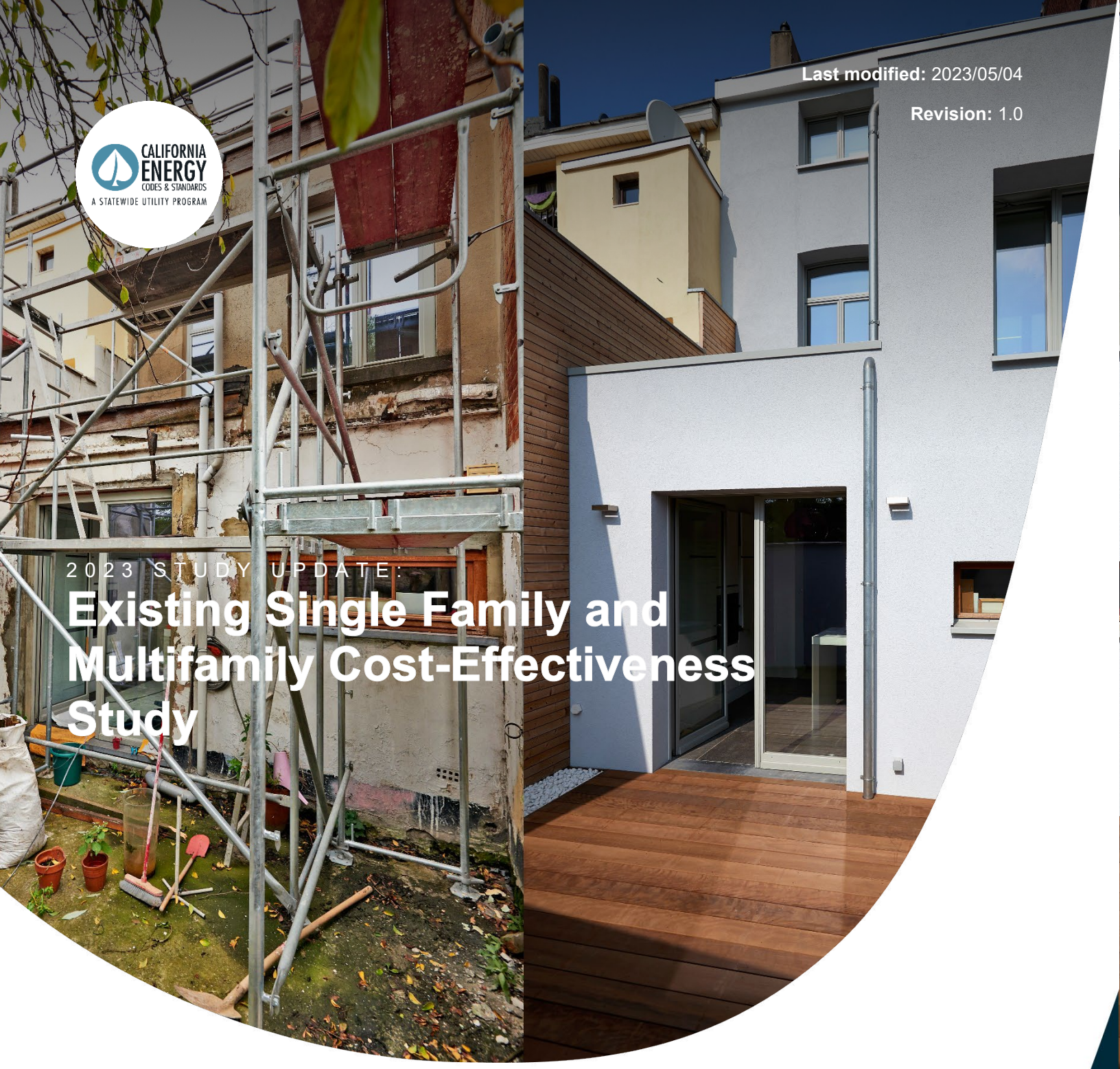

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

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2023 STUDY UPDATE:

Existing Single Family and Multifamily Cost-Effectiveness Study

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Pacific Gas and Electric Company

Southern California Edison — Energy for What's Ahead

SDGE

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Acronym List

B/C – Benefit-to-Cost Ratio

CBECC - California Building Energy Code Compliance

CBSC - California Building Standards Commission

CEC - California Energy Commission

CZ – Climate Zone

GHG - Greenhouse Gas

IOU – Investor-Owned Utility

POU – Publicly Owned Utility

PG&E – Pacific Gas & Electric (utility)

SCE – Southern California Edison (utility)

SCG – Southern California Gas (utility)

SDG&E – San Diego Gas & Electric (utility)

CPAU – City of Palo Alto Utilities

SMUD – Sacramento Municipal Utility District

LADWP – Los Angeles Department of Water and Power

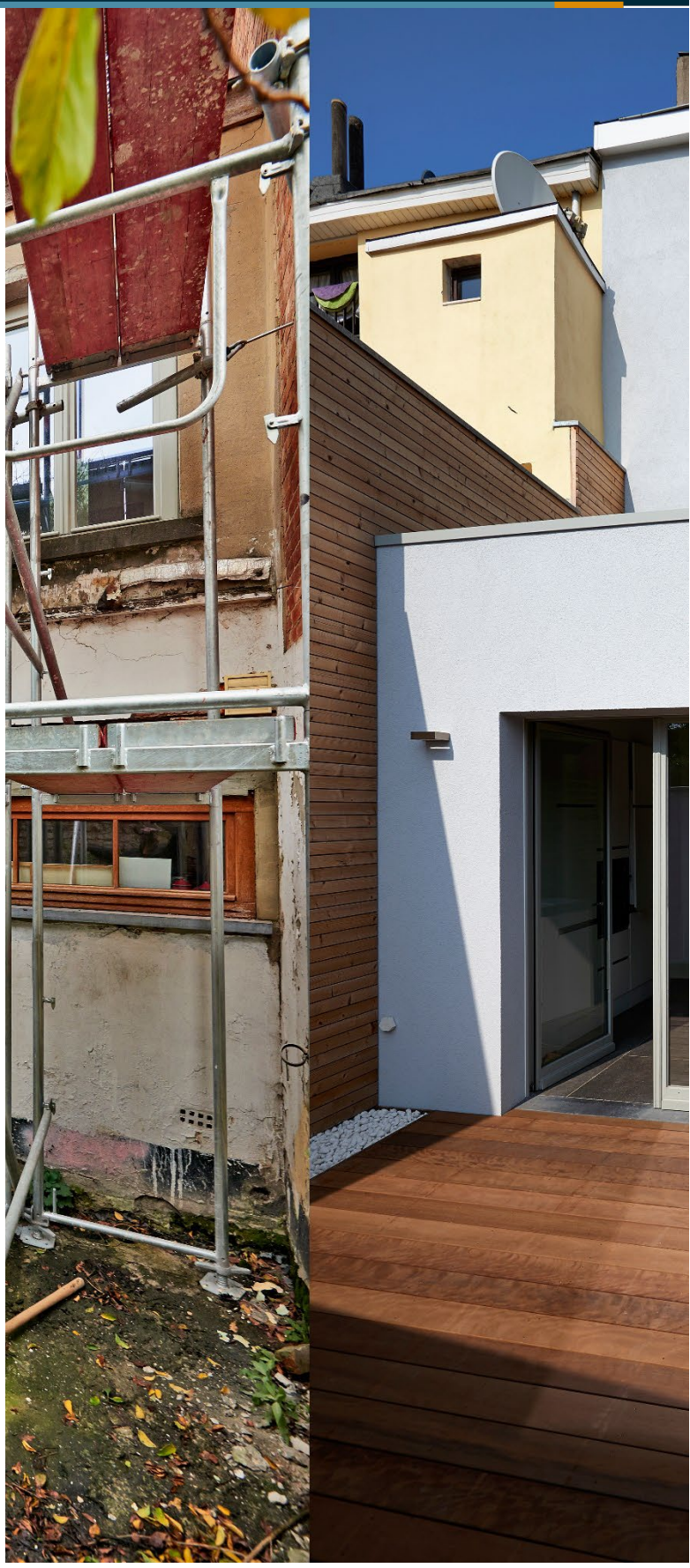
kWh – Kilowatt Hour

NPV – Net Present Value

PV - Solar Photovoltaic

TDV - Time Dependent Valuation

Title 24 – California Code of Regulations Title 24, Part 6



1 Introduction & Background

The California Codes and Standards (C&S) Reach Codes program provides technical support to local governments considering adopting a local ordinance (reach code) intended to support meeting local and/or statewide energy efficiency and greenhouse gas reduction goals. The program facilitates adoption and implementation of the code when requested by local jurisdictions by providing resources such as cost-effectiveness studies, model language, sample findings, and other supporting documentation.

In August 2021 the Statewide Reach Codes Team published the 2019 Cost-Effectiveness Study: Existing Single Family Residential Building Upgrades (Statewide Reach Codes Team, 2021). In March of 2022 the Statewide Reach Codes Team published the 2019 Cost-Effectiveness Study: Existing Multifamily Residential Building Upgrades (Statewide Reach Codes Team, 2022). These two studies focused on existing low-rise residential buildings identifying cost-effective measures and measure package upgrades in all 16 California climate zones. The studies document the estimated costs, benefits, energy impacts and greenhouse gas emission reductions that may result from implementing an ordinance to help residents, local leadership, and other stakeholders make informed policy decisions. The studies were conducted for the 2019 Building Energy Efficiency Standards (Title 24, Part 6), effective January 1, 2020, but also considered metrics used in the upcoming 2022 Title 24, Part 6, effective January 1, 2023.

The Statewide Reach Codes Team is initiating an update to these retrofit studies to address changes in market factors since the publication of the prior studies and respond to more recent requests from jurisdictions. The updated studies will follow a similar structure to the prior ones and evaluate various upgrade options including fuel substitution, efficiency, onsite generation, and load shifting measures. It will consider cost-effectiveness based on utility rates and the California Energy Commission's Time Dependent Valuation (TDV)[1] metrics for both the 2022 and 2025 Title 24, Part 6 code.

[1] TDV is the Energy Commission's lifecycle cost methodology. While the methodology remains the same, the metrics have been updated and the name has been changed to Long-term System Cost (LSC) for the 2025 Title 24, Part 6 code.

2 Single Family Update

The Statewide Reach Codes Team will first complete a study update for single family buildings. The proposed single family prototype is a 1,665 square foot building as described in Table 1. Three building vintages will be evaluated to determine the sensitivity of existing building performance on cost effectiveness of upgrades. The building characteristics for each vintage were determined based on either prescriptive requirements from Title 24, Part 6 that were in effect or standard construction practice during each time period. Appliances were assumed to be replaced over time based on average useful lifetime of the appliances. Table 3 in Appendix A summarizes the building characteristics for each of the three vintages. This approach is the same as was applied in the prior single family study.

Table 1: Single Family Prototype Characteristics

	Single Family Prototype
Existing Conditioned Floor Area	1,665 ft^2
Number of Stories	1
Number of Bedrooms	3
Window-to-Floor Area Ratio	13%
Attached Garage	2-car garage

Below is a description of the cost-related updates that the Statewide Reach Codes Team proposes for this updated analysis.

- Calculate utility costs based on the most recent utility tariffs.
    - Include analysis using any new electrification tariffs.
    - Include the impacts of the new Net Billing tariff (NBT) (also referred to as NEM 3.0).
    - Update the methodology for calculating monthly gas rates to align with the most recent new construction studies (Statewide Reach Codes Team, 2023).
- Update utility escalation rates.
    - The most recent reach code studies have applied escalation rates based on data from the California Public Utilities Commission's (CPUC's) 2021 En Banc hearings (California Public Utilities Commission, 2021a) combined with escalation assumptions from the 2022 TDV metric. The Statewide Reach Codes team will use these values unless more recent and reliable data becomes available.
- Update incremental cost estimates. This study will conduct cost research on all evaluated measures, with a focus on fuel substitution measures, using various sources including contractor/distributor interviews, other recent reports, and online research.
- Evaluate the sensitivity of the cost-effectiveness results based on the availability of incentives. Incentives will consider the Investment Tax Credit for PV, battery storage systems, heat pumps, and efficiency measures. Local or state incentives that directly offset first costs are highly variable; the study will not attempt to quantify these but rather will evaluate the impact of one or two average levels of incentives on cost-effectiveness.

Below is a description of the measure-related updates that the Statewide Reach Codes Team proposes for this updated analysis.

- For space conditioning system replacements evaluate the following scenarios. All scenarios will be analyzed at replace on burnout.

Existing Gas Equipment	Electric Upgrade
Ducted furnace and air conditioner	Ducted heat pump, standard & mini-split. Dual fuel heat pump.
Ducted furnace, no cooling (select climate zones)	Ducted heat pump, standard & mini-split
Ductless heating (wall or floor furnace), no cooling & room AC	Ductless mini-split heat pump

- For water heater replacements evaluate the impact on cost-effectiveness for the following:
    - Water heaters located in the garage and in conditioned space.
    - 120V and 240V heat pump water heater (HPWH) products.
    - Existing gas and electric resistance water heaters.
    - Minimum efficiency and NEEA rated HPWHs.
    - HPWHs with load shifting capabilities.
- Evaluate an all-electric case where gas water heating, space heating, cooking, and clothes drying are converted to electric appliances.
- Evaluate the impacts of existing electrical panel capacity. Consider both the costs of panel upgrades as well as alternatives. Recommend solutions for homes with 100/150A panels without requiring an upgrade. This analysis will leverage the recent work by NV5 in the Service Upgrades for Electrification Retrofits Study (NV5, Inc, 2022).

The following describes additional items that the Statewide Reach Codes Team will consider as part of this work.

- Specific to replace-on-burnout ordinances, the Statewide Reach Codes Team will evaluate both electric and mixed fuel paths. The intent will be to identify approaches that result in equivalent energy savings that don't preempt federal appliance regulations.
- As previously discussed, different building vintages will be evaluated to determine how the performance of the existing building impacts cost effectiveness of upgrades. This is important because the benefits of measures can be highly driven by the building loads. Adding attic insulation may be cost-effective in older homes with little insulation but may not be in newer or improved homes. However, quantifying the cost-effectiveness of measures based on building vintage is challenging for jurisdictions to implement. While the Statewide Reach Codes Team identified certain solutions in the prior studies, as part of the updated studies the Team will evaluate improved methods to differentiate between measure or package cost-effectiveness other than building vintage.
- Jurisdictions have indicated that a tool where the user can vary a selection of inputs to evaluate the sensitivity of the cost-effectiveness results would be very useful. The Statewide Reach Codes Team will investigate the feasible options and work with jurisdictions to identify and prioritize the desirable inputs. Inputs may include utility rate variables, utility escalation rates, and incentives. The Statewide Reach Codes Team will consider the best paths for implementation including integration with the Cost Effectiveness Explorer. Development on any tool would occur after development of the updated studies.

3 Multifamily Update

The Statewide Reach Codes Team will also complete a study update for multifamily buildings after completion of the single family study. This work will initially evaluate the low-rise garden style prototype described in Table 2. Depending on the needs of jurisdictions the Statewide Reach Codes Team will also consider evaluating the mid-rise mixed use prototype, also described in Table 2. Three building vintages will be evaluated similar to the single family approach. Details of the multifamily scope will be further determined as the single family work progresses.

Table 2: Multifamily Prototype Characteristics

	Low-Rise Garden Style Prototype	Mid-Rise Mixed Use Prototype
Existing Conditioned Floor Area	7,320 ft^2 residential	113,100 ft2 total: 33,660 ft2 nonresidential 79,440 ft2 residential
Number of Stories	2	6 stories total: 1 story parking garage (below grade) 1 story of nonresidential space 4 stories of residential space
Number of Units	(4) 1-bed (4) 2-bed	(8) studios (40) 1-bed units (32) 2-bed units (8) 3-bed units
Window-to-Floor Area Ratio	15%	25%

4 References

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5 Appendix A

Table 3 summarizes the existing building efficiency characteristics for the three vintages for the single family analysis.

Table 3: Efficiency Characteristics for Three Vintage Cases

Building Component Efficiency Feature	Vintage Case		
	Pre-1978	1978-1991	1992-2010
Envelope			
Exterior Walls	2x4, 16 inch on center wood frame, R-0[a]	2x4 16 inch on center wood frame, R-11	2x4 16 inch on center wood frame, R-13
Foundation Type & Insulation	Uninsulated slab (CZ 2-15) Raised floor, R-0 (CZ 1 & 16)	Uninsulated slab (CZ 2-15) Raised floor, R-0 (CZ 1 & 16)	Uninsulated slab (CZ 2-15) Raised floor, R-19 (CZ 1 & 16)
Ceiling Insulation & Attic Type	Vented attic, R-11 @ ceiling level Vented attic, R-5 @ ceiling level (CZ 6 & 7)	Vented attic, R-19 @ ceiling level	Vented attic, R-30 @ ceiling level
Roofing Material & Color	Asphalt shingles, dark (0.10 reflectance, 0.85 emittance)	Asphalt shingles, dark (0.10 reflectance, 0.85 emittance)	Asphalt shingles, dark (0.10 reflectance, 0.85 emittance)
Radiant Barrier	No	No	No
Window Type: U-Factor/SHGC[b]	Metal, single pane: 1.16/0.76	Metal, dual pane: 0.79/0.70	Vinyl, dual pane Low-E: 0.55/0.40
House Infiltration	15 ACH50	10 ACH50	7 ACH50
HVAC Equipment (for existing ducted furnace / air conditioner systems)			
Heating Efficiency	78 AFUE (assumes 2 replacements)	78 AFUE (assumes 1 replacement)	78 AFUE
Cooling Efficiency	10 SEER (assumes 2 replacements)	10 SEER (assumes 1 replacement)	13 SEER, 11 EER
Duct Location & Details	Attic, R-2.1, 30% leakage	Attic, R-2.1, 25% leakage	Attic, R-4.2, 15% leakage
Whole Building Mechanical Ventilation	None	None	None
Water Heating Equipment (for existing gas storage water heaters)			
Water Heater Efficiency	0.575 Energy Factor (assumes 2 replacements)	0.575 Energy Factor (assumes 1 replacement)	0.575 Energy Factor
Water Heater Tank	40-gallon uninsulated tank, located in exterior closet	40-gallon uninsulated tank, located in exterior closet	40-gallon uninsulated tank, located in exterior closet
Pipe Insulation	None	None	None
Hot Water Fixtures	Standard, non-low flow	Standard, non-low flow	Standard, non-low flow
Other			
Appliances	Gas cooktop, oven, and clothes dryer	Gas cooktop, oven, and clothes dryer	Gas cooktop, oven, and clothes dryer

[a] Pre-1978 wall modeled with R-5 cavity insulation to better simulate uninsulated wall performance with field data and not overestimate energy use.

[b] Window type selections were made based on conversations with window industry expert, Ken Nittler of Enercomp, Inc. If a technology was entering the market during the time period (e.g., Low-E during 1992-2010 or dual pane during 1978-1991) that technology was included in the analysis. This provides a conservative assumption for overall building performance.

Get In Touch

The adoption of reach codes can differentiate jurisdictions as efficiency leaders and help accelerate the adoption of new equipment, technologies, code compliance, and energy savings strategies.

As part of the Statewide Codes & Standards Program, the Reach Codes Subprogram is a resource available to any local jurisdiction located throughout the state of California.

Our experts develop robust toolkits as well as provide specific technical assistance to local jurisdictions (cities and counties) considering adopting energy reach codes. These include cost-effectiveness research and analysis, model ordinance language and other code development and implementation tools, and specific technical assistance throughout the code adoption process.

If you are interested in finding out more about local energy reach codes, the Reach Codes Team stands ready to assist jurisdictions at any stage of a reach code project.

Visit LocalEnergyCodes.com to access our resources and sign up for newsletters

Contact info@localenergycodes.com for no-charge assistance from expert Reach Code advisors

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Statewide Codes and Standards

Informing Updates to the Residential Retrofit Cost-effectiveness Analyses

4/27/2023



Pacific Gas and Electric Company
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Analysis and Ordinance Evolution

February 2020: Initial single family 2019 report released.

- Efficiency measures and packages.
- On-bill results only.

2021 Updates

- Efficiency measures and packages
- PV and battery storage systems
- Fuel substitution and demand flexibility measures
- New 2022 weather files
- On-bill, 2019 and 2022 TDV results

2022 Updates: Lowrise multifamily report released

Cost-Related Updates Identified

- Most recent utility tariffs
  - New electrification tariffs (E-ELEC)
  - NEM 3.0
  - Updated gas rate methodology
- Updated energy escalation rates
  - 2021 CPUC En Banc unless better data is available
- Measure incremental costs
- Investment tax credit
  - PV, storage, HPs, efficiency

Measure-Related Updates Identified

- Expanded space conditioned scenarios

Existing Gas Equipment	Electric Upgrade
Ducted furnace and air conditioner	Ducted heat pump, standard & mini-split
Ducted furnace, no cooling (select climate zones)	Ducted heat pump, standard & mini-split
Ductless heating (wall or floor furnace), no cooling	Ductless mini-split heat pump

- Expanded water heating scenarios
  - Water heaters in the garage and conditioned space
  - 120V and 240V HPWH products
  - Existing gas and electric resistance water heaters
  - Minimum efficiency and NEEA rated HPWHs
  - HPWHs with load shifting capabilities
- All-electric homes
- Panel upgrade alternatives

Additional Items to be Considered

- Mixed fuel paths alongside all-electric paths for replace-on-burnout
- Evaluate improved methods to differentiate measure cost-effectiveness other than building vintage
- Evaluate feasibility for future development on an expanded tool for jurisdictions

Thank You!

We appreciate your time!

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