California Public Utilities Commission

Energy Efficiency Natural Gas Incentive Phase-Out Staff Proposal (DRAFT)

CPUC ENERGY DIVISION STAFF

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Contents

Glossary of Key Terms and Acronyms

Avoided Cost Calculator (ACC)	The Avoided Cost Calculator is a tool established in 2004 and updated biennially to model the avoided costs of electricity based on generation energy, generation capacity, ancillary services, transmission and distribution capacity and decarbonization policy compliance.
Building Initiative for Low-Emissions Development (BUILD)	Residential building decarbonization program that provides incentives and technical assistance to support the adoption of advanced building design and all-electric technologies in new, low-income all-electric homes and multifamily buildings.
California Technical Forum (CalTF)	A collaborative of experts who use independent professional judgment and a transparent, technically robust process to review and issue technical information related to California's integrated demand side management portfolio. The California Technical Forum was created in 2014 by a broad group of stakeholders and is funded by participating program administrators.
California Air Resources Board (CARB)	The Air Resources Board is the state agency responsible for actions to protect public health from the harmful effects of air pollution.
California Energy Commission (CEC)	The state's energy policy and planning agency. The CEC is responsible for creating and updating energy efficiency (EE) building standards (known as Energy Codes) for newly constructed buildings and alterations to existing buildings.
California Energy Data and Reporting System (CEDARS)	The database that securely manages California Energy Efficiency Program data reported to the California Public Utilities Commission (CPUC) by Investor-Owned Utilities (IOUs), Regional Energy Networks (RENs), and certain Community Choice Aggregators.
Codes and Standards (C&S)	Codes and Standards refer to the set minimum efficiency levels that new buildings and appliances must meet or exceed. For this proposal, Codes and Standards refers to the California building energy code, updated triennially by the CEC (Title 24, Part 6 of California Code of Regulations).
Cost Effectiveness Tests	Cost-effectiveness tests are used to determine if an energy efficiency program or measure is cost-effective, where the value of benefits is greater than the value of costs. The CPUC identifies the Total Resource Cost Test (TRC) as the primary indicator of energy efficiency cost-effectiveness, but other tests may be considered while evaluating a program, such as the Program Administrator Cost Test (PAC) and Participant Cost Test (PCT). Formulas for calculating cost effectiveness under various tests can be found in the California Standard Practice

	Manual: Economic Analysis of Demand-Side Programs and Projects (2001).
Custom Projects	Site-specific energy efficiency projects that require unique calculations rather than DEER or measure package values. For custom projects, EE savings estimated values may be reviewed through the Custom Project Review (CPR) process prior to installation.
Database of Energy Efficiency Resources (DEER)	Provides estimates of the energy-savings potential for energy efficiency measures in residential and non-residential applications. DEER is used by California energy efficiency Program Administrators (PAs), private sector implementers, and the EE industry across the country to develop and design energy efficiency programs.
Deemed Measure	A prescriptive energy efficiency measure that uses predefined/CPUC-approved savings calculation, cost, eligibility, and other measure attributes, such as climate zone and building type. A deemed measure uses either values from DEER or an approved measure package of assumptions that are applied consistently to the same measure (see Energy Efficiency Measure).
Energy Division (ED)	The Energy Division of the California Public Utilities Commission (CPUC) is responsible for regulating and overseeing the state's energy utilities and policies. It ensures that California's investor-owned utilities (IOUs) provide safe, reliable, and affordable electric and gas services while advancing the state's climate and clean energy goals.
Energy Efficiency Measure	An energy-using appliance, equipment, control system, whose installation results in reduced energy use while maintaining a comparable or higher level of energy service as perceived by the customer. It also includes an installation or implementation practice that results in reduced energy use. In all cases, energy efficiency measures decrease the amount of energy used to provide a specific service or to accomplish a specific amount of work.
Effective Useful Life (EUL)	An estimate of the median number of years that an energy efficiency measure installed under an EE program will remain in place and operable.
Electrification	Switching an appliance from gas to electricity.
Electronic Technical Reference Manual (eTRM)	An online statewide repository of California's deemed measures, with predefined values and supporting documentation. The eTRM is maintained by the California Technical Forum (Cal TF).
Equity Programs	Programs with a primary purpose of providing energy efficiency to hard-to-reach or underserved customers and disadvantaged communities.

	Improving access to energy efficiency for ESJ communities, is in advancement of the CPUC's Environmental and Social Justice (ESJ) Action Plan and may provide corollary benefits to these customers such as increased comfort and safety, improved indoor air quality, and more affordable utility bills.
Fuel Substitution	Energy efficiency projects where all or a portion of the measures involve converting an existing energy use from one regulated fuel to another (e.g., natural gas to electricity).
Market Support	Programs with a primary objective of supporting the long-term success of the energy efficiency market by educating customers, training contractors, building partnerships, or moving beneficial technologies towards greater cost-effectiveness.
Measure	A specific customer action that reduces or otherwise modifies energy end-use patterns; a product whose installation and operation at a customer's premises reduces the customer's on-site energy use.
Measure Package	Documentation that is needed to make a deemed energy efficiency claim for a measure. This includes but is not limited to a narrative describing the baseline and energy efficient case features of the energy saving technology and methodologies to estimate energy impacts and incremental measure costs, unit savings calculations and values for all combinations of the technology specific parameters, and citations and links to references and other supporting documentation.
New Construction Measures	Equipment installed in either a new building or an area of an existing building that based on the relative square footage of the renovation would be considered new construction.
Program Administrator (PA)	An entity tasked with the functions of portfolio management of energy efficiency programs and program choice (e.g., Marin Clean Energy (MCE), Pacific Gas & Electric (PG&E), Southern California Edison (SCE), Southern California Gas (SCG), San Diego Gas & Electric (SDG&E)).
Permutations	A combination of values in the eTRM used to determine a measure's energy efficiency claims. For example, installing a measure in one building type and one climate zone will produce one permutation of energy efficiency values for the measure.
Resource Acquisition	Programs with a primary purpose of, and a short-term ability to, deliver cost-effective avoided cost benefits to the electricity and natural gas systems. Short-term is defined as during the approved budget period for the portfolio. This segment should make up the bulk of savings to achieve TSB goals.
Retrofit Measure	Equipment installed in an existing building, as opposed to new construction.

Program Administrator Cost Test (PAC)	Measures the net costs of a demand-side management program as a resource option based on the costs incurred by the program administrator (including incentive costs) and excluding any net costs incurred by the participant. For fuel substitution programs, benefits include the avoided supply costs for the energy-using equipment not chosen by the program participant only in the case of a combination utility where the utility provides both fuels.
Participant Cost Test (PCT)	measures the quantifiable benefits and costs to the customer due to participation in a program. For fuel substitution programs, the Participant Test can be used to determine whether program participation (i.e. choosing one fuel over another) will be in the long-run best interest of the customer.
Self-Generation Incentive Program (SGIP)	Provides incentives to support existing, new, and emerging distributed energy resources. SGIP provides incentives for qualifying distributed energy systems installed on the customer's side of the utility meter. Qualifying technologies include wind turbines, waste heat to power technologies, pressure reduction turbines, internal combustion engines, microturbines, gas turbines, fuel cells, linear generators, advanced energy storage systems, and combined solar and energy storage systems
Technology and Equipment for Clean Heating (TECH)	A statewide initiative to accelerate the adoption of clean space and water heating technology across California homes in order to help California meet its goal of being carbon-neutral by 2045 and install 6 million heat pumps by 2030. TECH offers incentives, pilot activities, technical assistance, and training to address barriers associated with clean space and water heating technologies across California homes
Total Resource Cost Test (TRC)	Measures the net costs of a demand-side management program as a resource option based on the total costs of the program, including both the participants' and the utility's costs. TRC test results for fuel substitution programs should be viewed as a measure of the economic efficiency implications of the total energy supply system.
Total System Benefit (TSB)	An expression, in dollars, of the lifecycle energy, ancillary services, generation capacity, transmission and distribution capacity, and greenhouse gas (GHG) benefits of energy efficiency activities, on an annual basis. TSB was adopted as the primary goal for energy efficiency portfolios.

Tables, Figures, & Equations

1 Executive Summary

This staff proposal makes recommendations for phasing out ratepayer-funded energy efficiency (EE) incentives for most natural gas measures over the next 10 years. Commission Decision (D.) 23-04-035 ordered the phase-out of EE ratepayer-funded incentives for new construction gas appliance measures in the residential and commercial sectors[1] that are not cost-effective, within the market support[2] and resource acquisition[3] segments of the EE portfolio beginning January 1, 2024. In short, the policy ended incentives for non-exempt, non-cost-effective EE gas measures installed in residential and commercial new construction with no existing gas line, or with an existing gas line if gas usage would materially increase. D. 23-04-035 identified "Exempt measures," defined as those that "result in gas savings but do not burn gas; and ... include building insulation, sealing, smart thermostats, faucet aerators and building envelope measures such as windows and doors", can continue to receive ratepayer-funded EE incentives.[4]

This staff proposal outlines Phase 2 of the expansion to phase-out ratepayer-funded EE incentives for non-cost-effective gas measures that are determined to have a Viable Electric Alternative (VEA) within retrofit projects and for cost-effective gas measures with a VEA installed in new construction projects. The applicable sectors, segments, projects, and exemptions, etc. are as in D.23-04-035, except this proposal includes the retrofit and equity segment of the EE portfolio. A gas measure has a VEA when an electric appliance measure provides the same functionality as a natural gas or mixed fuel baseline measure and is cost-effective to the customer. In the absence of a VEA, staff believes a wider elimination of EE gas measure incentives would lead to stranded assets, where developers install baseline gas appliances without EE funding, counter to the state's decarbonization goals. Staff proposes adopting the Participant Cost Test (PCT) as the primary method to determine cost-effectiveness when identifying the VEAs available for a gas EE measure.

Section 2 of this proposal sets out the policy rationale for this Phase 2 Staff Proposal, including trends in EE Codes and Standards and appliance standards. Section 3 contains the details of the proposal, including the method to determine when a VEA is available for a gas measure, taking into consideration potential customer bill impacts as an input to determine the cost-effectiveness of electric measures, and timelines and policies for phasing out incentives for new construction and

[1] Agricultural and industrial segments were excluded from the order.

[2] Market support segment: Programs with a primary objective of supporting the long-term success of the energy efficiency market by educating customers, training contractors, building partnerships, or moving beneficial technologies towards greater cost-effectiveness. (Defined in D.21-05-031)

[3] Resource Acquisition segment: Programs with a primary purpose of, and a short-term ability to, deliver cost-effective avoided cost benefits to the electricity and natural gas systems. Short-term is defined as during the approved budget period for the portfolio, which will be discussed further later in this decision. This segment should make up the bulk of savings to achieve TSB goals. (Defined in D.21-05-031).

[4] D.23-04-035, Section 2.1, pg. 8. The definition of exempt measures "includes behavioral measures (i.e., measures that rely on changes in energy usage behavior to achieve energy savings, such as home energy reports) as well as energy efficiency audits." CPUC staff considers any measure that burns natural gas (whether or not the measure also uses electricity) to be a natural gas measure subject to the incentive phase-out.

retrofits.[5] Section 3 also sets forth proposals for Program Administrators (PA) to implement pilot projects to incentivize low global warming potential (GWP) refrigerants, and recommends working groups to recommend a VEA policy for custom projects, as well as processes for initial and ongoing implementation of the expanded VEA policy. Section 4 identifies areas for stakeholder feedback.

Key elements of staff's proposal to phase out EE incentives for natural gas measures with a VEA, in all three EE portfolio segments (resource acquisition, market support, and equity), include:

1. To be eligible to receive ratepayer-funded EE incentives, require that developers use the Prescriptive approach, and apply the Title 24 energy code's climate zone-specific prescriptive appliance measures as the baseline or a VEA measure if one exists. (Section 3.1).
2. Adopt the PCT as the primary test for determining when a gas measure has a VEA measure. The PCT focuses on customer costs, which impact decision making and participation, and program administrator (PA) costs are not included in the cost-effectiveness calculation. Using the PCT allows for more viable electric measures compared to the Total Resource Cost (TRC) test. Alternatively, staff proposes maintaining the TRC as the primary cost-effectiveness test for VEAs. The TRC will reduce the number of cost-effective VEA measures, as compared to the PCT, because of the inclusion of PA costs (Section 3.3).
3. Direct the IOUs to conduct a market study on infrastructure and operating costs of gas measures that are not already accounted for in measures packages, for inclusion in the TRC or PCT (Section 3.3).
4. End ratepayer-funded EE incentives for new construction gas measures that have a VEA even when the gas measure has a TRC ratio of 1.0 or greater (Section 3.5).
5. Expand the new construction phase-out ordered in D.23-04-035 to include all EE portfolio segments, including the "equity" segment (Section 3.5).
6. End ratepayer-funded EE incentives for retrofit gas measures with a TRC below 1.0 if a VEA exists (Section 3.5).
7. Begin a stakeholder working group process that will establish technical recommendations for the criteria under which natural gas EE incentives will be phased out for custom projects, with the working group to submit technical recommendations to the CPUC by no later than June 31, 2027 (Section 3.5).
8. Direct PAs to begin pilot programs using EE incentives to reduce refrigerant leakage and increase use of low-GWP refrigerants, including refrigerant recycling, leak detection and mitigation, and refrigerant handling training for installers (Section 3.6).
9. Solicit technical recommendations from stakeholder working groups on ways to effectively incorporate the VEA Phase 2 policy changes into existing CPUC and PA EE program infrastructure and databases with minimal added administrative burden (Section 3.7-3.8).

[5] Retrofit measures are measures that are added to existing buildings, as opposed to new construction.

2 Policy Rationale for Staff Proposal

2.1 Statutes and CPUC Decisions

California has set ambitious goals to mitigate the impacts of climate change, including goals to limit greenhouse gas (GHG) emissions and decarbonize the economy. Assembly Bill (AB) 3232 (Stats. 2018, Ch. 373), among other statutes, aims to reduce GHG emissions in the building stock to 40 percent below 1990 levels by 2032, and Senate Bill (SB) 1279 (Muratsuchi, 2022) establishes a policy of the state to achieve net zero GHG emissions by 2045. California needs bold action to meet the state's goals to decarbonize the electric sector, and EE has an important role to play in that transition.

With this in mind, ED staff propose refining the ongoing, orderly and gradual transition away from using Investor-Owned Utility (IOU) ratepayer funds to incentivize natural gas EE measures, while remaining consistent with Cal Pub. Util. 454.56.[6] This staff proposal expands on policies adopted by Decision (D).23-04-035, which addressed the 2022 Energy Efficiency Natural Gas Incentive Phaseout Staff Proposal.[7]

In addition to beginning the phase-out of EE ratepayer incentives for new construction gas measures beginning January 1, 2024, D.23-04-035 laid the groundwork to phase out EE incentives for gas measures in retrofits, refrigerants, and custom projects as a means to move the state closer to meeting GHG emission reduction goals. This staff proposal incorporates conclusions from the Fuel Substitution Infrastructure Working Group, Measure Package Working Group, the Fuel Substitution Infrastructure Market Study[8] and the Customer Electrification Estimator[9]), to develop implementation recommendations.

D.23-04-035 established the TRC test as the cost-effectiveness test for new construction gas measures, with non-cost-effective gas measures ineligible for EE incentives. For VEA cost-effectiveness considerations, D.23-04-035 defined the potential customer benefits of electrification to include gas bill decreases that reflect the difference between an all-electric and an energy-efficient gas baseline monthly electricity usage and the potential customer costs to include electric bill increases that reflect the difference between post-electrification bills with the customer's existing electric baseline.[10] Findings from D.23-04-035 therefore warrant a more thorough consideration of the viability of an electric alternative from the customer's perspective, including the potential bill impacts of substituting the electric alternative for the efficient gas option. Defining customer

[6] Cal Pub. Util. 454.56(a) states "The commission, in consultation with the Energy Commission, shall identify all potentially achievable cost-effective natural gas efficiency savings and establish efficiency targets for the gas corporation to achieve, consistent with the targets established pursuant to subdivision (c) of Section 25310 of the Public Resources Code."

[7] ng-staff-prop-81622.pdf

[8] Fuel Substitution Behind the Meter Market Study, May 17, 2024 (Attached as Appendix A)

[9] Formerly called the Fuel Substitution Bill Impact Tool, currently in development for public display.

[10] D.23-04-035, section 2.3, pg. 18

benefits also requires including the cost of gas equipment (including installation, operations and maintenance, etc. in the cost-effectiveness test, such as the TRC test or PCT) that would have been installed rather than the electric alternative.

Staff propose expanding the phase-out to include the equity segment of the EE portfolio for new construction because installing new long-lived gas appliances may lock low-income customers into long-term gas consumption, based on the effective useful life of 20-23 years for space heating, cooling, and water heating, and disproportionately burden them with poor indoor air quality. The proposal also expands the incentive phase-out to some retrofits in line with findings from the market studies authorized in D.23-04-035. By taking an incremental approach to expanding the policy established by D.23-04-035, the proposal will allow EE PAs and implementers to ramp down existing programs, restructure portfolios accordingly and adapt to a new policy landscape.

2.2 Fuel Substitution Behind the Meter Market Study[11]

D.23-04-035 Ordering Paragraph 2 directed the CPUC and PAs to convene a stakeholder working group to create a VEA technical guidance document. Section 2 of that decision addressed the cost of customer-side-of-the-meter infrastructure upgrades related to electrifying end uses that traditionally used natural gas. In alignment with this ordering paragraph, CPUC staff convened a stakeholder working group beginning in the summer of 2023 and concluding in early spring of 2024 to investigate this topic. This working group included representatives from 11 organizations including the four Pacific Gas and Electric (PG&E), San Diego Gas & Electric (SDG&E), Southern California Edison (SCE), Southern California Regional Energy Network (SoCalREN), Sierra Club, Small Business Utility Advocates, Energy Solutions, The California Technical Forum[12] (Cal TF), California Air Resources Board (CARB), and the California Energy Commission (CEC).

The CPUC staff also contracted with consultant Opinion Dynamics to conduct a statewide market study on the frequency of infrastructure upgrades and related costs for fuel substitution for market rate customers in the residential and commercial sectors. This market study was important in learning the infrastructure costs of fuel substitution at the statewide level. The working group incorporated the market study results into its technical recommendations, which were shared with the public in a webinar on March 3, 2024. A data tool summarizing the findings of this market study, as well as the raw data, was made publicly available on the CPUC's website.[13] The CPUC released the market study report on June 12, 2024, and it is attached as Appendix A.

Opinion Dynamics surveyed residential customers, commercial customers, and electricians who serviced residential or commercial customers, or both. Each of the three surveys asked respondents

[11] The complete study is attached in Appendix A

[12] The California Technical Forum is an independent body that reviews EE measures and maintains the eTRM, an online application that serves as the repository for all statewide deemed measures for California.

[13] https://www.cpuc.ca.gov/about-cpuc/divisions/energy-division/building-decarbonization/fuel-substitution-in-energy-efficiency

about electrifying a single end use (HVAC, water heating, cooking), multiple end uses (HVAC and water heating), or fully electrifying their property, as well as other questions about the cost of such improvements and customer preference. Opinion Dynamics analyzed the results of the survey using regression analysis to determine what factors of existing building conditions were likely to be indicative of the need for an infrastructure upgrade to accommodate electrifying an end-use.

At a high level, the market study showed that a lack of physical (breaker) space within residential and commercial customers' electric panels was a greater constraint on electrifying appliances than a lack of amperage (electrical capacity). Single family homes had slightly greater constraints than multifamily homes, and the electrification of each additional end use amplified these constraints. Nonresidential buildings face similar but smaller constraints in terms of both available panel space and amperage, with the electrification of the cooking end use requiring the greatest percentage of buildings to upgrade their infrastructure.

Specifically, the market study and working group assessed pre-existing panel size, frequency of panel upgrades, and panel optimization and upgrade costs to develop assumptions to guide policymaking. The technical recommendations from the working group are in Appendix B of this staff proposal.

2.3 Code Compliance

VEAs must comply with current building codes and other regulations (e.g., CARB[14], AQMD[15], CEC Title 20[16], DOE[17]). Low Global Warming Potential (GWP) refrigerants help reduce the environmental impact of cooling and heating equipment and systems compared to traditionally used refrigerants, which pose long-term global warming impacts when leaked into the atmosphere. Low-GWP refrigerants may face non-compliance with ongoing updates to state and municipal fire and building codes or added concerns towards use due to their mildly/slightly flammable rating. Regulatory agencies expect to update building codes continually with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) ratings, which categorize refrigerants by toxicity (lower or higher toxicity) and flammability ratings (non-flammable, mildly/slightly flammable, moderately flammable, or highly flammable).

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[14] CARB has proposed potential regulation that would prohibit the sale of non-zero emission space and water heaters starting in 2030. (Zero-emission Space and Water Heaters - Frequently Asked Questions (FAQs) | California Air Resources Board)

[15] The 2022 Air Quality Management Plan (AQMP) adopted in December 2022 includes control measures for the industrial, commercial, and residential sectors that are based on accelerated deployment of the cleanest possible technologies available. Residential and Commercial Building Appliances (aqmd.gov)

[16] Title 20 established Appliance Energy Efficiency Standards that include minimum levels of operating efficiency and other cost-effective measures. (Appliance Efficiency Regulations - Title 20 (ca.gov))

[17] Department of Energy has established minimum energy conservation standards. (Appliance and Equipment Standards Program | Department of Energy)

3 Staff Proposals

3.1 Require Developers to Use Prescriptive Measures to be Eligible for EE Incentives

Starting with the 2022 Residential Building Energy Code, the CEC adopted heat pumps as the baseline.[18] As a threshold policy change, this staff proposal recommends requiring developers to use the California building energy code's climate zone-specific prescriptive measures baseline, in order to be eligible to receive ratepayer-funded EE incentives. This change would better align EE baselines with Building Energy Efficiency Standards Energy Code Title 24 (Cal. Code Regs., tit. 24, pt. 6).

California's building energy code, updated triennially by the CEC (Cal. Code Regs., tit. 24, pt. 6.), requires property developers to use one of two different approaches to meet building efficiency standards: (i) prescriptive, or (ii) performance-based. The prescriptive approach prescribes specific measures ("baselines") that buildings must use to meet code. The performance-based approach allows the developer to "trade off" various measures to install within a property, so long as they meet an overall efficiency standard, called the Energy Design Rating (EDR) for the building. In practice, residential developers have predominately applied the Title 24 performance-based approach over the prescriptive approach to meet efficiency standards.

Under the prescriptive approach, developers must use heat pumps as the baseline for both water heating and space conditioning, meaning heat pumps must be used to achieve prescriptive method code compliance in most cases. However, using the performance-based approach, residential developers often install gas appliances for HVAC and water heating and offset the installation of gas appliances with use of other higher efficiency measures elsewhere. Though heat pumps are shown to be cost-effective as an EE measure under Title 24 and are designated as the prescriptive method baseline, many developers of new residential buildings are still installing gas appliances through the performance-based method.

This staff proposal recommends that the CPUC EE portfolio requirements state that, to be eligible to receive ratepayer-funded EE incentives for HVAC, water heating, clothes drying, and stovetop measures, developers must use the Cal. Code Regs., tit. 24, pt. 6 climate zone-specific prescriptive measures as a baseline or a VEA measure. This staff proposal does not seek to prohibit the use of the performance-based method but seeks to end EE incentives for the above measures when a prescriptive baseline measure is not included in the performance-based method energy budget. This change would mean, for example, that where the code considers a heat pump water heater the energy code baseline (every climate zone except 3, 4, and 14), developers will either need to use the Title 24 prescriptive measure (i.e. a heat pump), or a more efficient electric measure to receive

[18] CEC, 2022 Single Family Residential Compliance Manual, pg. 1-7.

ratepayer-funded EE rebates for the measure end use. Exempt measures (gas saving measures that do not burn gas, like building envelope) would still be eligible for EE incentives.

3.2 Determining Viable Electric Alternatives to Gas Measures

This staff proposal builds upon the criteria for defining VEAs set out in D.23-04-035 and proposes a methodology for measuring cost-effectiveness to determine the set of VEAs available for any given gas measure.

D.23-04-035 Framework for Viable Electric Alternatives

A VEA exists for a gas EE measure if it serves the same function and provides similar benefits at a similar or lower cost. Examples of these types of measures could be from a gas furnace to a HVAC heat pump or a gas water heater to a heat pump water heater. D.23-04-035 states, "Certain electric measures may provide the same function as certain gas energy efficiency measures. The degree to which an electric measure is viable to displace a gas measure depends on its availability and on customers' net benefits from such displacement."[19]

Recommended Criteria for Determining Viable Electric Alternatives

This staff proposal recommends the Commission continue assessing the cost effectiveness of a gas measure using a TRC test but use the PCT to determine if a gas measure has a VEA. If the Commission does not adopt the PCT as the preferred cost-effectiveness test to determine a VEA, then as the alternative staff proposes using the TRC test of the electric measure to determine if a gas measure has a VEA. This will be further explained in section 3.3.

Staff propose using the following criteria for determining the availability of VEAs for a given gas measure:

Use the PCT to Determine if an Electric Measure is Cost-Effective: Once applicable gas measures have passed the TRC cost effectiveness threshold, evaluate the PCT[20] ratio (Section 3.7) of the alternative electric measure (VEA) based on the site-level permutation to determine if the VEA passes the PCT threshold. Alternatively, if the PCT is not selected as the VEA cost-effectiveness test, the TRC shall remain the cost-effectiveness test for VEA measures.

Maintain Consistency in TRC Methodology: Remain consistent with the Standard Practice Manual[21] and related integrated distribution energy resource (IDER) cost-effectiveness decisions.[22]

[19] D.23-04-035 Finding of Fact 5, pg. 32.
[20] Standard Practice Manual, Chapter 2
[21] Standard Practice Manual, Chapter 4
[22] Including D.19-05-019

Equity Considerations: Recognize that equity programs may have measures with no TRC requirements, and these should be evaluated differently (Section 3.5).

Defining Customer Costs

Defining customer cost impacts is a critical factor in this proposal and for determining VEA cost-effectiveness. It involves assessing how the adoption of electric alternatives affects the total upgrade costs of impacted end use customers and the Equivalent Annual Annuity (EAA)[23] (EAA equation on p. 37) of the VEA upgrade. Adopting the PCT to determine cost-effectiveness for VEAs will help to ensure that the full customer upgrade costs remain reasonable on a measure's useful life basis. It also should ensure that the customer's payback period using the sources of data indicated below is less than the VEA measure's total useful life. Due to large variances in energy usage between building types, delivery method, and climate zones, customer cost impacts will be established at the measure package permutation level. VEAs will be established for the majority of the measure package permutations for a given delivery method meeting the criteria below.

Factors determining customer cost impacts include:

Upfront cost to the customer: Electric infrastructure costs (panel optimization[24] and upgrade) will be auxiliary to the electric alternative's measure package required only for VEA measures, and based on the data from the fuel substitution infrastructure market study detailed in Appendix A The project should add facility upgrade costs (non-electric infrastructure) as well. These include any required design changes such as new evaporator venting, controls, and/or storage tank requirements that may not be captured.

Technology costs: Measure packages currently contain labor and material costs for measure installation, but do not capture additional technology infrastructure such as panel optimization and /or upgrades, which are additional costs specific to fuel substitution measures, which are incurred by customers. These include sub-panels, tandem breakers, or circuit sharing/splitting. Section 3.7 outlines the process for VEA measures, updated with the panel infrastructure optimization and upgrade costs. Staff recommend that the IOUs fund a market study on infrastructure and operating costs of gas measures that are not already included in measure packages.

Ongoing customer cost impacts: Impacts include the Unit Energy Consumption (UEC) for gas and electric measures in the PCT. This would likely use the Customer Electrification Estimator tool under development by the CPUC to assess estimated average potential customer costs at the measure package permutation level.[25] Incremental operational and maintenance costs that are the result of the VEA should also be considered, which are not typically provided in current measure packages.

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[23] Equivalent Annual Annuity is an equation that essentially levels out all cash flows and generates a single average cash flow for all periods that (when discounted) equal the project's NPV.

[24] Panel optimization strategies include smart circuit breakers, smart panels, circuit pausers, load-sharing, and meter collars.

[25] A measure package is documentation that is needed to make a deemed energy efficiency claim for a measure.

The measure lifecycle cost effectiveness using the EAA should be calculated to ensure customer net cost neutrality over the lifecycle of the measure. Data sources also considered, as part of the EAA calculation, include cost criteria like upfront costs, bill neutrality, lifecycle cost analysis, comparison with gas technology costs, infrastructure cost considerations, forecasting commodity costs, discount rate and measure life (which may vary by fuel).

3.3 Assessing Cost Effectiveness Using the Participant Cost Test

Staff proposes the CPUC use the PCT to determine cost-effectiveness for VEAs. A VEA for a gas measure exists when an electric appliance measure provides the same end use function as a natural gas or mixed fuel baseline measure and is a benefit in terms of cost to the customer.[26] The cost-effectiveness test for a VEA measure (PCT proposed) will be determined by whether or not the *electric measure* for a given end use has a PCT cost-effectiveness ratio of 1.0 or greater. The method to determine cost-effectiveness described in this section, outlines the eligibility for EE incentives regardless of whether or not the *gas measure* is cost effective (has a TRC ratio 1.0 or greater).

The TRC is the primary test used in EE cost-effectiveness assessments and to determine whether it is reasonable for ratepayers to fund a proposed portfolio. The large scope of the TRC may not be as appropriate for considering customer benefit and costs of substituting an electric EE measure for a gas EE measure. Focusing on customer costs prioritizes end-user considerations for fuel substitution without intertwining the values with PA costs. For this reason, staff recommend using the PCT as an option for determining VEA Cost-Effectiveness.

Given the complexity and administrative burden of running multiple cost-effectiveness tests for measures at the permutation level, staff recommend the selection of the PCT as the VEA cost effectiveness test.

Using results from the 2023 Potential and Goals Study[27], staff analyzed the potential change in measures that passed the cost-effectiveness criteria for both the PCT and TRC. Using the PCT, 29% of applicable measures passed the PCT cost-effectiveness at 1.0 or greater, whereas 13% of applicable measures passed the TRC with a ratio of 1.0 or greater. Initial results show the difference coming from ductless mini split heat pumps and central heat pump water heaters being cost-effective in hot/dry climate regions and marine climate regions with the PCT, with these measures being cost effective only in the marine climate regions according to the TRC test.

However, if the Commission does not adopt the PCT to determine cost effectiveness for assessing VEAs, staff recommend that the TRC remains the VEA cost effectiveness test. The TRC is the metric used to assess if the Resource Acquisition segment of the EE portfolios meets the CPUC's

[26] D.23-04-035, Section 2.2, pg. 16
[27] 2023 Potential and Goals Study

cost effectiveness requirements. Additionally, the TRC is used in the Potential and Goals study to assess EE potential. The Potential and Goals Study is a critical input used to determine EE goals.

Participant Cost Test

The purpose of using the PCT for VEA is to establish if the electric measure provides savings to the customer. The details of conducting this assessment are in Section 3.7. At a high level, the PCT is the measure of the quantifiable benefits and costs to the customer due to participation in a program. The benefits include the overall reduction in the customer's bill, incentives from the utility or other programs (ex: TECH), any tax credits received, and in the case of electrification the avoided capital (including infrastructure) and operating costs of the gas baseline measure. The costs are all out-of-pocket expenses that the customer incurs, including equipment and infrastructure costs, and any increase in the customer's total utility bill. [28] The details of how these various factors are used to assess ratepayer cost effectiveness will be weighted are in Section 3.7.

If the Commission selects the PCT instead of the TRC for VEA Cost effectiveness, it is important to note that use of the PCT for VEA is **not** a replacement for EE's TRC cost-effectiveness metric. Instead, the PCT is recommended to be used after cost effectiveness of gas measures has been established (using the TRC) for **comparing** gas measures to their potential VEAs to assess whether the gas measure can continue to receive ratepayer-funded EE incentives.

If an electric measure has a PCT ratio of 1.0 or greater than the gas measure will have a VEA, regardless of whether the gas measure is cost effective. A PCT ratio of 1.0 or greater indicates that the measure will yield at least as many benefits as it has costs, as calculated by the test. The measure package will establish VEA status for all of the gas measure package permutations for a given end use. [29]

Determining gas measure cost-effectiveness

Consistent with D. 23-04-035, for purpose of whether to reduce natural gas efficiency incentives for retrofits, this staff proposal applies the cost-effectiveness screen at the measure permutation level, such that each gas efficiency measure permutation will be deemed not cost-effective if its TRC benefit to cost ratio is less than 1.0. Cost effectiveness will be assessed at the measure permutation level in the eTRM, with administrative costs and assuming an incentive rebate level of 50% of the incremental measure cost (IMC).

Infrastructure costs – Market Study and Working Group Findings

The market study and working group only examined infrastructure costs for VEA measures for the residential and commercial sectors.

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[28] Standard Practice Manual, Chapter 4
[29] Standard Practice Manual, Chapter 4

Per the recommendations of the fuel substitution infrastructure cost stakeholder working group (Appendix B), programs should use a weighted-average value for the infrastructure costs of a single VEA measure for each of the sectors, building types, and end uses listed below. However, the working group recommends that these values include the standard costs of installing a VEA measure. Because these costs are generally captured in the eTRM measure packages, this staff proposal recommends only using the costs and likelihoods from optimization and upgrades using the following equation:

Equation 1. Weighted Average Infrastructure Cost

$$WeightedAvgInfraCosts = [Opt\% * InfCost\_Opt] + [Upg\% * (AttribF * InfCost\_Upg)]$$

Table 1. Definition of Equation Terms

Equation Term	Definition
Weighted Avg Infra Cost	Weighted average infrastructure cost associated with the installation of a single fuel substitution measure, to be included as part of the measure cost for fuel substitution measures in calculating the benefit/cost ratio for potential VEA measures.
Opt%	Likelihood this site needs/uses panel optimization (additional circuits or load management) devices to avoid an increase in panel capacity (i.e., a panel upgrade).
Upg%	Likelihood the site needs an increase in panel capacity (i.e., a panel upgrade).
$InfCost_{Opt}$	Infrastructure cost associated with panel optimization for a fuel substitution measure installation. In this case, the site needs/uses additional circuits or load management to avoid an increase in panel capacity (i.e., a panel upgrade). This definition assumes these costs include simple connection costs between the fuel substitution appliance and the electrical panel.
$InfCost_{Upg}$	Infrastructure cost associated with panel upgrade for a fuel substitution measure installation. In this case, the site needs/uses the panel capacity (i.e., the site upgrades the panel). This definition assumes these costs include simple connection costs between the fuel substitution appliance and the electrical panel.
AttribF	Attribution factor applied to the panel upgrade to account for the ability of the panel to support multiple future electrification loads, and thus all future

	electrification loads share. The formula for calculating the attribution factor is describe in Equation 2.

Based on this equation, and the values from the market study (which only looked at the end uses listed below) and working group definitions in the above table, the weighted average infrastructure cost values for each sector, building type, and end use shown below:

It is important to keep in mind that the above equation forms the basis for the following values and that many buildings will not need optimizations.

- <u>Residential (single family and multifamily)</u>
  - Space heating - $397
  - Water heating - $1,316
- <u>Commercial</u>
  - Space heating - $838
  - Water heating - $2,781
  - Cooking - $2,780

Table 2. Summary of Assumptions, Cost Attribution Adjustments, and Equation Terms by Building Type and End Use

Input Parameter to FS Cost Attribution	Residential (SFM/MFM)		Nonresidential *Non*-Food Service		Nonresidential Food Service (Restaurants, Cafeterias, etc.)
	Space Heating	DHW	Space Heating	DHW	
No. of fuel substitution treatments assumed	1	1	1	1	1
Frequency of No Upgrade (NoUp%)	82.1%	50.0%	85.8%	54.6%	37.8%
Frequency of Panel Optimization (Opt%)	7.9%	19.3%	4.4%	23.6%	14.8%
Frequency of Panel Upgrade (Upg%)	9.9%	30.8%	9.8%	21.7%	47.4%

Input Parameter to FS Cost Attribution	Residential (SFM/MFM)		Nonresidential *Non*-Food Service		Nonresidential Food Service (Restaurants, Cafeterias, etc.)
	Space Heating	DHW	Space Heating	DHW	
No Upgrade Infrastructure Cost ($InfCost_{NoUp}$)	$1,704	$2,804	$2,099	$3,430	$3,372
Panel Optimization Infrastructure Cost ($InfCost_{Opt}$)	$3,513	$4,613	$4,418	$5,749	$5,691
Panel Upgrade Infrastructure Cost ($InfCost_{Upg}$)	$6,057	$6,911	$13,128	$13,128	$13,624
Panel Upgrade Attribution Factor (AttribF)	0.2	0.2	0.5	0.5	0.3
Calculated Weighted Avg Infrastructure Cost for VEA Determination	$397	$1,316	$838	$2,781	$2,780

(The values differ from those in the final working group technical recommendation (Appendix B) because those do not include the costs of "no upgrade," as the measure packages should already capture these costs.)

The VEA Working Group determined that measure packages should attribute the optimization costs to a single fuel substitution measure, not to the cost of installing multiple electrification[30] measures (ex: HVAC heat pump and heat pump water heater during the same installation period) because customers are unlikely to replace all gas measures simultaneously. Replacing measures (appliances) is expensive, and customers are likely to replace measures when the previous appliance reaches its end of life. However, the working group acknowledged that pre-existing panel capacity and some optimization interventions, such as subpanel installation, may support more than one fuel substitution (or electrification) measure.

- For the attribution factor calculation, the VEA Working Group determined the calculation needs two sectors (residential and non-residential) and three building types (residential, general commercial, and commercial food service) to reasonably distinguish

[30] Electrification measures are electric measures that replace gas measures.

between the likely typical scenarios of future electrification end-uses to be supported by a single panel upgrade over the life of the panel (typically several decades in the absence of additional capacity needs).

The Working Group estimated that residential buildings are likely to have five future electrified end uses over the life of the panel that the calculation accounts for in the residential attribution factor: water heating, space heating, cooking, clothes drying, and EV charging. The working group did not consider additional solar PV to likely share a portion of these costs, as the market study showed that the majority of solar PV homes already had a 200-amp panel, and SolarApp+ Data[31] shows that the vast majority of homes with PV solar installed did not require a panel upgrade.

- The Working Group recommended the panel upgrade attribution factor to be calculated using an infrastructure upgrade cost equally weighted among all electrified end uses expected to be supported by the panel upgrade over the panel life.

Staff Proposal Recommendations for the Implementation of Tracking Fuel Substitution Infrastructure Costs

1. **California's EE administering PAs should not use the weighted average infrastructure cost values for reporting deemed fuel substitution measure costs in CEDARS (see #2 below for an alternative) and instead use actual project costs.** This is important to ensure the accuracy of the cost-effectiveness data in CEDARS, which would inform future fuel substitution and VEA policy. The working group notes that the weighted average infrastructure cost values would still be used for (a) the cost/benefit analysis for the determination of VEAs pursuant to D.23-04-035, and (b) fuel substitution measure cost assumptions in the Potential & Goals study.

2. **California's EE administering PAs should have the option to create separate *non-resource* incentive-based measures[32] specifically for electrification-enabling infrastructure upgrade costs[33] that support the (verified) installation of EE program fuel substitution measures.**
   - These infrastructure upgrade measures would be distinct from the fuel substitution measures for fuel substitution equipment and labor installation.
   - The non-resource infrastructure upgrade measures would not reflect *one weighted average cost value* for all potential upgrade scenarios but instead would reflect the *three different cost scenarios* considered within this report: no change, panel optimization, and panel upgrade.

[31] SolarAPP+ Performance Review (2022 Data). Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-85827. https://www.nrel.gov/docs/fy23osti/85827.pdf.

[32] A non-resource incentive-based measure is a measure that does not directly generate savings.

[33] D.23-06-055 Ordering Paragraph 29 allows for EE funding to be used for panel upgrades, which are not considered a stand-alone EE technology, stating (emphasis added) "Portfolio administrators (PAs) may set aside [limited funds]… from within their total budgets during 2024-2027 approved in this decision to fund innovative integrated demand-side management projects, including ongoing load-shifting that is not event-based**. Energy efficiency funding shall not be used for rebating capital costs of non-efficiency technologies, except as already provided for electric panel upgrades in Decisions 19-08-009 and 23-04-035**."

Projects may submit claims for the project specific costs of infrastructure optimizations or upgrades.

- The three infrastructure upgrade cost scenarios listed above: (1) panel upgrade, and (2) panel optimization, (3) no change, would leverage the market study results, each captured by the variables in Table 2 above without adjustments.
    - The projects should represent these infrastructure costs as **non-resource** measure packages based on the market survey results identified in Appendix A. Projects should submit only one non-resource incentive-based infrastructure measure package per customer site, per the findings identified by the working group and described in Appendix B.
    - The working group recommends separate non-resource measure packages for the electrification-enabling costs to enable:
        - More flexibility in incentive offerings for infrastructure upgrades, given the variability in infrastructure costs depending on an individual participant's existing electric panel characteristics;
        - Easier tracking of the different types of infrastructure upgrades that are needed to support fuel substitution measure installation, to inform future program offerings;
        - Potentially easier integration with infrastructure-specific financing opportunities.
- Projects could offer separate non-resource measure packages for fuel substitution infrastructure incentives (with no associated savings) in coordination with fuel substitution measures. The staff proposal offers the following program design considerations to assist PAs (IOUs and 3rd party implementers) in implementation of this proposed framework for separate infrastructure cost measures:
    - The same PA for the fuel substitution programs could offer the fuel substitution infrastructure non-resource measure package;
    - The project could create a separate Program ID in CEDARS for the infrastructure cost incentive offerings, and the project could report the full measure cost of the infrastructure installation cost in CEDARS but flag for exclusion from portfolio cost-effectiveness calculations;
    - Program participants must install a valid fuel substitution measure to qualify for the infrastructure cost incentive.
    - Projects would limit incentives for infrastructure costs that support multiple fuel substitution measures (such as a panel upgrade) to one per customer premises. Incentives for infrastructure costs that support a single fuel substitution measure (added circuit, wiring, etc.) may be available each time projects need those incentives for the specific fuel substitution measure.[34]

[34] Incentives for infrastructure costs that support a single fuel substitution measure (added circuit, wiring, etc.) should be available each time those incentives are needed for the specific fuel substitution measure; these types of infrastructure costs, and their associated incentives, could be captured as part of the fuel substitution measure package instead of through a separate infrastructure cost measure package.

- Program design should consider making infrastructure upgrade incentives contingent on installing upgrades that enable a fully electrified building, to prevent the need for multiple panel upgrades in the future.
- The program design team should determine details of incentive levels, eligibility requirements, and data collection requirements for eligibility verification as required by the measure package.

3. **The staff proposal recommends the creation of additional measure permutation fields for fuel substitution measure packages and the eTRM to capture different infrastructure measure cost scenarios (per technology type and sector) and associated cost attribution factors:**
   - This recommendation intends to align these additional fields with potential tax credits and other infrastructure cost rebates to the extent possible (considering web development and eTRM enhancement costs).[35]
   - Additional fields should address weighted average infrastructure costs and the full infrastructure costs for the three scenarios considered in this report (no panel upgrade, panel optimization, and panel upgrade), to support implementation of the recommendations for enabling incentive flexibility and easier tracking for fuel substitution upgrades.
   - The eTRM, could capture infrastructure measure cost in a "shared value table" for reference, at both 100% and adjusted amounts based on cost attribution adjustments per technology type and sector as determined by the working group. This enables multiple fuel substitution measure packages to reference the same cost data shared value table (per Table 2).
   - The staff proposal recommends that the project complete the fuel substitution infrastructure cost non-resource measure packages for use by PAs in Program Year (PY) 2027.

Potential Customer Bill Impacts

When customers replace gas measures with an electric alternative, their electric usage will rise while their gas usage will fall. Because of this increase in electric load and decrease in gas load, installing a fuel substitution measure involves not only the cost of the installation for the equipment, as well as the infrastructure needed to install it, but also the overall impact to a customer's utility bills.

As with the infrastructure costs of fuel substitution measures, per D.23-04-035, "...a more thorough consideration of the viability of an electric alternative, particularly from the customer's perspective, is warranted, including specifically the bill impacts of substituting the electric alternative for the efficient gas option."[36] The inclusion of bill impacts also aligns with the definition of the PCT.[37] Thus, the costs or savings from the bill impacts of electrifying end uses should be included in the

[35] Electrification-enabling infrastructure costs are associated with the installation of electric fuel substitution measures (where the baseline is a gas-fueled technology which would not include any electrification infrastructure costs as part of the baseline cost).
[36] D.23-04-035, p. 17
[37] Standard Practice Manual, Chapter 4

PCT assessment of the gas and electric measures. If the PCT is not selected, the TRC will remain the alternative.

To account for the customer bill impacts, D.23-04-035 identified the CPUC's development of a Customer Electrification Estimator tool (previously referred to in D.23-04-035 as the Fuel Substitution Bill Impact Tool). This tool focuses on the residential sector and models the potential differences in IOU customers' utility bills across the state before and after electrifying a given end use across residential building types and vintages, fuel substitution measures, approved gas and electric rates, and climate zones.

Based on the outputs of this modeling, the staff proposal recommends incorporating estimated-average customer bill impacts into the costs and benefits of electric VEA measures for the purpose of assessing the VEA cost-effectiveness including the following variables:

- VEA measures to incorporate estimated bill impacts are for the following four end uses:
    - HVAC
    - Water heating
    - Cooking
    - Clothes dryer
- The tool divides single-family homes into 3 different size categories based on CEC loadshapes[38]:
    - Small - homes less than or equal to 1,250 square feet
    - Medium - homes between 1,251 square feet and 1,750 square feet
    - Large - homes greater than 1,750 square feet
- This tool divides multi-family homes into 2 different size categories based on CEC loadshapes:
    - Small - homes in buildings with 3 or less stories and 5 or more units
    - Large - homes in buildings with 4 or more stories and 5 or more units
- As in the EE Potential and Goals Study, this tool divides the climate zones across the state into 3 climate regions:
    - Marine (climate zone 1-6)
    - Hot-dry (climate zones 7-15)
    - Cold (climate zone 16)
- This tool divides residential customers into two customer groups:
    - Market-rate customers
    - California Alternate Rates for Energy (CARE) program customers / Family Electric Rate Assistance (FERA) program customers

This tool only includes IOU customers' corresponding rates for functionality. IOU rates are the majority of active and approved residential rates. Table 3 provides the initial values for average bill impacts for the EUL of the electrification measure. For example, the assumed estimated bill impact

[38] 2022 Energy Code Compliance Software

of a market-rate customer in a single-family house in the marine climate region switching from a gas to an electric water heater over the 20-year effective useful life (EUL) of the appliance would be $5,846 in savings in 2024 dollars. These values represent "averages of averages" in that the tool aggregates the permutations for the above variables to create average bill impacts for the below categories of customers.

Table 3. Lifetime Estimated Average Bill Impact of Electric Fuel Substitution Measures by End Use

			Weighted Avg of all permutations (No PV or Storage, PV, PV+Storage)			
			HVAC (EUL: 23yrs)	*Water Heating (EUL: 20yrs)*	*Cooking (EUL 16yrs)*	*Clothes Drier (EUL: 12yrs)*
Customer Type	Climate Region	Building Type	Utility Bill Impact	Utility Bill Impact	Utility Bill Impact	Utility Bill Impact
Market-Rate	Marine	SF	$ 3,865.45	$ 5,771.31	$ (533.71)	$ (1,358.15)
Market-Rate	Marine	MF	$ (459.13)	$ 1,729.92	$ (1,121.95)	$ (2,490.27)
Market-Rate	Hot-Dry	SF	$ 8,493.03	$ 9,416.42	$ (503.22)	$ (1,372.00)
Market-Rate	Hot-Dry	MF	$ 202.08	$ 2,360.44	$ (982.25)	$ (2,191.30)
Market-Rate	Cold	SF	$ (31,801.81)	$ 5,932.35	$ (1,126.31)	$ (2,543.00)
Market-Rate	Cold	MF	$ (5,847.79)	$ (1,882.13)	$ (1,105.54)	$ (2,261.85)
CARE	Marine	SF	$ 5,641.98	$ 4,924.07	$ (284.69)	$ (785.19)
CARE	Marine	MF	$ (15.34)	$ 2,051.11	$ (696.48)	$ (1,569.52)
CARE	Hot-Dry	SF	$ 8,530.29	$ 7,293.76	$ (265.55)	$ (800.02)
CARE	Hot-Dry	MF	$ 433.34	$ 2,407.56	$ (602.59)	$ (1,370.10)
CARE	Cold	SF	$ (12,262.47)	$ 5,459.36	$ (687.21)	$ (1,583.77)
CARE	Cold	MF	$ (2,725.13)	$ (292.42)	$ (693.97)	$ (1,422.30)

The estimated lifetime bill impact calculations base the residential effective useful life (EUL) for the HVAC (23 years), water heating (20 years), cooking (16 years), and clothes dryer (12 years) measures on the approved measure packages in the eTRM.

The staff proposal recommends using weighted permutation averages of effective useful life for the purpose of assessing the cost-effectiveness for VEA measures.

The CPUC will host and update the public-facing Customer Electrification Estimator Tableau Dashboard. These updates will include biannual to triannual updates to the IOU gas and electric rates the tool uses as inputs. The Estimator outputs from the first annual update each year will be used in the cost-effectiveness calculations for the applicable measures in the following year. For example, the results from the Estimator's first 2025 rate update would be used as the estimated bill impact values in assessing cost-effectiveness for program year 2026. Because of the gap in customer awareness about heat pump technologies, it is important that the CPUC and the IOUs work together to raise awareness about electrification technologies. As part of this collaboration, the staff proposal recommends the CPUC direct the IOUs to provide a link to the Customer Electrification Estimator on each IOU website, as well as educate customers directly as a part of their EE programs.

3.4 Additional factors in assessing cost-effectiveness

The steps Staff recommends in this document coincide with other California efforts, such as those discussed below. Staff recommends coordinating with those efforts to enhance the impact of this proposal.

Complementary Policies: phasing out ratepayer-funded EE incentives for gas appliances coincides with complementary policies, such as TECH Clean California[39], for new and existing decarbonization incentives and rebates that help accelerate the adoption of electric alternatives. This staff proposal recommends leveraging and promoting these complimentary programs to yield a stronger, collective effort to decarbonize buildings. These programs include the Equitable Building Decarbonization Program (CEC Program) which offers direct install decarbonization measures for low-and moderate-income households and incentives for electric appliances statewide. CARB is also evaluating incentive programs for low-income households and building retrofit measures.

Consider Health Impacts of Reduced Indoor Air Pollution: The CPUC should consider the health benefits for participants of reduced indoor air pollution due to electrifying gas stoves as a part of assessing ratepayer benefit comparison for VEA (Section 3.7) for gas and induction stoves. This consideration is in line with the findings and spirit of AB 97 (Stats. 2017, Ch. 14) report, which encouraged EE refrigeration for corner stores in Los Angeles County and San Francisco City and County.[40] Several studies have concluded that natural gas appliances are linked to adverse respiratory illnesses including asthma and carbon monoxide poisoning. Research found that up to 20% of childhood asthma could theoretically be prevented in California if natural gas stoves were removed from homes[41]. Research into outdoor gas appliance health impacts found decreased respiratory-related fatalities, and acute and chronic bronchitis with a monetized value of $3.5 billion.[42] Asthma alone has associated medical treatment costs and time lost from school and work. Childhood asthma is estimated to cost an average of $3,076 to $13,612 per child in the United States, in 2013 dollars driven by inpatient and emergency-room asthma-related visits.[43] Converted into 2024 dollars and averaged across households in IOU territories,[44] electrifying kitchen stoves in California could save between $559 and $2,473 annually per household, with a median value of $1,516. Electrifying all outdoor residential gas appliances like water heaters and furnaces could reduce healthcare costs by an additional $314.79 per household.

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40 AB 97 Report (ca.gov)

41 Gruenwald et. Al., Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States, 2022 Dec 21;20(1):75. doi: 10.3390/ijerph20010075.

42 Zhu et al., "Effects of Residential Gas Appliances on Indoor and Outdoor Air Quality and Public Health in California" UCLA Fielding School of Public Health; April 2020.

43 Perry et. al., The Economic Burden of Pediatric Asthma in the United States: Literature Review of Current Evidence, 2019. DOI: 10.1007/s40273-018-0726-2

44 https://www.statista.com/statistics/242258/number-of-us-households-by-state/#:~:text=In%202021%2C%20about%2013.43%20million,most%20out%20of%20any%20state.

3.5 Phasing-out Natural Gas Measures for New Construction and Retrofits

This staff proposal seeks to expand the phase-out of incentives for gas measures in new construction that have cost-effective VEAs, begin the phase-out of incentives for retrofit measures, and include the equity segment of the EE portfolio.

New Construction

Staff proposes expanding the phase-out for the new construction measures to include all deemed natural gas measures that have a VEA, regardless of the cost-effectiveness of the gas measure in all three EE portfolio segments (market support, resource acquisition, and equity). California has established decarbonization as a critical goal and carrying out staff's proposal would ensure the state's ratepayers do not subsidize any gas measures in new construction where a VEA exists. This staff proposal recommends that this new construction policy go into effect in PY 2027.

D.23-04-035 phased out EE ratepayer-funded incentives for new construction gas appliance measures in the residential and commercial sectors for non-exempt and non-cost-effective measures within the market support and resource acquisition segments of the EE portfolio. The EE program determines measure cost-effectiveness within the eTRM based on the permutations within the gas appliance measure packages. The phase-out for EE ratepayer-funded incentives for these measures in new and existing programs began on January 1, 2024.

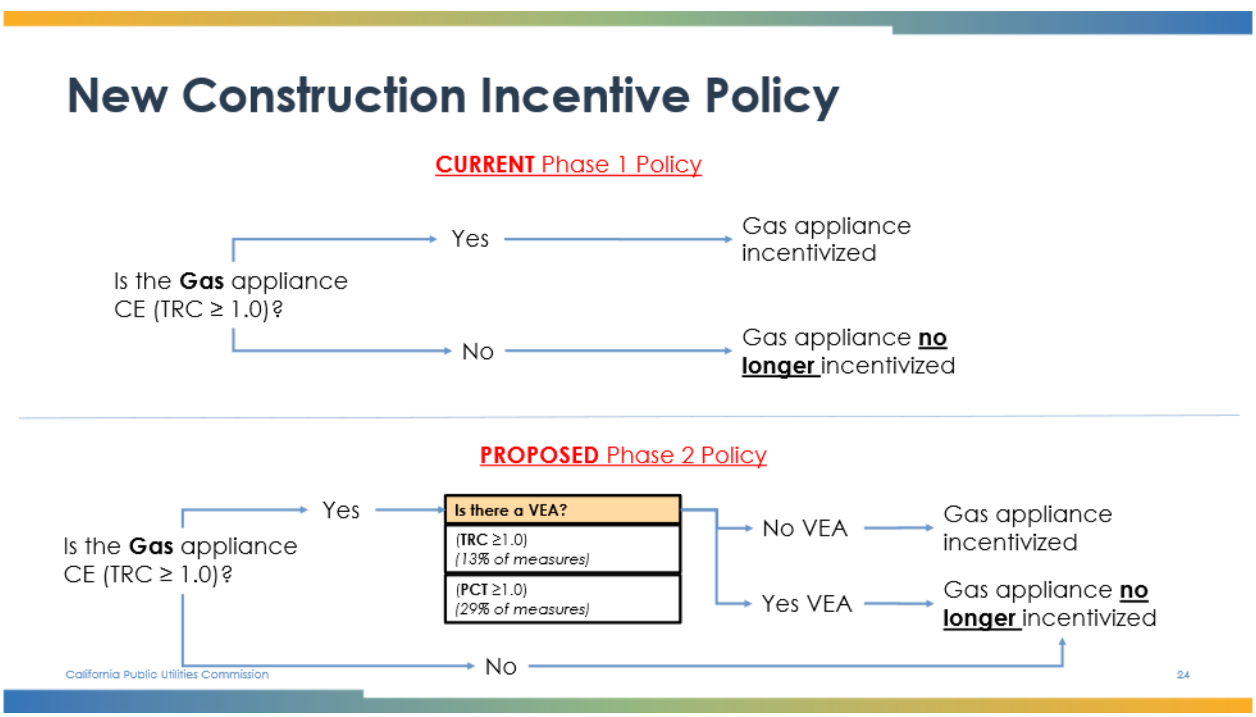
This staff proposal seeks to expand the phase-out of incentives for gas measures in new construction that have cost-effective VEAs. If a gas-measure has a VEA, it would be ineligible for EE incentives regardless of the gas-measure cost-effectiveness. This staff proposal also seeks to include the equity segment of PA's EE portfolios in the residential and commercial sectors. Table 4 lists an estimate of gas measures that would be affected. This phase-out is supported by the findings of the IOU's market studies stemming from Ordering Paragraph 7 in D.23-04-035.[45] These studies showed that differences between market rate and equity customers are relatively minor in terms of their response to incentives for fuel substitution and infrastructure upgrade costs. As explained below, expanding the VEA policy to include the equity segment for new construction will apply to customers who benefit from equity segment measures. Figure 1 illustrates how new construction incentives will change under this recommendation.

[45] Impacts of Incentives on Customer Fuel Substitution, May 31, 2024

Table 4. Example of Potential VEA New Construction Measures

Gas Equipment	Electric Alternative(s)	Sector(s) with Fuel-Substitution Measures	Sector(s) with Same-Fuel Measures	Fuel-Substitution Measure Package(s)	Same-Fuel Measure Package(s)
Clothes Dryer	Heat Pump Clothes Dryer	Res	-	SWAP014-03	-
Combination Oven	Electric Combination Oven	-	Com, Ag, Ind	-	SWFS009-03
Convection Oven	Electric Convection Oven	Com	Com, Ag, Ind	SWFS022-03	SWFS008-02
Food Fryer	Electric Food Fryer	Com	Com	SWFS021-04	SWFS011-06
Food Griddle	Electric Griddle	-	Com, Ag, Ind	-	SWFS004-02
Food Steamer	Electric Food Steamer		Com, Ag, Ind	-	SWFS005-04
Furnace (no AC)	Heat Pump	Res	Res Com, Ind	SWHC044-04	SWHC001-04 SWHC031-03 SWHC011-03 SWHC047-04
Furnace with AC	Heat Pump	Res Com	-	SWHC045-03, SWHC046-03	-
Pool/Spa Heater	Heat Pump Pool Heater	Res	-	SWRE005-03	-
Range	Electric Resistance Range Induction Cooktop/Electric Resistance Oven	Res	-	SWAP013-04	-
Space Heating Boiler, Steam	Electric Boiler	-	Res, Com, Ind	-	SWHC004-06
Space Heating Boiler, Water	Heat Pump Water Heater	-	Res, Com, Ind	-	SWHC004-06
Water Heater, Central Storage	Heat Pump Water Heater, Central	Res	-	SWWH028-04	-
Water Heater, Instantaneous	Heat Pump Water Heater	Res Com, Ind	Com, Ind	SWWH025-07 SWWH027-04	SWWH005-06
Water Heater, Storage	Heat Pump Water Heater	Res Com, Ind	-	SWWH025-07 SWWH027-04	-
Water Heating Boiler	Heat Pump Water Heater	-	Com, Ind	-	SWWH005-06
Water Heating Boiler, Central	Heat Pump Water Heater, Central	Res	-	SWWH028-04	-

Figure 1. New Construction VEA Flow Chart



The separate IOU market studies on fuel substitution infrastructure costs for equity and market rate customers showed that factors such as existing panel space and capacity constraints were very similar between these two customer segments. For example, the average panel size in a single-family equity home was 158 amps, and 175 amps for a single-family market rate home. For both customer segments, existing panel space constraints presented a far greater barrier to electrification than capacity constraints, for both single and multifamily homes. Similarly, both residential customer segments had panel upgrade costs ranging from $6,000 to $8,000. These similarities were also observed in the commercial sector results for both equity and market-rate customers.[46]

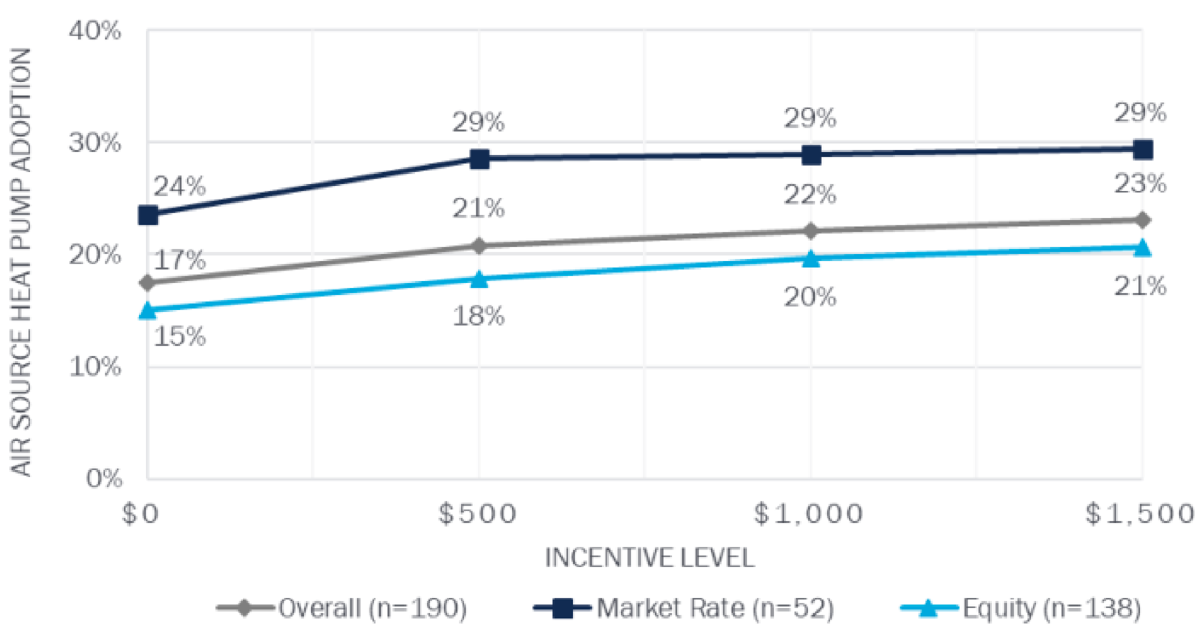
The market study on the impact of incentives for both market rate and equity customers also showed similarities across these two segments. As seen in Table 5, and Figures 2 and 3, both customer segments showed similar trends in the incentive amount that would lead them to electrify, as well as the trend in how they reported they would respond to increasing incentive levels for both replacement on burnout and accelerated replacement, with equity customers showing less sensitivity to incentives.

Table 5. Percentage Increase in Market Demand for Heat Pump Water Heaters by Customer Segment and Incentive Level

Incentive Level (as a % of Incremental Cost)	Residential Market Rate (n=221)	Residential Equity (n=322)	Commercial Market Rate (n=93)	Commercial Equity (n=139)
0% ($0)	N/A	N/A	N/A	N/A
25% ($250)	43%	44%	30%	32%
50% ($500)	21%	22%	26%	28%
75% ($750)	28%	30%	24%	26%
100% ($1,000)	37%	37%	28%	31%

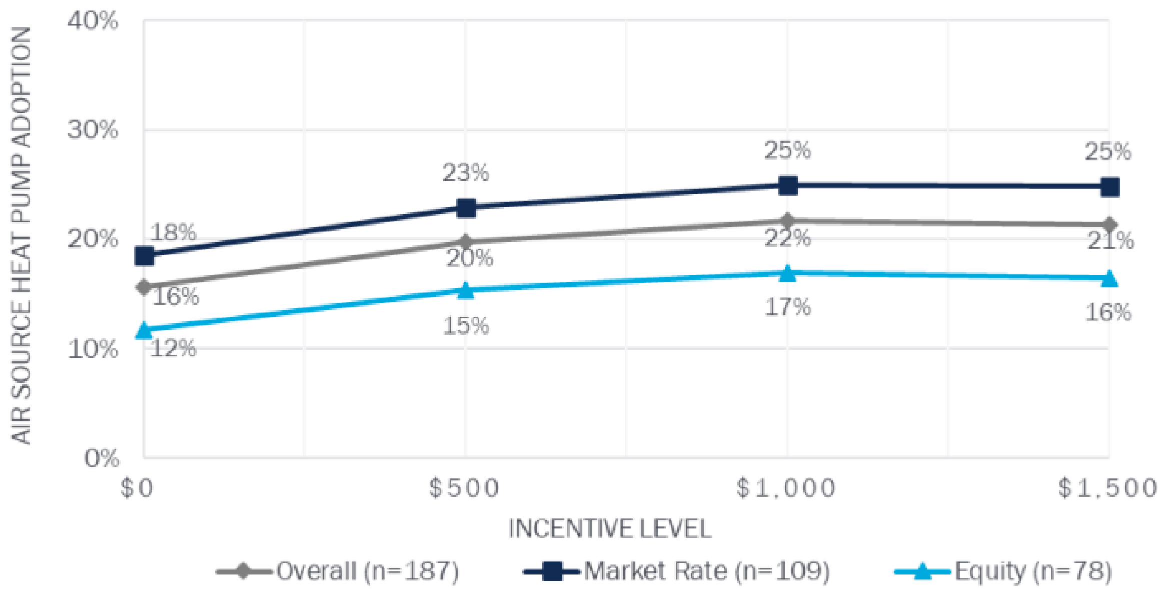
Source: Opinion Dynamics survey

Figure 2. Residential Heat Pump Price Sensitivity for Replace on Burnout



[46] Fuel Substitution Behind the Meter Infrastructure Study: Equity Segment, May 31, 2024

Figure 3. Residential Heat Pump Price Sensitivity for Accelerated Replacement



To make this change but also ensure the data on measure packages remains accessible for the purposes of VEA comparison, staff recommend that the Cal TF set up a new category of measure packages in the eTRM. This category will include gas measures rendered inactive due to a VEA for all permutations. These gas measures will be retained to assess whether new measure packages for the same end use could also become VEA measures. For example, a measure package for a gas furnace that is no longer eligible for EE incentives under VEA policy would be archived so it could be compared against new HVAC heat pump models to determine if these new models would qualify as VEA measures.

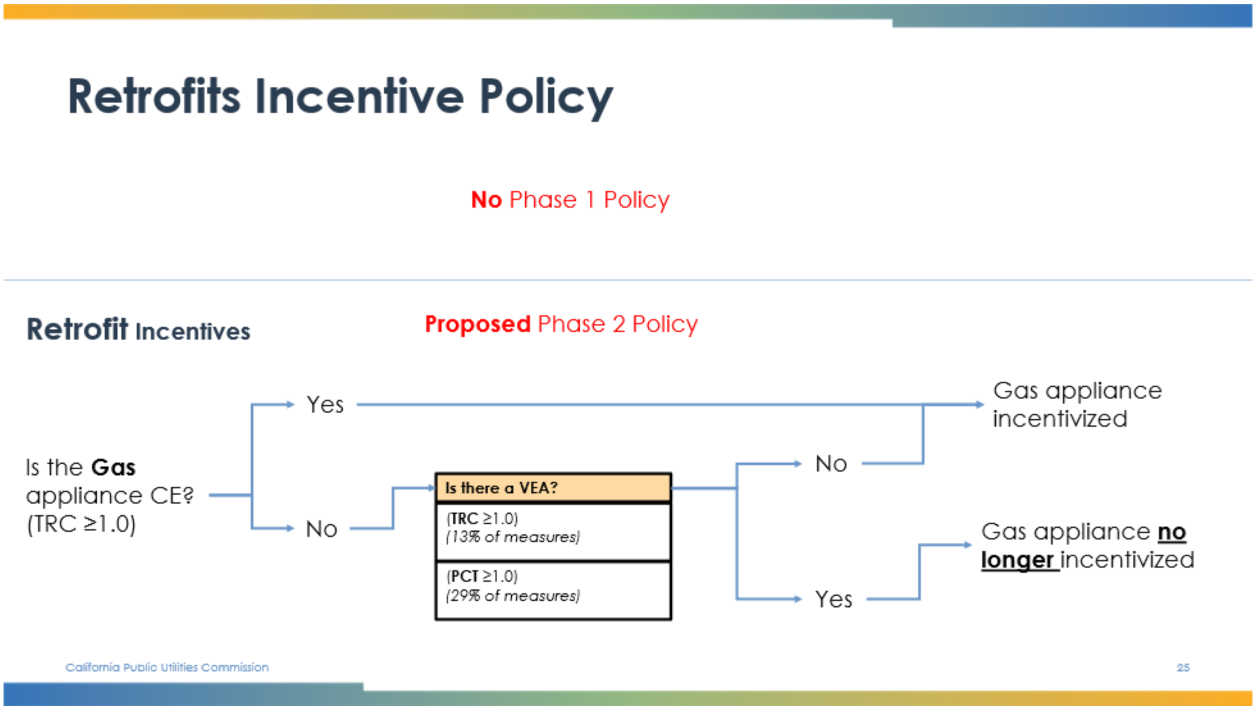
Retrofits

Staff recommend that if a retrofit gas measure permutation has a TRC below 1.0, and the alternative electric measure permutation has a cost-effectiveness ratio of 1.0 or more, then that gas measure permutation has a VEA and is no longer eligible for ratepayer-funded EE incentives (Section 3.3).

In Section 3.3, staff propose the PCT become the primary cost-effectiveness test for VEAs, in order to better consider the costs and benefits for the end-use customer. Alternatively, if the PCT is not selected, the TRC will remain the cost-effective criteria, resulting in fewer passing VEA measures due to the wider range of variables in the TRC calculation.

Staff proposes these changes to go into effect for new and existing programs on January 1, 2027. Staff recommends that third-party programs conform with D.23-04-035's directives on the same timeline as all other programs, given that standard contract language permits the utilities to modify a contract to maintain consistency with a Commission order. For both new construction and retrofit measures affected by this policy, appliances will be defined as any measure in the HVAC, water heating, food service, or appliance and plug load use category in CEDARS.

Figure 4. Retrofit Construction VEA Flow Chart



Custom Projects

This staff proposal recommends CPUC begin a stakeholder working group process to establish technical recommendations for the criteria under which natural gas EE incentives will be phased out for custom projects.

Decision 23-04-035 briefly addressed the topic of when and how a VEA policy should be adopted to phase out incentives for custom projects. Custom Projects are Site-specific EE projects that require unique calculations rather than Database of Energy Efficiency Resources (DEER) or measure package values. The stakeholder working group should address 1) how to determine VEA for custom projects' end-uses involving natural gas, 2) how to implement and use the definition of VEA to begin phasing out some ratepayer-funded EE incentives for custom projects, and 3) how to incentivize electrification in custom projects. Additionally, staff recommend these technical recommendations follow the VEA process and policy for deemed measures, such as the intent to phase out natural gas incentives where a VEA exists. The working group should submit final specific technical recommendations to the CPUC by June 1, 2027.

3.6 Pilots to Reduce Refrigerant GHG Emissions

Staff propose the Commission direct PAs submit proposals for pilot programs for GHG program opportunities, such as the examples below. These programs may be paid out of existing funding sources, including marketing and outreach budgets.

Heating, ventilation, and air conditioning (HVAC) technologies are common end-use measures with potential VEAs. Refrigerants used in refrigeration, air conditioning, and chillers have the global warming potential (GWP) to be thousands of times more polluting than carbon dioxide. Pilot programs could address education and the need for additional disposal channels to reduce refrigerant leakage risks at the stage of measure replacement and disposal to reduce end-of-life cycle emissions.[47] PAs could address and reduce refrigerant GWP through these new programs and incentives. CARB estimates leakage of refrigerants to be 1-4% for air conditioning units and 5-20% for more complex commercial refrigeration units. A 2024 CPUC-sponsored survey study found the rate of responsible recovery of refrigerants at the end-of-life is between 13% and 50%, implying up to half is vented into the atmosphere.[48]

California has existing regulations on refrigerant leakage detection, recovery and reporting through CARB, but this regulation only applies to commercial and industrial facilities with systems larger than 50lbs of refrigerant (about the size of a small grocery store), leaving the residential sector and smaller commercial facilities with less oversight and minimal incentives. Contractors responsible for refrigerant recovery have stated that there is a gap in training and awareness regarding the proper disposal and handling of refrigerants.[49] There are also significant time and labor costs associated with returning refrigerant to recycling/reclamation facilities and little to no compensation for doing so. In addition, contractors are unable to verify the quality of refrigerant until it is brought to a facility, where it may be deemed too contaminated to recycle for reuse, thereby limiting or eliminating resale value.[50]

Refrigerant Training Program Pilot

One potential pilot program could encourage contractors/technicians to provide verification of refrigerant recovery and provide simultaneous training on the importance of using low-GWP refrigerants when possible. The GWP savings achieved through the verification of recovery and use of low-GWP refrigerants could be eligible for Total System Benefit (TSB) cost claims. Natural and ultra-low-GWP refrigerants should be prioritized when and where they are permitted and not cost-prohibitive. This would help improve the adoption of low-GWP refrigerants and encourage contractors and technicians to practice verification of the recovery process.

Refrigerant Disposal Pilot Program

Another pilot program could incentivize disposal by establishing a monetary baseline for the recovery of contaminated refrigerants, which would lower contractor concerns of expending time and effort to recover refrigerants that may not be recyclable. This incentive could take the form of an emission credit for documented end-of-life refrigerant recovery and reclamation paid to contractors for approved documentation submitted to an approved drop-off facility. The pilot could identify

47 Stationary Hydrofluorocarbon Reduction Measures | California Air Resources Board
48 CPUC_Forward-Looking_Low-GWP_Refrigerant_Transition_Study.pdf
49 CPUC_Forward-Looking_Low-GWP_Refrigerant_Transition_Study.pdf
50 Voluntary registration could create a pattern of documentation and promote regular maintenance.

whether the coupling of a refrigerant recycling program with the timeline of actual installations could improve proper recycling and disposal habits. The program could establish a network of drop-off facilities using existing businesses or organizations involved in refrigerant distribution and offer incentives or compensation for participating distributors.

Refrigerant Leak Detection Program

The PAs could establish a leak detection program that offers free or discounted maintenance for buildings with systems using less than 50lbs of refrigerant, including small commercial facilities and residential sites. This avoids duplication, as CARB already mandates facilities with over 50lbs of refrigerant to register and report refrigerant leakage using the CARB website. The program could offer smaller commercial facilities additional credits or incentives for documenting and registering their refrigerant system. Voluntary registration could create a pattern of documentation and promote regular maintenance. Additionally, there could be an education campaign program for residential customers to better understand the environmental costs and energy costs of HVAC system refrigerant leaks. The leak detection program incentive could take the form of TSB credit for mitigated/discovered leakage.

All programs should be implemented and coordinated by PAs and adhered to be their 3rd party affiliates with input from CPUC staff, and with consideration of CARB and local Air District programs/incentives. PAs should encourage layering incentives, i.e., allowing end users to qualify for multiple programs and/or simultaneous programs, under the guidance provided in the CPUC's incentive layering decision (D. 21-11-002).

This Staff proposal does not seek to prescribe any specific low-GWP refrigerants over others. As discussed in the Code Compliance section, there are a variety of low-GWP refrigerants with varying levels of local code compliance. Additionally, costs and availability also vary. As such, the VEA GHG savings programs will follow CARB and US EPA designations for approved low-GWP refrigerants and follow local and state building codes for allowable use.

3.7 Viable Electric Alternative Assessment Methodology

Staff developed a methodology, detailed below, for PAs who want to offer a VEA. This methodology was informed by the 2023 Measure Package Working Group Recommendations, attached as Appendix C. This staff proposal recommends PAs follow these steps to determine if a program can offer a VEA in the EE Portfolio. PAs would apply the methodology to existing gas measures and potential VEA electric measures through a one-time review. As PAs or program implementors introduce new applicable gas and potential VEA electric measures into the portfolio, CPUC staff would check measures one by one or batched in a regular cadence.

The proposed VEA Assessment begins with the categories of electric measures then gas measures that could be removed. First the program adds each measure's specific information, followed by the existing gas and electric measure baselines. Then the program compares this measure specific information to existing gas and electric measure offers, proposed VEA measure package information, and proposed VEA gas measure baseline and VEA checks. The last step is to offer ID-level VEA viability tests.

Determine the Gas Measure and the corresponding proposed VEA Measure

The PA must first define or obtain the key parameters of the gas measure package and corresponding fuel substitution or electric alternative measure package and determine if the parameters are fundamentally similar and suitable for comparison. Often this would come from existing measure packages. In general, there will be one or more predefined electric measure offering (proposed VEA) with a gas baseline. Those "electrified" measure cases will have one or more existing gas baseline measure offerings as the proposed VEA and an energy efficient gas measure alternative to the fuel substitution measure.

Depending upon the measure and the number of relevant base cases, there potentially could be dozens of offering IDs to compare and even more permutations to compare. The more complex cases arise with water heating measures, where there could be multiple gas baselines (tank, condensing tank, tankless, boiler, etc.) paired to one or more "similar" electric measures.

As part of the framework, the key parameters to evaluate include:

- Similar technology delivery sizes/permutations for both,
- Qualified Product List (QPL) for each,
- Technology level of service (LOS) metric (e.g., first hour rating (FHR), lbs/hours, etc.) that typically do not exist in current measure packages,
- Similar normalized units, similar program measure eligibility,
- Similar program delivery,
- Similar baseline assumptions and permutations for both, similar eligibility restrictions,
- Similar building types and vintages,
- Similar measure application types (MATs),
- Similar climate zones,
- Similar code requirements that don't impact deployment and ratepayer cost-effectiveness metrics (TRC).

Determine if the VEA Measure passes the High-Level Screen

The high-level screen applies the VEA framework at the measure package offer ID level. The intent of the high-level screen is to determine the preliminary viability of the VEA measure, primarily at the offer ID level, before proceeding to more rigorous analysis at the permutation level.

The PA may need to further research beyond the information provided in the gas measure package and proposed VEA measure packages. The PA must consider local ordinance restricting use of electric measures, which can vary by location. The PA must perform a CET analysis to determine the TRC of the gas measure and the cost-effectiveness of the electric measures. There must also be market availability of the electric measure to verify it as a VEA.

The VEA Methodology describes the pathway sequence of how VEA documentation should proceed and how it should ideally align with DEER bus stop[51] schedules for submitting new measures packages that may drive changes to permutation eligibility recommended by the stakeholder VEA Measure Package Working Group. The itemized section below describes the various steps staff envision to implement VEA calculations.

It is likely that a significant "start-up" process could make the collection of data more complete and less rushed. This interim analysis could occur before the next update cycle for PY26 and could include much of the "no regrets" analysis including:

- Defining the customer costs within the measure package.
- Defining the inputs to the EAA analysis to ensure that VEA and gas offerings are comparable.

Staff recommend that this work fall under the PA lead for the measure packages that have been identified as proposed VEAs. Collecting "no regrets" information before measure development on PY26 measure packages begins will make it clear what data needs to be updated and/or collected during the typically busy measure development period. Gas and VEA data collectors will collect data outside of the eTRM initially, potentially in a Basecamp or SharePoint site, to ensure consistency. Programs will approve and store the collected data in new measure packages for the next program cycle as value tables mapped to measure-specific parameters. Close coordination between matched VEAs and gas offerings will be needed. The process will involve collecting data from the VEA offering and comparing it to the gas offering.

It is important to ensure that data sets are comparable between the VEA measures and the gas measures in terms of climate zones, building types, and offerings. The eTRM can set flags on a measure package permutation level, based on the cost-effectiveness using a methodology to calculate a typical program administration cost and a typical rebate amount. These values may change biennially to reflect the most recent Avoided Cost Calculator (ACC) year and appropriate starting year of claims. Programs use this approach for the Phase 1 VEA, within the eTRM permutation level data.

With that context, the following is a high-level overview of the steps in the VEA assessment process:

- **Step 1: Assemble Viable Measures**
    - The first step is to determine which measure packages may be eligible to become VEAs. The intent here is to filter out gas or exempt measure packages. The PA must determine what measure application type or types apply to each measure.

[51] DEER bus stop refers to the annual DEER resolution adoption date, September 1st, every year.

  - To perform the high-level screen, the PA must determine if the VEA is commercially viable, provides the same level of service, and if the VEA measures have viable program cost-effectiveness metrics (PCT/TRC). The PA must also determine if there are sufficient products and manufacturers available in the market. PAs should ask the following questions: Is the same level of service provided? Are code requirements met consistently throughout all PA territory? Has it passed the fuel substitution test? The PA must analyze the gas measure package and proposed VEA measure package as part of the VEA Assessment.
- **Step 2: Manual Adjustments**
  - Alignment at the measure package offering level between gas offerings and proposed VEA offerings (if they exist).
  - Alignment of the baselines between the measure package offerings that are being compared.
  - Documentation and/or tracking of documentation that VEA offerings fully comply with VEA criteria. For example, if only a small number of commercially available products are on the market, a tracking system should be available to make it easier to understand when this criterion is fulfilled.
  - Offerings should include recommendations on how to address common misalignments in a consistent manner.
  - Establishment of common level of service calculation between the gas and proposed VEA offerings that is appropriate for the offering.
  - Programs should analyze whether VEA offerings comply with code and if any features vary at the local (i.e., non-State) level.
    - Are code requirements met consistently throughout all PA service areas? The PA must consider code restricting use of electric alternatives, which can vary by location.
    - As part of this review, the PA should check whether local jurisdictions should define some code issues (i.e., refrigerants). Measure property data could document compliance when information is variable due to local codes. Whenever possible, rules should be consistent across the state so that implementers can avoid the administrative cost of complex/varying rules. This work may reasonably fall under the implementor or installer of the VEA measure packages. Measure property data fields in the eTRM or CEDARS could help collect site level (i.e. climate zone, building type, etc.) claim data to ensure compliance.
- **Step 3: Screening**
  - If the high-level screen identifies an electric measure as a potential VEA, the PA will proceed with the permutation-level screen. The intent of the permutation level screen is to determine which measure permutations meet cost-effectiveness criterion, as established within this framework. The expectation for many measures is that there will be scenarios where some permutations pass the test and others do not. PAs should follow the same general process to match baselines at a permutation level from step one.

    - For both the gas measure and proposed VEA measure the PA extracts the relevant measure package details from the eTRM, such as measure effective useful life, energy savings, and measure costs. The PA calculates the operating costs, such as incremental maintenance, level of service, and bill impacts. The PA accounts for benefits, such as program incentives, which per the VEA Phase 1 Decision are set at 50% IMC. Some of these items do not currently exist in current measure packages.
- **Step 4: Measure Feasibility Check**
    - Input from the infrastructure cost working group, including panel costs and allocations by measure and potential customer bill impacts would be additional inputs to supplement current measure package data for the purposes of cost effectiveness. The PA then calculates and evaluates the Equivalent Annual Annuity (EAA) of the gas measure and VEA measure relative to their respective baselines. The EAA is meant to align two measures with different lifecycles and compare them on an equivalent monthly cost basis.
        - The formula for the EAA is:
        - Equation 2. Equivalent Annual Annuity

$$EAA = \frac{r \times NPV}{1-(1+r)^{-n}}$$

        - r= Discount rate (The weighted average cost of capital - is the rate that a company is expected to pay on average to all its security holders to finance its assets. For residential it would be a loan rate. Should be the same basis as n, e.g., yearly discount rate)
        - n= Investment periods (should be the same basis as r, e.g. number of years)
        - NPV= Net Present Value
            - The EAA formula shows the NPV of an investment as a series of equal cash flows for the time duration of the investment. Longer dated investments are riskier as they take longer to pay back to the investor. The EAA compares multiple investment opportunities with different terms to maturity by translating returns into an equivalent annual rate, the value of selling in one year. This way, all investments are compared on equal terms.
- **Step 5: Review for "Potential Passes"**
    - In this step, the PA must review the permutation level values from Steps 3 and 4 to assess which permutations of a potential VEA a measure passes.
    - The values that go into assessing the level of service vary in their metrics across measures, and between gas and electric measures. Because of this the PA must

establish criteria for comparing the level of service between gas and electric measures for each of the measured packages.

- **Step 6: Administrative Review**
  - Staff propose that California Technical Forum (CalTF) act as the facilitator for the initial review of the permutations that reach this level to ensure the measures appropriately and consistently apply all steps – especially the level of service comparison and code comparison.
  - CPUC staff will then review the work, notify the PA of any required changes, and once the material is satisfactory, direct CalTFand/or the PA to flag the measure as a VEA in the eTRM.
- **Step 7: Final Notification**
  - Once the eTRM adds the VEA flags to the measure, CPUC staff will issue a 90-day notice to inform stakeholders of the update. This will allow PAs and implementers to adjust their programs accordingly.

This proposal welcomes any stakeholder feedback on the overview of steps above, including clarifications or additions or revisions.

3.8 Viable Electric Alternative Re-Evaluation Process

Staff propose the Commission's VEA policy also provide a process for re-evaluating measures over time, using recommended criteria and triggers to potentially reinstate rebates for gas measures replaced by a VEA measure.

The VEA processes and schedules identify VEAs and removes gas measures from eligible rebates. However, assumptions supporting the VEA criteria and methodology are not stagnant. It is important to recognize that assumptions may change over time and could warrant subsequent analysis to determine if gas measures could potentially be removed from a restricted list. Considerations include changes to policies, relative increases in electric rates versus gas rates, or new, efficient and cost-effective gas technologies being introduced to the EE portfolio. The intent of this staff proposal is that the VEA criteria are robust enough so that measures would be removed once and not returned; this approach would be used to accommodate one-off situations.

The staff proposal recommends completing a comprehensive analysis of all existing, relevant, active measures (elaborated in Appendix B). The results of this analysis would inform VEAs and gas measures no longer eligible for rebates for the next DEER bus stop[52]. Programs that retire any measures due to VEA approval would be subject to the same retirement period and notification as other measures. Typically, the measure review team would flag measures not eligible for rebates in a resource acquisition or any other program would be flagged as not eligible for rebates or incentives, however, they will be kept as active or inactive measures for use by programs not subject to any cost-effectiveness test.

[52] DEER bus stop refers to the annual DEER resolution adoption date, September 1st, every year.

All existing, relevant active measures will be re-evaluated in the following DEER bus stop, every two years, subject to other regulatory directives. This timeline aligns with avoided costs and DEER updates. Within the measure package update schedule, the staff proposal recommends that programs approve electric measure packages first such that any subsequent updates to gas measure packages can leverage the electric measure package data to apply within the VEA Assessment (versus initially updating both measure packages to align). Additionally, it will be necessary for the measure packages to produce permutation-level savings and costs under the same normalized units to enable ease of comparison. Since the measure package review team will flag permutations as ineligible for incentives or rebates from the gas measure, there will need to be documentation in the gas measure that will reference the VEA.

Programs should include the documentation in the measure package's non-energy impacts (related infrastructure improvements) section and include the VEA analysis, and a description of why the gas measure permutations are missing/flagged as ineligible or the entire measure retired. The VEA measure package shall include a linkage between an electric measure and its associated gas measure package. This is useful in the case all permutations of a gas measure package are phased out due to the VEA analysis.

Programs may introduce new fuel substitution measures between DEER bus stops. If the measure package review team approves a new fuel substitution measure, it will trigger a VEA Alternative Analysis for the relevant gas measure package. The result of the VEA analysis (previous section) will determine whether to phase out the gas measure permutations if the criteria are met for the electric alternative to be considered viable. The new fuel substitution measure should address the same level of service criteria in this VEA Technical Guidance to streamline the VEA Assessment application. To minimize disruption to ongoing programs, the staff proposal recommends that programs hold the VEA analysis for the associated gas measure package until the next DEER bus stop.

Finally, staff proposes that EE administering PAs track and report program results of the VEA analysis (including the VEA Assessment results for each measure) within the California eTRM. Currently, the "restricted permutation" flag provides the mechanism to identify permutations that do not meet criteria. Additional expansion of the "restricted permutation" flag may be needed to track the results of the VEA Assessment. In line with this, staff recommends the Cal TF to include a column in the eTRM showing the PCT for VEA measures with assumed admin costs using the methodology from VEA Phase 1.

4 Questions for Stakeholders

- Title 24 prescriptive versus performance-based standards
  - What data source should be used to identify the percentage of buildings that use either the prescriptive or performance-based standards?
- Exempt measures
  - Should the definition of "exempt measure", or the policy around it, be expanded or changed?
- Equity
  - What other actions should this staff proposal take to encourage electrification among equity customers?
- Fuel substitution infrastructure costs
  - Is it safe to assume that the basic costs for connecting a fuel substitution measure to a building (wiring, labor) is currently included in each fuel substitution measure package in the eTRM?
  - Going forward, what other infrastructure or other installation costs (beyond the behind-the-meter costs discussed in this staff proposal) should the CPUC consider in assessing cost effectiveness? Customer-funded utility-side-of-the-meter upgrades? Local permitting costs? Other costs?
  - What existing data sources should the CPUC use to assess the avoided capital and operating costs of not using a gas measure for the purpose of assessing the Participant Cost for gas and possible VEA measure permutations?
  - How often should the CPUC re-examine the likelihood and cost of customer infrastructure upgrades related to fuel substitution?
  - What other data sources should the CPUC consider to inform assumptions on the likelihood and cost of customer infrastructure upgrades related to fuel substitution?
- Fuel substitution potential estimated bill impacts
  - What is the best source to use for PV solar + battery storage penetration in California?
  - What level of granularity should the CPUC use for including potential bill impacts related to fuel substitution in assessing cost effectiveness for those measures?
- Refrigerant leakage detection and mitigation, and low-GWP refrigerant programs
  - Are PAs the appropriate implementors of refrigerant leakage detection, reclamation/recycling programs? If not, who is?
  - How should pilot programs use EE incentives to encourage refrigerant recycling and the use of low-GWP refrigerants be set up?
  - Should contractors be offered incentives for documenting refrigerant reclamation, how much should be offered or how should a documentation incentive be determined?
  - Should contractors be offered above market price for returning refrigerants that are deemed to be contaminated? If yes, how should this additional price be determined?

- VEA Cost Effectiveness
  - Should VEA measures use TRC or PCT for evaluating cost effectiveness?
  - Should other cost-effectiveness criteria be considered?
- VEA methodology and Assessment
  - Do you agree with the proposed VEA methodology? If not, what should be added or changed?
  - Should any additional specificity be added to the proposed VEA methodology and assessment?

5 Appendix A: Fuel Substitution Behind the Meter Infrastructure Market Study

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6 Appendix B: Fuel Substitution Infrastructure Cost WORKING GROUP Recommendations

Working Group Report:
Fuel Substitution Infrastructure Cost Attribution

March 2024

Drafted by a stakeholder group pursuant to California Public Utilities Commission Decision 23-04-035 Ordering Paragraph 1

Contents

1. Revision History

Version	Date	Updates
0.0	2/12/2024	Draft 01 – Fuel Substitution Infrastructure Cost Attribution Working Group Recommendations
1.0	2/16/2024	Draft 02 following first round of WG review
2.0	2/28/2024	Draft 03 following second round of WG review
3.0	3/11/2024	Draft 04 following third round of WG review
4.0	3/24/2024	Final Draft 05

2. Introduction

A. Policy Background

The CPUC's Energy Division Staff (ED Staff) in 2022 began working on phasing out EE incentives for some natural gas energy efficiency ("EE") measures, in line with the state-wide priority of decarbonization. On January 13, 2022, Sierra Club filed a motion in R.13-11-005 seeking a prohibition on EE incentives for non-cost-effective gas appliance incentive measures in utilities' EE portfolios.[53] Sierra Club identified that the vast majority of gas appliance incentive measures in EE programs had Total Resource Cost (TRC) Test and Program Administrator Cost (PAC) Test ratios of less than 1.0, and that their inclusion in utilities' EE Business Plans under the portfolio approach was a poor use of ratepayer funds intended to provide incentives for cost-effective EE measures and market support for promising new EE technologies that are not yet established in the market.[54] The Commission took up consideration of Sierra Club's Motion in August 2022 in A.22-02-005, et al., seeking comments on an ED Staff proposal for phasing out EE incentives for natural gas measures.[55] In their proposal, ED Staff suggested several criteria to determine whether a given gas measure has a Viable Electric Alternative (VEA), in which case the Commission should consider whether to phase out the corresponding EE gas measure incentive.[56]

After considering party comments on the ED Staff Proposal and a Proposed Decision, on April 14, 2023, the Commission issued Decision (D.)23-04-035.[57] Under this decision, beginning in 2024, the Commission eliminated ratepayer-funded incentives for non-exempt,[58] non-cost-effective gas measures in new construction projects with no existing gas line, and for new construction projects with an existing gas line if gas usage will materially increase.[59] This policy applies to the residential and commercial sectors in the resource acquisition and market support portfolio segments.[60] With regard to the equity segment programs and measures for retrofits, the Commission chose to "defer action on those recommendations" to allow time for development of a VEA analysis and related market studies.[61]

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[53] R.13-11-005, Sierra Club Motion to Prohibit Energy Efficiency Funding for Non-Cost-Effective Gas Appliance Incentive Measures, (Jan. 13, 2022) ("Sierra Club Motion"), https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M441/K160/441160400.PDF.
[54] Sierra Club Motion at 10–16.
[55] A.22-02-005, Administrative Law Judge's Ruling Inviting Comments on Staff Proposal for Gas Energy Efficiency Incentives and Codes and Standards Sub-Programs and Budgets, at 2–4 (Aug. 2, 2022), https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M496/K396/496396749.PDF; Energy Division Staff, EE Natural Gas Incentive Phase Out Staff Proposal, (July 2022) ("Staff Proposal"), https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M496/K397/496397066.PDF.
[56] Staff Proposal at 7, 8.
[57] D.23-04-035, Decision Addressing Codes and Standards Subprograms and Budgets and Staff Proposal on Reducing Ratepayer-Funded Incentives for Gas Energy Efficiency Measures, (April 14, 2023), https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M505/K808/505808197.PDF.
[58] A measure is considered "exempt" if it results in gas savings but does not burn gas (*e.g.*, building insulation, sealing, smart thermostats, faucet aerators and building envelope measures such as windows and doors). *Id.* at 8.
[59] *Id.* at 20–21.
[60] Id.
[61] *Id.* at 6. *See also id.* at 25–26 (describing upcoming market studies and ordering the investor-owned utilities to additionally fund three market studies exploring (1) fuel substitution infrastructure costs for equity segment customers, (2) market rate customer fuel substitution mark study, and (3) equity segment customer fuel substitution market study).

To develop the VEA analysis, D.23-04-035 directed CPUC staff to create a VEA Technical Guidance Document ("TGD"). The Commission adopted a modified version of ED Staff's proposed criteria for identifying whether a measure has a VEA, accepting the first two criterion and modifying the third criterion as reflected below:[62]

1. Is there an electric alternative to the gas measure that has the same end use in any eTRM measure package?
2. Is the measure package for the electric alternative substituting either from a natural gas baseline to electric, or from a mixed-fuel (natural gas and electric) baseline to electric?
3. Are the customers' benefits of electrification greater than their costs?

The Commission described the "potential customer benefits of electrification" and "potential customer costs of electrification" to be considered by Question 3 as follows:[63]

Table 1. Potential Customer Benefits and Costs of Electrification per D.23-04-035 Section 2.3

Potential Benefits	Potential Costs
Gas bill decreases: the difference between electrification and an energy-efficient gas baseline; *i.e.*, improved gas efficiency that would have occurred in the absence of electrification	Electric bill increases: the difference between post-electrification electric bills and the customer's existing electric baseline; these calculations will be based on the CPUC fuel substitution bill impact tool that is currently under development and planned for completion in 2024
All incentives and rebates for electric equipment, including from energy efficiency, SGIP, BUILD, TECH and programs administered/overseen by other agencies	Electric equipment costs, including installation, operations and maintenance, *etc.*
All tax credits, including federally-funded electrification support from the Inflation Reduction Act and other federal funding, as well as any available California tax credit	Costs of building or electric infrastructure upgrades needed for electrification; these costs should be proportional to the generalized percentage of building electric load that is required for any particular measure
The cost of gas equipment (including installation, operations and maintenance, *etc*.) that would have been incurred had the efficient gas measure been installed rather than the electric alternative	
The policies reduce air pollution and improve indoor air quality and health benefits	
Reduces the impact of stranded gas infrastructure	

Additionally, the TGD must address, at a minimum:[64]

- How to allocate costs of behind the meter electric infrastructure upgrades needed for electrification;
- How to use the customer bill impact calculator involved in the third viable electric alternative criterion;
- The best test for comparing the benefit to cost ratio for customers between the gas measure and its potential viable electric alternative;
- Development and maintenance of a list of measures no longer eligible for ratepayer-funded

[62] D.23-04-035 at 16–7.
[63] *Id.* at 17–18.
[64] D.23-04-035 at 23.

incentives; and

- The process for making updates or changes to measure packages and eTRM as needed, including what existing measures are viable electric alternatives, and removing measures that are no longer eligible for ratepayer-funded incentives.

The TGD was directed to be developed through a series of workshops and working groups. The draft TGD must be issued "in time to inform the 2025 Potential and Goals study."[65] The Commission stated that its intent is "to eliminate ratepayer-funded incentives for non-exempt, non-cost-effective gas efficiency appliances with a viable electric alternative in the market support segment and in the commercial and residential sectors of the resource acquisition segment for most projects (i.e., retrofits, custom and normalized metered energy consumption) if and when the Commission adopts the Technical Guidance Document."[66] ED Staff convened two stakeholder working groups to inform the development of the draft TGD: the working group to determine Viable Electric Alternatives in the California Electronic Technical Reference Manual (eTRM), the working group to determine Fuel Substitution Infrastructure Cost Attribution. The latter working group produced this report.

B. Goal of the Fuel Substitution Infrastructure Cost Attribution Working Group

The goal of the Fuel Substitution Infrastructure Cost Attribution Working Group (hereafter referred to as "WG") was to leverage the outcomes of Opinion Dynamics Market Study[67] and other relevant data sources to determine how to assess the fractional attribution of electrification-enabling building infrastructure upgrade costs between an energy efficient (EE) gas-to-electric fuel substitution measure[68] and other electrification equipment (e.g., electric vehicle charging or photovoltaic solar) that may be installed in parallel with, or subsequent to, the fuel substitution equipment.

Deliverables from the WG include recommendations for the approach to assessing (a) the percentage of electrification infrastructure upgrade costs that can be attributed to a single EE fuel substitution measure versus other electrification measures, (b) how frequently different types of infrastructure upgrades are needed for different building types, and (c) the costs of infrastructure upgrades for different building types for both residential and commercial sectors. The recommendations herein were developed by the WG members and CPUC Energy Division (ED) staff.

3. Scope of Fuel Substitution Infrastructure Upgrade Costs

[65] *Id.* at 24.
[66] *Id.* at 7.
[67] D.23-04-035 at 19-20 described a fuel substitution infrastructure cost market study to be conducted under Task 6 of the CPUC's current Group E contract by Opinion Dynamics ("Opinion Dynamics market study"). Final study results were shared with this WG in Q4 2023 and Q1 2024. The final report has not yet been published.
[68] An EE gas-to-electric fuel substitution measure consists of the equipment and labor required to install an electric appliance, where the baseline alternative is a gas appliance for the same end-use (e.g., domestic hot water heating, space heating, cooking, or clothes drying). Examples of gas-to-electric fuel substitution measures include heat pumps (HPs), heat pump water heaters (HPWHs), induction stoves, and heat pump dryers.

The WG recommends that the scope of fuel substitution infrastructure upgrade costs include the following components listed in this section. While the fuel substitution appliance measure costs include the costs of the appliance itself (e.g., heat pump water heater or heat pump) and the associated labor costs to install the appliance, as well as any necessary electrification-enabling building infrastructure upgrades, the focus of this WG is on the electrification-enabling building infrastructure upgrade costs only. The equipment and labor costs associated with the fuel substitution appliance itself are excluded from the scope of this WG.

A. Customer-side of the meter

The electrification-enabling building infrastructure upgrade costs should include the total cost of all labor and electric equipment and/or hardware on the customer side (or home side) of the meter required to enable the fuel substitution measure to operate (excluding the equipment and labor costs to install the fuel substitution appliance only). Customer-side of the meter costs potentially include equipment and labor costs associated with electric panel upgrades or modifications and electric wiring between the panel and the appliance.

B. Utility-side of the meter

The electrification-enabling building infrastructure upgrade costs should include electrification-enabling infrastructure upgrade costs on the utility-side of the meter for which the customer would normally be responsible to pay under the California electric investor-owned utilities'[69] tariffs (Electric Rule 16).[70] Additionally, per the electric utilities' tariffs,[71] WG understands that there are allowances covered by the Utilities to minimize cost to the customer; however, in many cases, these allowances may not cover the full cost of the service upgrade. Discussion of the potential variability in service upgrade costs for fuel substitution measures can be reviewed in a SDG&E and PG&E-sponsored study on service upgrades for electrification retrofits.[72] While service upgrade costs driven by added electric load from fuel

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[69] The California electric investor-owned utilities (IOUs) are San Diego Gas and Electric Company (SDG&E), Southern California Edison (SCE), and Pacific Gas and Electric Company (PG&E).

[70] Each electric Investor-Owned Utility's Electric Rule 16 for *Service Extensions* details cost responsibilities of the customer and the utility applicable to new service extensions and service upgrades. See SDG&E's Electric Rule 16 tariff.sdge.com/tm2/pdf/tariffs/ELEC_ELEC-RULES_ERULE16.pdf, SCE's Electric Rule 16 https://edisonintl.sharepoint.com/teams/Public/TM2/Shared%20Documents/Forms/AllItems.aspx?ga=1&id=%2Fteams%2FPublic%2FTM2%2FShared%20Documents%2FPublic%2FRegulatory%2FTariff%2DSCE%20Tariff%20Books%2FElectric%2FRules%2FELECTRIC%5FRULES%5F16%2Epdf&parent=%2Fteams%2FPublic%2FTM2%2FShared%20Documents%2FPublic%2FRegulatory%2FTariff%2DSCE%20Tariff%20Books%2FElectric%2FRules, and PG&E's Electric Rule 16 https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_RULES_16.pdf.

[71] Each electric Investor-Owned Utility's Electric Rule 15 for *Distribution Line Extensions* details service extension allowances for service upgrades. See SDG&E's Electric Rule 15 https://www.sdge.com/sites/default/files/elec_elec-rules_erule15.pdf, SCE's Electric Rule 15 edisonintl.sharepoint.com/teams/Public/TM2/Shared Documents/Public/Regulatory/Tariff-SCE Tariff
https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_RULES_15.pdf.
Books/Electric/Rules/ELECTRIC_RULES_15.pdf?CT=1708132490247&OR=ItemsView, and PG&E's Electric Rule 15

[72] NV5 Inc., *Service Upgrades for Electrification Retrofits Study Final Report*, dated May 27, 2022. Accessible at https://pda.energydataweb.com/api/view/2635/Service%20Upgrades%20for%20Electrification%20Retrofits%20Study%20FINAL.pdf.

substitution measures are considered valid components of measure cost consistent with CPUC policy,[73] these costs have not been included in this WG report due to lack of applicable data. Future data will be needed to better understand electrification-enabling infrastructure upgrade costs on the utility-side of the meter including cost incurred by the customer and cost allowances covered by Utilities. See Section 10 for more details on future data needs.

C. Building Permits

Many construction processes require permits from the local Building Department in accordance with Title 24 Part 6, for both residential or nonresidential electrification projects. Work on new construction or existing buildings that requires permitting include: installation, additions, and alterations of systems such as building envelope, plumbing, mechanical, and electrical. Permits for some types of simple projects may be issued at the building department counter with minimal documentation, while other more extensive projects require longer review by a plan examiner. In addition to regular field inspections by a building inspector, verification of specific systems may be needed by a Home Energy Rating System (HERS) provider and testing of certain equipment by an Acceptance Test Technician may be necessary when triggered by the code. Building permit costs are expected to differ for every city and county.

While building permit costs associated with an electric panel upgrade (or service upgrade) to accommodate the installation of electrification-enabling building infrastructure upgrades are considered valid components of measure cost consistent with CPUC policy,[74] these costs have not been included in this WG report due to lack of applicable data. See Section 10 for more details on future data needs.

4. Pre-Existing Electric Panel Conditions Prior to Fuel Substitution Measure Installation

A. Residential

A 2019 California Residential Building Electrification study[75] conducted by Energy+Environmental Economics (E3) suggests that in general, 200-amp electrical service is needed to serve homes with both an HVAC heat pump and a heat pump water heater. While most newer homes have 200-amp service, many older homes in California do not. In the E3 study, the panel upgrade costs were applied to pre-1978 vintage single family. The E3 study also suggested that the 2009 Residential Appliance Saturation

[73] D.19-08-009, *Decision Modifying the Energy Efficiency Three-Prong Test Related to Fuel Substitution,* (August 1, 2019) at 23 suggests that inclusion of building upgrade costs (including those necessary to increase the building total electric load) in the overall measure cost of a fuel substitution measure is consistent with general EE cost-effectiveness policy "which requires that all relevant participants costs be reflected in the [cost-effectiveness] analysis."

[74] D.19-08-009, *Decision Modifying the Energy Efficiency Three-Prong Test Related to Fuel Substitution,* (August 1, 2019) at 23 suggests that inclusion of building upgrade costs (including those necessary to increase the building total electric load) in the overall measure cost of a fuel substitution measure is consistent with general EE cost-effectiveness policy "which requires that all relevant participants costs be reflected in the [cost-effectiveness] analysis."

[75] Energy+Environmental Economics, *Residential Building Electrification in California - Consumer Economics, Greenhouse Gases and Grid Impacts*, April 2019. Accessible at ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf.

Study (RASS)[76] showed a clear trend towards increasing central air conditioning prevalence in newer home vintages, with over 90% of new single-family homes statewide including central air conditioning post-2000, which may be indicative of higher electric panel capacity.

Additionally, a recent program evaluation study of the Technology and Equipment for Clean Heating (TECH) Initiative[77] suggests that solar photovoltaic (PV) systems was a commonplace among TECH customers who purchased a HPWH, and that in most cases the existing electric panel capacity was able to accommodate the building electrification measure without an electric panel upgrade.

The Opinion Dynamics Market Study results[78] suggest that the predominant panel size in sampled residential customer homes, including both single family (SFM) and multi-family (MFM), was 200 amps followed by 100 amps, 125 amps, and 150 amps. The square footage of sampled SFM homes and MFM dwellings averaged 2,000 square feet (sqft.) and 1,245 sqft. respectively. See Figure 1 below for Opinion Dynamics Market Study results showing the distribution of existing residential panel size.

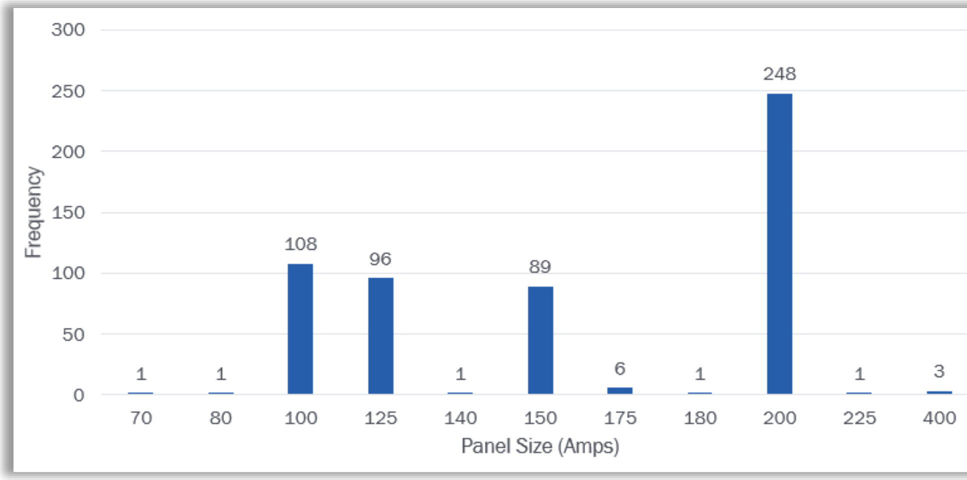


Figure 1. Opinion Dynamics Market Study Findings on Existing Residential Panel Size Distribution
Source: Opinion Dynamic Market Study – "CPUC_FSInfraMS_StakeholderPresentation_2024.02.15.pptx"

In terms of prescriptive requirements on residential panel capacity, the 2013 California Energy Standards (Title 24, Part 6) requirements for new construction including those for "Solar Ready Buildings" requires for the main electrical service panel to (1) have a minimum busbar rating of 200

[76] KEMA, 2009 California Residential Appliance Saturation Study, October 2010. CEC-200-2010-004.
[77] Opinion Dynamics, *TECH Customer Six Month Post-Install Survey* Findings, July 18, 2023. Accessible at https://pda.energydataweb.com/api/view/2826/TECH%20Customer%20Six%20Month%20Post-Install%20Report_DRAFT_7.18.23.docx. The Technology and Equipment for Clean Heating (TECH) Initiative is a $120 million pilot program designed to help advance California's mission to achieve carbon neutrality by driving the market adoption of low-emissions space- and water-heating technologies for existing single-family and multifamily residential homes.
[78] D.23-04-035 at 19-20 described a fuel substitution infrastructure cost market study to be conducted under Task 6 of the CPUC's current Group E contract by Opinion Dynamics ("Opinion Dynamics market study"). Final study results were shared with this WG in Q4 2023 and Q1 2024. The final report has not yet been published.

amps and (2) a reserved space to allow for the installation of a double pole circuit breaker for a future solar electric installation.[79]

Figure 2 provides the distribution of existing panel sizes for both residential SFM and MFM buildings as determined from the Opinion Dynamics Market Study.[80]

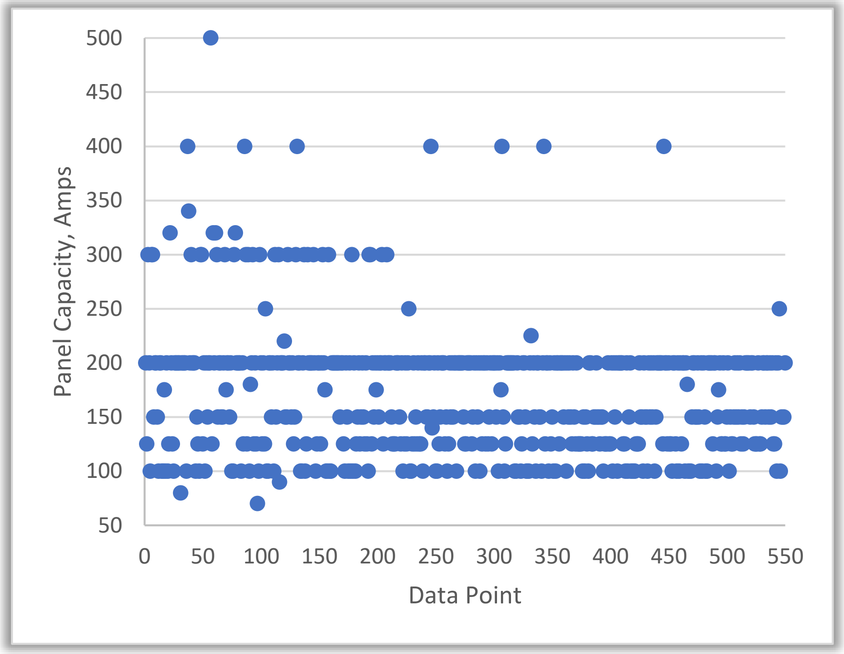
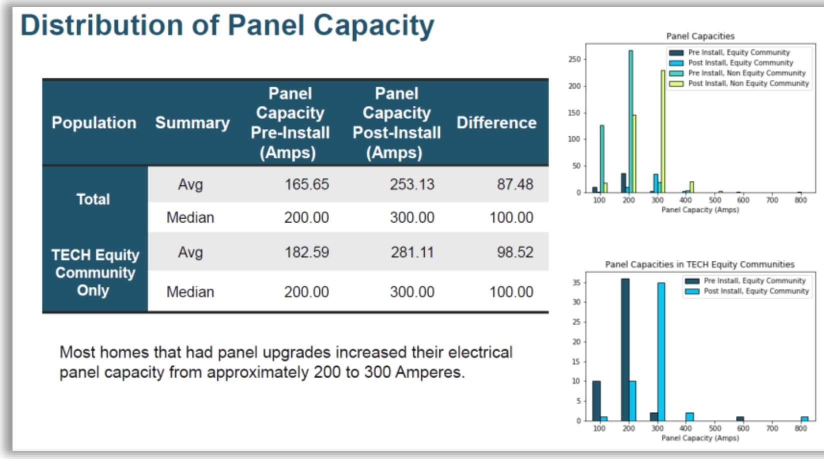


Figure 2. Opinion Dynamics Market Study - Existing Residential Panel Distribution
Source: Opinion Dynamic Market Study – "FSInfraMS_ResSurveyData_2023.11.16.xlsx"

Distribution panel capacity as reported by Energy Solutions[81] on the TECH program is documented below. The data suggest that that pre-fuel substitution existing panel capacity on TECH participants was generally (median) 200 amps.

[79] Section 110.10(e) of the 2013 Building Energy Efficiency Standards, which applies to single family residences only. Accessible at https://www.energy.ca.gov/sites/default/files/2021-04/CEC-400-2012-004-CMF-REV2.pdf.
[80] Opinion Dynamics Market Study – "FSInfraMS_ResSurveyData_2023.11.16.xlsx"
[81] Energy Solution Panel Upgrade Analysis – TECH Clean California, Derek Okada, July 19, 2023, P.6



Population	Summary	Panel Capacity Pre-Install (Amps)	Panel Capacity Post-Install (Amps)	Difference
Total	Avg	165.65	253.13	87.48
	Median	200.00	300.00	100.00
TECH Equity Community Only	Avg	182.59	281.11	98.52
	Median	200.00	300.00	100.00

Figure 3. TECH Data on Distribution of Panel Capacity
Source: TECH Panel Upgrade Capacity Presentation

B. Nonresidential

Related electric panel upgrade studies for nonresidential applications suggest that 200 Amp panels are the common choice for many commercial buildings with moderate power requirements. Larger nonresidential facilities with higher electric demand are commonly equipped with 400 Amp panels[82].

According to the Opinion Dynamics Market Study, there is wide range of existing panel sizes among nonresidential buildings with education, industrial, and lodging building types having the largest panel sizes. Furthermore, the market study determined that most nonresidential building have an average panel size between 200 Amps and 400 Amps, with a strong mix of the two panel sizes. The market study determined that the marine climate region has the largest average nonresidential panel size (averaging 400 amps), followed by the hot-dry climate region (averaging approximately 300 amps), and then the cold region (averaging approximating 200 amps). The following figure shows existing panel size distribution by nonresidential building type as determined by the Opinion Dynamics Market Study.

[82] The Cost Of Upgrading Your Commercial Electrical Panel (pennaelectric.com)

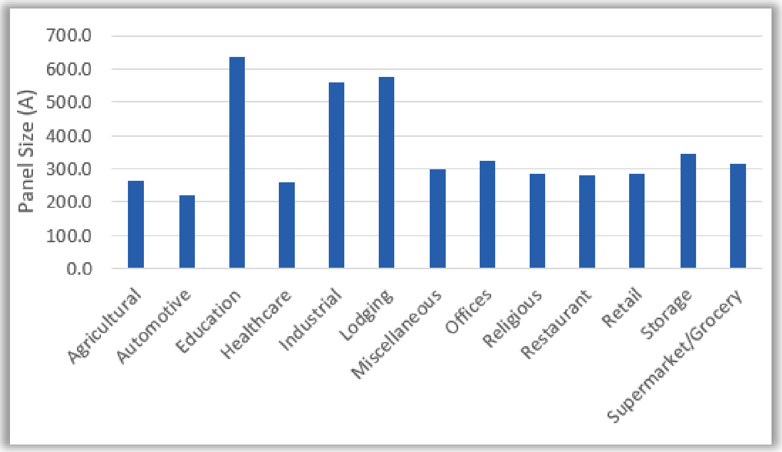


Figure 4. Opinion Dynamics Market Study Results on Existing Panel Size by Nonresidential Building Type
Source: Opinion Dynamics Market Study – Final Results December 20, 2024

5. Frequency of Panel Upgrades

A. Residential

The WG considers the frequency of panel upgrades to be the likelihood that a single customer participating in an EE fuel substitution program will require a panel upgrade to accommodate a single fuel substitution measure.

Opinion Dynamics Fuel Substitution Infrastructure Market Study Data

The Opinion Dynamics Fuel Substitution Infrastructure Market Study's[83] residential multivariate regression results suggest that the vintage of residences and their climate region are the best predictors of panel upgrade and/or optimization outcomes resulting from the installation of a fuel substitution measure, with (a) older homes (primarily 1976-1999) approximately 1.7 – 2.1 times more likely than newer homes (2000 or later) to require panel upgrades or optimization, and (b) the marine climate region approximately 2.1 – 3.8 times more likely than cold region to require panel upgrades or optimization. Although less influential than home vintage and climate zone, baseline equipment was determined to be a statistical predictor to some extent.

Furthermore, the Opinion Dynamics Market Study suggests that gas-to-electric conversions for space heating and domestic hot water heater (DHW) fuel substitution scenarios (when both types of equipment are present) are likely to trigger electric infrastructure upgrade (including panel upgrade) OR panel optimization (e.g., sub-panels, tandem breakers, or circuit sharing/splitting) approximately 49% to 56% of the time depending on housing type, with panel upgrades more likely than panel optimization.

[83] D.23-04-035 at 19-20 described a fuel substitution infrastructure cost market study to be conducted under Task 6 of the CPUC's current Group E contract by Opinion Dynamics ("Opinion Dynamics market study"). Final study results were shared with this WG in Q4 2023 and Q1 2024. The final report has not yet been published.

The WG recommends the following assumptions for residential building infrastructure upgrades resulting from fuel substitution measures based on the Opinion Dynamics Market Study results (without adjustments):

- Space heating fuel substitution measures: 82% of installations will require no panel upgrade or panel optimization (simple connection only), 9.9% panel upgrade, and 7.9% panel optimization.
- DHW fuel substitution measures: 50% of installations will require no panel upgrade or panel optimization (simple connection only), 30.8% panel upgrade, and 19.3% panel optimization.

See Section 9, Table 5 for a summary of the WG cost recommendations.

Error! Reference source not found.depicts percent of panel capacity (Amps) remaining as determined b y the Opinion Dynamics Market Study results.

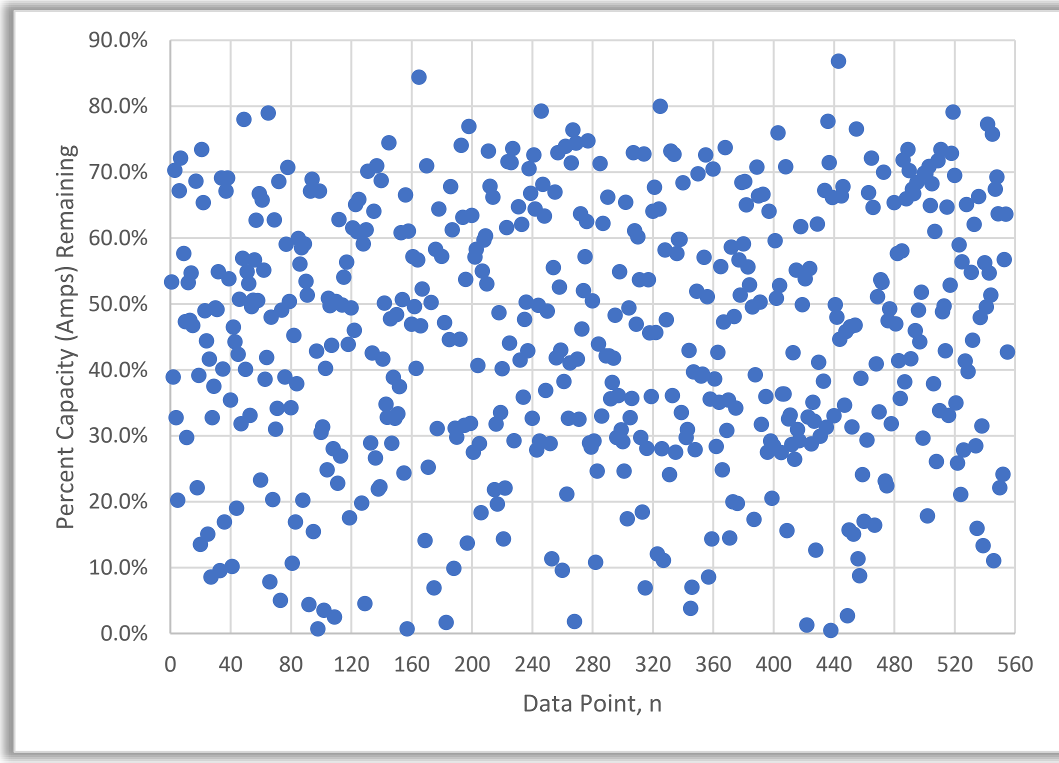


Figure 5. Opinion Dynamics Market Study Findings on Remaining Available Electric Panel Capacity in Amps
Source: Opinion Dynamic Market Study – "FSInfraMS_ResSurveyData_2023.11.16.xlsx"

Technology and Equipment for Clean Heating (TECH) Initiative Data

A TECH study of initial project results found that the frequency of panel upgrade for TECH projects was approximately 9.7% and 3.9% for HPWH and HVAC technology, respectively. The WG noted that the TECH population represents a subset of the overall customer demographics in California, and may not be representative of the population of customers that may participate in EE fuel substitution programs.

Generally, the frequency of panel upgrades in the TECH program was low, occurring in approximately 4.8% of the installations. The WG noted that most fuel substitution projects in SFM homes in the TECH program (>94%) supported a single end-use, e.g., HP HVAC or HPWH, as opposed to multiple end-uses.[84]

Product Group	Panel Upgrades	Homes Requiring Upgrade, %	Total Homes
HPWH	181	9.7%	1,873
HVAC	370	3.9%	9,541
Total	551	4.8%	11,414

Overall upgrade frequency

Broken out by Equity Community

Product Group	TECH Equity Community	Panel Upgrades	Homes Requiring Upgrade, %
HPWH	No	165	9.7%
	Yes	16	9.3%
HVAC	No	330	3.9%
	Yes	40	3.5%
Total		551	4.8%

The proportion of homes requiring panel upgrades did not differ significantly between Communities.

TECH Panel Upgrade Analysis 5

Figure 6. Percentage of SFM Homes Requiring Panel Upgrades for Fuel Substitution Measure Installation

Source: TECH Panel Upgrade Analysis Presentation

Lawrence Berkeley National Laboratory (LBNL) Research

Late in 2023, the LBNL team analyzed peak demand data from roughly 12,000 U.S. dwellings, and while this is still an ongoing study with pending final results, their interim results suggest a median peak demand of approximately 0.9 kW, which is approximately 38% of the capacity of a 100-Amp panel (Figure 7). Their interim results also indicates that, at peak demand, less than 2% of dwellings ever exceed 100-Amp and only 0.2% ever exceed 200-Amp.[85]

[84] Energy Solution Panel Upgrade Analysis – TECH Clean California, Derek Okada, July 19, 2023, P.5

[85] Less & Walker (2024). *Evaluating the Ability to Add New Electrical Loads to Existing US Dwellings.*

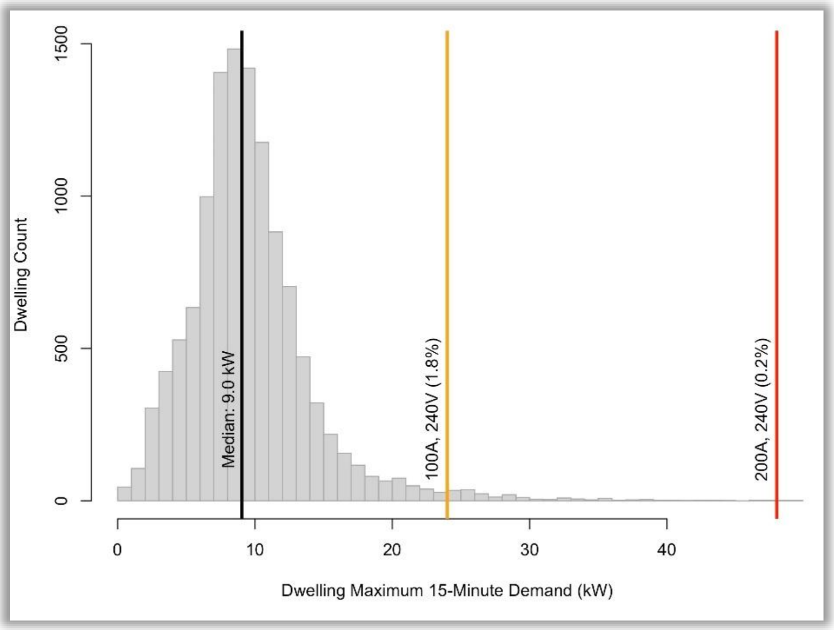


Figure 7. Maximum Dwelling Demand (kW)
Preliminary - Less & Walker (2024). Evaluating the Ability to Add New Electrical Loads to Existing US Dwellings.

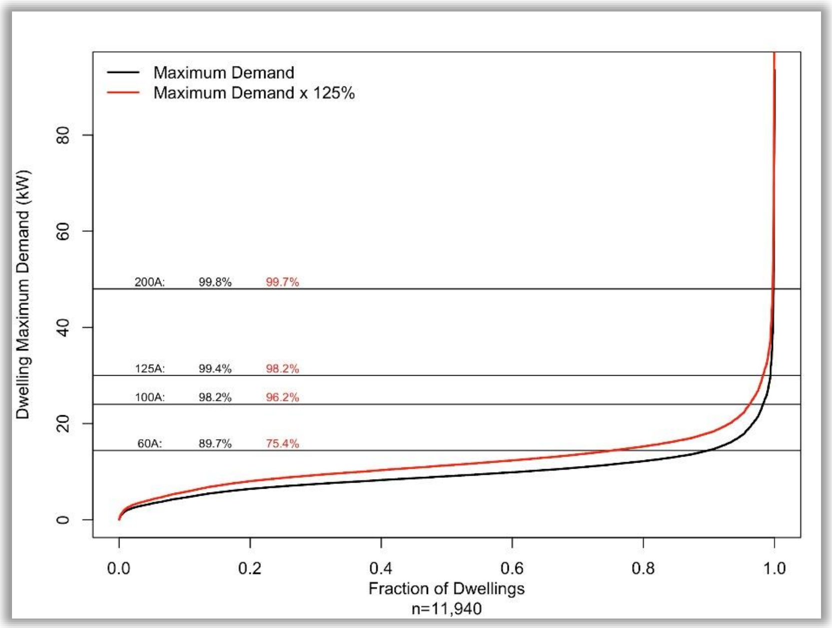


Figure 8. Maximum Dwelling Demand (kW) relative to the Fraction of Dwellings
Preliminary - Less & Walker (2024). Evaluating the Ability to Add New Electrical Loads to Existing US Dwellings.

B. Nonresidential

General Nonresidential

The WG recommends the following assumptions for nonresidential (non-food service) building infrastructure upgrades resulting from fuel substitution measures based on the Opinion Dynamics Market Study:

- Space heating fuel substitution measures: 85.8% of installations will require no panel upgrade or panel optimization (simple connection only), 9.8% a panel upgrade, and 4.4% panel optimization.
- DHW fuel substitution measures: 54.6% of installations will require no panel upgrade or panel optimization (simple connection only), 21.7% a panel upgrade, and 23.6% panel optimization.

See Section 9, Table 5 for a summary of the WG cost recommendations.

Nonresidential Food Service

The WG recommends the following assumptions for nonresidential food service building infrastructure upgrades resulting from fuel substitution measures based on the Opinion Dynamics Market Study: 37.8% of installations will require no panel upgrade or panel optimization (simple connection only), 47.4% of installations will required a panel upgrade, and 14.8% will require panel optimization. See Section 9, Table 5 for a summary of the WG cost recommendations.

6. Panel Upgrade and Optimization Cost

A. Residential

This section describes the data sources leveraged by the WG for informing its fuel substitution infrastructure upgrade cost attribution methodology and recommendations. Most of the WG's recommendations are informed by the Opinion Dynamics Market Study.[86] This study included over 1,000 surveys completed for residential and commercial buildings and 78 electrician interviews. Furthermore, the TECH program data and findings, including 11,414 SFM homes where a heat pump water heater and/or heat pump HVAC system was installed, were evaluated for informing and/or enhancing WG's recommendations.

The Opinion Dynamics Market Study's methodology for the estimation of fuel substitution infrastructure cost included the exploration of the relationship of various inputs on the likelihood of a customer's home needing substantial infrastructure work (e.g., panel upgrade or optimization) with regression analyses at various relative precision levels for both residential and commercial fuel substitution scenarios and independent variables (e.g., age of home, climate region, pre-existing electric HVAC or DHW equipment).

[86] D.23-04-035 at 19-20 described a fuel substitution infrastructure cost market study to be conducted under Task 6 of the CPUC's current Group E contract by Opinion Dynamics ("Opinion Dynamics market study"). Final study results were shared with this WG in Q4 2023 and Q1 2024. The final report has not yet been published.

The distribution of the surveys completed under the Opinion Dynamics Market Study included aggregated California climate zones into three climate regions used by the CPUC's Potential and Goals Study[87] and comparable representation among 'hot-dry' and 'marine' climate regions. Refer to the Opinion Dynamics Market Study final results for details including the specific distribution of surveys per building type and sector.

For the electrical panel upgrade costs, Opinion Dynamics' estimates include the total project cost including labor cost from contractor to assess, plan, and perform the work on site in addition to electrical material costs, such as electrical panel, wiring, circuit breakers, outlets, conduit, etc. An example from the Opinion Dynamics Market Study's contractor interviews regarding a sample HVAC heat pump upgrade scenario is included in Table 2 below. For panel optimization costs, Opinion Dynamics estimates included labor and materials associated for typical optimization options including sub-panel, load-sharing, and circuit pausers.

Table 2. Example Scenario of HVAC HP Upgrade Scenario from Opinion Dynamics Market Study Contractor Interview

HVAC HP Upgrade Scenario	Home Type	Square Footage	Year Built	Panel	Panel Location	Existing Wiring for HP Circuit	240V Circuit and Disconnect	Service Needed
Replace gas-fired forced-air furnace and central air conditioner with central air-source heat pump	Single-Family	2000 sf	2015	200 A, empty slots, no upgrade needed	Less than 50 feet away from equipment	In good condition, no remediation needed	Connection and disconnect in place, no upgrade needed	Connect central air-source heat pump to the existing electric panel

Source: Opinion Dynamics Market Study

Residential No Panel Upgrade or Optimization Cost (Simple Connection Only)

For residential scenarios, the WG recommends using the results of the Opinion Dynamics Market Study which suggests that the cost of a simple connection (wiring between the appliance and the electrical panel) for fuel substitution of SFM space heating heat pumps will average $1,704 and for SFM DHW heat pumps $2,804. The WG understands that, in most cases, the "simple connection ONLY" cost may be included in deemed fuel substitution measure packages, thus the existing measure package costs may need to be adjusted to avoid overlap between the measure package equipment and labor costs and the building infrastructure cost values recommended in this report. See Section 8 for recommendations on measure package implementation.

Residential Panel Upgrade Cost

For panel upgrade costs, the WG recommends using the results of the Opinion Dynamics Market Study, which determined that the cost to upgrade an electric panel averages $6,057 for SFM space heating heat pumps and $6,911 for SFM DHW heat pumps (in both cases actual costs depend on the complexity

[87] Guidehouse, *2023 Energy Efficiency Potential and Goals Study*. June 22, 2023. Prepared for the CPUC. ("2023 EE Potential and Goals Study")

of the fuel substitution installation). See Section 9, Table 5 for a summary of the WG cost recommendations._

The weighted average of electrician responses suggested that MFM panel upgrade costs are about 13% more expensive than SFM. For MFM, cost fluctuations (with lower costs) were generally attributed to shorter electrical runs and (with higher cost) to the lack of attic or crawl space access and/or dealing with landlords/property managers. See the Opinion Dynamics Market Study results on Residential Electrician Pricing Variance summarized in the figure below.

- Coefficient of Variation (CV) tells us the relative size of the standard deviation compared to the mean
- CV ranges from 0.42 to 0.87 across all residential pricing scenarios
- Individual price responses differ from the mean by 42% to 87%, on average, depending on the scenario
- CV < 1.0 is indicative of relatively low variability within the responses

Opinion Dynamics

Scenario	n	Average Cost	CV
Gas Fired Furnace w/CAC to ASHP			
Connect ASHP to panel (A*)	42	$1,576	0.87
Upgrade wiring and connect ASHP to panel (B)	42	$2,068	0.87
Gas Fired Furnace w/no CAC to ASHP			
Install 200A panel, install 240V circuit and disconnect, connect ASHP to panel	42	$5,605	0.52
Gas Wall Furnace w/no CAC to Mini-Split ASHP			
Install 240V circuit and disconnect, connect ASHP to panel (A)	41	$2,083	0.83
Install 200A panel, install 240V circuit and disconnect, connect ASHP to panel (B)	44	$6,158	0.46
Install 200A panel, install 240V circuit and disconnect, upgrade wiring, connect ASHP to panel (C)	45	$7,060	0.46
50-gallon gas DHW to HPWH			
Install 240V circuit and disconnect, connect HPWH to panel (A)	44	$2,591	0.56
Install 200A panel, install 240V circuit and disconnect, connect HPWH to panel (B)	42	$6,385	0.43
Install 200A panel, install 240V circuit and disconnect, upgrade wiring, connect HPWH to panel (C)	42	$7,004	0.42
Gas Furnace w/CAC AND Gas DHW to ASHP and HPWH			
Install 240V circuit and disconnect for HPWH, connect both ASHP and HPWH to panel (A)	41	$3,433	0.85
Install 200A panel, install 240V circuit and disconnect for HPWH, connect both ASHP and HPWH to panel (B)	41	$7,247	0.55
Install 200A panel, install 240V circuit and disconnect for HPWH, upgrade wiring, connect both ASHP and HPWH to panel (C)	43	$8,219	0.52
Gas-powered Range to Induction Range			
Connect induction range to panel (A)	43	$1,726	0.81
Install 200A panel and connect induction range to panel (B)	44	$6,240	0.49
Install 200A panel, install 240V circuit and disconnect for new induction range, upgrade wiring, connect induction range to panel (C)	42	$6,923	0.49

Figure 9. Opinion Dynamics Market Study Findings on Residential Electrician Pricing Variance
Source: Opinion Dynamic Market Study – Fuel Substitution Infrastructure Cost Market Study Webinar March 5, 2024

The following figure depicts the residential weighted average infrastructure cost distribution as determined by Opinion Dynamic's market study including various fuel substitution scenarios (e.g., heating only, DHW only, heating and DHW, and all-electric), climate regions (e.g., all, hot-dry, and marine), and building vintages (e.g., all, 1976-1999, and 2000 or older).

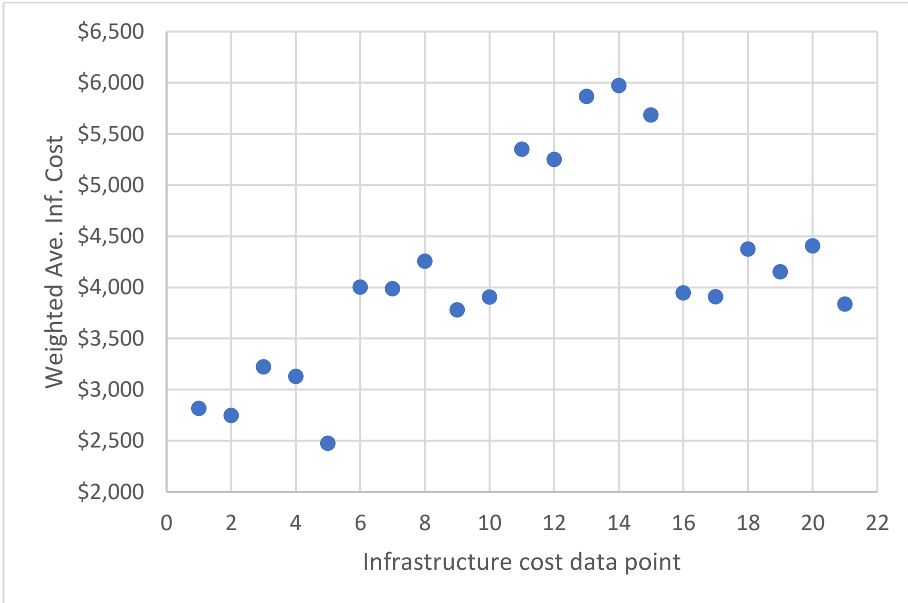


Figure 10. Opinion Dynamics Market Study Findings on Residential Weighted Average Infrastructure Cost at 10%/90% relative precision and confidence level
Source: Opinion Dynamics Market Study- FS Infra MS Data Tool_Draft_2024.01.29

Generally, the average panel upgrade cost estimated by Opinion Dynamics is similar to that from the 2023 EE Potential & Goals Study[88] for which the panel upgrade cost estimate averaged $4,600 with cost variations between $1,900 and $8,188. The WG notes that the 2023 EE Potential and Goals Study estimate was based on a literature review and the estimated proportion of homes that would need a panel upgrade to accommodate a fuel substitution measure installation.

The WG additionally evaluated the infrastructure cost estimated by Energy Solutions under the TECH Initiative (but did not adopt these estimates). Energy Solutions' cost estimate ($1,500) was much lower than that from the Opinion Dynamics Market Study or 2023 Potential and Goals study.[89] The TECH infrastructure cost was estimated based on the "median" incremental measure cost between projects including panel upgrades and those that did not. The following figure shows median project cost for TECH installations including 16,293 SFM homes where a heat pump water heater and/or heat pump HVAC system was installed, and the installer received a TECH incentive.

[88] See Table C-2 Summary of Upgrade Costs on page C-22 of the 2023 EE Potential and Goal Study report.
[89] Id.

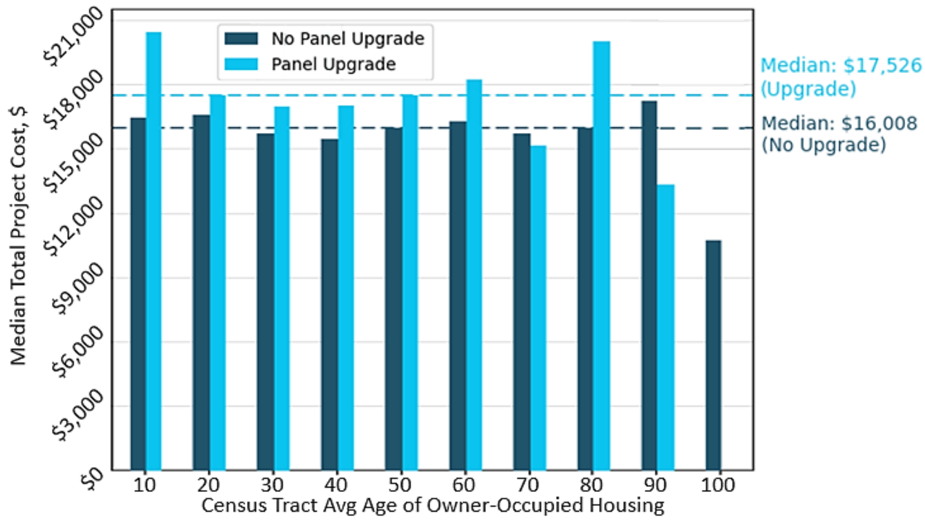


Figure 11. Energy Solutions' Finding on Median Project Cost by Area,
Average Age of Owner-Occupied Housing for TECH Installations
Source: TECH - Panel Upgrade Analysis - Energy Solutions Presentation, December 20, 2023.

Residential Panel Optimization Cost

The Opinion Dynamics Market Study reported an average panel optimization cost of $1,809 (with sub-panel optimization at $2,211), excluding the additional cost of connecting the fuel substitution appliance to the electrical panel. The study indicates that outside of the installation of sub-panels (generally completed 31% of the time), electrician respondents reported never using many of the panel optimization strategies identified in the survey, e.g., smart circuit breakers (4%), smart panels (0%), circuit pausers (2%), load-sharing (7%), meter collars (0%), and others (11%). Additionally, the Opinion Dynamics Market Study reported that smart circuit breakers and smart panels are more likely to be used in newer homes compared to other optimization options generally commissioned in older building vintages. Adding the simple connection costs for residential space heating and water heating fuel substitution end uses to the cost findings above, the WG recommends assuming total residential panel optimization cost values of $3,513 for space heating and $4,613 for water heating. See Section 9, Table 5 for a summary of the WG cost recommendations.

B. Nonresidential

Nonresidential No Panel Upgrade or Optimization Cost (Simple Connection Only)

For nonresidential scenarios, the WG recommends using the results of the Opinion Dynamics Market Study which suggests that the cost of a simple connection (wiring between the appliance and the electrical panel) for fuel substitution of space heating will average $2,099 and for water heating $3,430. Similarly, the study suggests that the simple (electric) connection for fuel substitution of nonresidential cooking equipment is expected to average $3,372. See Section 9, Table 5 for a summary of the WG cost recommendations.

Nonresidential Panel Upgrade Cost

For nonresidential scenarios, the WG recommends using the results of the Opinion Dynamics Market Study which suggests that the panel upgrade cost for fuel substitution of space heating will average $13,128 and for water heating $13,128, with both cost estimates varying based on complexity of the installation. Similarly, the study suggests that panel upgrades for fuel substitution of nonresidential cooking equipment is expected to average $13,624.

The following figure shows nonresidential electrician pricing variance determined by the Opinion Dynamics Market Study.

- Coefficient of Variation (CV) tells us the relative size of the standard deviation compared to the mean
- CV ranges from 0.32 to 0.84 across all nonresidential pricing scenarios
- Individual price responses differ from the mean by 32% to 84%, on average, depending on the scenario
- CV < 1.0 is indicative of relatively low variability within the responses

Scenario	n	Total Mean	CV
Packaged AC/Gas Furnace to Packaged HP with Electric Resistance Back-up			
Connect packaged HP to panel (A)	29	$2,099	0.84
Install 600A panel and connect packaged HP to panel (B)	31	$16,799	0.63
Add 200A panel and connect packaged HP to panel (C)	25	$5,616	0.70
Install 600A panel, upgrade wiring, connect packaged HP to panel (D)	30	$16,367	0.56
60-gallon gas DHW to 80-gallon HPWH			
Install 240V circuit and disconnect, connect HPWH to panel (A)	33	$3,430	0.54
Install 400A panel, install 240V circuit and disconnect, connect HPWH to panel (B)	28	$9,458	0.32
Add 200A panel and connect packaged HP to panel (C)	17	$4,946	0.45
Install 400A panel, install 240V circuit and disconnect, upgrade wiring, connect HPWH to panel (D)	32	$15,100	0.57
Gas Fryer to Electric Fryer			
Add circuit and disconnect, connect fryer to panel (A)	32	$2,904	0.63
Install 400A panel, add circuit and disconnect, connect fryer to panel (B)	27	$10,108	0.41
Add 200A panel, add circuit and disconnect, connect fryer to panel (C)	24	$7,407	0.62
Install 400A panel, upgrade wiring, add circuit and disconnect, connect fryer to panel (D)	32	$15,610	0.59
Gas Oven to Electric Convection Oven			
Add circuit and disconnect, connect oven to panel (A)	32	$3,840	0.59
Install 600A panel, add circuit and disconnect, connect oven to panel (B)	32	$17,141	0.60
Add 200A panel, add circuit and disconnect, connect oven to panel (C)	25	$7,385	0.62
Install 600A panel, upgrade wiring, add circuit and disconnect, connect oven to panel (D)	32	$18,262	0.59
Gas Oven AND Gas Fryer to Electric Convection Oven and Electric Fryer			
Add circuit and disconnect, connect oven and fryer to panel (A)	31	$5,405	0.60
Install 600A panel, add circuit and disconnect, connect oven and fryer to panel (B)	31	$18,160	0.61
Add 200A panel, add circuit and disconnect, connect oven and fryer to panel (C)	24	$7,156	0.54
Install 600A panel, upgrade wiring, add circuit and disconnect, connect oven and fryer to panel (D)	33	$20,092	0.63
Forced Air Gas Fired Furnace AND 60-gallon DHW to ASHP and 80-gallon HPWH			
Add circuit and disconnect, connect HPWH and ASHP to panel (A)	32	$5,334	0.67
Install 400A panel, add circuit and disconnect, connect HPWH and ASHP to panel (B)	33	$15,680	0.60
Add 200A panel, add circuit and disconnect, connect HPWH and ASHP to panel (C)	25	$9,190	0.71
Install 400A panel, upgrade wiring, add circuit and disconnect, connect HPWH and ASHP to panel (D)	33	$17,190	0.55

Opinion **Dynamics**

Figure 12. Opinion Dynamics Market Study Findings on Nonresidential Electrician Pricing Variance
Source: Opinion Dynamic Market Study – Fuel Substitution Infrastructure Cost Market Study Webinar March 5, 2024

Another data source reviewed by the WG supports the finding that nonresidential electric panel upgrade costs can vary significantly, but referenced a $4,000 panel upgrade cost including 8 to 20 hours of commercial electrician labor.[90]

Nonresidential Panel Optimization Cost

The Opinion Dynamics Market Study determined that small office and retail buildings are the most serviced (i.e., building types generally with most electrical work) nonresidential buildings by its market survey respondents, with most building vintages between 1975 and 1999. For existing buildings, the installation of subpanels is the most common optimization approach in addition to load-sharing and circuit pausers. For newer buildings, smart circuit breakers and panels are common. Accounting for the

[90] The Cost Of Upgrading Your Commercial Electrical Panel (pennaelectric.com)

frequency of adoption approaches and the relative pricing of each optimization strategy, the study determined that the average cost of nonresidential panel optimization is approximately $2,319, excluding the additional cost of connecting the fuel substitution appliance to the electrical panel. Adding this value to the simple connection costs for nonresidential space heating and water heating fuel substitution end uses, the WG recommends assuming total panel optimization cost values of $4,418 for space heating and $5,749 for water heating. For nonresidential food service, the WG recommends assuming a total panel optimization cost of $5,691. See Section 9, Table 5 for a summary of the WG cost recommendations.

The following figure shows the Opinion Dynamics Market Study findings on the frequency of panel optimization strategies in nonresidential buildings.

Optimization Approach	Most often	Often	Sometimes	Rarely	Never	Don't know	Pricing
Smart circuit breakers	3%	12%	9%	27%	48%	0%	$971
Smart panel	3%	0%	6%	24%	67%	0%	$3,720
Circuit pausers	0%	0%	12%	21%	67%	0%	$1,300
Load-sharing	0%	9%	27%	18%	45%	0%	$3,688
Sub-panel	21%	45%	33%	0%	0%	0%	$2,594
Meter collars	3%	0%	3%	12%	73%	9%	$1,792
Other	0%	0%	24%	3%	33%	39%	$1,647

Figure 13. Opinion Dynamics Market Study Findings on Nonresidential Optimization Approaches
Source: Opinion Dynamics Market Study – Final Results December 20, 2024

7. Solar Photovoltaic and Electric Vehicle

A. Solar Photovoltaic

According to the Opinion Dynamics Market Study, approximately 36.5% (203 of 555) of survey participants already have solar photovoltaic (solar PV) systems installed in their homes. Out of those 203 participants with solar installed, approximately 71% of homes have at least a 200-amp electrical panel installed.

According to data from the Solar Energy Industry Association (SEIA),[91] the Solar Automated Permit Processing Plus (SolarAPP+) platform's 2022 data (including permits for code-compliant residential rooftop solar PV suggests that approximately 45% of residential single-family homes in California have solar PV currently installed. SolarAPP+ Data[92] has complete permit data for 8,136 solar projects spanning mostly Arizona and California. 84% of those solar projects did not require a panel upgrade to install and

[91] https://www.altenergymag.com/article/2019/04/california-leads-nation-in-residential-solar-installation-rates-overall-homes-and-total-capacity/30812/#:~:text=Gavop's%20analysis%20of%20latest%20solar,6.3M%20total%20homes%20

[92] https://www.nrel.gov/docs/fy23osti/85827.pdf

67% of homes had a main service panel rating of at least 200 amps at the time of installation; see the figure below.

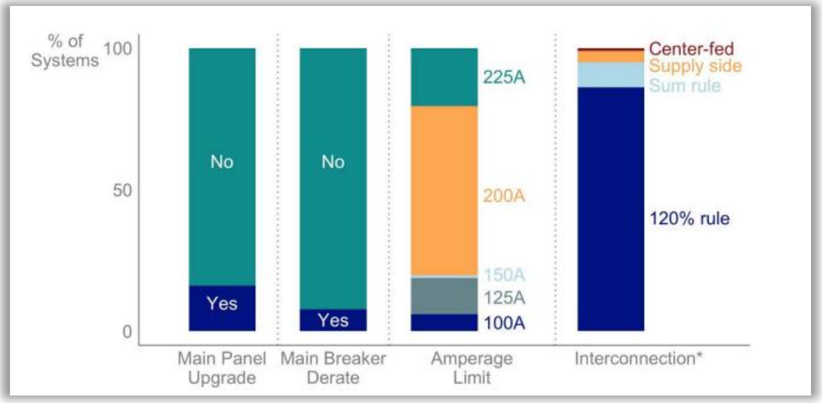


Figure 14. Electrical upgrade features of SolarAPP+ Systems –
Source: https://www.nrel.gov/docs/fy23osti/85827.pdf

The Opinion Dynamics Market Study's residential survey data breaks down residential homes with existing PV for both SFM and MFM. Per this data set, 37% (203/555) of the population currently have solar already installed in their homes with 71% (144/203) of those homes already having at least a 200-Amp panel installed. Since the Opinion Dynamics Market Study's residential survey data and evaluation of panel upgrade and optimization already accounts for customers with PV, the WG recommends to not include and/or further adjust fractional attributions for PV.

B. Electric Vehicle Chargers

For existing electric vehicle (EV) charger assumptions, The Opinion Dynamics Market Study's residential survey data documents 20% (113/555) of the population have an EV charger already installed with 65% (74/113) of those homes already having at least a 200-amp panel. The WG notes that there is an increased desire to purchase EV (approximately 26% of ODC survey participants prefer to purchase an EV as their first purchase preference). More importantly, California's Executive Order N-79-20 targets 100 percent of in-state sales of new passenger cars and trucks to be zero-emissions by 2035. The following figure depicts market penetration (as a function of percent of market sales share) in California.

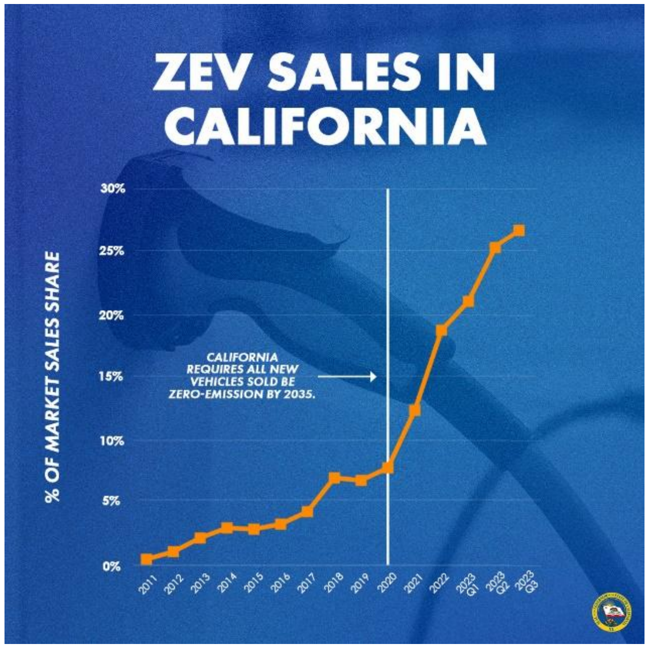


Figure 15. ZEV Sales in California
Source: www.gov.ca.gov/

The WG noted that the Opinion Dynamics Market Study data on infrastructure upgrades accounts for the incidence of existing EV chargers and solar PV load on customer sites. This means the market study data leveraged for the WG's infrastructure cost recommendations represent the likelihood of the panel intervention occurring for a sample of customers that include some customers with EV chargers and solar PV on their premises, and therefore the WG's infrastructure cost methodology (described in Section 8) does not need to further account for the impact of existing EV chargers or solar PV on the propensity for a customer to either upgrade or optimize their electric panels.

8. Infrastructure Cost Attribution Methodology

A. Methodology Overview

The WG leveraged a weighted average calculation of the three infrastructure cost scenarios identified in Section 5 (no panel upgrade, panel optimization, and panel upgrade) to calculate deemed cost values for the electrification-enabling infrastructure cost associated with the installation of a single end-use fuel substitution measure in residential, nonresidential, or food service building types. This weighted average cost is intended to be included as part of the measure cost of a given fuel substitution EE deemed measure, for the purposes of calculating a benefit to cost ratio for determining Viable Electric Alternatives pursuant to D.23-04-035.[93]

[93] D.23-06-055 section 2.3 describes the potential costs and benefits of electrification to be considered in determining whether an electric fuel substitution measure constitutes a "Viable Electric Alternative" to a comparable gas-powered measure. Potential costs of electrification include electrification-enabling infrastructure upgrades.

The WG developed this methodology based on average residential and commercial measure implementation characterization and pre-existing and market conditions to account for the primary cost scenarios for infrastructure upgrades, while striving to avoid complexity where reasonable and appropriate. Reduced complexity of methodology enables effective implementation while reducing the need for resource-intensive updates to methodological data sources and assumptions with future improvements to the WG recommendations.

B. Equations

The WG recommends Equation 1 to calculate a weighted average fuel substitution infrastructure cost for a single (end-use) measure. The terms in Equation 1 are defined in **Error! Reference source not found.** below. A unique value for each term has been evaluated and determined for Residential, Nonresidential, and Food Service building types, shown in

Table in Section 9. The attribution factor described in Equation 1 and defined in **Error! Reference source not found.** is applied to the panel upgrade infrastructure costs to account for the ability of the panel to support multiple future electrification loads, and thus attributes only a portion of the shared cost to the fuel substitution measure. The attribution factors are calculated using Equation 2, and attribution values are shown in **Error! Reference source not found.**.

Equation 1: Weighted Average Infrastructure Cost

$$\boldsymbol{Weighted\ Avg\ Infra\ Cost} = [\boldsymbol{NoUp}\% * \boldsymbol{InfCost_{NoUp}}] + [\boldsymbol{Opt}\% * \boldsymbol{InfrCost_{Opt}}] + [\boldsymbol{Upg}\% * (\boldsymbol{AttribF} * \boldsymbol{InfCost_{Upg}})]$$

Table 3. Definition of Equation Terms

Equation Term	Definition
Weighted Avg Infra Cost	Weighted average infrastructure cost associated with the installation of a single fuel substitution measure, to be included as part of the measure cost for fuel substitution measures in calculating the benefit/cost ratio for potential Viable Electric Alternative measures.
NoUp%	Likelihood that panel capacity and physical slots are sufficient, no panel optimization or upgrade changes needed. Only a simple connection (wiring between the fuel substitution appliance and the electrical panel) is needed.
Opt%	Likelihood that panel optimization (additional circuits or load management) devices are needed/used to avoid an increase in panel capacity (i.e., a panel upgrade).
Upg%	Likelihood that an increase in panel capacity (i.e., a panel upgrade) is needed.
$InfCost_{NoUp}$	Infrastructure cost associated with simple connection (i.e., wiring from the fuel substitution appliance to the electrical panel) and no panel optimization or panel upgrades for a fuel substitution measure installation. In this case, panel capacity and physical slots are sufficient, no panel optimization or upgrade changes needed.
$InfCost_{Opt}$	Infrastructure cost associated with panel optimization for a fuel substitution measure installation. In this case, additional circuits or load management is needed/used to avoid an increase in panel capacity (i.e., a panel upgrade). These costs are assumed to also include simple connection costs between the fuel substitution appliance and the electrical panel.
$InfCost_{Upg}$	Infrastructure cost associated with panel upgrade for a fuel substitution measure installation. In this case, the panel capacity is increased (i.e., panel is

	upgraded). These costs are assumed to also include simple connection costs between the fuel substitution appliance and the electrical panel.
AttribF	Attribution factor applied to the panel upgrade to account for the ability of the panel to support multiple future electrification loads, and thus these costs are shared among all future electrification loads. The formula for calculating the attribution factor is describe in Equation 2, and the values by building type are shown in **Error! Reference source not found.**.

Equation 2: Attribution Factor

$$\boldsymbol{AttribF = \frac{1}{(total\ number\ of\ future\ electrified\ end\ uses\ per\ building\ type)}}$$

Table 4. Attribution Factors by Building Type

Building Type	Total Number of Future Electrified End Uses for One Panel Upgrade	Attribution Factor Formula	Attribution Factor
Residential	5 electrified end uses: DHW, HVAC, cooking, clothes dryer, EV	$AttribF_{Res}$ = 1/5	0.2
Nonresidential – General	2 electrified end uses: DHW, HVAC	$AttribF_{SmallCom}$ = 1/2	0.5
Nonresidential – Food Service	3 electrified end uses: DHW, HVAC, Cooking	$AttribF_{Food}$ = 1/3	0.3

C. Methodology Discussion

The WG noted that the percentage likelihood values shown in **Error! Reference source not found.** for e ach of the three panel intervention types (no upgrade, optimization, upgrade) are based (unless noted otherwise) on Opinion Dynamics Market Study data, which in addition to accounting for fuel substitution implementation scenarios, (e.g., space heating, water heating, both space heating and water heating, all-electric, and food service), accounts for the incidence of existing EV chargers and solar PV load on customer sites. This means these percentage values represent the likelihood of the panel upgrade or optimization intervention occurring for a sample of customers that include some customers with EV chargers and solar PV on their premises, and therefore the methodology already accounts for the impact of existing EV chargers or solar PV on the propensity for a customer to need one of the three panel intervention types.

Additionally, the WG determined that the optimization costs should be attributed to a single fuel substitution measure, and not attributed to multiple electrification measures that may be installed at the same time, which the WG generally expects due to customer budget constraints in installing additional equipment (including total material cost) . While the WG acknowledges that pre-existing panel capacity and some optimization interventions, such as a subpanel installation, may support more than one fuel substitution (or electrification) measure, the WG decided that determining an optimization factor that accounts for the incidence of multiple fuel substitution measures has high uncertainty and will not add commensurate value to the analysis.

For the attribution factor calculation, the WG determined that two sectors (residential and non-residential) and three building types (residential, general nonresidential, and nonresidential food service) are needed to reasonably distinguish between the likely typical scenarios of future electrification end-uses to be supported by a single panel upgrade over the life of the panel (typically several decades in the absence of additional capacity needs).

The WG estimated that residential buildings are likely to have five future electrified end uses over the life of the panel that are accounted for the residential attribution factor: DHW, HVAC, cooking, clothes drying, and EV charging. The WG did not consider additional Solar PV to be likely to share a portion of these costs. (See Solar Photovoltaic section for additional details.) The WG estimated that nonresidential buildings were likely to have two electrified end uses supported by a panel upgrade that should be accounted for in the attribution factor: DHW and HVAC. Additionally, in the case of nonresidential food service, the WG assumed that a panel upgrade would likely support three end-uses: DHW, HVAC, and cooking equipment.

Furthermore, the WG recommended the panel upgrade attribution factor to be calculated using an infrastructure upgrade cost equally weighted among all electrified end uses expected to be supported by the panel upgrade over the panel life. Other methods considered by the WG included attributing the panel upgrade cost to the fuel substitution measure proportional to its electric load (e.g., total amperage per technology) relative to the total load of all electrified end uses expected on the panel. Another method considered accounting for the likelihood of adoption of the additional future electrified end-uses (e.g., based on customer prioritization) by attributing a greater share of cost to electrified end-uses most likely to occur sooner than later. The WG determined that the latter two methods would lead to additional methodological complexity likely without adding commensurate value to the analysis.

Finally, the WG acknowledges that some of the electrified end-uses assumed to be installed in the future over the life of the panel may become at some point – even within the coming decades – required by the energy Code and Standards (including building electrification requirements) for building retrofits, and thus the infrastructure costs supporting future *required* electric end-uses would be considered part of the baseline costs and potentially excluded from the incremental cost of the fuel substitution measure. However, in the absence of concrete timing of the adoption of such electrified end-use requirements for building retrofits, the WG assumed that the future electrified end uses will likely be installed on a voluntary basis.

9. Recommendations: Infrastructure Upgrade Cost Values for VEA Determination

This section documents the WG recommendations for key assumptions used to inform the fuel substitution cost attribution methodology for the residential sector including both SFM and MFM, and the nonresidential sector including nonresidential food service buildings which have significant cooking related infrastructure. Unless noted otherwise, recommendations and assumptions are primarily informed by the Opinion Dynamics Market Study. Table 5 below summarizes the WG recommendations on building infrastructure costs. The weighted average infrastructure cost methodology, and associated infrastructure cost scenarios represent costs resulting from a single fuel substitution measure installation (e.g., a single electric and/or heat pump technology for a single end-use).

The WG recommends that the existing measure cost assumptions in the fuel substitution measure packages be examined to ensure minimal to no overlap between the infrastructure cost values presented in Table 5 and the equipment material and labor cost assumptions in the fuel substitution measure packages. All three infrastructure cost scenarios below include the simple connection cost of the fuel substitution measure between the panel and the fuel substitution appliance (including electrical wiring/conduit), so the existing measure package equipment, material, and labor costs may need to be revised to avoid overlap with the building infrastructure cost values in Table 5 below. See Section 10 for detail on the WG's recommendations for measure package implementation.

For Photovoltaic (PV), given limited supporting documentation to evaluate infrastructure cost attributions at this time and variability of PV in commercial applications, the WG recommends not including and/or further adjusting fractional attributions due to PV. For Electric Vehicle (EV) Charging - given limited supporting documentation to evaluate infrastructure cost attributions at this time and the variability of EV in commercial applications, the WG recommends not including and/or further adjusting fractional attributions due to EV.

Table 5. Summary of Assumptions and Equation Terms by Building Type and End Use [1]

Input Parameter to FS Cost Attribution	Residential (SFM/MFM)		Nonresidential *Non*-Food Service		Nonresidential Food Service (Restaurants, Cafeterias, etc.)
	Space Heating	DHW	Space Heating	DHW	
No. of fuel substitution treatments assumed	1	1	1	1	1
Frequency of No Upgrade (NoUp%)	82.1%	50.0%	85.8%	54.6%	37.8%
Frequency of Panel Optimization (Opt%)	7.9%	19.3%	4.4%	23.6%	14.8%
Frequency of Panel Upgrade (Upg%)	9.9%	30.8%	9.8%	21.7%	47.4%
No Upgrade Infrastructure Cost ($InfCost_{NoUp}$) [2]	$1,704	$2,804	$2,099	$3,430	$3,372

Input Parameter to FS Cost Attribution	Residential (SFM/MFM)		Nonresidential *Non*-Food Service		Nonresidential Food Service (Restaurants, Cafeterias, etc.)
	Space Heating	DHW	Space Heating	DHW	
Panel Optimization Infrastructure Cost ($InfCost_{Opt}$) [3]	$3,513	$4,613	$4,418	$5,749	$5,691
Panel Upgrade Infrastructure Cost ($InfCost_{Upg}$) [4]	$6,057	$6,911	$13,128	$13,128	$13,624
Panel Upgrade Attribution Factor (AttribF)	0.2	0.2	0.5	0.5	0.3
Calculated Weighted Avg Infrastructure Cost for VEA Determination [5]	$1,798	$2,716	$2,639	$4,659	$4,055

[1] Source data for infrastructure cost values are based on the Opinion Dynamics Market Study: FS Infra MS Data Tool_Draft_20240304_Final.xls.
[2] Infrastructure cost values for no panel upgrades or optimization are based on the cost needed to support simple connections of the equipment to existing panel.
[3] Infrastructure cost values for panel optimization include both the cost of simple connection and electric panel optimization.
[4] Infrastructure cost values for panel upgrades include both the cost of simple connection and electric panel upgrade.
[5] Statewide weighted average infrastructure cost attributed to a single fuel substitution measure end-use is estimated as a function of cost and statistical likelihood from (a) panel optimization; (b) panel upgrade; and (c) simple connection. See Section 8, Equation 1 for details on how these values were calculated.

10. Recommendation: Measure Package Implementation and Infrastructure Upgrade Measure Costs

The WG recommends that for VEA determination and measure package implementation, the existing measure cost assumptions in the fuel substitution measure packages should be examined to ensure minimal to no overlap between the infrastructure cost values recommended in this report and the equipment, material, and labor cost assumptions in the fuel substitution measure packages. Specifically, all three infrastructure cost values in this report include the simple connection cost of the fuel substitution measure between the panel and the fuel substitution appliance, including electrical wiring/conduit. Thus, existing fuel substitution measure package cost values may need to be modified to ensure no overlap with infrastructure cost values from this report.

A. Enabling Incentive Flexibility and Easier Tracking for Fuel Substitution Upgrades

The WG recommends the following:

1. **The CA EE PAs should not be required to use the weighted average infrastructure cost values (calculated via the methodology in Section 8 and summarized in Section 9) for reporting deemed fuel substitution measure costs in CEDARS (see #2 below for an alternative).** The Cal TF and Reporting PCG can determine how best to operationalize this recommendation for reporting and measure package development. The WG notes that the weighted average infrastructure cost values would still be used for (a) the cost/benefit analysis to be applied for the determination of Viable Electric Alternatives pursuant to D.23-04-035, and (b) fuel substitution measure cost assumption in the Potential & Goals study.

2. **The CA EE PAs should have the option to create separate *non-resource* incentive-based measures specifically for electrification-enabling infrastructure upgrade costs[94] that support the (verified) installation of EE program fuel substitution measures.**
   a) These infrastructure upgrade measures would be distinct from the fuel substitution measures for fuel substitution equipment and labor installation.
   b) The non-resource infrastructure upgrade measures would not reflect *one weighted average cost value* for all potential upgrade scenarios, but instead would reflect the *three different cost scenarios* considered within this report: no panel upgrade, panel optimization, and panel upgrade.
   c) The three infrastructure upgrade cost scenarios listed above: (1) no panel upgrade or optimization needed / simple connection only, (2) panel upgrade, and (3) panel optimization) would leverage the Opinion Dynamics Market Study results, each captured by the variables in Table 5 above without adjustments.

While electrification-enabling infrastructure costs are recognized as being part of the total measure cost for a fuel substitution measure, the WG recommends separate non-resource measures for the electrification-enabling costs to enable:

- more flexibility in incentive offerings for infrastructure upgrades, given the variability in infrastructure costs depending on an individual participant's existing electric panel characteristics;
- easier tracking of the different types of infrastructure upgrades that are needed to support fuel substitution measure installation, to inform future program offerings;
- potentially easier integration with infrastructure-specific financing opportunities.

The Cal TF can determine how best to operationalize this recommendation. Under this WG recommendation, separate non-resource measures for fuel substitution infrastructure incentives

[94] D.23-06-055 Ordering Paragraph 29 allows for EE funding to be used for panel upgrades, which are not considered a stand-alone EE technology, stating (emphasis added) "Portfolio administrators (PAs) may set aside [limited funds]… from within their total budgets during 2024-2027 approved in this decision to fund innovative integrated demand-side management projects, including ongoing load-shifting that is not event-based**. Energy efficiency funding shall not be used for rebating capital costs of non-efficiency technologies, except as already provided for electric panel upgrades in Decisions 19-08-009 and 23-04-035**."

(with no associated savings) could be offered in coordination with fuel substitution measures. The WG offers the following program design considerations to assist in implementation of this proposed framework for separate infrastructure cost measures. However, these are not formal recommendations given that these program design considerations are outside the scope of this WG:

- The fuel substitution infrastructure non-resource measure package could be offered by the same Program Administrator for the fuel substitution programs;
- A separate Program ID could be created in CEDARS for the infrastructure cost incentive offerings, and the full measure cost of infrastructure cost installation is reported in CEDARS but flagged for exclusion from portfolio cost-effectiveness calculations;
- Program participants must install a valid fuel substitution measure to qualify for the infrastructure cost incentive.
- Incentives for infrastructure costs that support multiple fuel substitution measures (such as a panel upgrade) should be limited to one per customer premises. Incentives for infrastructure costs that support a single fuel substitution measure (added circuit, wiring, etc.) should be available each time those incentives are needed for the specific fuel substitution measure.[95]
- Program design should consider making infrastructure upgrade incentives contingent on installing upgrades that enable a fully electrified building, to prevent the need for multiple panel upgrades in the future.
- Details of incentive levels, eligibility requirements, and data collection requirements for eligibility verification should be determined by the program design team.

B. Infrastructure Cost Fields in Measure Packages and the eTRM

1. **The WG recommends the creation of additional measure permutation fields for fuel substitution measure packages and the California Electronic Technical Reference Manual (eTRM) to capture different infrastructure measure cost scenarios (per technology type and sector) and associated cost attribution factors:**
    - These additional fields are intended to align with potential IRA tax credit and other infrastructure cost rebates to the extent possible (considering web development and eTRM enhancement costs).[96]
    - Additional fields should address weighted average infrastructure costs <u>and</u> the full infrastructure costs for the three scenarios considered in this report (no panel upgrade, panel optimization, and panel upgrade), to support implementation of the

[95] Incentives for infrastructure costs that support a single fuel substitution measure (added circuit, wiring, etc.) should be available each time those incentives are needed for the specific fuel substitution measure; these types of infrastructure costs, and their associated incentives, could be captured as part of the fuel substitution measure package instead of through a separate infrastructure cost measure package.

[96] Electrification-enabling infrastructure costs are associated with the installation of electric fuel substitution measures (where the baseline is a gas-fueled technology which would not include any electrification infrastructure costs as part of the baseline cost). Thus, for accelerated replacement measures, electrification infrastructure costs should be associated with both the full measure cost (FMC) associated with the first existing conditions baseline, and the IMC associated with the second code/standard baseline.

recommendations in Section A above (for enabling incentive flexibility and easier tracking for fuel substitution upgrades).
- The Cal TF can determine how best to operationalize this recommendation.

The WG offers the following program design considerations to assist in implementation of this proposed framework for additional measure permutation fields in measure packages and the eTRM. However, these are not formal recommendations given that these measure package and eTRM design considerations are outside the scope of this WG:

- Within the eTRM, infrastructure measure cost could be captured in a "shared value table" for reference, at both 100% and adjusted amount based on cost attribution adjustments per technology type and sector as determined by the WG. This enables multiple fuel substitution measure packages to reference the same cost data shared value table.

11. Future Data Needs

This chapter outlines future data needs based on the WG recommendations by identifying data gaps and opportunities for improvements with additional research.

A. Data Gaps

In the process of developing the Workgroup recommendations and the infrastructure cost attribution methodology, the Workgroup identified a number of data gaps:

1. **Residential Utility Service Upgrade Cost.** As stated in Section 2, additional data will be needed to better understand electric infrastructure requirements and costs on the utility side of the meter including cost incurred by the customer and cost allowances covered by utilities. Knowing these costs will allow for a more complete understanding of electric infrastructure upgrade costs, particularly costs incurred by the customer.

2. **Permitting Costs.** As stated in Section 2, there is a lack of statewide data of building permit cost associated with electric panel upgrades needed to accommodate the added electric load resulting from the installation of building electrification measures. Permitting costs are expected to differ for each jurisdiction. Knowing and accounting for permit costs will also allow for a more complete understanding of electric infrastructure upgrade costs incurred by the customer, but by location. Additional research might help identify the standard permit closure process timing, which is expected to vary across Authorities Having Jurisdiction (AHJs).

3. **Attribution of EVs to Commercial Infrastructure Upgrades.** As stated in Section 7, the **WG** does not recommend including EV charging as part of commercial FS infrastructure attribution. Currently, there is not enough information related to commercial EV charging attribution to infrastructure upgrade/optimization. The purchase and use of EVs are expected to continue increasing in California in the next several years due to the impending requirement for all new

cars sold in California to be zero-emission by 2035.[97] Additional data related to commercial EV charging should be considered, particularly because commercial sites are more likely to require multiple EV chargers than many residential buildings (especially single family residences).

4. **Revise and Use the Infrastructure Cost Data Reporting Template for Fuel Substitution Measures.** A preliminary version of a template for fuel substitution cost data reporting by program implementers is currently posted on the fuel substitution website. If the template can be revised and updated for consistency with the scenarios and cost categories used for this WG report, then the data collected from implementers can better inform validation, improvement, and enhancement of the deemed infrastructure cost values recommended by this WG report. The TECH Clean California midstream program has been very successful at capturing this type of data at scale.[98]

B. Opportunities for Improvement

Additional research and data would improve future iterations of the Viable Electric Alternative Technical Guidance Document, Fuel Substitution Infrastructure Cost Report.

1. **Continue to Monitor and Leverage Other Studies.** Data on existing building electrical panel capacity, amps, condition, and physical breaker slot space for additions/modifications (including alternatives to full panel upgrades such as smart switches or sub-panels) were helpful in predicting the need for panel upgrade for electrification end use installation. Currently, building vintage and location/climate zone are indicators used in predicting existing building panel capacity. Improved data on existing building panel capacity will improve understanding of the factors that contribute to the likelihood of needing a panel upgrade for building electrification. Additional research should be conducted to gather panel capacity data by building type, age, and location, especially for the commercial sector. This data would also support understanding the percent likelihood of the three general electrification infrastructure scenarios (no upgrade, optimization, and panel upgrade) for both the residential and commercial sectors. For example, the WG was made aware of a national assessment being conducted by LBNL and other active studies and research efforts in California.

2. **Commercial Infrastructure Impacts.** Additional research is needed to understand commercial retrofit panel upgrade costs for this diverse sector. For example, infrastructure cost impacts for businesses that currently rely on gas cooking equipment such as restaurants and institutional facilities will be significantly impacted by electrification. [99] With improved data, the recommendations and methodology of this WG can better reflect the fuel substitution infrastructure costs for customers in the commercial sector.

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[97] Executive Order N-79-20 establishes a goal that 100 percent of in-state sales of new passenger cars and trucks be zero emission by 2035. The California Air Resources Board developed the Advanced Clean Cars II Regulations to accomplish this goal.

[98] The WG notes that the TECH Clean California program participant group reflects customers that have elected to proceed with fuel substitution projects; customers that declined to participate in the program because of infrastructure upgrade cost barriers are not represented in the TECH program participant population.

[99] CalNEXT All-Electric Commercial Kitchen Electrical Requirements Study Final Report, ET22SWE0010

3. **Residential Attribution Factor.** As electric appliance saturation increases in residences, the attribution factor assumptions regarding the number of future electrified end-uses that would be supported by a panel upgrade will need to be revisited. The best data source for updating these assumptions would be the residential appliance saturation study (RASS) which is performed every 10 years, most recently in 2019. This study shows the penetration of different appliances and the fuel they each use within a home. As of 2019, 6% of homes have electric DHW, 19% of homes have primary electric space heating, 47% have electric range/oven, 32% have electric dryer, and 6% have EV charging. As penetration of these technologies increases, the residential attribution factor should be updated to either account for the varied electric appliance penetration or remove the end uses which have largely transitioned from gas to electric fuel types within the residential populations targeted by fuel substitution measures.

4. **Order of Installation of Appliances.** The current data reflected in the Opinion Dynamics market study assume only one fuel substitution measure to be installed. This assumption is supported by TECH program data which shows the majority of fuel substitution projects among TECH participants have involved only one end use at a time. As customers who do not need panel upgrades to support one fuel substitution measure installation complete multiple electrification measure installations in the future, the need for a panel upgrade may arise for those customers. Therefore, both the attribution percentages and the percent of customers needing panel upgrade/optimization will need to be updated as second or third electrification measure installations become more typical among customers participating in EE fuel substitution programs.

7 Appendix C: 2023 Measure Package WORKING GROUP Recommendations

CPUC staff should manage the review and approval process for minor issues with measures. In addition to this, the working group recommends a dedicated, independent, consultant to do the initial comprehensive analysis, and a single party to drive consistency and accuracy of assumptions. The working group also recommends considering a tool or system/data extract that automates this process by extracting existing data from the eTRM to generate the inputs for the "VEA Check Calculator". Also identify which party would be responsible for identifying consistent baselines and conducting the analysis outside of the measure packages.

Recommended agents for these tasks include:

- CalTF
- 3rd Party Implementer
- PA lead of the gas measure
- PA lead of the FS measure

Other issues the Working Group recommends considering:

1. Measure packages today are not ready to easily compare level of service between a gas and electric technology. Consider additional efforts to produce level of service data within eTRM for all measures to enable comparative analysis between a gas and electric technology.
2. Consider conducting a separate analysis to assess an increment above the 1.0 TRC for an average value above. Consider establishing a threshold of permutations (e.g., 70% of permutations) that would determine if the entire measure package would be removed from eligibility of rebates. However, an offering may include some reasonable permutations that should remain eligible. This could be handled as exceptions. The working group prepared a preliminary analysis of the percent difference in the TRC, that may be considered by the CPUC staff to establish TRC thresholds when excluding admin.
3. Misalignment of parameters in the measure packages was found to be the norm for most of the measures the working group reviewed.
    - Instead of only evaluating the measure packages that exist today, an analysis could be performed that enables "apples to apples" comparison by pulling data from multiple existing gas and/or electric measures. As the measure packages exist today, there is a need to convert existing measure package assumptions to enable the appropriate comparison. The working group recommends a comprehensive analysis using the guidance outlined below, rather than allow gas measures to continue in the portfolio simply because the parameters and/or data do not currently match.
    - For existing fuel substitution measure packages: Get to a point where it's "close" – propose to align mismatched assumptions outside of the measure package (e.g.,

convert units) to do the comparison. The calculator can be leveraged to perform and document these approaches.
    - CPUC staff review/approval of the process to review minor issues with measures. Ex Ante Team *(P. Biermayer)* would be responsible for final review & decision.
    - The working group recommends a dedicated, independent, consultant to do the initial comprehensive analysis, and a single party to drive consistency and accuracy of assumptions. Consider CalTF, as a separate contract outside of their normal Business Plan. Consider a tool or system/data extract that automates this process by extracting existing data from the eTRM to generate the inputs for the "VEA Check Calculator".
        - Identify which party would be responsible for identifying consistent baselines and conducting the analysis outside of the measure packages.
            - 3rd Party Implementer
            - PA lead of the gas measure
            - PA lead of the FS measure
    - Going forward, the working group proposes that this review is synced with the measure package update cycle for the impacted measures.
4. Screening Process for newly developed gas measures
    - When is this analysis performed? The working group considered the VEA analysis to occur at the Measure Package Portfolio level before the full draft, research, etc. is completed. This could be part of the preliminary review. The working group also considered splitting the review into two processes, one for existing measures and another for proposed new measures or perhaps every 2 years on an ongoing basis.
5. VEA must be a CPUC approved measure package, which could pose some limitations with current measure packages
    - With 3rd Party-Implemented resource programs, Implementers experience financial and resource challenges to proactively develop new measure packages. Without support from Program Administrators, it is unlikely that Implementers will fund new measure packages for the EE industry. Additionally, 3rd Party-Implemented program contracts are only 3-5 years in duration. This exacerbates the issue because the Implementers have less time to reap the benefits of investments in a measure package, which could take several months to a year to develop and gain approval from the CPUC.
    - Often newer measure packages have newer assumptions and/or data than older ones of similar types, this issue may trigger a review of both the older and newer measures to ensure the data sources are consistent.
    - If a VEA must be a CPUC approved measure package, the working group should acknowledge that the available dataset is incomplete. Instead of only evaluating the measure packages that exist today, the working group recommends a mechanism to drive a comprehensive comparative analysis.
6. Defining commercially viable

- The working group held discussions on the minimum number of products available and minimum number of manufacturers available to determine commercial viability. The VEA Calculator currently assumes 5-8 minimum products available and 3 minimum manufacturers, based upon the transportation electrification proceeding but this may need further review by the CPUC.
- At a 5-8 product threshold, the Commission risks long-lived gas efficiency water heater measures to be "locked-in". A 2-product minimum threshold could address the risk of customers installing only code-compliant gas appliances but could create a risk of an emerging market that is not ready for full deployment and unintentionally undermine forward progress.
- Also, it was agreed that measures moving into and out of a non VEA status, would cause undesired risk and confusion in the market and thus should be avoided unless there is a major change that would impact most measures (e.g. a regulatory decision).
- For customized solutions with truly unique solutions, such as technologies found in the Industrial sector, the proposed ratepayer cost effectiveness thresholds may not apply, although the current scope applies only to deemed measures.
- The CEC Recommendation for Deployment of ISO 15118-Ready Chargers discusses Market Readiness for ISO 15118-Ready Chargers. It concluded that the availability of five or more charger brands (not models) is reasonably indicative of a market prepared for widespread deployment. CPUC may consider if this reference is comparable to EE technologies.

7. Code requirements of the VEA requires further clarification
   - Generally, existing measures would be developed that meet current codes; however, implementation of codes, especially building codes, is reviewed at a local level. While this issue exists for most measures, the refrigerants used in some new measures may not be fully accepted by all local municipalities in PA territories. Thus, the recommendation is for any measure where this is an issue, that the measures need to be generally accepted by most local municipalities within PA territories.
     - Example: HPWH may not fit in a manufactured home, under California Housing which restricted to interior space only creating space constraint challenges.
   - Sometimes "exceptions" can be used for one off code approval outside of the normal process. For the same reasons cited previously, the expectation is that on a PA statewide basis, the VEA measures would not usually require exceptions.
8. Cost-effectiveness threshold
   - The high-level screen currently applies a 1.0 TRC (non-administrator cost) threshold and a TSB>0 threshold to screen the electric measure at an offer ID and permutation level.
     - The working group discussed potentially eliminating the TRC threshold from the VEA criteria. If a TRC threshold must be applied per the Decision, the working group also considered several scenarios, including:

        - Reducing the threshold to 0.70 TRC (highest TRC permutation) and performing a comparison with the gas measure TRC when below this threshold.
            - VEA active or expired measures with less than a 1.0 TRC may be eligible in Equity Programs.
            - A 1.0 TRC threshold makes sense at the portfolio level. A program may have a mix of measures at various TRCs and is required to manage towards a > 1.0 TRC.
        - Note that a 0.85 TRC threshold is consistent with the threshold applied in the EE Potential & Goals Study.
        - For comparing TRC, consider: Is the electric measure permutation with the highest TRC greater than 0.85? If yes, then it is a VEA. If the electric measure permutation with the highest TRC is greater than the gas measure permutation with the highest TRC, then it is a VEA.
        - The working group also discussed increasing the TRC threshold. The TRCs used in the VEA Calculator are measure level and don't account for program administrative costs. Inclusion of administrative costs would increase the required TRC level by 55% across all sectors. Additionally, Equity programs typically have higher incentives and have lower TRCs, thus a higher TRC level may increase accessibility to equity and/or underserved programs.
        - TRC thresholds that change over time as the market matures were also discussed.
        - Also note that residential TRCs have historically been lower than other sectors due to lower operating hours and energy intensity. This was also discussed, but no direction was noted.
    - The working group also investigated using the TSB as a national ratepayer threshold. The consensus is that the proposed VEA TSB>0 is required to pass the threshold.

9. Customer cost-effectiveness includes several assumptions that warrant further review.
    - The working group would prefer to have the output from the utility cost calculator from the infrastructure working group to be blended kWh/therm rate by CZ/BT, not a total cost that won't align with our proposed calculations and measure package assumptions if they change.
    - Assumptions for incentive
        - What is an appropriate assumption for rebate? Is 50% IMC acceptable (the current placeholder)?
        - How would CPUC staff handle incentives differently for different delivery methods?
    - How will maintenance costs be determined as most measures do not contain maintenance costs (the current value in the spreadsheet is a place holder).

- Assumptions for infrastructure (panel) cost, which currently are not in the measure packages, but would likely come from the infrastructure working group.
- Assumptions for discount rate, which could vary by customer type and /or access to capital.

10. The customer cost analysis only accounts for the items below. Is there anything that is missing that should be considered?
    - Gas bill changes
    - Electric bill changes
    - Gas equipment costs (install, maintenance) vs the gas baseline approach
    - Electric equipment costs (install, infrastructure costs, maintenance) vs the gas baseline for the measure case
    - EE incentive/rebate for either case
11. CPUC should consider how to incorporate other VEA benefits for customers, as defined in the Decision. The working group did not think there was an easy and fair way to account for these.
    - Multiple entity rebates - Consider the TECH program. This was a challenge for the working group since the specific values were not quantifiable and could change over time as incentive money is used up and/or replenished.
    - Tax Credits - This was a challenge for the working group since it could vary significantly by customers, tax code year, and other complexities of taxes in general. While tax credits are easier to deal with than tax deductions, they often have lifetime limits and/or income thresholds that would complicate their application on a measure-by-measure basis.
    - Improved indoor air quality and health benefits - No amount denoted as the cost impacts are not readily quantifiable.
    - Reducing impacts of stranded gas infrastructure - Perhaps, not considered in the customer cost effectiveness. Rather in the cost working group as the gas infrastructure costs would show up in the ACC and not be "seen" by customers. Elimination of gas service if fully electrified would reduce the monthly billing surcharge. This would vary by customer but is more quantifiable than the others.