2025 Energy Efficiency Potential and Goals Study – Public Draft

Prepared for:

California Public Utilities Commission

Submitted by:

Guidehouse Inc.
400 Capitol Mall
Room #08-102
Sacramento, CA 95814
Telephone (415) 399-2109

Reference No.: 535313
May 2, 2025

guidehouse.com

This study is covered under Contract 21NC0594 between Guidehouse and the California Public Utilities Commission (CPUC).

Contact Information

For more information contact: Neil Podkowsky, npodkowsky@guidehouse.com

Principal authors include:

- Neil Podkowsky
- Amul Sathe
- Karen Maoz
- Brian Chang
- Jordan Neeley
- John Mitchell
- Kate Martella
- Yamini Arab
- Raniel Chan

Guidehouse was supported by:

Mitchell Analytics

DNV

Special thanks to the staff of the CPUC and the many stakeholders for providing direction, guidance, insight, and data throughout this study.

The project team would like to acknowledge:

- California Energy Commission staff for assistance on project data needs.
- Sound Data for guidance regarding the use of CEDARS data.

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Executive Summary

Guidehouse Inc. (Guidehouse) and its partners, Jai J. Mitchell Analytics and DNV (collectively known as the Guidehouse team), prepared this study (*2025 Energy Efficiency Potential and Goals Study* or 2025 Study) for the California Public Utilities Commission (CPUC).

This study develops estimates of the energy and demand savings and fuel substitution (FS) potential in the service territories of California's major investor-owned utilities (IOUs) during the post-2025 energy efficiency (EE) rolling portfolio planning cycle. This report includes results for Pacific Gas and Electric (PG&E), Southern California Edison (SCE), San Diego Gas & Electric (SDG&E), and Southern California Gas (SCG). A key component of the study is the Potential and Goals Model (PG Model). This model provides a single platform to conduct quantitative scenario analysis to examine the interactions among inputs and policy drivers for the full EE portfolio.

Background and Approach

The 2025 Study updates the previous potential and goals study completed in 2023 (2023 Study).[1] The 2025 Study reflects the market and policy changes that have taken place in the past 2 years since the Guidehouse team completed the 2023 Study. The team initiated the current study cycle in January 2024, which included the following stakeholder workshops:

- Study Updates Workshop, January 2024
- Workplan Workshop, April 2024
- Income Qualified Workshop, September 2024
- Scenarios Workshop, September 2024

These workshops helped to shape and guide the direction of the work presented in this report.

Study Utilization

The 2025 Study supports CPUC objectives, and provides the following:

- Informs the CPUC as it proceeds to adopt updated EE and FS goals for IOUs
- Serves as one of several sources of guidance to the IOUs and other program administrators in portfolio planning
- Informs the budget-setting process for IOU EE portfolios
- Identifies new EE savings and FS opportunities
- Provides forecasting inputs to support the procurement and planning efforts of California's principal energy agencies including the CPUC, California Energy Commission (CEC), and California Independent System Operator (CAISO)

[1] Guidehouse, 2023 Energy Efficiency Potential and Goals Study, August 2023.

- Provides forecasting inputs to support the analysis and accounting of EE contributions to Senate Bill (SB) 350 targets:[2] SB 350 targets doubling EE by 2030

The 2025 Study forecast period spans from 2026 to 2037 and focuses on current and potential drivers of energy savings in IOU service areas.

Consistent with the 2023 Study and common industry practice, the 2025 Study forecasts potential at three levels for rebate programs:

- **Technical potential.** Defined as the energy savings and related system benefits that would be possible if all inefficient measures[3] in the market were replaced with the highest level of efficiency (considering both EE and FS equipment as replacement options). Technical potential represents a maximum upper limit, but it is not reasonably achievable due to cost and other barriers.
- **Economic potential.** Calculated as the total potential available when limited to only measures that pass a specific measure-level cost-effectiveness threshold.[4] Economic potential is a subset of technical potential but still ignores a variety of market realities and barriers.
- **Achievable potential.** Calculated as the EE and FS potential reasonably expected to occur based on specific incentive levels, program delivery methods, assumptions about existing CPUC policies, market influences, and barriers. The CPUC has used achievable potential to inform the goal-setting process. The remainder of this executive summary discusses only achievable potential.

The 2025 Study forecasts the potential energy savings from various EE and FS programs as well as codes and standards (C&S) advocacy efforts for the following customer sectors: residential, commercial, agriculture, and industrial. The study does not set IOU goals, nor does it make goal-setting recommendations. Rather, it informs the CPUC's goal-setting process.

Scenarios

The 2025 Study explores market response and how potential might change based on three scenarios. The key variables that change across scenarios are cost-effectiveness threshold, FS adoption parameters, program engagement, and program incentive levels.

- **Total Resource Cost (TRC) cost-effectiveness threshold.** The cost-effectiveness threshold is set to a TRC[5] of 0.85 or 1.0, depending on the scenario. Different cost-effectiveness screening tests or thresholds allow different technologies in forecast potential. The cost-effectiveness screening test threshold applies only to rebate programs.

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[2] California SB 350

[3] The CPUC *Energy Efficiency Policy Manual* defines *measure* as an energy using appliance, equipment, control system, or practice whose installation or implementation results in reduced energy use while maintaining a comparable or higher level of energy service as perceived by the customer.

[4] The model can use different metrics of cost-effectiveness as defined by the California Standard Practice Manual.

[5] The TRC test is an econometric comparison of the total economic benefits, including offsets to built infrastructure costs necessary to compensate for the lack of efficiency gains provided by the measure.

- **FS adoption.** This variable captures varying adoption parameters such as awareness of FS technology, willingness to adopt, price sensitivity, and stock turnover.
- **Program engagement.** Program engagement refers to the level of marketing awareness and effectiveness as well as the level of aggressiveness of the behavior, retrocommissioning, and operational efficiency (BROs) program participation.
- **Incentive levels.** The study uses two levels of incentives: Reference and Aggressive. Guidehouse analyzed historic program data from 2023 to calculate incentive levels as a percentage of technology cost. From this data, the team identified the mean and 75th percentile values to represent the Reference and Aggressive scenario levels, respectively.

Error! Not a valid bookmark self-reference. summarizes the various scenarios considered for the 2025 Study. These scenarios are built primarily around policies and program decisions that CPUC and its stakeholders collectively have influence over. The scenario variation focused on assumptions for FS adoption parameters, cost-effectiveness, program engagement, and program incentive levels.

Each of the three scenarios uses the TRC test as the basis for cost-effectiveness determination. Each scenario also uses consistent assumptions about the Inflation Reduction Act (IRA) tax credits:

- **Scenario 1: Reference.** Market achievable potential with inputs reflecting the best available information, calibrating the model using IOU program results
- **Scenario 2: High TRC.** Consistent with Scenario 1 but with measure-level cost-effectiveness screening increased from 0.85 to 1; the team anticipates this scenario will generate a more conservative outcome with lower achievable TSB compared with Scenario 1
- **Scenario 3: Aggressive FS.** Consistent with the Scenario 1 but modified to model more aggressive assumptions specifically for FS potential; this scenario includes increasing program budgets and increasing the influence of IOU FS programs on adoption:
  - Increase measure incentive caps to represent the top quartile value represented in current FS program offerings
  - Simulate increased willingness to adopt representing greater market adoption
  - Simulate increased program engagement through enhanced marketing, education, and outreach

Table ES-1. Summary of Scenarios for Achievable Potential

Levers → Scenario ↓	C-E Test	C-E Threshold	Incentive Levels Capped*	FS**	Program Engagement***
1: Reference	TRC	0.85	Reference	Reference	Reference
2: High TRC	TRC	1.0	Reference	Reference	Reference
3: Aggressive FS	TRC	0.85	Aggressive	Aggressive	Aggressive

C-E = cost-effectiveness
*Incentives caps vary based on program sector and end use. For a full list see Table 2-11.
**FS adoption parameters are set based on end use and sector-specific calibration targets
***Program engagement refers to the level of marketing awareness and effectiveness as well as the level of aggressiveness of the behavior, retrocommissioning, and operational efficiency (BROs) program participation.
Source: Guidehouse

Guidehouse calculated results for each of the three scenarios using two zero-emissions appliance standard (ZEAS)[6] frameworks, which represent different assumptions for the effective dates of the California Air Resources Board (CARB) proposed statewide standards. One framework (termed ZEAS 2030) assumes an effective date of 2030 for all affected measures. The other framework, termed ZEAS Phased, assumes staggered effective dates between 2027 and 2031 according to a CARB-specified schedule and includes a multiyear compliance ramp-up period for select technology groups. Sections 1.3 and 2.3 and 4.5.1Appendix B provide additional detail on the incorporation of these standards into the 2025 Study analysis. The remainder of this section outlines the results for the three scenarios modeled within the ZEAS 2030 framework.

Impactful Data Updates and Policy Changes

Error! Reference source not found. highlights key 2025 Study data updates and policy changes and how each change directionally affects overall results. Directional changes reflect impacts on 2025 Scenario 1 relative to the 2023 goal-setting scenario unless noted otherwise.

Table ES-2. Key Changes Relative to 2023 Study

[6] Zero-Emission Space and Water Heater Standards | California Air Resources Board

Category	Update Relative to Previous Study		Directional Impact on the 2025 PG Study Relative to the 2023 PG Study
Cost-Effectiveness	A variety of inputs affecting cost-effectiveness have changed since the last study. Electric-avoided costs decreased while gas-avoided costs increased. Measure lifetimes for several key measures increased and overall savings assumptions for measures have been updated.	↑	Overall, the Guidehouse team sees a 60% -85% increase in cost-effectiveness driven by key items: • Updated avoided costs, measure lifetimes, and savings assumptions resulted in more cost-effective FS Select highly cost-effective measure categories—notably strategic energy management (SEM)—have a substantial reduction in cost per unit impact thus increasing cost effectiveness
TSB	To better align with TSB as the statewide goal-setting metric, Guidehouse modeled technical and economic potential in terms of TSB. Guidehouse based the calibration of achievable potential on TSB whereas previous studies calibrated based on energy savings.	↓↑	Although it was a notable update to the study's approach versus the analysis conducted in 2023, the impact of Guidehouse's incorporation of TSB was not a major driver of study-over-study changes in achievable potential. Rather it represents a refinement in the determination of technical and economic potential, as well as within the calibration of market achievable potential. This refinement results in greater consistency of avoided cost inputs and improved alignment of the PG Model outputs with TSB as the statewide goal-setting metric.
Natural Gas Appliance Standards	CARB ZEAS	↓↑	Guidehouse incorporated the CARB decision to work toward banning the sale of natural gas appliances into the 2023 Study, resulting in the removal of applicable measures from consideration after 2030. In the 2025 study, Guidehouse included alternative scenarios applying a phased-in assumption for these standards' effective dates beginning in 2027. This approach flattened the previous large step change forecast in 2030 and distributed those reductions in the immediate years prior.

Category	Update Relative to Previous Study	Directional Impact on the 2025 PG Study Relative to the 2023 PG Study	
Industrial, Agricultural, Commercial Custom	Guidehouse conducted primary research to inform a restructured analysis for industrial, agricultural, and commercial custom EE. Achieved TSB in recent program years additionally trended upward for these sector and savings types.	↑	Guidehouse conducted a market study in 2024 to inform a modified top-down analysis that the team employed to assess industrial, agricultural, and commercial custom potential. Although a change in methodology does not affect the overall potential savings, forecast potential is grounded in historical achievements and insights from market actors (via surveys) to provide directional and qualitative volume of participation in future years. Program claims data showed increasing trends in overall industrial sector-achieved TSB, driven by growth in SEM savings. As a result, the 2025 Study shows an increase in achievable potential for this sector.

Source: Guidehouse

Results

The 2025 Study provides a rich dataset of results, which is available on the CPUC 2025 Potential and Goals website.[7] The report presents results by program type:

- **EE equipment.** These programs incentivize the installation of EE equipment. These measures have been traditionally incentivized by IOU programs for decades. This program type specifically excludes FS.
- **FS.** These programs replace gas appliances with electric appliances. Doing so eliminates gas use (resulting in gas savings) while increasing electric consumption. The potential study calculates impacts on electric and gas consumption that result from FS.
- **BROs.** These programs change customer behavior and usage patterns without relying on new equipment installations to generate savings.
- **C&S.** These programs consist of IOU advocacy efforts to increase the minimum level of efficiency for appliance standards and building codes. The IOUs claim a portion of the savings these new C&S generate based on IOU efforts to advocate for them.
- **Income qualified.** This type represents the Energy Savings Assistance (ESA) program that offers measures to qualified customers.

Total Achievable Potential

[7] 2025 Potential and Goals Study

Error! Reference source not found. summarizes results for program year 2026. This section discusses results only for the year 2026 unless otherwise noted. The table shows the net[8] achievable potential results for Scenarios 1 through 3 (previously listed in **Error! Reference source not found.**).[9] For comparison, Table ES-3**Error! Reference source not found.** also includes the 2023 Study scenario that the CPUC used to inform previous goals.

Table ES-3. 2026 Net TSB and First-Year Savings by Scenario (Statewide)

Savings Metric	Program Type	2023 Goals Scenario	1: Reference	2: High TRC	3: Aggressive FS
TSB ($ millions)	FS	$36	$183	$159	$195
	EE	$554	$657	$630	$656
	Total	**$590**	**$839**	**$789**	**$851**
Electric Energy (GWh/Year)	FS*	-24	-140	-105	-148
	EE	714	589	564	589
	Total	**690**	**449**	**459**	**441**
Converted Electric Energy (GWh/Year)**	FS	102	275	238	293
	EE	714	589	564	589
	Total	**816**	**864**	**802**	**883**
Electric Demand (MW)	FS***	0	0	0	0
	EE	148	123	119	123
	Total	**148**	**123**	**119**	**123**
Gas Energy (MMtherms/ year)	FS	4	14	12	15
	EE	43	39	39	39
	Total	**47**	**54**	**50**	**54**

* FS impacts reflect additional electric energy consumption, resulting in negative savings and peak demand impacts.
**Converted electric energy represents the net reduction in energy consumption resulting from FS, calculated by converting gas energy units to equivalent electric energy units.
*** In accordance with CPUC guidance, FS does not count for or against peak demand savings goals and is therefore presented as zero in this study. *Source: California Public Utilities Commission, Energy Division, 2019,* Fuel Substitution Technical Guidance, Version 1.1, *October 31, 2019*.

Source: Guidehouse

The following are notable takeaways and details regarding the TSB results:

- **Overall achievable TSB increases relative to the 2023 Study range from 34% in Scenario 2 to 44% in Scenario 3.** The primary driver is a significant increase in achievable potential associated with FS technologies (339% - 437% higher) and growth in achievable EE potential within the industrial sector (63% higher).

[8] The CPUC Energy Efficiency Policy Manual defines net savings as those realized when free ridership is accounted for. The savings is calculated by multiplying the gross savings by the net-to-gross ratio. The PG Model calculates TSB using net savings.

[9] Phased ZEAS assumptions do not affect the PG Model outputs in 2026. Accordingly, the results detailed in this section do not vary across ZEAS assumption sets. More details on Scenarios 4-6 are found in Section 4.

- **Water heating, particularly in the commercial sector, drives the increase in FS TSB.** Overall growth is present in each of the three scenarios, where FS represents between 20% and 23% of overall statewide achievable TSB. This finding is primarily the result of Guidehouse employing recent FS program data to calibrate the 2025 PG Model, which included dramatic increases in claimed activity versus those immediately prior to the 2023 Study. Commercial heat pump water heaters are the largest individual contributor to achievable potential, representing greater than 60% of achievable FS gas savings across all scenarios. The large increase in the Scenario 1 FS potential limited the impact of aggressive FS assumptions applied in Scenario 3.

- **Updates to gas and electric avoided cost inputs are also drivers of increased FS TSB.** The 2025 study has higher gas avoided costs and lower electric avoided costs than those used in the 2023 study. As FS measures eliminate gas use and increase electric load, higher gas avoided costs increase TSB while lower electric avoided costs decrease the TSB "penalty" for increased load. Both of these act to increase TSB from FS measures.

- **The application of a higher cost-effectiveness threshold in Scenario 2 results in a moderate decrease in achievable TSB of 6% versus Scenario 1.** FS potential is relatively more affected, with an overall decrease of 13%, versus Scenario 1. EE TSB decreases by 4%. This difference can be interpreted as the proportion of achievable potential resulting from measures with TRC benefit-cost ratios between 0.85 and 1.0.

- **Achievable TSB resulting from EE has increased between 14% and 18% versus the prior study.** This increase is driven primarily by industrial measures generating a greater portion of TSB due to longer effective useful life[10] (EUL) pursuant to the Database for Energy-Efficient Resources (DEER) resolution.[11] Residential and commercial sector EE potential increased by 14% and 15%, respectively.

The following are notable takeaways from the energy savings results:

- **Overall achievable gas savings for all program types relative to the 2023 Study are 7%-16% higher.** For reasons consistent to those noted earlier, higher achievable FS in the 2025 Study relative to the 2023 Study reflect large increases in the proportion of overall gas savings resulting from FS measures.

- **Overall achievable GWh electric savings for all program types shows a decrease of 34%-36% versus the 2023 Study.** FS impacts on electricity consumption, shown as equivalent to negative EE savings, have increased notably, which then impacts the statewide electric energy potential. Total first year GWh savings from EE decreased 17%-21% overall. When FS gas savings are converted to GWh equivalent, total statewide impacts across all program types are within 8% of the prior study cycle.

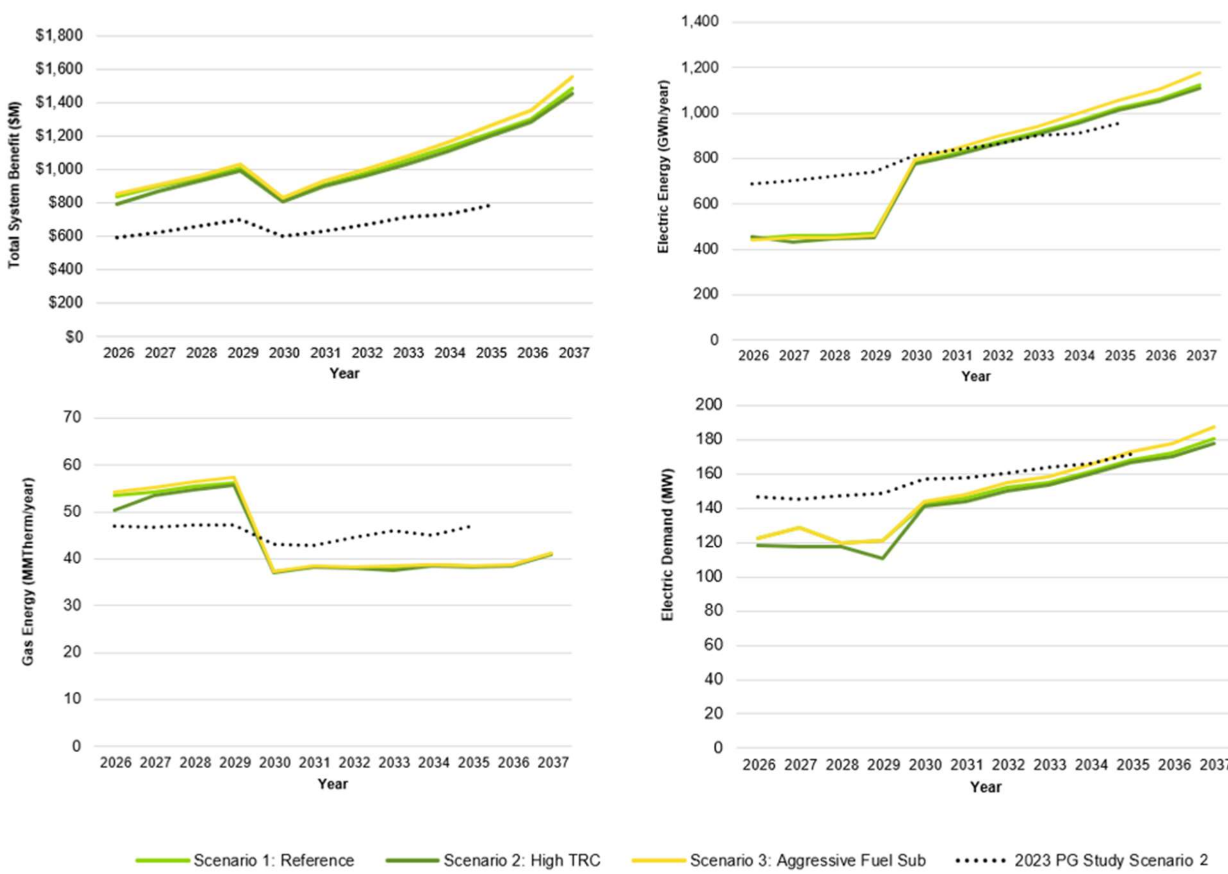
- **Achievable electric demand (MW) impacts resulting from EE are 17%-20% lower versus the 2023 Study**. This finding aligns with the similar reduction in EE electric energy impacts noted earlier.

[10] The CPUC Energy Efficiency Policy Manual defines EUL as an estimate of the median number of years that the measures installed under the program are still in place and operable.

[11] https://cedars.cpuc.ca.gov/deer-resources/deer-versions/2026/file/3162/download/

Error! Reference source not found. shows the 12-year forecast for TSB, first-year net electric, peak demand, and gas achievable potential for EE and FS combined.

Figure ES-1. Net TSB and First-Year Savings by Scenario (1-3)



Note: Electric savings and TSB values include the impacts of FS where there is an increase in electric supply negatively impacting the savings and system benefit.

Source: Guidehouse

The following are notable takeaways from the TSB and energy savings results over the 2026-2037 study period:

- **Achievable TSB, energy, and demand savings are all substantially affected following the ZEAS 2030 effective date.** In 2030, gas savings potential declines sharply versus the prior year as a result of the affected FS measures' impacts shifting from gas to electric baselines. Although this shift eliminates gas savings potential for those measures, there remains substantial achievable potential for these efficient technologies to be adopted. This potential drives achievable electric and demand savings increases in this same year.
- **Increases in achievable TSB versus the prior study are driven by a combination of savings associated with longer EUL measures and changes to avoided costs.** While achievable electric savings prior to 2030 is lower than was shown in the 2023 Study, overall TSB is higher in all years. This finding is primarily the result of two factors:

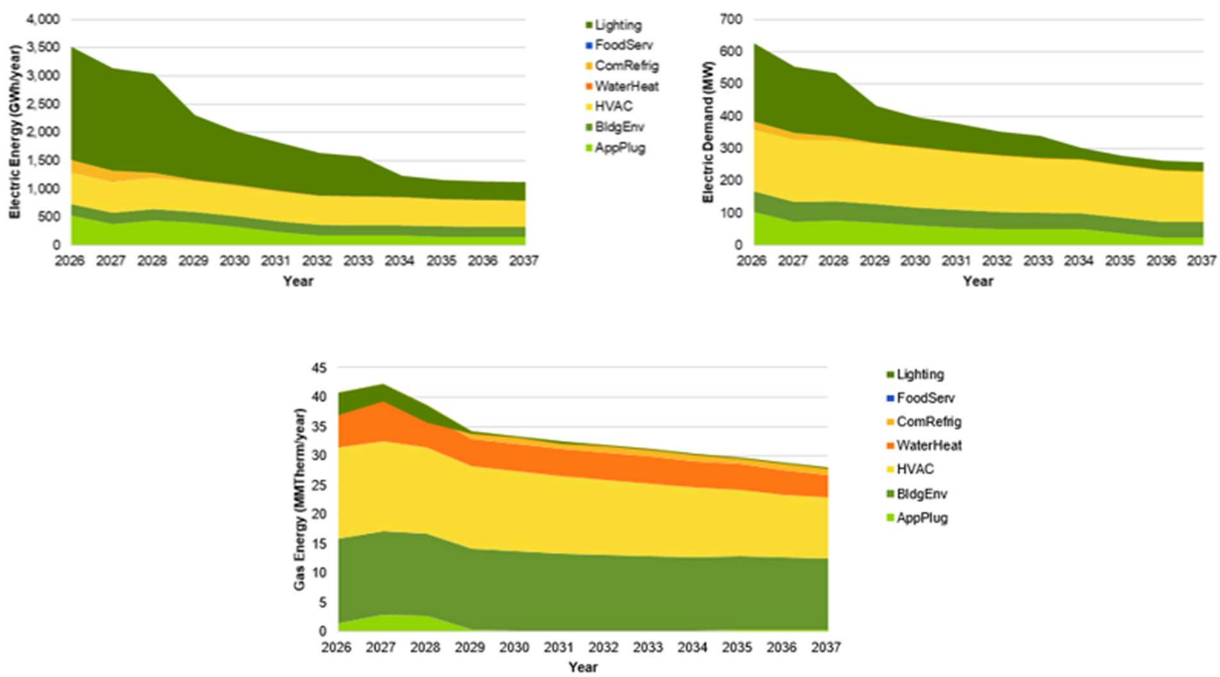
a higher proportion of TSB being generated by measures with longer assumed EULs, and higher gas avoided costs versus those used in the prior study cycle.

C&S Savings

C&S savings do not vary across each scenario and tend to be larger than the magnitude of savings from any other source. Thus, this study presents a single set of results separate from EE and FS impacts. **Error! Reference source not found.** illustrates incremental annual savings from C&S that have been passed into law.

As was the case in the 2023 Study, the most current CPUC impact evaluation of C&S[12] and data provided by the IOUs inform the current study's results. Accordingly, year-over-year trends in forecast impacts for both electric (MWh and MW) and gas impacts are similar to the prior study's results for 2026-2035. Electric savings trend down through the study period primarily as a result of declining lighting end use impacts. Gas savings trend up slightly for the initial year of the study following water heating and appliance plug load end use trends. Incremental savings attributed to C&S trend down in the outer years of the study as the Guidehouse analysis assumes the technologies impacted by a code or standard reach the end of their useful life. Beyond this point, new installations no longer yield incremental energy impacts under current codes.

Figure ES-2. C&S Savings (Including Interactive Effects)

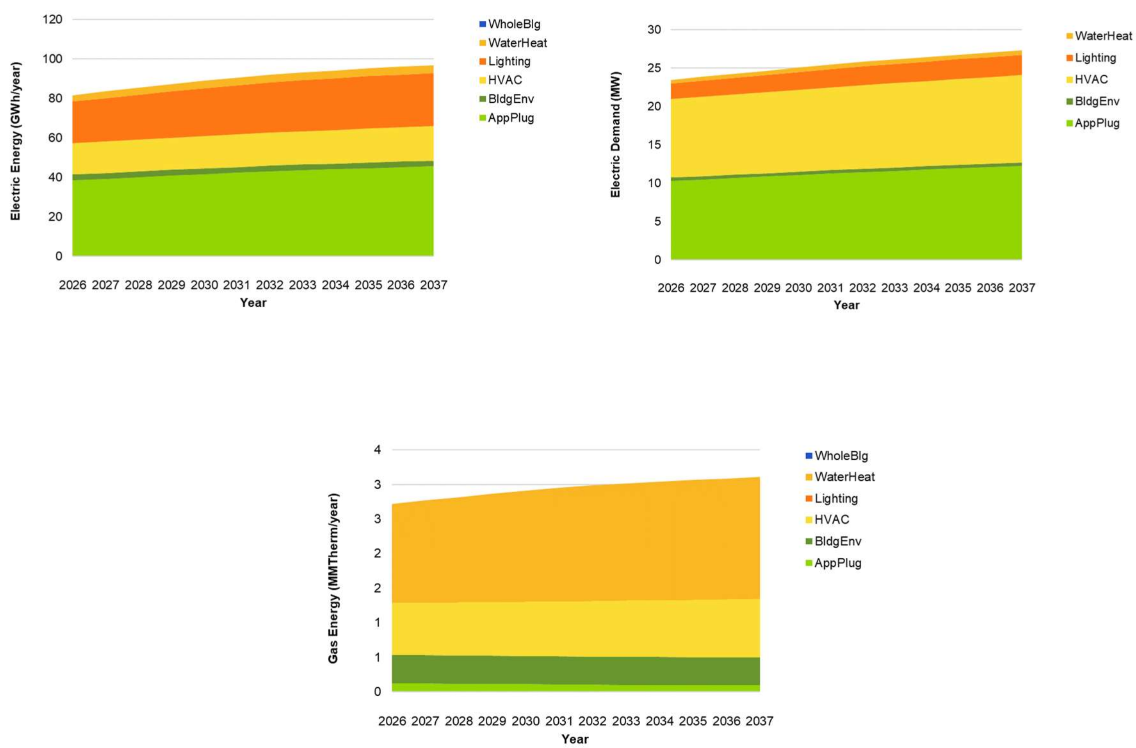


12 PY 2016-2018 Building Codes Advocacy Program Evaluation Volume II – Final Report

Income Qualified Savings

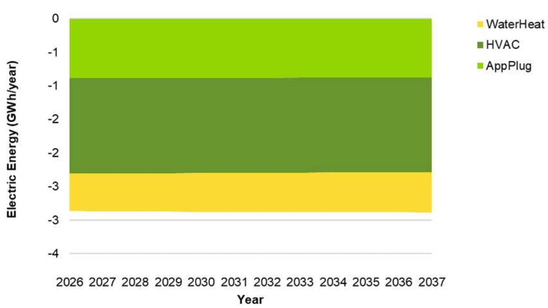
Error! Reference source not found. provides income qualified EE electric and gas savings and electric demand by end use. **Error! Reference source not found.** provides income qualified FS electric and gas savings and electric demand by applicable end use. This study's income qualified savings forecast employs a bottom-up modeling approach separate from the applications and goals adopted from D.21-06-015 in A.19-11-003. However, the measures provided by IOUs as part of their ESA programs were key inputs to this study. Additional details can be found in a separate income qualified savings forecast report targeted for release in June 2025.

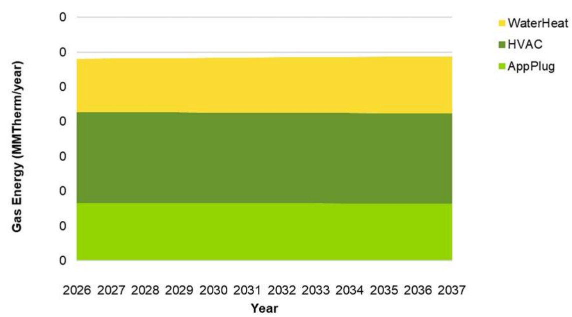
Figure ES-3. 2026 Study Income Qualified EE Savings by End Use



Source: Guidehouse

Figure ES-4. 2026 Study Income Qualified FS Savings by End Use





Source: Guidehouse

1. Introduction

1.1 Context of the Potential and Goals Study

Guidehouse and its partners, Jai J. Mitchell Analytics and DNV (collectively known as the Guidehouse team), prepared this study (*2025 Energy Efficiency Potential and Goals Study* or 2025 Study) for the California Public Utilities Commission (CPUC). The purpose of this study is to develop estimates of energy and demand savings potential for energy efficiency (EE) and fuel substitution (FS) in the service territories of California's major investor-owned utilities (IOUs) during the post-2025 EE rolling portfolio planning cycle. This report includes results for Pacific Gas and Electric (PG&E), Southern California Edison (SCE), San Diego Gas & Electric (SDG&E), and Southern California Gas (SCG). A key component of the 2025 Study is the Potential and Goals Model (PG Model), which provides a single platform to conduct robust quantitative scenario analysis that reflects the complex interactions among various inputs and policy drivers.

The 2025 Study is the eighth consecutive potential study conducted by the Guidehouse (formerly Navigant) team on behalf of the CPUC. The previous study published was the 2023 Study, which informed goals for 2024 and beyond.[13]

The 2025 Study supports multiple related efforts:

- Informs the CPUC as it proceeds to adopt goals and targets, providing guidance for the next IOU EE portfolios. The potential study is a framework that assesses impacts reasonably expected to occur by IOU-funded programs based on certain policies and expectations of market uptake.

- The California Energy Commission (CEC) then uses the CPUC-adopted goals to develop its forecast of additional achievable energy efficiency (AAEE) and additional achievable fuel substitution (AAFS) potential. Furthermore, the data becomes an input to Senate Bill (SB) 350 scenario analysis, which targets doubling the AAEE by 2030.[14]

- Guides the IOUs and other program administrators in portfolio planning. Although the PG Model cannot be the sole source of data for program administrator program planning activities, it can provide critical guidance for the program administrators as they develop their plans for the 2026 and beyond portfolio planning period.

The 2025 Study continues to apply the enhancements from the 2023 Study (key areas that were updated are discussed further in Section 1.3). The project kicked off in January 2024 and the draft workplan was presented to stakeholders on April 17, 2024. The 2025 Study was further informed by stakeholder sessions to review approaches for the income qualified sector and 2025 Study scenarios.

The study period spans from 2025 to 2037 based on the direction provided by the CPUC. The study focuses on current and potential drivers of energy savings and Total System Benefit

[13] Guidehouse, *2023 Energy Efficiency Potential and Goals Study*, August 2023.
[14] California SB 350

(TSB) in IOU service areas. Analysis of potential in publicly owned utility service territories is not part of the scope of this effort.

1.2 Types of Potential

Consistent with the 2023 Study and common industry practice, the 2025 Study forecasts potential at three levels for rebate programs:

- **Technical potential.** Technical potential is defined as the amount of energy savings that would be possible if the highest level of efficiency within a group of competing measures for all technically applicable opportunities to improve EE or FS were taken. Technical potential in existing buildings represents the replacement of applicable equipment-based technologies with the highest level of efficiency available, regardless of the cost of the replacement. Technical potential in new construction buildings represents installation of the highest level of efficiency at the time of construction. Technical potential in this study is undefined for codes and standards (C&S); whole building; and behavior, retrocommissioning (RCx), and operational efficiency (BROs) programs.[15]

- **Economic potential.** Using the results of the technical potential analysis, the economic potential is calculated as the total potential available when limited to only measures that pass a specific measure-level cost-effectiveness threshold.[16]Economic potential is a fraction of technical potential as the economic screen is applied separately to new construction versus existing buildings. Lower efficiency measures are included in the economic potential resource mix. High-cost, higher-efficiency measures used to determine the technical potential results may be excluded if these highest efficiency measures are not cost-effective within a group of competing measures. Economic potential is undefined for C&S, whole building, BROs, and income qualified programs[17].

- **Achievable potential.** The final output of the potential study is an achievable potential analysis, which calculates the potential that could be expected in response to specific levels of incentives and assumptions about existing CPUC policies, market influences, and barriers. Some studies also refer to this as market potential. Achievable potential is a subset of economic potential but may include additional measures beyond what are included in the economic potential. Achievable potential allows any measure that is cost -effective to be adopted within a group of competing measures. Achievable potential is used to inform the utilities' goals, as determined by the CPUC. Achievable potential is primarily reported as a net savings value (CPUC shifted to setting goals based on net savings in 2017), though gross values are also produced by the PG Model. The 2025 Study also includes detailed output for TSB.

[15] C&S effectively introduces a new, legislated baseline to the model results and works to negate savings from voluntary rebate programs. Accordingly, the Study does not attempt to calculate technical potential for C&S. Whole building savings are excluded from technical potential because its savings would double count with individual rebated technologies. BROs technical potential is out of scope of this study because it is highly uncertain whether a technical potential for BROs would be additive to a technical potential for rebate programs.

[16] The model can use different metrics of cost-effectiveness as defined by the California Standard Practice Manual.

[17] While technical potential is calculated for income qualified programs, these offerings are not bound by a requirement to meet the same threshold of cost-effectiveness as those serving the market at large. As such they are excluded from this Study's determination of Economic Potential.

Achievable potential is represented in the 2025 Study in several ways, detailed below. Each is based on the same data and assumptions, however the different representations serve separate needs and provide distinct critical perspectives:

- **TSB** represents the total lifecycle benefit generated by EE and FS programs, based on the offset costs of any new generation, transmission and distribution (T&D), carbon, or fuel that a measure provides. It includes the total avoided cost benefits less any increase in supply costs as exhibited in Equation 1-1. There are two forms of increased supply costs. One is for interactive effects such as increased heating load due to decreased heat gain from more efficient lighting. The other is for the new electricity consumption due to FS of natural gas technologies with electric technologies. TSB is the same as the present value of the TRC benefits for EE measures only; in other words, TSB equals net avoided cost benefits (energy and capacity) for EE measures.

Equation 1-1. Total System Benefit

$$\textit{Total System Benefit} = \textit{Net Avoided Cost Benefits (Energy and Capacity)} - \textit{Increased Supply Cost}$$

- **Incremental first-year net savings** represent the annual energy and demand savings achieved by the set of measures and BROs programs in the first year the measure is implemented. It does not consider the additional savings the measure will produce over the life of the equipment. A view of incremental savings is necessary to understand what additional savings an individual year of programs will produce.
- **Cumulative savings** represent the total savings from program efforts from measures installed since 2026 and that are still active in the current year, and includes the decay of savings as measures reach the end of their useful lives. Cumulative savings also account for the timing effects of C&S that become effective after measure installation.

Many variables drive the calculation of achievable potential. These include assumptions about the way efficient products and services are marketed and delivered, the level of customer awareness, and customer willingness to install efficient equipment or operate equipment in ways that are more efficient. The Guidehouse team used the available current market knowledge to calibrate achievable potential for voluntary rebate programs.

1.3 Scope of This Study

This 2025 Study forecasts the above-described types of potential energy savings from the EE and FS programs and C&S across all customer sectors: residential, income qualified, commercial, agriculture, and industrial. This study does not set IOU goals, nor does it make recommendations as to how to set goals. Rather, it informs the CPUC's goal setting process.

Key scope items in the 2025 Study include the following:

- **Potential forecast emphases.** The core effort to forecast potential includes developing a model and producing scenario results. This forecast accounted for new and enhanced topics such as a restructuring of the Industrial, and Agricultural (I&A) sector analysis, non-characterized Custom savings potential and NMEC program delivery mechanism, and refinement of the Study's treatment of both the CARB Zero Emission Appliance Standards (ZEAS) and Inflation Reduction Act (IRA) provisions.

- **Industrial and Agricultural Sectors.** Past PG Studies analyzed four categories of measures for Industrial and Agricultural sectors: characterized custom (technologies defined at the end-use and sector level), generic custom (unique measures specific to an industry segment or production method), emerging technologies, and SEM. To align the study approach more closely with the measures that have generated the highest TSB over recent years, the 2025 PG study recategorizes these sectors into Capital and Non-Capital.
- **Commercial Sector Custom.** The 2025 Study incorporates a custom measure categorization into the determination of potential within the Commercial Sector. Figure This was designed to acknowledge stakeholder feedback and recognize the increasing focus on NMEC-type programs as well as participation of market access or SEM within the sector.
- **Zero Emission Appliance Standards.** In the 2023 PG Study, Guidehouse incorporated the anticipated impact of the California Air Resources Board (CARB) Zero Emission Appliance Standard (ZEAS) regarding natural gas water and space heating technologies. The 2023 Study analysis assumed a 2030 effective date for the phase out of new natural gas appliances. In the 2025 Study, Guidehouse introduced an alternative ZEAS implementation timeline with effective dates ranging from 2027 to 2031 based on an updated CARB proposal.[18] Some affected measures are also modeled with a multiyear compliance ramp up period instead of assuming full compliance in one year. This alternative ZEAS framework is designed to capture potential outcomes for which there is currently some uncertainty.
- **IRA.** Adopted into law in 2022, the Inflation Reduction Act includes provisions that offer tax credits for Residential and Commercial property owners that adopt select energy efficient measures. The 2023 Study incorporated the impacts of IRA tax credits for qualifying measures that are also included in the Study. Tax credits will be available for a 10--year period beginning in 2023. Per direction from the CPUC, the 2025 Study again incorporated IRA impacts into its analysis of achievable potential for applicable EE and FS measures. The 2025 Study retained the assumptions as defined in the prior Study's "Reference" case for all scenarios and does not include an "Aggressive" version of IRA tax credit assumptions as was the case in 2023's Study

- **TSB analysis.** TSB is a metric that calculates the relative value of each measure to the gas or electric system over its lifetime, independent of measure cost, program cost, or fuel type. Previous studies included calculations of benefits (in avoided costs) from rebate programs in their datasets. This study, like the 2023 Study, calculates TSB for both rebate programs and BROs and displays the TSB results prominently alongside fuel-specific savings outputs as an additional metric. In alignment with the continued emphasis of TSB as the statewide goal-setting metric, the 2025 PG Study newly incorporates TSB as the metric of determination for Technical Potential, Economic Potential and the basis for calibrating the PG Model outputs.

[18] California Air Resources Board, Zero-Emission Space and Water Heater Standards, Public Workshop, May 29, 2024, https://ww2.arb.ca.gov/sites/default/files/2024-05/May_2024_Workshop_Slides.pdf.

- **FS.** A 2019 CPUC decision established a new Fuel Substitution Test (FST)19 to be applied when considering measures that seek to replace gas consuming equipment with electric equipment. Consistent with the past PG study, the 2025 Study incorporated FS measures into the measure list including space heating, water heating, and cooking, and included the modeling methods to allow EE technologies to compete with the FS alternatives. Additional secondary research was utilized to assign costs associated with electrical infrastructure upgrades (e.g., electric panel upgrades). See Section **Error! Reference source not found.** for methodology, Section **Error! Reference source not found.** and **Error! Reference source not found.** and 4.5.1Appendix C for data sources and characterization, and Section 4.3 for analysis results.

- **Refresh measure data.** The study used the California electronic Technical Reference Manual (CA eTRM) as the primary data source for refreshing input assumptions for measures. Old measures no longer in programs were removed while new measures were added. To account for potential differences in savings resulting in impacts to cost -effectiveness, the team developed three representative climate regions in each utility territory to reflect the cost-effective potential and savings analysis for climate-sensitive measures.

- **Refresh cost-effectiveness inputs and outputs.** This study uses draft 2024 vintage of avoided costs to assess the cost-effectiveness and benefits generated by IOU programs. Guidehouse employed all avoided costs in alignment with the current eTRM measure details as noted above. Gas avoided costs are overall higher compared with those used in the 2023 Study. Electric avoided costs for non-residential sectors are lower than those used in 2023. Residential sector avoided costs are lower for the initial 5 years of the study but are higher after 2030 than those used in the prior PG Study. This study also details the types of benefit and cost outputs being provided to stakeholders, including detail on the cost-effectiveness of individual measures and the total benefits, total costs, and TSB of programs.

- **Income qualified analysis.** The method for analyzing income qualified potential is based on existing and potential measures for the Energy Savings Assistance (ESA) program. The income qualified program potential uses researcher-defined adoption curves based on historical participation rates and planned adoption trends for measures as well as customer characteristics. The 2025 Study again incorporates a sector-specific cost-effectiveness screen using the ESA Cost-effectiveness Tool (ESACET).

1.4 Stakeholder Engagement

The Guidehouse team engaged with stakeholders through multiple public workshops held during the 2025 Study cycle. All meeting materials are available on the CPUC 2025 EE Potential and Goals page website.[20] These workshops were used to request data, collect feedback on scope, discuss methodology, and discuss key assumptions. Attendees represented included but were not limited to IOUs, CPUC contractors, CEC, NRDC, CEDMC, and Sierra

[19] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M310/K159/310159146.PDF

[20] California Public Utilities Commission website, *2025 Potential and Goals Study*, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/energy-efficiency-potential-and-goals-studies/2025-potential-and-goals-study.

Club. Table 1-1 provides the schedule of meetings that were held. After each meeting, stakeholders were provided a period in which they could submit informal comments to the Guidehouse team and CPUC staff. The team reviewed all comments received and worked directly with CPUC staff to incorporate input provided into the study.

Table 1-1. Stakeholder Meeting Schedule

Date	Topics of Discussion
April 17, 2024	2025 Potential and Goals Study Workplan Webinar
August 29, 2024	Stakeholder input—Income Qualified Approach*
September 18, 2024	Stakeholder webinar—Scenario Design
May 21, 2025 (planned)	Stakeholder input—Preliminary Results & Scenarios
Summer 2025 (planned)	Stakeholder input—Post Processing Tasks

*Target audience for this webinar was the ESA working group.

Source: Guidehouse

1.5 Contents of This Report

This report documents the data sources for and results of the 2025 Study:

- **Section 2** provides an overview of the methodology for each key area of the study.
- **Section 3** details the input data used for each key area of the study. It describes the data sources and process taken to incorporate the data into the PG Model.
- **Section 4** provides the study's results on a statewide basis.
- **The appendices** provide additional details on key topic areas. Areas include the IRA, FS methodology, and the BROs methodology and input assumptions.

Aside from this report, the following supporting deliverables are available to the public via the CPUC website:[21]

- **2025 PG Results Viewer.** A tool that allows readers to dynamically explore the results of the study, including achievable potential for all scenarios.
- **2025 PG Measure Input Workbook.** A spreadsheet version of the Measure Input Characterization System documenting all final values for all rebated technologies forecast in the model.
- **2025 PG BROs Inputs.** A spreadsheet version of all measure-level inputs for BROs measures.
- **2025 PG Measure-Level Results Database.** A spreadsheet of technical, economic, and achievable potential for each measure in each sector, end use, and utility. The database

[21] California Public Utilities Commission website, *2025 Potential and Goals Study*, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/energy-efficiency-potential-and-goals-studies/2025-potential-and-goals-study.

also includes measure-level C&S results, BROs results, and cost-effectiveness test results for each avoided cost vintage.

- **2025 PG Model File(s).** An Analytica-based file that contains the PG Model used to create the results of this study.
- **2025 PG Model Users Guide.** Document that helps advanced users who want to open and run the PG Model file in Analytica.
- **2025 Income Qualified Potential Measure-Level Results Database.** A spreadsheet of technical and achievable potential for each measure by utility. The database also includes the full potential and potential limited by the income qualified policy and procedure manual (please see Attachment 3 for more details).

2. Study Methodology

The primary purpose of the 2025 Study is to provide the CPUC with information and analytical tools to engage in goal setting for the IOU EE portfolios. The study itself informs the CPUC's goal setting process but does not establish goals.

The 2025 Study forecasts potential energy savings from a variety of sources within five distinct customer sectors: residential, commercial, agricultural, industrial, and income qualified. These sectors are also used in the CEC's Integrated Energy Policy Report (IEPR) forecast. The IOU portfolio of savings include the following:

- **Incentive programs.** Incentive programs make up discrete categories of characterization that are further described in this report.
    - **Rebated technologies.** Discrete mass market technologies incentivized and provided to IOU customers in the residential, commercial, industrial, agriculture, and mining sectors. These sectors are modeled using individual measures for specific applications.
    - **Whole building approaches.** In the case of whole building initiatives, the Guidehouse team characterized retrofitting the entire home or building or constructing a new home or building to a higher-than-code efficiency level. The specific technologies used to achieve the higher level are not characterized individually because the exact technologies used to achieve the higher efficiency level may vary from building to building. Whole building initiatives are modeled for the residential and commercial sectors.
    - **Custom measures and emerging technologies.** This study defines custom measures as improvements to processes specific to the industrial and agriculture sectors. The measures themselves are not individually defined as a discrete technology but could be defined in site-specific analysis, rather they represent a wide array of niche technologies. Similarly, emerging technologies are represented as a wide array of technologies and are not individually defined.
- **BROs.** For this study, the Guidehouse team defines behavior-based initiatives as those providing information about energy use and conservation actions rather than financial incentives, equipment, or services. Savings from BROs are modeled as incremental impacts of behavior and operational changes beyond equipment changes.
- **C&S.** Codes regulate building design, requiring builders to incorporate high efficiency measures. Standards set minimum efficiency levels for newly manufactured appliances. Savings are forecast from C&S that went into effect starting in 2006.
- **Residential income qualified.** The 2025 Study conducts a bottom-up forecast of savings from the residential income qualified sector. This analysis uses income qualified-specific market characterization data and measure list, sourced through IOU ESA program applications and savings reports, with additional measures added from expert opinion and professional judgement. The study uses adoption calculations different from the residential sector. More details are available in a separate report, and only topline results are provided in this report.

The rest of this section discusses the 2025 Study methodology.

2.1 Modeling Methods

Table 2-1 summarizes the modeling approach for each savings source. Each approach is discussed in more detail in the subsequent subsections.

Table 2-1. Overview of Modeling and Calibration Approach

Savings Source	Summary of Modeling Approach	Summary of Calibration Approach	Methodology Change Relative to 2023 Study
Rebated technologies: multi-attribute analysis	Bass diffusion forecast puts equipment in competition with each other using multi-attribute analysis for below code, at code, FS (if applicable), and above code technologies	Calibrated to historical program activity and market saturation data, as appropriate	Calibrated to TSB rather than energy savings
Rebated technologies: FS	FS equipment competes with EE equipment using the same fuel as the baseline equipment; FS includes added electric load	Calibrated to 2022-2023 historical program activity, 2022-2023 IOU budget filings data, and market saturation data, as appropriate	Calibrated to TSB rather than energy savings
Whole building packages	Bass diffusion forecast puts below code, at code, and above code technologies in competition with each other	Calibrated to historical program savings	Introduced eTRM measure packages as key source for characterizing Title 24 building code measures
Industrial/ agriculture measures and commercial custom measures	Top-down trend forecast based on recent IOU project savings in these (custom only for commercial) sectors and survey of PA stakeholders administrating and implementing to the target market	Forecast is anchored in IOU program history and input from stakeholders and thus is inherently calibrated to current market conditions	No characterized industrial and agricultural; removed emerging technology since captured within custom; and moved commercial custom into a top-down approach
BROs	Interventions are limited to the applicable customers and markets; for applicable markets, Guidehouse assumptions are made regarding reasonable penetration rates	Starting penetration rates are based on current program penetration rates, as applicable	None

Savings Source	Summary of Modeling Approach	Summary of Calibration Approach	Methodology Change Relative to 2023 Study
C&S	Model replicates the algorithms of the CPUC's Integrated Standards Savings Model (ISSM)	Calibration not needed because evaluated results and IOU claims are directly used	None
Residential Income Qualified	Adoption curves based on measure type and historical and planned implementation	Calibrated to historical accomplishments in 2023 for Income Qualified programs. Includes FS measures and applied ESACET values for measure screening	Applied willingness research to bound modeled adoption

Source: Guidehouse

2.1.1 Rebated EE Technologies

Rebated technologies make up the majority of historical program spending and lifetime savings claims; they are a core part of the forecast. The Guidehouse team's approach of using a Bass diffusion model to model rebated technologies has remained consistent with recent past PG Studies. This section details the methodological approach for modeling rebated EE technologies.

2.1.1.1 Types of Technologies

The 2025 Study forecasts the adoption of more than 170 representative EE technologies. To determine an appropriate set of rebated measures to include, the Guidehouse team aggregated and reviewed the measures in the CA eTRM, California Energy Data and Reporting System (CEDARS), and considered stakeholder input and other industry sources. The team utilized the 2023 Study measure list as a starting point and adjusted based on CEDARS claims, previous study results, and stakeholder input (see Section 3.2.1 for additional detail about the technology selection process).

Measures may have multiple variations for efficiency level, climate zone, building type, and replacement type. The study typically calculates an average across the variations (weighted average, as appropriate) for a representative set of baseline and efficient equipment in the characterization. This process distills thousands of unique technologies into a more manageable set of representative technologies that can be characterized and modeled within the timeline and budget afforded to this study.

Each unique measure is then classified by one or more replacement types that represent the nature of each measure in the built environment. Each replacement type is treated differently when calculating cost-effectiveness, energy savings relative to the baseline, and modeling consumer decisions and market adoption. These differences are discussed throughout this section. The types of measure installations are outlined below:

- **New construction (NEW).** Equipment installed in a newly constructed building; in this situation, energy savings calculations are always relative to code.

- **Installation in existing buildings.**
  - **Normal replacement (NR) (i.e., replace on burnout [ROB]).** New equipment replaces equipment that has reached the end of its useful life, has failed, or is no longer functional. Upon failure, normal replacement equipment is generally not repaired by the customer and is instead replaced with a new piece of equipment. Codes (appliance standards) are applicable to some types of equipment and thus define the baseline for normal replacement installations.
  - **Retrofit (RET)—accelerated replacement.** These are measures installed to replace previously existing equipment that has either not failed or is past the end of its EUL but is not compromising use of the building (such as insulation and water fixtures). Many of these installations are subject to building code, but upgrades are not always required by code until a major building renovation (and even then, some may not be required).
  - **Retrofit (RET)—add-on equipment.** New equipment installed onto an existing system, either as an additional, integrated component or to replace a component of the existing system; in either case, the primary purpose of the add-on measure is to improve the overall efficiency of the system. These measures cannot operate on their own as standalone equipment and are not required to operate the existing equipment or building. Codes or standards may be applicable to some types of add-on measures by setting minimum efficiency levels of newly installed equipment, but the codes or standards do not require the measure to be installed.

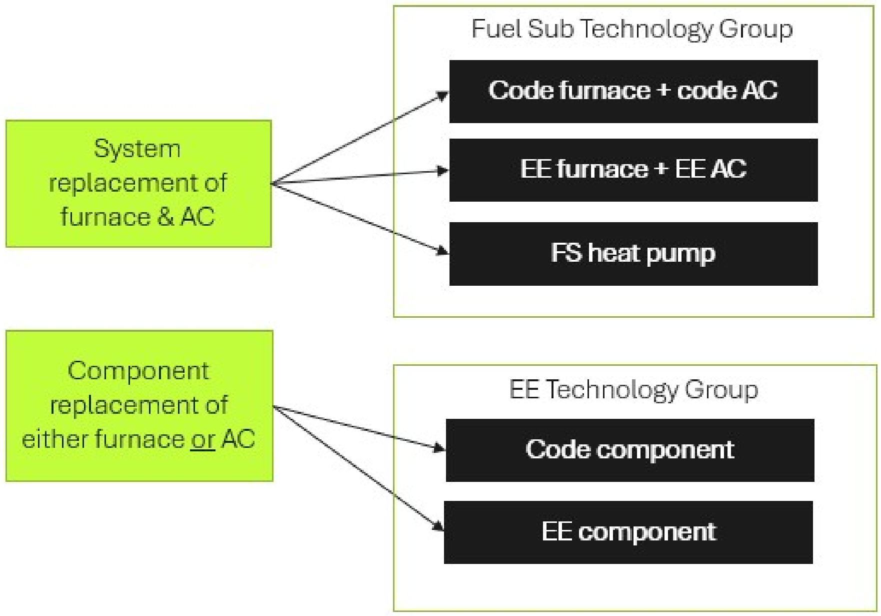
2.1.1.2 Technology Groups, Efficiency Levels, and Competition

The measures considered in the study are organized into technology groups. Each technology group consists of multiple levels of efficiency of the same technology, including a baseline level technology (defined as code or average existing level) and one or more efficient technology levels (also referred to as “measures” that can be rebated). Efficient technologies within a technology group compete for installations; because of this, technology groups are also sometimes called a competition group (CG).

Figure 2-1 provides an example of technology groups. The individual technologies characterized within each group are designed to capture varied efficiency levels including below code units, at code units, and one or more levels of high efficiency units, and (where appropriate) FS technologies (discussed further in Section 2.1.2). For technology groups with FS levels, the FS involves replacing a gas baseline technology with an electric efficient technology. The electric technology competes with high efficiency gas technologies.

In determining which technologies to include in a group, the Guidehouse team considered baseline and efficient levels defined in the CA eTRM, possible future code levels, and efficiency levels historically rebated by IOU programs.

Figure 2-1. Technology Group Examples—FS and EE



Source: Guidehouse

Where the Guidehouse team is aware of an upcoming code change for a certain technology, the team adjusts the code baseline from the year of the code change onward. The code efficiency level in Table 2-2 refers to the level that complies with code as of 2024. For higher efficiency levels that will be future code levels, the characterization includes an input for the year that the higher level becomes the code. Then, for that year and thereafter, the model treats that higher level as the code-level baseline, and previous code level(s) become below code efficiency level(s) for purposes of the analysis.

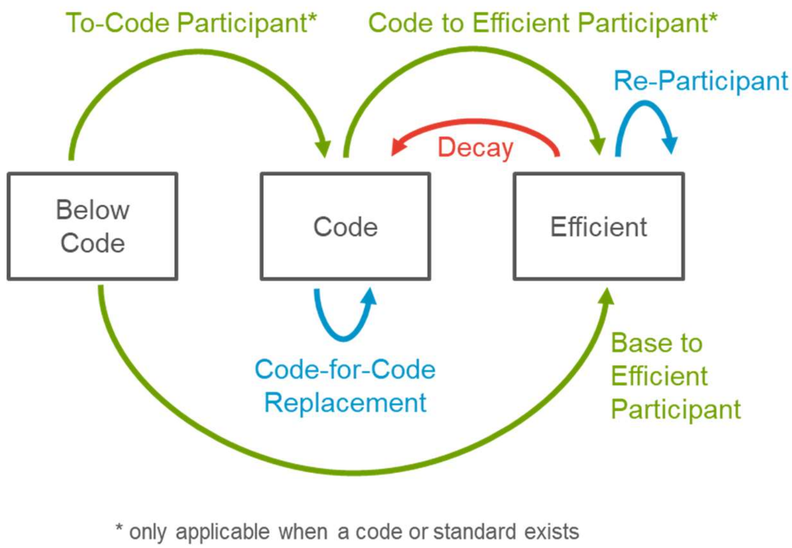
Table 2-2. Example of Technologies within a Technology Group—Non-FS

Technology Group	Technology	Description
Floor Insulation Retrofit	R0 Floor Insulation	Average Below Code Efficiency Level
	R19 Floor Insulation	Code Efficiency Level
	R30 Floor Insulation	High Efficiency Level

Source: Guidehouse

The model simulates the flow of equipment stock across the different technologies within a technology group. Flow of stock occurs when the customer owning the equipment reaches a decision point to replace the equipment with a new unit. The decisions available to the customer in the model depend on the type of technology category the equipment in question falls into (discussed in Section 2.1.1.1). Figure 2-2 illustrates the replacement options a customer faces. The model allows customers to upgrade to higher efficiency equipment or downgrade from high efficiency equipment to at-code level equipment. With each replacement, a unit energy savings, cost, TSB, and cost-effectiveness value are associated with the decision.

Figure 2-2. Stock Flow within a Technology Group



Source: Guidehouse

2.1.1.3 Technical and Economic Potential

Technical potential is defined as the amount of energy savings that would be possible if the highest TSB measure for all modeled opportunities to improve EE (including FS) were taken, including retrofit add-on or retrofit accelerated replacement measures, normal replacement measures, and new construction measures. Technical potential can be reported in two forms: instantaneous and annualized. The following considerations are factored into the calculation of technical potential:

- Technical potential assumes all eligible customers within a technology group adopt the highest TSB measure available within the technology group.
- Total technical potential is the sum of all individual technical potential within each technology group excluding whole building packages and BROs. Whole building packages are excluded from the technical potential because including them would be duplicative with the technical potential considered for individual NEW measures. Highly efficient new buildings will have no additional opportunity for individual EE technologies to be installed (for the lifetime of each efficient measure). Technical potential for BROs interventions is not considered in this study.

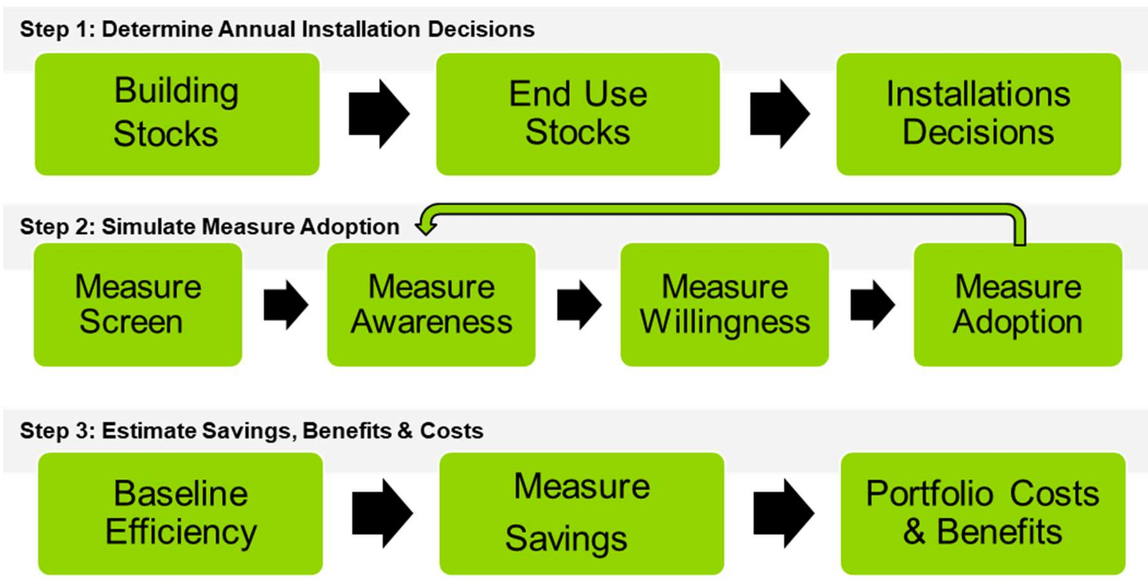
Using the results of the technical potential analysis, **economic potential** is calculated as the total EE potential available when limited to only cost-effective measures. This is defined as those with a measure-level TRC ratio of 1.0 or greater. All components of economic potential are a subset of technical potential. In addition to the above considerations in modeling technical potential, the team's calculation of economic potential assumes all eligible customers within a technology group adopt the highest cost-effective level of efficiency available within the technology group. The highest TSB measure within the group may not be cost-effective.

4.5.1Appendix H describes the cost-effectiveness analysis and the steps the 2025 Study team took to calculate results. The appendix also describes the 2025 Study work to align with the Cost-Effectiveness Tool (CET) methodology and inputs.[22]

2.1.1.4 Achievable Potential

To estimate the achievable potential for rebated technologies, the model employs a three-step process, which is generally illustrated in Figure 2-3. and described in detail after the figure.

Figure 2-3. Three-Step Approach to Calculating Achievable Potential for Rebated Measures



Source: Guidehouse

In the first step, the model calculates the number of installation decisions expected to occur for each measure in each year. The types of installation decisions vary by technology type:

- For normal replacement technologies, the customer decision to adopt occurs at the end of the base measure's EUL.
- For retrofit add-on or retrofit accelerated replacement technologies, the customer decision to adopt is not governed by equipment failure and can occur before or after the EUL.

The model simulates technology stocks for base and efficient technologies separately to account for EUL differences. The number of adoption decisions that occur in each year is based on the eligible population, which is a function of the building stocks, technology saturation, technology type, and technology burnout rates (i.e., based on EUL).

In the second step, the model simulates the adoption of each measure that passes a cost -effectiveness screen in each year. For each measure that passes the cost-effectiveness

[22] California Public Utilities Commission, IDSM website, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/idsm.

screen, the model estimates the awareness level in the eligible population and the willingness to adopt. In this step, the model employs the Bass diffusion approach to simulate adoption (described in more detail later in this section). For the 2025 Study, the Guidehouse team retained the methodology used in the 2023 Study, which incorporated factors beyond financial attractiveness. These factors were typically based on the customers' lifetime cost or payback period, and non-economic factors such as ease of install, environmental impacts and more, detailed in the approach to calculating willingness section below.

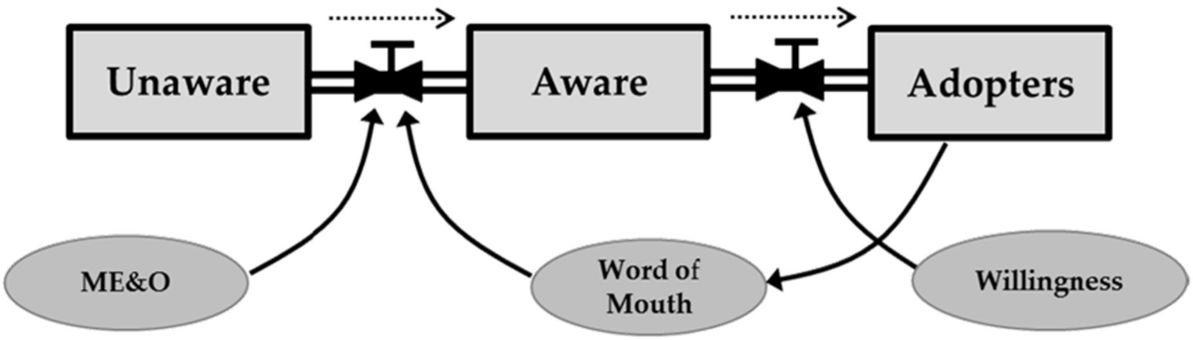
In the final step, the model calculates energy savings and corresponding costs and benefits resulting from measure adoption decisions in the second step. Savings are calculated relative to the appropriate baseline efficiency level depending on the replacement type.

The model employs a bottom-up, dynamic Bass diffusion approach to simulate market adoption of efficient measures. Figure 2-4. illustrates the Bass diffusion model, which contains three parameters:

- **Marketing, education, and outreach (ME&O)** moves customers from the unaware group to the aware group at a consistent rate annually. Unaware customers have no knowledge of the energy efficient technology option. Aware customers have knowledge of the product and understand its attributes. ME&O is often referred to as the advertising effect in Bass diffusion modeling.
- **Word of mouth** represents the influence of adopters (or other aware consumers) on the unaware population by informing them of efficient technologies and their attributes. This influence increases the rate at which customers move from the unaware group to the aware group. Word of mouth influence occurs in addition to ongoing ME&O. When a product is new to the market with few installations, ME&O is often the main source driving unaware customers to the aware group. As more customers become aware and adopt, however, word of mouth can have a greater influence on awareness than ME&O and lead to exponential growth. Exponential growth is ultimately damped by market saturation, leading to a Bass diffusion model adoption curve, which has been observed frequently for efficient technologies.
- **Willingness** is the key factor affecting the move from an aware customer to an adopter. Once customers are aware of the measure, they consider adopting the technology based on the attractiveness of the measure. The 2025 PG Model uses a multi-attribute decision model to characterize the adoption behaviors of customers and ultimately calculate willingness. The Market Adoption Study[23] conducted in 2021 collected survey data from customers to provide quantitative inputs to a new multi-attribute decision model. Additional discussion of willingness and how the Market Adoption Study was used follows Figure 2-4.

[23] Guidehouse and Opinion Dynamics for the CPUC, Market Adoption Characteristics Study, 2021.

Figure 2-4. The Bass Diffusion Framework: A Dynamic Approach to Calculating Measure Adoption[24]



Source: Guidehouse

These parameters can also help define various scenarios or outcomes in the PG study. For instance, increasing the awareness and word-of-mouth parameters reflects greater impact of enhanced ME&O efforts. Similarly, boosting willingness, by improving measure costs and incentives for example, influences the multi attribute decision model ultimately increasing customer's willingness to adopt.

Approach to Calculating Willingness

Customer willingness to adopt is a key determinant of long-run market share—that is, what percentage of individuals choose to purchase a technology provided those individuals are aware of the technology and its relative merits (e.g., the energy- and cost-saving features of the technology). The PG Model applies a logit approach to calculate willingness for the residential and commercial sector equipment rebate programs which have information on baseline and efficient measure costs.

To understand how willingness is calculated in the 2025 Study, it helps to understand the logic used in the 2019 and subsequent Studies. These PG Models calculated willingness using a single-attribute decision model focusing on financial attractiveness, where the Levelized Measure Cost (LMC)[25] was the main value factor input. Value factors are the factors that customers consider valuable when deciding to adopt energy efficient equipment. Refer to Section 2 of the 2019 Study for more information on the willingness model.[26]

A key difference introduced with the 2021 and later PG Models is the inclusion of multiple value factors that inform a customer's willingness to adopt instead of solely using the LMC.[27] This approach also divides the residential sector into customer groups to reflect that different types of

[24] Adapted from John Sterman, *Business Dynamics: Systems Thinking and Modeling for a Complex World*, McGraw-Hill, 2000.

[25] Levelized Measure Cost (LMC) amortizes the present value of purchasing and operating each technology by translating the present value into an annual expense so that competing technologies with differing lifetimes may be compared.

[26] Guidehouse (as Navigant), *2019 Energy Efficiency Potential and Goals Study*, July 2019.

[27] The 2019 Study only used the LMC but did attempt to value non-cost factors that drive decisions through an assumed implied discount rate. The additional value factors included in the 2021 Study replace the use of an implied discount rate and provide actual data to inform the adoption drivers.

customers behave uniquely and often change what they value when considering different technologies.

The Guidehouse team used the Market Adoption Study conducted in 2021[28] that collected information from customers to understand the relative importance of these six value factors and how each factor would affect a customer's multifaceted consumer decision-making process and ultimately their willingness to adopt a technology. Table 2-3 provides the value factor descriptions used in the Market Adoption Study.

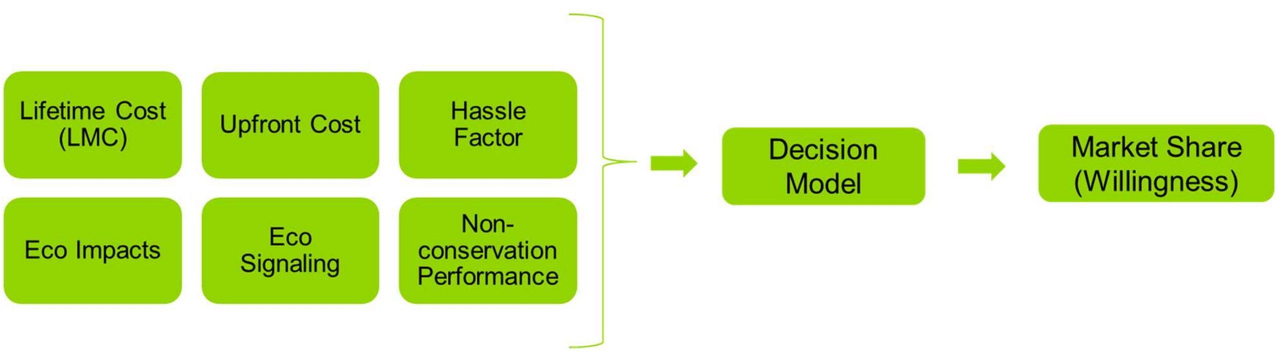
Table 2-3. Value Factor Descriptions

Value Factor	Customer Value Perspective
Lifetime Costs	Long-term energy costs and savings of the technology
Upfront Costs	Initial out-of-pocket price of the technology
Hassle Factor	Ease in installing and using a technology, which is also related to convenience of the purchase and installation
Non-consumption Performance	Other non-financial and non-energy elements that customers likely consider when deciding to purchase a new appliance or technology
Eco Impacts	Environmental impacts from energy consumption
Social Signaling	Being perceived as environmentally or socially responsible by one's peers

Source: Guidehouse

Figure 2-5 illustrates the 2025 Study's willingness model.

Figure 2-5. Model Willingness Calculation



Source: Guidehouse

Through surveys, the Market Adoption Study determined the levels to which a customer values one or more factors more than the others. The Guidehouse team refers to this set of information as customer preference weights. Customer preference weights indicate how much of a customer's total decision to adopt is attributed to a given value factor. For example, 18% of a

[28] Guidehouse and Opinion Dynamics for the CPUC, Market Adoption Characteristics Study, 2021.

customer's decision to adopt may be driven by the lifetime cost, 16% by the hassle associated, and so on, with all factors summing to 100% (Figure 2-7 provides an example). These weights vary by technology type and for each individual customer. Although there are variations across individual customers, customer preference weighting tends to cluster into distinct groups in the population.

Using a clustering analysis of these preference weights, the Market Adoption Study created customer groups in the residential single-family customer segment. The survey analysis resulted in four distinct residential customer groups: Average Californians, Eager Adopters, Likely Laggards, and Economically Strained Environmentalists. Each customer group had its own set of customer preference weights defining how these customers approach making purchase decisions. After forming these groups, the Market Adoption Study calculated a set of preference weights for each customer group. For the multifamily segment and commercial sector, the team did not develop any further analysis to formulate customer segment groups.[29] The Market Adoption Study did calculate the average preference weights for multifamily and commercial.

Building on the customer preference weights associated with the six value factors, the Guidehouse team developed corresponding characteristics for equipment across the same six value factors. Combining these two datasets allowed the team to quantify how a customer with a certain preference weighting will assess two competing equipment options with different characteristics. In short, a technology's characteristics that align with a customer's preferences drives their decision to adopt.

The Guidehouse team calculated the equipment characteristics using two different methods depending on whether the value factor represented a quantitative or qualitative value. For the quantitative value factors (lifetime cost, upfront cost, hassle factor, eco impact), technology characterization data was used and resulted in a numerical value for each technology. For the qualitative value factors (eco-signaling and non-conservation performance), qualitative assessments of each technology were performed, which resulted in a binary value for each technology. This binary value represented whether the technology exhibited this characteristic (e.g., a non-conservation performance value of 1 indicates the technology exhibits this characteristic). Table 2-4 shows how each value factor is assigned a numeric value for the characteristic value determination.

[29] The customer grouping analysis conducted for the single-family segment was not replicated for the multifamily and commercial segments because they did not have sufficient sample sizes for additional sub-segmentation.

Table 2-4. Value Factors

Value Factor	Technology Characteristic	Characteristic Value Determination
Lifetime cost	LMC	Present value of lifetime energy costs and upfront technology costs*
Upfront cost	Measure cost	Upfront cost of purchasing the technology*
Hassle factor	Labor cost	Hassle assumed to scale with the level of effort required to install the technology; because labor costs scale with effort and complexity, these costs were used as a proxy for hassle*
Eco impact	Energy consumption	Total annual energy consumption, converted to neutral units of Btu and summed over gas and electric impacts*
Eco-signaling	Energy consumption and 1 = Value eco-signaling 0 = Not value eco-signaling	First, the technology was qualitatively assessed to be a 1 if it was visible; then, the 1 or 0 value was multiplied by the eco impacts to increase the weighting of that factor for those who valued eco-signaling*
Non-conservation performance	1 = High touch 0 = Low touch	Qualitatively assessed to be a 1 if the technology was both visible in the space AND customers interacted with it relatively frequently (e.g., refrigerator)

*Indicates technology characterization data was used to calculate the associated value.

Source: Guidehouse

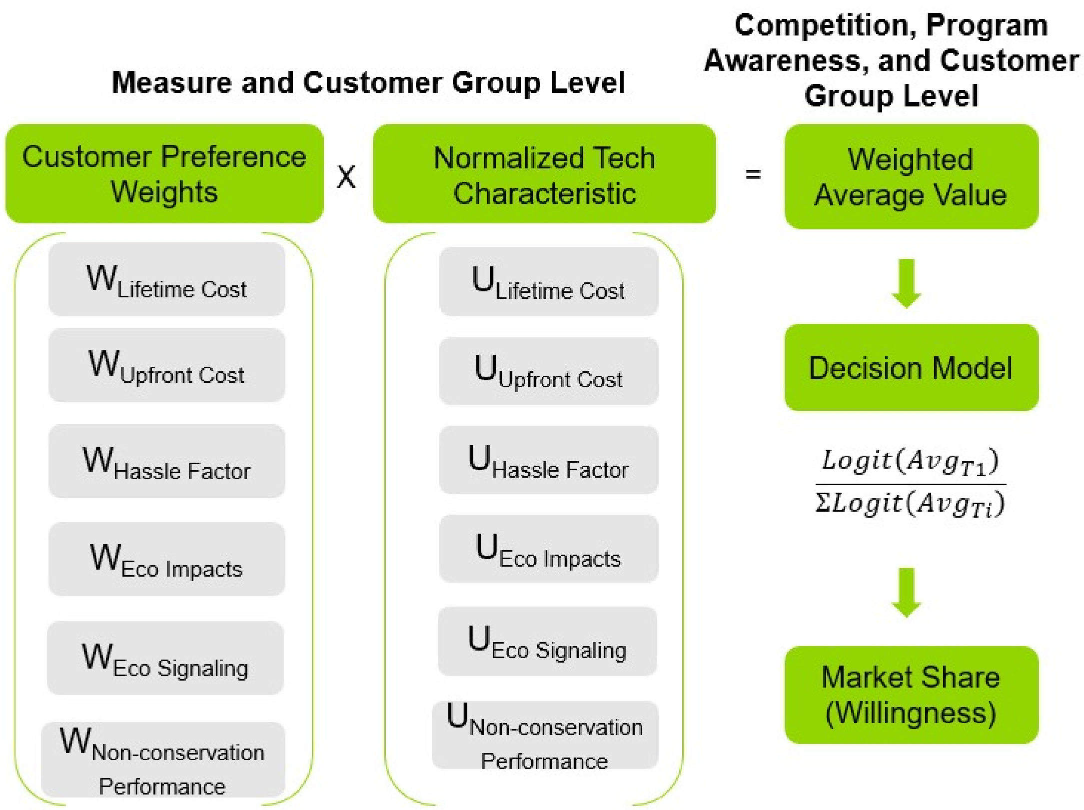
The team then converted the technology characteristics associated with each value factor to a dimensionless, normalized technology characteristic by dividing the value of the technology by the average value of the CG. This value can be interpreted as the relative characteristic value of the technology compared to the other CG measures, as Equation 2-1 shows. Further description of the CG analysis in calculating market share is shown in Figure 2-6.

Equation 2-1. Normalized Technology Characteristic Calculation

$$Normalized\ Technology\ Characteristic = \frac{Characteristic\ Value\ (for\ measure)}{Average\ Characteristic\ Value\ (across\ CG)}$$

For each technology and customer group, the Guidehouse team generated weighted average characteristics by taking the sum-product of the customer preference weightings for that customer group and the normalized technology characteristics for that technology. This weighted average is the combined value that indicates the relative attractiveness of a technology compared to the other measures in its CG. Figure 2-6 shows how customer preference weightings and technology characteristics are combined and fed into the decision model, resulting in the market share calculation for each technology.

Figure 2-6. Calculating Market Share



Source: Guidehouse

Figure 2-7 shows an example with values provided for customer preference weights and normalized technology characteristics for two technologies within the same CG (the baseline and efficient technologies). The weighted averages for the efficient and baseline case are calculated by multiplying the customer preference weights by the normalized technology characteristics. After running the resulting weighted averages through the logit decision model, the efficient technology in this example garners 60% of the market share within its CG.

Figure 2-7. Multi-Attribute Market Share Example

Source: Guidehouse

Applying Incentives

The two value factors for informing customer adoption are upfront cost and lifetime cost. These are the net out-of-pocket costs a customer pays to purchase and install a technology. Rebates and incentives provided to the customer act to decrease the cost.

The PG Model is agnostic as to the funding source for the utility incentive; instead, it models the customer's response to the total incentive amount they are offered. EE and FS incentives are calculated on a $/kWh and $/therm basis capped at a maximum value (depending on the sector and end use based on historical program data).

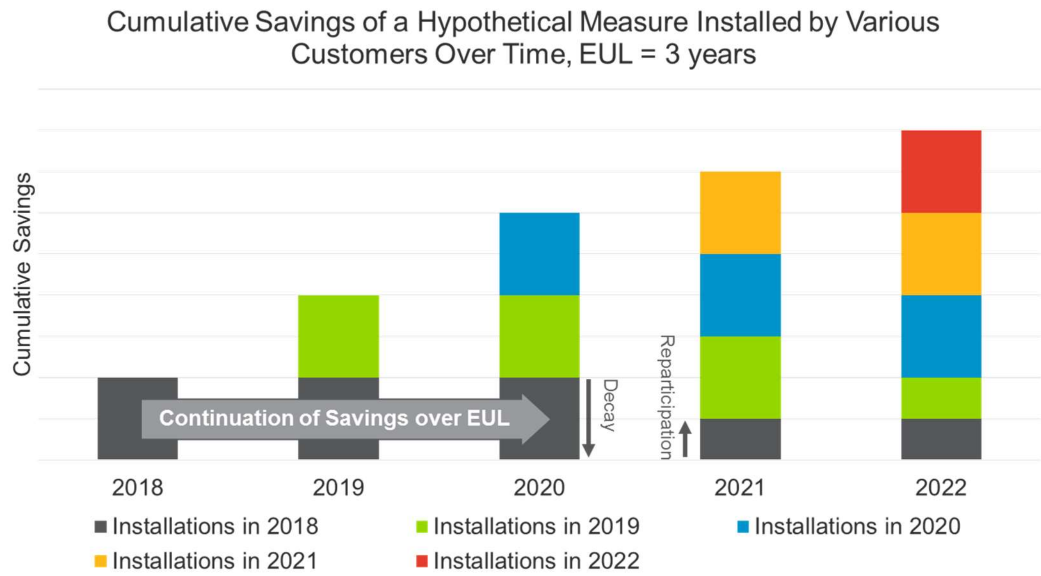
2.1.1.5 Calculating Cumulative Achievable Potential

Potential and goals studies report both incremental and cumulative savings. Prior to adoption of TSB as the statewide goal setting metric, IOU goals were based on incremental savings, while cumulative savings were used to inform the CEC demand forecast. Cumulative savings represent the total EE program savings from measures installed since a start year (2025 for this study) and that are still active in the current year. Active savings are calculated by accounting for the following:

- Decay of savings as measures reach the end of their useful lives
- C&S that come into effect over time

Unlike annual savings, cumulative savings include savings from re-participants. Incremental savings only consider first time adopters. Sustained savings from re-adoptions need to be counted in cumulative savings for the demand forecast. The PG Model assumes re-participants re-adopt measures at the same rate as new participants, consistent with the 2023 Study. Figure 2-8 illustrates the calculation of cumulative savings.

Figure 2-8. Cumulative Savings Illustration



Source: Guidehouse

2.1.2 Fuel Substitution

Like the 2023 Study, the 2025 Study includes FS technologies in addition to traditional EE technologies. FS technologies leverage much of the same methodology as used by historically rebated EE technologies previously described in Section 2.1.1. This section describes the methodology differences that accommodate FS measures. More details on the FS methodology are contained in 4.5.1Appendix B.

FS involves replacing equipment utilizing one regulated fuel with equipment utilizing another regulated fuel, most notably the replacement of gas equipment for electric equipment. In the PG Study, FS encompasses replacing a gas baseline technology with an electric efficient technology. The current study includes FS measure packages that were approved and published in the CA eTRM as of late fall 2024. The current scope of FS includes only gas to electric substitution in HVAC, water heating, food service, and appliance end uses.

2.1.2.1 Technology Groups, Efficiency Levels, and Competition

Most FS measures compete with efficient EE measures within a technology group. That is, the electric technology competes with one or more of the high-efficiency gas technologies that serve the same end use load. Table 2-5 illustrates a technology group with both EE and FS efficient levels.

Table 2-5. Example of Technologies within a Technology Group—FS

Technology Group	Technology	Description
Small Gas Water Heaters (normal replacement and New)	Small Gas Storage Water Heater	Code Efficiency Level
	Condensing Gas Storage Water Heater (EE)	High Efficiency Gas Level
	Instantaneous Gas Water Heater (EE)	High Efficiency Gas Level
	Heat Pump Water Heater (FS)	High Efficiency Electric Level

Source: Guidehouse

2.1.2.2 Panel Upgrade and Infrastructure Costs

Substituting gas technologies for electric technologies can increase electric load for a building or house. This can sometimes require upgrades to the infrastructure within the building, for example, increasing the size of the electrical panel to accommodate the added load. The 2023 Study was the first PG Study to consider panel upgrade and other infrastructure costs for FS measures with assumptions based on a literature review.

For the 2025 Study, the Guidehouse team applied panel upgrade cost adders to residential and non-residential FS measures according to the recommendations from a March 2024 Viable Electric Alternatives (VEA) working group report.[30] The report provides assumptions for the average cost and frequency of three FS install cases—panel upgrade, panel optimization, or no panel upgrade or optimization (simple connection only). The values differ by sector (residential, nonresidential) and end use (space heating, domestic hot water, and non-res food service).

The Guidehouse team incorporated the working group report assumptions into the measure characterization by creating two versions of each FS measure within the affected end uses, with one version representing the no upgrade case and the other representing the panel upgrade case (which is a weighted average of the panel upgrade and panel optimization cases from the working group report). The relevant FS panel upgrade cost adder was added to the panel upgrade version of the measure only. The overall measure density (i.e., the number of measure units per building stock) was also split between the no upgrade and panel upgrade cases using the working group report values for the proportion of installs falling into the upgrade cases.

For example, if the total density of residential gas water heaters is 0.4 water heaters per household, and the working group report indicates that 30% of homes will require a panel upgrade or optimization for water heating FS installs, then the measure would be split into a panel upgrade version with a density of 0.12 water heaters per household (0.4 * 30%) and a no upgrade version with a density of 0.28 water heaters per household (0.4 * 70%). The appropriate average panel upgrade cost value would then be added to the measure cost for the panel upgrade version of the measure only.

4.5.1Appendix C contains additional detail on the panel upgrade cost assumptions from the VEA working group report and their application to the 2025 Study.

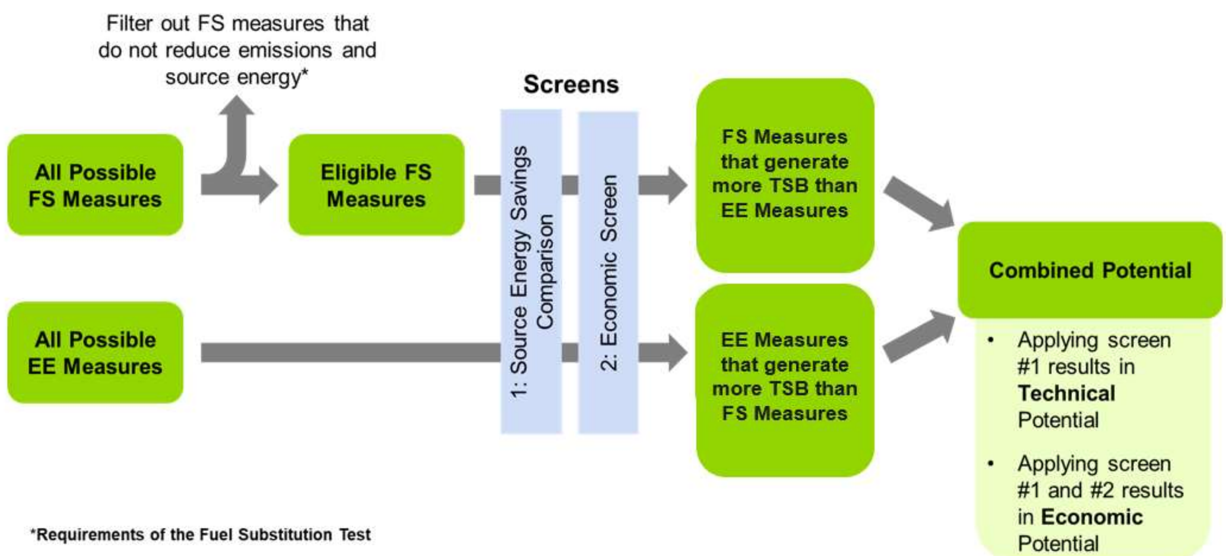
[30] Working Group Report: Fuel Substitution Infrastructure Cost Attribution. March 2024. This report was drafted by a VEA stakeholder working group pursuant to CPUC D. 23-04-035.

2.1.2.3 Technical and Economic Potential

Current FS measures decrease gas load but increase electric load, as per the existing workpapers. FS measures must pass the FST to be included in either the technical or economic potential. Figure 2-9 illustrates the methods used to screen measures for potential analysis and how the FS measures are handled. The 2025 Study only analyzed eligible FS measures (those determined to pass the FST); the study excluded FS measures that failed the FST. There are some unique differences in assessing FS measures compared to EE measures:

- **Technical Potential.** If the FS measure generates more TSB than its competing EE measures, the FS measure wins the competition and thus represents technical potential.
- **Economic Potential.** FS measures value both the gas savings (a positive benefit) and the increased electricity supply cost (a negative benefit). For FS measures that fall in the overlapping SCG and SCE territory, the model applies SCG avoided gas costs to value the gas savings benefits and SCE avoided electric costs to value the increased supply cost. This contrasts with EE measures in the SCG and SCE territories where only one fuel is valued for each utility (even in the case of interactive effects or dual fuel saving measures).

Figure 2-9. Screening for Technical and Economic Potential



Source: Guidehouse

Technical and economic potential for FS measures are assigned to the electric IOU that serves the new electric load. This means that reductions in SCG gas energy use due to FS are assigned to SCE. However, if a FS measure does not win the technical or economic potential competition, the gas efficiency savings resulting from the competing efficient gas technology remain with SCG. Equipment that passes the cost-effectiveness screening criteria regardless of whether it wins technical or economic competition is carried through to the achievable potential calculations as well.

2.1.2.4 Achievable Potential

Because FS technologies compete with EE measures, their adoption is modeled the same way. This section describes the additional considerations made for FS technologies.

Approach to Calculating Willingness

The approach to calculating willingness to adopt FS measures is nearly identical to the methods discussed in Section 2.1.1.4, except for one difference. The customer preference weights defining how much of a customer's total decision to adopt is attributed to a given factor varies by technology type. The results of the market study revealed that customers indeed have different customer preference weights for FS technologies as compared to same fuel technologies. Factors most important to customers for adopting an energy efficient or FS technology include energy savings, lifespan, and comfort benefits. The most important barriers include uncertainty about energy savings, upfront costs, and the potential disruption to install the technology. FS has an additional important barrier in that the unfamiliarity with the technology does not get identified for EE. Thus, although the approach to calculating market share is the same as it is for same fuel technologies, the customer preference weights used in the calculation are different.

Applying Incentives

The two value factors for informing customer adoption are upfront cost and lifetime cost. These are the net out-of-pocket costs a customer pays to purchase and install a technology. Rebates and incentives provided to the customer act to decrease the cost.

The PG Model is agnostic as to the funding source for the utility incentive; instead, it models the customer's response to the total incentive amount they are offered. FS incentives (like those for EE) are calculated on a $/kWh and $/therm basis capped at a maximum value (based on sector and end use based on historical program data).

Furthermore, the 2025 Study considers additional incentives available from outside the IOU programs, which are described in the following bullets. These were not included in the constrained (capped) incentive amounts for applicable FS measures, and Guidehouse did not assign weighting or unique attribution values to these incentives based on direction from CPUC staff.

- IRA tax credits (see Section 2.1.7).
- Incentives from the Technology and Equipment for Clean Heating (TECH) program. TECH incentives are applicable for single-family heat pump HVAC and water heating measures but are expected to last only through 2025.[31]

  For the 2025 Study, Guidehouse also included incentives from the IRA Home Electrification and Appliance Rebates (HEERA) program, which is being implemented through the TECH program for a broader set of FS measures. However, HEERA incentives are assumed to only be available in 2025.

[31] This is a change from the 2023 Study, where TECH incentives for heat pumps were modeled out to 2035.

- Incentives from the Self Generation Incentive Program (SGIP) for heat pump water heaters are only modeled in 2023 and 2024 based on historic funding and achievements.

Based on the latest information at the time of characterization, incentives from TECH and SGIP are expected to run out by the end of 2025. Therefore, these incentives will only impact adoption in years prior to the forecast period that begins in 2026.

2.1.3 Whole Building Measure Packages

Whole building measures (which primarily consist of packages of measures defined by Title 24 building codes) are modeled the same way as rebated technologies with one exception. Technical and economic potential results are not presented for whole building measures because these results are duplicative with the technical and economic potential of individual rebated technologies. Highly efficient new buildings will have no additional opportunity for individual EE technologies to be installed (for the lifetime of each efficient measure). When accounting for other measures that could technically be installed in the highly efficient building, double counting of savings would occur (to prevent double counting, either the whole building package would have to be removed, or all other technologies potentials would be underestimated).

2.1.4 Industrial and Agriculture Measures and Commercial Custom Measures

The measure characterization process outlined above works well for prescriptive types of measures that have a specific deemed savings and cost value per unit of equipment installed. However, many energy efficiency opportunities are realized through customized solutions whose costs and savings are specific to the installation. This is particularly applicable for larger commercial, and agricultural and industrial customers, where each customer's energy profile and energy efficiency project is unique to that customer.

In previous studies, Guidehouse analyzed two types of custom measures for industrial and agricultural sectors only: characterized custom (technologies that can be readily defined at the end-use and sector level) and generic custom (unique measures or process improvement measures that tend to be specific to an industry segment or production method). The 2025 PG study introduces a new approach which incorporates generic custom and SEM savings into the analysis of these sectors. Claimed and verified impacts from Generic Custom and SEM have grown in recent years, and a significant proportion of total EE program Total System Benefit (TSB) is generated from these two measure types. In reviewing the 2023 PG study results, the allocation of the TSB savings was disproportionately allocated to the industrial and agricultural generic custom and SEM as exhibited in Table 2-6.

Table 2-6. 2023 PG Study TSB Results

Measure	% of Total TSB in 2024
Res HERs	12.3%
Ind & Ag Generic Custom	11.7%

Measure	% of Total TSB in 2024
Ind & Ag SEM	6.5%
177 other measures	69.5%

Source: Guidehouse

Historically, we have characterized generic custom by sector, and we assumed that all of SEM will be BROs type of measures for industrial and agricultural. For the commercial sector, we have not characterized a custom category since most of the savings at an end use level from custom could be allocated across the characterized measure in a bottom-up analysis. The specific categorization into technology groupings for industrial and agricultural was:

- **Characterized custom** measures are identified by the team's review of the records list, focusing on the high impact measures (i.e., those contributing significant amounts of energy savings) and excluding records with negligible savings contributions or those representing niche activities. The characterized custom category includes readily defined measures. They make up the forecast using the Bass diffusion model and savings estimates sourced from the Industrial and Agriculture Market Study (as the primary source) and are supplemented with the Industrial Assessment Center database[32] for measures and segments not included in the 2023 data collection study.[33] Some measures in this category may fall under the custom review process established by the CPUC.

- **Generic custom** measures are those measures included in projects unique to various subsectors that cannot be readily defined at the measure level or forecast using a Bass diffusion model. CEDARS measures that were marked as process improvement or other process, other, or system were considered as generic custom. Additionally, if there were measures with small portfolio savings contribution within the sector that could be considered as characterized custom, then the team aggregated them under the generic custom group. The aggregated savings of these small savers contribute no more than 10% of the sector savings of the characterized custom list. Most of the savings established within generic custom fall under the custom review process.

- **Emerging technologies** measures are considered nascent or emerging and cannot be readily defined at the measure level or forecast using a Bass diffusion model. The 2023 study leveraged expansive work beginning in the 2017 study cycle which reviewing emerging technologies run through a screening process resulting in characterizing over 100 measures.

- **BROs or SEM-like** measures that include retrocommissioning (RCx) and some optimization. This group is modeled alongside other BROs measures and cannot be readily forecast using a diffusion model.

[32] Industrial Assessment Centers

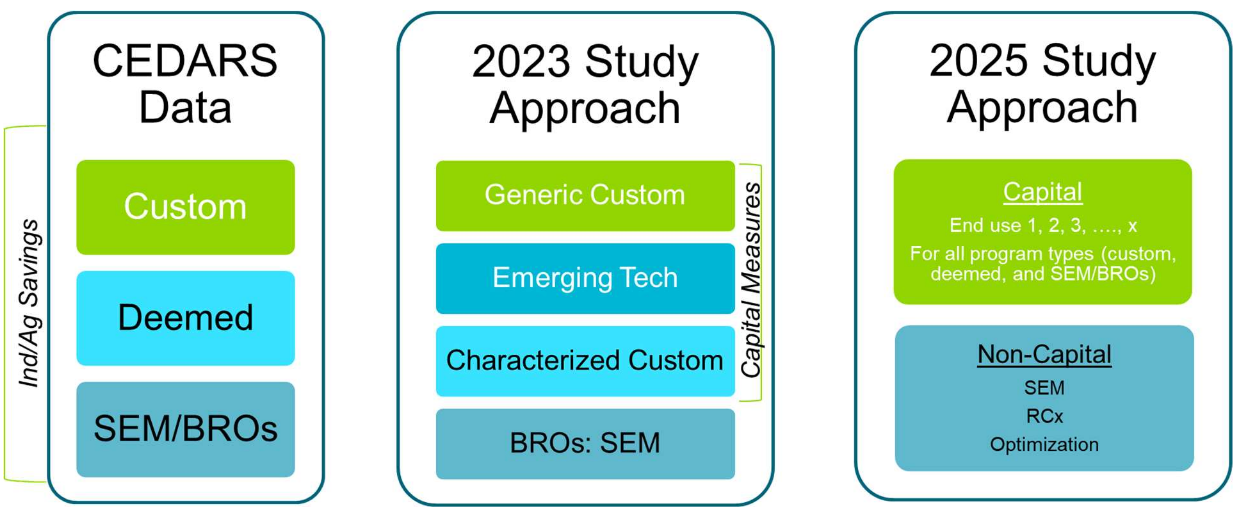
[33] Guidehouse, Industrial and Agricultural Market Saturation Study, April 2021, https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/energy-efficiency/2021-potential-goals-study/industrial-ag-market-saturation-study-final.pdf?sc_lang=en&hash=123825958BE1A39B21ED8E4592D8F665.

Figure 2-10 illustrates the incorporated changes to industrial and agricultural measure characterization. The most significant differences from previous PG study cycles are that we eliminate emerging technology and combine generic and characterized custom. The characterization will only include two categories capital and non-capital.

To do the analysis for 2025, Guidehouse updated the composition of measures within the technology groupings. CEDARS program data was incorporated through the following steps:

1. Extract measure-level data from the reported program data (CEDARS database). The team identified over 1,300 measure-level data points for the industrial and agriculture sectors in the 2021 CEDARS program data. 2022 and 2023 program data were used to append this data set.
2. Categorize CEDARS data into capital by end use vs. non-capital (RCx, optimization, SEM measures). The capital categorization is broken down by sector and end use. The end use breakdown balances the more detailed approach previously conducted by the characterized custom and the one average data point for the generic custom.
3. Use previous SEM program evaluations to further disaggregate the SEM measures into capital and non-capital categories to ensure proper EUL and measure cost assignments.

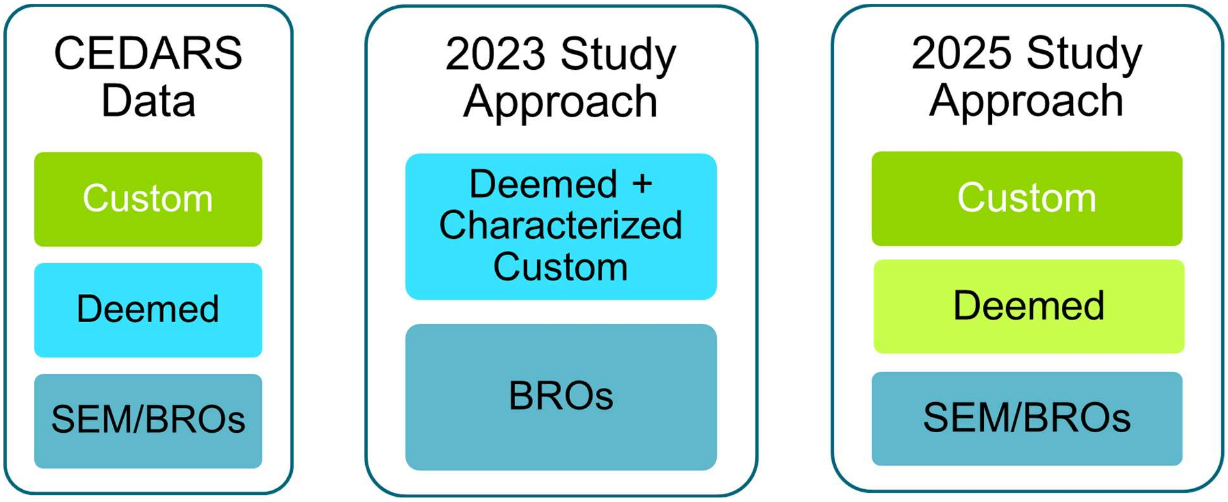
Figure 2-10. Recategorizing Industrial and Agricultural Measures



Source: Guidehouse

For commercial, there has never been a custom measure categorization. Figure 2-11 provides a more disaggregated structural change to the categories. As the scope of NMEC-type programs and participation of market access or SEM into the commercial sector, our team identified a need to capture the savings potential that have not previously been characterized by the existing measure list. Guidehouse acknowledges stakeholder feedback regarding the Normalized Metered Energy Consumption (NMEC) as a specified part of the 2025 PG Study. Within the context of a bottom-up, technology-driven model, we believe NMEC acts as a program delivery mechanism and the measures typically associated with an NMEC participation will be captured within the analysis of custom or prescriptive commercial sector potential. This new change captures those “custom” savings.

Figure 2-11. Revisions to the Commercial Measure Categories



Source: Guidehouse

The top-down approach for custom is applied at the market segment level (i.e., agriculture and industrial) and is presented in Equation 2-2.Guidehouse defined unit energy savings in terms of savings as a percentage of the sector-level consumption. Additional variable details and definitions follow Equation 2-2.

Equation 2-2. Incremental Achievable Potential for Generic Custom

$$\begin{aligned} &\mathit{Incremental\ Market\ Potential} \\ &= \mathit{Savings\ Rate\ Multiplier} \times \mathit{Annual\ Sector\ Consumpion} \times \mathit{Penetration\ Rate} \end{aligned}$$

Where:

- **Population** is a global input represented as the total energy consumption by subsector within the industrial and agriculture sectors.
- **Applicability Factor** represents eligibility and other program-specific variables applied at the subsector level.
- **Unit Energy Savings** represent the percentage of savings expected from customers adopting technologies at the subsector level.
- **Savings Rate Multiplier** represent the percentage of savings expected from customers adopting technologies at the total sector consumption level.
- **Annual Sector Consumption** represents the total energy consumption by total sector for the industrial and agriculture sectors
- **Penetration Rate** represents annual new participation and varies over time; it can also vary by scenario for emerging technologies. Penetration rate is applied at the market sector level.

Section 3.6 discusses the data inputs for this equation. Industry standard practices (ISPs) are not forecast to impact the potential from custom measures. ISPs are technology- and segment-specific, while custom programs and emerging technologies as forecast in this study do not contain technology-specific information to allow ISPs to be applied.

2.1.5 BROs

For this study, the Guidehouse team defines behavior-based initiatives as those providing information about energy use and conservation actions to drive customer actions rather than financial incentives, equipment, or services to support customer investment. The savings potential modeled for these initiatives is designed to be additive to the savings from rebated technologies (which do not account for any behavior-based savings).

2.1.5.1 Energy and Demand Savings

Equation 2-3 is the general equation for the BROs potential model. Each of the components are described below.

Equation 2-3. Incremental Achievable Potential for BROs

$$Incremental\ Market\ Potential = Population \times Applicability\ Factor \times Unit\ Energy\ Savings \times Penetration\ Rate$$

Where:

- **Population** is a global input that can be represented in two ways: number of homes and square feet of floor space or sector energy consumption.
- **Applicability factor** represents eligibility and other program-specific variables, including existing saturation that precludes customers from participating in future IOU interventions.
- **Unit energy savings** represent the savings expected from participants and can be represented in two ways: kWh and therms or percentage of consumption. Savings may vary by segment and amount within a program. For example, the home energy report (HER) participants are binned into low, medium, and high savers.
- **Penetration rate** represents participation and varies over time and by scenario (reference or aggressive). The penetration rate reflects both utility-driven rollout and customer uptake of the program, depending on the nature of the program.

The initial penetration rates are based on existing levels of participation, either for the California IOUs for existing programs or the program from which data was drawn and applied to California IOU territories. The forecast inputs are the result of previous study stakeholder review, existing program operations, and historical participation rates, and on whether participation is utility--driven (opt out) or customer-driven (opt in).

The potential for double counting among BROs programs was addressed in the characterization of programs in the same sector. The Guidehouse team adjusted penetration and applicability to avoid the double counting of savings. This effort does not examine programs that focus on demand reduction (e.g., Demand Response) but includes demand savings from the characterized BROs programs using Equation 2-4.

Equation 2-4. BROs Demand Savings

$$Incremental\ Market\ Potential\ (kW) = Incremental\ Market\ Potential\ (kWh)\ \times\ Peak\ to\ Energy\ Ratio$$

2.1.5.2 BROs Costs

Similar to demand savings, utility program costs are calculated from the energy savings in Equation 2-3. The cost factor in Equation 2-5 is a unit energy cost expressed in either dollars per kWh or dollars per therm. For programs that save both electricity and gas, it was sometimes possible to divide the costs by fuel type; however, in instances where this was not possible, all costs were assigned to one fuel type to avoid double counting.

Equation 2-5. BROs Program Costs

$$Program\ Cost = Incremental\ Market\ Potential\ \times\ Cost\ Factor$$

Although cost and cost-effectiveness of BROs measures are calculated by this study, the methodology does not include any screening for cost-effectiveness; there is no calculation of an economic potential for BRO. There are reasons for this:

- Costs for new BROs are inherently uncertain and are sometimes based on pilot programs or programs from other jurisdictions.
- Cost-effectiveness for HERs can vary by the selection criteria used to populate each individual new grouping of treated homes, also called a ‘treatment wave’. In the real world, there is a variable supply curve for HERs enrollments that determines the cost-effectiveness of each new treatment wave. While all previous enrollments could be cost-effective, the costs associated with each new incremental treatment wave may not be. Due to the high levels of uncertainty produced in the model, and because of the high volume of total portfolio savings represented by the HERs program, the simpler approach for the PG Model outlined earlier does not accurately model each new treatment wave. Since the screening process is binary, each treatment wave would either be included or excluded based on model output and would invalidate the entire wave savings for that program year. For a program as large as HERs to be as uncertain as it would in the PG Model would be too far removed from the real world and would lead to vast swings in total program portfolio potential that are unrealistic. Therefore, economic screening of each successive treatment wave is not performed.

2.1.6 C&S

C&S impact EE potential in two ways:

- C&S impacts the code baseline for IOU-rebated measures. The Guidehouse team have modeled that as C&S become more stringent in the future, above code savings claimable by IOU programs decrease. The impacts of code baseline changes on existing measures in the incentive programs are addressed in the EE technology rebates methodology and discussed further in Section 2.1.1.2.

- C&S results in holistic changes in the market penetration of efficient technologies. Per CPUC policies, IOUs can claim a portion of savings from C&S that come into effect through the IOU C&S advocacy programs. This section describes the calculation of IOU claimable savings from C&S.

This study calculates the estimated savings of C&S in multiple formats, each for a different use:

- **Net C&S savings** are the total energy savings estimated to be achieved from the updates to C&S since 2006. Net savings calculations account for naturally occurring market adoption (NOMAD) of code-compliant equipment and are used to inform demand forecasting, procurement planning, and tracking against greenhouse gas (GHG) targets. The net C&S savings inform the CEC forecast of AAEE and SB 350 target setting.
- **Net IOU C&S program savings** identifies the portion of the net C&S savings that can be attributed to the advocacy work of the IOU's C&S program. This result is used to inform the IOU's program goals.

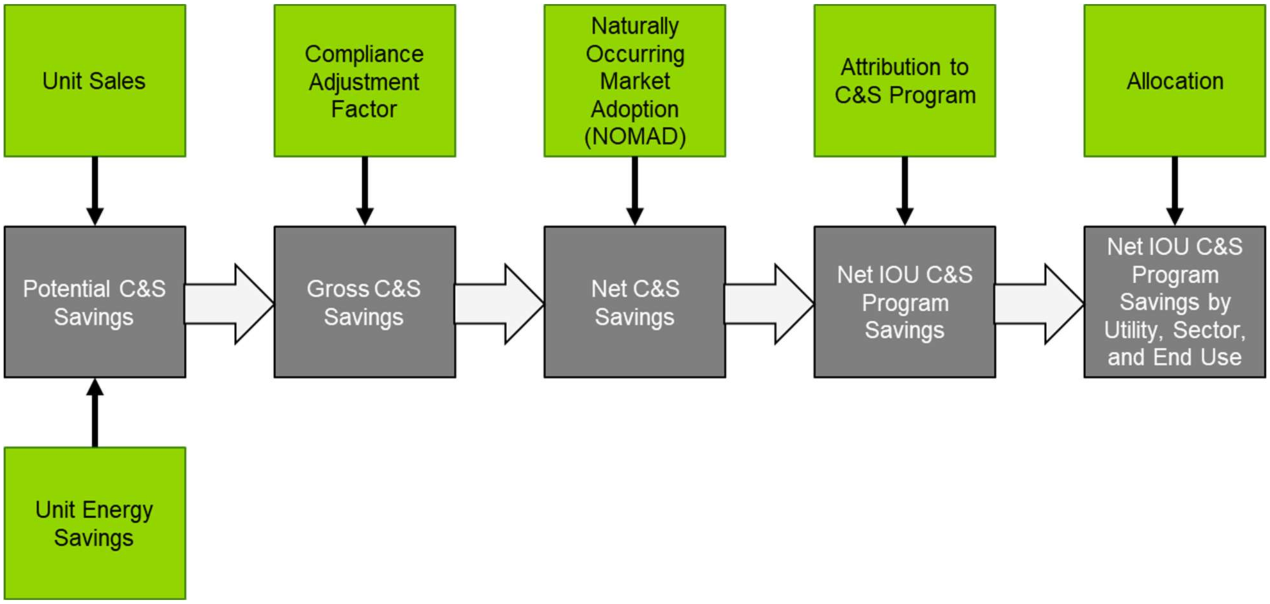
The modeling methodology of C&S savings was based on the ISSM[34] originally developed by Cadmus and DNV GL and used by CPUC in C&S program evaluation. The Guidehouse team replicated the ISSM methodology in the PG Model for use in this study. Figure 2-12 illustrates the process to calculate net C&S savings and net IOU C&S program savings.[35] Key components of the calculation listed in Figure 2-12 include the following:

- **Unit sales.** The assumed baseline units sold each year for each measure; they represent the expected population of code-compliant or standard-compliant equipment adopted
- **UES.** The energy savings (in kWh, kW, or therms) relative to the previous code or standard for the new compliant equipment
- **Compliance adjustment factor.** The baseline assumption for the rate at which the population complies with codes or standards
- **NOMAD.** The fraction of the population that would naturally adopt the code-compliant or standard-compliant measure in the absence of any C&S
- **Attribution.** The portion of gross C&S savings in California that can be claimed by IOU code support programs
- **Allocation factors.** The fraction of the statewide C&S savings that occur in each IOU territory; additional allocation factors assumed by the Guidehouse team break down the savings into sectors and end uses

[34] Cadmus and DNV GL, *Integrated Standards Savings Model (ISSM),* 2017.

[35] The impact evaluation of the California Codes & Standards was conducted by DNV and CADMUS in 2017, found here Codes and Standards Impact Evaluation Report

Figure 2-12. C&S Savings Calculation Methodology



Source: Guidehouse

The PG study forecasts potential in IOU service territories based on the best approximation for where savings are expected to occur. For C&S this means using an IOU allocation factor based on energy sales. Table 2-7 shows allocation factors used in the PG obtained from the most recent evaluation of IOU C&S appliance advocacy program[36]. The values are used to allocate the evaluated statewide benefits and costs, by fuel type, to each utility for the cost effectiveness calculations.

Table 2-7. Electric and Gas C&S Savings Allocation by IOU

IOU	Electric				Gas			
	2016	2017	2018	Average	2016	2017	2018	Average
PG&E	36.4%	35.8%	36.2%	36.1%	36.6%	37.5%	37.9%	37.3%
SCE	35.9%	35.8%	36.7%	36.1%	0%	0%	0%	0%
SCG	0%	0%	0%	0%	41.1%	40.9%	40.7%	40.9%
SDG&E	7.4%	7.3%	7.5%	7.4%	3.8%	3.8%	3.8%	3.8%
Other*	20.3%	21.1%	19.6%	19.6%	18.4%	17.8%	17.6%	17.9%

*The "Other" category for electric included publicly owned load-serving entities, rural electric cooperatives, community choice aggregators, and non-IOU electric service providers. For gas, the "Other" category includes publicly owned utilities, and the western area power administration.

[36] Final Report: Appliance Standards Vol. 1 California Public Utilities Commission Energy Efficiency Program Evaluation, 2021. https://pda.energydataweb.com/#!/documents/2522/view

Source: Final Report: PY 2016-2018 Appliance Standards Evaluation Vol. 1

- The PG study uses an average across three years (2016-2018) as shown in the "Average" column of Table 2-7. We note that CPUC policy on how utilities can claim savings from statewide programs varies from the approach taken in the PG study. According to Decision 16-08-019, Section 4.3 page 55, *"The lead statewide administrator for each area will not be assigned credit for all of the results of the program; rather, the energy savings will be apportioned to all contributing administrators based on actual customer participation.*" [37]
- In Decision 18-05-041 CPUC clarifies the earlier D.16-08-019: *"We clarify that this means that credit for energy savings generated will be based on funding contributed only, and not in relation to the geographic region in which the energy efficiency measure was sold or installed."*[38]

The PG study continues to approximate potential in the regions where equipment is sold or installed (not just for C&S programs but for all types of savings potential that the study forecasts).

2.1.7 IRA

The IRA was passed into US federal law in August 2022. It includes provisions for tax credits to help reduce the cost of purchasing energy efficient end use equipment in both residential and nonresidential premises. In the 2023 Potential & Goals Study, CPUC requested Guidehouse incorporate the impact of Energy Efficiency Home Improvement (EEHI) tax credits introduced through the 2023 Inflation Reduction Act (IRA).[39] This section outlines the methodology and approach for including these tax credits within the 2025 Potential & Goals Study core modeling process, including a detailed discussion of inputs and assumptions. Tax Credits will have two effects in the model:

1. **Changing Cost-Effectiveness.** Tax credits feed into the TRC test and act to increase cost-effectiveness of measures. This increased economic potential overall as a result measures that were near the threshold of cost-effectiveness becoming so due to the tax credit. The PG Model followed the California Standard Practice Manual and supplemental guidance from CPUC staff on how to properly incorporate tax credits into the TRC test.
2. **Increasing Willingness to Adopt.** Tax credits reduce the lifetime ownership cost of energy efficient equipment. Lifetime cost is an input to the PG Model's calculation of willingness to adopt; reducing cost increases willingness and thus increases achievable potential. No significant algorithm changes were necessary to model this aspect.

[37] D.16-08-019 Decision Providing Guidance For Initial Energy Efficiency Rolling Portfolio Business Plan Filings, 08/25/2016

[38] D.18-05-041 Decision Addressing Energy Efficiency Business Plans, 05/31/2018

[39] Energy Efficient Home Improvement Credit | Internal Revenue Service

The DSMSim model has an input for tax credit that can be defined at the measure level, which impacts the model output as defined above. The methodology for developing measure-specific tax credit values differs between residential and commercial sectors:

- **Residential Sector Characterization.** For applicable Residential EE and FS measures, Guidehouse used IRS Tax Credit Statistics to calculate an estimated $/return value for each measure qualifying for an EEHI tax credit. Guidehouse then calculated a scaling factor to account for the requirement that the measures are installed in owner-occupied single-family homes. For a more extended explanation of the methodology, see Appendix J
- **Commercial Sector Characterization.** The IRA tax credit for commercial buildings applies to HVAC, Lighting, and Water measures. The tax credit within the legislation is specified as $/sq ft and is a range depending on the total reduction in baseline energy usage. Using secondary research, Guidehouse applied California-specific building vintage and stock data, market-level efficiency potential and measure density to estimate a measure-level tax credit value ($/unit) that was input into the PG Model and reflected in the outputs of Scenarios 2, 3, and 4.

Further detail regarding the methodology and assumptions employed to incorporate IRA tax credits into the PG Model can be found in Appendix J.

2.2 Calibrating Rebated Technologies and Whole Building Approaches

Like any model that forecasts the future, the PG Model faces challenges with validating results because there is no future basis against which one can compare simulated versus actual results. Calibration, however, provides both the developer and recipient of the model results with a level of comfort that simulated results are reasonable. Calibration is intended to achieve the following:

- Reflect actual market conditions for the bottom-up approach model to calculate potential of historical adoption. This enables a process for ensuring the model can calculate previous market conditions.
- Establish a realistic starting point from which future projections are made.
- Account for varying levels of market barriers and influences across different types of technologies observed by historical trends. The model applies general market and consumer parameters to forecast technology adoption. There are often reasons why markets for certain end uses or technologies behave differently than the norm—both higher and lower. Calibration offers a mechanism for using historical observations to account for these differences.

The calibration process is not a regression of savings or spending (not drawing a future trend line of savings based on past program accomplishments). Rather, calibration develops parameters that align the customer decision-making process, and the velocity of the market based on recent history. Once these parameters are set, the model uses them as a starting point for the forecast period.

The process to develop these parameters requires historical market data. The PG Model uses 2020-2023 EE program data (gross savings, program spending data) and performs a backcast to fit model parameters such that historical achievements are generally matched. In the 2025 Study, adoption was calibrated based on TSB.

FS calibration methodology differs from the 2023 Study approach. For the 2023 Study, historical data for 2022 was used to calibrate FS adoption to historical program activity and market saturation, as appropriate. The calibration for adoption was based on historical savings. For the 2025 Study, historical data for 2022-2023 was available, and adoption was calibrated based on TSB. The study also applied FS program-specific budget filings for 2022-2023 to ensure a robust basis of sector and end use calibration data.

The primary method of calibration was reviewing EE portfolio achievements to assess how the market has reacted to program offerings in the past. The gross TSB and spending during this backcast period are compared with actual program gross TSB and spending. Modeling parameters are adjusted to reasonably align the backcast to historical data.

For additional details on calibration, see 1.1.1.1Appendix A.

2.3 Scenarios

This study forecasts six achievable potential scenarios to inform the CPUC's goal setting process. Guidehouse will conduct additional scenario analysis as part of the additional achievable energy efficiency (AAEE)additional achievable fuel substitution (AAFS) analysis after the 2025 Study is finalized. AA scenarios feed into the CEC's IEPR and are built around the adopted IOU goals and are informed by potential and goals scenarios. AA scenarios consider additional variables, policy context, and, most importantly, do not impact IOU goals.

This study considers scenarios primarily built around policies and program decisions under the control of the CPUC and IOUs collectively; these are referred to as internally influenced variables. External variables are those the CPUC and IOUs collectively have no control over. Table 2-8 provides examples of internally and externally influenced variables.

Table 2-8. Variables Affecting EE Potential

Internally Influenced	Externally Influenced
• Cost-effectiveness test • Cost-effectiveness measure screening threshold • Incentive levels • Marketing & outreach level of effort (ME&O) • BROs customer enrollment over time • IOU financing programs	• Federal tax credits • Building stock forecast • Retail energy price forecast • Measure-level input uncertainties (UES, unit costs, densities) • Non-IOU financing programs • Enacting future C&S

Source: Guidehouse

Potential and goals scenarios fix the following externally influenced variables to a single setting across all scenarios:

- CEC mid-case forecast for retail rates, population, and building stock

- CA eTRM values used as is (measure-level inputs)
- One set of assumptions about future Title 24, Title 20, and Federal Appliance C&S

Table 2-9 details the different potential variables considered while defining the 2025 Study's achievable potential scenarios.

Table 2-9. Variables Considered for Scenario Setting

Lever	Description	Potential Impact Applicability	
		Economic	Achievable
Federal Tax Credits (IRA)	Including tax credit impact levels specified by the IRA within the P&G Model for applicable measures	✔	✔
Incentive levels	Varying incentive levels (at a percentage of incremental measure cost) will change the cost-effectiveness of measures and their value proposition to customers	✔	✔
C-E Measure Screening Threshold	Applying different values for the TRC benefit cost threshold will impact the modeled total achievable potential and overall portfolio cost-effectiveness		✔
FS	Varying adoption parameters (Awareness, Willingness, Sensitivity, Stock Turnover)		✔

Source: Guidehouse

Table 2-10 describes the range for the scenario levers.

Table 2-10. Range of Values for Scenario Variables

Lever	Range/Bounds	
	Lower	Upper
C-E Measure Screening Threshold	TRC = 0.85	TRC = 1.0
Incentive levels	Capped at the mean incentive percentile outlined in Table 2-11	Capped at the 75^{th} percentile of incentives outlined in Table 2-11
Fuel Substitution Adoption	Reference: Default calibrated value	Aggressive: Increased parametric adoption lever values to model broader increases in willingness to adopt, market dynamism

Lever	**Range/Bounds**	
	Lower	**Upper**
Program Engagement	Reference: Default calibrated value	Aggressive: Increased Awareness calibration parameter value

Source: Guidehouse

Table 2-11 lists the incentive levels applied to end uses. Guidehouse used CEDARS record level claims from 2023 to inform and generate incentive levels best aligned with available data. Incentive levels were first calculated at the record level as a percentage of measure incremental cost. The mean and 75th percentile were then determined for each end-use, omitting custom commercial measures as per Section 3.1.3. As described in Table 2-11, the mean incentive percentage represents the lower bound of incentive levels and is applicable to conservative scenarios. The 75th percentile represents the upper bound, applicable to more aggressive scenarios.

Table 2-11. Incentive Levels

Program Sector	FS/EE	End Use	Incentive Percent—75th Percentile	Incentive Percent - Mean
Com	EE	AppPlug	48%	48%
Com	EE	BldgEnv	40%	40%
Com	EE	ComRefrig	54%	50%
Com	EE	FoodServ	71%	63%
Com	EE	HVAC	59%	42%
Com	EE	Lighting	95%	95%
Com	EE	ProcHeat	95%	79%
Com	EE	WaterHeat	83%	73%
Com	EE	WholeBlg	26%	16%
Com	Fuel Sub	HVAC	91%	82%
Com	Fuel Sub	WaterHeat	98%	93%
Res	EE	AppPlug	95%	94%

Program Sector	FS/EE	End Use	Incentive Percent—75th Percentile	Incentive Percent - Mean
Res	EE	BldgEnv	95%	95%
Res	EE	HVAC	94%	83%
Res	EE	Lighting	61%	46%
Res	EE	WaterHeat	95%	94%
Res	EE	WholeBlg	69%	59%
Res	Fuel Sub	AppPlug	85%	72%
Res	Fuel Sub	HVAC	91%	81%
Res	Fuel Sub	WaterHeat	77%	74%

Source: CEDARS Measure Level Claims Data

The Guidehouse team presented this scenario framework to stakeholders on September 18, 2024, and invited stakeholders to provide feedback. Building on stakeholder feedback, the Guidehouse team worked with CPUC staff to develop scenarios to consider in the goal setting process. Each of the selected variables in Table 2-10 is expected to impact the forecast of EE potential. The combined impact of these variables represents a scenario. The final selected scenarios are listed in Table 2-12.

Table 2-12. Summary of Primary Scenarios for EE Potential

Levers → Scenario ↓	ZEAS	C-E Test C-E Threshold	IRA Tax Credits	Incentive Levels Capped*	FS**	Program Engagement
1: Reference	2030	TRC = 0.85	Reference	Incentive Percent - Mean	Reference	Reference
2: High TRC	2030	TRC = 1.0	Reference		Reference	Reference
3: Aggressive FS	2030	TRC = 0.85	Reference	Incentive Percent—75th Percentile	Aggressive	Aggressive
4: Reference	Phased	TRC = 0.85	Reference	Incentive Percent - Mean	Reference	Reference
5: High TRC	Phased	TRC = 1.0	Reference		Reference	Reference
6: Aggressive FS	Phased	TRC = 0.85	Reference	Incentive Percent—75th Percentile	Aggressive	Aggressive

C-E = cost-effectiveness
*Incentive caps outlined in Table 2-9
**FS adoption parameters are set based on end use and sector-specific calibration targets.
Source: Guidehouse

2.3.1 Scenario Descriptions

The scenarios can be interpreted as follows:

- **Scenarios 1 & 4: Reference** represents market achievable potential with inputs reflecting the best available information, calibrating the model using unadjusted IOU program results. Reference IRA assumptions are applied; per-measure tax credit values represent the best available information regarding provisions of the law and a conservative set of assumptions related to the proportion of commercial sector buildings able to achieve the minimum IRA-specified reduction in baseline energy consumption required to qualify for tax credits.

- **Scenarios 2 & 5: High TRC** Reference Scenario but with measure-level cost-effectiveness screening set to 1. This is anticipated to generate a more conservative outcome with lower achievable Total System Benefit.

- **Scenarios 3 & 6: Aggressive FS** builds on the Reference but modified to model the impact on achievable Fuel Substitution potential of increasing program budgets and increasing the influence of IOU FS programs on adoption.

- Measure incentive value caps will be increased to the “high” value
- Increasing willingness, and/or Stock Turnover parametric calibration inputs to represent greater market response to adoption influences
- “Awareness” parametric calibration inputs will be leveraged up to represent higher Marketing, Education, and Outreach (ME&O) and/or increased ME&O effectiveness

In developing program savings results for each of the above scenarios, an overarching baseline was applied to the model results designed to simulate legislative changes to earlier or later codes and standards adoption rates. If more aggressive codes and standards policies are implemented, then the program savings are adjusted down to reflect shifting market adoption baselines.

2.3.2 Variation by Proposed Zero Emission Appliance Standards

The 2025 Study includes two distinct sets of assumption frameworks for the implementation of the California Air Resources Board’s (CARB) proposed zero-emission appliance standards (ZEAS) for space and water heating equipment.

1. **ZEAS 2030 Framework**. Applied in Scenarios 1-3. All affected measures have a ZEAS effective date of 2030. This framework was also considered in the 2023 Study.
2. **ZEAS Phased Framework**. Applied in Scenarios 4-6. Effective dates for ZEAS-affected measures vary between 2027 and 2031 based on an updated CARB proposal from May 2024. For small boilers and water heaters, compliance is phased-in over a three-year period (2027 to 2029). This framework represents a new set of assumptions for the 2025 Study.

Each scenario applied to the 2025 Study is modeled under both ZEAS frameworks, resulting in results for a total of six assumption sets. Section 3.2.2.6 and 4.5.1Appendix A contain additional detail on the two ZEAS frameworks considered in the 2025 Study.

3. Data Sources

The 2025 Study relied on vast and varied data sources. Throughout the study, the Guidehouse team sought to rely on CPUC-vetted products as much as possible. In several cases, the team sought alternate data sources where CPUC resources did not provide the necessary information. This section describes the data update process, assumptions, and sources for key topic areas.

3.1 Global Inputs

Global inputs are macro-level model inputs not specific to any measure that apply to market segments or sectors. The Guidehouse team reviewed the data source for each of these inputs to determine the most recent data to be used for the 2025 Study. Table 3-1 provides an overview of all global inputs within the PG Model and their data source. Each item is discussed in the subsections that follow.

Table 3-1. Overview of Global Inputs Updates and Sources

Global Input *(Description)*	**Data Source for Update**
Retail rates *($/kWh, $/therm)*	CEC, 2023 Integrated Energy Policy Report (IEPR), adopted Jan 2024
Consumption forecasts *(GWh, MW, and MMtherm)*	CEC, 2023 Integrated Energy Policy Report (IEPR), adopted Jan 2024 CEC Energy Consumption Database (ECDMS), 2022
Building stocks *(Households, floor space, consumption)*	CEC, 2023 Integrated Energy Policy Report (IEPR), adopted Jan 2024
Avoided costs *(Avoided energy and capacity costs)*	2024 Draft Avoided Costs. Avoided Cost Calculator, files representing Quarterly Avoided Cost Combinations received from DNV Aug. 2024.
Historical program accomplishments *(Used for calibration)*	CPUC, California Energy Data and Reporting System (CEDARS) program cycle 2020-2023 data. CPUC, California Energy Data and Reporting System (CEDARS) 2020-2023 filings and Plan (FS).
Non-incentive program costs	CPUC, California Energy Data and Reporting System (CEDARS) program cycle 2020-2023 filings.

Source: Guidehouse

3.1.1 Retail Rates and Consumption Forecasts

The CEC's IEPR, which includes a forecast that is updated annually, is the source for retail rates and consumption forecasts in the 2025 Study. The Guidehouse team used the preliminary 2023 IEPR for electric and gas rates.

The consumption forecasts from the IEPR were disaggregated by the CEC's eight planning areas, which differ slightly from the IOU service territory areas. Some CEC planning areas include the territories of small publicly owned utilities in California or other non-IOU electricity providers, so an adjustment is needed. Using data from the CEC's Energy Consumption Database (ECDMS)[40] on service territory and planning area sales for 2022, the most recent year for which data was available, the team calculated ratios to adjust the planning area consumption (found within the IEPR) down to each IOU's actual service territory consumption for all electric utilities. These ratios are referred to as service territory to planning area adjustment ratios and are detailed in Table 3-2.

Table 3-2. Electric Service Territory to Planning Area Adjustment Ratios

IOU	Residential	Commercial	Industrial	Agriculture
PG&E	77%	76%	71%	80%
SCE	80%	85%	74%	54%
SDG&E	70%	89%	92%	91%

Source: ECDMS, 2023

Most publicly owned utilities in California do not offer gas service (only the City of Palo Alto and Island Energy offer natural gas service). The CEC estimates that California IOUs sell approximately 99% of the state's natural gas. To obtain service territory consumption values, the Guidehouse team used 2022 data from the CEC's ECDMS, shown in Table 3-3.[41] The CEC planning area for San Diego directly maps to the SDG&E service territory, so the team did not need to calculate an adjustment ratio for SDG&E.

Table 3-3. Gas Service Territory to Planning Area Adjustment Ratios

IOU	Residential	Commercial	Industrial	Agriculture
PG&E	99.5%	98.3%	99.9%	100.0%
SCG	98%	96.9%	97.6%	99.3%
SDG&E	100%	100%	100%	100%

Source: ECDMS, 2022

The Guidehouse team applied these ratios to the sales forecast and the building stocks for electric and gas impacts.

3.1.2 Building Stocks

Building stocks are the total population metrics of a given sector, though represented by different metrics for most sectors. Residential building stocks are based on the number of households in an IOU's service territory. Commercial building stocks are represented by total floor space for each commercial building type. Industrial and agriculture building stocks are

[40] California Energy Commission, California Energy Consumption Database, http://ecdms.energy.ca.gov/.

[41] Ibid.

represented by energy consumption. The residential, commercial, industrial, and agriculture building stock metrics are derived from the CEC's IEPR. The model requires building stocks by sector, scenario, and utility for 2013-2037.

The IEPR organizes building stock data into the eight electric planning areas. Each planning area aligns to a utility and includes one or more CEC forecasting zones, as listed in Table 3-4.

Table 3-4. Mapping CEC Electric and Gas Planning Areas to IOU Service Territories

<table>
<tr><th>CEC Forecasting Climate Zone</th><th>Electric Planning Area Number</th><th>Electric Planning Area Utilities</th><th>Natural Gas Planning Area Utilities</th></tr>
<tr><td>Climate Zone 1</td><td rowspan="6">1 - PG&E</td><td rowspan="6">PG&E</td><td rowspan="6">PG&E</td></tr>
<tr><td>Climate Zone 2</td></tr>
<tr><td>Climate Zone 3</td></tr>
<tr><td>Climate Zone 4</td></tr>
<tr><td>Climate Zone 5</td></tr>
<tr><td>Climate Zone 6</td></tr>
<tr><td>Climate Zone 7</td><td rowspan="5">2 - SCE</td><td rowspan="5">SCE</td><td rowspan="5">SCG</td></tr>
<tr><td>Climate Zone 8</td></tr>
<tr><td>Climate Zone 9</td></tr>
<tr><td>Climate Zone 10</td></tr>
<tr><td>Climate Zone 11</td></tr>
<tr><td>Climate Zone 12</td><td>3 - SDG&E</td><td>SDG&E</td><td>SDG&E</td></tr>
<tr><td>Climate Zone 13</td><td rowspan="3">4 - NCNC</td><td>SMUD</td><td rowspan="3">PG&E</td></tr>
<tr><td>Climate Zone 14</td><td>Turlock Irrigation District</td></tr>
<tr><td>Climate Zone 15</td><td>Other (Modesto, Redding, Roseville, Trinity, and Shasta Lake)</td></tr>
<tr><td>Climate Zone 16</td><td rowspan="2">5 - LADWP</td><td rowspan="2">Los Angeles Department of Water and Power (LADWP)</td><td rowspan="5">SCG</td></tr>
<tr><td>Climate Zone 17</td></tr>
<tr><td>Climate Zone 18</td><td>6 - Burbank/Glendale</td><td>Burbank/Glendale</td></tr>
<tr><td>Climate Zone 19</td><td>7 - IID</td><td>Imperial Irrigation District</td></tr>
<tr><td>Climate Zone 20</td><td>8 - Valley Electric</td><td>Valley Electric</td></tr>
</table>

Source: CEC

3.1.3 Historical Rebate Program Activity

The historical rebate program achievements for each of the IOUs are important inputs to calibrate the forecast of rebate programs. The CPUC maintains CEDARS, an online resource that collects program achievement data, for public use. These datasets include program savings, expenditures, cost-effectiveness, and emissions for EE programs statewide. For the 2025 Study, the team used this dataset to quantify historical portfolio net and gross savings for each utility, sector, and end use.

Table 3-5 provides the 2020-2023 gross ex post savings at the utility and sector levels for EE programs, which informed calibration. Actual calibration was conducted at the end use level. Some program savings were not modeled as a rebate program; those savings are excluded from this analysis (for example, residential HERs, industrial & agricultural, and custom commercial which includes RCx). Table 3-6 shows the excluded programs and their reasons for exclusion.

Table 3-5. 2020-2023 IOU-Reported Portfolio Gross Program Savings—EE

IOU	Sector	Gross GWh	Gross MMtherms	Expenditures ($ Millions)
PG&E	Residential	53.45	2.48	$72.88
	Commercial	104.11	13.33	$92.15
	Industrial	34.81	38.08	$46.37
	Agriculture	56.98	5.14	$45.55
SCE	Residential	45.51	0.52	$47.22
	Commercial	109.90	0.56	$61.87
	Industrial	10.71	-0.01	$2.77
	Agriculture	5.49	-	$2.79
SCG	Residential	20.43	15.94	$72.28
	Commercial	0.34	22.28	$56.97
	Industrial	0.01	9.11	$15.65
	Agriculture	0.78	4.01	$9.57
SDG&E	Residential	11.48	5.19	$24.38
	Commercial	60.33	1.35	$33.94
	Industrial	9.69	0.34	$3.03
	Agriculture	0.11	0.12	$1.15

Source: CPUC, CEDARS (2020-2023) Claims Data

Table 3-6. Programs Excluded from EE Portfolio Gross Program Savings

Program Category	Reason for Exclusion	Modeling Location
BROs-type programs	Behavioral programs are modeled through the BROs methodology.	BROs / Custom top-down
Commercial custom	These are measures or programs that are modeled separately.	Top-down
Agriculture and industrial incentives	These are measures or programs that are modeled separately.	Industrial and agriculture top-down
C&S	The Guidehouse team modeled C&S separately from the rebate programs.	C&S

Program Category	Reason for Exclusion	Modeling Location
ESA	The Guidehouse team modeled income qualified potential separately.	Income qualified
Financing programs	Most historical financing programs only report a cost and no savings.[42]	N/A
Non-resource or non-savings programs	These programs have no associated savings and do not contribute to the goals.	N/A
Whole building retrofit	These programs have not been cost-effective historically and are rarely cost-effective in the PG Model. The team removed them so its calibration for whole building new construction would not be artificially inflated	N/A

Source: Guidehouse

FS calibration data was available from the 2022-2023 CEDARS data and was used to inform the calibration.

Table 3-7 provides the 2022-2023 gross savings at the utility and sector levels for FS programs, which informed calibration. GWh savings are negative because FS results in increased energy consumption. Industrial and Agriculture FS is not represented due to the 2025 Study not modeling specific characterized measures within these sectors.

Table 3-7. 2022-2023 IOU-Filed Portfolio Gross Program Savings - FS

IOU	Sector	Gross GWh	Gross MMtherms	Expenditures ($ Millions)
PG&E	Residential	-3.00	0.30	$3.82
	Commercial	-3.41	5.66	$15.55
SCE	Residential	-1.21	3.08	$49.38
	Commercial	-19.45	5.73	$14.25
SDG&E	Residential	-1.32	0.11	$0.92
	Commercial	-5.75	1.54	$3.27

Source: CPUC, CEDARS (2022-2023) Claims Data

Error! Reference source not found. includes additional discussion on the calibration process.

3.1.4 Non-Incentive Program Costs

Non-incentive program costs come from historic evaluated program participation data.

[42] There are two types of on bill financing (OBF) programs administered by the CA IOUs. For several years, the IOUs have offered the OBF plus rebate pathway as this program requires participants to receive a rebate through another IOU program to qualify for OBF. The program savings are claimed through the incentive programs. The other OBF program is known as AP or Alternative Pathway. PG&E started this as a pilot program in 2018. No claims have been made for both costs and savings, yet.

For the PG Model, the Guidehouse team determined program costs per unit of first-year kWh or therm by sector. In CEDARS, program costs for each program and measure line are already listed, and program costs combine administrative costs, marketing costs, implementation (customer service) costs, overhead, and evaluation, measurement, and verification (EM&V) costs. Interactive effects and non-resource programs are not included in calculating the program costs. Similarly, BROs program and C&S program costs were not included in the rebate program costs because these categories are modeled elsewhere, and their costs are accounted for in that analysis.

Table 3-8 provides an overview of the non-incentive program costs based on gross reported savings.

Table 3-8. Non-Incentive Program Costs Summary

IOU	Electric Savings ($/Gross kWh)				Gas Savings ($/Gross therms)			
	Res	Com	Ag	Ind	Res	Com	Ag	Ind
PG&E	$0.36	$0.11	$0.15	$0.03	$10.66	$3.09	$4.30	$0.95
SCE	$0.19	$0.34	$0.25	$0.16	N/A	N/A	N/A	N/A
SCG	N/A	N/A	N/A	N/A	$1.21	$1.28	$0.86	$1.18
SDG&E	$0.04	$0.14	$0.66	$0.06	$1.23	$4.17	$19.27	$1.82

Source: CPUC, CEDARS—2020-2023 Program Claims Data

3.1.5 Avoided Costs

Avoided costs represent the economic value on the amount of energy and GHG emissions saved by implementing an energy-saving measure. Avoided costs are a key input to calculating cost-effectiveness. One set of avoided costs are used for this analysis, the draft 2024 vintage of the avoided cost calculators (ACC).

To source the 2024 vintage of avoided costs, Guidehouse worked with CPUC contractor DNV to obtain avoided cost inputs. Gas avoided costs were provided for each utility and sector, and electric avoided costs were provided by sector, utility, and end use. For the electric avoided costs, Guidehouse mapped each measure to an end use by matching to the Electric Loadshape Identifier in the eTRM.

The 2025 PG Model is not meant to exactly replicate the CET in all its functions and granularity. Rather, the model applies avoided costs to the algorithms specified in the California Standard Practice Manual for cost-effectiveness calculations. Appendix I describes the avoided cost development for the 2025 Study analysis.

3.2 Residential and Commercial Technology Characterization

The technology characterization step develops the essential inputs used in the PG Model to calculate potential. This section provides an overview of the technology selection process for the residential and commercial sectors, describes the fields along which technologies are characterized, lists the data sources and describes how these sources are used for characterization, and directs the reader to the complete database of characterized technologies.

Like previous PG Models, the 2025 Study uses a technology-based characterization, which characterizes individual technology levels within a technology group. A **technology group** includes multiple technologies with different efficiency levels that compete for stock replacement under an end use. A technology group is also commonly referred to as a Competition Group (CG). For example, floor insulation retrofit measures with different efficiency levels (below code R0, code level R19, efficient level R30, etc.) are considered a single technology group termed floor insulation retrofits.

3.2.1 Technology Selection Process

The technology selection process for the 2025 Study used the 2023 Study's technology list as a starting point. The Guidehouse team retained many technologies from the previous study but refreshed the list by adding and removing some technology groups and levels within groups. The draft residential and commercial measure list for the 2025 Study was released to stakeholders and posted to the CPUC website on May 22, 2024, for review and feedback. Major changes from the previous study include the following:

- Approximately 30 technology groups from the 2023 Study were removed for the 2025 Study based on the criteria that they had less than 0.1% contribution to 2023 Study total portfolio TSB, less than 0.1% contribution to 2023 CEDARS total portfolio TSB, and are not characterized in the California eTRM (or are expiring or sunsetting prior to 2026). This included the removal of all technology groups within the commercial Data Center and residential Lighting end uses.

- New technology groups were added based on a review of most recent IOU claims and the eTRM. Measures were added if they had both a meaningful contribution to 2023 CEDARS claims (0.1% or greater contribution to total portfolio TSB) and were also characterized as active in the California eTRM (and not sunsetting or expiring prior to 2026). Measures added per these criteria include gas dryer modulating valves, hot water tank insulation, ultra-low temperature freezers, contact conveyor toasters, electric deck ovens, ice machines, and insulated hot food holding cabinets.

- Residential HVAC measures were updated with SEER2 rather than SEER efficiency definitions to align with the latest eTRM measure packages (SWHC044, SWHC045, SWHC049, SWHC050). This affected measures such as central air conditioners, central heat pumps, and ductless heat pumps.

- Additional efficiency levels were added for heat pump water heaters (HPWH) within the small gas water heater FS technology groups (for both residential and commercial sectors). The 2023 Study only considered 3.30 UEF HPWHs; the 2025 Study adds 3.50 UEF and 3.75 UEF levels to align with eTRM options (SWWH025 and SWWH027).

Table 3-9 shows the number of technology groups and individual technologies characterized in the study by end use for the residential and commercial sectors, including technologies under the electric and gas fuel types.[43]

[43] Please refer to the Measure Input Characterization System (MICS) database for additional detail.

Table 3-9. Final List of Technology Groups

Sector	End Use	Technology Group Examples*	Number of Technology Groups	Number of Individual Technologies†
Residential	Appliances/ Plug Loads	Refrigerators, Dishwashers, Clothes Dryers	11	25
	Building Envelope	Attic/Ceiling Insulation, Floor Insulation, Wall Insulation	5	11
	HVAC	Air Conditioners (ACs), Heat Pumps, Furnaces, Thermostats	18	83
	Water Heating	Water Heaters, Faucet Aerators, Showerheads	11	36
	Total		**45**	**155**
Commercial	Appliances/ Plug Loads	Process Laundry, Pool Covers	3	6
	Building Envelope	Wall Insulation	1	3
	Com. Refrigeration	Display Case Motors, Refrigeration Compressors, Anti-Sweat Heat Controls	8	16
	Food Service	Ovens, Steamers, Fryers	16	63
	HVAC	Unitary ACs, Mini-Split Heat Pumps, Chillers, Energy Management Systems (EMS)	18	55
	Lighting	High and Low Bay Fixtures, LED Fixtures and Retrofit Kits	3	8
	Water Heating	Water Heaters, Faucet Aerators, Pre-Rinse Spray Valves	14	42
	Total		**72**	**193**

*The complete list of technology groups is presented in the measure-level input workbook.
†The technology list does not include whole building packages and BROs interventions. The approach used to select and characterize these measures is discussed in separate sections of this report. Please refer to the measure input characterization system spreadsheet for a complete list of the technologies included in the study.
Source: Guidehouse

3.2.1.1 FS Considerations

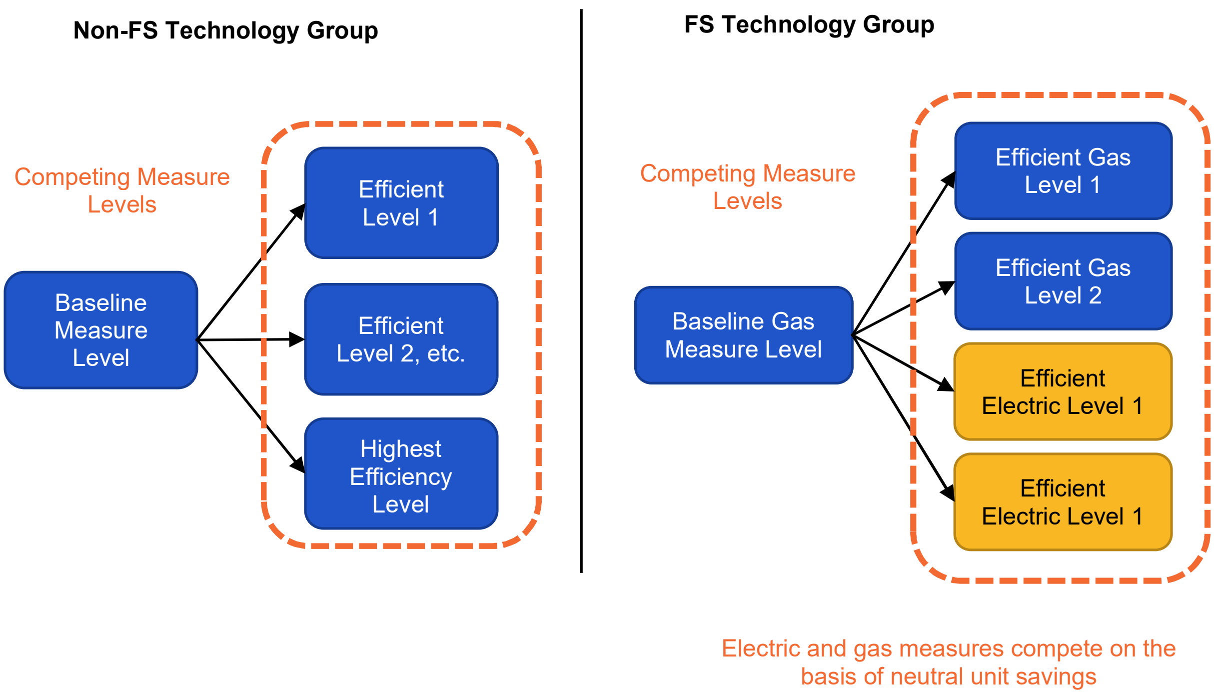
For FS measures, the team followed a similar approach to the non-FS (EE technologies) technology selection process. The team excluded any measures that did not pass the FST, alternatively, the team included only approved measure packages in the eTRM. As implemented by CPUC Decision 19-08-009, the FST specifies that to be included in an EE portfolio, a measure must not increase source energy, and it must not harm the environment (where environmental harm is measured by net CO2 emissions).[44]

[44] CPUC Decision 19-08-009

The Guidehouse team analyzed FS technologies in the same technology group as the gas technology being replaced. In other words, a FS measure replacing a baseline gas technology would compete with the efficient gas technology that would replace the gas technology. The electric and gas measures compete based on neutral unit savings; unit energy consumption for the technologies are converted to the same unit by converting gas energy units to equivalent electric energy units.

Figure 3-1 illustrates how measures compete within a technology group, comparing a technology group without FS (left side) to a technology group incorporating FS (right side). In the FS technology group, two efficient gas technology levels compete with two efficient FS levels.

Figure 3-1. Example FS Technology Group



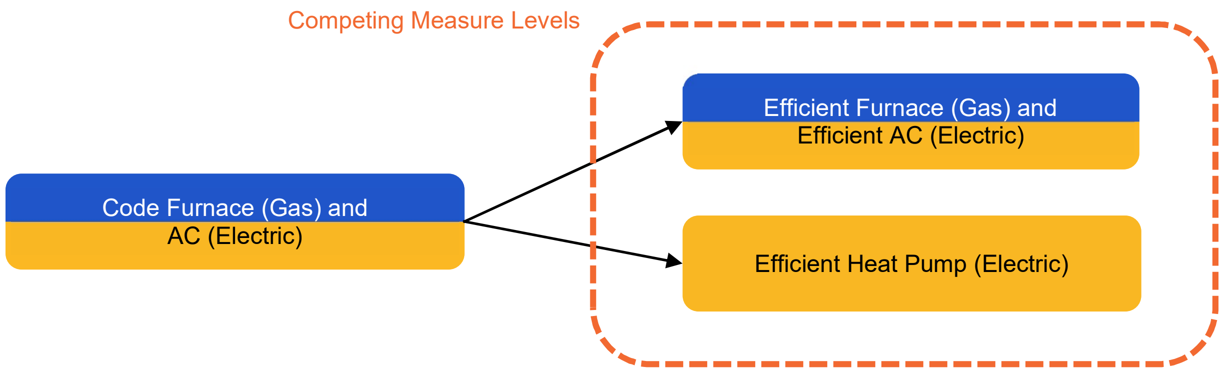
Source: Guidehouse

For most FS technology groups, an electric appliance directly replaces a gas appliance. For residential HVAC FS measures, however, the electric FS level—a heat pump—provides heating and cooling, while the gas appliance being replaced only provides heating. The 2025 Study, like previous PG Models, considers three possible situations:

- Homes with a central gas furnace providing heating and an electric central air conditioner providing cooling
- Homes with a ductless wall furnace providing heating and an electric ductless room air conditioner providing cooling
- Homes with a central gas furnace and no cooling

For homes with both a gas furnace and an electric air conditioner, FS would involve replacing both the furnace and the air conditioner with a heat pump (central heat pump or ductless mini-split heat pump), which provides heating and cooling. The technology group(s) consist of a heat pump competing with an efficient furnace and air conditioner combination, as Figure 3-2 shows for the Central HVAC System situation.

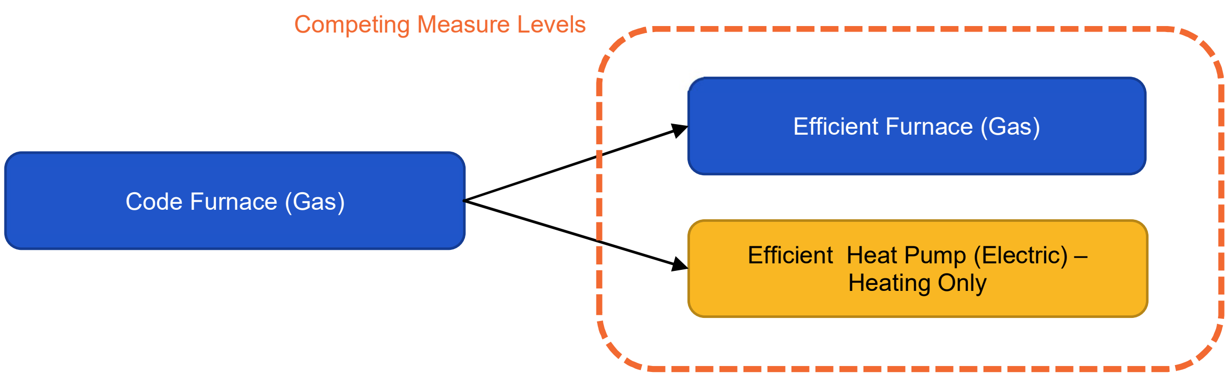
Figure 3-2. Residential HVAC FS Technology Group



Source: Guidehouse

For homes with a gas furnace only, the FS level competed with the efficient gas appliance only. The Guidehouse team only considered the heating energy from the heat pump when comparing energy use across the technology group. However, Guidehouse compared the full cost of the heat pump in the characterization to the full cost of the baseline furnace.[45] Figure 3-3 shows the efficiency levels in this technology group.

Figure 3-3. Residential Furnace FS Technology Group



Source: Guidehouse

[45] Conversation with CPUC on October 21, 2020.

3.2.2 Technology Characterization

Characterizing selected technologies involves developing various inputs for each technology necessary to calculate potential. Table 3-10 summarizes the key items the Guidehouse team used to characterize the technologies and provides brief descriptions.

Table 3-10. Key Fields for Measure Characterization

Items	Brief Description
Technology description	• Sector • End use • Fuel type • Climate zone • Segment or building type • Replacement type
Energy use	• Energy use (electric and gas) • Coincident peak demand • Interactive effects
Technology costs	• Equipment cost • Installation cost • Panel upgrade costs (for applicable FS technology groups)
Market information	• Applicability by segment or building type • Density associated with the technology group • Saturation for individual technologies
Other items	• Technology lifetime (EUL and RUL) • Net-to-gross (NTG) ratio • Lifecycle refrigerant impacts

Source: Guidehouse

For the 2025 Study, Guidehouse undertook comprehensive measure updates with the primary goal of utilizing the latest available eTRM measure version at the time of characterization for as many measures as possible. Almost 90% of technology groups were updated to use a newer eTRM measure version compared to the 2023 Study. For the 10% of measures that were not updated, this was a result of either the measure not being in the eTRM (so the same non-eTRM source as the 2023 Study was used), or the result of there not being a newer eTRM measure version available to use since the 2023 Study.

Additionally, of the technology groups that are characterized primarily using the eTRM (around 94% of all groups), 72% of these were updated with a PY2026-effective eTRM measure version for the 2025 Study. The remaining 28% did not have a PY2026 eTRM version available in time for Guidehouse to use prior to the conclusion of measure characterization; instead, the latest eTRM version was used which was most often for PY2024.

The following subsections detail how the Guidehouse team developed energy use, costs, market information, and other relevant fields and provide the associated hierarchical list of data sources for this information.

3.2.2.1 Energy Use

Energy use is a key input for technology characterization. The technology-based approach followed in this study requires that the energy use associated with each technology level be specified relative to the baseline level of the technology group in which the technology competes. If the measure is an early retirement measure (i.e. efficient equipment replacing old equipment before the end of its life) or a retrofit component being added on to existing equipment, the baseline is typically considered to be at the average efficiency of that equipment type currently existing in homes or buildings (termed “average existing”). If the measure is replacing burned-out equipment or being installed in new construction, the baseline is the minimally code-compliant efficiency level, because that is the least efficient equipment that could be purchased.

Unit energy use is specified in kWh for electric technologies and in therms for gas-fueled technologies. For dual fuel technologies that can achieve both electric and gas savings such as insulation, both metrics are calculated. Some technologies have interactive effects. An example is energy efficient lighting, which produces less waste heat than inefficient lighting and has additional HVAC energy consumption associated with it. These interactive effects are included in the savings for the technology characterization, as they are included in the eTRM.

The characterization of electric technologies also includes reduction in coincident peak demand in kW.

Some measures’ energy use varies depending on the climate where they are located. For example, ACs are operated more frequently in hotter climates and have higher annual energy use in these climates. Previous PG Studies characterized climate-dependent measures for each of the 16 climate zones that exist within each utility’s service territory. The model then aggregated the costs and savings across the climate zones in a pre-processing step before determining overall cost-effectiveness for an IOU territory and assigning achievable potential. This approach could result in some measures appearing to have lower savings than were achievable because low cost-effectiveness in one region could outweigh high cost-effectiveness in another region, making the entire measure appear nonviable.

Beginning with the 2021 Study, the Guidehouse team characterized climate-dependent measures in up to three climate regions for each utility: Marine, Hot-Dry, and Cold. The team chose these designations to approximately align with the International Energy Conservation Code regions 3C, 3B, and 4B, respectively, which cover most of the state’s population.[46]

Most California energy data sources provide energy values for climate-dependent measures for each of the 16 climate zones. Table 3-11 shows the mapping the team used to select the appropriate energy value from data sources that calculated energy consumption by climate zone. In the 2023 Study, Guidehouse updated the designated climate zone for SCE Hot-Dry

[46] U.S. Department of Energy, International Energy Conservation Code Climate Zones, https://www.energy.gov/sites/prod/files/2015/10/f27/ba_climate_region_guide_7.3.pdf.

and SCE All from CZ08 to CZ09 because CZ09 was a more representative zone in terms of climate characteristics across all of SCE service territory. This change was maintained for the 2025 Study.

Table 3-11. Map of Climate Region to Designated Climate Zones 1-16 for Each IOU

Climate Region	PG&E	SCE	SCG	SDG&E
Marine	CZ03	CZ06	CZ06	CZ06
Hot-Dry	CZ12	CZ09	CZ09	CZ07
Cold	CZ16	CZ16	CZ16	N/A
Non-Climate-Dependent*	CZ03	CZ09	CZ09	CZ07

CZ = climate zone

*The Non-Climate-Dependent row shows the mapping used for measures not treated as climate-dependent in the 2025 Study. Measures were treated this way if their savings did not vary significantly across climate regions, but the data source had climate zone-specific savings. An example is lighting measures with interactive effects varying slightly across climate zones. For simplification purposes, the Guidehouse team did not characterize this measure separately for individual climate regions and chose the deemed savings value corresponding to the climate zone in the Non-Climate-Dependent row.

Source: Guidehouse

The team characterized climate-dependent measures separately for each climate region and appended the climate region name to the measure name. The climate-specific measures were considered as entirely separate measures throughout the analysis (e.g., Packaged/Split System AC (SEER2 16.0)—Marine). The model does not aggregate the costs and savings across the climate zones, which allows it to consider a measure's cost-effectiveness independently for each climate region.

3.2.2.2 Equipment Costs

The measure characterization requires specification of equipment costs, which include material costs, labor costs for installation, and repair costs where applicable. Like energy savings data, most cost data for characterized technologies came from eTRM measure packages. Many of the other California-specific technology cost data sources reference underlying research conducted through the California Measure Cost Study.[47]

Labor costs for FS technologies generally account for the cost of capping the original gas line and wiring needed to accommodate the new electric appliance. Infrastructure costs associated with FS panel upgrade requirements were also added for applicable residential and commercial FS measures, as described in Appendix C.

3.2.2.3 Market Information: Density and Saturation Values

Density and saturation are two essential technology characterization inputs for scaling potential from the measure level to the full applicable building stock.

[47] Itron, California Measure Cost Study, May 2014, http://www.calmac.org/publications/2010-2012_WO017_Ex_Ante_Measure_Cost_Study_-_Final_Report.pdf.

- **Density** represents the number of measure units per building. The PG Model uses density information to determine the number of applicable technology units on the appropriate scaling basis (per household for residential and per square foot for commercial) to scale up the technology stock by segment or building type. Density is specified by technology group. Technologies within a technology group share the same density under the assumption that lower efficiency technologies are replaced on an equivalent unit basis with higher efficiency technologies. Density can be expressed as the following: units/home, bulbs/home, lighting fixtures/1,000 square feet, tons of cooling/1,000 square feet, etc.
- **Saturation** is the share of a specific technology within a technology group, so that the sum of the saturations across a technology group always sums to 100%. Saturation can also be calculated by dividing the individual technology density by the total technology group maximum density.

As an example, Table 3-12. shows example densities and saturations for the floor insulation retrofit technology group in single-family homes in PG&E's service territory.

Table 3-12. Example of Density and Saturation Calculation: Floor Insulation Retrofit Technology Group in Single-Family Homes, PG&E Service Territory

Technology Name	Base Year Efficiency Level	Unit Basis	Technology Density (Units per Household)	Technology Saturation
Floor Insulation (R0)	Below Code	Sq.Ft.insulation	1,840	90%
Floor Insulation (R19)	Code	Sq.Ft.insulation	1,840	8%
Floor Insulation (R30)	Efficient	Sq.Ft.insulation	1,840	2%
Total			**1,840**	**100%**

Source: Guidehouse

The example shows that an average single-family home in PG&E's territory has 1,840 square feet of floor insulation per home, which is the density value. The saturations of below code, code-compliant, and efficient floor insulation for single-family homes are 90%, 8%, and 2%, respectively. This means that 90% of existing floor insulation is at a below code level, 8% is at code, and 2% is above code. The saturation changes over time with population growth and stock turnover as more below code stock gets replaced with at code and higher efficiency stock.

Measure characterization also requires specifying a technical suitability factor. Technical suitability refers to the percentage of customers with the physical or infrastructural prerequisites to install a technology. Technical suitability is less than 100% for technologies that cannot physically be installed in some cases. For example, the technical suitability for geothermal heat pumps is less than 100% because not all homes have access to space below the ground where a heat exchanger loop can be installed. The technical suitability factor assumptions are based on data sources, wherever available, and the team's industry and subject matter expertise.

As noted in Section 3.2.1, the Study includes separate FS technology groups to represent the portion of homes that may require an electrical panel upgrade to substitute from gas to electricity. Based on the recommendations from the VEA working group report described in

2.1.2.2 and Appendix C, Guidehouse split the total density for a FS technology among panel upgrade and non-panel upgrade versions. For example, if the total density of residential gas stove is 0.75 per household and the estimated proportion of homes that would require a panel upgrade for induction cooking FS is one-third, then the total density would be split up to 0.25 stovetops per household in the panel upgrade technology group and 0.5 stovetops per household in the non-panel upgrade technology group.[48]

3.2.2.4 Effective Useful Life Updates

Technology characterization includes the specification of an appropriate EUL value for each technology. In general, EUL values are sourced from approved eTRM measure versions and align with the latest CPUC-adopted policy at the time of the eTRM version approval.

For the 2025 Study, based on direction from CPUC staff, the Guidehouse team used new (generally longer) EUL values for certain technologies to align with updates that were expected to be adopted with the PY2026 DEER resolution at the time of characterization, and which were ultimately adopted in Resolution E-5350 in December 2024.[49] At the time of the completion of technology characterization for the 2025 Study, these EUL updates were also being incorporated into PY2026 eTRM measure updates but were not fully complete. These updated EUL values are summarized in Table 3-13.

Table 3-13. Notable EUL Updates per Expected PY2026 DEER Resolution

Sector	Technology	Previous EUL (Years)	New EUL (Years)
Residential	Heat Pump HVAC (Ductless & Central)	15	23
Residential	Heat Pump Water Heater	10	20
Residential	Gas Furnace (Central & Wall)	20	30
Residential	Gas Storage Water Heater	11	25
Commercial	Heat Pump Water Heater	10	13
Commercial	Gas Storage Water Heater	10	13

Source: Guidehouse and CPUC Staff

In cases where the PY2026 eTRM version of an affected measure was available in time for use in measure characterization, the EUL values from the PY2026 eTRM already reflected these EUL updates and no further action was required for the Study. However, in some cases where the PY2026 eTRM measure version was not complete in time for use in the 2025 Study, Guidehouse still applied the new PY2026 EUL values despite using a pre-PY2026 measure version for savings and cost values.

[48] These numbers are for illustrative purposes only.
[49] CPUC Resolution E-5350

3.2.2.5 Net-to-Gross Ratio Updates

Another measure input with notable updates for the 2025 Study is the NTG ratio (NTGR). Like EUL described previously, NTGR values are sourced from approved eTRM measure versions that align with the latest CPUC-adopted policy at the time of the eTRM version approval.

For the 2025 Study, based on direction from CPUC staff, the Guidehouse team implemented updated NTGRs that were expected to be adopted with the PY2026 DEER resolution at the time of characterization, and which were ultimately adopted in Resolution E-5350 in December 2024.[50] The new default NTGR values for PY2026 are 0.90 for residential and 0.70 for commercial, as shown in Table 3-14.

Table 3-14. Default NTGR Updates per Expected PY2026 DEER Resolution

Sector	Previous Default NTGR	New Default NTGR
Residential	Res-Default>2: **0.55**	Res-Default-di: **0.90**
	All-default<=2yrs: **0.70**	
	Res-Default-HTR-di: **0.85**	
Commercial	Com-Default>2yrs: **0.60**	Com-Default-di: **0.70**
	All-Default<=2yrs: **0.70**	
	Com-Default-HTR-di: **0.85**	

Source: Guidehouse and CPUC Staff

Default NTGRs (as opposed to evaluated NTGRs) are used for approximately two-thirds of characterized measures in the 2025 Study, in alignment with their eTRM characterizations. Additionally, evaluated NTGRs for some measures were updated per PY2026 eTRM measure updates which were available in time for use in the 2025 Study.

3.2.2.6 Proposed Zero Emission Appliance Standards

In September 2022, the California Air Resources Board (CARB) published a state implementation plan (SIP) memo to propose a "zero-emission standard for space and water heaters," which would phase-out the sale of natural gas-burning HVAC and water heating appliances starting in 2030.[51] Beginning with the 2023 Study, the PG Study accounted for these proposed zero emission appliance standards (ZEAS) by removing any natural gas EE or FS savings for space heating and water heating appliances beginning in 2030.[52] For FS technologies, this meant that starting in 2030, the assumed baseline for replace-on-burnout and new construction gas space or water heating appliances changed from a gas code baseline to a minimum-efficient electric code baseline. More efficient electric appliances within a FS technology group would therefore save electricity relative to the new electric code baseline, resulting in apparent electric savings for FS measures from 2030 onward. This **ZEAS 2030**

[50] CPUC Resolution E-5350

[51] CARB 2022 State Strategy for the State Implementation Plan

[52] However, the Guidehouse team kept natural gas savings from technologies that indirectly save gas, such as home insulation, because these would not involve the replacement of an affected gas-burning appliance.

framework, where updated electric baselines for all ZEAS measures are assumed to take effect in 2030, is also considered in the 2025 Study.

In May 2024, CARB shared an updated draft regulatory proposal (referred to as Refined Concept B) with compliance dates that vary by equipment type based on varying levels of technological feasibility.[53] As a result, for the 2025 Study, Guidehouse introduced an additional framework for ZEAS with phased implementation dates consistent with the Refined Concept B proposal. This new framework is referred to as **ZEAS Phased** for the 2025 Study. Based on the rebated residential and commercial technology groups considered in the 2025 Study, this framework results in modeled ZEAS effective dates that vary between 2027 and 2031.

The earliest proposed effective date in the updated CARB proposal is 2027, for small boilers and water heaters, which falls within the goal-setting period for the 2025 Study. Because of the proposed status of the standard, a fast-approaching compliance year, and some stakeholder concerns with feasibility, the PG team ramped in this baseline change over a three-year period (from 2027 to 2029) rather than assuming full compliance in 2027. This three-year phase-in approach for small boilers and water heaters is consistent with what Guidehouse shared in the September 2024 Scenarios Workshop.

In summary, the 2025 Study includes two distinct sets of assumption frameworks for the implementation of the proposed CARB ZEAS.

1. **ZEAS 2030 Framework.** All affected measures have a ZEAS effective date of 2030. This framework was also considered in the 2023 Study.
2. **ZEAS Phased Framework.** Effective dates for ZEAS-affected measures vary between 2027 and 2031 based on the updated CARB proposal. For small boilers and water heaters with a proposed effective date of 2027, compliance is phased-in over a three-year period (2027 to 2029). This framework represents a new set of assumptions for the 2025 Study.

The three scenarios for the 2025 Study are each modeled under both ZEAS frameworks, resulting in model outputs for six total assumption sets. **Error! Reference source not found.** contains additional detail on the implementation of the ZEAS 2030 and ZEAS Phased frameworks for the 2025 Study, including a list of affected technology groups and staggered effective dates.

3.2.3 Data Sources Hierarchy

The primary data source for characterizing residential and commercial rebate technologies is the CA eTRM measure packages and supporting data. Approximately 94% of technology groups were characterized using the eTRM as the primary source for savings and cost values. For measures not available in the eTRM, characterization leverages a mix of other California-specific and non-California sources. Table 3-15 lists the data sources for cost and energy use (in hierarchical order) and provides brief descriptions of each source.

[53] California Air Resources Board, Zero-Emission Space and Water Heater Standards Public Workshop, May 29, 2024, https://ww2.arb.ca.gov/sites/default/files/2024-05/May_2024_Workshop_Slides.pdf.

Table 3-15. Hierarchy of Data Sources for Cost and Energy Use Information

Priority	Energy Consumption Source Name	Description	Author	Publication Year
1	California Electronic Technical Reference Manual (eTRM)	According to the website, “the eTRM is a statewide repository of California’s deemed measures, including supporting values and documentation.” It includes DEER and non-DEER measures and aligns with the latest approved workpapers.	California Technical Forum	2020-2024 (continuously updated)
2	IOU workpapers (with CPUC disposition) or other California Studies	The team referred to IOU workpapers for additional measure information not contained in the eTRM or for measures that had not yet been added to the eTRM. This category also refers to California-specific studies or evaluations such as CEC Title 24 Impact Evaluations.	California IOUs or other Entities	Various
3	IOU program data	The team referred to the CEDARS database for the California IOUs in cases where energy use information was not available from the above-listed sources.	CPUC, IOUs	2021-2024
4	Non-California source examples	In cases where California-specific sources were not available for energy use information	Various	Various
	Guidehouse potential study database	Guidehouse’s archive of characterized measure savings from previous potential studies and projects with other utilities.	Guidehouse	Various

Source: Guidehouse

Table 3-16 lists the resources used to calculate density and saturation for the residential and commercial sectors in the 2025 Study (in order of priority). Major updates to density and saturation values were not in scope for the 2025 Study, so these sources are similar to those used in the 2023 Study. The Guidehouse team primarily used California-specific sources for this data and referred to non-California sources only in cases where the California-specific sources did not have the required data.

Table 3-16. Sources for Density and Saturation Characterization

Priority	Sources	Description	Author	Year
1	Residential Appliance Saturation Study (RASS)	Residential end use saturations for 39,000 households in California.	DNV GL	2019

Priority	Sources	Description	Author	Year
2	California Lighting and Appliance Saturation Survey	Residential baseline study of 1,987 homes across California.	DNV GL	2012
3	Commercial Saturation Survey	Baseline study of 1,439 commercial buildings across California.	Itron	2012
4	Non-California source examples: • Residential Building Stock Assessment • Commercial Building Stock Assessment	Survey of residential and commercial building stock across the Northwest states (Idaho, Montana, Oregon, Washington).	Northwest Energy Efficiency Alliance (NEEA)	2014
	• Residential Energy Consumption Survey (RECS) • Commercial Building Energy Consumption Survey (CBECS)	RECS and CBECS are surveys of residential and commercial building stock in the US by region. Used West regional data only.	U.S. Department of Energy (DOE)	2018, 2021
	• ENERGY STAR Shipment Database	Unit shipment data of ENERGY STAR-certified products collected to evaluate market penetration and performance.	US Environmental Protection Agency (EPA)	2003-2020

Source: Guidehouse

3.2.4 Measure Characterization Workbook

The measure characterization workbook consolidates information from the measure characterization effort in an Excel spreadsheet that serves as an input to the PG Model. The workbook presents the characterized measures with all the separate fields used for modeling. The workbook is publicly available and can be downloaded through the CPUC website.[54]

3.3 Market Adoption Characteristics

As discussed in Section 2.1.1.4, the 2023 Study updated the drivers of customer willingness to adopt EE technologies. The 2023 Study used a broader set of customer preferences on economic and non-economic factors when modeling technology adoption. The 2025 Study retained the 2023 Study's new approach to adoption modeling. The market adoption characteristics collected via the 2021 Market Adoption Survey[55] resulted in a table indicating the

[54] California Public Utilities Commission website, *2025 Potential and Goals Study*, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/energy-efficiency-potential-and-goals-studies/2025-potential-and-goals-study.

[55] Guidehouse and Opinion Dynamics, California Energy Efficiency Market Adoption Characteristics Study, 2021, https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/energy-efficiency/2021-potential-goals-study/market-adoption-report-final.pdf?sc_lang=en&hash=131848F75C4A50EB35D9247F45FB4257.

importance of each of the six value factors (previously introduced in Section 2.1.1.4) to each respondent's decision on whether to adopt energy efficient technologies.

Table 3-17Table 3-17 summarizes the survey responses mapped to each value factor, transformed using an ordinal-to-metric analysis[56] (described in more detail in the 2021 Study report), and averaged over all example EE technologies. There are analogous tables for each EE measure, FS measure, and DR measure used in the surveys.

Table 3-17. Average Importance of Value Factors by Customer Clusters Across All EE Measures

Value Factor	Average Americans	Eager Adopters	Economically Strained Environmentalists	Likely Laggards	Multifamily	Commercial
Eco Impacts	4.00	5.10	4.50	3.20	4.10	4.03
Hassle Factor	3.09	3.11	3.39	3.06	3.33	3.13
Lifetime Costs	3.23	3.27	3.60	2.87	3.03	3.28
Non-Consumption Performance	2.97	3.09	3.41	2.80	2.73	2.91
Social Signaling	2.80	3.40	3.80	2.50	3.50	3.63
Upfront Costs	2.27	1.80	2.73	2.14	2.63	2.53

Source: Guidehouse, CEC Market Adoption Characteristics Study

Because the survey was only able to ask about a subset of the 2021 Study measure list, the Guidehouse team conducted an exercise to map the surveyed measures to the entire 2021 Study measure list for residential and commercial measures which align with the 2025 measures. The first step in conducting this mapping was categorizing each surveyed technology as high or low for the attributes shown in Table 3-18. Each technology in the 2021 Study was then mapped to the surveyed technologies with which it shares the most attribute categorizations.

Table 3-18. Technology Attributes and Examples

Technology Attribute	Description	Examples
Urgency	How urgently a piece of equipment needs to be replaced when it fails	Low urgency: LED bulb High urgency: Water heater
Visibility	Whether or not the equipment is visible on the customer premise on a day-to-day basis	Visible: Clothes dryer Invisible: Insulation

[56] Ordinal is a non-metric scale and cannot be used for analysis. The survey responses are transformed to a numerical value, ordinal -to-metric.

Technology Attribute	Description	Examples
Disruption	Level of disruption experienced by the customer when adopting a new or replacement version of the equipment	Low disruption: Power strip High disruption: Insulation
Cost	Relative cost of an equipment	Low cost: Thermostat High cost: Refrigerator

Source: Guidehouse, Human Behavior and Decarbonization Potential draft paper

Table 3-19 shows how various combinations of sector and technology attributes (defined in Table 3-18) are linked to sample measures. Due to the limited number of sampled measures, one measure may appear to represent the full range of one of the attributes (indicated by both under each attribute in Table 3-19). For example, Clothes Dryer is listed as both for disruption and costs. For low urgency, visible technology, the team did not survey different technologies that are low and high disruption and low and high cost. Each residential and commercial measure in the 2025 Study is mapped to a combination of urgency, visibility, disruption, cost, and type (DR or FS, if applicable). Based on the measure assignments, the Guidehouse team applied the appropriate surveyed response dataset for the sampled measures to each 2023 Study measure. Based on the example, if a characterized measure is low urgency and visible, it will be mapped to the survey results for Clothes Dryer.

Table 3-19. Attribute Mapping and Linking to Surveyed Measures

Sector	Urgency	Visibility	Disruption	Cost	FS?*	Sample Measure Name
Residential	High	Invisible	High	High		Air Source Heat Pump
Residential	High	Invisible	High	High		Central AC
Residential	Low	Visible	*Both*	*Both*		Clothes Dryer
Residential	High	Invisible	*Both*	*Both*		Furnace
Residential	High	Invisible	High	High	FS	Heat Pump Water Heater
Residential	Low	Invisible	*Both*	*Both*		Insulation
Residential	High	Visible	*Both*	High		Refrigerator
Residential	High	Visible	*Both*	Low		Thermostat
Residential	High	Invisible	High	Low		Water Heater
Commercial	High	Invisible	Low	*Both*		EMS
Commercial	Low	Invisible	High	*Both*		Insulation
Commercial	Low	Visible	Low	*Both*		Lighting Control
Commercial	Low	Invisible	Low	*Both*		PC Power Management System
Commercial	Low	Visible	High	*Both*		Power Strip
Commercial	High	Visible	*Both*	High		Refrigeration Case/Unit

Sector	Urgency	Visibility	Disruption	Cost	FS?*	Sample Measure Name
Commercial	High	Visible	*Both*	Low		Thermostat
Commercial	High	Invisible	High	*Both*		Water Heater

* Blank cells indicate that the survey did not address FS for the specific measure.

Source: Guidehouse

3.3.1 Impacts of the Multi-Attribute Analysis

The market study results have the greatest effect on measure groups where the relative magnitude of the lifetime measure cost (LMC) value factor alone is different than the weighted average of the non-LMC value factors.

The examples in this section show the value factors associated with the efficient measure and indicates whether their associated technology characteristics serve as a benefit or barrier to adoption relative to the rest of the Competition Group.

In the illustrative instance in Figure 3-4, all the value factors add benefits (+) to the efficient measure. However, a multi-attribute analysis does not necessarily calculate an increase in efficient measure adoption compared to the single attribute analysis. This is because the adoption depends on the relative magnitude of the technology characteristics between measures in a technology CG when all value factors are included compared to when only LMC is included. For a single attribute analysis only considering LMC, if the LMC of the efficient measure is only slightly better than the baseline measure, then, correspondingly, there would be slightly more adoption of the efficient measure compared to the baseline measure. In a multi-attribute analysis, the following are cases where this figure can hold true.

- The technology characteristics for all the other (non-LMC) value factors for the efficient measure are only slightly better than the baseline measure. In this case, the adoption of the efficient measure would be nearly identical to the adoption in the LMC-only case since the LMC value factor is also only slightly more attractive for the efficient measure.
- The technology characteristics for all the other (non-LMC) value factors are significantly more attractive for the efficient measure compared to the baseline measure, then the adoption of the efficient measure would be higher when considering all value factors than in the LMC-only case since the LMC value factor is only slightly more attractive for the efficient measure.

Figure 3-4. Illustrative Example of Efficient Measure

Source: Guidehouse

In the applied example in Figure 3-5 for instantaneous gas water heaters, the value factors address both benefits and barriers to the adoption of this measure. If the model only considered LMC, there would be adoption of instantaneous gas water heaters because LMC is preferable to the baseline. With the addition of all the value factors and application of the customer preference weightings, there is lower adoption of efficient instantaneous water heaters. The reason is that the barriers from upfront costs and hassle factor lead to efficient measures being less attractive compared with if only LMC was considered. While there are benefits in the eco impacts value factor, those are outweighed by the barriers from upfront cost and hassle factor.

Figure 3-5. Gas Water Heaters

Social signaling for this measure is blank because it is not a visible measure; thus, this value factor does not have any impact on adoption.

Source: Guidehouse

Table 3-20 summarizes the impacts of including multiple value factors into the adoption logic for several case study measure groups. The examples above and the case studies below show that the impacts of the market study logic are dependent on both the individual measure characteristics and the customer preference weightings. The “market study impacts” column describes the relative change in adoption compared to an LMC-only attribute analysis. No residential technology group is included in the table since including non-LMC value factors did not have significant impacts on high savings residential technology groups.

Table 3-20. Technology Group Case Studies

Sector	Technology Group	Market Study Impacts	Description
Commercial	Split System AC-Hot-Dry*	Higher adoption	Benefits from eco impacts outweigh the barriers posed by upfront costs, which makes the efficient measures more attractive compared to a pure LMC analysis.
Commercial	LED High and Low Bay	Minimal impact to adoption	Relative benefits of other value factors are similar to the benefits of LMC.
Commercial	Small Gas Water Heaters	Lower adoption	Barriers from upfront costs and hassle factor lead to efficient measures being less attractive than the baseline measure compared to the LMC-only case.
Commercial	FS Convection Oven†	Lower adoption	Upfront costs, which are a barrier to adoption, feature more prominently in the decision-making consideration as a barrier to adoption.

* In this instance, only LMC, upfront costs, and eco impacts serve to differentiate measures within a CG.
† Not all value factors are applicable and social signaling is not considered for FS technologies.
Source: Guidehouse

3.4 Whole Building New Construction Initiatives

Whole building initiatives aim to deliver savings to residential and commercial customers as a package of multiple efficiency measures all installed at the same time. The 2025 Study models whole building initiatives via the technology levels indicated in Table 3-21.. The 2025 Study only contains whole building initiatives for new construction; retrofit measures for existing measures that were included in previous Studies were removed for the 2025 Study based on the criteria described in Section 3.2.1.

Table 3-21. Whole Building Technology Levels

Technology Group	Residential Technology Levels	Commercial Technology Levels
New Construction Building Standards	Title 24 2019 Code	Title 24 2019 Code
	Title 24 2022 Code	Title 24 2022 Code
	Title 24 2025 Code	-
	All-Electric Homes	-

Source: Guidehouse

The whole building technology groups are used to analyze the potential associated with building above-code for new construction. The final values for savings, cost, measure life, and other key model inputs can be found in the measure characterization spreadsheet.

The Guidehouse team analyzed the following efficiency levels for new construction:

- Title 24 2019 Code level, which became effective in 2020; this level is considered the base code level starting in 2020.
- Title 24 2022 Code level, which became effective in 2023; this level becomes the code baseline starting in forecast year 2023.
- Title 24 2025 Code level (for residential only), which will become effective in 2026; this level is considered the code baseline starting in forecast year 2026.
- All-Electric Homes level (for residential only), where new homes are built above-code baseline such that all building systems are powered by electricity. This level is based on the eTRM measure package SWWB008.

To calculate energy impacts between the 2019 and 2022 Code levels, the team utilized the CEC-published impact analysis for the 2022 code.[57] This report provided average annual savings values for new construction buildings relative to the 2019 Code level. The team weighted the savings data by building type according to construction forecasts by climate zone in order to match the building type and utility granularity used in the PG Study. This approach was used to determine impacts between the 2019 and 2022 Code levels for both residential and commercial sectors.

For the residential sector, energy impacts for the additional 2025 Code and All-Electric Homes levels were characterized using the eTRM measure package SWWB008 (All-Electric Homes, Residential, New Construction). Two separate versions of this measure package were used; one version that characterizes impacts for All-Electric Homes relative to the Title 24 2022 Code, and a second version that characterizes impacts relative to the Title 24 2025 Code. The team compared relative savings between these two versions to determine the implicit impact of the 2025 Code level relative to the 2022 Code level.

The eTRM measure package SWWB008 was also used to calculate incremental costs for the residential sector between each of the Title 24 Code levels and the All-Electric Homes level. Where necessary, the team calculated cost ratios for incremental measure cost per energy unit saved on a fuel neutral basis and applied these ratios to estimate costs between Code levels that were not explicitly calculated in the eTRM.

Without a similar eTRM measure for commercial new construction buildings, the team calculated incremental costs for the commercial sector in a manner similar to previous PG Studies. The approach was based on cost impact analyses and communications from the CEC and a New Building Institute study and provided costs between the 2016 and 2019 Code levels. For the 2025 Study, the team normalized these cost estimates on a per-fuel neutral savings basis and applied them to the impacts between the 2019 and 2022 Code levels. Table 3-22

[57] Athalye, Rahul, Eric Shadd, John Arent, Mohammad Dabbagh, Nikhil Kapur, Roger Hedrick, Alea German, Impact Analysis, 2022 Update to the California Energy Code, California Energy Commission, Publication Number: CEC-400-2023-008, https://www.energy.ca.gov/publications/2023/impact-analysis-2022-update-california-energy-code.

summarizes the sources used to characterize new construction whole building initiatives. These sources represent the best usable datasets available to the team at the time of characterization.

Table 3-22. New Construction Whole Building Data Sources

Data Category	Data Items	Data Sources
Energy consumption and savings	Title 24 2022 Code impacts relative to 2019 Code	California Energy Commission, Impact Analysis, 2022 Update to the California Energy Code.
	All-Electric Homes impacts relative to Title 24 2022 Code (Residential only)	eTRM Measure Package SWWB008-02
	All-Electric Homes impacts relative to Title 24 2025 Code (Residential only)	eTRM Measure Package SWWB008-03
Cost	Residential Costs	eTRM Measure Package SWWB008
	Commercial: Cost of 2016 Title 24	California Energy Commission, 2016 Notice of Proposed Action[58]
	Commercial: Incremental cost of 2019 Title 24T	Extrapolation based on 2016 Title 24

Source: Guidehouse

3.5 Agriculture and Industrial Technology Characterization and Commercial Custom

The 2025 Study update for the industrial and agricultural sectors plus commercial custom focused on two key data sources:

- **Recently completed Agriculture Market Study.**[59] This study collected information from stakeholders to identify existing conditions and potential market penetration.
- **Historical IOU program data.** This data allowed the team to directly characterize the existing penetration of savings by category, if applicable.

This section and the material in 4.5.1F.1 represent the team's use of the best available data for the characterization of the industrial and agricultural sectors, as well as commercial custom. There are several reasons that results and observations of what occurs in the market do not align:

[58] California Energy Commission, 2016 Notice of Proposed Action, last accessed September 2018, google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjpwKOiuOmMAxXskokEHWbpBbcQFnoECBkQAQ&url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D76289%26DocumentContentId%3D16600&usg=AOvVaw1_aFOimJ6h6Vb1eipISggK&opi=89978449.

[59] Appendix F-1 summarizes the referenced Market Study and its findings. The full report is Attachment 2 to this report.

- No good baseline or saturation data exists for the industrial and agricultural sector.
- Assumptions are made regarding costs.
- Many studies leverage the Industrial Assessment Center (IAC) database[60] to various levels.
- Opportunities for commercial custom are large and unique

3.5.1 Agriculture and Industrial Sectors

For 2025 Study, we are using the same methodology but expanding the scope of the top-down analysis to all industrial and agricultural and commercial custom.

To address forecasting the EE potential for these measures, Guidehouse employes the following steps.

1. Download the 2021-2023 program records (i.e., CEDARS) for the following:
    a. Industrial and agricultural
    b. Commercial custom (filtered out new construction)
2. Extract the following fields from the program records:

- Primary Sector
- Year
- PA
- Technology Group
- Delivery Type and Measure Description
- Deemed
- Category
- Measure Application Type
- First Year Gross kWh
- First Year Gross Therm
- Gross Participant Cost
- Gross Measure Cost
- Total System Benefit Gross

60 Industrial Assessment Centers Database, https://iac.university/#database.

- Electric Benefits
- Gas Benefits
- Electric Supply Cost
- Gas Supply Cost
- Rebates and Incentives

3. Map Technology Group to a set of end uses. Any whole building end use, further group by SEM, NMEC, RCx, or generic whole building using the Measure Description. This new mapping is provided in the Category field. The data is to be grouped by this field for analysis. The following were some data cleaning steps:

   a. Some deemed measures still made it through in commercial and were filtered out
   b. Some Technology Group seemed to be mismatched to the Measure Description. These were changed.
   c. Commercial was also categorized by new construction versus non-new construction.

4. Analyze the trends over the three years by sector and by category.

5. Consider simplifying categories to align with historical participation with the following concepts to consider:

   a. Different categories (end uses) have different values regarding measure and program costs, savings, and measure life
   b. Disaggregated analysis may tie future forecasts to historical performance which may have favored certain segments, technologies, etc. and not representative of remaining market potential
   c. Considering a balanced approach requires the consideration for differentiation but not overfitting that results in false precision, especially due to smaller populations.

6. Simplify categories based on the concepts analyzed in step 5 to the following analysis categories based on similarities in historical participation trends:

   a. Industrial Electric and Gas: SEM and Non-SEM, fuel agnostic.
   b. Agricultural Electric and Gas: All end uses, fuel agnostic.
   c. Commercial Custom Electric: 1) HVAC, Whole Building, NMEC, RCx, 2) Process, Lighting, Refrigeration, Water Heating, 3) SEM.
   d. Commercial Custom Gas: 1) NMEC, RCx, 2) SEM, 3) HVAC, Whole Building, Water Heating.

7. Define a trend line (see Appendix F.1)

After initial categorization and trend identification is completed, Guidehouse proceeded with calculating the following:

1. A Savings Rate Multiplier is calculated by dividing the annual ex ante gross natural gas and electricity savings by total sector consumption for each year being analyzed. The final Savings Rate Multiplier used in the 2023 forecast is based on the average annual reported ex ante savings for three program years, from 2021 through 2023.

2. CEDARS data is also analyzed to determine the trend in Generic Custom (GC) savings over time. This trend is referred to as the GC Penetration Rate and is used to increase or decrease savings over the forecast horizon. For the GC forecast, the penetration rate is stated as a compound annual growth or decline rate.

3. An annual EE savings forecast (GWh and MMtherms) is produced by 1) multiplying annual sector consumption forecasts by the Savings Rate Multiplier, and 2) multiplying the annual forecast by the Penetration Rate % to account for saturation over time.

The Savings Rate Multiplier, and other inputs for the 2025 Study forecast of categorized potential are provided in Table 3-23. The following discussions provide additional details on the assumptions and methodology used to derive these inputs.

Table 3-23. Industrial, Agricultural, Commercial Custom—Key Assumptions

Sector	Bundle	EUL Years	Savings Rate Multiplier		Cost		kW/kWh Savings Ratio
			kWh	therm	kWh	therm	
Industrial	SEM	5	0.1727%	0.1456%	$0.02	$0.84	0.0001409
Industrial	Non-SEM	11.8	0.044%	0.346%	$0.32	$1.42	0.0001186
Agriculture	All	8.5	0.1193%	1.2706%	$0.55	$2.11	0.0002347
Com Custom	HVAC, Whole Building, NMEC, RCx	9.3	0.0199%	N/A	$0.19	N/A	0.00011
Com Custom	Process, Lighting, Refrigeration, Water Heating	8.9	0.0725%	N/A	$0.50	N/A	0.00011
Com Custom	SEM	5	0.0008%	N/A	$0.60	N/A	0.00011
Com Custom	HVAC, Whole Building, Water Heating	4.6	N/A	0.003%	N/A	$4.07	N/A
Com Custom	NMEC, RCx	3.8	N/A	0.015%	N/A	$8.44	N/A
Com Custom	SEM	5	N/A	0.001%	N/A	$10.07	N/A

Source: Guidehouse

- **Savings Rate Multiplier.** Savings rate multipliers are defined as the percent of total sector energy consumed in a year that can be reduced through EE. The forecast energy savings values (kWh and Therms) are then derived by multiplying total forecast sector consumption by the savings rate multiplier. For the 2025 Study, the team analyzed CEDARS data for program years 2021 through 2023 to define savings associated with categorized measures.

- **Costs.** The Guidehouse team primarily used the CEDARS database to calculate the incremental cost per Unit Energy Savings (UES) for technologies included in the industrial and agriculture analysis.[61] The team aligned the costs to the more recent (2021-2023) dataset because measure costs can be variable year-over-year and from project to project.

- **EUL and NTG.** The Guidehouse team used the CEDARS database to calculate the weighted average EUL and NTG ratios.

3.6 C&S

C&S modeled in the 2025 Study uses data from multiple sources.

- For evaluated C&S, the study uses the latest CPUC impact evaluations of IOU C&S programs. The data for these is housed in ISSM[62] which is regularly updated with the completion of each impact evaluation. The most recently completed evaluation was published in May 2023.[63]

- For unevaluated C&S, the study uses data provided by California IOUs via a formal data request.[64]

Table 3-24 lists the number and type of C&S and their data source. 4.5.1Appendix E contains a full list of the modeled C&S, their compliance rates, and effective dates.

[61] The costs include labor to represent the full incremental cost of implementation. The lighting end use relied on cost per kWh consumed rather than cost per kWh saved because the team relied on commercial data for the industrial lighting end use measures.

[62] Market Logics and Opinion Dynamics*, Integrated Standards Savings Model (ISSM),* 2020.

[63] Opinion Dynamics et al., *PY 2016-2018 Building Codes Advocacy Program Evaluation Volume II*, April 2023.

[64] PG&E, SCE, SDG&E, and SCG provided their most recent set of data after the data request on December 6, 2024.

Table 3-24. C&S Data Source Summary

IOU C&S Group	Number and Type of C&S	Data Source
Evaluated Title 20 and Federal	99 appliance standards	ISSM
Evaluated Title 24 2005-2016	119 building codes	ISSM
Unevaluated Title 20 and Federal	11 appliance standards	IOU data request
Unevaluated Title 24 2019	40 building codes	IOU data request
2022-2028 Title 24	85 building codes	IOU data request
Future Title 20 and 24	100 Building codes	IOU data request

Sources: Market Logics and Opinion Dynamics. ISSM. 2022.; IOU data request filed May 28, 2024; CEC

For 2013 Title 24, the ISSM provides the option to use either bounded or unbounded energy savings adjustment factors, which are analogous to compliance factors for appliance standards.[65] Unbounded refers to the case where a building, project, or measure can consume less energy than the level established by the current Title 24 code, resulting in an energy savings adjustment factor greater than 100%. Bounded refers to limiting the energy savings adjustment factor values to a maximum of 100%. The 2025 Study uses bounded values from the ISSM.

[65] Cadmus and DNV GL, California Statewide Codes and Standards Program Impact Evaluation Phase Two, Volume Two: 2013 Title 24, August 2017

Table 3-25. Progression of Commercial Title 24

Title 24 Code Cycle	Cumulative Percentage of 2028 Savings Target	Incremental Savings toward 2028 Target
2016	0%	-
2019	33%	33%
2022	50%	17%
2025	67%	17%
2028	100%	33%

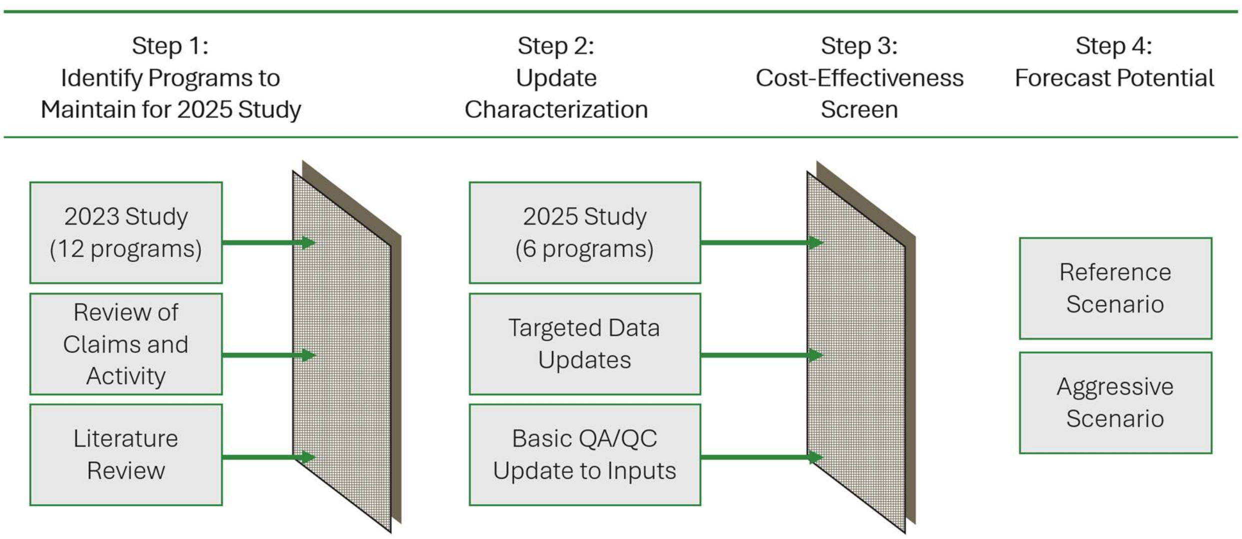
Source: Guidehouse 2019 based on communications with CEC Staff

The team scaled 2019 Title 24 claimed savings based on the Incremental Savings toward 2028 Target column in Table 3-25 to develop estimates of savings for the 2025-2028 Title 24. NOMAD factors for 2025-2028 Title 24 were adapted from 2019 Title 24 and time-shifted to an appropriate start date.

3.7 BROs EE

To forecast customer BROs energy savings, the Guidehouse team considered a range of behavioral intervention types for residential and commercial customers. Figure 3-6 illustrates the process used to update BROs measures in the 2025 Study.

Figure 3-6. Update Process for Residential and Commercial BROs EE Programs



Source: Guidehouse

3.7.1 Step 1: Identify Programs to Maintain for 2025 Study

The first step in the BROs update process was to determine which previously characterized behavioral programs should be maintained for the 2025 Study. The 2023 and earlier PG Studies considered 12 residential and commercial BROs interventions, many of which have had historically little if any realized potential. Guidehouse conducted a review of CEDARS claims and a literature review to identify BROs measure to remove from the 2025 Study based on low achievable potential, and a lack of implementation not only in California but also in other jurisdictions.

As a result of this review, four interventions from previous PG Studies were removed for the 2025 Study: Residential Small Challenges and Competitions, Residential Large Challenges and Competitions, Commercial Challenges, and Commercial Building Energy and Information Management Systems (BEIMS). Additionally, Commercial Strategic Energy Management and Retro-commissioning were moved to the new Commercial Custom characterization (see Section 3.5). 4.5.1Appendix D provides additional detail on the interventions that were removed from the BROs analysis for the 2025 Study and the rationale for their removal. Table 3-26 describes the six interventions that remained for the 2025 Study after these removals.

Table 3-26. Behavioral Intervention Summary

Sector	Type of Behavioral Intervention	Brief Description	EUL (Years)
Residential	Home energy reports (HERs)	Reports periodically mailed to residential customers that provide feedback about their home's energy use, including normative comparisons to similar neighbors, tips for improving EE, and occasionally messaging about rewards or incentives	1
Residential	Universal audit tool (UAT)	An opt in online tool that asks residential customers questions about their homes, their use of household appliances, and occupancy patterns; it then offers EE advice regarding ways they can save money and energy	1
Residential	Real Time Feedback	Real-time information and feedback about household energy use provided via energy monitoring and feedback devices installed in customer homes	1
Commercial	Business energy reports (BERs)	Reports periodically mailed to small and midsize businesses to provide feedback about their energy use, including normative comparisons to similar businesses, tips for improving EE, and occasionally messaging about rewards or incentives	2
Commercial	Building benchmarking	Scores a business customer's facility or plant and compares it with other peer facilities based on energy consumption; it also often includes goal setting and rewards in the form of recognition*	2

Sector	Type of Behavioral Intervention	Brief Description	EUL (Years)
Commercial	Building operator certification	Trains and educates commercial building operators about how to save energy by encouraging them to adopt EE behaviors and make building changes that reduce energy use	3

*Pursuant to Assembly Bill (AB) 802, building benchmarking is mandated for all commercial buildings greater than 50,000 sq. ft. under the CEC's Building Energy Benchmarking Program. Beginning with the 2021 Study, the Guidehouse team limited the applicability of the benchmarking measure to buildings less than 50,000 sq. ft. but greater than 10,000 sq. ft. to reflect additionality from IOU interventions. Due to uncertainty surrounding additional benchmarking requirements from local ordinances that might further preclude IOUs from claiming savings, the team included benchmarking only in the aggressive BROs scenario.

Source: Guidehouse

3.7.2 Step 2: Update Characterization

For programs that were maintained for the 2025 Study, Guidehouse also determined in Step 1 that there was limited new data available to warrant significant updates to the characterization. As a result, the inputs used for the 2025 Study were largely the same as those in the 2023 Study. The most significant updates made to the BROs characterization included updating to the latest building stock forecasts and adding in the most recent CEDARS claims data for Residential HERs and Universal Audit Tool (UAT).

Prior to passing through the data and inputs from the previous study, the team performed a basic quality assurance/quality control (QA/QC) review of all inputs and made any minor updates as needed. This included extending the forecast period out to 2037 and, for programs with little evidence of implementation through 2024, updating the starting year in which non-zero penetration rate begins to 2025.

As with the 2023 Study, the team calculated savings rates and penetration rates using relevant EM&V-reported program participation rates for current California IOU program offerings and reported participation in programs in other states. The team modeled an EUL of 1 year for residential programs. Commercial programs used a 2- or 3-year EUL per CPUC Decision 16-08-019 unless evidence supported a longer duration.

Appendix D details specific modeling inputs for each intervention type.

3.7.3 Step 3. Forecast potential

The BROs forecasts incorporated in the 2025 Study apply assumptions regarding program operations, historical participation, and whether participation is utility-driven (opt out) or customer-driven (opt in). The team developed two BROs potential scenarios, Reference and Aggressive. Two interventions, Commercial business energy reports and building benchmarking are considered only in the Aggressive BROs scenario. For the other interventions that are present in both scenarios, the difference between the scenarios is primarily in the assumed rate of participation growth.

3.7.4 Data Rigor

The Guidehouse team conducted an extensive industry scan for data on BROs initiatives for the 2019 and 2021 Studies and only for HERs in 2023. The team found that many of these programs are still relatively new and learning about their effectiveness is ongoing. The published data has studies with different levels of statistical rigor on the data around energy savings resulting from these interventions. Table 3-27. provides a qualitative assessment of the quality of data collected for the 2025 Study BROs interventions.

Table 3-27. Qualitative Assessment of BROs Data Quality

Sector	Program	Savings			Cost	Applicability	Participation Rate	Penetration Forecast
		kWh	therms	kW				
Residential	Home Energy Reports							
	Real-Time Feedback							
	Universal Audit Tool							
Commercial	Business Energy Reports							
	Building Operator Certification							
	Building Benchmarking							

Legend	
(light green)	California-specific program data or derivatives
(dark green)	Aggregated reports or non-verified savings reported by utilities outside of California
(blue)	Assumed equivalence to similar programs or other forms of professional judgement

Source: Guidehouse

Penetration forecasts are the most uncertain because of limited historical penetration rates on which to base a forecast. Across the board, demand savings data is often limited, and cost data is hard to obtain. No new primary research on BROs was conducted for the 2025 Study. The team continues to recommend that the industry consider pilot studies and measurement and verification to provide better data to future PG studies.

4. 2025 Study Results

Table 4-1Potential studies model program portfolios that contain discrete technology and delivery mechanisms across varying future policy and economic outlooks. These studies help inform policymakers and program implementers on what reasonable expectations may be had for achievable savings of future programs across various market sectors. Policymakers have used the results of past potential studies as a technical foundation to set savings goals for the next regulatory cycle. The 2025 Study is the basis for the CPUC's 2026 and beyond EE goal setting process. Table 4-1 summarizes key findings from this study.

Table 4-1. 2025 Study Key Findings

Key Finding	Description and Drivers
Overall Achievable Statewide TSB has increased by 42%, driven primarily by FS technologies and the industrial sector.	The 2025 Study presents a significant increase in forecasted achievable potential versus the 2023 Study mirroring recent changes in program achievements. Key drivers of this include growth in achievable TSB generated by Fuel Substitution measures and Industrial Sector EE (see subsequent key findings below). This increase in recent program performance re-calibrates the potential study forecast to a "higher bar".
Achievable FS potential has increased dramatically, driven by recent increases in IOU program claims relative to the data available in the 2023 study.	TSB from FS measures in this study is significantly higher than that of the 2023 study informed by recent program data which shows programs titling more heavily to FS measures vs EE measures. This result is largely produced by a 400% increase in FS measure installation rates, primarily heat pump water heaters in the Commercial Sector.
Industrial sector shows an increasing sector TSB potential trend.	CEDARS data overall showed increasing trends in sector wide achieved TSB with particularly growth in SEM savings. The energy impact potential has minimum change from the 2023 Study (except for a drop in PG&E overall electric energy savings but aligns with CEDARS documented trends). The portfolio TSB increases mostly due to the increase in avoided gas costs. PG&E furthermore has an increase in electric avoided costs in later years which help increase the TSB further.
Achievable Potential is not highly sensitive to the 2025 Study's Aggressive FS or High TRC Scenario assumptions	The Aggressive FS Scenarios produce only a slight increase overall in FS TSB compared to the Reference case. This is due to the much higher rates of FS already present in the Baseline Scenarios. Similarly, increasing the threshold for measure level TRC to 1.0 results in an overall decrease in achievable TSB of 6%, driven most significantly by Residential FS HVAC measures falling under the required TRC value.

Key Finding	Description and Drivers
The savings potential from C&S continues to represent a significant portion (33-80%) of the GWh potential highlighted in this study.	C&S savings show approximately 1,760 GWh and 18 MMtherm in 2026 a 13% and 48% decrease respectively versus the 2023 Study. Despite this trend C&S still accounts for well over half of EE that eventually feed into the CEC's IEPR forecast during the initial years of the 2026 Study period. While updated C&S data was incorporated cases into this Study in all instances, Guidehouse retains its prior Study's conclusion that refinements and improvements may be made to improve C&S savings estimates forecasts.
BROs programs continue to represent a significant portion of the first-year energy savings potential.	BROs measures provide the bulk of the total first year energy savings (GWh) in each year and consistently perform at levels 180% or greater than electricity savings associated with equipment-based measures for each year. However, when reviewing TSB results, the scale of BROs impact is much smaller due to its low EUL.

Source: Guidehouse

4.1 Summary

The 2025 Study provides a rich dataset of results, the details of which can be found on the CPUC's 2025 Potential and Goals website.[66] The report presents higher level results by program type for the following:

- **EE equipment.** EE traditionally incentivized by IOU programs are modeled in the study. This specifically excludes FS.
- **FS.** FS equipment replaced gas appliances with electric appliances. It will indicate gas savings and simultaneously an increase in electric consumption. The potential study calculates impacts on electric and gas consumption that result from FS.
- **Behavior, retrocommissioning, and operational efficiency (BROs).** These programs are based on customer changes that may not rely on any new equipment installations. BROs programs are a key driver of the total first-year savings. However, the impact that BROs have on TSB is limited due to the shorter measure life.
- **C&S savings.** These are provided only in terms of energy impacts; TSB results are not provided. As such, any tables and graphs the present TSB savings specifically exclude C&S.

4.1.1 Total Achievable Potential

Table 4-2 shows the achievable potential results in 2026 for EE equipment, FS, and BROs (excludes C&S) for scenarios 1-3. Scenarios 4-6 are differentiated only after 2027, thus results detailed immediately below for scenarios 1-3 are identical for scenarios 4-6 respectively. Table 4-2 also includes the 2023 Study scenario that was used by the CPUC to inform previous goals as a comparison.

[66] California Public Utilities Commission website, *2025 Potential and Goals Study*, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/energy-efficiency-potential-and-goals-studies/2025-potential-and-goals-study.

Table 4-2. 2026 TSB and Net First-Year Incremental Savings by Scenario

Savings Metric	Program Type	2023 Goals Scenario	1: Reference	2: High TRC	3: Aggressive FS
Total System Benefit (TSB) ($ Millions)	FS	$36	$183	$159	$195
	BROs	$158	$71	$71	$71
	EE Equipment	$396	$585	$559	$585
	Total	**$590**	**$839**	**$789**	**$851**
Electric Energy (GWh/Year)	**FS***	-24	-140	-105	-148
	BROs	556	386	386	386
	EE Equipment	158	203	178	203
	Total	**690**	**449**	**459**	**441**
Converted Electric Energy (GWh/Year)**	FS	102	275	238	293
	BROs	556	386	386	386
	EE Equipment	158	203	178	203
	Total	**816**	**864**	**802**	**883**
Electric Demand (MW)	FS*	0	0	0	0
	BROs	101	74	74	74
	EE Equipment	47	49	45	49
	Total	**148**	**123**	**119**	**123**
Gas Energy (MMtherms/ Year)	FS	4	14	12	15
	BROs	22	12	12	12
	EE Equipment	20	27	27	27
	Total	**47**	**54**	**50**	**54**

* FS impacts reflect additional electric energy consumption, resulting in negative savings and peak demand impacts

**Converted Electric Energy represents the net reduction in energy consumption resulting from FS, calculated by converting gas energy units to equivalent electric energy units

*** In accordance with CPUC guidance, fuel substitution does not count for or against peak demand savings goals and are therefore presented as zero in this study. Source: California Public Utilities Commission (CPUC), Energy Division. 2019. Fuel Substitution Technical Guidance, Version 1.1. October 31. 2019.

Source: Guidehouse

The following are notable takeaways from the TSB results:

- **Overall achievable TSB increases relative to the 2023 Study ranging from 34% in Scenario 2 to 44% in Scenario 3.** Primary drivers of this include a significant increase in achievable potential associated with FS technologies (339%-437% higher), and well as growth in achievable EE potential within the Industrial Sector (63% higher).
- **The increase in FS TSB is driven by the Water Heating end use, notably in the Commercial Sector.** Overall growth is present in each of three scenarios, where FS represents between 20% and 23% of overall statewide achievable TSB. The 2023 Goal Setting Scenario presented a much lower achievable FS potential versus the current Study, which is primarily the result of much higher program activity within in the 2025 Study's calibration period (program years 2022-2023). Additionally, the large increase in Reference Scenario FS potential limited the incremental impact of applying Aggressive FS assumptions to Scenario 3.

- **Achievable TSB resulting from EE has increased between 14% and 18% versus the prior study.** This is driven primarily by growth in Industrial Sector potential, notably Custom and SEM measures, and is coincident with a greater portion of the TSB being generated by measures within this sector that have longer effective useful lives (EUL). Residential and Commercial sector EE potential increased by 14% and 15%, respectively.

- **Achievable TSB categorized as EE Equipment has increased as a proportion of overall EE benefits.** As detailed in Section 2.1.4, the 2025 PG Study employed a restructured characterization of the Industrial and Agricultural Sectors. As part of this update, Industrial SEM measures are recategorized from BROs to the Whole Building end use category which in this study falls within the EE Equipment program type. Accordingly, a portion of the relative increase in the current study's achievable TSB associated with EE Equipment is the result of this reclassification. SEM measures account for 14% of achievable Industrial Sector TSB across each scenario. Total Achievable TSB for EE Equipment end uses outside of BROs and Whole Building are nominally (1%-2%) lower in 2026 versus the prior study. They grow in each year subsequent to 2026 for all Scenarios, with increases of 2% - 21% versus the 2023 Goal Setting Scenario.

- **BROs program activity results in the majority of Residential sector TSB returns in all scenarios but provide only a small portion of the total state-wide benefits of the overall EE and FS program portfolio** benefits in all scenarios. In contrast, over 50% of TSB in the commercial and industrial sector come from lighting and whole building measures.

- **The application of a higher cost effectiveness threshold in Scenario 2 results in a moderate decrease in achievable TSB of 6% versus the Reference Scenario.** FS potential in the High TRC Scenario decreases 13% versus the Reference Scenario. EE Equipment TSB decreases by 12% while BROs are unaffected. The overall difference between Scenarios 1 and 2 can be interpreted as the proportion of Reference case achievable potential resulting from measures with TRC benefit-cost ratios close to unity (>0.85) but still not cost effective by a stricter definition.

The following are notable takeaways from the energy savings results:

- **Overall achievable GWh electric savings for all program types shows a decrease of 34% - 36% versus the 2023 Study.** FS impacts on electricity consumption, shown as equivalent to negative EE savings, have increased notably which impacts the statewide electric energy potential. Total first year GWh savings from EE decreased 17%-21% overall. When FS savings are converted to GWh equivalent, total impacts are within 8% of the 2023 Study.

- **Total first year achievable GWh savings are dominated by BROs.** BROs produce approximately 180% more energy savings than all non-BRO program activities combined. BRO energy savings are dominated by HERS programs in the residential sector.

- **Overall achievable gas savings for all program types relative to the 2023 Study are 7%-16% higher.** For reasons consistent to those noted above, higher achievable FS in the 2025 Study relative to the 2023 Study reflect large increases in the proportion of overall gas savings resulting from fuel switching measures.

- **Achievable Electric Demand (MW) impacts resulting from EE are 17% - 19% lower versus the prior PG Study**, in alignment with the similar reduction in overall EE electric energy impacts noted above. As expected, based on BROs contribution to achievable EE GWh potential, these measures also drive overall demand impacts.
  - The majority of all savings across each major customer sector (Residential, Commercial, Industrial, and Agriculture) are driven by a dominant grouping of measures or program delivery mechanism. Industrial electrical energy savings are entirely Whole Building measure types with the majority savings incurred by SEM and Custom program activities. Commercial sector GWh savings is overwhelmingly produced by whole building measures which generate 75% - 85% of their total achievable impact. Residential energy savings are dominated by BROs program activities, with the overwhelming majority of these savings provided by Home Energy Reports (HERS).

4.2 Incentive and BROs Program Savings

This section summarizes statewide achievable potential results for each scenario for all IOUs combined inclusive of EE, FS, and BROs program types. The IOU breakdown for these savings can be found in the Results Viewer that accompanies this report (see Section 4.5 for details). All results are presented as net savings. All results are inclusive of interactive effects[67] and include FS in the form of positive gas savings and negative electric savings. The purpose of this report is to present the findings of the Guidehouse team's 2025 Study and not to establish goals—goal setting is under the purview of the CPUC. As such, the scenario comparisons presented in the following subsections are meant to illustrate a range of potential that can be achieved based on the team's study.

Figures in this section focus on TSB, electric savings, peak demand impact, and gas savings. Full results for all scenarios and all utilities are available in the Results Viewer (discussed further in Section 4.5).

This section describes primarily the high-level scenario results "top line" (the sum of EE equipment, BROs, and FS for all sectors and IOUs). The findings primarily show the impact of differences across levers for the six scenarios:

- Scenarios 1 and 4 serve as the reference or "business as usual" case, and most directly compares to the 2023 Scenario used to set the EE goals.
- Scenarios 2 and 5 represent a conservative program administration criterion whereby all eligible measures must meet a TRC value of 1.0 or greater. This specific lever used to define these scenarios are not applicable to BROs measures and thus yield the same results as the baseline scenario for this category. Overall achievable potential is reduced slightly as the higher screening criteria eliminates measures defined in the Reference Scenarios as marginally cost effective.
- Scenarios 3 and 6 represent the aggressive Fuel Substitution scenarios. These variations only impact FS potential. They are intended to model a potential future outcome where the CA market is both more aware of these technologies incrementally more willing to replace gas measures with electrified alternatives.

[67] Interactive effects are the unintended consequence of increasing a fuel's consumption due to a reduction in energy use. For example, efficient lighting results in reduced internal heat gain, resulting in a higher need for space heating.

Overall, these Aggressive Scenarios produce a moderate increase in potential versus the baseline case, within which FS potential is already much higher than the 2023 Study forecasted.

- Scenarios 1-3 and 4-6 as sets represent two potential future outcomes for the implementation timing of ZEAS, which at the time of this Study has not been determined conclusively. Both Phased and 2030 assumption sets work to decrease program gas impact-attributed benefits due to the shifting baseline that new appliance standards incur, however electric impact benefits are present representing a change in baseline fuel type.

The remainder of this section describes the total incremental achievable potential from all savings sources by scenario. A few important notes about these results:

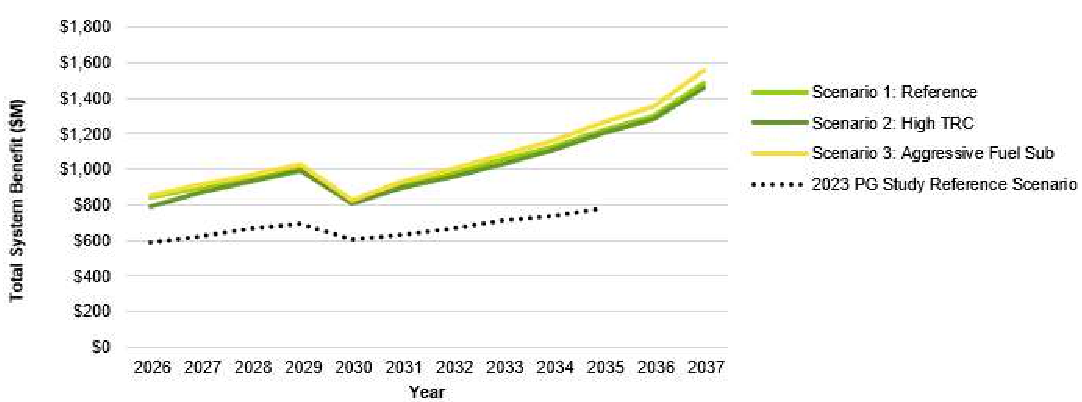
- Equipment rebate potential, which include impacts from discrete equipment including FS, Whole Building, and Envelope measures, are different for each scenario based on parameters discussed in Section 2.3.
- BROs savings do not vary by scenario. Section 4.2.4 provides additional detail regarding BROs savings by year. BROs residential savings includes income qualified and non-income qualified customers since these programs are applicable to all customers independent of income. Furthermore, there are no income qualified specific BROs programs.
- C&S savings do not vary by scenario and are not presented in these three figures. C&S potential analysis results are detailed in Section 4.4.

Appendix I contains versions of the results in tabular format for each IOU.

4.2.1 TSB by Scenario

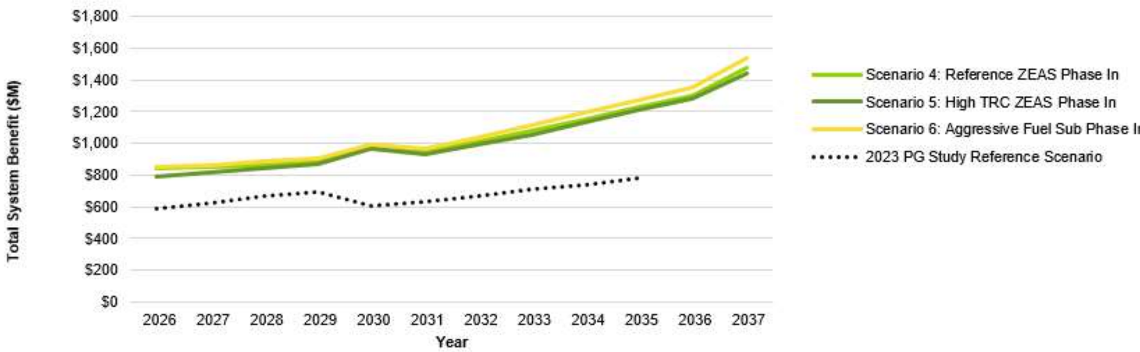
TSB generally increases over the study period, and the trends and shape do not vary significantly across each of the scenarios within the distinct ZEAS assumption sets. **Error! Reference source not found.** and Figure 4-2 show the TSB by scenario including FS and EE measures but excluding C&S. The figures detail separately the three scenarios modeled across the ZEAS 2030 and Phased ZEAS assumptions sets.

Figure 4-1. TSB ($) by Scenario (2030 ZEAS)



Source: Guidehouse

Figure 4-2. TSB ($) by Scenario (ZEAS Phased)



Source: Guidehouse

Achievable TSB in the 2025 Reference Scenario ranges from 42% to 45% higher in the initial 4 years of the study period versus the 2023 Goal Setting Scenario. This difference trends upward, increasing over the study period to as high as 55% above the prior Study. TSB growth is driven by both FS and EE technology types. Accounting for the impact of ZEAS reduces total TSB from FS activities by eliminating ability to incentivize measures that represent switch from a natural gas baseline to an electric equipment. Additionally, EE potential is reduced where applicable gas measures are removed from those eligible to receive EE program incentives as a result of ZEAS becoming effective.

The impact of 2030 ZEAS assumptions in this study is consistent with 2023 Goal Setting Scenario in the shape of the year-over-year trend. Proportional impact is reduced however because of the much higher levels of commercial sector FS potential, which models measures that are not impacted by these standards. The implementation of a Phased ZEAS adoption works to slightly reduce the overall impacts on TSB performance in our model and yields a slightly greater return on FS activities post ZEAS adoption compared to the 2030 adoption scenarios. This reflects the well-documented fact that sudden changes in delivered environments can negatively impact program potential, whereas a more nuanced policy can work to not only allow more effective program operations but provide a lower bound of uncertainty for forecasted portfolio achievements.

The following are notable takeaways from the TSB results:

- TSB for Commercial water heat FS measures increased substantially compared to the prior Study, with achievable potential growth ranging between 3x and 20x versus the 2023 Goal Setting scenario. The technical feasibility of heat pump water heat for low-temperature processes increased during this period and the resulting adoption rates, coupled with a 10%-15% increase in avoided gas prices produced a sizeable increase in benefits when compared to the 2023 report. Additional details related to FS are in Section 4.3.
- BROs program activity results in the majority of Residential sector TSB returns in all scenarios but provide only a small portion of the total state-wide benefits of the overall energy efficiency and fuel substitution program portfolio benefits in all scenarios. In contrast, over 50% of TSB in the commercial and industrial sector come from lighting and whole building measures.

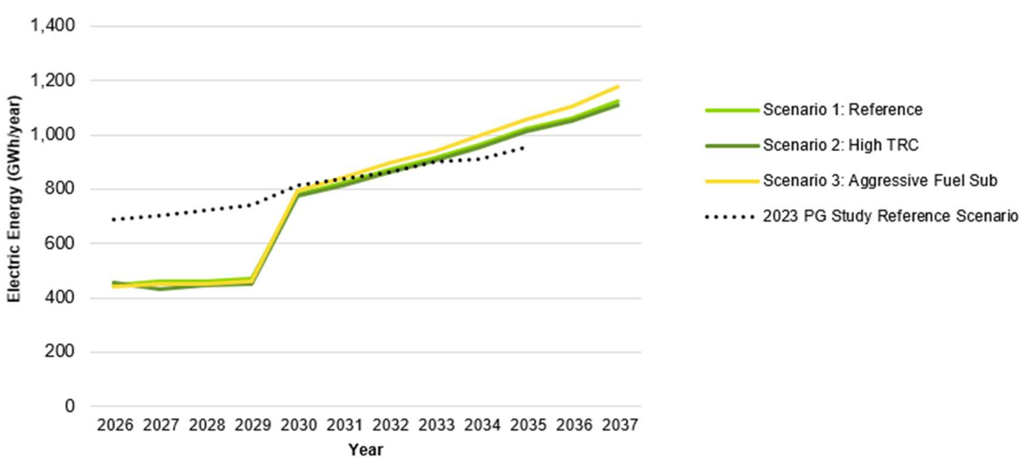
4.2.2 Total Savings by Scenario

Figure 4-3 through Figure 4-8 provide the top line savings (electric energy, peak demand, and natural gas) by scenario for the 2026-2037 forecast period. Similar to the achievable TSB forecast described in the previous section, variation between Scenarios within each of the two ZEAS frameworks is minimal, in particular in the initial years of the 2025 Study period. In all scenarios a decline in total achievable energy and demand impacts versus the prior study is observed prior to 2030. Achievable gas savings impacts are higher in particular within Scenarios 1-3. This is interpreted to be driven by the influence of FS measure potential on the aggregated statewide potential. The impact on FS potential resulting from the ZEAS standards influence these trends both year over year and against the 2023 Goal Setting Scenario.

The following are notable takeaways from the savings results:

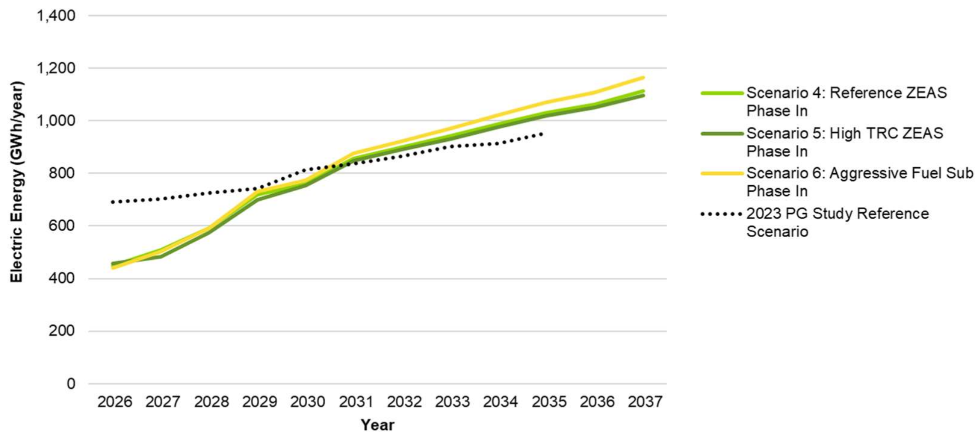
- Aggregate electric energy and demand savings potential is lower in the 2025 Study's initial four years versus the 2023 Study. Total impacts are driven in particular by the increased adoption rate of heat pump water heaters for FS and these measures associated added electric load. In all scenarios, electric energy and peak demand impacts from EE equipment increase relative to the previous goals.
- Growth in energy savings potential after 2030 is driven by a continued increase in achievable potential for Commercial HPWH measures, primarily those characterized as FS technologies. These generate achievable electric energy savings following the transition to the electric baseline.
- Achievable Gas savings are higher than those forecasted in the prior study for all Scenarios prior to the assumed ZEAS effective dates. This is driven by the same set of high-potential HPWH FS measures that generate the majority of TSB for this end use. Achievable potential subsequent to the gas appliance standards' effective date trends overall flat and is associated with Residential BROs and Industrial Whole Building measure impacts.

Figure 4-3. Statewide Net First-Year Incremental Electric Savings (Scenarios 1-3)



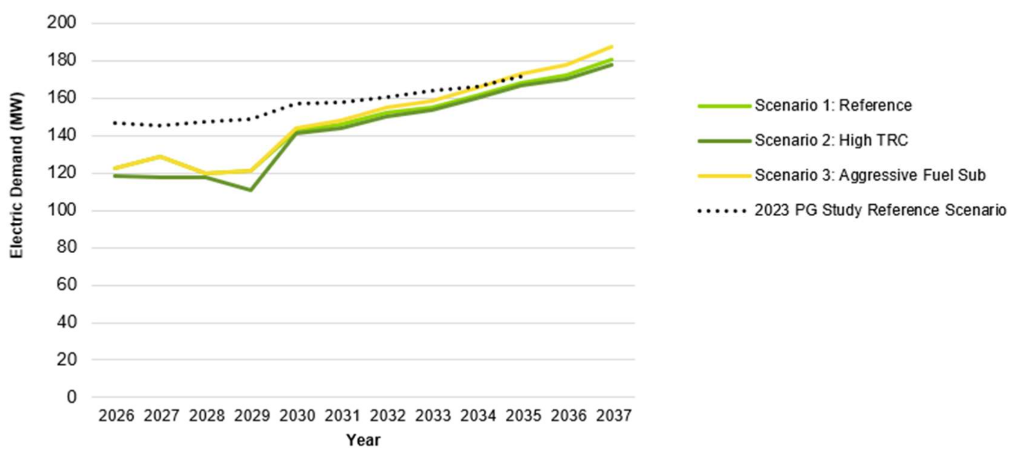
Source: Guidehouse

Figure 4-4. Statewide Net First-Year Incremental Electric Savings (Scenarios 4-6)



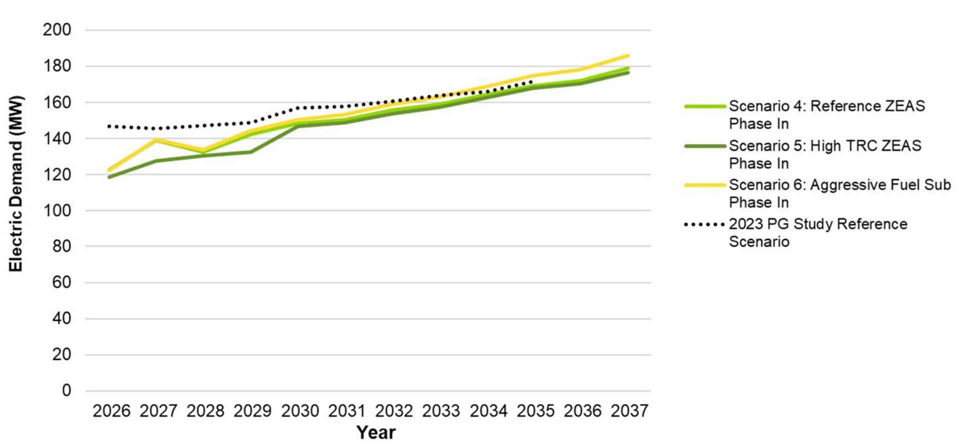
Source: Guidehouse

Figure 4-5. Statewide Net First-Year Incremental Demand Savings (Scenarios 1-3)



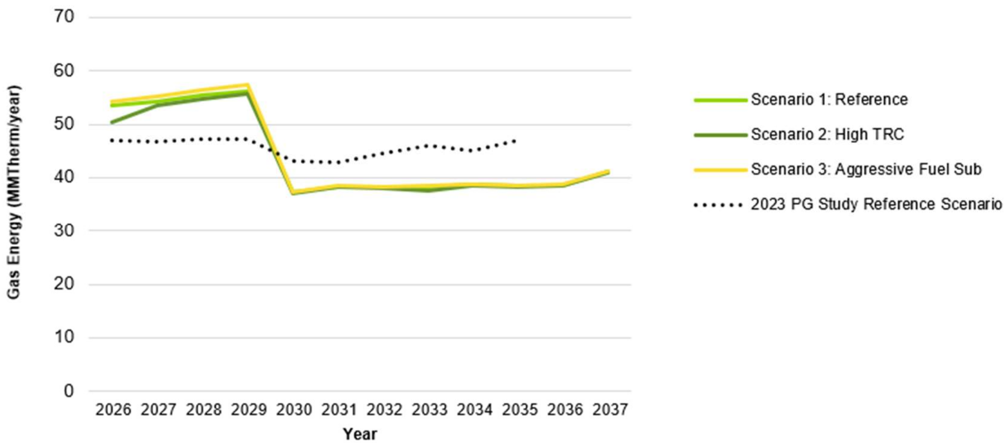
Source: Guidehouse

Figure 4-6. Statewide Net First-Year Incremental Demand Savings (Scenarios 4-6)



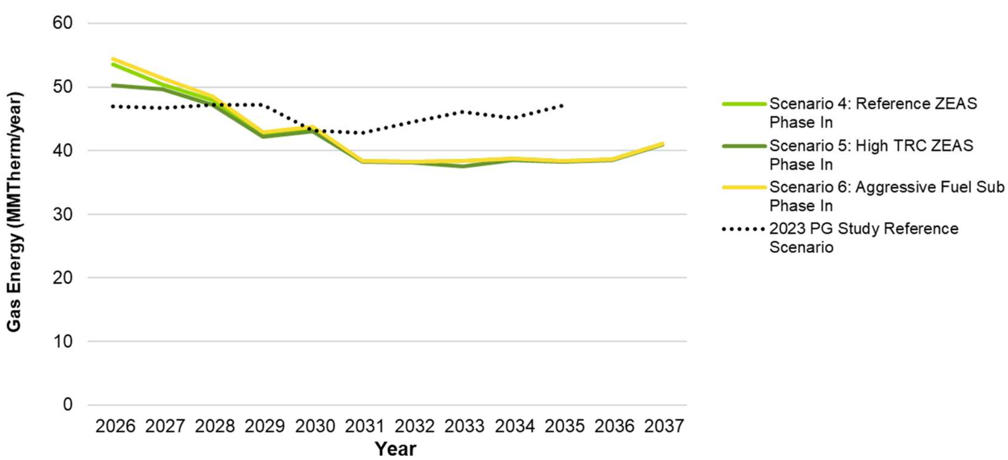
Source: Guidehouse

Figure 4-7. Statewide Net First-Year Incremental Gas Savings (Scenarios 1-3)



Source: Guidehouse

Figure 4-8. Statewide Net First-Year Incremental Gas Savings (Scenarios 4-6)

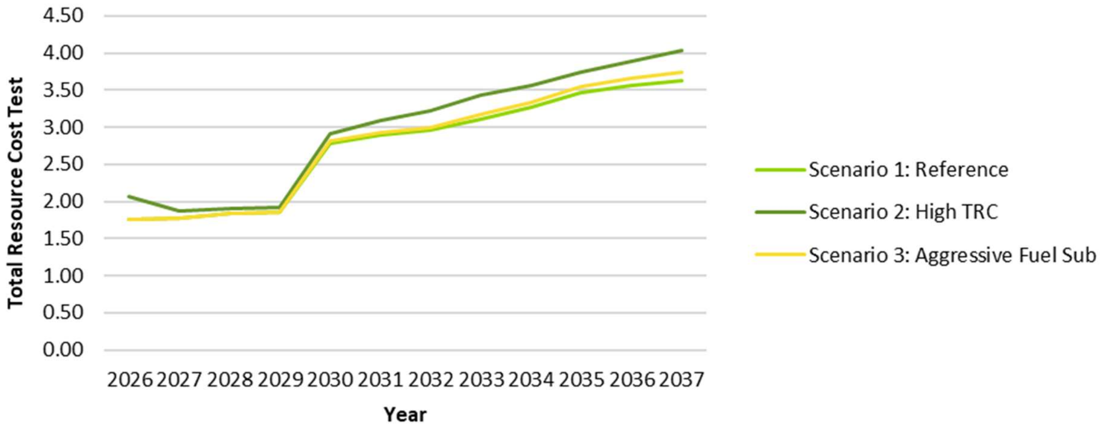


Source: Guidehouse

4.2.3 Cost-Effectiveness by Scenario

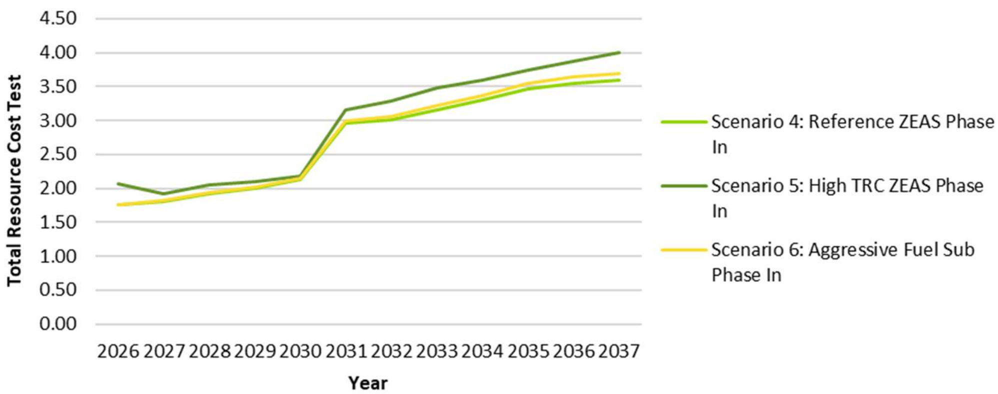
Figure 4-9 and Figure 4-10 provide the statewide TRC ratio for each scenario in each year of the study. These results account for benefits and costs from rebated measures that contribute to equipment savings but exclude low income and C&S savings. Results exclude non-resource program costs, which are typically accounted for in a portfolio-level cost-effectiveness assessment.

Figure 4-9. TRC Test Benefit to Cost Ratio (Scenarios 1-3)



Source: Guidehouse

Figure 4-10. TRC Test Benefit to Cost Ratio (Scenarios 4-6)



Source: Guidehouse

Forecasted statewide cost-effectiveness over the 2025 Study period represents a 60%-80% increase over the prior PG Study. This is driven by several key factors, notably:

- Decreases in electric avoided costs versus the 2022 ACC vintage—most significantly between 2026 and 2030, and increases in Gas avoided costs. These two concurrent influences combine to make all FS measures more cost effective. Gas EE measures were similarly impacted. With proportionally larger savings coming from FS measures relative to EE measures in the 2025 study relative to the 2023 study, we see a higher overall TRC.
- Cost effectiveness increases dramatically between 2030 and 2031 due to the high impact FS measures noted earlier transitioning from generating for positive gas savings offset by negative electric savings to only positive electric savings associated with the post-ZEAS electric baseline.
- Applied measure lifetimes for several key measures increased since the 2023 study following the most current DEER Resolution, and overall savings assumptions for measures have also been updated. Select highly cost-effective measure categories—notably SEM - have a substantial reduction in cost per unit impact thus increasing cost effectiveness.

- Achievable potential for both FS and SEM measures has grown study over study, amplifying these upward trending impacts on overall statewide TRC.

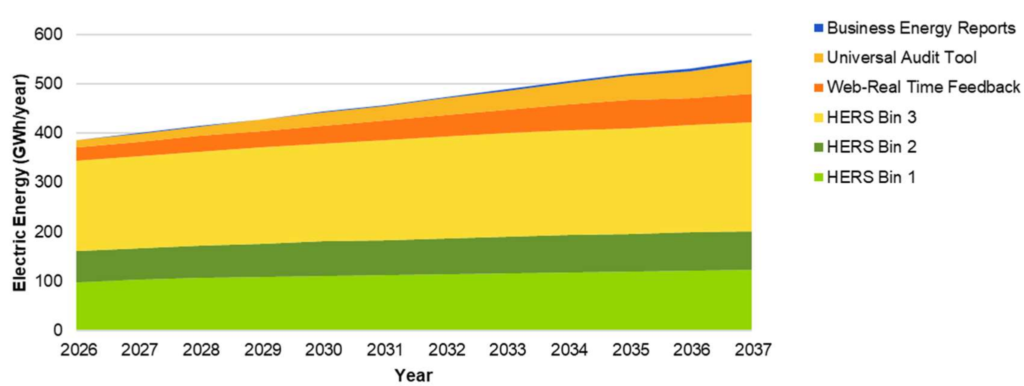
Over the 2025 Study period, year over year cost effectiveness trends upwards within all scenarios. The High TRC assumptions included in Scenarios 2 and 5 offer insight on the potential impacts from employing a more conservative program implementation approach including only measures that are strictly cost effective by a TRC equal to or greater than 1.0. This condition results in overall portfolio cost effectiveness between 3% and 18% higher versus the Reference Scenario. Scenarios 4-6 are moderately more cost effective (2%-7% higher) during the ZEAS Phase in period due to the FS measures driving overall portfolio impacts being impacted less dramatically.

4.2.4 BROs Program Results

The section below details achievable potential attributed to BROs measures. These savings are independent of the avoided costs since they are not screened by cost-effectiveness. The program adoption rates are based on the program rollout and participation assumptions outlined in Appendix D. As previously mentioned this study lumps SEM savings with EE equipment savings. Although SEM savings are not displayed below, they are included in the overall EE savings in the previous subsections.

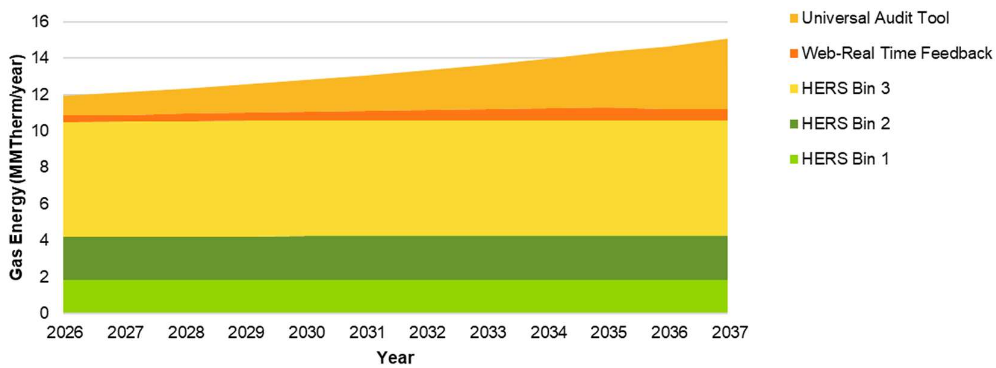
Figure 4-11 and Figure 4-12 provide BROs impacts for electric and gas fuel types across all sectors, detailed by BROs intervention. BROs savings grow over time as program participation rates increase. The residential HERs program dominates the BROs savings for electric and gas energy and peak demand savings.

Figure 4-11. BROs Program First-Year Electric Energy Savings by Program Type



Source: Guidehouse

Figure 4-12. BROs Program First-Year Gas Energy Savings by Program Type



Source: Guidehouse

4.3 FS

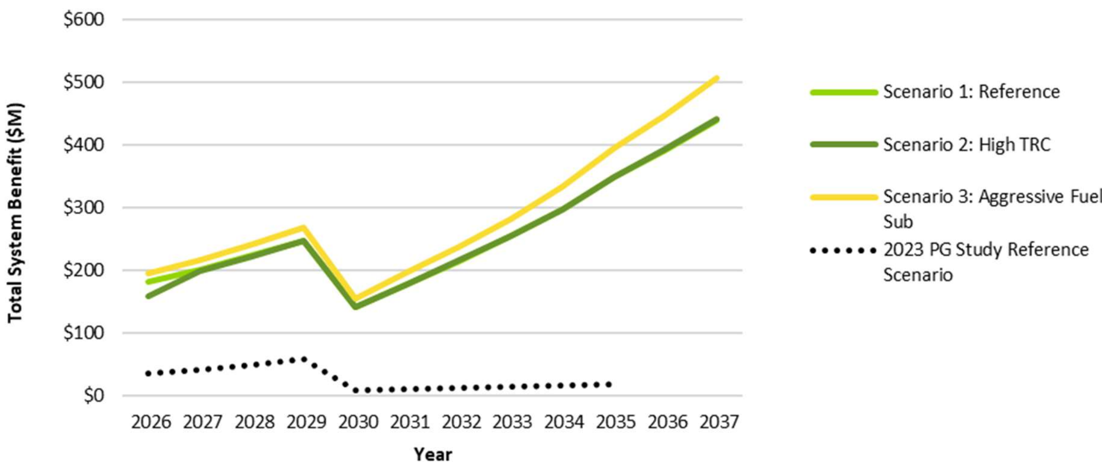
This section provides FS-specific results. Overall, the 2025 Study indicates significantly higher statewide achievable Fuel Substitution potential than was presented in the 2023 analysis. The primary driver of this is an increase in Commercial and Residential heat pump water heating (HPWH) measure TSB. The forecasted market potential is highly influenced by historic program data used during the 2022-2023 calibration period. Processing this data for the PG model revealed substantial growth in market adoption relative to the data that was available in the 2023 Study. As part of the 2025 Study results review, Guidehouse examined PY 2024 FS program claims outside of the forecast model, which were not available until immediately prior to this Report's release. Although PY 2024 was not part of our calibration data, the PY 2024 data shows a continuation of this upward trend in FS adoption across IOUs.

4.3.1 Results

For the 2030 ZEAS scenarios illustrated in Figure 4-13 and Figure 4-14, achievable FS TSB grows year over year prior to the effective date of the Standard. The implementation of a Phased ZEAS somewhat reduces this difference for between pre and post ZEAS benefit gains. The higher growth in achievable TSB prior to ZEAS implementation is due to the additional gains provided by HVAC FS measures that may be achieved prior to the shift in baseline that is incurred by ZEAS and subsequently removes any program benefits for these measures.

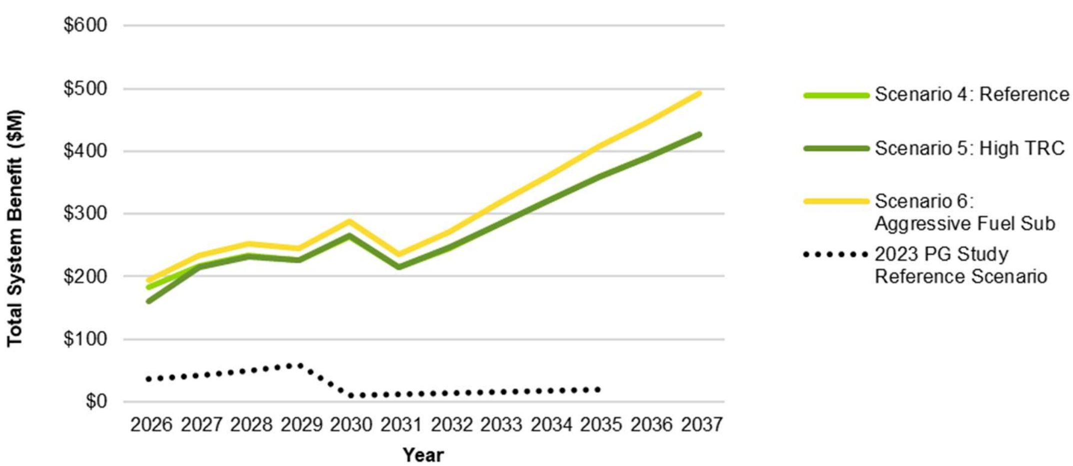
Further long-term benefits in the latter half of the study period are the result of continued potential growth in adoption of these measures. Associated TSB results from electric savings impacts measured against the minimum efficiency electric water heating measure baseline. Additional details regarding the treatment of FS measure baselines post-ZEAS is detailed in Appendix 4.5.1B.4. Implementation of ZEAS within both Phased and 2030 implementation scenarios removed the bulk of FS benefits from all HVAC end use measures.

Figure 4-13. FS TSB ($) by Scenario (Scenarios 1-3)



Source: Guidehouse

Figure 4-14. FS TSB ($) by Scenario (Scenarios 4-6)



Source: Guidehouse

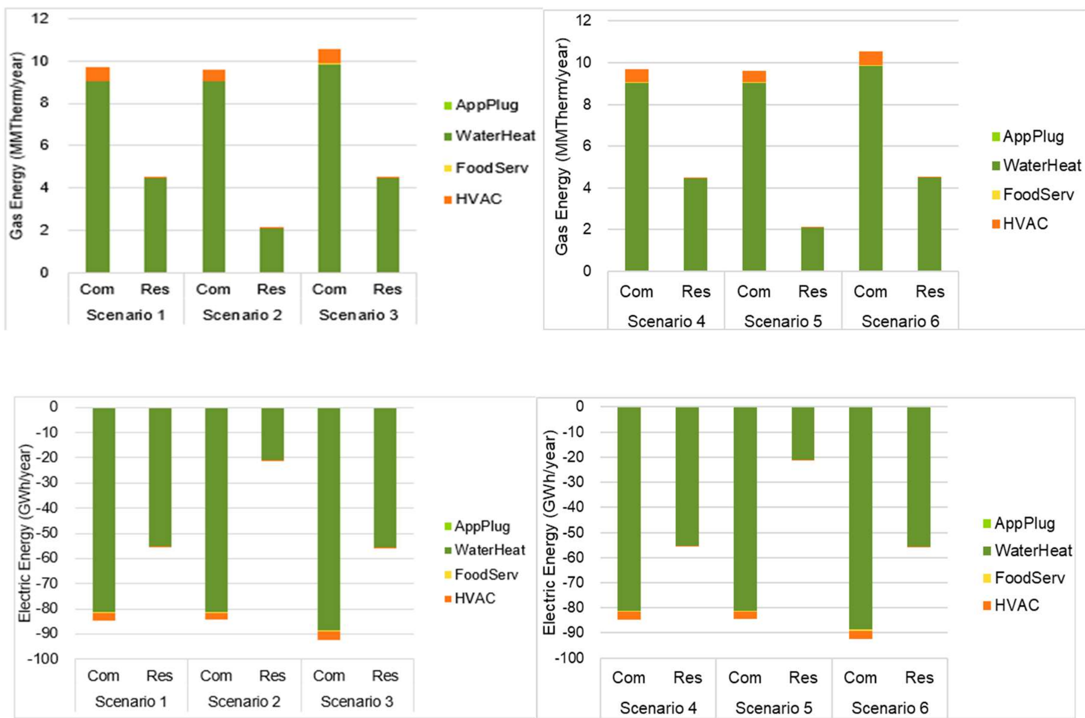
Figure 4-15 shows electric consumption increase and natural gas consumption decrease (savings) resulting from achievable FS impacts in 2026 for the six scenarios. All FS measures in the analysis pass the FST[68] independent of cost-effectiveness or customer adoption metrics.

In all scenarios, Water Heating measures are the primary driver of overall FS potential energy impacts. Commercial HPWH are by a substantial margin the largest individual contributor to achievable potential, representing greater than 60% of achievable FS gas

[68] California Public Utilities Commission, *Decision Modifying The Energy Efficiency Three-Prong Test Related to Fuel Substitution*, 2019. CPUC Decision 19-08-009 specifies that to be included in an EE portfolio, a measure must not increase source energy, and it must not harm the environment (where environmental harm is measured by net CO_2 emissions).

savings across all scenarios. Residential HPWH prior to 2030 also present a moderate contribution to overall achievable impacts. The aggressive FS Scenario parameters in Scenarios 3 and 6 drive Water Heating and Commercial HVAC measures to a significantly larger degree in both Residential and Commercial sectors.

Figure 4-15. FS Electric and Gas Energy Impacts in 2026



Note: Negative electric savings indicated an increase in electricity use due to FS.

Source: Guidehouse

4.4 C&S Savings

Incremental annual savings from C&S are illustrated in Figure 4-16 and Figure 4-17. Unlike results displayed earlier in this section, C&S savings do not vary by scenarios because there are no modeled policy or program design decisions under the purview of the IOUs or CPUC that influence C&S savings.

These graphs display incrementally new savings due to baseline changes from new C&S. Incremental savings decreases over time for two reasons:

- When a new C&S goes into effect it has an immediate impact of forcing old inefficient equipment that reaches the end of its useful life to be replaced which higher efficiency equipment generating incremental savings. However, after a period of time, the entire population of old inefficient equipment has been replaced and thus the code or standard no longer generates new savings. As various C&S savings reach this “end point” throughout the forecast, total savings decreases.

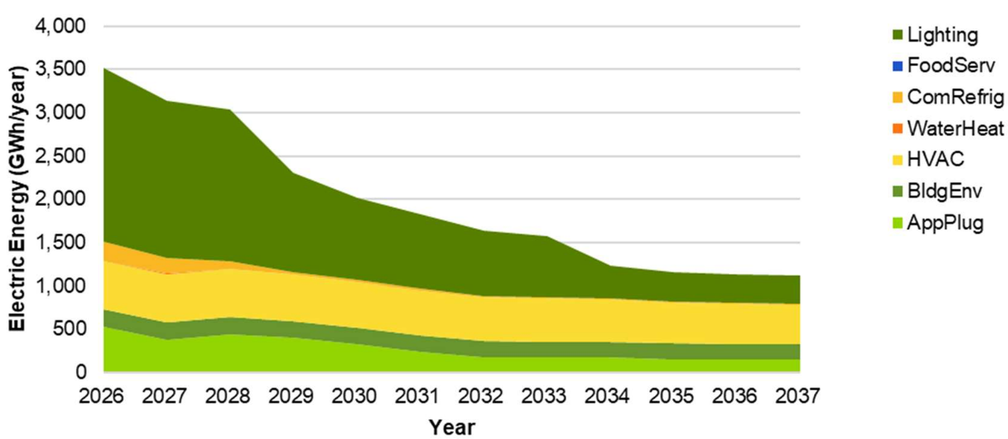
- This report provides net savings results. Net savings is the result of Gross savings minus NOMAD. NOMAD is a value that tends to grow over time (eventually plateauing). As NOMAD grows over time it decreases the remaining Net savings.

Electric savings from on-the-books C&S have decreased by 20%-40% relative to those estimated in the 2023 Study, with larger comparative declines shown in the later years of the 2025 Study. Gas savings are similarly reduced for the current study compared to the earlier 2023 study. Reasons for the change relative to the 2023 Study are described below.

As discussed in Section 3.6, C&S modeled in the 2025 Study uses data from two primary data sources. The 2023 study also used similar sources and methods to obtain data. Relative difference between the two studies are described below:

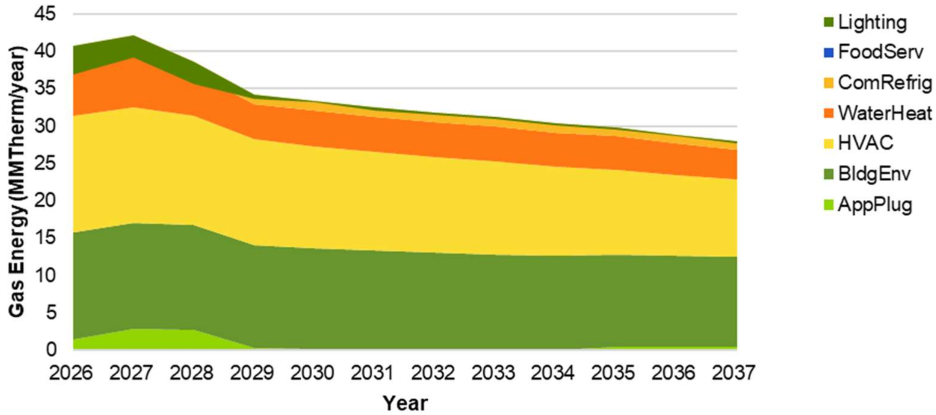
- At the time of publication in 2022, the 2023 Study was using available draft impact evaluation data (prior to the final being published later in April 2023). This study uses the final, CPUC approved evaluated data.
- For unevaluated C&S, IOU-provided data in December 2024 replaces that which was provided in the fall of 2022 for the 2023 Study. The unevaluated data for this study reflects IOU staff's best estimate of the future outlook for federal and state C&S accounting for their best available assumptions on the direction of the new federal administration regarding federal appliance standards. We note that much is still uncertain in this regard.

Figure 4-16. C&S Electric Savings Scenarios (Including Interactive Effects)



Source: Guidehouse

Figure 4-17. C&S Gas Savings (Including Interactive Effects)



Source: Guidehouse

Additional versions of Figure 4-16 and Figure 4-17 for each IOU and including peak demand savings can be found in the Results Viewer, under the Codes & Standards tab.

4.5 Detailed Study Results

Along with the model file and the summary results shown in the previous sections, the Guidehouse team developed an online Tableau dashboard, the 2025 PG Results Viewer and a measure-level database. The Results Viewer allows stakeholders to manipulate and visualize model outputs. A separate spreadsheet database of measure-level results for rebate (EE, FS, and BROs) programs is also made available with this release.

Users can look at energy savings, including yearly incremental and cumulative savings over time, as well as their equivalent TSB values. They can also explore the cost-effectiveness of program subcategories and the spending from the utility rebate and BROs programs. The results can be viewed by the following:

- **Savings type:** Electrical energy, peak power demand, and natural gas
- **Utility:** PG&E, SDG&E, SCE, and SCG
- **Scenario:** Multiple scenarios as discussed earlier in this report
- **Sector:** Covers residential, commercial, industrial, and agriculture
- **End Use category:** Includes appliances and plug loads, lighting, HVAC, data centers, building envelope, commercial refrigeration, process heat and refrigeration, water heating, and food service. Whole building and BROs are also identified as end use categories
- **Measure type:** EE, FS, or both

4.5.1 Results Viewer Tabs

The full Results Viewer can be found on the CPUC website. The link will be provided when the Results Viewer is published for public access. The Landing Page and Data Definitions tabs give a short overview of the project and provide key definitions used throughout the results tabs. The remaining nine tabs allow users to view and slice data in a variety of ways, from high level statewide to granular utility and end use-specific results. Results tabs include the following:

- **Potential by Type.** Detailed data on technical, economic, and cumulative achievable potential from IOU equipment rebate programs. These graphs only show IOU claimable savings from behavior and C&S advocacy programs. for the cumulative achievable potential result, because the technical and economic potential for these sources are undefined. Technical potential in this view is based on instantaneous potential, which is defined as the amount of energy savings that would be possible if the highest level of efficiency for all technically applicable opportunities to improve EE were taken. It does not account for equipment stock turnover. Economic potential is the subset of technical potential that is cost-effective under the relevant screening test in each scenario.

- **Potential by Scenario.** Detailed data on incremental and cumulative achievable potential across each of the modeled scenarios. Dimensions include end use, building type, sector, utility, and measure type. Achievable potential includes rebate programs and BROs. This tab does not include C&S savings.

- **Potential Breakdown.** Detailed data showing how different subcategories make up the total potential results. All potential types for all scenarios can be broken down to show their components by end use, sector, utility, or measure type. These results can be further filtered down to provide more specific insights.

- **Cost-Effectiveness.** The cost-effectiveness ratio compares total program benefits to total program costs for the portfolio of forecast measures under the equipment rebate and BROs programs for each scenario. Tests define costs and benefits differently, and all are defined by the California Standard Practice Manual. The four cost tests shown are the TRC, PAC, participant cost (PCT), and ratepayer impact measure (RIM) tests.

- **TSB by Scenario.** Detailed data on TSB from the equipment rebate and BROs programs under each scenario. The TSB is the present value of avoided cost less additional supply costs due to measure adoption.

- **TSB Breakdown.** Detailed data showing the subcategories of the TSB. The TSB can be broken down to show its components by end use, sector, utility, or measure type.

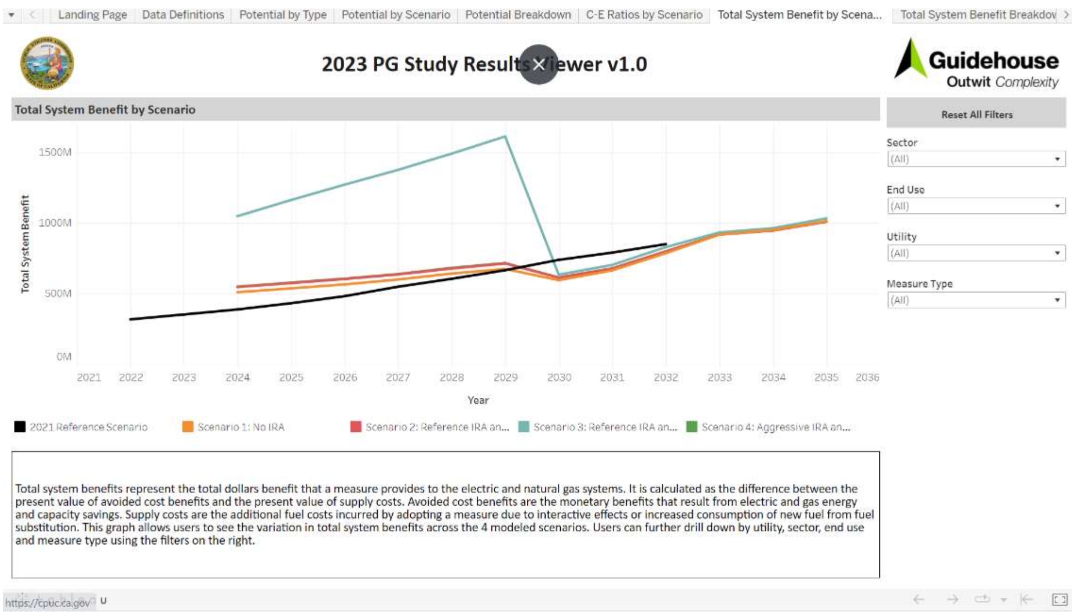
- **Program Costs by Scenario.** Detailed data on utility program costs across the scenarios. Utility program costs includes incentives and non-incentive costs paid for equipment rebate programs and BROs interventions. This data does not include costs associated with non-resource programs or C&S advocacy.

- **Program Costs Breakdown.** Detailed data showing the subcategories of program costs. Utility program costs includes incentives and non-incentive (admin) costs paid for equipment rebate programs and BROs interventions. This data does not include costs associated with non-resource programs or C&S advocacy. Program spending can be broken down to show its components by end use, sector, utility, or incentive type.

- **C&S Breakdown.** Data showing savings as a result of C&S implemented under three different policy scenarios (on-the-books, expected, and possible). These savings can be broken down by end use, sector, or utility.

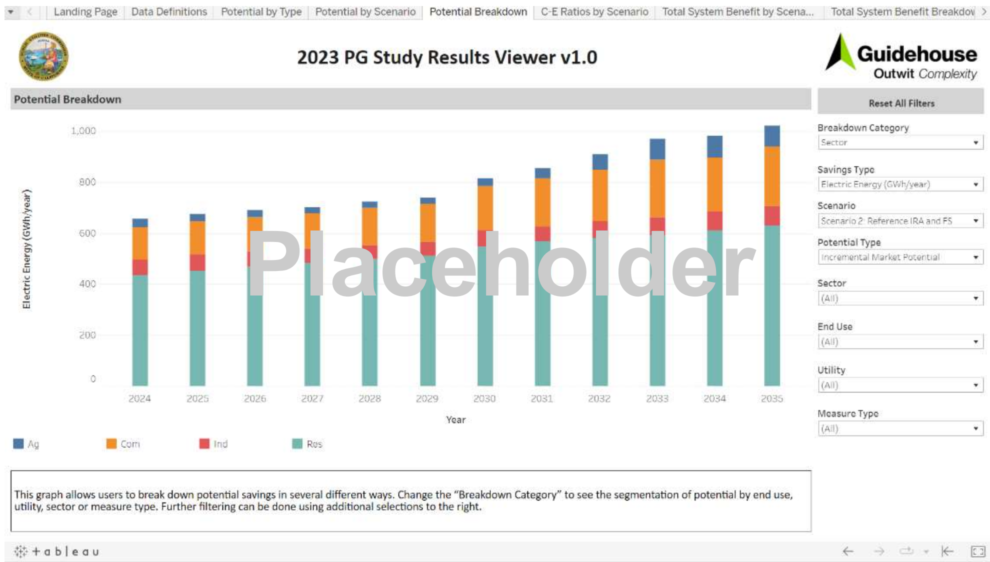
Each results tab includes a description of the viewable data, a dynamic chart, and drop-down filters for available chart configuration dimensions. Figure 4-18 and Figure 4-19 illustrate the viewer.

Figure 4-18. Results Viewer TSB by Scenario (Illustrative)



Source: Guidehouse

Figure 4-19. Results Viewer Potential Breakdown by Sector (Illustrative)



Source: Guidehouse

Appendix A. Calibration

A.1 Overview

Forecasting is the inherently uncertain process of estimating future outcomes by applying a model to historical and current observations. As with all forecasts, the Potential and Goals Model (PG Model) results cannot be empirically validated a priori because there is no future basis against which one can compare simulated versus actual results. Despite the fact that all future estimates are untestable at the time they are developed, forecasts can still warrant confidence when historical observations can be shown to reliably correspond with generally accepted theory and models.

Calibration refers to the standard process of adjusting model parameters such that model results align with observed data. Calibration provides the forecaster and stakeholders with a degree of confidence that simulated results are reasonable and reliable. Calibration is intended to achieve three main purposes:

- Anchor the model in actual market conditions and ensure the bottom-up approach to calculating potential can replicate previous market conditions.
- Establish a realistic starting point from which future projections are made.
- Account for varying levels of market barriers and influences across different types of technologies.

The PG Model applies general market and consumer parameters to forecast technology adoption. There are often reasons why markets for certain end uses or technologies behave differently than the norm—both higher and lower. Calibration offers a mechanism for using historical observations to account for these differences.

The calibration process is not a regression of savings or spending (not drawing a future trend line of savings based on past program accomplishments). Rather, calibration develops parameters that describe the customer decision-making process, and the velocity of the market based on recent history. Once these parameters are set, the model uses them as a starting point for the forecast period.

The Guidehouse team calibrated the PG Model based on historical program and market data from 2020 through 2023 for EE measures, and 2022-2023 data for fuel substitution (FS) measures. Due to the recency of rebated FS parameters, no reliable data on FS adoption prior to 2022 was available. For the calibration, any new measures or programmatic aspects not applicable in the historical years were removed from the analysis to optimize the PG Model compatibility to the historical period.

A.2 Necessity of Calibration

SB 350 directs the following: “In assessing the feasibility and cost-effectiveness of EE savings … the Public Utilities Commission shall consider the results of EE potential studies that are not restricted by previous levels of utility EE savings.” This does not imply that a potential study should not be calibrated.

In evaluative statistical models, calibration is called regression, and goodness of fit is typically the main focus because the models are usually simple. In situations of complex dynamics and non-linearity (as in this study), model sophistication and adequacy can become the main focus. However, grounding the model in observation remains equally necessary. The ability of a forecast to reasonably simulate observed data affords credibility and confidence to forecast estimates.

Although data supports all underlying parameters in the PG Model, much of the data is at an aggregate level that can be inadequate to forecast differences across the various classes of technologies and end uses. The incentive costs are a good example of this effect. The model uses incentives to forecast customer purchase tendencies (thus their adoption of technologies) based on the upfront and lifetime cost factors for which customers have self-reported their importance. The incentive inputs read into the model are provided at the sector and end use level, yet calibration allows the Guidehouse team to scale up and down these inputs by utility to better match historical market activity.

Calibration is not an optional exercise in modeling. One might suggest that the average customer data should be sufficient to make a reliable aggregated forecast. Nevertheless, two important non-linearities compel a more granular parameterization:

- Program portfolios are not evenly composed across end uses. Straight averaging of customer willingness and awareness may not lead to the correct total savings and costs calculations due to unevenness of adoption of technologies.
- The dynamics in the model regarding the timing of adoption can become incompatible with the remaining potential indicated by program achievements. For example, if the forecast results were not calibrated for LED lighting in the residential sector, the saturation may remain inaccurately low in early years and indicate a larger remaining potential in future years. Calibrating upward may increase potential in the early years but decrease potential in later years. Without the calibration, the model adoption would imply that in the absence of IOU program intervention, residential LED lighting would have historically had much lower adoption. Calibration allows us to capture these program influences to reflect more accurately remaining potential.

The team treats the calibrated results as the most basic set of interpretable results from which to develop alternate scenarios.

A.3 Interpreting Calibration

Calibration can constrain achievable potential for certain end uses when aligning model results with past IOU EE portfolio accomplishments. Although calibration provides a reasonable historical basis for estimating future achievable potential, past program achievements may not capture the potential because of structural changes in future programs or changes in consumer values. Calibration can be viewed as holding constant certain factors that might otherwise change future program potential, such as:

- Consumer values and attitudes toward energy efficient measures (the Market Adoption Study created the value factors to address this item in the forecast)
- Market barriers associated with different end uses (the Market Adoption Study created the value factors to address this item in the forecast)
- Program efficacy in delivering measures
- Program spending constraints and priorities

Changing values and shifting program characteristics would likely cause deviations from achievable potential estimates calibrated to past program achievements.

Does calibrating to historical data constrain the future forecast? In a strictly numeric sense, yes. If a certain end use is calibrated downward or upward, then future adoption and its timing are affected. Nevertheless, this should not be interpreted as “calibration constrains the level of adoption thought possible.” Rather, calibration provides a more accurate estimate of the rate of technology turnover in the market, current state of customer willingness, market barriers, program characteristics, and remaining adoption potential.

One interpretation is that the calibration process creates a floor for the remaining potential. Market barriers, customer attitudes, and program efficacy generally move in the direction of improvement.

A.4 Implementing Calibration

The potential and goals study calibration process primarily seeks to develop a set of consumer decision and market parameters that represent recent history. Once developed, these parameters are used as the starting point for the PG Model’s stock turnover algorithms and consumer decision algorithms.

Developing these parameters requires historical market data. The PG Model uses 2020--2023 program data (gross savings, program spending data) and performs a backcast to fit model parameters such that historical achievements are generally matched. 2022-2023 program data was used to calibrate FS measures, as it was only these years for which historical achievement data was available. The Guidehouse team found that some of the program data was mislabeled as EE when it was FS. The mislabeled FS data was identified by the measure type, as well as positive therm savings and negative electric savings. Where this was applicable for data in 2022-2023, an adjustment was made to the historical data prior to calibration.

The Guidehouse team calibrated by reviewing the EE portfolio data from 2020 through 2023 to assess how the market has reacted to program offerings in the past. This method calibrated gross program savings in the PG Model to gross program savings in the 2020--2023 period. After reviewing the gross savings calibration, the Guidehouse team additionally calibrated the resulting program cost to further tune the incentive levels offered to each end use. In some cases, the first calibration step of gross savings matched the historical gross savings, but the resulting program costs may have been significantly different. This result implies the model overpredicts or underpredicts the sensitivity of customers to rebates. The Guidehouse team further tuned the incentive levels, within their specified scenario caps. Changing incentives would result in a change in gross savings, so an iterative process of adjusting factors to calibrate gross savings and program budget was needed in some cases.

To execute calibration, the Guidehouse team adjusted model parameters and compared the backcast of the model against historical program data for 2020-2023. Guidehouse made individual adjustments to four key levers (listed in Table A-1) primarily at the IOU, sector, and end use levels until achieving a reasonable match with historical data. In some cases where a specific technology witnessed adoption at unexpectedly high or low levels, the team adjusted these levers at the technology level; adjusting at the end use level in these cases would cause the entire end use to undershoot or overshoot the historical program targets.

Table A-1. Calibration Levers

Lever	Drivers and Impact on Model Results
Awareness	• Increasing initial awareness shortens the time required for a measure to reach 100% consumer awareness and accelerates adoption. • Increasing marketing strength increases the adoption rate of technologies in the nascent stage (i.e., having low initial consumer awareness). • Increasing word of mouth strength increases the adoption rate of technologies in the mid to later stages of adoption (i.e., having medium to high consumer awareness).
Willingness	• Increasing incentive levels increases adoption, budget, and savings. • Overriding a technology's cost-effectiveness allows it to be considered for adoption (otherwise, non-cost-effective measures are not considered in achievable potential). • Adjusting the weighted utility adjusts the attractiveness of a technology relative to the others in its CG.
Stock Turnover	• Adjusting turnover rates allows the model to better reflect real-world market dynamics. The model assumes technologies turn over based on effective useful life (EUL). However, the real velocity of the market and turnover dynamics are not this perfect or exact.
Adoption	• Adjusting adoption of FS measures enables better alignment of the model's backcast with limited historic program data.

Source: Guidehouse

The 2025 PG Model is informed by the 2021 Market Adoption Study, which provided data to better model the dynamics of customer willingness. Use of the Market Adoption Study data alone does not itself address calibration. The Market Adoption Study data provided a more accurate starting point for the 2025 PG Model calibration. However, the true value of the Market Adoption Study is in governing the dynamics of customer choice that influence which measures they prefer when presented with multiple competing measures, each with different characteristics. Calibration happens at the IOU, sector, and end use levels, whereas the Market Adoption Study data influences adoption at a much more granular (measure) level.

Appendix B. FS Methodology Details

The PG Study characterizes FS measures—that is, replacing equipment utilizing one regulated fuel with equipment utilizing another regulated fuel, for example, substituting gas equipment for electric equipment. The characterization process involved the following steps:

1. Select FS technologies and formulate technology groups.

- The Guidehouse team considered FS measures in the residential and commercial space heating, water heating, appliance, and cooking/food service end uses.
- The team excluded technologies that did not pass the CPUC fuel substitution test (FST)[69] or that did not have a technically suitable, commercially available electric equivalent to the gas technology being replaced.
- The team analyzed FS technologies in the same technology group as the gas technology being replaced. In other words, a FS measure replacing a baseline gas technology would compete with the efficient gas technology(ies) that would be a candidate to replace the baseline gas technology.

2. Characterize FS technologies.

- In most cases, the Guidehouse team characterized the electric technology that would directly replace the gas technology in a one-for-one replacement. Inputs for each technology included energy use, costs, market information, and other relevant fields. The primary source for characterizing FS technologies, like EE technologies, was California eTRM measure packages.
- For FS measures competing with gas measures in Southern California Edison (SCE)/Southern California Gas (SCG) territory, the team characterized the entire technology group in SCG territory and then assigned gas savings from the fuel sub-measure to SCE.
- For residential HVAC situations where the FS measure (a heat pump) would replace both a gas appliance (furnace) and an electric appliance (air conditioner, or AC), the team conducted a literature review to estimate what proportion of households would likely replace both appliances with the FS measure and adjusted the technology group density accordingly.

3. Account for Proposed Zero Emission Appliance Standards

- In September 2022, CARB published a SIP memo to propose a “zero-emission standard for space and water heaters,” which would phase-out the sale of natural gas-burning HVAC and water heating appliances.70 This original SIP proposed an effective date of 2030 for all ZEAS measures. In May 2024, CARB shared an updated draft regulatory proposal (referred to as Refined Concept B) with compliance

[69] As implemented by CPUC Decision 19-08-009, the FST specifies that to be included in an EE portfolio, a measure must not increase source energy, and it must not harm the environment (where environmental harm is measured by net CO_2 emissions). California Public Utilities Commission, Fuel Substitution in Energy Efficiency, https://www.cpuc.ca.gov/about-cpuc/divisions/energy-division/building-decarbonization/fuel-substitution-in-energy-efficiency.

[70] California Air Resources Board, 2022 State Strategy for the State Implementation Plan, https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy.

dates that vary by equipment type between 2027 and 2033 based on varying levels of technological feasibility.[71]

- The Guidehouse team anticipates that ZEAS will effectively eliminate natural gas savings from FS measures, because customers would not be able to install a new gas appliance in a new building or as a replacement for an existing gas appliance at the end of its life. The Guidehouse team accounted for ZEAS by removing the natural gas baseline and any competing natural gas efficiency levels from FS technology groups from the effective data onwards. Once ZEAS takes effect, the "baseline" for that technology group is a low-efficiency electric appliance. This is a similar effect as other measures when a code or standard takes effect and removes non-code-compliant baseline products from the market.
- For the 2025 Study, Guidehouse calculated potential results for each of the three primary scenarios detailed in Section 2.3.2 subject to two ZEAS frameworks: ZEAS 2030 and ZEAS Phased (which includes a special three-year phase-in over 2027-2029 for small gas water heaters). Thus, the 2025 Study produces results for six distinct sets of assumptions—three scenarios using the ZEAS 2030 framework plus three scenarios using the ZEAS Phased framework.

4. Calculate infrastructure costs.

- Substituting gas technologies for electric technologies can increase electric load for a building or house. This can sometimes require upgrades to the infrastructure within the building, for example, increasing the size of the electrical panel to accommodate the added load.
- The Guidehouse team utilized recommendations from the March 2024 VEA working group report to estimate the cost of a panel upgrade, as well as the likelihood that a given installation of FS technology would necessitate a panel upgrade.
- The team then incorporated these costs into the measure characterization by determining the proportion of installations of each technology that would be likely to require a panel upgrade and included the cost of the panel upgrade for that proportion of installations.
- See Section 2.1.2.2 and Appendix C for more detail on panel upgrade and infrastructure cost methodology and assumptions.

The following sections discuss the technology selection process and the technology characterization method in further detail.

B.1 Technology Selection Process

The Guidehouse team followed a similar approach to the technology selection process as the other, non-FS measures, excluding any measures that did not pass the FST. As implemented by CPUC Decision 19-08-009, the FST specifies that to be included in an EE portfolio, a measure must not increase source energy, and it must not harm the environment (where environmental harm is measured by net CO_2 emissions).[72] The team assumed that

[71] California Air Resources Board, Zero-Emission Space and Water Heater Standards Public Workshop, https://ww2.arb.ca.gov/sites/default/files/2024-05/May_2024_Workshop_Slides.pdf.

[72] California Public Utilities Commission, Fuel Substitution in Energy Efficiency, https://www.cpuc.ca.gov/about-cpuc/divisions/energy-division/building-decarbonization/fuel-substitution-in-energy-efficiency.

measures with active workpapers had already been determined by the CPUC to pass the FST.

Technology groups that did not have a technically suitable, commercially available electric equivalent that could directly replace the gas technology were excluded from consideration. An example is commercial gas boilers. Each electric option for commercial space heating that could replace an existing gas boiler has physical or operational considerations that would discourage a direct replacement:

- Commercial **electric resistance boilers** carry large electrical demands in addition to likely higher operating costs.
- **Hydronic heat pumps, including air-to-water systems and heat recovery chillers,** have supply temperature limitations (140°F-160°F max) that are lower than the design temperatures for many existing steam or hot water boiler heating systems. For FS of steam or hot water boilers would require a system redesign, which would likely be prohibitive in a normal replacement or accelerated replacement scenario.
- **Central air-to-air heat pumps, variable refrigerant flow systems, water source heat pumps, and ground source heat pumps** would also require an alternative design configuration than the hot water/chilled water distribution systems.

Table B-1. shows the list of FS technologies characterized in this study, along with the technology group to which each belongs. The technology group often includes the gas designation because the baseline technology is a gas technology. The designation distinguishes these technology groups from those where electric technologies replace baseline electric technologies.

Table B-1. FS Technologies Characterized

Sector	End Use	FS Technology	Technology Group
Residential	AppPlug	Heat Pump Clothes Dryer	Clothes Dryers (Gas)
Residential	AppPlug	Heat Pump Pool Heater	Res Pool Heaters
Residential	AppPlug	ENERGY STAR Cooking	Res Cooking Appliances
Residential	HVAC	Ductless Mini-Split Heat Pump (SEER2* 15.2)	Res Ductless HVAC System—Fuel Sub
Residential	HVAC	Ductless Mini-Split Heat Pump (SEER2 16.0)	Res Ductless HVAC System—Fuel Sub
Residential	HVAC	Ductless Mini-Split Heat Pump (SEER2 17.8)	Res Ductless HVAC System—Fuel Sub
Residential	HVAC	Ductless Mini-Split Heat Pump (SEER2 19.6)	Res Ductless HVAC System—Fuel Sub
Residential	HVAC	Packaged/Split Heat Pump (SEER2 15.2)	Res Central HVAC System—Fuel Sub
Residential	HVAC	Packaged/Split Heat Pump (SEER2 16.0)	Res Central HVAC System—Fuel Sub
Residential	HVAC	Packaged/Split Heat Pump (SEER2 16.9)	Res Central HVAC System—Fuel Sub
Residential	HVAC	Packaged/Split Heat Pump (SEER2 17.8)	Res Central HVAC System—Fuel Sub

Sector	End Use	FS Technology	Technology Group
Residential	HVAC	Packaged/Split Heat Pump (SEER2 18.7)	Res Central HVAC System—Fuel Sub
Residential	HVAC	Packaged/Split Heat Pump (SEER2 19.6)	Res Central HVAC System—Fuel Sub
Residential	HVAC	Res Furnace Heat Pump Heating Only (SEER2 15.2)	Res Central Furnace Only—Fuel Sub
Residential	HVAC	Res Furnace Heat Pump Heating Only (SEER2 16.0)	Res Central Furnace Only—Fuel Sub
Residential	HVAC	Res Furnace Heat Pump Heating Only (SEER2 16.9)	Res Central Furnace Only—Fuel Sub
Residential	HVAC	Res Furnace Heat Pump Heating Only (SEER2 17.8)	Res Central Furnace Only—Fuel Sub
Residential	HVAC	Res Furnace Heat Pump Heating Only (SEER2 18.7)	Res Central Furnace Only—Fuel Sub
Residential	HVAC	Res Furnace Heat Pump Heating Only (SEER2 19.6)	Res Central Furnace Only—Fuel Sub
Residential	WaterHeat	Res Heat Pump Water Heater (3.30 UEF - 50 Gal)	Res Gas Water Heaters
Residential	WaterHeat	Res Heat Pump Water Heater (3.50 UEF - 50 Gal)	Res Gas Water Heaters
Residential	WaterHeat	Res Heat Pump Water Heater (3.75 UEF - 50 Gal)	Res Gas Water Heaters
Residential	WaterHeat	Res Central Heat Pump Water Heater (150+ kBtuh, 3.0 COP)	Res Multifamily Central Gas Water Heaters
Commercial	FoodServ	ENERGY STAR Combination Oven	Gas Combination Ovens
Commercial	FoodServ	ENERGY STAR Convection Oven	Gas Convection Ovens
Commercial	FoodServ	ENERGY STAR Fryer	Gas Fryers
Commercial	FoodServ	ENERGY STAR Griddle	Gas Griddles
Commercial	FoodServ	ENERGY STAR Steamer	Gas Steamers
Commercial	HVAC	Small Packaged Heat Pump (SEER 15)	Com Central HVAC (Small)—Fuel Sub
Commercial	HVAC	Small Packaged Heat Pump (SEER 16)	Com Central HVAC (Small)—Fuel Sub
Commercial	HVAC	Small Packaged Heat Pump (SEER 17)	Com Central HVAC (Small)—Fuel Sub
Commercial	HVAC	Small Packaged Heat Pump (SEER 18)	Com Central HVAC (Small)—Fuel Sub
Commercial	HVAC	Large Packaged Heat Pump (IEER 14.0)	Com Central HVAC (Large) - Fuel Sub
Commercial	WaterHeat	Com Heat Pump Water Heater (3.30 UEF - 50 Gal)	Com Small Gas Water Heaters
Commercial	WaterHeat	Com Heat Pump Water Heater (3.50 UEF - 50 Gal)	Com Small Gas Water Heaters
Commercial	WaterHeat	Com Heat Pump Water Heater (3.75 UEF - 50 Gal)	Com Small Gas Water Heaters
Commercial	WaterHeat	Com Heat Pump Water Heater (100+ Gal, 200+ kBtuh—4.3 COP)	Com Large Gas Water Heaters

*SEER = seasonal energy efficiency ratio; UEF = unit energy factor
Source: Guidehouse

B.2 Technology Characterization

The Guidehouse team characterized FS technologies and competing technologies within a technology group in the same way. The team developed inputs for each technology; these inputs include energy use, costs, market information, and other relevant fields (see Table 3-10 for a full list of technology characterization inputs). As with non-FS technologies, the absolute energy use associated with the technology level is specified. Because the FS technology is specifically substituting gas use with electricity use, the energy use for the FS level is specified in kilowatt-hours (kWh), while the energy use for the baseline and competing gas efficient technology levels are specified in therms. The model calculates TSB for each technology separately and competition is based on highest TSB.

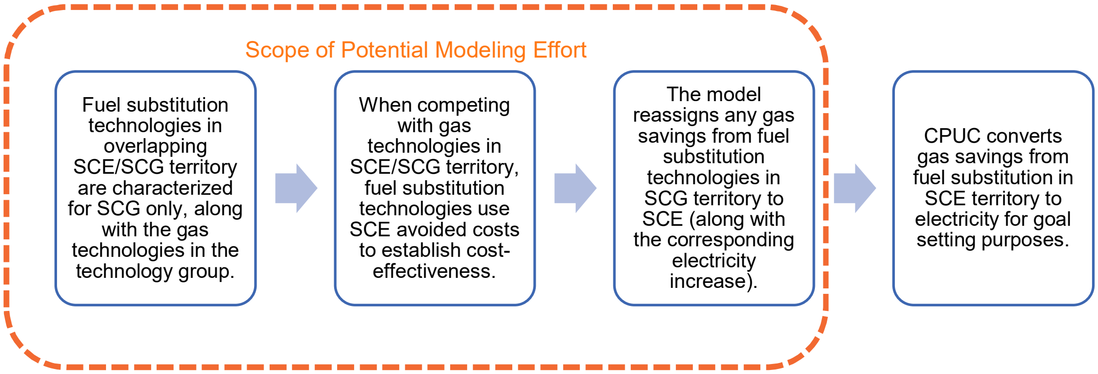
For customers whose electricity and gas are provided by different utilities (i.e., where SCG is the gas utility and SCE is the electric utility), the Guidehouse team modified the usual approach to allow the gas and electric technologies to compete in the same technology group. Under California policy, when SCE implements FS programs in areas where the gas service is provided by SCG, SCE is assigned savings by converting the gas savings to electricity savings using a predetermined conversion factor. Within the PG Study, however, the model needs to account for the competing gas efficient technology, whose gas savings would normally be assigned to SCG. The team implemented the following analysis steps to allow the electric FS measure to compete with the efficient gas measure.

- **Step 1. Characterization.** The team characterized FS technology groups as though they were in SCG territory only (not in SCE territory). This was done so the FS measures could compete with the gas measures.
- **Step 2. Cost-effectiveness analysis.** The team used SCE avoided costs for fuel sub measures competing with gas measures for the cost-effectiveness analysis.
- **Step 3. Potential modeling.** The model logic reassigns any gas savings from FS technologies from SCG to SCE with a de-rating factor to account for the proportion of SCG customers whose electricity is provided by utilities other than SCE (primarily Los Angeles Department of Water and Power, or LADWP). The energy savings potential for the study would include a certain amount of gas savings being assigned to SCE.
- **Step 4. Goal setting.** Guidehouse calculated a converted FS savings to the new fuel units.

Figure B-1. illustrates this step-by-step process for characterizing FS measures in overlapping SCE/SCG territory.[73]

[73] This study does not incorporate incentive and savings alignment to the different incentive offerings that exist. Some FS programs incur incentive layering. The assessment of allocating savings and incentives to the various FS programs is outside the scope of this study.

Figure B-1. Steps in FS Characterization in SCE/SCG Territory



Source: Guidehouse

For most FS measures, electric technologies replace gas technologies on a one-to-one basis. For example, a commercial gas fryer is replaced by an electric fryer. Two technologies need an alternative approach:

- **Residential furnace replacements.** The heat pump would also be replacing the AC.
- **Commercial water heaters.** In many cases, buildings are served by multiple water heating units. Because of differences in capacity between gas and electric water heaters, there is not necessarily a unit-for-unit replacement, so the team characterized this measure by normalizing the water heater energy to building square footage. For heat pump water heaters, the team developed cost reduction vectors for residential and commercial products because this is an emerging technology with few products currently on the market.

The following subsections detail these technology-specific modifications.

B.2.1 Residential Heat Pump Replacing Residential Furnace and AC Combination

The electric FS level for residential HVAC—a heat pump—provides heating and cooling, while the gas appliance being replaced provides heating only. For homes with a gas furnace and an electric AC, FS would involve replacing both the furnace and the AC with a heat pump that provides heating and cooling. This technology group consists of a heat pump competing with an efficient furnace and AC combination. For homes with a gas furnace only, FS would involve replacing the furnace with a heat pump that provides heating and cooling. This technology group consists of a heat pump competing with an efficient furnace only. The two technology groups are shown in Table B-2.

Table B-2. Residential Heat Pump FS Technology Groups

Technology Group	Technology Name	Base Year Efficiency Level
Res Central HVAC System—Fuel Sub	Code HVAC System Furnace (TE 80%) and AC (SEER2 14.3)	Code
	Efficient HVAC System Furnace (AFUE 95) and AC (SEER2 15.2)	Efficient EE
	Packaged/Split Heat Pump (SEER2 15.2)	Efficient FS
	Packaged/Split Heat Pump (SEER2 16.0)	Efficient FS
	Packaged/Split Heat Pump (SEER2 16.9)	Efficient FS
	Packaged/Split Heat Pump (SEER2 17.8)	Efficient FS
	Packaged/Split Heat Pump (SEER2 18.7)	Efficient FS
	Packaged/Split Heat Pump (SEER2 19.6)	Efficient FS
Res Central Furnace Only—Fuel Sub	Res Furnace FS (AFUE and HIR at Code Level)	Code
	Res Efficient Furnace FS (AFUE = 95)	Efficient EE
	Res Furnace Heat Pump Heating Only (SEER2 15.2)	Efficient FS
	Res Furnace Heat Pump Heating Only (SEER2 16.0)	Efficient FS
	Res Furnace Heat Pump Heating Only (SEER2 16.9)	Efficient FS
	Res Furnace Heat Pump Heating Only (SEER2 17.8)	Efficient FS
	Res Furnace Heat Pump Heating Only (SEER2 18.7)	Efficient FS
	Res Furnace Heat Pump Heating Only (SEER2 19.6)	Efficient FS

Source: Guidehouse

The Guidehouse team used the 2019 RASS to determine the proportion of households with both a furnace and an AC that would be eligible to replace the equipment with a heat pump. The team also assumed that not all households would be willing to replace the whole system—i.e., the gas appliance and electric appliance—at the same time. For the 2021 Study, the team researched information to estimate what proportion of households would be likely to replace the whole space conditioning system with a heat pump, which is detailed below. This same approach was used for the 2023 Study and 2025 Study.

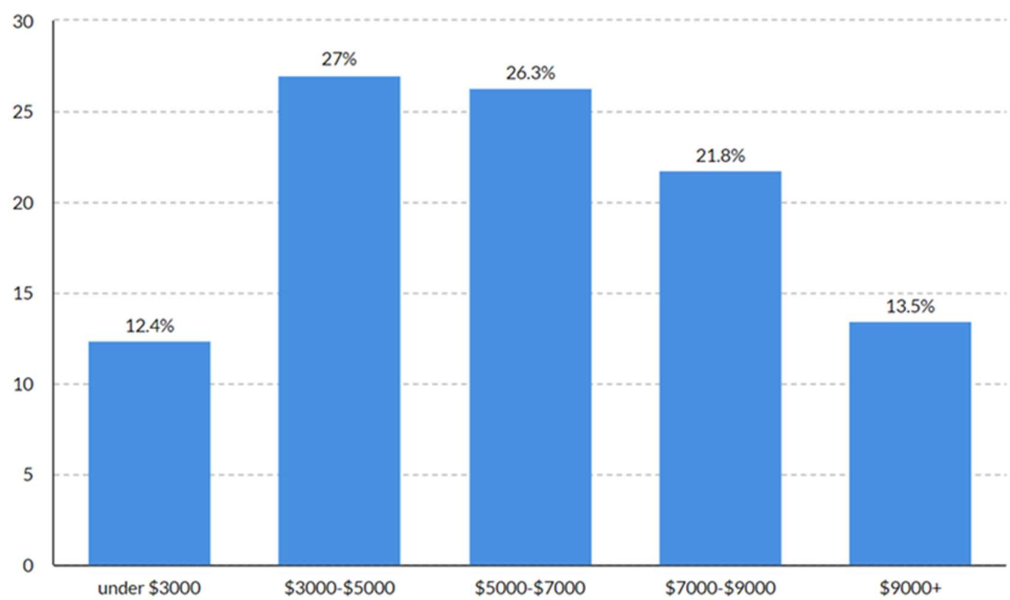
Whole system replacements are the most likely consumer choice when the furnace and AC are at or near the end of their useful life. These projects are generally initiated when either the heating or AC unit fail and it is most practical to replace a component, such as the furnace, indoor coil, and outdoor condenser. Rarely will both the heating and AC units fail at the same time; however, in climate zones where heating and AC systems are each used for long periods every year, they will often fail within a few years of one another. In those cases, a whole system replacement makes sense.

The team completed a literature review to assess what percentage of HVAC projects involve component replacements versus whole system replacements.

A 2020 survey by PickHVAC[74] surveyed the typical project cost and included a breakdown of what project types are being completed, component versus whole systems, within various project cost categories:

- Under $3,000. One component was installed or replaced.
- $3,000-$5,000. One midrange component, perhaps with a thermostat or other accessory, or two entry-level components were installed or replaced.
- $5,000-$7,000. The homeowner bought one midrange or top tier component and thermostat, two entry-level or small midrange components, or a complete system with a thermostat.
- $7,000-$9,000. One top tier component, perhaps with an accessory such as a thermostat or media filter, two midrange components, or a complete system was installed or replaced.
- $9,000+. These sales were either one large, efficient, top tier component or, in more cases, a complete midrange HVAC system.

Figure B-2. Distribution of HVAC Projects by Total Project Cost



Source: PickHVAC, 2020

Table B-3 shows two items: (1) the percentage of HVAC projects across the cost bins provided in Figure B-2; and (2) what percentage of each cost bin and the total sales are for whole systems. The estimates for whole systems replacement percentage are based on professional judgement and an estimate of whole system projects as a percentage of all sales.

[74] PickHVAC is a for-profit HVAC advisory service and is a participant in the Amazon Services LLC Associates Program, an affiliate advertising program designed to provide a means for sites to earn advertising fees by advertising and linking to amazon.com. Survey accessed in August 2020 a https://www.pickhvac.com/.

Table B-3. Whole Systems as a Percentage of All Sales

Cost Bin	% of All Sales	Whole Systems as % of Cost Bin	Whole Systems as % of All Sales
Under $3,000	12.4%	0.0%	0.0%
$3,000-$5,000	27.0%	10.0%	2.7%
$5,000-$7,000	26.3%	33.0%	8.6%
$7,000-$9,000	21.8%	66.0%	14.5%
$9,000+	13.5%	90.0%	11.7%
Total	**100%**	**37.5%**	**37.5%**

Source: Tierra Resource Consultants

The *2014-16 HVAC Permit and Code Compliance Market Assessment*[75] reviewed EUL values by climate region and equipment type, as Table B-4. summarizes; Figure B-3. shows the geographic regions defined in the study. Table B-4. indicates that the EUL of AC systems and furnaces is roughly the same in the South Coast region, while furnaces in the North Coast have EULs that are 57% of the AC EULs, likely the result of longer annual run hours due to the colder climate. In contrast, all inland regions have furnace EULs that exceed the AC EUL, but the extent varies by location. The average inland EUL is 14 years for AC systems and 22 years for furnaces. Figure B-4 illustrates the differences in AC and gas furnace EULs by the study climate regions defined in Table B-4.

Table B-4. EULs by Climate Region and Equipment Type

Region	Central AC EUL	Central Natural Gas Furnace EUL	Ratio (Furnace EUL/ AC EUL)
North Coast: CZ 1, 3, 5	30	17	0.57
North Inland: CZ 2, 11, 16	16	17	1.06
Central Inland: CZ 4, 12, 13	14	23	1.64
South Coast: CZ 6, 7	21	19	0.90
South Inland: CZ 8, 9, 10, 14, 15	11	27	2.45

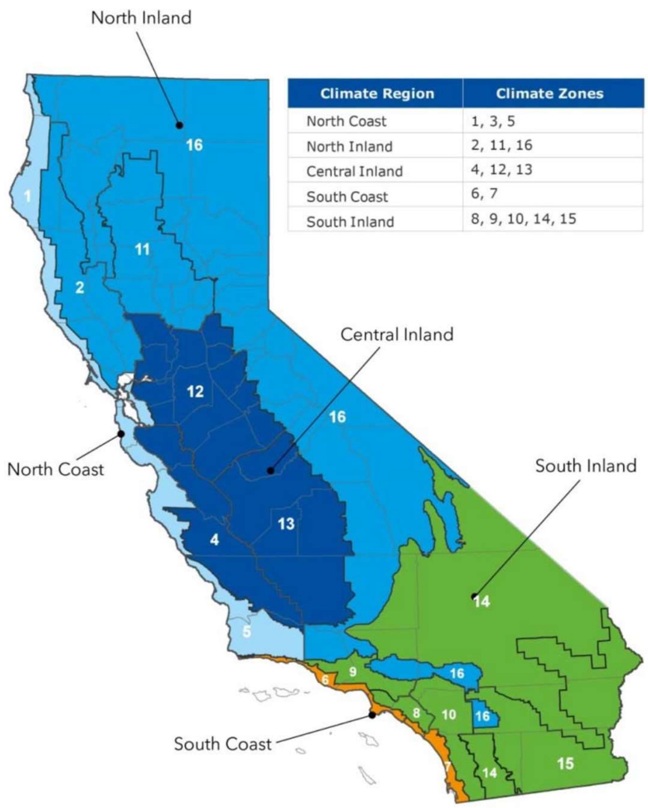
CZ = climate zone

Source: DNV GL, 2017

[75] Final Report: 2014-16 HVAC Permit and Code Compliance Market Assessment (Work Order 6) Volume I – Report.

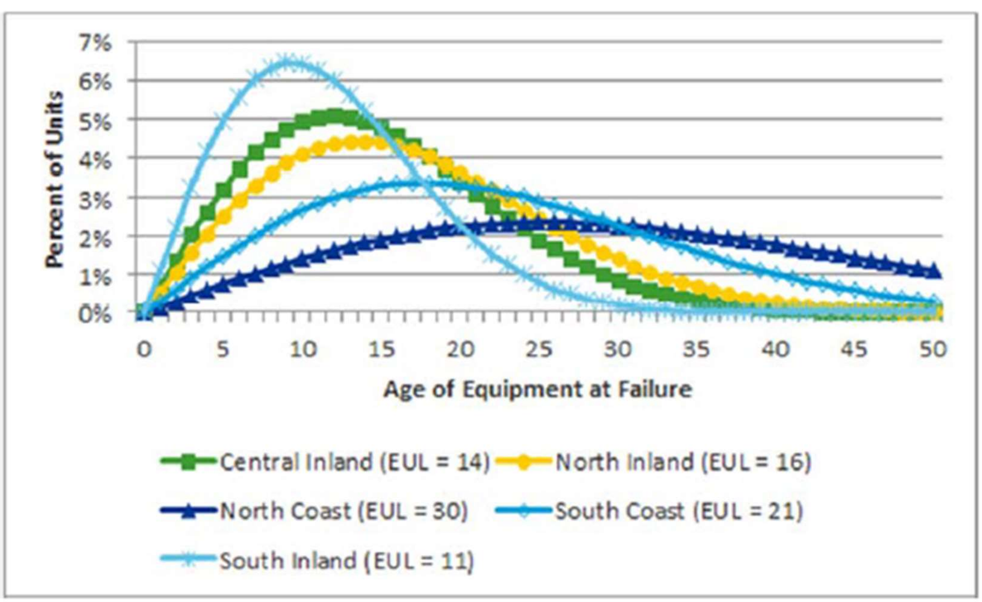
California Public Utilities Commission, DNV-GL, September 22, 2017, CALMAC Study ID: CPU0172.01, Contract #12PS5119 (HVAC WO6).

Figure B-3. HVAC Permit and Code Compliance Market Assessment Climate Regions



Source: DNV GL, 2017

Figure B-4. Probability Distribution of Lifetimes for Central ACs



Source: DNV GL, 2017

The 2014-16 HVAC Permit and Code Compliance Market Assessment study also reviewed the permitting records on 196 HVAC changeout projects for the 2008 and 2013 code cycles. The study completed onsite inspections for two climate regions: a coastal region comprising climate zones 1, 3, 5, 6, and 7, and an inland region comprising climate zones 2, 4, and 8-16. The final sample of 196 inspections contained 143 installations in the inland region and 53 in the coastal region. Because this was a random sample of actual permitted projects, this analysis is considered representative of broader market characteristics for HVAC replacements. Table B-5. contains analysis of data provided in the *2014-16 HVAC Permit and Code Compliance Market Assessment* on the distribution of HVAC system type by climate region[76] and compares the sample HVAC system distribution by the coastal and inland climate regions. Overall, 65% of replacements projects included heating and AC components. This result varies by area, with 36% of coastal projects being full system replacements versus 76% of inland projects.

Table B-5. Distribution of HVAC Replacements by System Component and Climate Region

System Type	Coastal	Inland	Total
Both heating and cooling components	19	109	128
Cooling component only	3	8	11
Heating component only	31	26	57
Total Onsite	**53**	**143**	**196**
% Both heating and cooling components	36%	76%	65%
% Cooling component only	6%	6%	6%
% Heating component only	58%	18%	29%
Total %	**100%**	**100%**	**100%**

Source: Tierra Resource Consultants

Based on component EUL discussed in Table B-4., Table B-6 illustrates the relationship between system EUL and the probability that heating or AC component replacement align by study region and corresponding climate zone. Where a heating or AC EUL do not align, there is a low probability that a full system replacement will occur. Conversely, when the component EULs align, there is a high probability that a full system replacement will occur, offering the best opportunity to convert a gas furnace to a heat pump.

[76] Final Report: 2014-16 HVAC Permit and Code Compliance Market Assessment (Work Order 6) Volume I – Report.
California Public Utilities Commission, Table 14. Distribution of HVAC system type by climate region.

Table B-6. Component EUL Comparison and Probability of System Replacement Alignment

<table>
<tr><th>Region</th><th>Ratio (Furnace EUL/ AC EUL)</th><th>Observation</th><th>EUL Alignment</th><th>Likely Project Type</th></tr>
<tr><td>North Coast:
CZ 1, 3, 5</td><td>0.57</td><td>Furnace has a shorter EUL than the AC and is replaced more frequently</td><td>Low probability of alignment between furnace and AC EULs</td><td>Higher probability of a furnace only project</td></tr>
<tr><td>North Inland:
CZ 2, 11, 16</td><td>1.06</td><td rowspan="2">Furnace has approximately the same EUL as the AC and is replaced with the same frequency</td><td rowspan="2">High probability of alignment between furnace and AC EULs</td><td rowspan="2">Higher probability of whole system project</td></tr>
<tr><td>South Coast:
CZ 6, 7</td><td>0.90</td></tr>
<tr><td>Central Inland:
CZ 4, 12, 13</td><td>1.64</td><td rowspan="2">Furnace has a longer EUL than the AC and is replaced less frequently</td><td rowspan="2">Low probability of alignment between furnace and AC EULs</td><td rowspan="2">Higher probability of an AC-only project</td></tr>
<tr><td>South Inland:
CZ 8, 9, 10, 14, 15</td><td>2.45</td></tr>
</table>

CZ = climate zone

Source: Tierra Resource Consultants

Using the component EUL comparison and probability of system replacement alignment discussed in Table B-6 and the distribution of HVAC replacements by system component and climate region discussed in Table B-5., Table B-7 provides the Guidehouse team's recommended distribution of projects types by region. Figure B-5. graphically represents the percentage of projects that are system replacements as listed in Table B-7.

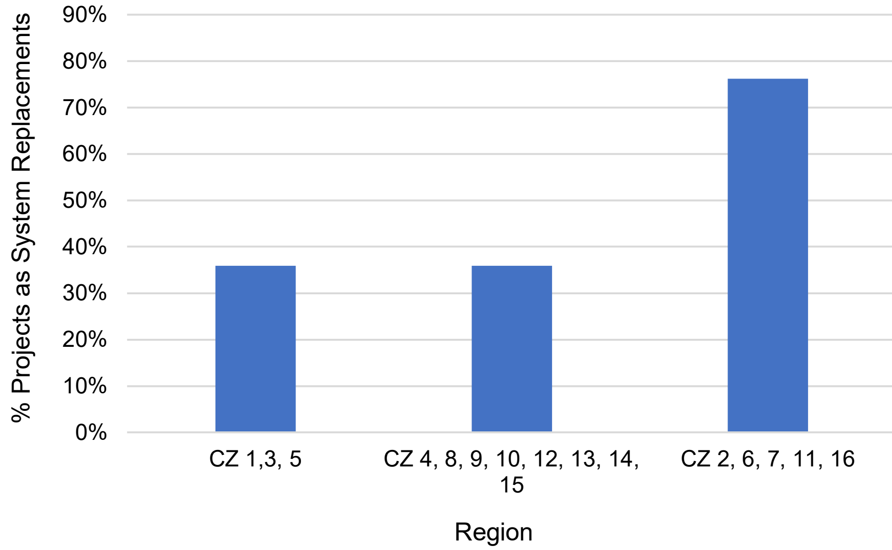
Table B-7. Probable Project Type by Region

<table>
<tr><th>Region</th><th>System</th><th>Component</th></tr>
<tr><td>North Coast: CZ 1, 3, 5</td><td>36%</td><td>64%</td></tr>
<tr><td>North Inland: CZ 2, 11, 16</td><td rowspan="2">76%</td><td rowspan="2">24%</td></tr>
<tr><td>South Coast: CZ 6, 7</td></tr>
<tr><td>Central Inland: CZ 4, 12, 13</td><td rowspan="2">36%</td><td rowspan="2">64%</td></tr>
<tr><td>South Inland: CZ 8, 9, 10, 14, 15</td></tr>
</table>

CZ = climate zone

Source: Tierra Resource Consultants

Figure B-5. Percentage of Projects as Whole System Replacements by Region



CZ = climate zone

Source: Tierra Resource Consultants

Table B-8. maps the percentage of system versus component replacements discussed in the previous tables and figures to the climate regions analyzed.

Table B-8. System vs. Component Replacements for Residential HVAC FS by Climate Region

Climate Region	System Replacements	Component Replacements
SCE-Marine SCG-Marine SDG&E-Marine SDG&E-Hot-Dry	76%	24%
All others	36%	64%

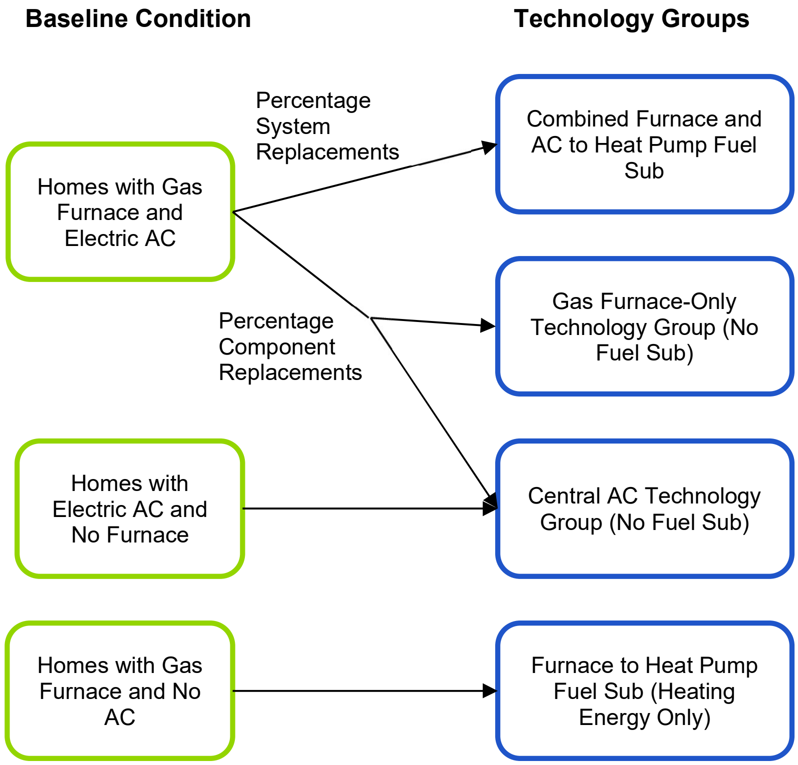
Source: Guidehouse

These percentages influenced the density of the residential HVAC technology groups. The technology group that consists of a heat pump replacing the furnace and AC combination (shown in Table B-2.) would apply to all households with both a furnace and an AC multiplied by the percentage of households undergoing whole system replacements (shown in Table B-8.—e.g., 76% in the SDG&E-Marine climate region). The remaining percentage of households would undergo component replacements; the components are characterized separately in furnace only or AC-only technology groups.

In this approach, the furnace only technology group is separate from the furnace only fuel sub technology group. The latter applies in cases where homes have a gas furnace but no AC. For homes with a gas furnace only, the electric heat pump competes with the efficient gas appliance. Although a heat pump provides heating and cooling, introducing an additional cooling load where there was none before, per guidance from the CPUC, the team only considered the heating energy from the heat pump when comparing energy use across the technology group. However, the full cost of the heat pump compared to the full cost of the baseline technology is included in the characterization.[77]

Figure B-6. illustrates how the various scenarios are distributed among the relevant residential HVAC technology groups.

Figure B-6. Distribution of Residential HVAC Scenarios among Technology Groups



Source: Guidehouse

B.3 Approach for FS Cost-Effectiveness Analysis

The FS analysis follows the cost-effectiveness calculations that require addressing the increase in supply costs. FS measures value both the gas savings (a positive benefit) and the increased electricity supply cost (a negative benefit). FS measures are assigned to the IOU that serves the new load. FS for dual fuel utilities (PG&E and SDG&E) is straightforward in the PG Study because the model assumes the customer is not shifting revenue from one utility to another when making the switch.

This matter is far more complicated when dealing with gas technologies in SCG territory being replaced by electric technologies. SCG territory overlaps mostly with SCE territory. However, there is overlap with publicly owned utilities (e.g., LADWP), PG&E, and even San Diego Gas & Electric (SDG&E). The Guidehouse team developed a simplifying assumption as part of the 2021 PG Study, which has been applied for the 2023 and 2025 Studies as well, that for each SCG FS replacement 64% of that occurs in the territory overlapping with SCE and is subsequently tracked in the model. Consistent with the prior Study, the remaining 36% is not tracked further. The reason the team only tracks SCG to SCE

[77] Conversation with CPUC on October 21, 2020.

substitution is because valuing cost-effectiveness and increased supply cost is far simpler when dealing with just two utilities and two sets of avoided costs (one gas and one electric).

B.4 Accounting for Proposed Zero Emission Appliance Standard

In September 2022, CARB published a State Implementation Plan (SIP) memo to propose a "zero-emission standard for space and water heaters," which would phase-out the sale of natural gas-burning HVAC and water heating appliances.[78] This original SIP proposed an effective date of 2030 for all Zero Emission Appliance Standard (ZEAS) measures.

In May 2024, CARB released an updated draft regulatory proposal (referred to as Refined Concept B) with compliance dates that vary by equipment type based on varying levels of technological feasibility.[79] Table B-9 summarizes CARB's Refined Concept B proposal.

Table B-9. CARB Draft Proposal for ZEAS—Refined Concept B

Draft Effective Year	Equipment Type(s)
2027	Boilers and water heaters (<75 kBtuh)
2029	Furnaces (≤2 MMBtuh) Boilers and water heaters (≤400 kBtuh) Instantaneous water heaters (≤200 kBtuh)
2031	Boilers and water heaters (≤2 MMBtuh) Instantaneous water heaters (≤2 MMBtuh) Pool heaters (<2 MMBtuh)
2033	High temperature (>180°F) boilers and water heaters (≤2 MMBtuh)

Source: CARB May 2024 Workshop

The Guidehouse team anticipates that upon taking effect, ZEAS will effectively eliminate natural gas savings from FS measures because customers would not be able to install a new gas appliance in a new building or as a replacement for an existing gas appliance at the end of its life. This is a similar effect as other measures when a code or standard takes effect and increases the efficiency of the baseline product. In this case, the study considers the "baseline" for this product group to be a low-efficiency electric appliance—in other words, the minimum cost and minimum efficiency product that the customer would be able to install at that point in time.

This is implemented in the measure characterization as a "future baseline" level that becomes the baseline starting in the assumed effective year of the standard. The natural gas baseline and any competing natural gas efficiency levels are removed from the analysis from the effective year and onwards. In effect, this means that technologies categorized as FS technologies will appear to have electric EE savings once the ZEAS takes effect.

Figure B-10 below illustrates the change in technology levels for an example technology group.

[78] California Air Resources Board, 2022 State Strategy for the State Implementation Plan, Adopted September 22, 2022, https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf.

[79] California Air Resources Board, Zero-Emission Space and Water Heater Standards Public Workshop, May 29, 2024, https://ww2.arb.ca.gov/sites/default/files/2024-05/May_2024_Workshop_Slides.pdf.

Figure B-10. Example Technology Group Change With ZEAS

Before ZEAS Effective Year			After ZEAS Effective Year	
Technology	**Description**		**Technology**	**Description**
Small Gas Storage Water Heater	Code Efficiency Level	→	Electric Resistance Water Heater	Baseline Electric Level
Condensing Gas Storage Water Heater	High Efficiency Gas Level	→	Electric Resistance Water Heater	Baseline Electric Level
Instantaneous Gas Water Heater	High Efficiency Gas Level	→	Heat Pump Water Heater	High Efficiency Electric Level
Heat Pump Water Heater	High Efficiency Electric Level	→	Heat Pump Water Heater	High Efficiency Electric Level

Source: Guidehouse

In the 2023 Study, Guidehouse modeled a ZEAS effective year of 2030 for all affected measures based on the original SIP proposal. This **ZEAS 2030** framework, where updated electric baselines are assumed to take effect in 2030, is also considered in the 2025 Study.

For the 2025 Study, Guidehouse introduced an additional framework for ZEAS with phased implementation dates consistent with the 2024 Refined Concept B proposal. This new framework is referred to as **ZEAS Phased** for the 2025 Study. Based on the rebated residential and commercial technology groups considered in the 2025 Study, this framework results in modeled ZEAS effective dates that vary between 2027 and 2031. Table B-10 lists the technology groups that Guidehouse modeled as being impacted by ZEAS along with the assumed ZEAS effective year under the two frameworks.

Table B-10. ZEAS Measures and Effective Year Assumptions for 2025 Study

Sector and End Use	Technology Group	Savings Type(s)	ZEAS 2030 Framework Eff. Year	ZEAS Phased Framework Eff. Year
Com HVAC	Com HVAC Boilers	EE	2030	2031
	Com Furnaces	EE	2030	2029
	Com Central HVAC (Large)	FS	2030	2029
	Com Central HVAC (Small)	FS	2030	2029
Com WaterHeat	Com Gas Water Heating Boilers	EE	2030	2031
	Com Small Gas Water Heaters	EE, FS	2030	2027-2029
	Com Large Gas Water Heaters	FS	2030	2031
Res AppPlug	Res Pool Heaters	EE, FS	2030	2031
Res HVAC	Res Furnaces	EE	2030	2029
	Res Central Boilers	EE	2030	2031
	Res Central HVAC System	EE, FS	2030	2029
	Res Central Furnace Only	EE, FS	2030	2029
	Res Ductless HVAC System	EE, FS	2030	2029
Res WaterHeat	Res Gas Water Heaters	EE, FS	2030	2027-2029
	Res Multifamily Central Gas Water Heaters	FS	2030	2031

Source: Guidehouse

The earliest proposed ZEAS effective date is 2027 for small boilers and water heaters, which affects the Com Small Gas Water Heaters and Res Gas Water Heaters technology groups. Because of the proposed status of the standard, a fast-approaching compliance year, and some stakeholder concerns with feasibility, the PG team ramped in this baseline change over a three-year period (from 2027 to 2029) rather than assuming full compliance in 2027 (which falls within the 2025 Study goal setting period). This three-year ramp was implemented using a mixed gas and electric baseline that linearly changes over time from 100% gas in 2026 to 100% electric in 2029 as shown in Table B-11.

Table B-11. 2027-2029 Phase-In for Small Gas Water Heaters ZEAS

Model Year	Gas Baseline Weight	Electric Baseline Weight
2026	100%	0%
2027	66.7%	33.3%
2028	33.3%	66.7%
2029	0%	100%

Source: Guidehouse

These weights were applied to the energy consumption and cost values of each respective baseline to calculate the appropriate mixed baseline in each year. This three-year phase-in approach for small boilers and water heaters is consistent with what Guidehouse shared in the September 2024 Scenarios Workshop.

For the 2025 Study, Guidehouse calculated potential results for each of the three primary scenarios detailed in Section 2.3 subject to both ZEAS frameworks. Thus, the 2025 Study produces results for six distinct sets of assumptions—three scenarios using the ZEAS 2030 framework plus three scenarios using the ZEAS Phased framework.

Appendix C. Panel Upgrade Methodology Details

Summary of Panel Upgrade Costs Assumptions for Rebated FS Measures

Substituting gas technologies for electric technologies can increase electric load for a building or house. This can sometimes require upgrades to the infrastructure within the building, for example, increasing the size of the electrical panel to accommodate the added load. Deemed per-unit costs of FS technologies typically do not consider such costs.

For the 2025 Study, the Guidehouse team applied panel upgrade cost adders to residential and non-residential FS measures in the measure characterization based on recommendations from a March 2024 Viable Electric Alternatives (VEA) Working Group report (WG Report).[80] The following subsections detail the WG Report recommendations and how they were incorporated into the 2025 Study.

The 2023 Study considered panel upgrade costs for residential FS measures within the AppPlug, HVAC, and WaterHeat end uses based on research conducted by Opinion Dynamics. Based on the WG Report, the 2025 Study considers panel upgrade costs for FS measures in the HVAC and WaterHeat end uses for both residential and commercial sectors, as well as commercial FoodServ (but not residential AppPlug).

C.1 VEA Working Group Report Recommendations

The WG Report provided a summary table with recommended assumptions for the average cost and frequency of three FS upgrade cases:

- **No Upgrade.** Including only the cost needed to support simple connections of the equipment to the existing panel.
- **Panel Optimization.** Including both the cost of a simple connection and electric panel optimization.
- **Panel Upgrade.** Including both the cost of a simple connection and an electric panel upgrade.

The estimates provided differed by sector (residential, nonresidential) and end use (space heating, domestic hot water, and non-res food service). Table C-1 below replicates the summary table from the WG Report.

Table C-1. Summary of VEA WG Report FS Infrastructure Cost Parameters

Input Parameter	Residential		Nonresidential Non-Food Service		Nonresidential Food Service
	Space Heating	Hot Water	Space Heating	Hot Water	
No. of fuel substitution	1	1	1	1	1

[80] Working Group Report: Fuel Substitution Infrastructure Cost Attribution. March 2024. This report was drafted by a VEA stakeholder working group pursuant to CPUC D. 23-04-035.

Input Parameter	Residential		Nonresidential Non-Food Service		Nonresidential Food Service
	Space Heating	Hot Water	Space Heating	Hot Water	
treatments assumed					
Frequency of No Upgrade (NoUp%)	47.0%	50.0%	81.4%	54.6%	37.8%
Frequency of Panel Optimization (Opt%)	26.2%	19.3%	6.7%	23.6%	14.8%
Frequency of Panel Upgrade (Upg%)	26.8%	30.8%	11.9%	21.7%	47.4%
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	$2,046	$2,716	$2,786	$4,659	$4,055

Source: VEA WG Report, Table 5

The final row, Calculated Weighted Avg Infrastructure Cost for VEA Determination, is calculated to provide a single weighted value that can be applied to an average installation according to the relative prevalence of each of the three cases (equation also replicated from WG Report):

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

For the panel upgrade case, there is also an attribution factor applied, which is intended to account for the ability of the new panel to support multiple future electrification loads, and thus represents a sharing of the full upgrade cost among many future electrification loads.

The weighted average cost value thus represents the average infrastructure cost that can be attributed to a generic FS installation.

C.2 Inputs for Measure Characterization

The WG Report recommends that the weighted average infrastructure cost value be used for a single FS measure representing an average across all three upgrade cases. However, in the PG Study, FS measures subject to panel upgrade costs are not characterized as a single average measure; rather, the Guidehouse team characterizes no upgrade and panel upgrade cases separately.

Therefore, while the WG report started from three upgrade cases to calculate a single weighted average case, the Guidehouse team used the same values to calculate panel upgrade assumptions for two cases: No Upgrade and Upgrade (where the upgrade case is a weighted combination of the panel optimization and panel upgrade cases in the WG report).

Table C-2 shows the results of this re-weighting. The No Upgrade case frequency and cost adders are unchanged from the WG Report. For the PG Study Upgrade case, the frequency is the sum of the frequency of the optimization and upgrade cases, and the cost adder is a weighted average of the optimization and upgrade cases, including the attribution factor for the full upgrade case.

Table C-2. Re-weighted Panel Upgrade Values for 2025 Study

Sector	End Use	Frequency %		Cost Adder	
		No Upgrade	Upgrade*	No Upgrade	Upgrade*
Res	HVAC	47.0%	53.0%	$1,704	$2,349
Res	WaterHeat	50.0%	50.0%	$2,804	$2,627
Com	HVAC	81.4%	18.6%	$2,099	$5,791
Com	WaterHeat	54.6%	45.3%	$3,430	$6,139
Com	FoodServ	37.8%	62.2%	$3,372	$4,469

*Upgrade Case is a weighted result of the Panel Optimization and Panel Upgrade cases from the VEA report.

Source: Guidehouse

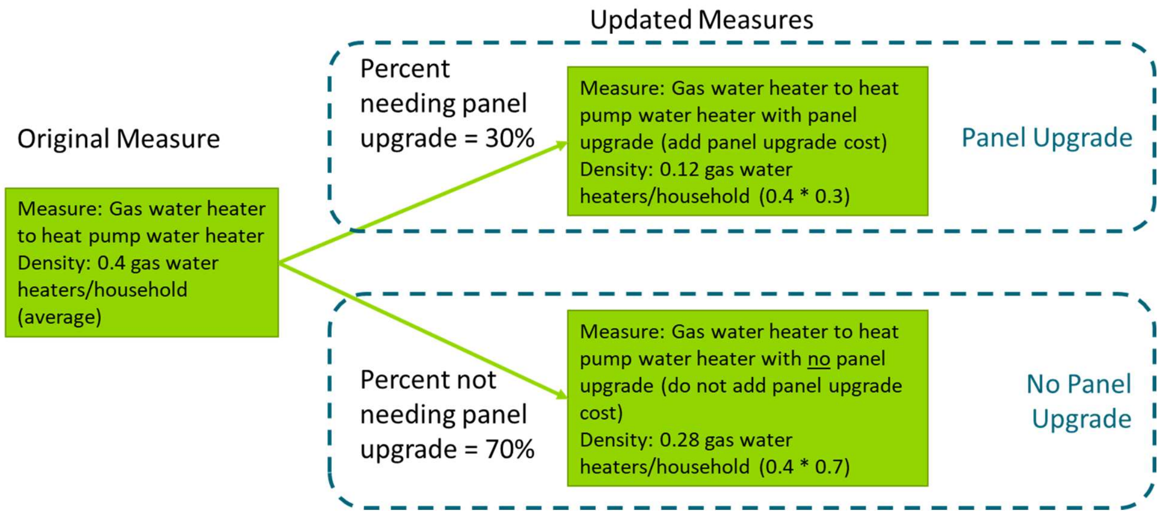
The No Upgrade cost adder is only applied with the eTRM measure package does not already include basic FS installation costs (i.e., the costs of simple connections). This was only the case for certain Com FoodServ measures where a FS upgrade case is not explicitly characterized in the eTRM. The Guidehouse team verified that simple connection costs were already included in the eTRM-characterized costs for HVAC, WaterHeat, and most FoodServ FS measure packages. These re-weighted values were incorporated into the measure characterization for separate panel upgrade technology groups as described in the next section.

C.3 Panel Upgrade Technology Groups

The Guidehouse team modeled panel upgrade costs in the measure characterization by creating two versions of each FS technology group within the affected end uses, with one version representing the no upgrade case and the other representing the panel upgrade case (which is a weighted average of the panel upgrade and panel optimization cases from the WG Report). The relevant FS panel upgrade cost adder was added to the panel upgrade version of the measure only. The overall measure density (i.e., the number of measure units per building stock) was also split between the no upgrade and panel upgrade cases using the working group report values for the proportion of installs falling into the upgrade cases.

For example, if the total density of residential gas water heaters is 0.4 water heaters per household, and the WG Report indicates that 30% of homes will require a panel upgrade or optimization for water heating FS installs, then the measure would be split into a panel upgrade version with a density of 0.12 water heaters per household (0.4 * 30%) and a no upgrade version with a density of 0.28 water heaters per household (0.4 * 70%). The appropriate average panel upgrade cost value would then be added to the measure cost for the panel upgrade version of the measure only. Figure C-1 illustrates this split (percentages are for illustrative purposes only).

Figure C-1. Illustration of Disaggregating Measures to Panel Upgrade and No Panel Upgrade Versions



Source: Guidehouse analysis

Table C-3 lists the panel upgrade measure groups included for the 2025 Study.

Table C-3. List of Panel Upgrade Measure Groups for 2025 Study

Sector	End Use	Panel Upgrade Technology Group Name
Com	FoodServ	Com Gas Fryers—Panel Upgrade
Com	FoodServ	Com Gas Steamers—Panel Upgrade
Com	FoodServ	Com Convection Ovens—Panel Upgrade
Com	FoodServ	Com Gas Griddles—Panel Upgrade
Com	FoodServ	Com Gas Combination Ovens—Panel Upgrade
Com	HVAC	Com Central HVAC (Large)—Fuel Sub—Panel Upgrade
Com	HVAC	Com Central HVAC (Small) - Fuel Sub - Panel Upgrade
Com	WaterHeat	Com Small Gas Water Heaters - Panel Upgrade
Com	WaterHeat	Com Large Gas Water Heaters - Panel Upgrade
Res	HVAC	Res Central HVAC System - Fuel Sub - Panel Upgrade
Res	HVAC	Res Central Furnace Only - Fuel Sub - Panel Upgrade
Res	HVAC	Res Ductless HVAC System - Fuel Sub - Panel Upgrade

Sector	End Use	Panel Upgrade Technology Group Name
Res	WaterHeat	Res Gas Water Heaters - Panel Upgrade
Res	WaterHeat	Res Multifamily Central Gas Water Heaters - Panel Upgrade

Source: Guidehouse

Appendix D. BROs

This appendix discusses the BROs interventions included in the PG Model. It describes each intervention and discusses data sources and assumptions. A separate spreadsheet is also made available for stakeholders to review the final detailed inputs for each intervention specific to each utility and building type.

For the 2025 PG Study, Guidehouse removed some BROs interventions in consultation with CPUC Staff. Table D-1 summarizes the reasoning for keeping or removing each of the BROs interventions that were previously included in the 2023 Study. The measures that were removed for the 2025 Study (and not moved to the commercial custom analysis) were all previously considered in the 2023 Study only in the Aggressive (non-goal setting) Scenario.

Table D-1. Summary of Reasoning for Keeping/Removing BROs Interventions

2023 Study BROs Measure	Action for 2025 Study	Justification
Residential—Home Energy Reports	Keep	Measure is characterized in the California eTRM.
Residential—Universal Audit Tool	Keep	Measure is characterized in the California eTRM.
Residential—Real Time Feedback	Keep	There are examples of implementation in other jurisdictions (but not California as of now).
Residential—Small Competitions and Challenges	Remove	Measure represents low or no Achievable Potential, and there are not major examples of implementation in other jurisdictions.
Residential—Large Competitions and Challenges	Remove	Measure represents low or no Achievable Potential, and there are not major examples of implementation in other jurisdictions.
Commercial—Business Energy Reports	Keep	Measure is characterized in the California eTRM.
Commercial—Building Benchmarking	Keep	There are examples of implementation in other jurisdictions (but not California as of now).
Commercial—Building Operator Certification	Keep, but only use in Aggressive (“High BROs”) Scenario	There are examples of implementation in other jurisdictions (but not California as of now).
Commercial—Strategic Energy Management	Move	Measure moved to Commercial Custom analysis.
Commercial - Retrocommissioning	Move	Measure moved to Commercial Custom analysis.

2023 Study BROs Measure	Action for 2025 Study	Justification
Commercial—Competitions	Remove	Measure represents low or no Achievable Potential, and there are not major examples of implementation in other jurisdictions.
Commercial—Building Energy and Information Management Systems	Remove	Measure represents low or no Achievable Potential, and there are not major examples of implementation in other jurisdictions.

Source: Guidehouse

D.1 Residential—Home Energy Reports

D.1.1 Summary

Home energy reports (HERs) are among the most prevalent and widely studied behavioral interventions and are the largest source of behavior-based savings in California. Residential customers are periodically mailed HERs that provide feedback about their home's energy use, including normative comparisons to similar neighbors, tips for improving EE, and occasionally messaging about rewards or incentives. HER programs are generally provided to customers on an opt out basis, although utilities in other states have conducted opt in programs.

Estimated electric and gas savings ranges differ based on savings bin. Costs are less variable are set at $0.05-$0.14 per kWh and $0.49-$1.88 per therm. Table D-2 provides details.

Table D-2. HERs—Key Assumptions

Sector	Type	EUL Years	Savings		Cost		kW/kWh Savings Ratio
			kWh	therms	kWh	therms	
Residential	HERs Bin 1	1	0.52-0.56%	0.00%-0.46%	$0.05-$0.14	$0.49-$1.88	0.000107 – 0.000243
	HERs Bin 2	1	0.92-1.03%	0.52%-1.12%	$0.05-$0.14	$0.49-$1.88	0.000088 — 0.000232
	HERs Bin 3	1	1.33-1.62%	0.80%-1.66%	$0.05-$0.14	$0.49-$1.88	0.000220 — 0.000261

Source: Guidehouse

D.1.2 Assumptions and Methodology

Bin-Based Measures

For the 2023 PG Study, Guidehouse introduced a new method to forecast future HERs savings by establishing three bins based on grouping historical waves (batches of new participants) of customers into low, moderate, and high energy savers. This method was maintained for the 2025 Study. The purpose of this change was to better describe the expected trend of new customers entering the program who are more likely to have lower energy savings than the historical participants that resulted in higher energy savings.

Bin assignments were based on the reported kWh savings. For those gas-only waves without kWh savings, a bin was assigned based on the reported therm savings. Low energy savers (Bin 1) include waves with reported energy savings less than 0.75%. Moderate energy savers (Bin 2) include waves with a minimum reported energy savings of 0.75% and a maximum reported energy savings of 1.249%. High energy savers (Bin 3) include waves with a minimum reported energy savings of 1.25%. Table D provides an overview of these ranges.

Table D-3. HERs Bins

Bin Name	Energy Savings Range
1	<0.75%
2	0.75%- 1.249%
3	<1.25%

Source: Guidehouse

Eligibility and Participation

Although all targeted residential households may receive HERs as participants in an opt out program, PG&E found that 0.5% of customers elect to opt out. For this reason, the Guidehouse team reduced applicability to 99.5% for single-family homes. The team applied this assumption to all IOUs as similar utility-specific data was not available. The team reduced the applicability for multifamily homes by 10% to 89.5% based on an American Council for an Energy-Efficient Economy (ACEEE) study that found an average of 10% master-metered multifamily buildings across 50 metropolitan areas across the country.[81] SCE provided data indicating that only 0.17% of its multifamily customers are master-metered, so the applicability in its territory remains higher at 99.33%. The applicability factor adjustment applies to the targeted treatment population; the PG Model assumes a separate control population is still required for evaluation purposes.

While participation rates in HER programs fluctuate over time due to program opt outs and attrition, customer moves, and changes in program implementation such as adding new waves, specific forecasts require details beyond those publicly available via investor-owned utility (IOU)-filed rolling Business Plans. Additionally, the use of the new Bin methodology means that the eligible population is spread across three groups with separate penetration rates depending on the population of previous waves and their reported energy savings.

For this reason, the Guidehouse team reviewed all formal California IOU evaluations of HER programs to ascertain historical participation rates and wave sizes. The team then applied an average of wave sizes to forecast the future cohort waves in each HERs measure. The 2021 Study included results from formal impact evaluations through program year (PY)

[81] Kate Johnson and Eric Mackres, *Scaling up Multifamily Energy Efficiency Programs: A Metropolitan Area Assessment*, Report Number E135, March 2013, American Council for an Energy Efficient Economy, from Scaling up Multifamily Energy Efficiency Programs: A Metropolitan Area Assessment

2018.[82, 83, 84] For the 2023 Study, the Guidehouse team added data from PY2019 and PY2020 for PG&E.[85] No further updates were made for the 2025 Study.

The forecast uses a cap of 60% on the penetration of all three HERs measures based on the following considerations:

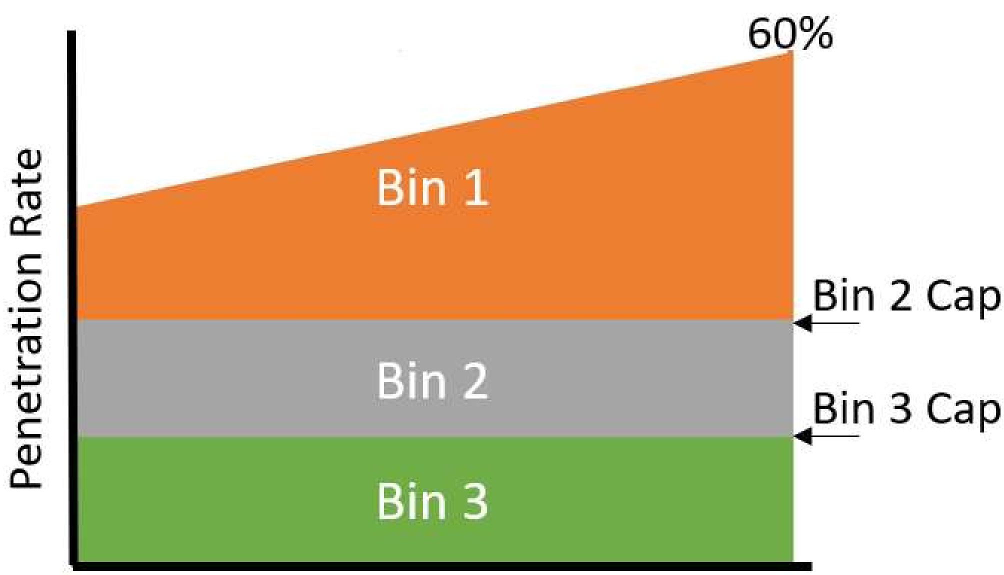
- Feedback from previous potential and goals studies noted that the bottom quartile of energy consumers will not be targeted for cost-effectiveness reasons.
- Not all of the remaining 75% of customers can be targeted because some need to be reserved as a control group for evaluation purposes. The PY2018 evaluation shows that the ratio of treatment customers to control group customers ranges from approximately 3:1 to over 6:1. The Guidehouse team assumed a 4:1 ratio.

In following the expected trend of new customers entering the program with lower energy savings, penetration for moderate and high energy savings measures (Bins 2 and 3), are held to the latest reported year, either PY2018 or PY2020 based on the data available. The low energy savings measure (Bin 1) has a penetration cap using Equation D-1. Figure D-1 provides an illustrative view of the calculation.

Equation D-1. HERs Bin 1 Penetration Cap

$$Penetration\ Cap = 60\% - (Bin\ 2\ Penetration\ Cap + Bin\ 3\ Penetration\ Cap)$$

Figure D-1. Illustrative Application of Penetration Cap by Bin



Source: Guidehouse

[82] DNV GL. May 1, 2019. Impact Evaluation Report: Home Energy Reports – Residential Program Year 2016. California Public Utilities Commission. CALMAC Study ID: CPU0190.01.

[83] DNV GL. May 1, 2019. Impact Evaluation Report: Home Energy Reports – Residential Program Year 2017. California Public Utilities Commission. CALMAC Study ID: CPU0194.01.

[84] DNV GL. April 16, 2020. Impact Evaluation of Home Energy Reports: Residential Sector – Program Year 2018. California Public Utilities Commission. CALMAC Study ID: CPU0206.01.

[85] Nexant. January 3, 2021. PG&E HER 2020 Energy and Demand Savings Early EM&V. Pacific Gas & Electric. CALMAC Study ID: PGE0466.01.

The PG Model applies these projected penetration rates to the number of forecast IOU households, which increases over time from 2026 to 2037, resulting in an increase in the absolute number of actual HER participants over time. Penetration is modeled using a linear growth rate rather than an exponential compound annual growth rate (CAGR) to better reflect the observed rollout of the program over the evaluated years.

Savings

The model uses an EUL of 1 year for HER program participants. That is, while customers may participate in a utility HER program for more than 1 year, their average adjusted savings are assumed to be the same as for all other participants in that year. While some recent evaluations of HER programs have found savings persistence of more than 1 year, reported savings percentages vary—some sources citing higher later year savings and others showing a degradation of savings over time. For this model, an EUL of 1 year is assumed, as is standard with traditional persistence calculations for HER programs.

The team developed the ratio of kilowatt (kW) to kWh savings using an average of adjusted kW and kWh savings as reported in the impact evaluation findings for PG&E, SCE, and SDG&E through 2018. This ratio was then updated based on California hourly load profiles to align with the current DEER peak period definition.[86]

Cost

The Guidehouse team sourced the costs per unit of kWh and therm savings from California Energy Data and Reporting System (CEDARS) data for PY2016 through PY2024. For the 2025 Study, Guidehouse updated CEDARS cost data for years 2022-2025. The team divided the costs reported in CEDARS by the evaluated kWh and therms savings values from impact evaluations (through 2018) or by the claimed savings in CEDARS as available through 2024. The team then weighted and apportioned the costs for PG&E and SDG&E to electric and gas using a common energy conversion to Btus. The Energy Advisor costs sourced from the CEDARS database for PG&E and SCE are an aggregate of HER and UAT costs.

D.2 Residential—Universal Audit Tool

D.2.1 Summary

The Universal Audit Tool (UAT) is an opt in online tool that asks residential customers questions about their homes, household appliance use, and occupancy patterns and then offers EE advice on how they can save money and energy. The UAT is provided by all four of California's large IOUs. While each utility has its own branding and some utilities require customers to log in and others do not, their features and functionality are similar. All four tools enable customers to develop plans to save energy based on estimates of the annual savings they are likely to see if the enact the recommended energy-saving advice.

[86] California Public Utilities Commission (CPUC). Resolution E-4952, October 11, 2018, effective 2020. CPUC Resolution E-4952

There is some danger of double counting UAT savings with other program savings such as HERs.[87] The DNV GL study used to characterize savings specifically addresses this potential and "find[s] no evidence of joint savings between the UAT and HER programs."[88]

Estimated electric savings range from 1.2% to 1.8%, while gas savings are 1.5%-2.6%. Costs are set at $0.01-$0.02 per kWh and $0.18-$0.38 per therm.

Table D-4. UAT—Key Assumptions

Sector	Type	EUL Years	Savings		Cost		kW/kWh Savings Ratio
			kWh	therms	kWh	therms	
Residential	UAT	1	1.2% - 1.8%	1.5%- 2.6%	$0.01- $0.02	$0.18- $0.38	0

Source: Guidehouse

D.2.2 Assumptions and Methodology

No major updates were made to UAT potential analysis in the 2025 Study, aside from updating with CEDARS cost data for 2022-2024. The Guidehouse team determined UAT to be a low priority measure for updates based on a review of implementation activity and recently published California-specific data sources. The methodology described here is unchanged from the 2023 and 2021 Studies.

Eligibility and Participation

All residential customers of the four IOUs are eligible to use the UAT. Customers can access the tool after signing up for online services through their utility's My Energy or Energy Advisor web portals. As with the HERs forecast, the Guidehouse team reduced the applicability for multifamily homes by 10% to account for multifamily homes that do not have individual meters.

According to a 2017 evaluation of the UAT by DNV GL,[89] the UAT tools have seen active growth in customer use. Customer engagement and online survey completion vary by IOU, as does the associated level of marketing effort to drive customers to participate or re-participate for deeper savings. To forecast participation levels for the 2021 PG Model, the Guidehouse team relied on the participation numbers from the 2017 DNV GL evaluation to establish cumulative treatment sizes; the team then determined saturation levels based on the number of households per utility. Because evaluated participation rates were not available for SCE in reviewed sources, the team calculated this value using an average saturation percentage from the other California electric utilities. Starting saturation rates for early model years range from 0.5% to 0.8% and grow at a compound annual growth rate of 12% per year, topping out at between 3.2% and 5.0% participation by 2032.

[87] Stakeholder comments from 2019 Study May 9, 2019 stakeholder meeting.

[88] DNV GL. March 31, 2017. Universal Audit Tool Impact Evaluation-Residential: California Public Utilities Commission, March 31, 2017. CALMAC ID: CPU0160.01.

[89] DNV GL. March 31, 2017. Universal Audit Tool Impact Evaluation-Residential: California Public Utilities Commission, March 31, 2017. CALMAC ID: CPU0160.01.

Savings

The Guidehouse team relied on the above-mentioned 2017 DNV GL evaluation of the UAT to set per household adjusted kWh and therm savings values for participating customers at each utility. Evaluated kWh savings were not available for SCE, so a rate of 1.2% kWh savings was applied because it equaled the evaluated savings for PG&E, which was more conservative than the higher percentage of evaluated savings for SDG&E.

The PG Model uses an EUL of 1 year for UAT participants. While customers may participate in a utility UAT for more than 1 year, their average adjusted savings are assumed to be the same as for all other participants in that year. This assumed value is standard with traditional persistence calculations for residential behavior programs.

Per the SWWB002-01 workpaper for the UAT,[90] there is uncertainty on claiming peak demand savings. As a result, Guidehouse does not include peak demand savings potential for UAT.

Cost

The team based the costs per unit of kWh and therm savings on CEDARS data for Residential Energy Advisor, which is an aggregate of HER and online audit tool costs.[91] These costs were distributed to the kWh and therm savings (weighted by savings) as reported in the CEDARS database.

D.3 Residential—Real-Time Feedback: In-Home Displays and Online Portals

D.3.1 Summary

Unlike HERs that arrive in the mail or email on a periodic basis, real-time feedback programs change customer behaviors by delivering advanced metering data on household consumption to utility customers via an in-home display (IHD) or remotely via an online portal, such as a website or a smartphone application. While some feedback programs only provide information, others provide energy-saving tips, rewards, social comparisons, and alerts.

Although utility behavior programs using IHDs and online portals both provide feedback opportunities, the Guidehouse team separated its modeling inputs for the two categories to better capture differences in adoption, energy savings, and costs between the two types of programs. Of note is the higher cost typically associated with offering IHDs due to the need to install specialized hardware, whereas online portals typically provide cloud-based information directly to the customer's smartphone, tablet, or computer.

Real-time feedback programs may also be associated with different customer rates, including time-of-use plans and more traditional usage-based billing. Although real-time feedback is a popular behavioral intervention for demand response (DR) programs, the team's analysis focused on programs designed to drive EE. In all, the Guidehouse team reviewed 38 programs, including 20 providing IHDs and 18 offering online portals. Several

[90] California Electronic Technical Reference Manual, https://www.caetrm.com/login/?next=/measure/SWWB002/01/.

[91] Energy Advisor programs savings and costs, CEDARS, 2017.

programs offered both types of feedback. In those cases, the team categorized them in the IHD category because they had associated costs for the hardware.

Table D-5. Real-Time Feedback—Key Assumptions

Sector	Type	EUL Years	Savings		Cost		kW/kWh Savings Ratio
			kWh	therms	kWh	therms	
Residential	Real-Time Feedback—IHD	1	2.3%	–	$0.19	–	0.000224
Residential	Real-Time Feedback—Online Portal	1	2.2%	1.2%	$0.07	–	0.000224

Source: Guidehouse

D.3.2 Assumptions and Methodology

No major updates were made to real-time feedback input data for the 2025 Study. The Guidehouse team determined that real-time feedback is a low priority measure for updates based on a review of implementation activity and recently published California-specific data sources. The methodology described here is generally unchanged from the 2023 and 2021 Studies, except for pushing out the beginning of the penetration forecast to 2025 and extending the forecast period through 2037.

Eligibility and Participation

Web-based and IHD real-time feedback programs are offered on an opt in basis to customers with smart meter-equipped homes. Although most residential feedback programs are focused on providing information about electricity consumption, some natural gas savings result from these programs; these savings are likely the result of tips and recommendations concerning thermostat settings. For modeling purposes, the Guidehouse team assumes 100% applicability for electric savings among individually metered homes and 59% applicability for gas. This latter figure is conservative given that 59% of California households use natural gas as their main source of space heating and 84.4% of California homes use natural gas for water heating.[92]

For the 2025 Study, the Guidehouse team pushed out the beginning of the penetration forecast to 2025 to reflect that the program has not yet been deployed. The team assumes penetration rates for programs that use online portals to display customer information will be higher than those that rely on IHDs. For online portals, the team assumes an 8% increase in penetration per year. PG&E provided penetration rate data for IHDs and used for all IOUs.[93]

Savings

Savings forecasts differ for online portals and IHDs. For online portals, the Guidehouse team estimates 1.3% savings for both kWh and therms. For IHDs, the team estimates 2.3%

[92] U.S. Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS). "Table CE2.5 – Household Site Fuel Consumption in the West Region, Totals and Averages." (2009). Available at: U.S. Energy Information Administration - EIA - Independent Statistics and Analysis

[93] Informal comments on the 2019 Study April 20, 2017 webinar.

savings for kWh and no gas (therms) savings. The team developed these estimates based on numerous data points for kWh savings.[94,95,96,97,98,99]

The PG Model uses an EUL of 1 year, the same as the team applies for HER program participants. Because insufficient demand savings data was available for real-time feedback for non-DR programs, the ratio of kW to kWh for HERs is used for the three electric utilities.

Cost

Hardware acquisition and installation constitute the primary cost associated with IHD programs and are accrued during the first year of customer participation. Sometimes these costs are paid by the utility, and other times they are paid by the customer. For modeling purposes, the Guidehouse team assumed utilities will provide the hardware and that IHDs cost $100, annualized over 5 years, which is similar to the life of other consumer electronics.[100]

To calculate the cost, the team began with a 2014 report by the Alberta Energy Efficiency Alliance for the City of Calgary that estimates the cost for a real-time direct feedback program to be about $0.07 per kWh saved not including the hardware.[101] For IHDs, the team added in the annualized $100 hardware acquisition and installation cost, resulting in $0.19 per kWh of savings (assuming 7,000 kWh per household).

D.4 Commercial—Business Energy Reports

D.4.1 Summary

Business energy reports (BERs) are the commercial sector equivalent to the HERs sent to residential customers. BERs (and other similar programs) shares reports via mail (or electronic format) with small- and medium-sized businesses at specific intervals (often monthly). The objective is to provide feedback about the business' energy use, including normative comparisons to similar businesses, tips for improving EE, and occasionally messaging about rewards or incentives. BERs and other similar programs typically send reports to customers on opt out basis. BER-type programs are a relatively new addition in the emerging field of behavior change programs and are in pilot testing at PG&E and other non-California utilities.

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94 Kira Ashby, *2016 Behavior Program Summary*, 2016, Consortium for Energy Efficiency, https://library.cee1.org/content/2016-behavior-program-summary-public.

95 Susan Mazur-Stommen and Kate Farley, "ACEEE Field Guide to Utility-Run Behavior Programs," 2013, American Council for an Energy-Efficient Economy (ACEEE), http://aceee.org/research-report/b132.

96 Illume Advising, *Energy Efficiency Behavioral Programs: Literature Review, Benchmarking Analysis, and Evaluation Guidelines, Conservation Applied Research & Development (CARD) FINAL REPORT*, Prepared for: Minnesota Department of Commerce, Division of Energy Resources, May 4, 2015

97 Ben Foster and Susan Mazur-Stommen. 2012. "Results from Real-Time Feedback Studies." American Council for an Energy Efficient Economy. Report Number B122

98 Reuven Sussman and Maxine Chikumbo. 2016. "Behavior Change Programs: Status and Impact." American Council for an Energy Efficient Economy. Report Number B1601

99 Opinion Dynamics. "PY2013-2014 California Energy Efficiency and Demand Response Residential Behavior Market Characterization Study Report: Volume 1." Prepared for the California Public Utilities Commission Energy Division. July 2015.

100 PG&E provided this reference in response to the webinar on April 20, 2019

101 Alberta Energy Efficiency Alliance, *Energy Savings through Consumer Feedback Programs*, February 2014, City of Calgary.

The Guidehouse team's modeling estimates are primarily based on three sources:

- PG&E's response to the 2019 Study webinar on April 20, 2017.
- Cadmus review of a BER pilot with Xcel Energy business customers (smaller than 250 kW service) in Colorado (10,000 participants) and Minnesota (20,000 participants) conducted between June 2014 and June 2015.
- Commercial customer behavior change pilot conducted by Commonwealth Edison and Agentis Energy in Illinois beginning in 2012.

Xcel Energy provided BERs to a sample of businesses operating in the following sectors: small office, small retail trade, small retail service, and restaurants.[102] In the Commonwealth Edison pilot, the utility engaged 6,009 medium-sized (100 kW-1,000 kW) commercial customers in Illinois.[103] While the Commonwealth Edison customers represented numerous sectors, only those businesses in the lodging and other categories showed significant savings.

Table D-6. BERs—Key Assumptions

Sector	Type	EUL Years	Savings		Cost		kW/kWh Savings Ratio
			kWh	therms	kWh	therms	
Commercial	BERs	2	0.32%	–	$0.20	$2.56	0.000092

Source: Guidehouse

D.4.2 Assumptions and Methodology

No major updates to inputs were made to BERs in the 2025 Study. Guidehouse determined BERs be a low priority measure for updates based on a review of implementation activity and recently published California-specific data sources. The methodology described here is unchanged from the 2023 Study, except for pushing out the beginning of the penetration forecast to 2025.

Eligibility and Participation

BERs typically target small- or medium-sized businesses. Utilities may use BERs to target businesses across all sectors or only a select set. As the number of BER pilots continues to grow, a greater amount of information about the effectiveness of BER programs in different business sectors will become available. The team assumes utilities will be more likely to limit the use of BERs to those sectors for which significant savings have been documented. The PG Model constrains its savings estimates to those business sectors that have already achieved significant energy savings by means of business energy feedback programs such as BERs.

The model includes businesses in the following sectors: retail, restaurants, lodging, and other. Within each of these business sectors, the applicability of savings is further

[102] Jim Stewart, Energy Savings from Business Energy Feedback [for Xcel Energy], Cadmus, October 21, 2015, Behavior, Energy, and Climate Change Conference 2015

[103] Gajus Miknaitis, John Lux and Deb Dynako, Mark Hamann and William Burns, "Tapping Energy Savings from an Overlooked Source: Results from Behavioral Change Pilot Program Targeting Mid-Sized Commercial Customers," 2014 ACEEE Summer Study on Energy Efficiency in Buildings, Commonwealth Edison and Agentis Energy, http://aceee.org/files/proceedings/2014/data/papers/7-153.pdf.

constrained by the estimated proportion of business customers in each of the relevant sectors that may be classified as either a small- or medium-sized enterprise. Based on data from the Commercial Building Energy Consumption Survey (CBECS), the team estimated that roughly 63% of retail customers can be considered small or medium businesses given that approximately 63% of retail space is shown to be under 100,000 square feet.[104] Given the small size of restaurants, the team assumes 100% applicability for this sector.

The Commonwealth Edison study specifically targeted medium-sized businesses in the lodging and other sectors. Therefore, the model's savings estimates are only calculated for medium-sized customers in the lodging and other categories based on relevant data from the CBECS. For example, the model assumes that 50% of lodging establishments can be considered medium-sized establishments based on CBECS data, which indicates 50% of lodging establishments have an average annual energy consumption of 500,000 kWh or more per year. For businesses in the other category, the Guidehouse team used CBECS data to estimate the proportion of establishments that fall in the medium-sized category (<1 million kWh per year). The team estimates that 25% of buildings in the other category are using an average of 400,000 kWh per year.

The projected penetration rates assume a delayed start for BERs, with formal utility programs launching in 2021 for the 2023 Study. For the 2025 Study, Guidehouse delayed the beginning of the penetration forecast to 2025 to reflect that the program has not yet been deployed. Thus, the analysis assumes a starting penetration of 1% in 2025, increasing 1% per year and reaching 12% by 2036.

Savings

The model uses electricity savings of 0.32%, no gas savings,[105] and an EUL of 2 years per CPUC Decision 16-08-019. Because no demand savings data was available for BERs, the team averaged the ratio of kW to kWh savings calculated for BEIMS, BOC, and SEM. This yielded a result of 0.000092, which is the figure used for all four utilities.

Cost

Because BER programs are new and in pilot phases, data regarding utility costs is scant. Furthermore, the limited availability of statistically significant adjusted savings percentages reported to date indicates that BER-related savings are lower among businesses than the household savings produced by HERs. For these reasons, the Guidehouse team modeled BER costs that are double those of HERs. The team projects $0.20 per kWh (2 x $0.10) for electric savings for PG&E, SCE, and SDG&E.

D.5 Commercial—Benchmarking

D.5.1 Summary

Building benchmarking scores a business customer's facility or plant and compares it to peer facilities based on energy consumption. It also often includes goal setting and rewards in the form of recognition. In previous potential and goals studies, benchmarking was generally modeled as an opt in activity, although some municipalities (e.g., San Francisco) had passed

[104] U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey, https://www.eia.gov/consumption/commercial/data/2012/index.php?view=consumption#c13-c22.
[105] Informal comments on the 2019 Study webinar presented on April 20, 2017 from PG&E cite results of a trial that ran January-October 2014.

ordinances requiring it for buildings of certain types and sizes. For the 2021 Study, the team updated the measure to reflect that benchmarking is mandated statewide for commercial buildings greater than 50,000 square feet under the CEC's Building Energy Benchmarking Program.[106]

Estimated electric savings range from 0.4% to 1.6%, while gas savings are 0.3%-1.0%. These values are applied consistently across utilities but vary by building type. Costs are estimated to be $0.08 per kWh and $0.37 per therm and are not utility specific.

Table D-3. Benchmarking—Key Assumptions

Sector	Type	EUL Years	Savings		Cost		kW/kWh Savings Ratio
			kWh	therms	kWh	therms	
Commercial	Building Benchmarking	2	0.4%-1.6%	0.2%-1.0%	$0.30	$1.72	0.000092

Source: Guidehouse

D.5.2 Assumptions and Methodology

After reviewing implementation activity and searching for any recently published California-specific data sources, no major updates were made to benchmarking in the 2025 Study. As noted previously, benchmarking is considered only in the Aggressive BROs scenario for the 2025 Study. The methodology described here is generally unchanged from the 2023 Study, except for pushing out the beginning of the penetration forecast to 2025.

Eligibility and Participation

Pursuant to AB 802, building benchmarking is mandated for all commercial buildings greater than 50,000 square feet under the CEC's Building Energy Benchmarking Program. Therefore, the Guidehouse team limited the applicability of the benchmarking measure to buildings less than 50,000 square feet but greater than 10,000 square feet to reflect additionality from IOU intervention. While any building and business type may be subject to benchmarking, reliable savings data exists for the following segments: colleges, healthcare, lodging, large offices, retail, and schools. For these sectors, the team applied CBECS data to determine the proportion of commercial stock in buildings between 10,000 and 50,000 square feet.[107] **Error! Reference source not found.** compares the applicability factors for benchmarking in the 2023 and 2021 PG Model, which ranges from 16% to 31% to address

[107] U.S. EIA. "Table B7. Building size, floorspace, 2012." CBECS (May 2016).

the mandate change, to the 2019 Study in which applicability ranged from 35% to 100%. No changes were made to the applicability factors in the 2025 Study.

Table D-4. Adjustments to Building Benchmarking Applicability Factors

Building Type	Applicability Factor	
	2019 Study	2021 and 2023 Studies
Com—College	100%	21%
Com—Health	69-83%	16%
Com—Lodging	100%	25%
Com—Office (Large)	100%	27%
Com—Retail	35%	31%
Com—School	90%	22%

Source: Guidehouse

There is uncertainty as to what extent the utilities will be able to claim savings from benchmarking if it is mandated to a greater degree by another level of government. For example, San Francisco has a benchmarking ordinance for any building greater than 10,000 square feet.

Savings

Estimated electric savings range from 0.4% to 1.6%, while gas savings range from 0.2% to 1.0%; these values are applied consistently by building and fuel type across utilities. Savings estimates are based on actual savings levels from city benchmarking reports.[108,109,110,111,112] Reported savings were divided in half because the team assumes that half of the savings come from technologies and half from operation-related behaviors. Furthermore, the team applied a consistent split of 60% electric savings and 40% gas savings. This split likely varies by building type, but because this data was not available, the team did not make this calculation based on specific building type consumption information.

The model uses an EUL of 2 years per CPUC Decision 16-08-019.

Because no demand savings data was available for benchmarking, the team used the ratio of kW to kWh savings calculated for BOC. This yielded a result of 0.000092, which is the figure used for the three electric utilities.

Cost

Available data suggests that benchmarking programs often include a utility in concert with a municipality. The model's estimates use PG&E's estimated 3-year program budget of $2.3

[108] SF Environment and ULI Greenprint Center for Building Performance. "San Francisco Existing Commercial Buildings Performance Report: 2010-2014." (2015)
[109] Katherine Tweed. "Benchmarking Drives 7 Percent Cut in Building Energy." Greentech Media. October 2012.
[110] City of Chicago. "City of Chicago Energy Benchmarking Report 2016."
[111] Jewel, Amy; Kimmel, Jamie; Palmer, Doug; Pigg, Scott; Ponce, Jamie; Vigliotta, David; and Weigert, Karen. "Using Nudges and Energy Benchmarking to Drive Behavior Change in Commercial, Institutional, and Multifamily Residential Buildings." 2016. Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings.
[112] Navigant Consulting, Inc., Steven Winter Associates, Inc., and Newport Partners, LLC. *New York City Benchmarking and Transparency Policy and Impact Evaluation Report*. Prepared for the U.S. Department of Energy. May 2015.

million.[113] Attributing all costs to either electricity or gas, this utility program cost was divided by estimated savings to calculate a per-unit savings cost. Costs amounted to $0.30 per kWh and $1.72 per therm and are not utility specific.

D.6 Commercial—Building Operator Certification

D.6.1 Summary

Building operator certification (BOC) offers EE training and certification courses to building operators in the commercial sector. BOC has been modeled as a component of behavioral savings since the 2011 Study, and research conducted for previous studies indicates that O&M practices mostly fell into the following categories:[114]

- Improved air compressor O&M
- Improved HVAC O&M
- Improved lighting O&M
- Improved motors/drives O&M
- Water conservation resulting in energy savings
- Adjusted controls of HVAC systems
- Adjusted controls of energy management systems

The model inputs for electric and natural gas shown in Table D-5 represent savings associated with changes in operation and behavior estimated per 1,000 square feet of floor space. Savings vary depending on the energy intensity of facilities in each market segment and IOU and as defined in the 2009 Commercial End Use Survey (CEUS).[115] The EUL is set to 3 years per CPUC Decision 16-08-019, and costs for electricity and natural gas savings are sourced from EEStats data from 2013 through 2017. The model applies cost and EUL values consistently by building and fuel type across all utilities.

Table D-5. Commercial Building Operator Certification—Key Assumptions

Sector	Type	EUL Years	Savings		Cost		kW/kWh Savings Ratio
			kWh	therms	kWh	therms	
Commercial	BOC	3	14-153	0.3-35.7	$0.29	$3.65	0.000092

Source: Guidehouse

D.6.2 Assumptions and Methodology

[113] CPUC, *Statewide Benchmarking Process Evaluation*, Volume 1, CPU0055.01, Submitted by NMR Group and Optimal Energy, April 2012.

[114] Literature search results provided in Appendix C, *Analysis to Update Potential Goals and Targets for 2013 and Beyond*, Navigant Consulting Inc., March 19, 2012

[115] As defined in the California Energy Commission (CEC), California Commercial End-Use Survey, CEC-400-2006-005, prepared by Itron, Inc., March 2006. Final report available at: 2006 California Commercial End-Use Survey (CEUS) Data available at: Itron

After reviewing implementation activity and searching for any recently published California-specific data sources, no major updates were made to BOC in the 2025 Study. As noted previously, BOC is considered only in the Aggressive BROs scenario for the 2025 Study. The methodology described here is generally unchanged from the 2023 Study, except for pushing out the growth in participation to 2025.

Eligibility and Participation

Consistent with prior studies, BOC savings apply to all commercial market segments, though the applicability factor of BOC ranges from 5% to 100% depending on the market segment. The PG Model assumes that BOC program interventions in the commercial market have been ongoing, and a CAGR was used to forecast growth in participation of 12.5% through the model forecast horizon. While these growth rates appear ambitious, low initial sector engagement in BOC results in forecast market penetrations of 8.25% in 2032. For the 2025 PG Study, the penetration forecast was adjusted such that growth begins in 2025, and values from 2016-2024 remain steady at the starting saturation of 1.18% While there is the potential for overlap in savings between BOC and SEM interventions, the current saturation of these measures and relatively low penetration rate forecast indicate that the risk of double counting savings is minimal and, therefore, was not considered in this model.

Going forward, the team expects the role of BOC to expand with the development and increasingly widespread use of energy management and information systems to help building operators identify and address building performance issues. Future revisions of the study should consider data on the relationship between BOC and energy management and information systems as it becomes available, including revised saturation estimates for equipment associated with energy management and information systems from the forthcoming CEUS update.

Savings

The method to calculate unit energy savings (UES) has changed over time, and the 2025 Study uses the same approach and values as the 2017, 2019, 2021, and 2023 studies. For context, the 2015 Study used the average electric and natural gas savings of 58 kWh and 5.6 therms per 1,000 square feet of participating building space for all market segments.[116] The 2017 Study refined this approach and applied a market segment-specific UES value that accounted for differences in building energy density. For example, a grocery store with much higher energy densities than a warehouse would experience a proportionally greater savings rate per unit of conditioned space. In this example, a grocery store in PG&E territory is expected to save 151.3 kWh and 5.2 therms per 1,000 square feet compared to an unrefrigerated warehouse that would be expected to save 18.2 kWh and 0.8 therms per 1,000 square feet after accounting for differences in energy density.

Consistent with the 2023 and 2021 Studies, the 2025 PG Model uses an EUL of 3 years per CPUC Decision 16-08-019, and a ratio of 0.000092 kW to kWh was applied to the three electric utilities. The peak kW to kWh value is based on an analysis of several third-party programs operating in California during the 2014-2015 portfolio cycle. This ratio was then updated based on California hourly load profiles to align with the current DEER peak period definition.[117]

[116] Navigant Consulting, Inc. "Section 3.7.1 Non-Residential Behavior Model Updates," *Energy Efficiency Potential and Goals Study for 2015 and Beyond Stage 1*. Final Report., September 25, 2015.

[117] CPUC. Resolution E-4952, October 11, 2018. CPUC Resolution E-4952

Cost

Costs for electricity and natural gas savings are estimated at $0.29 per kWh and $3.65 per therm; these values are applied consistently by building type across utilities.

Appendix E. Codes and Standards

Table E-1 describes the list of codes and standards (C&S) accounted for in the model.

Table E-1. C&S in the Model

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
2005 T-20	2005 T-20: Commercial Dishwasher Pre-Rinse Spray Valves	100%	4/16/2015
2005 T-20	2005 T-20: Commercial Ice Maker Equipment	70%	1/1/2010
2005 T-20	2005 T-20: Commercial Refrigeration Equipment, Solid Door	70%	4/16/2015
2005 T-20	2005 T-20: Commercial Refrigeration Equipment, Transparent Door	70%	10/1/2010
2005 T-20	2005 T-20: Consumer Electronics - Audio Players	100%	1/1/2006
2005 T-20	2005 T-20: Consumer Electronics - DVDs	31%	1/1/2010
2005 T-20	2005 T-20: Consumer Electronics - TVs	96%	1/1/2006
2005 T-20	2005 T-20: External Power Supplies, Tier 1	100%	10/1/2010
2005 T-20	2005 T-20: External Power Supplies, Tier 2	99%	10/1/2010
2005 T-20	2005 T-20: General Service Incandescent Lamps, Tier 1	69%	9/1/2010
2005 T-20	2005 T-20: Hot Food Holding Cabinets	70%	10/1/2010
2005 T-20	2005 T-20: Large Packaged Commercial Air-Conditioners, Tier 1	70%	1/1/2010
2005 T-20	2005 T-20: Large Packaged Commercial Air-Conditioners, Tier 2	70%	1/1/2010
2005 T-20	2005 T-20: Modular Furniture Task Lighting Fixtures	70%	1/1/2006
2005 T-20	2005 T-20: Portable Electric Spas	70%	1/1/2010
2005 T-20	2005 T-20: Pulse Start Metal Halide HID Luminaires, Tier 1(Vertical Lamps)	100%	10/1/2010
2005 T-20	2005 T-20: Pulse Start Metal Halide HID Luminaires, Tier 2(All other MH	100%	1/1/2006
2005 T-20	2005 T-20: Refrigerated Beverage Vending Machines	37%	1/1/2010
2005 T-20	2005 T-20: Residential Pool Pumps, High Eff Motor, Tier 1	100%	1/1/2010
2005 T-20	2005 T-20: Unit Heaters and Duct Furnaces	100%	10/1/2010
2005 T-20	2005 T-20: Walk-In Refrigerators / Freezers	91%	1/1/2010
2005 T-20	2005 T-20: Water Dispensers	70%	1/1/2010
2005 T-24	2005 T-24: Bi-level lighting control credits	79%	10/1/2010
2005 T-24	2005 T-24: Composite for Remainder - Non-Res	85%	10/1/2010
2005 T-24	2005 T-24: Composite for Remainder - Res	120%	1/1/2010
2005 T-24	2005 T-24: Cool roofs	75%	10/1/2010
2005 T-24	2005 T-24: Cooling tower applications	88%	1/1/2010
2005 T-24	2005 T-24: Duct improvement	59%	1/1/2006
2005 T-24	2005 T-24: Duct testing/sealing in new commercial buildings	82%	10/1/2010
2005 T-24	2005 T-24: Ducts in existing commercial buildings	75%	1/1/2010
2005 T-24	2005 T-24: Lighting controls under skylights	8%	1/1/2010
2005 T-24	2005 T-24: Multifamily Water Heating	78%	1/1/2010
2005 T-24	2005 T-24: Relocatable classrooms	100%	7/1/2016
2005 T-24	2005 T-24: Res. Hardwired lighting	113%	1/1/2006
2005 T-24	2005 T-24: Time dependent valuation, Nonresidential	0%	1/1/2006
2005 T-24	2005 T-24: Time dependent valuation, Residential	0%	4/16/2015
2005 T-24	2005 T-24: Whole Building - Non-Res New Construction (Electric)	0%	10/1/2010

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
2005 T-24	2005 T-24: Whole Building - Non-Res New Construction (Gas)	0%	1/1/2006
2005 T-24	2005 T-24: Whole Building - Res New Construction (Electric)	120%	12/1/2010
2005 T-24	2005 T-24: Whole Building - Res New Construction (Gas)	235%	1/1/2011
2005 T-24	2005 T-24: Window replacement	80%	9/1/2010
2006 T-20	2006 T-20: BR, ER and R20 Incandescent Reflector Lamps: Commercial	82%	1/1/2011
2006 T-20	2006 T-20: BR, ER and R20 Incandescent Reflector Lamps: Residential	82%	7/1/2008
2006 T-20	2006 T-20: General Service Incandescent Lamps, Tier 2 #1	87%	10/1/2010
2006 T-20	2006 T-20: General Service Incandescent Lamps, Tier 2 #2	87%	10/1/2010
2006 T-20	2006 T-20: General Service Incandescent Lamps, Tier 2 #3	89%	10/1/2010
2006 T-20	2006 T-20: Residential Pool Pumps, 2-speed Motors, Tier 2	86%	1/1/2010
2008 T-20	2008 T-20: General Purpose Lighting -- 100 watt	88%	1/1/2010
2008 T-20	2008 T-20: General Purpose Lighting -- 60 and 40 watt	85%	1/1/2011
2008 T-20	2008 T-20: General Purpose Lighting -- 75 watt	40%	1/1/2011
2008 T-20	2008 T-20: Metal Halide Fixtures	95%	1/1/2010
2008 T-20	2008 T-20: Portable Lighting Fixtures	93%	1/1/2010
2008 T-24	2008 T-24: CfR HVAC Efficiency	397%	10/1/2010
2008 T-24	2008 T-24: CfR IL Area Category Method	569%	10/1/2010
2008 T-24	2008 T-24: CfR IL Complete Building Method	571%	10/1/2010
2008 T-24	2008 T-24: CfR IL Egress Control	397%	10/1/2010
2008 T-24	2008 T-24: CfR Res Central Fan WL	83%	10/1/2010
2008 T-24	2008 T-24: CfR Res Cool Roofs	83%	10/1/2010
2008 T-24	2008 T-24: Cool Roof Expansion	153%	10/1/2010
2008 T-24	2008 T-24: DDC to Zone	397%	10/1/2010
2008 T-24	2008 T-24: DR Indoor Lighting	397%	10/1/2010
2008 T-24	2008 T-24: Envelope insulation	123%	10/29/2029
2008 T-24	2008 T-24: MF Water heating control	0%	10/1/2010
2008 T-24	2008 T-24: Outdoor Lighting	83%	4/1/2015
2008 T-24	2008 T-24: Outdoor Signs	83%	1/1/2010
2008 T-24	2008 T-24: Overall Envelope Tradeoff	397%	10/29/2029
2008 T-24	2008 T-24: Refrigerated warehouses	83%	1/1/2010
2008 T-24	2008 T-24: Residential Fenestration	83%	10/1/2010
2008 T-24	2008 T-24: Residential Swimming pool	83%	10/1/2010
2008 T-24	2008 T-24: Sidelighting	397%	1/1/2010
2008 T-24	2008 T-24: Site Built Fenestration	83%	10/1/2010
2008 T-24	2008 T-24: Skylighting	397%	10/29/2029
2008 T-24	2008 T-24: Tailored Indoor lighting	573%	1/1/2010
2008 T-24	2008 T-24: TDV Lighting Controls	0%	4/1/2015
2009 T-20	2009 T-20: Televisions - Tier 1	98%	7/1/2008
2009 T-20	2009 T-20: Televisions - Tier 2	99%	1/1/2010
2011 T-20	2011 T-20: Large Battery Chargers (≥2kW rated input)	78%	10/29/2029
2011 T-20	2011 T-20: Small Battery Chargers—Tier 1 (consumer with no USB charger or USB charger <20 watt-hours)	90%	1/1/2010
2011 T-20	2011 T-20: Small Battery Chargers—Tier 2 (consumer with USB charger ≥20 watt-hours)	88%	1/1/2010
2011 T-20	2011 T-20: Small Battery Chargers—Tier 3 (non-consumer)	85%	10/29/2029
2013 T-24	2013 T-24: NRA-Envelope-Cool Roofs	83%	10/1/2010

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
2013 T-24	2013 T-24: NRA-HVAC-Equipment Efficiency	83%	10/1/2010
2013 T-24	2013 T-24: NRA-Lighting-Alterations-Existing Measures	91%	10/1/2010
2013 T-24	2013 T-24: NRA-Lighting-Alterations-New Measures	91%	10/1/2010
2013 T-24	2013 T-24: NRA-Lighting-Egress Lighting Control	95%	10/1/2010
2013 T-24	2013 T-24: NRA-Lighting-Hotel Corridors	91%	10/1/2010
2013 T-24	2013 T-24: NRA-Lighting-MF Building Corridors	91%	10/1/2010
2013 T-24	2013 T-24: NRA-Lighting-Warehouses and Libraries	91%	10/1/2010
2013 T-24	2013 T-24: NRA-Process-Air Compressors	95%	10/1/2010
2013 T-24	2013 T-24: NRNC-DHW - Hotel DHW Control and Solar	83%	4/1/2015
2013 T-24	2013 T-24: NRNC-DHW-Solar Water Heating	83%	4/1/2015
2013 T-24	2013 T-24: NRNC-Envelope-Cool Roofs	93%	10/1/2010
2013 T-24	2013 T-24: NRNC-Envelope-Fenestration	90%	10/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Acceptance Requirements	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Chiller Min Efficiency	93%	10/29/2029
2013 T-24	2013 T-24: NRNC-HVAC-Commercial Boilers	93%	1/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Cooling Towers Water	83%	1/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Evap Cooling Credit	83%	1/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Fan Control & Economizers	93%	10/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Garage Exhaust	83%	1/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Guest Room OC Controls	93%	10/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-HVAC Controls and Economizers	93%	10/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Kitchen Ventilation	93%	1/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Laboratory Exhaust	83%	1/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Low-Temp Radiant Cooling	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Occupant Controlled Smart Thermostats	83%	4/1/2015
2013 T-24	2013 T-24: NRNC-HVAC-Outside Air	83%	1/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Reduced Reheat	93%	10/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Small ECM Motor	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-HVAC-Water & Space Heating ACM	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-Controllable Lighting	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-Daylighting	93%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-DR Lighting Controls	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-Egress Lighting Control	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-Hotel Corridors	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-Indoor Lighting Controls	93%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-MF Building Corridors	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-Office Plug Load Control	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-Outdoor Lighting & Controls	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-Parking Garage	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-Retail	93%	10/1/2010
2013 T-24	2013 T-24: NRNC-Lighting-Warehouses and Libraries	83%	10/1/2010
2013 T-24	2013 T-24: NRNC-Process-Air Compressors	83%	4/1/2015
2013 T-24	2013 T-24: NRNC-Process-Data Centers	83%	4/1/2015
2013 T-24	2013 T-24: NRNC-Process-Process Boilers	83%	4/1/2015
2013 T-24	2013 T-24: NRNC-Refrigeration-Supermarket	83%	4/1/2015
2013 T-24	2013 T-24: NRNC-Refrigeration-Warehouse	83%	10/1/2010

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
2013 T-24	2013 T-24: NRNC-Solar-Solar Ready	83%	4/1/2015
2013 T-24	2013 T-24: NRNC-Whole Building	93%	4/1/2015
2013 T-24	2013 T-24: RA-MF Whole Building	83%	10/1/2010
2013 T-24	2013 T-24: RA-SF Whole Building	67%	10/1/2010
2013 T-24	2013 T-24: RNC-DHW - High Efficiency Water Heater Ready	83%	4/16/2015
2013 T-24	2013 T-24: RNC-DHW - MF DHW Control and Solar	83%	4/16/2015
2013 T-24	2013 T-24: RNC-DHW - Solar for Electrically Heated Homes	83%	10/1/2010
2013 T-24	2013 T-24: RNC-DHW-SF DHW	83%	1/1/2010
2013 T-24	2013 T-24: RNC-Envelope-Advanced Envelope	83%	10/1/2010
2013 T-24	2013 T-24: RNC-Envelope-Fenestration	47%	4/16/2015
2013 T-24	2013 T-24: RNC-Envelope-Roof Envelope	83%	4/16/2015
2013 T-24	2013 T-24: RNC-Envelope-Wall Insulation	76%	10/1/2010
2013 T-24	2013 T-24: RNC-HVAC - Refrigerant Charge	83%	1/1/2010
2013 T-24	2013 T-24: RNC-HVAC-Duct	68%	4/16/2015
2013 T-24	2013 T-24: RNC-HVAC-Whole House Fans	59%	10/1/2010
2013 T-24	2013 T-24: RNC-HVAC-Zoned AC	42%	4/16/2015
2013 T-24	2013 T-24: RNC-Lighting	0%	4/16/2015
2013 T-24	2013 T-24: RNC-MF Whole Building	83%	10/1/2010
2013 T-24	2013 T-24: RNC-SF Whole Building	67%	10/1/2010
2013 T-24	2013 T-24: RNC-Solar - Solar Ready & Oriented Homes	83%	10/1/2010
2016 T-20	2016 T-20: Air Filter Labeling	90%	1/1/2022
2016 T-20	2016 T-20: Computers - Desktops - Tier 1	90%	10/1/2010
2016 T-20	2016 T-20: Computers - Desktops - Tier 2	90%	10/1/2010
2016 T-20	2016 T-20: Computers - Notebooks	90%	10/1/2010
2016 T-20	2016 T-20: Displays - Monitors	90%	10/1/2010
2016 T-20	2016 T-20: LED Quality - Tier 2	88%	10/1/2010
2016 T-20	2016 T-24: Nonresidential Lighting Alterations (Units = sq ft)	98%	10/29/2029
2016 T-20	2016 T-24: Non-Residential New Construction-Whole Building (Units = sq ft)	96%	1/1/2010
2016 T-20	2016 T-24: NRA-HVAC-ASHRAE Equipment Efficiency	95%	1/1/2010
2016 T-20	2016 T-24: NRA-HVAC-ASHRAE Measure-DDC	95%	1/1/2010
2016 T-20	2016 T-24: NRA-Lighting-ASHRAE Elevator Lighting & Ventilation	95%	1/1/2010
2016 T-20	2016 T-24: NRA-Lighting-Outdoor Lighting Controls (unit = control)	95%	1/1/2010
2016 T-20	2016 T-24: NRA-Process-ASHRAE Measure-Escalator Speed Control	95%	1/1/2010
2016 T-20	2016 T-24: Residential Alterations-Multifamily Whole Building (Units = # of dwellings)	95%	1/1/2010
2016 T-20	2016 T-24: Residential Alterations-Single Family Whole Building (Units = # of homes)	95%	1/1/2010
2016 T-20	2016 T-24: Residential New Construction-Multifamily Whole Building (Units = # of dwellings)	95%	4/16/2015
2016 T-20	2016 T-24: Residential New Construction-Whole Building (units=# of homes)	100%	10/29/2029
Federal	2016-18 Fed App: Commercial CAC and HP (65,000 Btu/hr to 760,000 Btu/hr) - Tier 2	87%	10/1/2010
2018 T-20	2018 T-20: Portable Electric Spas - Inflatable	90%	10/1/2010
2018 T-20	2018 T-20: Portable Electric Spas - Rigid	90%	10/1/2010

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
2019 T-20	2019 T-20: General Service Lamps - Expanded Scope	90%	10/1/2010
2019 T-24	2019 T-24: NRA-Indoor Lighting-Alterations (Control)	90%	10/1/2010
2019 T-24	2019 T-24: NRA-Indoor Lighting-Alterations (LPD)	90%	10/1/2010
2019 T-24	2019 T-24: NRA-Indoor Lighting-New Controls	90%	10/1/2010
2019 T-24	2019 T-24: NRA-Indoor Lighting-New LPD	90%	10/1/2010
2019 T-24	2019 T-24: NRA-MECH-ASHRAE 90.1	90%	10/1/2010
2019 T-24	2019 T-24: NRA-MECH-Cooling Towers	90%	10/1/2010
2019 T-24	2019 T-24: NRA-MECH-HE Fume Hoods in Lab Spaces	90%	10/1/2010
2019 T-24	2019 T-24: NRA-MECH-Variable Exhaust Flow Control	90%	10/1/2010
2019 T-24	2019 T-24: NRA-Outdoor Lighting-Controls	90%	10/1/2010
2019 T-24	2019 T-24: NRA-Outdoor Lighting-LPA (General Hardscape)	90%	10/1/2010
2019 T-24	2019 T-24: NRA-Outdoor Lighting-LPA (Specific Applications)	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-Envelope-Dock Seals	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-Indoor Lighting-Controls	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-Indoor Lighting-LPD	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-MECH-Adiabatic Condensers for Refrigeration	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-MECH-ASHRAE 90.1	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-MECH-Cooling Towers	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-MECH-Economizer FDD	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-MECH-HE Fume Hoods in Lab Spaces	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-MECH-Variable Exhaust Flow Control	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-MECH-Ventilation & IAQ	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-Outdoor Lighting-Controls	90%	10/1/2010
2019 T-24	2019 T-24: NRNC-Outdoor Lighting-LPA (General Hardscape)	90%	10/1/2020
2019 T-24	2019 T-24: NRNC-Outdoor Lighting-LPA (Specific Applications)	90%	10/1/2020
2019 T-24	2019 T-24: RA(MF)-Envelope-QII	90%	10/1/2010
2019 T-24	2019 T-24: RA(MF)-Envelope-Windows and Doors	90%	10/1/2010
2019 T-24	2019 T-24: RA(MF)-MECH-Quality HVAC	90%	10/1/2010
2019 T-24	2019 T-24: RA(SF)-Envelope-High Performance Walls	90%	10/1/2010
2019 T-24	2019 T-24: RA(SF)-Envelope-QII	90%	10/1/2010
2019 T-24	2019 T-24: RA(SF)-Envelope-Windows and Doors	90%	10/1/2010
2019 T-24	2019 T-24: RA(SF)-MECH-Quality HVAC	90%	10/1/2010
2019 T-24	2019 T-24: RNC(MF)-Envelope-High Performance Attics	90%	10/1/2010
2019 T-24	2019 T-24: RNC(MF)-Envelope-QII	90%	10/1/2010
2019 T-24	2019 T-24: RNC(MF)-Envelope-Windows and Doors	90%	10/1/2010
2019 T-24	2019 T-24: RNC(MF)-MECH-Quality HVAC	90%	10/1/2010
2019 T-24	2019 T-24: RNC(SF)-Envelope-High Performance Attics	90%	10/1/2010
2019 T-24	2019 T-24: RNC(SF)-Envelope-High Performance Walls	90%	10/1/2010
2019 T-24	2019 T-24: RNC(SF)-Envelope-QII	90%	10/1/2010
2019 T-24	2019 T-24: RNC(SF)-Envelope-Windows and Doors	90%	10/1/2010
2019 T-24	2019 T-24: RNC(SF)-MECH-Quality HVAC	90%	10/1/2010
Federal	2019-21 Fed App: Ceiling fan light kits	87%	10/1/2010
Federal	2019-21 Fed App: Ceiling Fans	87%	10/1/2010
Federal	2019-21 Fed App: Commercial and industrial pumps	87%	10/1/2010

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
Federal	2019-21 Fed App: Dedicated-purpose pool pumps	87%	10/1/2010
Federal	2019-21 Fed App: Dehumidifiers	87%	10/1/2010
Federal	2019-21 Fed App: Pre-rinse spray valves	87%	10/1/2010
Federal	2019-21 Fed App: Refrigerated beverage vending machines	87%	10/1/2010
Federal	2019-21 Fed App: Residential boilers - gas-fired hot water and electric hot water	87%	10/1/2010
Federal	2019-21 Fed App: Residential boilers - gas-fired steam and electric steam	87%	10/1/2010
Federal	2019-21 Fed App: Residential furnace fans	87%	7/3/2019
Federal	2019-21 Fed App: Single package vertical AC and HP - <65,000 Btu/hr	87%	10/1/2010
Federal	2019-21 Fed App: Wine chillers	87%	10/1/2010
2021 T-20	2021 T-20: Replacement Dedicated-Purpose Pool Pump Motors	90%	7/19/2021
2022 T-20	2022 T-20: Air Compressors	90%	1/1/2022
2022 T-24	2022 T-24: MFA - Outdoor Lighting - Lighting Power Allowances	90%	2/1/2023
2022 T-24	2022 T-24: MFA - Restructuring - Airflow and Fan Watt Draw	90%	10/1/2010
2022 T-24	2022 T-24: MFA - Restructuring - Duct Insulation	90%	2/1/2023
2022 T-24	2022 T-24: MFA - Restructuring - Duct Sealing and Testing	90%	10/1/2010
2022 T-24	2022 T-24: MFA - Restructuring - Fenestration Properties	90%	10/1/2010
2022 T-24	2022 T-24: MFA - Restructuring - Refrigerant Charge Verification	90%	10/1/2010
2022 T-24	2022 T-24: MFA - Restructuring - Roof Assemblies	90%	10/1/2010
2022 T-24	2022 T-24: MFNC - All Electric Package - Prescriptive Alternative for Central HPWH	12%	10/1/2010
2022 T-24	2022 T-24: MFNC - All Electric Package - Single Zone Heat Pump Electric Space Heating for Mid-rise and High-rise MF	33%	10/1/2010
2022 T-24	2022 T-24: MFNC - Boilers and Service Water Heating - Gas Service Water Heating	90%	10/1/2010
2022 T-24	2022 T-24: MFNC - Domestic Hot Water - Increased Insulation for Hot Water Distribution	90%	10/1/2010
2022 T-24	2022 T-24: MFNC - Indoor Air Quality - Central Ventilation Duct Sealing	90%	10/1/2010
2022 T-24	2022 T-24: MFNC - Indoor Air Quality - Heat or Energy Recovery Ventilator	90%	10/1/2010
2022 T-24	2022 T-24: MFNC - Outdoor Lighting - Lighting Power Allowances	90%	9/1/2023
2022 T-24	2022 T-24: MFNC - Restructuring - Airflow and Fan Watt Draw	90%	10/1/2010
2022 T-24	2022 T-24: MFNC - Restructuring - Duct Insulation	90%	9/1/2023
2022 T-24	2022 T-24: MFNC - Restructuring - Duct Sealing and Testing	90%	10/1/2010
2022 T-24	2022 T-24: MFNC - Restructuring - Fenestration Properties	90%	10/1/2010
2022 T-24	2022 T-24: MFNC - Restructuring - Refrigerant Charge Verification	90%	10/1/2010
2022 T-24	2022 T-24: MFNC - Restructuring - Roof Assemblies	90%	10/1/2010
2022 T-24	2022 T-24: MFNC - Restructuring - Wall U-Factor	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Air Distribution - Duct Leakage Testing	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Air Distribution - Fan Energy Index	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Air Distribution - Fan Power Budget	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Boilers and Service Water Heating - Process Boiler Oxygen Concentration	90%	2/1/2023

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
2022 T-24	2022 T-24: NRA - Compressed Air Systems - Monitoring	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Computer Room Efficiency - Uninterruptible Power Supply Efficiency	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Controlled Environment Horticulture - Efficient Dehumidification	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Controlled Environment Horticulture - Lighting Efficacy	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Daylighting - Automatic Daylight Dimming to 10%	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Daylighting - Mandatory Automatic Daylighting Controls in the Secondary Sidelit Daylit Zone	90%	2/1/2023
2022 T-24	2022 T-24: NRA - Envelope - Cool Roofs: Steep-Sloped	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Envelope - Roof Recovers	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Envelope - Roof Replacements	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Grid Integration - Demand Responsive Lighting Systems	90%	10/1/2010
2022 T-24	2022 T-24: NRA - HVAC Controls - Dedicated Outdoor Air Systems (DOAS)	90%	2/1/2023
2022 T-24	2022 T-24: NRA - HVAC Controls - Exhaust Air Heat Recovery	90%	10/1/2010
2022 T-24	2022 T-24: NRA - HVAC Controls - Expand Economizer Requirements	90%	10/1/2010
2022 T-24	2022 T-24: NRA - HVAC Controls - VAV Deadband Airflow	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Indoor Lighting - Lighting Power Densities	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Indoor Lighting - Multi-zone Occupancy Sensing in Large Offices	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Outdoor Lighting - Lighting Power Allowances for General Hardscapes	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Outdoor Lighting - Lighting Zone Reclassification	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Reduce Infiltration - Require air barrier where not currently required	90%	10/1/2010
2022 T-24	2022 T-24: NRA - Refrigeration System - Automatic Door Closers for Refrigerated Spaces	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Air Distribution - Duct Leakage Testing	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Air Distribution - Fan Energy Index	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Air Distribution - Fan Power Budget	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Boilers and Service Water Heating - Gas Boiler Systems	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Boilers and Service Water Heating - Gas Service Water Heating	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Boilers and Service Water Heating - Process Boiler Oxygen Concentration	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Compressed Air Systems - Leak Testing	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Compressed Air Systems - Monitoring	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Compressed Air Systems - Pipe Sizing	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Computer Room Efficiency - Increased Temperature Thresholds for Economizers	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Computer Room Efficiency - Uninterruptible Power Supply Efficiency	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Controlled Environment Horticulture - Efficient Dehumidification	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Controlled Environment Horticulture - Lighting Efficacy	90%	10/1/2010

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
2022 T-24	2022 T-24: NRNC - Daylighting - Automatic Daylight Dimming to 10%	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Daylighting - Mandatory Automatic Daylighting Controls in the Secondary Sidelit Daylit Zone	90%	10/1/2023
2022 T-24	2022 T-24: NRNC - Envelope - Cool Roofs: Steep-Sloped	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Envelope - High Performance Windows	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Envelope - Opaque Envelope: Wall	90%	10/1/2023
2022 T-24	2022 T-24: NRNC - Grid Integration - Demand Responsive Lighting Systems	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - HVAC Controls - Dedicated Outdoor Air Systems (DOAS)	90%	10/1/2023
2022 T-24	2022 T-24: NRNC - HVAC Controls - Exhaust Air Heat Recovery	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - HVAC Controls - Expand Economizer Requirements	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - HVAC Controls - VAV Deadband Airflow	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Indoor Lighting - Lighting Power Densities	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Indoor Lighting - Multi-zone Occupancy Sensing in Large Offices	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Outdoor Lighting - Nonresidential Lighting Power Allowances for General Hardscapes	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Outdoor Lighting - Nonresidential Lighting Zone Reclassification	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Reduce Infiltration - Require air barrier where not currently required	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Refrigeration System - Automatic Door Closers for Refrigerated Spaces	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Refrigeration System - Design and Control Requirements for Transcritical CO2 Systems - Adiabatic Condenser	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Steam Trap - FDD	90%	10/1/2010
2022 T-24	2022 T-24: NRNC - Steam Trap - Strainers	90%	10/1/2010
2022 T-24	2022 T-24: SFA - Cool roof for low-sloped roof	90%	2/1/2023
2022 T-24	2022 T-24: SFA - Cool roof for steep-sloped roofs	90%	2/1/2023
2022 T-24	2022 T-24: SFA - Electric resistance space heating	90%	2/1/2023
2022 T-24	2022 T-24: SFA - Prescriptive attic insulation for alterations	90%	2/1/2023
2022 T-24	2022 T-24: SFA - Prescriptive duct insulation	90%	2/1/2023
2022 T-24	2022 T-24: SFA - Prescriptive duct sealing	90%	2/1/2023
2022 T-24	2022 T-24: SFA - Roof deck insulation for low-sloped roofs	90%	2/1/2023
2022 T-24	2022 T-24: SFNC - Prescriptive attic insulation for additions	90%	2/1/2023
Federal	2022-24 Fed App: Air purifiers - Tier 1	87%	1/1/2024
Federal	2022-24 Fed App: Commercial boilers	87%	10/1/2010
Federal	2022-24 Fed App: Commercial warm air furnaces	87%	1/1/2023
Federal	2022-24 Fed App: Residential central AC & HP	87%	10/1/2010
Federal	2022-24 Fed App: Uninterruptible Power Supplies	87%	10/1/2010
2005 T-20	2024 FDAS: Flexible Demand Appliance standard - Pool Controls	90%	9/29/2025
2024 T-20	2024 T-20: Air Filter Labeling	90%	7/1/2024
2024 T-20	2024 T-20: Standalone Fans	90%	4/29/2024
2025 T-24	2025 T-24: CEH - Greenhouse Lighting - Cannabis (Alterations)	90%	2/1/2026

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
2025 T-24	2025 T-24: CEH - Greenhouse Lighting - Cannabis (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: CEH - Greenhouse Lighting - Greens (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: CEH - Greenhouse Lighting - Greens (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: CEH - Greenhouse Lighting - Tomatoes (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: CEH - Greenhouse Lighting - Tomatoes (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: CEH - Indoor Lighting - Cannabis (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: CEH - Indoor Lighting - Cannabis (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: CEH - Indoor Lighting - Greens (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: CEH - Indoor Lighting - Greens (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: CEH - Indoor Lighting - Tomatoes (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: CEH - Indoor Lighting - Tomatoes (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: Cooling Towers - Cooling Tower Efficiency (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Cooling Towers - Cooling Tower Efficiency (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: Daylighting - Revise Automatic Daylighting Controls Exceptions (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Daylighting - Revise Automatic Daylighting Controls Exceptions (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: Industrial Pipe Insulation and Verification - Pipe & Fittings Insulation and Verification (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Industrial Pipe Insulation and Verification - Pipe & Fittings Insulation and Verification (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: Laboratories - ACH Setbacks (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Laboratories - ACH Setbacks (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: Laboratories - Exhaust Fan Control (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Laboratories - Exhaust Fan Control (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: Laboratories - Heat Recovery (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Laboratories - Heat Recovery (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: Laboratories - Reheat Limitation (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Laboratories - Reheat Limitation (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - CPC Appendix M Pipe Sizing-Gas (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - CPC Appendix M Pipe Sizing-HPWH (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - DHW Balancing Valves-Gas (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - DHW Balancing Valves-Gas (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - DHW Balancing Valves-HPWH (Alterations)	90%	2/1/2026

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - DHW Balancing Valves-HPWH (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - DHW Master Mixing Valves-Gas (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - DHW Master Mixing Valves-HPWH (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - DHW Pipe Insulation Enhancement-Gas (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - DHW Pipe Insulation Enhancement-HPWH (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - Individual HPWH Ventilation - Exterior (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - Individual HPWH Ventilation - Exterior (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - Individual HPWH Ventilation - Interior (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Multifamily Domestic Hot Water - Individual HPWH Ventilation - Interior (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Envelope - Cool Roof Improvements (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Envelope - High Performance Windows (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Envelope - Window Alterations (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Multifamily IAQ - Compartmentalization and Balanced or supply-only ventilation (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Restructuring - Central Ventilation Shaft Sealing (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: Multifamily Restructuring - Slab Perimeter Insulation (New Construction + Additions)	90%	10/1/2026
2025 T-24	2025 T-24: NR High Performance Envelope - Prescriptive Heavy Mass Walls U-Value (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR High Performance Envelope - Prescriptive Light Mass Walls U-Value (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR High Performance Envelope - Prescriptive Metal Building Walls U-Value (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR High Performance Envelope - Prescriptive Metal Roof U-Value (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR High Performance Envelope - Prescriptive Woodframed and Other Roof U-Value (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR High Performance Envelope - Prescriptive Woodframed Walls U-Value (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR High Performance Envelope - Reduced Infiltration Vestibules: require vestibules for certain buildings (Thermal bridging) (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR High Performance Envelope - Windows/Fenestration - Alterations (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: NR High Performance Envelope - Windows/Fenestration - New Construction (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR HVAC - Limit Hot Water Supply Temperatures - Electric (Alterations)	90%	2/1/2026

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
2025 T-24	2025 T-24: NR HVAC - Limit Hot Water Supply Temperatures - Electric (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR HVAC - Limit Hot Water Supply Temperatures - Gas (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: NR HVAC - Limit Hot Water Supply Temperatures - Gas (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR HVAC - Mechanical Heat Recovery - SHW Heat Recovery (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR HVAC - Mechanical Heat Recovery (without TES, waterside HR) (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR HVAC - Mechanical Heat Recovery Scenario A - Gas Baseline (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR HVAC - Mechanical Heat Recovery Scenario B - Gas Baseline (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR HVAC Controls - Guideline 36 (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: NR HVAC Controls - Guideline 36 (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: NR Refrigeration - Evaporator Specific Efficiency for Refrigerated Warehouses (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: NR Refrigeration - Evaporator Specific Efficiency for Refrigerated Warehouses (New Construction + Additions)	90%	11/1/2026
2025 T-24	2025 T-24: Residential HVAC Performance - Multifamily Design (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Residential HVAC Performance - Refrigerant Charge Verification (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Residential HVAC Performance - Refrigerant Charge Verification (New Construction + Additions)	90%	7/1/2026
2025 T-24	2025 T-24: Residential HVAC Performance - Single Family Defrost (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Residential HVAC Performance - Single Family Defrost (New Construction + Additions)	90%	7/1/2026
2025 T-24	2025 T-24: Residential HVAC Performance - Single Family Design (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Residential HVAC Performance - Single Family Design (New Construction + Additions)	90%	7/1/2026
2025 T-24	2025 T-24: Single Family High-Performance Envelope - High-Performance Windows (Alterations)	90%	2/1/2026
2025 T-24	2025 T-24: Single Family High-Performance Envelope - High-Performance Windows (New Construction + Additions)	90%	7/1/2026
2025 T-24	2025 T-24: Single Family HVAC - Supplemental Heating Combined (New Construction + Additions)	90%	7/1/2026
2025 T-24	2025 T-24: Solar Pool and Water Heating - Solar Pool Heating - Nonresidential (New Construction + Additions)	90%	7/1/2026
2025 T-24	2025 T-24: Solar Pool and Water Heating - Solar Pool Heating - Residential (New Construction + Additions)	90%	7/1/2026
2025 T-24	2025 T-24: Solar Pool and Water Heating - Solar Pool Heating - Residential (Alterations)	90%	2/1/2026
Federal	2025-27 Fed App: Air Compressors	87%	1/10/2025
Federal	2025-27 Fed App: Air purifiers - Tier 2	87%	1/1/2026
Federal	2025-27 Fed App: Commercial water heaters - Commercial gas-fired storage water heaters and instantaneous gas-fired storage-type water heaters	87%	10/6/2026
Federal	2025-27 Fed App: Commercial water heaters - Gas-fired instantaneous water heaters and hot water supply boilers	87%	10/6/2026

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
Federal	2025-27 Fed App: Commercial water heaters - Residential-duty gas-fired storage water heaters	87%	10/6/2026
Federal	2025-27 Fed App: Dedicated Purpose Pool Pump Motors - Tier 1 - Extra small	87%	9/29/2025
Federal	2025-27 Fed App: Dedicated Purpose Pool Pump Motors - Tier 1 - Standard	87%	9/29/2025
Federal	2025-27 Fed App: Dedicated Purpose Pool Pump Motors - Tier 2 - Small	87%	9/29/2027
Federal	2025-27 Fed App: Electric Motors - AO-MEM (Standard Frame Size)	87%	6/1/2027
Federal	2025-27 Fed App: Electric Motors - AO-Polyphase (Specialized Frame Size)	87%	6/1/2027
Federal	2025-27 Fed App: Electric Motors - MEM 1-500 hp, NEMA Design A & B	87%	6/1/2027
Federal	2025-27 Fed App: Electric Motors - MEM 501-750 hp, NEMA Design A & B	87%	6/1/2027
Federal	2025-27 Fed App: Microwave ovens - Built-In and Over-the-Range Convection Microwave Ovens	87%	6/22/2026
Federal	2025-27 Fed App: Microwave ovens - Microwave-Only Ovens and Countertop Convection Microwave Ovens	87%	6/22/2026
Federal	2025-27 Fed App: Portable ACs	87%	3/10/2025
Federal	2025-27 Fed App: Room ACs	87%	5/26/2026
Federal	Fed Appliance: ASHRAE Products (Commercial boilers)	95%	10/1/2010
Federal	Fed Appliance: Commercial CAC and HP - <65,000 Btu/hr	100%	10/1/2010
Federal	Fed Appliance: Commercial CAC and HP - 65,000 Btu/hr to 760,000 Btu/hr - Tier 1	99%	10/29/2029
Federal	Fed Appliance: Commercial Clothes Washers	80%	10/1/2010
Federal	Fed Appliance: Commercial Clothes Washers #1	94%	10/1/2010
Federal	Fed Appliance: Commercial Ice Makers	100%	10/29/2029
Federal	Fed Appliance: Commercial Refrigeration	70%	6/1/2014
Federal	Fed Appliance: Commercial Refrigeration Equipment	100%	10/1/2010
Federal	Fed Appliance: Computer Room Acs >=65,000 Btu/h and < 760,000 Btu/h	100%	10/1/2010
Federal	Fed Appliance: Distribution transformers	100%	10/1/2010
Federal	Fed Appliance: Electric Motors	97%	10/1/2010
Federal	Fed Appliance: Electric Motors 1-200HP	91%	10/29/2029
Federal	Fed Appliance: External Power Supplies	0%	10/1/2010
Federal	Fed Appliance: Fluorescent Ballasts	80%	10/1/2010
Federal	Fed Appliance: General Service Fluorescent Lamps #1	95%	10/29/2029
Federal	Fed Appliance: GSFLs	80%	10/1/2010
Federal	Fed Appliance: Incandescent Reflector Lamps	65%	1/1/2010
Federal	Fed Appliance: Large and Very Large Commercial Package Air-Conditioners ≥135 kBtu/h	100%	10/1/2010
Federal	Fed Appliance: Metal Halide Lamp Fixtures	86%	10/1/2010
Federal	Fed Appliance: Microwave ovens	91%	10/1/2010
Federal	Fed Appliance: Refrigerated Beverage Vending Machines	37%	10/29/2029
Federal	Fed Appliance: Residential Central AC, Heat Pumps and Furnaces	99%	10/1/2010
Federal	Fed Appliance: Residential Clothes Dryers	99%	10/1/2010
Federal	Fed Appliance: Residential Clothes Washers - Top-loading	100%	10/1/2010
Federal	Fed Appliance: Residential Clothes Washers (Front Loading)	100%	10/1/2010

Regulation	Measure Name for Model 2025	Compliance Rate	Compliance Date
Federal	Fed Appliance: Residential Clothes Washers (Top Loading) Tier I	100%	10/1/2010
Federal	Fed Appliance: Residential Direct Heating Equipment	95%	10/1/2010
Federal	Fed Appliance: Residential Dishwashers	99%	10/1/2010
Federal	Fed Appliance: Residential Electric & Gas Ranges	100%	7/1/2008
Federal	Fed Appliance: Residential Electric storage water heater	88%	10/1/2010
Federal	Fed Appliance: Residential Gas-fired instantaneous water heater	87%	10/1/2010
Federal	Fed Appliance: Residential Gas-fired water heater	98%	10/1/2010
Federal	Fed Appliance: Residential Oil-fired storage water heater	85%	10/1/2010
Federal	Fed Appliance: Residential Pool Heaters	95%	10/1/2010
Federal	Fed Appliance: Residential Refrigerators & Freezers	95%	10/1/2010
Federal	Fed Appliance: Residential Room AC	91%	10/1/2010
Federal	Fed Appliance: Single package vertical AC and HP - >65,000 Btu/hr and <240,000 Btu/hr	90%	10/1/2010
Federal	Fed Appliance: Small Commercial Package Air-Conditioners ≥65 and <135 kBtu/h	100%	10/1/2010
Federal	Fed Appliance: Small Electric Motors	35%	10/1/2010
Federal	Fed Appliance: Walk-in coolers and freezers	79%	10/1/2010
T-20	T-20: Commercial Toilets	85%	10/29/2029
T-20	T-20: Computers - Small Scale Servers	0%	4/16/2015
T-20	T-20: Computers - Workstations	0%	1/1/2010
T-20	T-20: Dimming Ballasts	83%	10/1/2010
T-20	T-20: GSLs - Original Scope - Tier 2	100%	10/1/2010
T-20	T-20: LED Lamps - Tier 1	99%	1/1/2010
T-20	T-20: Public Lavatory Faucets	0%	10/1/2010
T-20	T-20: Residential Faucets & Aerators - Kitchen w/ Electric Water Heating	85%	10/1/2010
T-20	T-20: Residential Faucets & Aerators - Kitchen w/ Natural Gas Water Heating	85%	10/1/2010
T-20	T-20: Residential Faucets & Aerators - Lavatory w/ Electric Water Heating - Tier 1	0%	7/14/2012
T-20	T-20: Residential Faucets & Aerators - Lavatory w/ Electric Water Heating - Tier 2	100%	10/29/2029
T-20	T-20: Residential Faucets & Aerators - Lavatory w/ Natural Gas Water Heating - Tier 1	0%	7/1/2008
T-20	T-20: Residential Faucets & Aerators - Lavatory w/ Natural Gas Water Heating - Tier 2	100%	10/29/2029
T-20	T-20: Residential Toilets	85%	4/16/2015
T-20	T-20: Showerheads - w/ Electric Water Heaters - Tier 1	85%	10/1/2010
T-20	T-20: Showerheads - w/ Electric Water Heaters - Tier 2	70%	4/16/2015
T-20	T-20: Showerheads - w/ Natural Gas Water Heaters - Tier 1	85%	10/1/2010
T-20	T-20: Showerheads - w/ Natural Gas Water Heaters - Tier 2	70%	10/1/2010
T-20	T-20: Small Diameter Directional Lamps	67%	10/1/2010
T-20	T-20: Urinals	76%	10/1/2010

Source: Guidehouse

Table E-2 specifies all standards that are assumed to be superseded by other standards.

Table E-2. Superseded C&S

Superseded Code or Standard	Superseding Code or Standard	Source
2005 T-20: Walk-in Refrigerators/Freezers	Fed Appliance: Walk-in coolers and freezers	Guidehouse assumption
2005 T-20: Commercial Dishwasher Pre-Rinse Spray Valves	Fed Appliance: Pre-Rinse Spray Valves	Guidehouse assumption
2006 T-20: Residential Pool Pumps, 2-speed Motors, Tier 2	Fed Appliance: Pool Pumps	Guidehouse assumption

Source: Guidehouse

Appendix F. Industrial and Agriculture and Commercial Custom

F.1 Custom (NMEC) and SEM Market Study Findings and Trendline Adjustment Recommendations for 2025 PG Study

Past potential and goals studies calculated the forecast for energy savings in custom and SEM for the industrial and agricultural sector in a top down approach. The methodology only relied on historical program achievements. Due to program and market changes, Guidehouse recommended an alternative approach using market insights accessed by surveys. This memo describes our survey approach, survey design, methodology, and results. We conclude with key takeaways if there is a plan to revisit and replicate the approach used for this study cycle.

Survey Approach

Guidehouse conducted a market-focused survey to supplement the work of using the historical achievements. The survey collected market insights of the active program experience with market actors input on where the program participation and savings forecasting may go. Since there are fluctuations in market activities with changing program requirements and program models, the surveys can support the direction and magnitude of the program savings forecasts as a function of the historical regressions.

The surveys collected perspectives on the market based on previous experience and potential customer adoption and implementation engagement with the evolution in NMEC/Custom and SEM programs. We surveyed the following:

- Program managers and/or their outreach/field team at both utilities and 3P implementers
- Market participants/stakeholders (researchers, non-profits, etc.)

The sample was not designed to seek a statistically significant sample/respondent size, as the input collected from the sample is based on professional experience and familiarity with the programs. We have treated these responses as feedback that might be collected from a workshop, rather than a survey pool that reflects the universal truth of these markets.

Since the adoption analysis is top-down using a historical trajectory extrapolation, Guidehouse used the survey results to adjust the forecasted trajectory based on the survey results. The historical program data identified the baseline savings incurred in terms of percent of sector consumption.

Markets Covered

Guidehouse used the same survey design to collect feedback on nine commercial, industrial, and agricultural markets:

- Agricultural Electric
- Industrial SEM
- Industrial Non-SEM

- Commercial Electric
  - HVAC, Whole Building, NMEC, RCx
  - Process, Lighting, Refrigeration, Water Heating
  - SEM
- Commercial Gas
  - HVAC, Whole Building, Water Heating
  - NMEC, RCx
  - SEM

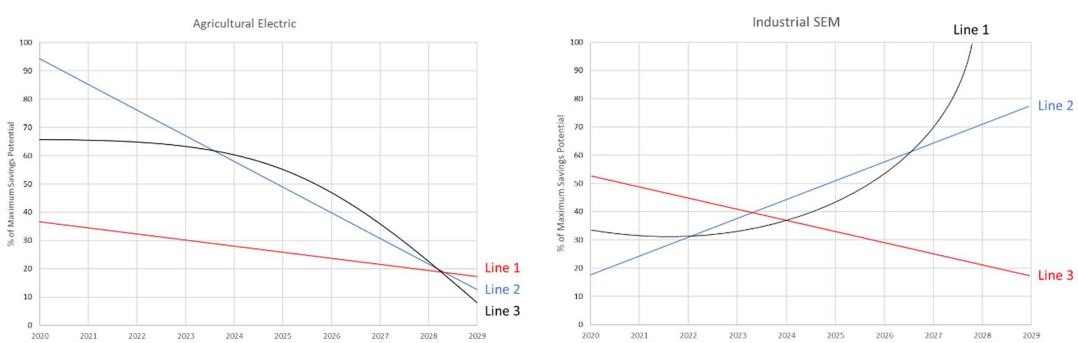
Markets not included in this study, such as Agricultural Gas, were omitted since the agricultural gas consumption is very low in comparison to the other sectors. The industrial markets were posed as fuel agnostic. The grouping for the commercial sector is based on the analysis of historical program participation in these categories showing similar trends. Some of these categories also had very small levels of participation and grouping provides a more robust dataset.

Survey Design

Initial Trendlines

Each industry survey begins with the respondent selecting which trendline they believe best represents the current trajectory of savings. Figure F-1 provides two examples of the graph and trendlines provided to the respondents for consideration. For all initial trendlines, Line 2 (blue) was derived from the real dataset and is considered "true" interpretations of the trajectory of the available data. Survey participants were not informed which was the true trendline. The vertical (y-axis) is not fixed to a specific value and respondents were asked to interpret the graph as an "illustrative trajectory of potential savings".[118]

Figure F-1. Example Initial Trendlines with "True" Trendline in Blue (Line 2)



Source: Guidehouse

Two additional trendlines were included on each initial trendline graph. Additional trendlines may be "less steep, but same trajectory" as the true trendline or curved to depict a delay in the relative increase or decrease of savings potential. The initial trendlines offered did not

[118] One lesson learned was that providing values on the y-axis was confusing to participants and the relative value of each line (i.e.., not trend) also impacted participants responses. We intuited this conclusion based on open-ended questions.

include an exhaustive offering and respondents were required to select only one initial trendline to move forward in the survey.

Following this question, respondents were asked to explain their reasons for selecting the given initial trendline.

Program Characteristics

In the next section of the survey, respondents were asked to rate the relative impact of program design characteristics on three categories: **customer savings, program participation, and administrative burden**. Guidehouse provided four program characteristics that were repeated for each category:

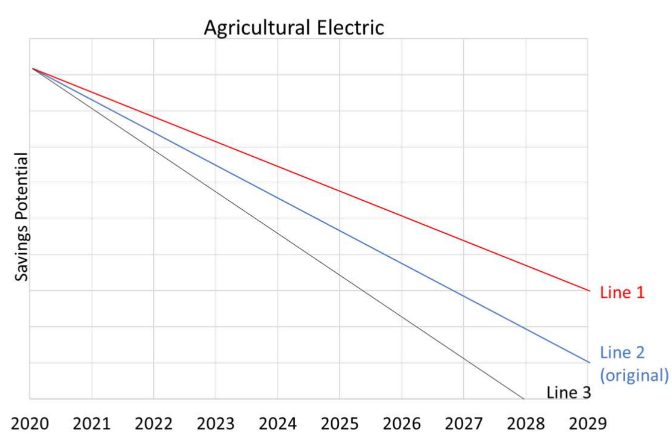
- Shift from incentives to performance-based programs
- Requirement of post 12-month M&V for savings validation
- Relatively high level of rigor necessary to justify savings
- Potential of additional program requirements

Respondents rated each program characteristic along a five-point scale which began at “strongly negative” and ended at “strongly positive” with a neutral point in the middle. Respondents could also select “no impact”. Additionally, respondents were asked to provide an example of another relevant program characteristic and rate it’s relative impact on the given category.

Secondary Trendlines

In the final phase of the survey, respondents were asked to reconsider the initial trendline they selected at the start of the survey. Respondents were presented with a secondary trendline graph which included the original trendline they chose and two alternative trendlines. The alternative trendlines in the secondary trendline question were designed to offer a slightly more steep or slightly less steep option, relative to the trajectory of the original trendline. See Figure F-2 for an example of a secondary trendline offered to respondents who selected Line 2 (blue) in the initial trendline question.

Figure F-2. Example Secondary Trendline with Initial (Original) Trendline in Blue (Line 2)



Source: Guidehouse

Methodology

Guidehouse outlined the following methodology to interpret the responses collected for each survey.

1. Identify the most favored initial trendline.
    a. Guidehouse reviewed all popular trendlines, in particular those with more than 2 votes during the initial trendline question. If two initial trendlines had the same number of votes, Guidehouse reviewed written justifications to understand if there was strong opposition to the other popular trendline. Guidehouse also reviewed all the other trendline justifications to further validate the findings or consider a course correction based on the justification.
    b. Guidehouse also reviewed the written justifications for selecting the trendlines and excluded those that stated that “no trendline is correct”.
    c. The trajectories of the favored initial trendlines are compared to the true trendline and recorded for development of the recommendation.
2. Review respondents’ choice of secondary trendlines for further tailoring of final recommendation.
    a. The distribution of respondents around each secondary trendline was reviewed with the same level of granularity as the initial trendline responses, taking into consideration the number of respondents and their written justifications to confirm the intention of the respondent.
    b. For example, if the majority of respondents initially chose a trendline that was more negative than the “true” trendline, and the respondents’ secondary choice was even more negative than their initial choice, then the recommendation would be to adjust the true trend significantly more negative. In this example, if the respondents’ secondary choice was less negative than their initial choice, then the recommendation would be to adjust the true trend only slightly more negative or to perform no adjustment at all.
3. Review the average ratings for the program characteristics for each group of respondents based on which trendline they chose.
    a. Guidehouse converted the respondent ratings for the program characteristics, so that “strongly negative” ratings were marked as -2, “strongly positive” ratings were marked as 2, and “neutral” ratings were 0. Then the ratings for all program characteristics, including those provided by the respondents, were averaged for each category.
    b. Table F-1 outlines a rubric created by the Guidehouse team to translate average ratings, taking into consideration that most program characteristics are likely negative in impact. For example, the Guidehouse supplied “relatively high rigor necessary to justify savings” is expected to be a negative influence across all categories and all markets.

Table F-1. Interpreted Influence of Average Ratings for Program Characteristics

Average Rating	Interpreted Influence
1 or higher	Strongly positive

0.5 to 1	Moderately positive
0 to 0.5	Slightly positive
0 to -0.5	Neutral
-0.5 to -1	Slightly negative
-1 to -1.5	Moderately negative
-1.5 or lower	Strongly negative

Source: Guidehouse

For example, if the majority of respondents chose a trendline that is more negative than the “true” trendline, then the average response to the program characteristics should fall in the negative ranges as indicated in the table.

c. This step provides a check on the trendlines identified by respondents but is not interpreted as a major input to the final recommendation. Meaning if the majority of respondents select a single initial trendline and are consistent with their secondary trendline selection, we may discount average ratings for program characteristics that do not align with the proposed trendline shift from the “true” trendline.[119]

Results

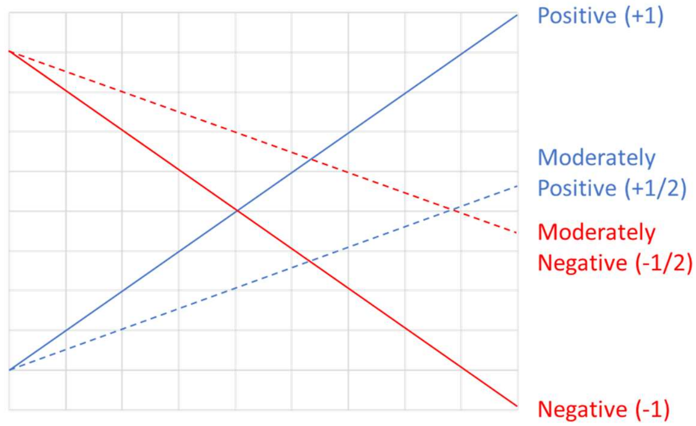
Guidehouse sent invitations to 83 contacts provided by Investor-Owned Utilities by request of the CPUC and received 62 responses (75% response rate) across 9 market surveys.

In general, our team recommended no more than a slight increase or decrease in the slope of the true trendline. Table F-2 summarizes the response rate and true trendline for each industry and program area, as well as the final adjusted trendline recommendation. The adjusted trendline recommendation describes the slope of the recommended trendline, after accounting for survey responses. Figure F-3 provides a visual to aid in interpreting the trendline descriptions utilized in Table F-2.

The following sections describe the survey results analysis in depth for each industry. Following these recommendations, the “true” trendlines were adjusted. All graphs presented in this report, including those with a visual of the original “true” trendline are considered interpretations and do not represent the true values. Subsequently the final recommendations may not be interpreted exactly as written, depending on the available data and input of the Guidehouse team regarding the adjustments to the “true” trendline.

[119] See “Market Study Survey Results - Trendline Recommendations” PowerPoint deck for additional details.

Figure F-3. Example of Trendline Descriptions



Source: Guidehouse

Prior to the release of the Market Study, the modeling team created bundled categories of measure level data based on the end use subcategory. Any measure that listed “NMEC” or “SEM” as the delivery type was sorted out into their own groups for analysis. In the original data, certain technology groups were split into smaller categories, such as “Lighting-Fixtures”, “Lighting-Lamps”, etc. As the team analyzed savings, the more granular categories were condensed into groups labeled Air Compressor, Building Shell, Food Service, Process, Fans and Pumps, HVAC, Irrigation, Lighting, Water Heating and Whole Building.

Once data was organized from 2021-2023, we continued to condense groups focusing on those with similar trends to increase the number of records in a bundle. The following bundled end use categories identified for the market study are listed in the following detailed trendline adjustment summary.

Table F-2. Summary of Trendlines and Final Adjustment Recommendation

Market	# of Responses	True Trendline Description	Trendline Recommendation[120]
Agricultural Electric	7	Negative	Moderately Negative
Industrial SEM	13	Moderately Positive	Moderately Positive*
Industrial Non-SEM	12	Moderately Negative	Slightly Negative
Commercial Electric HVAC, Whole Building, NMEC, RCx	11	Moderately Negative	Slightly Negative
Commercial Electric Process, Lighting, Refrigeration, Water Heating	5	Positive	Positive*
Commercial Electric SEM	2	Positive	Positive*
Commercial Gas	2	Moderately Positive	Slightly Positive

[120] Actual adjustments to the “true” trendlines are discussed in section Trendline Adjustments Reflected in Final Model.

Market	# of Responses	True Trendline Description	Trendline Recommendation[120]
HVAC, Whole Building, Water Heating			
Commercial Gas NMEC, RCx	8	Moderately Negative	Moderately Negative*
Commercial Gas SEM	2	Moderately Positive	Moderately Positive*

* Indicates no change from the true trendline to the recommended trendline

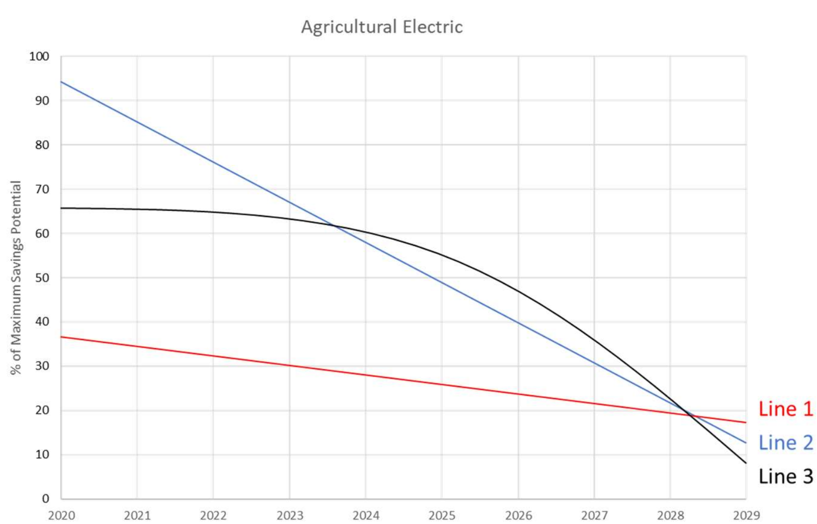
Source: Guidehouse

Agricultural Electric (n = 7)

The following summarizes results for the Agricultural Electric industry:

- **Initial trendline response.** For the initial trendline selection (Figure F-4), the majority of respondents selected Line 1, which is less negative than the "true" trend. Two respondents also selected Line 2, the "true" trendline. Most respondents focused on the overall small nature of the market, which is not inherently relevant to the trajectory of the trendline.

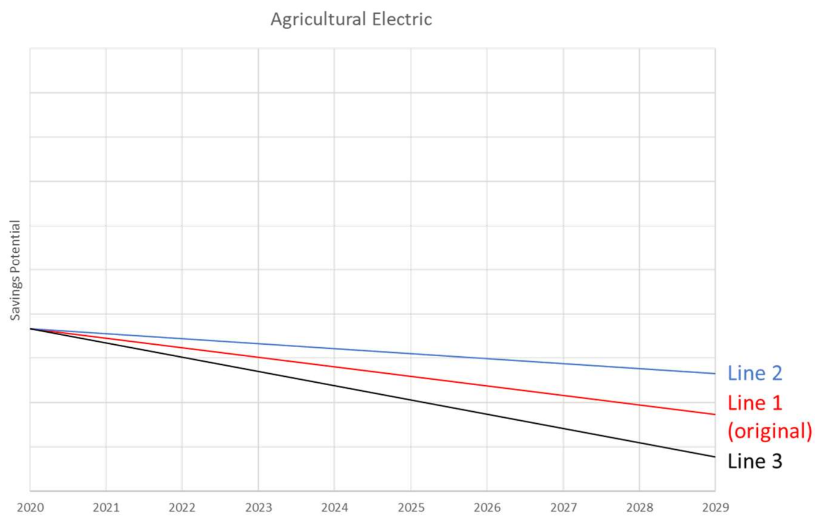
Figure F-4. Initial Trendline Selection for Agricultural Electric



Source: Guidehouse

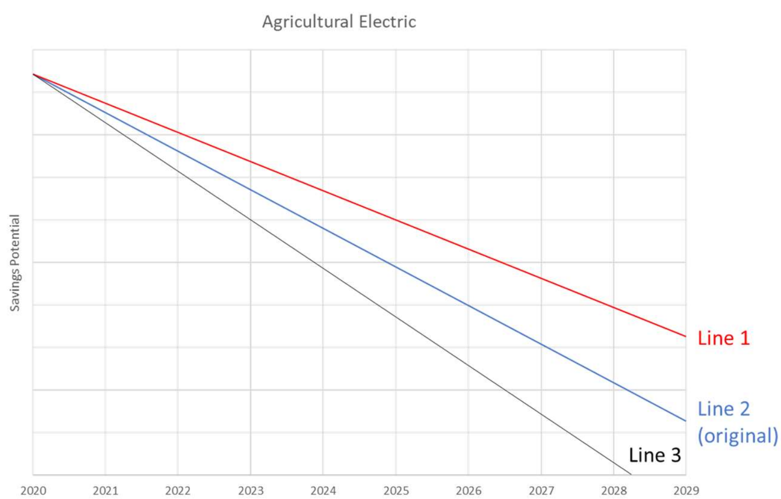
- **Secondary trendline response.** The majority of respondents who initially chose Line 1 selected an even less negative line in the secondary line selection (Figure F-5). The two respondents who originally selected Line 2 were split between a more steep trajectory and the original trendline when offered secondary options (Figure F-6).

Figure F-5. Secondary Trendline Selection for Agricultural Electric, Line 1



Source: Guidehouse

Figure F-6. Secondary Trendline Selection for Agricultural Electric, Line 2



Source: Guidehouse

- **Average ratings for program characteristics.** Of those who selected Line 1, the average ratings for the program characteristics fell within the Slightly Negative range, which supports the selection of a line that is less negative than the "true" trendline. Respondents who selected Line 2 did not have as clear of a relationship between their average ratings, ranging between Neutral and Slightly Negative.

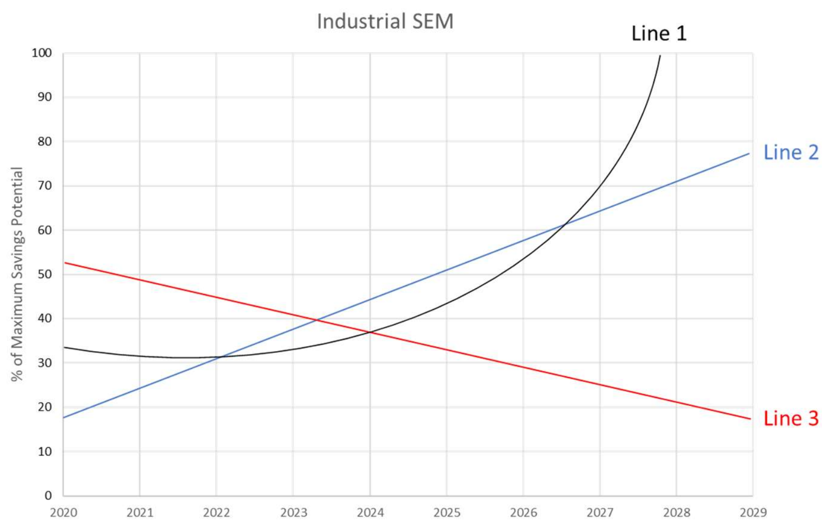
Given these responses, the final recommendation for the Agricultural Electric industry is to *adjust the "true" trendline to be less negative, halfway to the slope of Line 1.* In the final adjustments made to trendlines, the slopes for both Agricultural Electric and Gas programs (not surveyed) were reduced to zero after additional review by the Guidehouse team of the existing program trends.

Industrial SEM (n = 13)

The following summarizes results for the Industrial SEM industry:

- **Initial trendline response.** For the initial trendline selection (Figure F-7), the majority of respondents selected Line 2, the "true" trend. A significant number of respondents also selected Line 1 which includes a steeper positive trajectory after a shallow dip/delay in savings. These respondents noted that a curved trajectory better reflects compounding savings, although the Guidehouse found that to be a less accurate description of savings from Industrial SEM programs.

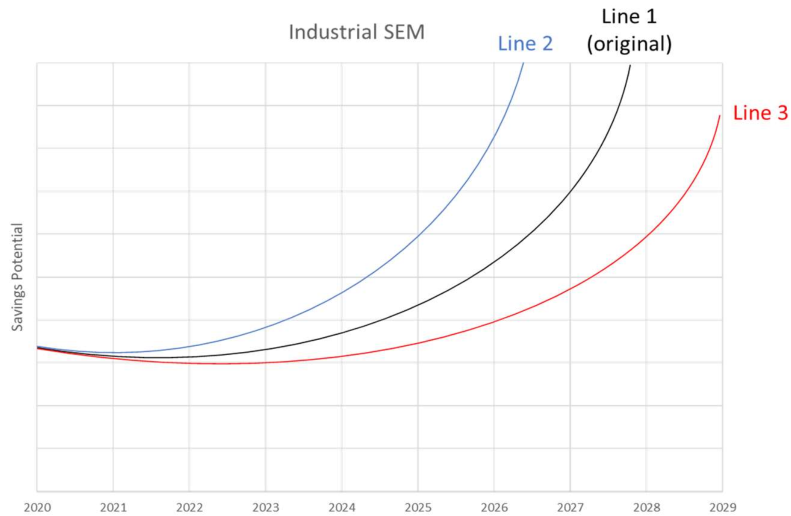
Figure F-7. Initial Trendline Selection for Industrial SEM



Source: Guidehouse

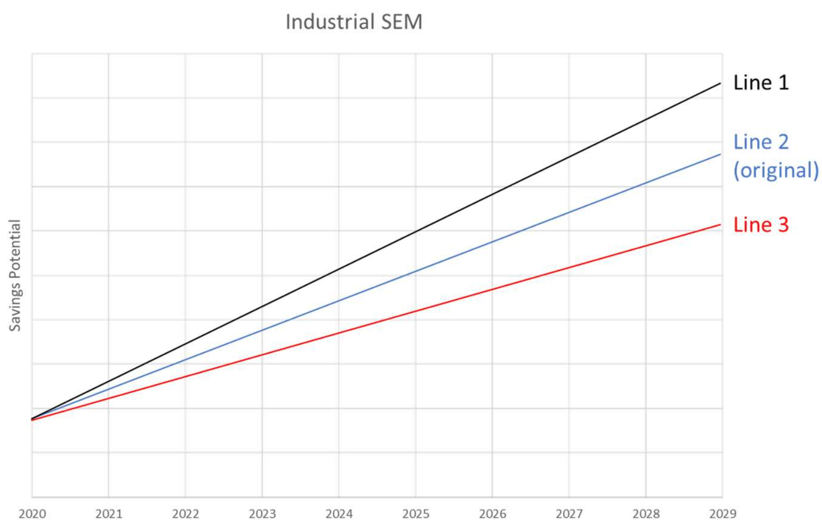
- **Secondary trendline response.** Those respondents who originally selected Line 1, most selected a less steep trajectory from the secondary trendlines offered (Figure F-8). The majority of respondents who initially selected Line 2 selected the same trendline with no adjustment in the secondary trendline selection (Figure F-9).

Figure F-8. Secondary Trendline Selection for Industrial SEM, Line 1



Source: Guidehouse

Figure F-9. Secondary Trendline Selection for Industrial SEM, Line 2



Source: Guidehouse

- **Average ratings for program characteristics.** Of those who selected Line 2, the average ratings ranged from Neutral to Moderately Negative across the three program characteristics. However, the overwhelming selection of Line 2 (8 out of 13) made us comfortable with maintaining the "true" trendline overriding the inconsistencies in the average ratings for program characteristics. Those respondents who selected Line 1 had Neutral ratings across the program characteristics, which supported their positive expectations for the savings trendline.

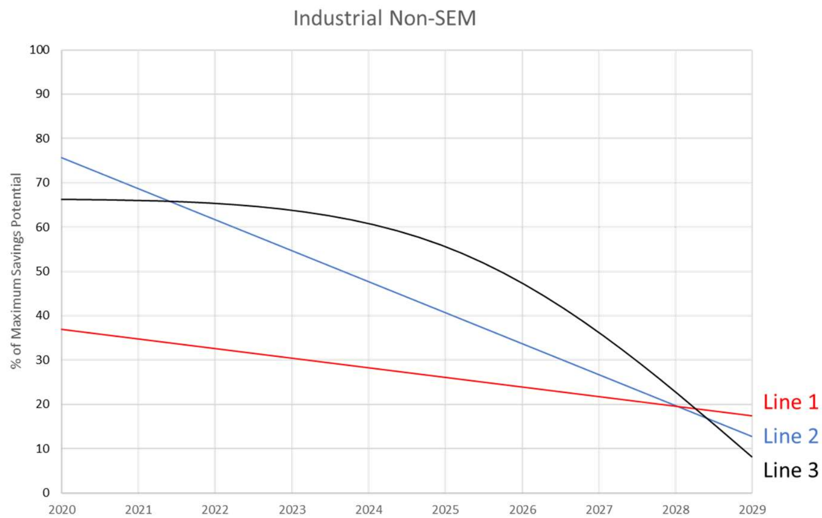
Given these responses, the final recommendation for the Industrial SEM industry is to *make no adjustment to the "true" trendline.*

Industrial Non-SEM (n = 12)

The following summarizes results for the Industrial Non-SEM industry:

- **Initial trendline response.** The majority of respondents selected Line 1 in the initial trendline selection (Figure F-10), which is less negative than the “true” trend. A smaller number of respondents selected Line 3, which communicates a delayed downward trend.

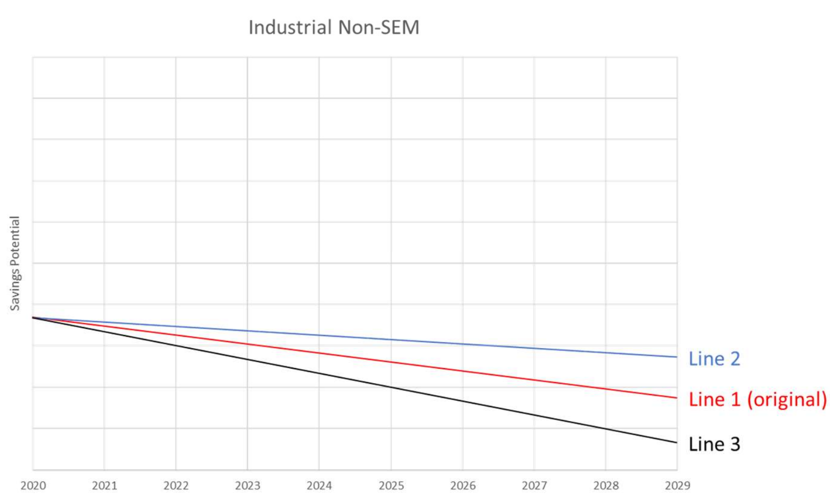
Figure F-10. Initial Trendline Selection for Industrial Non-SEM



Source: Guidehouse

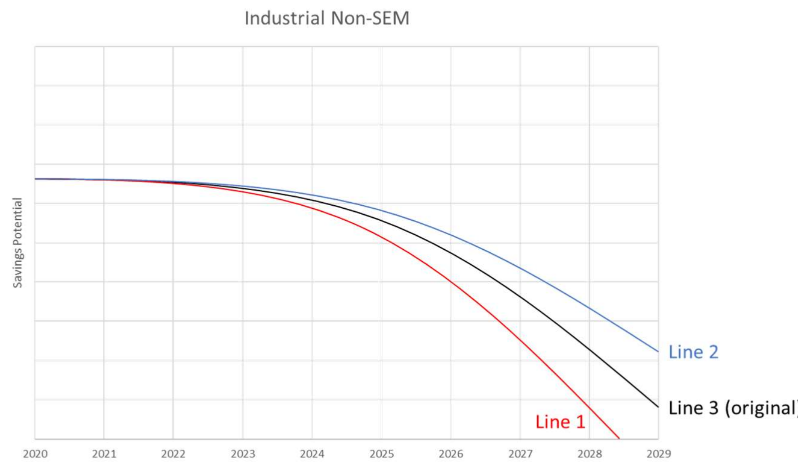
- **Secondary trendline response.** The majority of respondents who initially selected Line 1 selected the same trendline with no adjustment in the secondary trendline selection (Figure F-11). For those respondents who originally chose Line 3, two of the three selected Line 2, a less steep slope in the secondary trendlines (Figure F-12).

Figure F-11. Secondary Trendline Selection for Industrial Non-SEM, Line 1



Source: Guidehouse

Figure F-12. Secondary Trendline Selection for Industrial Non-SEM, Line 3



Source: Guidehouse

- **Average ratings for program characteristics.** Of those who selected Line 1, the average ratings for the program characteristics fell within the Slightly Negative range, which supports the selection of a line that is less negative than the "true" trendline. Those respondents who selected Line 3 had similar Slightly Negative ratings for program characteristics.

Given these responses, the final recommendation for the Industrial Non-SEM industry is to *adjust the "true" trendline to be less negative, halfway to the slope of Line 1.*

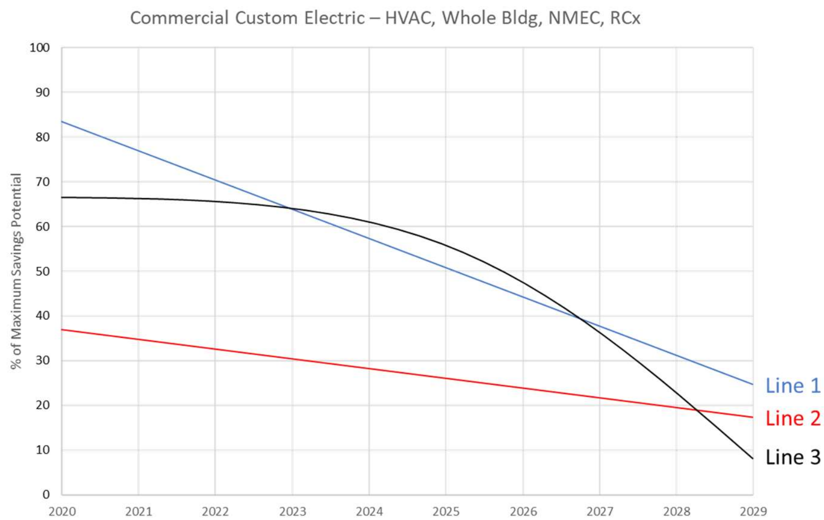
Commercial Electric

HVAC, Whole Building, NMEC, RCx (n = 11)

The following summarizes results for the Commercial Electric HVAC, Whole Building, NMEC, and RCx industry:

- **Initial trendline response.** For the initial trendline selection (Figure F-13), the majority of respondents selected Line 3, which is a downward trending line with roughly the same rate of decrease as the "true" trend, but with a curved trajectory indicating slower decay in earlier years and more rapid decay in later years. A significant number of respondents also selected Line 2, which is a linear, downward trending line that is less negative than the "true" trend.

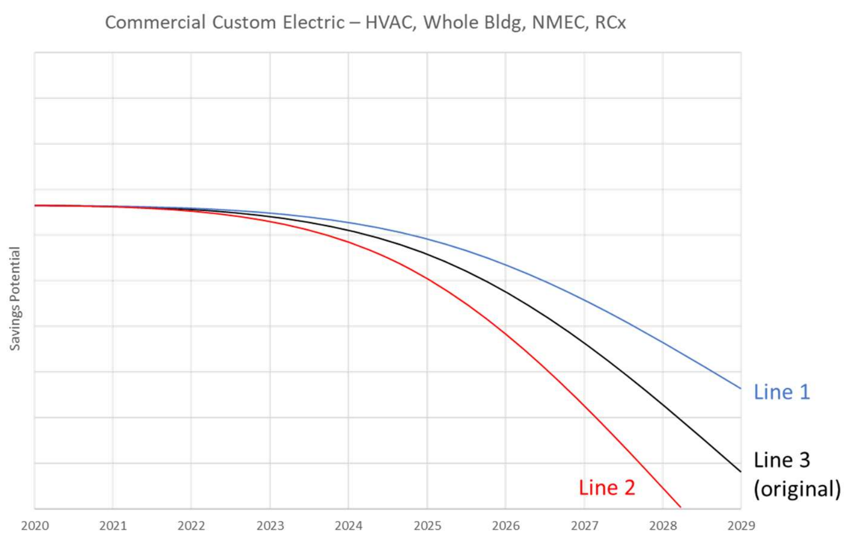
Figure F-13. Initial Trendline Selection for Commercial Electric HVAC, Whole Building, NMEC, RCx



Source: Guidehouse

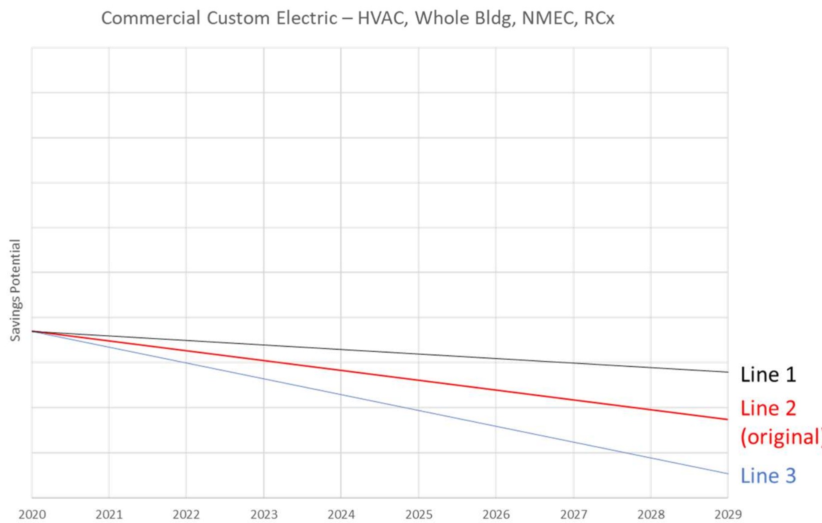
- **Secondary trendline response.** The majority of respondents who initially selected Line 3 or Line 2 selected the same trendline with no adjustment in the secondary line selection (Figure F-14 and Figure F-15).

Figure F-14. Secondary Trendline Selection for Commercial Electric HVAC, Whole Building, NMEC, RCx, Line 3



Source: Guidehouse

Figure F-15. Secondary Trendline Selection for Commercial Electric HVAC, Whole Building, NMEC, RCx, Line 2



Source: Guidehouse

- **Average ratings for program characteristics.** The average ratings for respondents who selected Line 3 ranged from Slightly Negative to Moderately Negative across the three program characteristics, which supports the selection of a curved trendline. The average ratings for respondents who selected Line 2 were neutral, which supports the selection of a line that is less negative than the "true" trend.

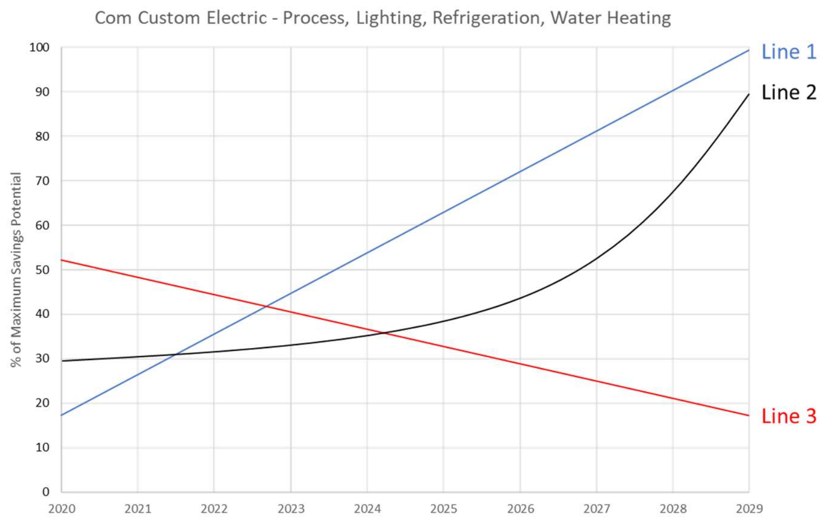
Given these responses, the final recommendation for the Commercial Electric HVAC, Whole Building, NMEC, and RCx industry is to *adjust the "true" trend to be less negative, halfway to the slope of Line 2.* We noted that based on the respondent's written comments there may be a potential decline in savings towards zero in the future but did not recommend the current trendline be updated to reflect that estimate.

Process, Lighting, Refrigeration, Water Heating (n = 5)

The following summarizes results for the Commercial Electric Process, Lighting, Refrigeration, Water Heating industry:

- **Initial trendline response.** For the initial trendline selection (Figure F-16), the majority of respondents selected Line 2, which is an upward trending line with roughly the same rate of increase as the "true" trend, but with a curved trajectory indicating slower growth in earlier years and more rapid growth in later years.

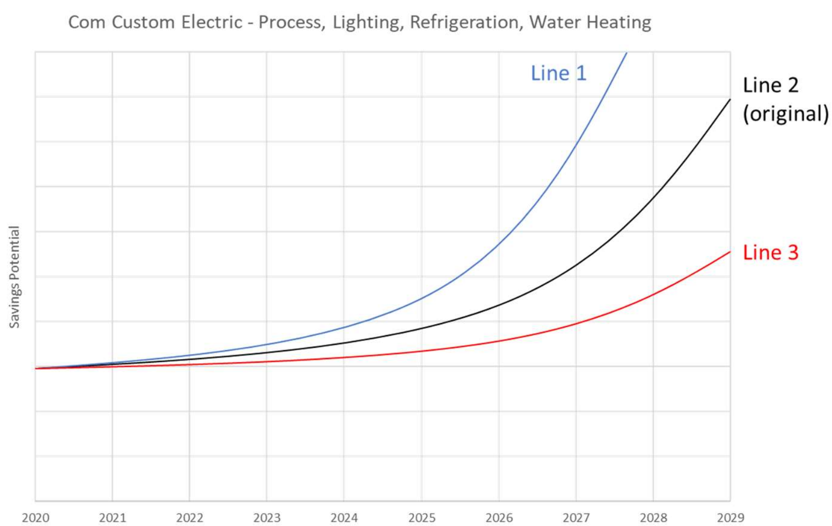
Figure F-16. Initial Trendline Selection for the Commercial Electric Process, Lighting, Refrigeration, Water Heating



Source: Guidehouse

- **Secondary trendline response.** The majority of respondents who initially selected Line 2 chose a line with faster growth compared to the original Line 2 in the secondary trendline selection (Figure F-17).

Figure F-17. Secondary Trendline Selection for the Commercial Electric Process, Lighting, Refrigeration, Water Heating



Source: Guidehouse

- **Average ratings for program characteristics.** Of those who selected Line 2, the average ratings for the program characteristics fell within the Neutral to Slightly Negative range, which can support the selection of an upward sloping line with gradual growth in the earlier years.

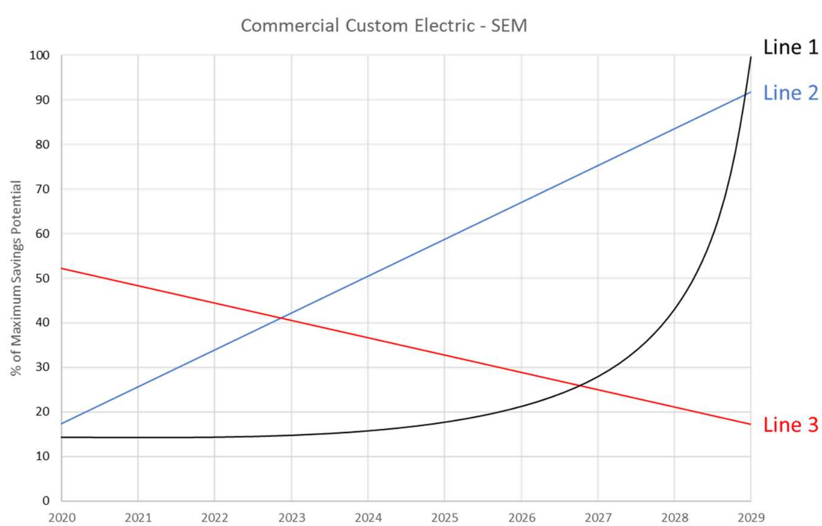
Given these responses, the final recommendation for the Commercial Electric Process, Lighting, Refrigeration, Water Heating industry is to *adjust the "true" trendline to be slightly less positive or introduce a slight curve that is more gradual at the start, with a ramp-up in savings over time.*

SEM (n = 2)

The following summarizes results for the Commercial Electric SEM industry:

- **Initial trendline response.** All respondents selected Line 2, the "true" trend, in the initial trendline selection (Figure F-18).

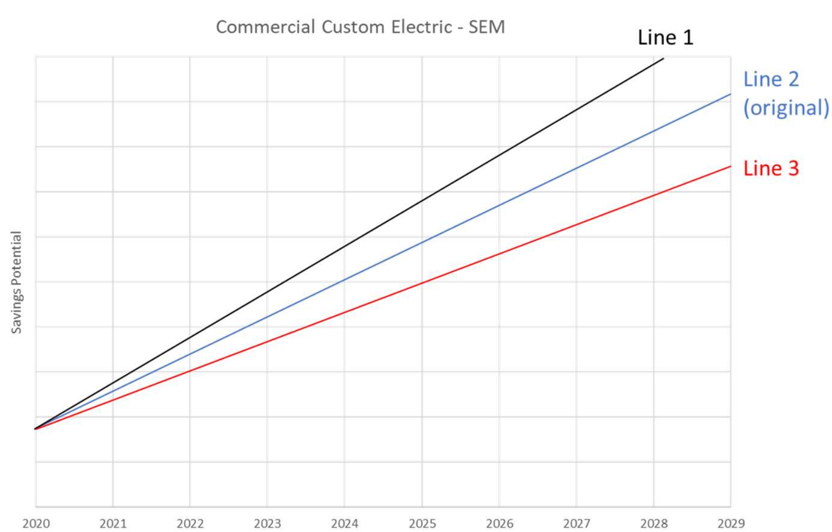
Figure F-18. Initial Trendline Selection for Commercial Electric SEM



Source: Guidehouse

- **Secondary trendline response.** All respondents selected the original Line 2 in the secondary trendline selection (Figure F-19).

Figure F-19. Secondary Trendline Selection for Commercial Custom SEM



Source: Guidehouse

- **Average ratings for program characteristics.** The average ratings for program characteristics were varied, some positive and some negative, with no clear trend. Because the number of respondents was low for this industry, the program characteristics ratings were not considered in the final recommendation.

Given these responses and because the Commercial Electric SEM program is relatively new, the final recommendation for the Commercial Electric SEM industry is to *make no adjustments to the "true" trendline.*

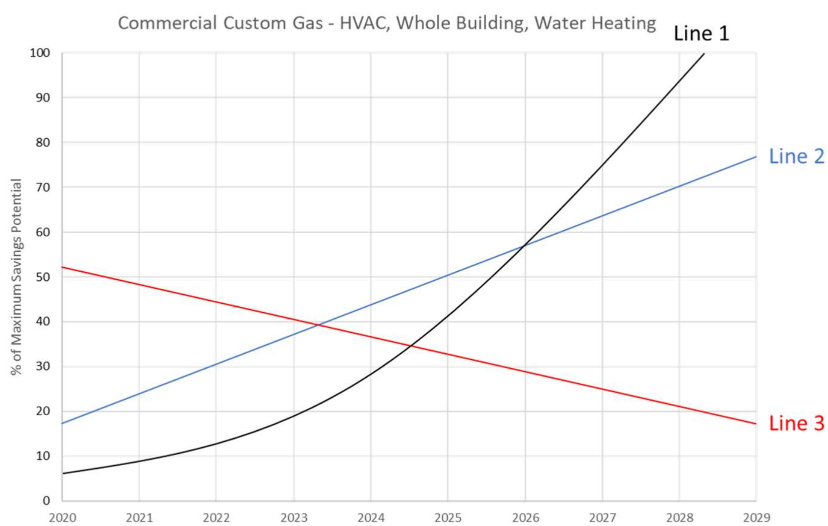
Commercial Gas

HVAC, Whole Building, Water Heating (n = 2)

The following summarizes results for the Commercial Gas HVAC, Whole Building, and Water Heating industry:

- **Initial trendline response.** For the initial trendline selection (Figure F-20), respondents were split evenly between Line 2, the "true," upward sloping trend, and Line 3, which is negative sloping.

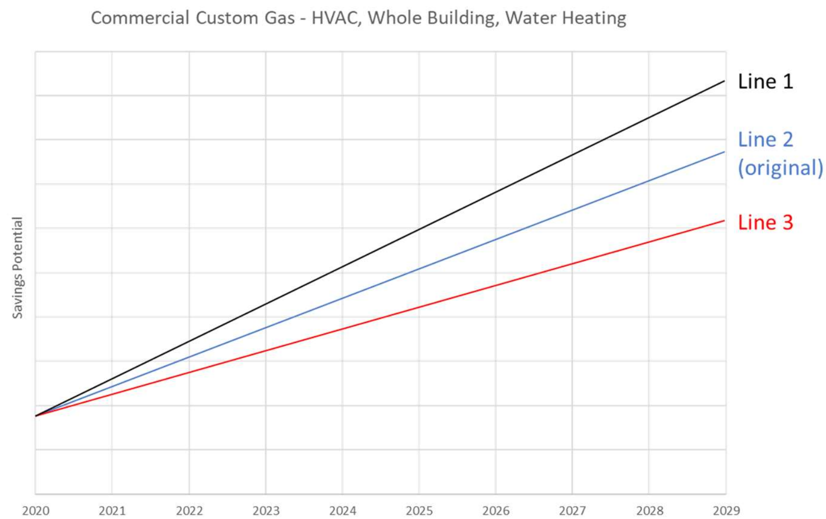
Figure F-20. Initial Trendline Selection for Commercial Gas HVAC, Whole Building, Water Heating



Source: Guidehouse

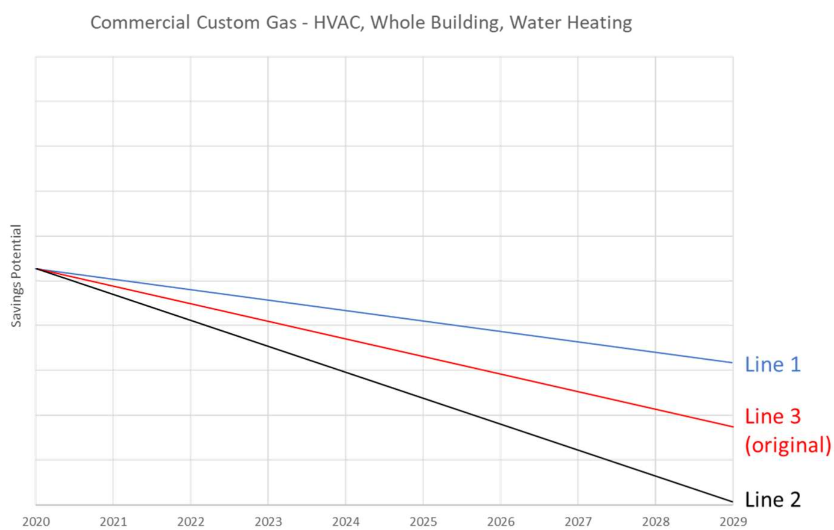
- **Secondary trendline response.** Both Line 2 and Line 3 respondents selected adjustments in the secondary trendline selection (Figure F-21 and Figure F-22) that moved their initial selection closer to neutral.

Figure F-21. Secondary Trendline Selection for Commercial Gas HVAC, Whole Building, Water Heating, Line 2



Source: Guidehouse

Figure F-22. Secondary Trendline Selection for Commercial Gas HVAC, Whole Building, Water Heating, Line 3



Source: Guidehouse

- **Average ratings for program characteristics.** Average ratings for Line 2 respondents were Moderately Positive, while average ratings for Line 3 respondents were slightly negative. These support the trends of the lines they chose.

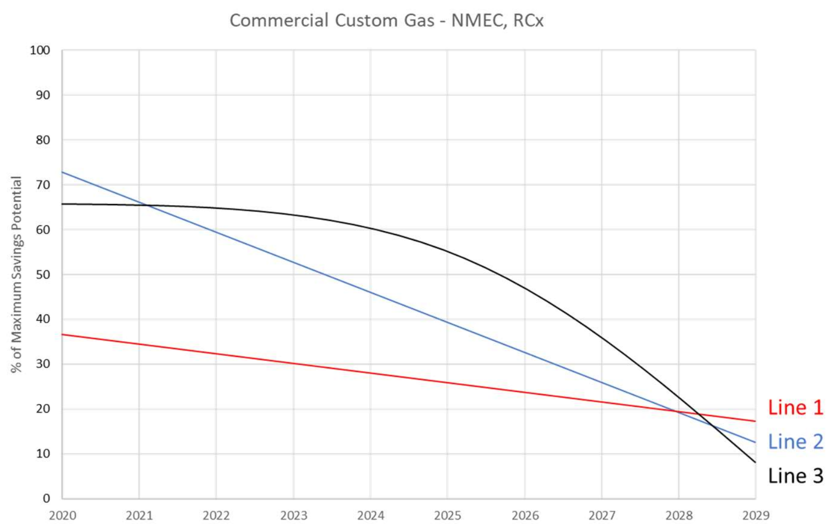
Given these responses, the final recommendation for the Commercial Gas HVAC, Whole Building, and Water Heating industry is to *adjust the "true" trendline to be slightly less positive.*

NMEC, RCx (n = 8)

The following summarizes results for the Commercial Gas NMEC and RCx industry:

- **Initial trendline response.** For the initial trendline selection (Figure F-23), the majority of respondents selected Line 3, which is a downward trending line with roughly the same rate of decrease as the "true" trend, but with a curved trajectory indicating slower decay in earlier years and more rapid decay in later years.

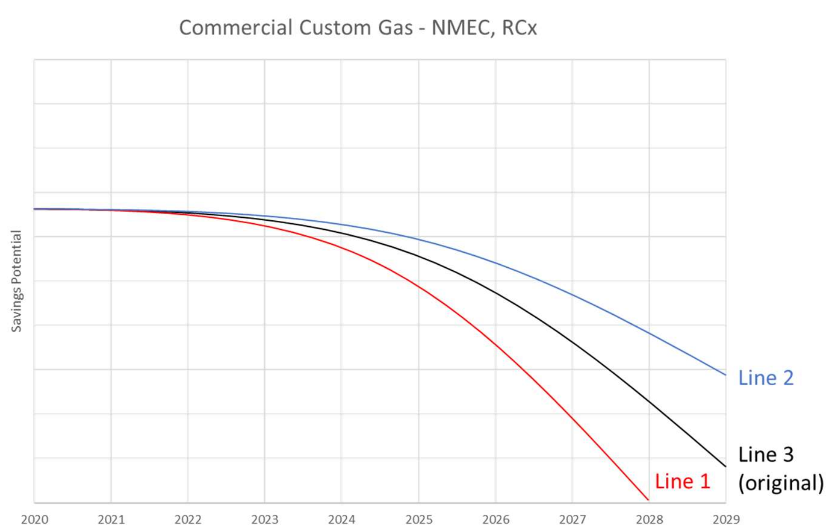
Figure F-23. Initial Trendline Selection for Commercial Gas NMEC, RCx



Source: Guidehouse

- **Secondary trendline response.** The majority of respondents who initially selected Line 3 selected the same trendline with no adjustment in the secondary line selection (Figure F-24).

Figure F-24. Secondary Trendline Selection for Commercial Gas NMEC, RCx



Source: Guidehouse

- **Average ratings for program characteristics.** Of those who selected Line 3, the average ratings for the program characteristics fell within the Slightly Negative range, which supports the downward trending line.

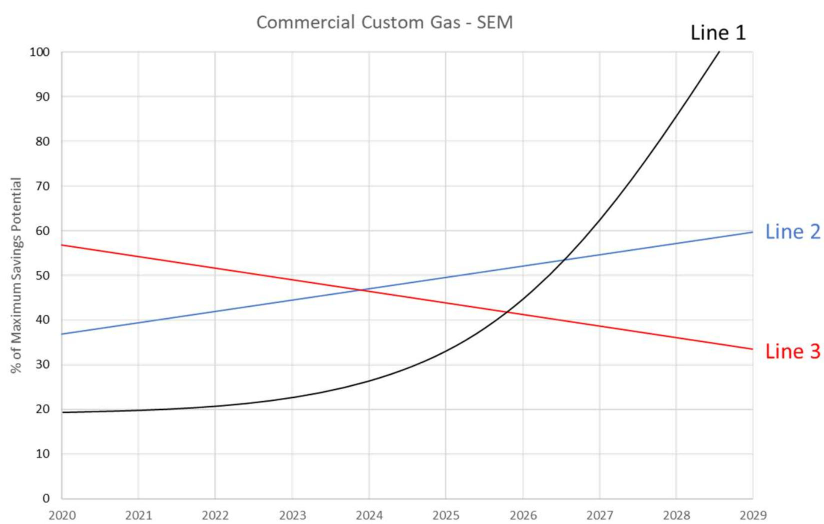
Given these responses, the final recommendation for the Commercial Gas NMEC and RCx industry is to *make no adjustment to the "true" trendline,* because the rationale provided for Line 3 was not compelling enough to conclude the trend should be curved.

SEM (n = 2)

The following summarizes results for the Commercial Gas SEM industry:

- **Initial trendline response.** All respondents selected Line 2, the "true" trend, in the initial trendline selection (Figure F-25).

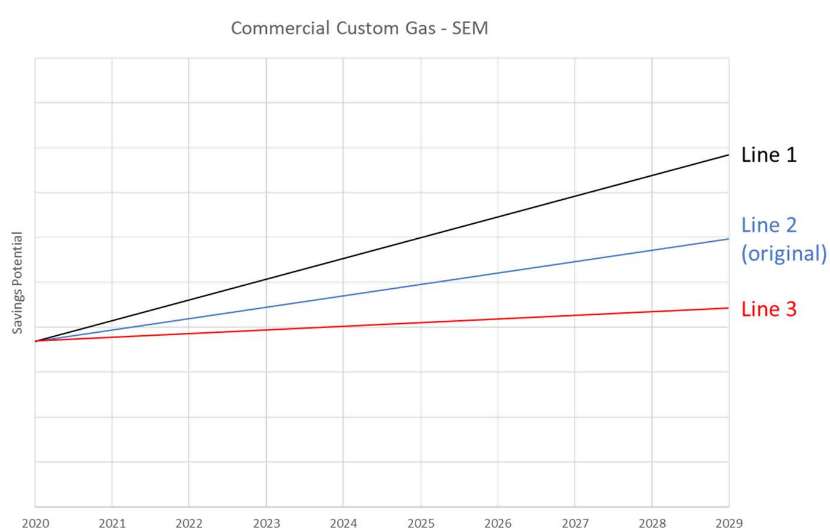
Figure F-25. Initial Trendline Selection for Commercial Gas SEM



Source: Guidehouse

- **Secondary trendline response.** All respondents selected the original Line 2 in the secondary trendline selection (Figure F-26).

Figure F-26. Secondary Trendline Selection for Commercial Gas SEM



Source: Guidehouse

- **Average ratings for program characteristics.** The average ratings for program characteristics were varied, some positive and some negative, with no clear trend. Because the number of respondents was low for this industry, the program characteristics ratings were not considered in the final recommendation.

Given these responses and because the Commercial Gas SEM program is relatively new, the final recommendation for the Commercial Gas SEM industry is to *make no adjustments to the "true" trendline.*

Trendline Adjustments Reflected in Final Model

Based on the recommendations given in the Market Study, the following slope adjustments were made in the final model.

Table F-3. Slope Adjustments

Market	Slope Adjustments
Agricultural Electric & Gas	The reference scenario slope reduced to zero, and the 2023 penetration was forecasted until 2045. The aggressive scenario will maintain the slope consistent with the true trend.
Industrial SEM Electric & Gas	The reference scenario had no adjustments and will retain a slope consistent with the true trend. The aggressive scenario will undergo a slope adjustment of a 50% increase compared to the true trend.
Industrial Non-SEM Electric & Gas	The reference scenario adjusted to 50% less negative compared to the true trend. The aggressive scenario will maintain the slope consistent with the true trend.
Commercial Electric HVAC, Whole Building, NMEC, RCx	The reference scenario adjusted to 50% less negative compared to the true trend. The aggressive scenario will maintain the slope consistent with the true trend.
Commercial Electric Process, Lighting, Refrigeration, Water Heating	The reference scenario adjusted to 66% less positive compared to the true trend. The aggressive scenario will maintain the slope consistent with the true trend.
Commercial Electric & Gas SEM	The reference scenario had no adjustments and will retain a slope consistent with the true trend. The aggressive scenario will undergo a slope adjustment of a 50% increase compared to the true trend.
Commercial Gas HVAC, Whole Building, Water Heating	The reference scenario was adjusted to become 25% less positive compared to the true trend. The aggressive scenario will maintain the slope consistent with the true trend.
Commercial Gas NMEC, RCx	The reference scenario had no adjustments and will retain a slope consistent with the true trend. The aggressive scenario will undergo a slope adjustment of a 50% increase compared to the true trend.

Source: Guidehouse

Future Studies

We recommend that future potential studies of the custom and SEM for the commercial, industrial, and agricultural sector revisit the significant amount of direct information collected from the surveyed experts in this study. For example, our team has not closely reviewed the program characteristics provided by the respondents which may be useful in identifying expected program changes across these segments. This additional data was not applicable to the analysis for this PG cycle.

We also recommend that future annual savings and updated trends be compared to these recommendations in the future so that this approach can be reviewed and annotated for future applications. However, when conducting the surveys, the graphs should probably not have values on the axes to minimize any confusion and have the participants focus on trends only.

F.2 Industrial and Agriculture and Custom Commercial Measures

Forecasting the EE potential for these sector measures requires a different approach that involves several steps.

1. Program records (i.e., CEDARS) are reviewed to determine what annual ex ante gross natural gas and electricity savings have historically been reported.
2. A Savings Rate Multiplier is calculated by dividing the annual ex ante gross natural gas and electricity savings by total sector consumption for each year being analyzed. The final Savings Rate Multiplier used in the 2025 forecast is based on the average annual reported ex ante savings for three program years, from 2021 through 2023.
3. CEDARS data is also analyzed to determine the trend in savings over time. This trend is referred to as the Penetration Rate and is used to increase or decrease savings over the forecast horizon. For the forecast, the penetration rate is stated as a compound annual growth or decline rate. See the previous section for more details.
4. An annual EE savings forecast (GWh and MMtherms) is produced by 1) multiplying annual sector consumption forecasts by the Savings Rate Multiplier, and 2) multiplying the annual forecast by the Penetration Rate % to account for saturation over time.

The Savings Rate Multiplier, and other inputs for the forecast of potential are provided in Table F-4.

Table F-4. Industrial, Agriculture, and Commercial Custom GC– Key Assumptions

Sector	Bundle	EUL Years	Savings Rate Multiplier		Cost		kW/kWh Savings Ratio
			kWh	therm	kWh	therm	
Industrial	SEM	5	0.1727%	0.1456%	$0.02	$0.84	0.0001409
Industrial	Non-SEM	11.8	0.044%	0.346%	$0.32	$1.42	0.0001186
Agriculture	All	8.5	0.1193%	1.2706%	$0.55	$2.11	0.0002347
Com Custom	HVAC, Whole Building, NMEC, RCx	9.3	0.0199%	N/A	$0.19	N/A	0.00011
Com Custom	Process, Lighting, Refrigeration, Water Heating	8.9	0.0725%	N/A	$0.50	N/A	0.00011
Com Custom	SEM	5	0.0008%	N/A	$0.60	N/A	0.00011

Sector	Bundle	EUL Years	Savings Rate Multiplier		Cost		kW/kWh Savings Ratio
			kWh	therm	kWh	therm	
Com Custom	HVAC, Whole Building, Water Heating	4.6	N/A	0.003%	N/A	$4.07	N/A
Com Custom	NMEC, RCx	3.8	N/A	0.015%	N/A	$8.44	N/A
Com Custom	SEM	5	N/A	0.001%	N/A	$10.07	N/A

Source: Guidehouse

Appendix G. Adoption Logic Theory and Application of a Multi-Attribute Model

G.1 Background

The method to estimate customer willingness to purchase energy efficient equipment in potential studies has evolved over the past decade. Early approaches used adoption curves that directly related willingness to a simple payback period based on survey questions. This approach was not desirable because it lacked a formal model of customer decision-making and lacked parameters with values that might vary across measures and customers and that might change over time. Eventually a formal choice model[121] was selected from widely accepted research in behavioral science; this model uses a single sensitivity parameter to define choice based on expected value factor. This model could closely fit the earlier payback curves when simple payback was used as the metric for the decision-making value factor.

Around the same time, another measure of utility was introduced, the Levelized Measure Cost (LMC), that better described the investment characteristics of competing measures in terms of standard cash flow analysis. Rather than using a simple time value of money for the discount rate in the LMC calculation, an implied discount rate was used to better describe economic inefficiencies in customer choices.[122] The implied discount rate is the effective discount rate that would describe consumer adoption behavior if adoption was based solely on the financial characteristics of an EE measure. High observed implied discount rates for EE purchases indicated a range of market barriers and risk factors influence adoption beyond just the consumer time value of money such as lack of access to capital, liquidity constraints, split incentives, hassle, information search costs, and behavioral failures.[123, 124] The difference between the consumer's implied discount rate and their risk-adjusted time value of money is often referred to as the efficiency gap. Research has explained the discrepancy between the implied discount rate and the risk-adjusted time value of money as due to market barriers facing the EE industry.[125]

This gap in consumer choices contributes substantially to the inability of achievable potential forecasts to reach economic potential forecasts in EE potential studies. Model scenarios have since been run using assumptions about improvements in implied discount rate as a basis of finding the future limits of achievable potential. Studies have also attempted to estimate improvements in implied discount rates due to specific program interventions like financing and on-bill repayment.[126] Until the 2021 Study, the measure of utility used in the logit choice model is a purely economic measure (LMC) adjusted in aggregate by the degree to which this measure is insufficient (implied discount rate).

Unlike potential studies before 2021, customer preferences are not based solely on the financial attributes of the product. Instead, customers make decisions based on multiple

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121 McFadden, D. and K. Train, "Mixed MNL Models for Discrete Response," *Journal of Applied Econometrics* 15, no. 5: 447-470, 2000.

122 Gillingham, Newell, Palmer, "Energy Efficiency Economics and Policy," 2009.

123 J A Dubin, "Market barriers to conservation: are implicit discount rates too high?" Proceedings of the POWER Conference on Energy Conservation, p. 21-33, 1992.

124 Gillingham, Newell, Palmer, "Energy Efficiency Economics and Policy," 2009.

125 Jaffe, Newell, and Stavins, "Economics of Energy Efficiency," *Encyclopedia of Energy* Vol. 2: 79-89, 2004.

126 Corfee et.al., "Riding the Financing Wave: Integrating Financing with Traditional DSM Programming," International Energy Program Evaluation Conference, 2013.

product attributes. Switching to a multi-attribute model in a potential study offers two key advantages:

- Accounts for customers' different price sensitivities to different types of products (for example, dishwasher price, capacity, and noise level versus water heater may just be price and capacity).
- Accounts for the different customer responses for the same product based on each customer's unique set of preferences and attitudes (for example, customer attitudes toward sustainability, waste, environment, and climate).

G.2 Multi-Attribute Theory

Competition between products is based on multiple attributes, and the importance of each attribute to the decision-making process is likely to vary depending on the product type and the consumer type. Consumer preferences determine the relative importance of a product's attributes, and those preferences can affect a consumer's sensitivity to price and potential future energy savings. Even when all other attributes are equal, a consumer may be less sensitive to prices and financial characteristics for certain classes of products. As an example, this section compares dishwasher and water heater purchasing decisions. When purchasing a dishwasher, consumers are likely to consider the price, capacity, internal design features, noise levels, and EE. When purchasing a water heater, a consumer is likely to have a much shorter and somewhat different set of attributes in mind such as capacity, efficiency, and price. Given these differences, a 5% (for example) rebate for purchasing an energy efficient dishwasher is unlikely to be as influential as it would be for the purchase of a water heater because price is of higher relative importance for a water heater.

The expansion of the "willingness to adopt" factor (implemented since the 2021 Study) to include multiple features allows the model to account for the relative importance of price and future cost savings in the context of how important they are relative to other product features (such as style, size, etc.). This expansion also allows the model to incorporate variation between segments of customers that have different preferences for product attributes and, importantly, different attitudes toward the sustainability attributes of the products.

A multi-attribute model requires additional data beyond what is normally collected in the EE industry. This new data is collected through surveys designed for conjoint analysis—a sample-efficient survey design technique that helps determine customer preferences for different features and feature combinations. Product design processes often use conjoint analysis to prioritize tradeoffs between feature areas (for example, strong versus lightweight). Conjoint analysis can also be combined with other survey data to help establish customer segments that behave differently toward electrification decisions.

Consumer values and attitudes toward sustainability, waste, environment, and climate can be accounted for in this new multi-attribute model. Product attributes that align with the decision maker's values are likely to be the primary driver of consumer preferences. Strong values can overwhelm purchase decisions and lead consumers to make seeming irrational decisions from a purely financial perspective. However, when decisions consider all attributes and values, the outcome may be completely rational.

G.3 Implementing the Multi-Attribute Model

This study uses the following attributes to characterize a product:

- LMC at a consumer discount rate rather than the implied discount rate

- Upfront cost for increased sensitivity to budget and decreased sensitivity to future economic benefits
- Hassle (with install costs as a proxy) to assess inconvenience, especially for retrofit measures or switching to new kinds of technology that require different infrastructure (such as insulation, instantaneous water heaters, or FS)
- Eco-friendliness, which is based on energy or greenhouse gas (GHG) savings
- Eco-signaling, which is based on energy or GHG savings and is only applied to public-facing end uses
- Non-consumption performance to account for other important attributes of certain product types (like aesthetic appeal) that are not typically correlated with efficiency levels but that may reduce sensitivity to the other attributes

The Guidehouse team conducted primary data collection through surveys to obtain data on the customer preferences for these attributes across each residential and commercial building type. The team used preference clusters to determine the proper number and sizes of customer segments and their preferences.

G.3.1 Customer Preference Weighting

Through the Market Adoption Study surveys conducted in 2019, customers answered questions on a 1-5 scale indicating how important each value factor is to their decision-making process.

After applying an ordinal-to-metric transformation to the raw responses, the Guidehouse team converted transformed responses for each value factor to relative weightings (0%-100%) that indicate the importance of each value factor in determining adoption. Values can be interpreted as a percentage of decision driven by each technology characteristic. Table G-1 provides information on converting survey response to preference weightings with the calculation in Equation G-1.

Table G-1. Converting Survey Responses to Preference Weightings

Value Factor	Average Transformed Response	Preference Weighting
	Sample Customer Group	Sample Customer Group
Lifetime Cost (LMC)	3.5	18%
Upfront Cost	2.3	12%
Hassle Factor	3.1	16%
Eco Impacts	4.1	22%
Eco-Signaling	3.0	16%
Non-Consumption Performance	3.0	16%
Total		**100%**

Source: Guidehouse

Equation G-1. Customer Preference Weighting

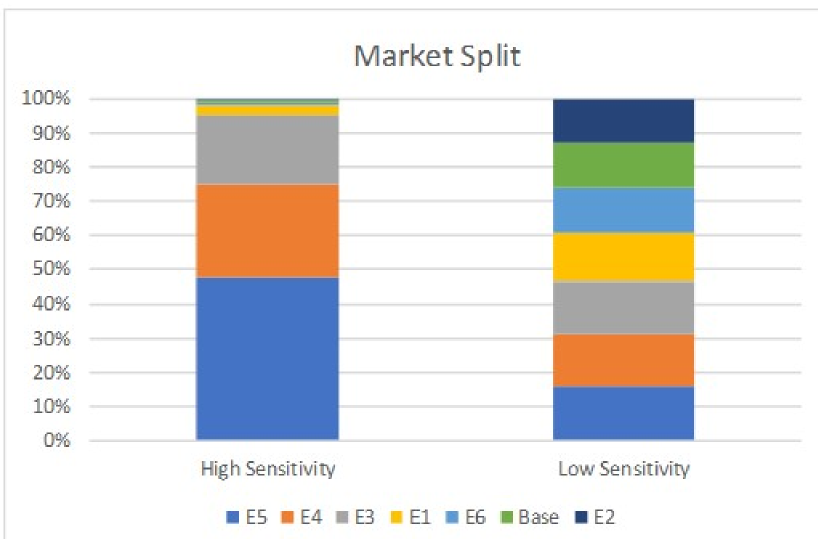
Preference Weighting =

$$\frac{Average\ Transformed\ Response\ (for\ Tech\ Attribute)}{Sum\ of\ Average\ Response\ (of\ all\ Tech\ Attributes)}$$

Although converting the responses into percentages accounts for variation across value factors, the model also accounts for variation in magnitude of responses across customer groups. Imagine a scenario where one customer group answered all 1s to the questions, and another group answered all 5s, with 1 indicating that the value factors do not influence decision-making and 5 indicating that the value factors have a high influence on decision-making. Simply using the percentage approach would lead to the same customer preference weightings across the board for both customer groups even though the raw data shows that one group feels far more strongly than the other about each value.

To account for this difference in magnitude, the study applied a parameter that indicates the level of sensitivity to differences in technology characteristics. This parameter is correlated to the average response across all value factors and influences how evenly the market splits. Lower sensitivities indicate the customer is not significantly more likely to adopt one technology over another due to the technology characteristics, so the market share is split evenly across all technologies. High sensitivities mean that customers are highly attuned to the technology characteristics that distinguish one technology from another and thus they tend to adopt the ones that align the closest with their preferences. Figure G-1 illustrates an example of how the market split could differ for two customer groups with different sensitivities.

Figure G-1. Effect of Sensitivity on Market Split



Source: Guidehouse

G.3.2 Normalized Technology Characteristic

The team used measure characterization data and subject matter knowledge to develop a numerical or binary value for each characteristic for each measure, which was converted to a dimensionless, normalized technology characteristic (shown in Equation G-2) by dividing by the average over the competition group (CG). This value can be interpreted as the relative characteristic value of the measure compared with the other CG measures.

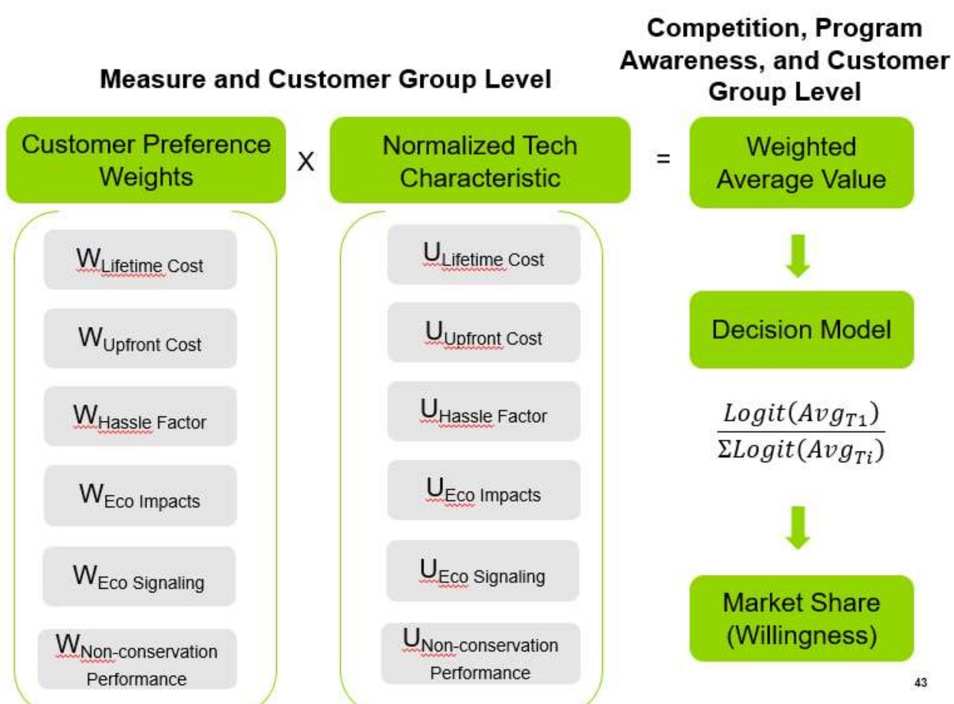
Equation G-2. Normalized Technology Characteristic

$$Normalized\ Technology\ Characteristic_{ValueFactor}(measure)$$
$$= \frac{Characteristic\ Value\ (for\ measure)}{Average\ Characteristic\ Value\ (across\ CG)}$$

G.4 Calculating Market Share

For each measure and customer group, the Guidehouse team generated weighted average characteristics by taking the sum-product of the preference weightings for that customer group and the normalized technology characteristics for that measure. Figure G-2 shows how customer preference weightings and technology characteristics are combined and fed into the decision model.

Figure G-2. Calculating Market Share



Source: Guidehouse

The full equation for the decision model is shown in Equation G-3.

Equation G-3. Decision Model Market Share Calculation

$$MarketShare(t) = \frac{e_t^{-\beta A_t}}{\sum_i^n e_i^{-\beta A_i}}$$

Where:

$n =$ Number of technologies in competition group
$n =$ Number of technologies in competition group
$t =$ Technology of interest

$\beta =$ Customer group sensitivity to differences in technology characteristics (or customer preference weighting)
$A =$ Weighted average, dimensionless technology characteristic

Appendix H. Cost-Effectiveness Analysis Methodology

Assessing cost-effectiveness for each measure is a core element to the 2025 Study. Cost-effectiveness at the measure level drives multiple critical outputs of the study:

- Cost-effectiveness of each measure determines what measures are included or excluded for each scenario—based on total resource cost (TRC) and cost-effectiveness thresholds—driving the amount of savings each scenario produces.
- Aggregation of measure-level cost-effectiveness data informs the study's output for portfolio cost-effectiveness.
- Avoided cost benefits for each measure and increased supply cost for FS measures are the key inputs to calculating the total system benefit (TSB).

The California Public Utilities Commission (CPUC) maintains the Cost-Effectiveness Tool (CET) used by the IOUs to inform program plans and filed savings claims to evaluate program cost-effectiveness. The 2025 Study mirrors the CET's calculation methodologies. However, the study cannot capture the full granularity that the CET does. This is a purposeful design to keep the PG Model to a reasonable size to allow it to run efficiently, both for the Guidehouse team and for stakeholders who choose to run the model.

Table H-1 highlights similarities and differences between the CET and the PG Model.

Table H-1. CET and PG Model Comparison

Category	Difference?	CET	PG Model
Cost-Effectiveness Definitions	No	Cost-effectiveness definitions for TRC, PAC and ratepayer impact measure (RIM) come from the California Standard Practice Manual and additional guidance from CPUC staff.	
Vintage of Avoided Cost	No	Uses the latest CPUC-approved avoided costs (published in 2024)	
Avoided Cost Components	No	Inputs primarily two types of avoided cost: Generation (which embeds emissions) and T&D. Applies these as appropriate to UES to calculate total avoided cost benefits. Refrigerant avoided costs (RACs) are also applied specific to individual measures (and not embedded within Generation or T&D)	
Unit Energy Savings Input	Yes	Allows users to input UES for any measure specific to any utility, any building type, and any climate zone within the IOU territory.	Measure list is constrained to those representative measures characterized in the study. Not every level of efficiency is captured. Climate zones are grouped in three representative regions for each IOU as shown in Table 3-11.

Category	Difference?	CET	PG Model
Electric Load Shape Input	Yes	Allows users to select a specific load shape and assign it to each measure. Load shapes vary by utility (PA), end use (EU), sector (TS), and climate zone (CZ). There are over 1,000 possible load shapes to choose from in CET.	The PG Model using the mapping provided by eTRM which assigns each measure an EU. For each EU and PA, Guidehouse selected a representative climate zone (see Table 3-11) to apply to each measure within each PA.
Load Shape Processing	Yes	Load shapes are input with quarterly (every 3 months) time steps. CET splits annual UES into quarterly savings and applies each quarter's savings to the quarterly avoided costs. Discounting to present data is possible on a quarterly time step.	The study operates on an annual basis, not a quarterly basis. Quarterly avoided costs are summed into an annual value before they are fed into the model.

Source: Guidehouse

Although these differences are a necessary simplification, they are sufficient and common practice for this type of higher level forecasting in a potential study.

H.1 Avoided Cost Components

The PG Model applies avoided costs to the algorithms outlined for TRC, PAC, and TSB taking guidance from the California Standard Practice Manual. Electric avoided costs for the PG Model are the aggregate of the avoided costs of generation and Transmission & Distribution from the CET.

- Generation in the CET is expressed in $/annual kWh. The CET embeds the cost of carbon in its valuation of generation avoided cost.
- T&D costs are expressed in two different ways (denoted by DSType within CET): $/kWh and $/kW. Those with kW DSTypes have this component of avoided cost valuing peak demand reductions and those with kWh DSTypes have value reductions in annual electric consumption. When the PG study team mapped avoided costs to eTRM, only those EUs that have kWh DSTypes were needed, thus only the Guidehouse team only needed and processed T&D costs on a per kWh basis.
- The avoided cost of refrigerant leakage is not applied per kWh saved and therefore must be calculated differently. RACs are quantified at the measure level and are expressed in units of dollars. They are a net present value of the avoided cost over the lifetime of the technology. In the case of FS measures, RAC often is a negative value implying it appears as a cost component in the C-E calculations.

Gas avoided costs are the sum of the avoided costs of generation and T&D as reported by the CET. There is no DSType for gas T&D avoided costs. Gas avoided costs include the valuation of methane leakage.

H.2 Total Resource Cost and Total System Benefit Definitions

The cost-effectiveness analysis in the 2025 Study includes calculating the TRC. The model also calculates TSB. TSB is not a cost-effectiveness test itself, but it is calculated from key components that also feed into the TRC test.

H.2.1 TRC

The TRC ratio for each measure is calculated each year and compared against the measure-level TRC ratio screening threshold. A measure with a TRC ratio greater than or equal to 1.0 is a measure that provides monetary benefits greater than or equal to its total resource costs. If a measure's TRC meets or exceeds a given scenario's threshold, it is included in the economic potential for that scenario.

The TRC test is a benefit-cost metric that measures the net benefits of EE measures from the combined stakeholder viewpoint of the utility (or program administrator) and the customers. The TRC benefit-cost ratio is calculated in the model using Equation H-1.

Equation H-1. Benefit-Cost Ratio for the TRC Test

$$TRC = \frac{PV(Avoided\ Cost\ Benefits)}{PV(Incremental\ Cost + Admin\ Costs) - \mathrm{PV}(Supply\ Costs)}$$

Where:

- **PV** is the present value calculation that discounts cost streams over time. Discount rates are sourced from the CET and vary by utility.
- **Avoided Cost Benefits** are the monetary benefits that result from electric and gas energy and capacity savings—e.g., avoided or deferred costs of infrastructure investments and avoided long-run marginal cost (commodity costs) due to electric energy conserved by efficient measures. These avoided costs decrease due to the increased consumption of any interactive effects. The avoided cost benefits is calculated by applying annual measure savings to avoided costs over the lifetime of the measure
- **Incremental Cost** is the measure cost as defined by replacement type. This is sourced from the electronic Technical Reference Manual (eTRM), measure packages, and other sources as appropriate and are decremented by any applicable tax credits. Incremental cost specifically excludes panel upgrade costs for FS measures
- **Admin Costs** are the non-incentive costs incurred by the utility or program administrator (not including incentives). These are described in Section 3.1.4.
- **Supply Costs** are the increased electric or gas consumption and refrigerant leakage for FS measures. Increased supply cost is valued by applying the annual increase in the new fuel use to the avoided electricity or gas cost over the life of the measure and adding the refrigerant avoided cost.

The Guidehouse team calculated TRC ratios for each measure based on the present value of benefits and costs (as defined in the numerator and denominator, respectively) over each measure's life.

H.2.2 TSB

TSB represents the sum of the benefit that a measure provides to the electric and natural gas systems. TSB is a metric to show the relative value of each measure compared to each other independent of its measure cost, program cost, or fuel type. TSB is calculated in the model using Equation H-2.

Equation H-2. Total System Benefit

$$TSB = PV(Avoided\ Cost\ Benefits) - PV(Supply\ Costs)$$

Where:

- **PV** is the present value calculation that discounts cost streams over time.
- **Avoided Cost Benefits** are the monetary benefits that result from electric and gas energy and capacity savings—e.g., avoided or deferred costs of infrastructure investments and avoided long-run marginal cost (commodity costs) due to electric energy conserved by efficient measures. The avoided costs are only included for fuels offered by the utility.
- **Supply Costs** come in several forms:
    - Interactive effects such as increased heating load due to decreased heat gain from more efficient lighting
    - Increased fuel consumption (i.e., electricity) due to FS
    - Refrigerant avoided costs that result in negative benefits (i.e., a furnace being replaced by a heat pump thus introducing refrigerants where there previously were none)

Appendix I. Detailed Scenario Results by IOU

I.1 TSB by Utility

This section presents the TSB by utility and Scenario.

Table I-1. TSB by Utility by Scenario—2030 ZEAS ($ Millions)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
PG&E												
Scenario 1: Reference	$301	$327	$350	$388	$338	$391	$414	$449	$491	$541	$589	$742
Scenario 2: High TRC	$292	$319	$346	$383	$334	$382	$405	$433	$482	$532	$576	$719
Scenario 3: Aggressive Fuel Sub	$307	$335	$360	$400	$347	$403	$429	$469	$517	$576	$633	$796
SCE												
Scenario 1: Reference	$188	$198	$206	$215	$151	$176	$198	$214	$222	$233	$240	$246
Scenario 2: High TRC	$153	$184	$193	$202	$149	$173	$193	$208	$217	$228	$235	$241
Scenario 3: Aggressive Fuel Sub	$189	$199	$207	$216	$152	$177	$198	$214	$222	$233	$241	$247
SCG												
Scenario 1: Reference	$278	$292	$307	$316	$249	$259	$274	$289	$305	$322	$340	$360
Scenario 2: High TRC	$273	$288	$304	$314	$247	$256	$271	$285	$301	$321	$340	$359
Scenario 3: Aggressive Fuel Sub	$277	$292	$306	$315	$248	$258	$274	$288	$304	$321	$339	$359
SDG&E												
Scenario 1: Reference	$73	$80	$86	$93	$76	$85	$93	$101	$109	$121	$130	$138
Scenario 2: High TRC	$71	$78	$84	$91	$75	$85	$92	$100	$109	$121	$130	$137
Scenario 3: Aggressive Fuel Sub	$77	$85	$92	$100	$81	$91	$100	$109	$118	$132	$141	$150

Source: Guidehouse

Table I-2. TSB by Utility by Scenario—2027 ZEAS ($ Millions)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
PG&E												
Scenario 4: Reference	$301	$340	$342	$357	$381	$398	$423	$464	$506	$549	$590	$734
Scenario 5: High TRC	$292	$331	$339	$353	$377	$389	$415	$448	$496	$540	$577	$712
Scenario 6: Aggressive Fuel Sub	$307	$349	$353	$369	$397	$411	$441	$488	$536	$587	$635	$789
SCE												
Scenario 4: Reference	$188	$195	$204	$206	$234	$202	$214	$222	$226	$233	$228	$242
Scenario 5: High TRC	$153	$181	$192	$194	$232	$199	$209	$217	$220	$228	$232	$237
Scenario 6: Aggressive Fuel Sub	$189	$196	$205	$206	$235	$202	$214	$222	$226	$233	$238	$243
SCG												
Scenario 4: Reference	$278	$224	$234	$241	$265	$259	$274	$289	$305	$322	$340	$360
Scenario 5: High TRC	$273	$220	$232	$239	$264	$256	$271	$285	$301	$321	$340	$359
Scenario 6: Aggressive Fuel Sub	$277	$224	$234	$241	$264	$258	$274	$288	$304	$321	$339	$359
SDG&E												
Scenario 4: Reference	$73	$89	$84	$81	$91	$89	$97	$107	$115	$124	$130	$136
Scenario 5: High TRC	$71	$87	$82	$80	$89	$88	$97	$107	$115	$123	$130	$135
Scenario 6: Aggressive Fuel Sub	$77	$96	$91	$88	$98	$96	$105	$116	$125	$134	$141	$147

Source: Guidehouse

I.2 Detailed Achievable Energy Impacts by IOU

This section presents impacts by fuel type using the 2024 vintage of avoided cost. The tables reflect FS as positive gas savings (decreased gas consumption) with negative electric savings (increased electric consumption). In this section, SCE shows gas savings due to FS measures funded by SCE ratepayers.

I.2.1 PG&E

Table I-3. PG&E Electric Energy Savings (GWh/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	78.4	82.8	75.9	82.7	80.6	85.1	86.7	86.9	88.8	90.1	92.1	100.3
FS	-22.8	-26.9	-31.6	-37.0	43.0	54.4	67.2	81.0	102.6	130.1	153.8	182.7
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
Scenario 2: High TRC (2030 ZEAS)												
EE	72.3	73.1	74.2	80.6	77.5	79.3	81.2	81.5	83.2	84.7	85.6	90.5
FS	-22.8	-26.9	-31.6	-37.0	43.0	54.4	67.2	81.0	102.6	130.1	153.8	182.7
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	78.4	82.8	75.9	82.7	80.6	85.1	86.7	86.9	88.8	90.1	92.1	100.3
FS	-26.7	-31.8	-37.5	-44.1	51.6	65.4	81.2	98.2	125.0	159.2	189.2	225.9
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
Scenario 4: Reference (2027 ZEAS)												
EE	78.4	82.8	75.9	82.7	80.6	85.1	86.7	86.9	88.8	90.1	92.1	100.3
FS	-22.8	-17.5	1.0	32.7	40.3	60.7	75.8	94.3	115.4	136.7	154.4	176.9
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
Scenario 5: High TRC (2027 ZEAS)												
EE	72.3	73.1	74.2	80.6	77.5	79.3	81.2	81.5	83.2	84.7	85.6	90.5
FS	-22.7	-17.5	1.0	32.6	70.2	60.7	75.7	94.3	115.4	136.7	154.4	176.9
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	78.4	82.8	75.9	82.7	80.6	85.1	86.7	86.9	88.8	90.1	92.1	100.3
FS	-26.7	-20.6	1.4	38.9	48.0	73.2	91.8	114.8	141.1	168.0	190.8	219.8
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
C&S (All Scenarios)												
w/ Interactive Effects	1595.1	1426.3	1377.3	1049.2	917.6	827.3	743.8	713.3	559.9	526.4	516.4	508.5
w/o Interactive Effects	1579.8	1416.3	1367.7	1051.0	922.9	833.0	749.6	719.2	565.8	532.8	522.8	514.8

Source: Guidehouse

Table I-4. PG&E Demand Savings (MW)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	15.3	22.4	13.5	16.0	13.7	14.3	14.5	13.9	14.0	14.2	14.4	16.2
FS	0.0	0.0	0.0	0.0	5.8	7.3	9.0	10.8	13.7	17.3	20.3	24.2
BROs	26.6	27.3	28.2	29.1	30.1	31.1	32.1	33.1	34.1	35.0	34.0	34.9
Scenario 2: High TRC (2030 ZEAS)												
EE	12.9	12.9	12.9	15.3	13.0	13.2	13.5	13.1	13.2	13.4	13.5	14.6
FS	0.0	0.0	0.0	0.0	5.8	7.3	9.0	10.8	13.7	17.3	20.3	24.2
BROs	26.6	27.3	28.2	29.1	30.1	31.1	32.1	33.1	34.1	35.0	34.0	34.9
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	15.3	22.4	13.5	16.0	13.7	14.3	14.5	13.9	14.0	14.2	14.4	16.2
FS	0.0	0.0	0.0	0.0	6.9	8.7	10.8	13.1	16.6	21.2	24.9	29.9
BROs	26.6	27.3	28.2	29.1	30.1	31.1	32.1	33.1	34.1	35.0	34.0	34.9
Scenario 4: Reference (2027 ZEAS)												
EE	15.3	23.2	13.5	15.3	13.7	14.3	14.5	13.9	14.0	14.2	14.4	16.2
FS	0.0	1.1	2.9	5.5	6.7	8.1	10.1	12.6	15.4	18.2	20.4	23.4
BROs	26.6	27.3	28.2	29.1	30.1	31.1	32.1	33.1	34.1	35.0	34.0	34.9
Scenario 5: High TRC (2027 ZEAS)												
EE	12.9	13.6	12.9	14.8	13.0	13.2	13.5	13.1	13.2	13.4	13.5	14.6
FS	0.0	1.1	2.9	5.5	6.7	8.1	10.1	12.6	15.4	18.2	20.4	23.4
BROs	26.6	27.3	28.2	29.1	30.1	31.1	32.1	33.1	34.1	35.0	34.0	34.9
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	15.3	23.2	13.5	15.3	13.7	14.3	14.5	13.9	14.0	14.2	14.4	16.2
FS	0.0	1.3	3.5	6.6	8.0	9.8	12.3	15.3	18.8	22.4	25.2	29.1
BROs	26.6	27.3	28.2	29.1	30.1	31.1	32.1	33.1	34.1	35.0	34.0	34.9
C&S (All Scenarios)												
w/ Interactive Effects	296.5	262.6	254.0	207.2	191.1	181.6	170.2	163.7	146.5	135.5	128.3	125.8
w/o Interactive Effects	281.5	252.0	243.6	203.1	188.6	179.5	168.2	161.8	144.6	134.2	127.0	124.6

Source: Guidehouse

Table I-5. PG&E Gas Energy Savings (MMtherm/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	11.2	11.4	11.8	12.0	11.1	12.0	11.5	11.5	11.4	10.8	10.8	12.9
FS	2.6	3.1	3.6	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
Scenario 2: High TRC (2030 ZEAS)												
EE	11.1	11.0	11.3	11.5	11.5	11.9	11.5	10.7	11.4	10.7	10.7	12.8
FS	2.6	3.1	3.6	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	11.2	11.4	11.8	12.0	11.1	12.0	11.5	11.5	11.4	10.9	10.8	12.9
FS	9.6	9.4	9.3	9.2	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
Scenario 4: Reference (2027 ZEAS)												
EE	11.2	11.4	11.8	12.0	11.1	12.0	11.5	11.5	11.4	10.9	10.8	12.9
FS	9.5	7.9	6.3	3.6	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
Scenario 5: High TRC (2027 ZEAS)												
EE	11.1	11.0	11.3	11.5	11.5	11.9	11.5	10.7	11.4	10.7	10.7	12.8
FS	2.6	3.0	2.5	1.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	11.2	11.1	11.4	11.6	11.5	12.0	11.5	11.5	11.4	10.8	10.8	12.9
FS	3.1	3.5	2.9	1.2	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
C&S (All Scenarios)												
w/ Interactive Effects	16.6	17.7	16.1	15.2	15.0	14.5	14.2	13.9	13.6	13.3	12.9	12.5
w/o Interactive Effects	20.3	20.4	18.8	16.7	16.1	15.5	15.2	14.9	14.5	14.1	13.7	13.3

Source: Guidehouse

I.2.2 SCE

Table I-6. SCE Electric Energy Savings (GWh/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	98.5	95.7	92.9	91.1	90.5	90.0	91.6	90.1	89.8	90.2	90.6	91.2
FS	-99.5	-97.7	-96.3	-95.0	55.4	68.3	80.0	88.4	93.5	96.1	96.9	96.6
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
Scenario 2: High TRC (2030 ZEAS)												
EE	80.5	79.0	78.3	73.0	88.4	87.6	87.5	85.9	85.6	85.9	86.3	86.8
FS	-64.9	-96.0	-95.2	-94.4	55.4	68.3	80.0	88.4	93.5	96.1	96.9	96.5
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	98.5	95.7	92.9	91.1	90.5	90.0	91.6	90.1	89.8	90.2	90.6	91.2
FS	-100.3	-98.4	-97.0	-95.7	55.4	68.1	79.7	88.1	93.2	95.7	96.5	96.2
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
Scenario 4: Reference (2027 ZEAS)												
EE	98.5	95.7	92.9	91.1	90.5	90.0	91.6	90.1	89.8	90.2	90.6	91.2
FS	-99.5	-67.9	-28.5	27.1	37.1	89.2	92.6	95.2	96.2	95.9	95.0	93.5
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
Scenario 5: High TRC (2027 ZEAS)												
EE	80.5	79.0	78.3	73.0	88.4	87.6	87.5	85.9	85.6	85.9	86.3	86.8
FS	-64.0	-66.3	-27.5	27.4	37.1	89.2	92.6	95.2	96.1	95.9	94.9	93.5
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	98.5	95.7	92.9	91.1	90.5	90.0	91.6	90.1	89.8	90.2	90.6	91.2
FS	-100.3	-68.3	-28.7	26.8	36.8	88.9	92.3	94.8	95.8	95.6	94.6	93.2
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
C&S (All Scenarios)												
w/ Interactive Effects	1595.1	1426.3	1377.3	1049.2	917.6	827.3	743.8	713.3	559.9	526.4	516.4	508.5
w/o Interactive Effects	1579.8	1416.3	1367.7	1051.0	922.9	833.0	749.6	719.2	565.8	532.8	522.8	514.8

Source: Guidehouse

Table I-7. SCE Demand Savings (MW)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	28.5	25.5	22.8	20.6	19.2	17.7	17.0	14.9	14.0	13.6	13.3	13.1
FS	0.0	0.0	0.0	0.0	8.4	10.3	12.1	13.3	14.1	14.5	14.6	14.6
BROs	37.5	39.0	40.4	41.3	42.3	43.2	44.2	45.2	46.2	47.1	48.1	49.2
Scenario 2: High TRC (2030 ZEAS)												
EE	27.3	24.2	21.6	11.3	18.7	17.1	16.1	14.1	13.3	12.9	12.6	12.4
FS	0.0	0.0	0.0	0.0	8.4	10.3	12.1	13.3	14.1	14.5	14.6	14.6
BROs	37.5	39.0	40.4	41.3	42.3	43.2	44.2	45.2	46.2	47.1	48.1	49.2
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	28.5	25.5	22.8	20.6	19.2	17.7	17.0	14.9	14.0	13.6	13.3	13.1
FS	0.0	0.0	0.0	0.0	8.4	10.3	12.0	13.3	14.1	14.5	14.6	14.5
BROs	37.5	39.0	40.4	41.3	42.3	43.2	44.2	45.2	46.2	47.1	48.1	49.2
Scenario 4: Reference (2027 ZEAS)												
EE	28.5	25.5	22.8	20.6	19.2	17.7	17.0	14.9	14.0	13.6	13.3	13.1
FS	0.0	2.6	6.2	11.2	12.6	13.5	14.0	14.4	14.5	14.5	14.3	14.1
BROs	37.5	39.0	40.4	41.3	42.3	43.2	44.2	45.2	46.2	47.1	48.1	49.2
Scenario 5: High TRC (2027 ZEAS)												
EE	27.3	24.2	21.6	11.3	18.7	17.1	16.1	14.1	13.3	12.9	12.6	12.4
FS	0.0	2.6	6.2	11.1	12.6	13.5	14.0	14.3	14.5	14.5	14.3	14.1
BROs	37.5	39.0	40.4	41.3	42.3	43.2	44.2	45.2	46.2	47.1	48.1	49.2
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	28.5	25.5	22.8	20.6	19.2	17.7	17.0	14.9	14.0	13.6	13.3	13.1
FS	0.0	2.6	6.2	11.1	12.5	13.4	13.9	14.3	14.5	14.4	14.3	14.1
BROs	37.5	39.0	40.4	41.3	42.3	43.2	44.2	45.2	46.2	47.1	48.1	49.2
C&S (All Scenarios)												
w/ Interactive Effects	275.7	242.5	234.4	188.3	172.5	163.6	152.6	147.0	130.6	120.0	113.0	110.8
w/o Interactive Effects	260.9	232.1	224.1	184.3	170.2	161.6	150.7	145.1	128.7	118.8	111.9	109.6

Source: Guidehouse

Table I-8. SCE Gas Savings (MMtherms)—FS Only

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	9.5	9.3	9.2	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 2: High TRC (2030 ZEAS)												
EE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	7.1	9.2	9.1	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	9.6	9.4	9.3	9.2	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
BROs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 4: Reference (2027 ZEAS)												
EE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	9.5	7.9	6.3	3.6	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 5: High TRC (2027 ZEAS)												
EE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	7.1	7.8	6.2	3.6	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	9.6	8.0	6.3	3.6	3.6	0.0	0.0	0.1	0.1	0.1	0.1	0.1
BROs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C&S (All Scenarios)												
w/ Interactive Effects	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
w/o Interactive Effects	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Guidehouse

I.2.3 SCG

Table I-9. SCG Gas Savings (MMtherm/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	15.0	14.9	14.7	14.5	12.4	12.3	12.3	12.2	12.2	12.1	12.0	12.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
Scenario 2: High TRC (2030 ZEAS)												
EE	14.4	14.4	14.5	14.3	12.3	12.1	12.1	12.1	12.1	12.1	12.0	11.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	15.0	14.8	14.7	14.4	12.4	12.3	12.3	12.2	12.2	12.1	12.0	11.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
Scenario 4: Reference (2027 ZEAS)												
EE	15.0	12.8	12.7	12.5	12.8	12.3	12.3	12.2	12.2	12.1	12.0	12.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
Scenario 5: High TRC (2027 ZEAS)												
EE	14.4	12.4	12.4	12.3	12.7	12.1	12.1	12.1	12.1	12.1	12.0	11.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	15.0	12.8	12.7	12.5	12.8	12.3	12.3	12.2	12.2	12.1	12.0	11.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
C&S (All Scenarios)												
w/ Interactive Effects	18.5	19.7	17.9	16.9	16.7	16.1	15.8	15.5	15.1	14.9	14.4	13.9
w/o Interactive Effects	22.6	22.7	20.9	18.6	17.9	17.3	16.9	16.6	16.2	15.7	15.2	14.8

Source: Guidehouse

I.2.4 SDG&E

Table I-10. SDG&E Electric Energy Savings (GWh/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	22.8	23.3	23.0	23.5	24.0	24.6	25.2	25.4	25.9	26.4	26.8	27.2
FS	-17.8	-19.4	-20.9	-22.4	36.2	41.4	46.3	50.3	56.3	62.9	67.7	70.8
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
Scenario 2: High TRC (2030 ZEAS)												
EE	21.5	21.8	22.4	23.0	23.6	24.1	24.7	25.1	25.6	26.1	26.5	26.9
FS	-17.8	-19.4	-20.9	-22.5	36.4	41.7	46.5	50.6	56.6	63.3	68.1	71.3
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	22.8	23.3	23.0	23.5	24.0	24.6	25.2	25.4	25.9	26.4	26.8	27.2
FS	-21.0	-22.8	-24.6	-26.4	41.9	47.9	53.4	57.9	64.7	72.1	77.3	80.8
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
Scenario 4: Reference (2027 ZEAS)												
EE	22.8	23.3	23.0	23.5	24.0	24.6	25.2	25.4	25.9	26.4	26.8	27.2
FS	-17.8	-12.0	7.9	34.2	37.9	45.3	50.6	56.3	61.6	65.2	67.5	69.0
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
Scenario 5: High TRC (2027 ZEAS)												
EE	21.5	21.9	22.4	23.0	23.6	24.1	24.7	25.1	25.6	26.1	26.5	26.9
FS	-17.8	-12.0	8.0	34.4	38.1	45.6	50.9	56.7	62.0	65.6	68.0	69.5
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	22.8	23.3	23.0	23.3	24.0	24.6	25.2	25.4	25.9	26.4	26.8	27.2
FS	-21.0	-14.0	9.2	39.6	43.9	52.4	58.3	64.8	70.6	74.6	77.1	78.7
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
C&S (All Scenarios)												
w/ Interactive Effects	326.7	292.1	282.1	214.9	187.9	169.4	152.3	146.1	114.7	107.8	105.8	104.1
w/o Interactive Effects	323.5	290.0	280.1	215.2	189.0	170.6	153.5	147.3	115.9	109.1	107.1	105.4

Source: Guidehouse

Table I-11. SDG&E Demand Savings (MW)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	3.2	3.2	3.2	3.2	3.0	3.0	3.1	2.9	2.9	2.9	3.0	3.0
FS	0.0	0.0	0.0	0.0	5.3	6.1	6.8	7.4	8.2	9.2	9.9	10.4
BROs	9.4	9.6	9.9	10.2	10.6	10.9	11.2	11.6	11.9	12.1	12.3	12.6
Scenario 2: High TRC (2030 ZEAS)												
EE	3.0	2.9	2.9	2.9	3.0	2.8	2.8	2.8	2.8	2.9	2.9	2.9
FS	0.0	0.0	0.0	0.0	5.3	6.1	6.8	7.4	8.3	9.3	10.0	10.4
BROs	9.4	9.6	9.9	10.2	10.6	10.9	11.2	11.6	11.9	12.1	12.3	12.6
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	3.2	3.2	3.2	3.2	3.0	3.0	3.1	2.9	2.9	2.9	3.0	3.0
FS	0.0	0.0	0.0	0.0	6.1	7.0	7.8	8.5	9.5	10.6	11.3	11.8
BROs	9.4	9.6	9.9	10.2	10.6	10.9	11.2	11.6	11.9	12.1	12.3	12.6
Scenario 4: Reference (2027 ZEAS)												
EE	3.2	3.8	3.2	3.0	3.0	3.0	3.1	2.9	2.9	2.9	3.0	3.0
FS	0.0	1.3	3.2	5.4	6.0	6.6	7.4	8.2	9.0	9.5	9.9	10.1
BROs	9.4	9.6	9.9	10.2	10.6	20.9	11.2	11.6	11.9	12.1	12.3	12.6
Scenario 5: High TRC (2027 ZEAS)												
EE	3.0	3.5	2.9	2.9	3.0	2.8	2.8	2.8	2.8	2.9	2.9	2.9
FS	0.0	1.3	3.2	5.5	6.0	6.7	7.5	8.3	9.1	9.6	10.0	10.2
BROs	9.4	9.6	9.9	10.2	10.6	10.9	11.2	11.6	11.9	12.1	12.3	12.6
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	3.2	3.8	3.2	3.0	3.0	3.0	3.1	2.9	2.9	2.9	3.0	3.0
FS	0.0	1.5	3.7	6.3	7.0	7.7	8.5	9.5	10.3	10.9	11.3	11.5
BROs	9.4	9.6	9.9	10.2	10.6	10.9	11.2	11.6	11.9	12.1	12.3	12.6
C&S (All Scenarios)												
w/ Interactive Effects	55.2	48.3	46.6	37.1	33.9	32.0	29.8	28.7	25.3	23.1	21.7	21.2
w/o Interactive Effects	52.1	46.1	44.5	36.3	33.4	31.6	29.4	28.3	24.9	22.9	21.4	21.0

Source: Guidehouse

Table I-12. SDG&E Gas Energy Savings (MMtherm/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	1.1	1.2	1.3	1.3	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0
FS	2.0	2.2	2.4	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
Scenario 2: High TRC (2030 ZEAS)												
EE	1.1	1.1	1.1	1.1	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9
FS	2.0	2.2	2.4	2.5	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	1.1	1.2	1.3	1.3	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0
FS	2.4	2.6	2.8	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
Scenario 4: Reference (2027 ZEAS)												
EE	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	1.0	1.0	1.0
FS	2.0	2.4	1.6	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
Scenario 5: High TRC (2027 ZEAS)												
EE	1.1	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
FS	2.0	2.4	1.6	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	1.0	1.0	1.0
FS	2.4	2.8	1.9	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
C&S (All Scenarios)												
w/ Interactive Effects	1.7	1.8	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3
w/o Interactive Effects	2.0	2.1	1.9	1.7	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.3

Source: Guidehouse

I.3 Impacts Converted to Energy Savings Credits—2024 Avoided Costs

This section presents impacts in terms of energy savings credits using the 2024 vintage of avoided costs. The tables reflect FS with their net electric energy savings credit (decreased gas consumption converted into kWh savings credit minus increased electric consumption). In this section, FS savings are only expressed in kWh units—no gas units are used to express FS savings.

I.3.1 PG&E

Table I-13. PG&E Electric Energy Savings (GWh/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	78.4	82.8	75.9	82.7	80.6	85.1	86.7	86.9	88.8	90.1	92.1	100.3
FS	53.4	63.9	73.9	86.1	43.0	54.4	67.2	81	102.6	130.1	153.8	182.7
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
Scenario 2: High TRC (2030 ZEAS)												
EE	72.3	73.1	74.2	80.6	77.5	79.3	81.2	81.5	83.2	84.7	85.6	90.5
FS	53.4	63.9	73.9	86.1	43.0	54.4	67.2	81	102.6	130.1	153.8	182.7
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	78.4	82.8	75.9	82.7	80.6	85.1	86.7	86.9	88.8	90.1	92.1	100.3
FS	254.6	243.6	235.0	225.5	51.6	65.4	81.2	101.1	127.9	162.1	192.1	228.8
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
Scenario 4: Reference (2027 ZEAS)												
EE	78.4	82.8	75.9	82.7	80.6	85.1	86.7	86.9	88.8	90.1	92.1	100.3
FS	255.6	214.0	185.6	138.2	142.9	60.7	75.8	94.3	115.4	136.7	154.4	176.9
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
Scenario 5: High TRC (2027 ZEAS)												
EE	72.3	73.1	74.2	80.6	77.5	79.3	81.2	81.5	83.2	84.7	85.6	90.5
FS	53.48	70.4	74.25	61.9	102.43	60.7	75.7	94.3	115.4	136.7	154.4	176.9
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	78.4	82.8	75.9	82.7	80.6	85.1	86.7	86.9	88.8	90.1	92.1	100.3
FS	64.1	82.0	86.4	74.1	89.0	73.2	91.8	114.8	141.1	168	190.8	219.8
BROs	175.7	180.4	186.5	192.8	199.9	206.3	213.7	220.9	228.1	234.7	234.4	242.1
C&S (All Scenarios)												
w/ Interactive Effects	1595.1	1426.3	1377.3	1049.2	917.6	827.3	743.8	713.3	559.9	526.4	516.4	508.5
w/o Interactive Effects	1579.8	1416.3	1367.7	1051	922.9	833	749.6	719.2	565.8	532.8	522.8	514.8

Source: Guidehouse

Table I-14. PG&E Gas Energy Savings (MMtherm/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	11.2	11.4	11.8	12.0	11.1	12.0	11.5	11.5	11.4	10.8	10.8	12.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
Scenario 2: High TRC (2030 ZEAS)												
EE	11.1	11.0	11.3	11.5	11.5	11.9	11.5	10.7	11.4	10.7	10.7	12.8
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	11.2	11.4	11.8	12.0	11.1	12.0	11.5	11.5	11.4	10.9	10.8	12.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
Scenario 4: Reference (2027 ZEAS)												
EE	11.2	11.4	11.8	12.0	11.1	12.0	11.5	11.5	11.4	10.9	10.8	12.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
Scenario 5: High TRC (2027 ZEAS)												
EE	11.1	11.0	11.3	11.5	11.5	11.9	11.5	10.7	11.4	10.7	10.7	12.8
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	11.2	11.1	11.4	11.6	11.5	12.0	11.5	11.5	11.4	10.8	10.8	12.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.4	7.5	7.7	7.7	7.9
C&S (All Scenarios)												
w/ Interactive Effects	16.6	17.7	16.1	15.2	15.0	14.5	14.2	13.9	13.6	13.3	12.9	12.5
w/o Interactive Effects	20.3	20.4	18.8	16.7	16.1	15.5	15.2	14.9	14.5	14.1	13.7	13.3

Source: Guidehouse

I.3.2 SCE

Table I-15. SCE Electric Energy Savings (GWh/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	98.5	95.7	92.9	91.1	90.5	90	91.6	90.1	89.8	90.2	90.6	91.2
FS	178.9	174.8	173.3	171.6	55.4	68.3	80	88.4	93.5	96.1	96.9	96.6
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
Scenario 2: High TRC (2030 ZEAS)												
EE	80.5	79	78.3	73	88.4	87.6	87.5	85.9	85.6	85.9	86.3	86.8
FS	143.1	173.6	171.4	169.3	55.4	68.3	80	88.4	93.5	96.1	96.9	96.5
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	98.5	95.7	92.9	91.1	90.5	90	91.6	90.1	89.8	90.2	90.6	91.2
FS	181.0	177.0	175.5	173.9	55.4	68.1	79.7	91.03	96.13	98.63	99.43	99.13
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
Scenario 4: Reference (2027 ZEAS)												
EE	98.5	95.7	92.9	91.1	90.5	90	91.6	90.1	89.8	90.2	90.6	91.2
FS	178.9	163.6	156.1	132.6	139.7	89.2	92.6	95.2	96.2	95.9	95	93.5
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
Scenario 5: High TRC (2027 ZEAS)												
EE	80.5	79	78.3	73	88.4	87.6	87.5	85.9	85.6	85.9	86.3	86.8
FS	144.0	162.2	154.2	132.9	139.7	89.2	92.6	95.2	96.1	95.9	94.9	93.5
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	98.5	95.7	92.9	91.1	90.5	90	91.6	90.1	89.8	90.2	90.6	91.2
FS	181.0	166.1	155.9	132.3	142.3	88.9	92.3	97.73	98.73	98.53	97.53	96.13
BROs	168.3	175.6	182.8	188.2	194.1	199.8	206.3	212.8	219.7	226.2	234.1	242.5
C&S (All Scenarios)												
w/ Interactive Effects	1595.1	1426.3	1377.3	1049.2	917.6	827.3	743.8	713.3	559.9	526.4	516.4	508.5
w/o Interactive Effects	1579.8	1416.3	1367.7	1051	922.9	833	749.6	719.2	565.8	532.8	522.8	514.8

Source: Guidehouse

I.3.3 SCG

Table I-17. SCG Gas Savings

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	15.0	14.9	14.7	14.5	12.4	12.3	12.3	12.2	12.2	12.1	12.0	12.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
Scenario 2: High TRC (2030 ZEAS)												
EE	14.4	14.4	14.5	14.3	12.3	12.1	12.1	12.1	12.1	12.1	12.0	11.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	15.0	14.8	14.7	14.4	12.4	12.3	12.3	12.2	12.2	12.1	12.0	11.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
Scenario 4: Reference (2027 ZEAS)												
EE	15.0	12.8	12.7	12.5	12.8	12.3	12.3	12.2	12.2	12.1	12.0	12.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
Scenario 5: High TRC (2027 ZEAS)												
EE	14.4	12.4	12.4	12.3	12.7	12.1	12.1	12.1	12.1	12.1	12.0	11.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	15.0	12.8	12.7	12.5	12.8	12.3	12.3	12.2	12.2	12.1	12.0	11.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5.0	5.2	5.4	5.6
C&S (All Scenarios)												
w/ Interactive Effects	18.5	19.7	17.9	16.9	16.7	16.1	15.8	15.5	15.1	14.9	14.4	13.9
w/o Interactive Effects	22.6	22.7	20.9	18.6	17.9	17.3	16.9	16.6	16.2	15.7	15.2	14.8

Source: Guidehouse

I.3.4 SDG&E

Table I-16. SDG&E Electric Energy Savings (GWh/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	22.8	23.3	23.0	23.5	24.0	24.6	25.2	25.4	25.9	26.4	26.8	27.2
FS	40.8	45.1	49.4	50.9	36.2	41.4	46.3	50.3	56.3	62.9	67.7	70.8
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
Scenario 2: High TRC (2030 ZEAS)												
EE	21.5	21.8	22.4	23.0	23.6	24.1	24.7	25.1	25.6	26.1	26.5	26.9
FS	40.8	45.1	49.4	50.8	45.2	53.4	46.5	50.6	56.6	63.3	68.1	71.3
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	22.8	23.3	23.0	23.5	24.0	24.6	25.2	25.4	25.9	26.4	26.8	27.2
FS	49.3	53.4	57.4	61.5	41.9	47.9	53.4	57.9	64.7	72.1	77.3	83.73
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
Scenario 4: Reference (2027 ZEAS)												
EE	22.8	23.3	23.0	23.5	24.0	24.6	25.2	25.4	25.9	26.4	26.8	27.2
FS	40.8	58.3	54.8	45.9	49.6	45.3	50.6	56.3	61.6	65.2	67.5	69
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
Scenario 5: High TRC (2027 ZEAS)												
EE	21.5	21.9	22.4	23.0	23.6	24.1	24.7	25.1	25.6	26.1	26.5	26.9
FS	40.8	58.3	54.9	46.1	49.8	45.6	50.9	56.7	62	65.6	68	69.5
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	22.8	23.3	23.0	23.3	24.0	24.6	25.2	25.4	25.9	26.4	26.8	27.2
FS	49.3	68.0	64.9	54.3	58.6	52.4	58.3	64.8	70.6	74.6	77.1	81.6
BROs	42.5	43.8	45.5	47.3	49.3	51.3	53.4	55.6	57.8	59.9	61.6	64.3
C&S (All Scenarios)												
w/ Interactive Effects	326.7	292.1	282.1	214.9	187.9	169.4	152.3	146.1	114.7	107.8	105.8	104.1
w/o Interactive Effects	323.5	290.0	280.1	215.2	189.0	170.6	153.5	147.3	115.9	109.1	107.1	105.4

Source: Guidehouse

Table I-17. SDG&E Gas Energy Savings (MMtherm/year)

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Scenario 1: Reference (2030 ZEAS)												
EE	1.1	1.2	1.3	1.3	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
Scenario 2: High TRC (2030 ZEAS)												
EE	1.1	1.1	1.1	1.1	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
Scenario 3: Aggressive FS (2030 ZEAS)												
EE	1.1	1.2	1.3	1.3	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
Scenario 4: Reference (2027 ZEAS)												
EE	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	1.0	1.0	1.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
Scenario 5: High TRC (2027 ZEAS)												
EE	1.1	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
Scenario 6: Aggressive FS (2027 ZEAS)												
EE	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	1.0	1.0	1.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
BROs	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6
C&S (All Scenarios)												
w/ Interactive Effects	1.7	1.8	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3
w/o Interactive Effects	2.0	2.1	1.9	1.7	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.3

Source: Guidehouse

Appendix J. Inflation Reduction Act Tax Credits

The Guidehouse team accounted for Inflation Reduction Act (IRA) tax credits in the 2025 Study. While the IRA also specifies EE rebate programs designed to promote the adoption of efficient and electrified end use technologies, these programs will be left to individual states to design and administer, and their impact was not quantified here. In the 2023 Potential & Goals Study, CPUC requested Guidehouse incorporate the impact of Energy Efficiency Home Improvement (EEHI) tax credits introduced through the 2023 Inflation Reduction Act (IRA).[127] This section outlines the methodology and approach for including these tax credits within the 2025 Potential & Goals Study core modeling process, including a detailed discussion of inputs and assumptions. Tax Credits will have two effects in the model:

The model includes two effects potentially caused by the tax credits:

- **Changing Cost-Effectiveness.** Tax credits are a benefit in the TRC test and could act to increase cost-effectiveness of measures. Economic Potential could increase if measures cross the threshold of cost-effectiveness due to the tax credit. The PG Model followed the California Standard Practice Manual and supplemental guidance from CPUC staff to properly incorporate tax credits into the TRC test.
- **Increasing Willingness to Adopt.** Tax credits reduce the lifetime ownership cost of energy efficient equipment. Lifetime cost is an input to the PG Model's calculation of willingness to adopt; reducing cost increases willingness and thus increases Achievable Potential. We do not expect significant algorithm changes to be necessary to model this aspect.

The critical step to modeling the IRA in the PG Model is to characterize the tax credits for each applicable measure. Within the PG Model measure input workbooks, there is a field for both residential and commercial measures input workbooks for tax credits in a $/unit value.

The IRA has specific provisions for developing and quantifying the appropriate tax credit for measures in the residential and commercial sectors, which are detailed below. Once the values are characterized, they can be imported to the PG Model and run to calculate the resulting savings.

J.1 Residential Sector Characterization

For applicable Residential EE and FS measures, Guidehouse used IRS Tax Credit Statistics to calculate an estimated $/return value for each measure qualifying for an EEHI tax credit. Guidehouse then calculated a scaling factor to account for the requirement that the measures are installed in owner-occupied single-family homes.

Background on IRA Tax Credit Amounts

The IRA Energy Efficiency Home Improvement Credit[128] equals 30% of qualified expenses, and the maximum allowable credit claimed per year is:

[127] Internal Revenue Service, Energy Efficient Home Improvement Credit, https://www.irs.gov/credits-deductions/energy-efficient-home-improvement-credit.

[128] Internal Revenue Service, Energy Efficient Home Improvement Credit, https://www.irs.gov/credits-deductions/energy-efficient-home-improvement-credit.

- The smaller of $1200 or the measure cost for non-heat pump HVAC, insulation, and envelope measures (excluding windows and exterior doors)
- The smaller of $2000 or the measure cost for heat pump HVAC or HPWH
- The smaller of $600 or the measure cost for windows
- The smaller of $500 or the measure cost for doors

In August 2024, the IRS released initial 2023 tax statistics data detailing the actual use of residential EEHI tax credits under the IRA.[129] Data was provided in three formats: (1) by measure at the national level, (2) in aggregate, across all measures, by income, and (3) in aggregate at the state level. Guidehouse considered several approaches to using this data to refine study assumptions and ultimately recommend **deriving and apply the measure level $/tax return value** from the above referenced data**.** This replaces the adjusted tax credit value used in the 2023 Study with a measure-specific credit per return value calculated using the data from the IRS.

The Guidehouse team notes that this approach applies two critical assumptions:

- Measure-level data at the national level is applicable to California at the state level. Guidehouse believes this is generally reasonable and represents the most accurate possible application of publicly available data.
- The $/return value calculated from IRS data considers partial claims, and thus removes the step used in the prior study where effective per measure tax credit values are adjusted to account for sufficient tax burden.

Residential Sector Detailed Approach

The following steps detail the process by which the Guidehouse team assigns a specific tax credit $/measure unit value to be inputted into the Residential Sector Potential & Goals Study model.

Step 1—Identify the number of total tax returns claiming an EEHI Tax Credit and the total $ amount of these credits claimed in 2023 within the state of California. This data comes from Tax Form 5695 Residential Energy Credits, by State, Tax Year 2023.[130]

Step 2—Calculate the % of total filed tax returns and % of total EEHI tax credit amount ($) represented by each EE measure detailed within the IRS data. These values represent nationwide data.

- The % of total returns for each measure are calculated by dividing the individual number of returns claimed for one measure by the total number claimed for all measures.
- The % of total $ amount by measure is calculated by dividing the total amount for one measure by the total amount for all measures.

[129] Internal Revenue Service, SOI tax stats - Clean energy tax credit statistics, https://www.irs.gov/statistics/soi-tax-stats-clean-energy-tax-credit-statistics.

[130] Internal Revenue Service, SOI tax stats - Clean energy tax credit statistics, https://www.irs.gov/statistics/soi-tax-stats-clean-energy-tax-credit-statistics.

Step 3—Apply the % of total returns for each measure and % of total $ for each measure (both from Step 2) to the number of returns and EEHI tax credit $ in California from Step 1. This estimates the number of returns and total amount for each measure group for claims in California. These values are listed by measure in Table J-1 columns 2 and 3.

Step 4—For each measure, divide the amount by the number of returns to get $/return (Table J-1, column 4).

Step 5—Adjust the $/return values (Table J-1, column 5) by applying the percentage of single-family homes that are owner occupied. This is to account for the IRA requirement that to claim a tax credit the occupant must own the home. The data for this calculation comes from the 2019 RASS data set.

- # of SF homes that are owner occupied ÷ # of SF homes = 90.12%

Step 6 - Add adjusted $/return from Step 5 to residential measure workbooks.

- Per the IRA language this includes HVAC equipment, air sealing, insulation, improvements to or replacements of panelboards, sub-panelboards, branch circuits, or feeders used with qualifying property would also be credit-eligible costs. We mapped the measures included in the tax credit data to the PG study measure list based on technologies that would fit into the defined PG Study Technology Groups, such as insulation, central air conditioners, gas water heaters, etc. Some measures included in the tax credit data are not included in the PG study measure list, such as doors, skylights, home energy audits, and biomass technologies.

Table J-1. Results from Residential IRA Tax Credit Analysis and Reference Maximum Claim Amounts

IRA Tax Credits—IRS Stats measure categories (PG Study applicable)	Number of Returns	Total Amount	$/Return	Adjusted $/Return	IRA-specified Maximum Claim (reference)
Insulation or Air Sealing	35,229	$24,698,557	$701	**$632**	$1200
Central air conditioners	24,582	$31,995,633	$1,302*	**$1,173**	$1200
Natural gas, propane, or oil water heaters	14,773	$6,463,770	$438	**$394**	$600
Natural gas, propane, or oil furnace or hot water boilers	14,274	$13,868,653	$972	**$876**	$1200
Electric or natural gas heat pumps	13,487	$23,784,598	$1,763	**$1,589**	$2000
Electric or natural gas heat pump water heaters	5,247	$3,314,290	$632	**$569**	$2000

Source: Guidehouse

J.2 Commercial Sector Characterization

The IRA tax credit for commercial buildings applies to HVAC, Lighting, and Water measures achieving at least 25% reduction from baseline energy consumption. The tax credit is $/sq ft and dependent on the total reduction in baseline energy usage:

> *The deduction would be set at $0.50 per square foot and increased by $0.02 for each percentage point by which the certified efficiency improvements reduce energy and power costs, with a maximum amount of $1.00 per square foot. For projects that meet prevailing wage and registered apprenticeship requirements the base amount is $2.50, which would be increased by $0.10 for each percentage point increase in energy efficiency, with a maximum amount of $5.00 per square foot.*[131]

Establishing Assumptions and Calculations

In order to apply IRA tax credit assumptions for the Commercial sector to eligible EE rebate measures, Guidehouse used the following steps to convert the IRA-defined **$/sq ft** tax credit value into **$/kWh** and **$/therms** values that are compatible with the PG Study measure characterization. These tax credit $/kWh and $/therm values are then applied to the kWh and therm savings in the measure characterization to estimate tax credit values at the measure level.

Step 1—Identify the base unadjusted tax credit value per the IRA of **$2.50/sq ft** for projects that (a) achieve a 25% reduction in consumption and (b) meet prevailing wage and registered apprenticeship requirements.

Step 2—For each Building Type and Consumption Type (kWh or therms), calculate average baseline consumption per sq ft of building stock. These values are available from the Global Inputs.

kWh/sq ft consumption = Total consumption (kWh) ÷ Total stock (sq ft)

therm/sq ft consumption = Total consumption (therms) ÷ Total stock (sq ft)

Step 3—Calculate the expected savings per square foot, using the minimum threshold of 25% reduction in consumption.

kWh/sq ft saved = kWh/sq ft consumption [Step 2] × 25%

therm/sq ft saved = therm/sq ft consumption [Step 2] × 25%

Step 4—Calculate an **unadjusted** value for tax credit $/kWh saved or $/therms saved.

Unadjusted tax credit $/kWh saved = $2.50/sq ft [Step 1] ÷ kWh/sq ft saved [Step 3]

Unadjusted tax credit $/therm saved = $2.50/sq ft [Step 1] ÷ therm/sq ft saved [Step 3]

[131] Congress.gov, Tax Provisions in the Inflation Reduction Act of 2022, https://crsreports.congress.gov/product/pdf/R/R47202.

Step 5—Apply eligibility adjustments that represent estimates for the subset of buildings, by Building Type, that have the potential to achieve the minimum 25% reduction in baseline energy consumption as required by the IRA.[132]

Adjusted tax credit $/kWh saved =

Unadjusted tax credit $/kWh saved [Step 4]

× Pre-1992 Adjustment (%) [Step 5a]

× Achievability Adjustment (%) [Step 5b]

× Prevailing Wage/Apprenticeship Adjustment (%) [Step 5c]

Adjusted tax credit $/therm saved =

Unadjusted tax credit $/therm saved [Step 4]

× Pre-1992 Adjustment (%) [Step 5a]

× Achievability Adjustment (%) [Step 5b]

× Prevailing Wage/Apprenticeship Adjustment (%) [Step 5c]

The following bullets describe each of the three applicability adjustments.

- *Step 5a*—**Pre-1992 Adjustment**. First, Guidehouse assumed that only Commercial buildings constructed prior to 1992 will realistically be able to meet the required 25% reduction in baseline energy usage. For each commercial Building Type, Guidehouse analyzed the Global Inputs stock data to develop percentages for the proportion of the building stock that was constructed before 1992, which range between 71% and 88%.
- *Step 5b*—**Achievability Adjustment**. This represents the proportion of pre-1992 buildings that can meet the 25% reduction threshold, by Building Type. Guidehouse conducted a review of publicly available secondary data sources combined with Guidehouse expertise to establish an estimate of applicable buildings. The Guidehouse team research found that “on average, 30% of the energy used in commercial buildings is wasted”[133] and the Commercial Buildings Integration program has set a target of a 30% reduction in commercial building energy use intensity from 2010 levels by 2030.

  To refine this assumption, Guidehouse analyzed the overall commercial building stock by building type and vintage. Of these buildings, it was assumed that on average 30% can reduce energy usage by 25% or greater through analyzed EE measures.

  To compare relative achievable potential by different building types, Guidehouse applied a “Low” (15%), “Medium” (30%”), or “High” (45%) designation to each building type (Table J-2). This represents a conservative, bounded estimate of the assumed proportion of building square footage built prior to 1992 for each building type that could achieve at least the minimum required savings of 25%. These percentage values were developed through consultation with Guidehouse

[132] Energy efficient commercial buildings deduction | Internal Revenue Service
[133] DOE Commercial Buildings Integration

commercial sector building and EE potential subject matter experts and indexed to each building type based on achievable potential from the 2023 Study.

Table J-2. Assumed Percentage of Pre-1992 Vintage Buildings Achieving > 25% Energy Reduction to Qualify for IRA Tax Credits

Building Type	Percent of Pre-1992 Building Square Footage Achieving >25% Energy Reduction
College	30%
Grocery	45%
Health	45%
Lodging	30%
Office (Large)	30%
Office (Small)	15%
Other	30%
Refrig. Warehouse	15%
Restaurant	45%
Retail	45%
School	15%
Warehouse	15%

Source: Guidehouse

- *Step 5c*—**Prevailing Wage/Apprenticeship Adjustment**. Guidehouse assumes a prevailing wage/apprenticeship adjustment factor of **85**%. California law establishes a requirement for public works projects to meet prevailing wage requirements. 134 Guidehouse assumes that compliance is not 100% but in general will represent most projects.

Step 6—Perform a final fuel-split adjustment to account for the fact that there are two separate fuel types (electric and gas) that together contribute to each building's energy consumption. This adjustment is necessary to avoid double counting of the tax credit because there is not one tax credit for electric savings and another tax credit for gas savings; rather, there is one tax credit for achieving a 25% reduction in building consumption which can be a combination of electric and gas savings.

Final tax credit $/kWh saved = adjusted tax credit $/kWh saved [Step 5]
× electric consumption split (%)

Final tax credit $/therm saved = adjusted tax credit $/therm saved [Step 5]
× gas consumption split (%)

[134] State of California Department of Industrial Relations, Prevailing Wage Requirements, https://www.dir.ca.gov/public-works/prevailing-wage.html#:~:text=Prevailing%20Wage%20Requirements-,Prevailing%20Wage%20Requirements,and%20location%20of%20the%20project.

Table J-3. IRA Tax Credit Value by Building Type

Building Type	Reference IRA tax credit value ($/kWh saved)	Reference IRA tax credit value ($/therm saved)
Com - College	$0.08	$3.30
Com - Grocery	$0.06	$2.35
Com - Health	$0.07	$2.82
Com - Lodging	$0.16	$9.98
Com - Office (Large)	$0.10	$4.49
Com - Office (Small)	$0.05	$1.98
Com - Other	$0.11	$4.53
Com - Refrig. Warehouse	$0.02	$0.75
Com - Restaurant	$0.02	$0.75
Com - Retail	$0.35	$4.94
Com - School	$0.16	$2.28
Com - Warehouse	$0.30	$4.22

Source: Guidehouse

These are the final values that are applied in the measure characterization.

Guidehouse calculated the electric and gas consumption splits by converting the kWh and therm consumption values for each Building Type [Step 2] to fuel-neutral units (MMBtu). Thus, the splits apportion the tax credit among electric and gas savings based on the relative consumption of each fuel type within each Building Type.

Table J-4. Electric and Gas Consumption Splits by Building Type

Building Type	Electric Split	Gas Split
College	30%	70%
Grocery	70%	30%
Health	80%	20%
Lodging	77%	23%
Office (Large)	83%	17%
Office (Small)	48%	52%
Other	55%	45%
Refrig. Warehouse	47%	53%
Restaurant	23%	77%
Retail	97%	3%
School	27%	73%
Warehouse	72%	28%

Source: Guidehouse