.3	10.8
CZ04	CPAU	3.7	8.6	8.6	13.5	0.2	6.3	6.3	10.8
CZ05	PGE	1.1	6.1	6.1	14.3	0.4	2.4	2.4	7.9
CZ05	PGE/SCG	1.1	6.1	6.1	14.3	0.4	2.4	2.4	7.9
CZ06	SCE/SCG	2.5	7.8	7.8	11.6	0.2	6.2	6.2	9.8
CZ07	SDGE	2.3	7.0	7.0	9.9	0.4	6.3	6.3	9.1
CZ08	SCE/SCG	0.6	4.0	4.0	10.4	0.6	3.6	3.6	10.0
CZ09	SCE	1.2	4.6	4.6	9.9	0.6	3.7	3.7	8.8
CZ10	SCE/SCG	1.1	4.6	4.6	10.1	0.4	3.8	3.8	9.1
CZ10	SDGE	1.1	4.6	4.6	10.1	0.4	3.8	3.8	9.1
CZ11	PGE	3.5	8.4	8.4	14.1	0.2	7.7	7.7	13.2
CZ12	PGE	4.0	8.5	8.5	14.7	0.3	6.8	6.8	12.6
CZ12	SMUD/PGE	4.0	8.5	8.5	14.7	0.3	6.8	6.8	12.6
CZ13	PGE	2.1	6.8	6.8	12.0	0.1	6.8	6.8	11.9
CZ14	SCE/SCG	1.6	7.9	7.9	13.2	0.4	7.3	7.3	12.4
CZ14	SDGE	1.6	7.9	7.9	13.2	0.4	7.3	7.3	12.4
CZ15	SCE/SCG	1.6	4.2	4.2	8.6	1.3	6.5	6.5	11.1
CZ16	PG&E	6.0	9.7	9.7	18.1	0.1	8.8	8.8	16.4

Table 2. Summary of Mixed Fuel Efficiency EDR2 Margins and Cost-Effectiveness

Climate Zone	Electric /Gas Utility	Single Family			ADU		
		EE	EE+PV	EE+PV/B	EE	EE+PV	EE+PV/B
CZ01	PGE	12.0	12.0	30.0	14.9	14.9	24.3
CZ02	PGE	8.8	8.8	13.5	9.4	9.4	14.5
CZ03	PGE	5.7	5.7	11.2	6.3	6.3	12.1
CZ04	PGE	4.8	4.8	8.4	6.7	6.7	12.2
CZ04	CPAU	4.8	4.8	8.4	6.7	6.7	12.2
CZ05	PGE	4.8	4.8	16.8	2.3	2.3	7.8
CZ05	PGE/SCG	4.8	4.8	16.8	2.3	2.3	7.8
CZ06	SCE/SCG	6.1	6.1	9.2	6.1	6.1	9.8
CZ07	SDGE	5.5	5.5	8.3	6.3	6.3	9.1
CZ08	SCE/SCG	3.5	3.5	9.5	3.6	3.6	10.1
CZ09	SCE	3.6	3.6	8.6	3.7	3.7	8.9
CZ10	SCE/SCG	3.7	3.7	8.3	3.8	3.8	9.0
CZ10	SDGE	3.7	3.7	8.3	3.8	3.8	9.0
CZ11	PGE	5.7	5.7	11.0	7.5	7.5	13.1
CZ12	PGE	5.3	5.3	11.0	6.8	6.8	12.6
CZ12	SMUD/PGE	5.3	5.3	11.0	6.8	6.8	12.6
CZ13	PGE	4.7	4.7	9.6	7.2	7.2	12.8
CZ14	SCE/SCG	6.2	6.2	11.2	8.5	8.5	14.2
CZ14	SDGE	6.2	6.2	11.2	8.5	8.5	14.2
CZ15	SCE/SCG	4.3	4.3	8.5	6.6	6.6	11.2
CZ16	PG&E	14.9	14.9	22.6	8.7	8.7	16.2

Local jurisdictions may also adopt ordinances that amend different Parts of the California Building Standards Code or may elect to amend other state or municipal codes. The decision regarding which code to amend will determine the specific requirements that must be followed for an ordinance to be legally enforceable. Reach codes that amend Part 6 of the CA Building Code and require energy performance beyond state code minimums must demonstrate the proposed changes are cost-effective and obtain approval from the CEC. Although a cost-effectiveness study is only required to amend Part 6 of the CA Building Standards Code, this study provides valuable context for jurisdictions pursuing other ordinance paths, such as a health and safety approach, to understand the economic impacts of any policy decision. This study documents the estimated costs, benefits, energy impacts and greenhouse gas emission reductions that may result from implementing an ordinance based on the results, helping residents, local leadership, and other stakeholders make informed policy decisions.

Model ordinance language and other resources are posted on the C&S Reach Codes Program website at [LocalEnergyCodes.com](http://LocalEnergyCodes.com). Local jurisdictions that are considering adopting an ordinance may contact the program for further technical support at [info@localenergycodes.com](mailto:info@localenergycodes.com).

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