Guidehouse

Attachment 3:

Low Income Program Energy Efficiency Potential Study

2021 Potential and Goals Study

Prepared for:

California Public Utilities Commission

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

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Summary

The 2021 Low Income Program Potential Study (2021 Low Income Study) forecasts energy efficiency (EE) potential for investor-owned utility (IOU) Energy Savings Assistance (ESA) programs for 2022-2032. The results of this study are used by California Public Utilities Commission (CPUC) staff to inform the low income proceeding.

Prior EE potential studies also forecast the potential from low income programs. In the 2017 Study,[1] Guidehouse forecast low income EE potential through a simple top-down analysis. The 2019 Study[2] conducted a bottom-up Bass diffusion forecast of low income sector savings using the same measure list as the residential sector but with low income-specific market characterization data (household counts, consumption, rebates, and retail rates). The 2021 Study analysis methodology changed from these prior studies by using a measure list developed specifically for the low income sector.

The 2021 Low Income Study forecasts technical and achievable EE potential. The low income program potential uses researcher-defined adoption curves based on historical participation rates and measure and customer characteristics to calculate achievable potential. Achievable potential is represented as incremental first-year savings. The incremental savings have historically been the basis for ESA program reporting and goals.

The 2021 Low Income Study does not include a cost-effectiveness analysis, fuel substitution, EE-demand response co-benefits modeling, new construction savings, or reporting in a total system benefit metric.

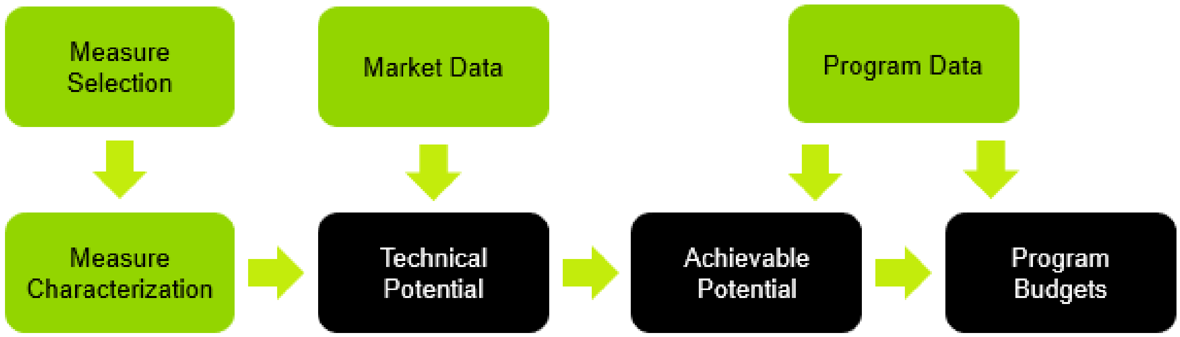
Methodology

Figure 1 illustrates the methodological process at a high level, highlighting the key input data and analysis steps. Guidehouse aggregated low income measure characterization and market data to model technical potential. The team then calculated achievable potential as a percentage of technical potential. Guidehouse also calculated total program budgets based on technical and achievable potential. Each key input data and analysis step is described in greater detail in Section 2.

[1] Guidehouse (as Navigant). *Energy Efficiency Potential and Goals Study for 2018 and Beyond*. September 2017. ftp://ftp.cpuc.ca.gov/gopher-data/energy_division/EnergyEfficiency/DAWG/2018_Potential%20and%20Goals%20Study%20Final%20Report_092517.pdf.

[2] Guidehouse (as Navigant). *2019 Energy Efficiency Potential and Goals Study*. July 2019. ftp://ftp.cpuc.ca.gov/gopher-data/energy_division/EnergyEfficiency/DAWG/2019%20PG%20Study%20Report_Final%20Public_PDFA.pdf.

Figure 1. 2021 Low Income Study Input Data and Analysis Flow



Source: Guidehouse

The study input data includes:

- **Measure selection and characterization**. The final measure list (provided in Appendix A) includes 61 unique measures derived from current and proposed ESA program measures in the 2021-2026 ESA applications and select additional measures informed by the CPUC and other stakeholders.
- **Market data.** Guidehouse used the same data source for the market data as the 2021 Potential and Goals Study to characterize the low income building stock. The data is based on the 2019 Integrated Energy Policy Report (IEPR)[3] forecast and 2019 Residential Application Saturation Study (RASS)[4] datasets.
- **Program data.** Guidehouse used both the historical and application data for the ESA programs. The dataset provided historical and planned installations and program administration and measure costs.

With this input data, Guidehouse conducted the following:

- **Technical potential analysis.** The technical potential is the theoretical maximum savings possible from converting all equipment that is at or below code to high efficiency. This study calculated annualized technical potential by limiting the available potential based on stock turnover.
- **Achievable potential analysis.** Guidehouse's approach defines achievable potential as a percentage of technical potential in each forecast year. The team calculated achievable potential at the following levels of granularity: IOU, building type, and measure. The aggregated results are calibrated to the aggregate historical market activity.
- **Program budget analysis.** Program budgets contain two components with separate estimates: measure costs and program costs. Guidehouse calculated program budgets for each utility for technical and achievable potential.

[3] CEC, [2019 Integrated Energy Policy Report (IEPR) Update and Demand Forecast Forms](). Adopted February 2020.
[4] DNV GL, *2019 Residential Appliance Saturation Survey (RASS).* Accessed September 2020.

Results

Technical Potential

Technical potential should be considered aspirational because it assumes no market or economic constraints. Technical potential includes every measure selected for the study that has non-zero potential in electric energy savings, gas energy savings, and electric peak demand savings for every applicable utility. Table shows the total statewide annualized technical potential for 2022-2032.

Table 1. Statewide Low Income Annualized Technical Potential

Fuel Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Electric (GWh/Year)	2,122	2,116	2,110	2,104	2,099	2,093	2,087	2,081	2,076	2,070	2,064
Demand (MW/Year)	478	476	475	474	472	471	470	468	467	466	464
Gas (MMTherm/ Year)	570	568	567	565	564	562	561	559	558	556	555

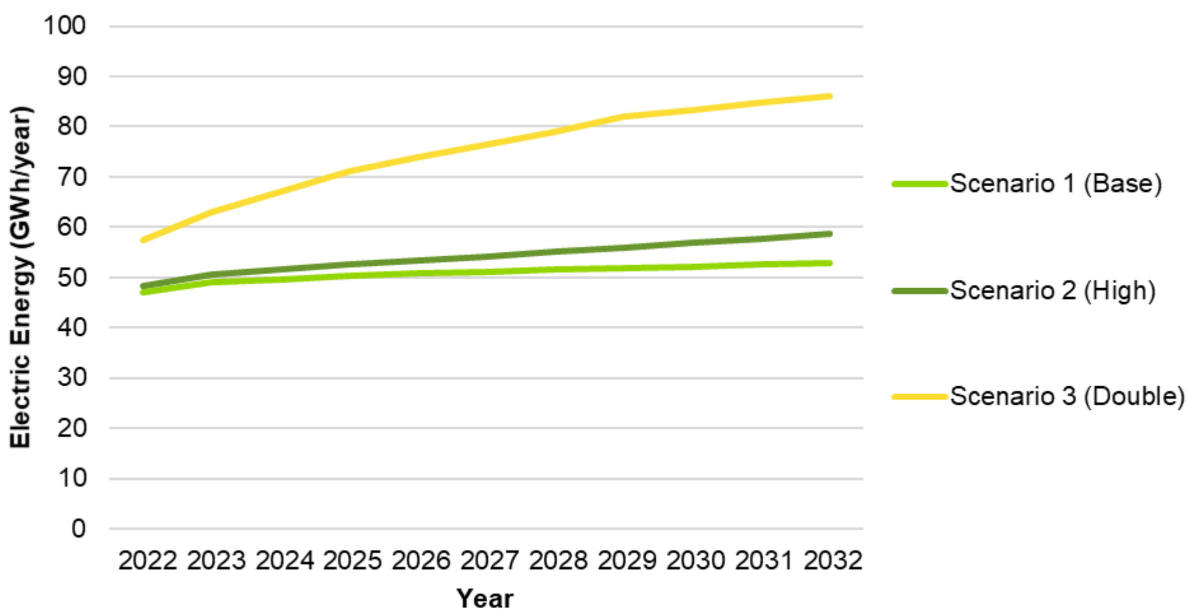
Source: Guidehouse

Achievable Potential

While Guidehouse did account for current program restrictions and measure eligibility, achievable potential in this report includes all *possible* achievable potential and is not limited to current program restrictions. For a dataset that only reflects current program restrictions as specified by the low income program policies and procedure manual, please see Appendix C.

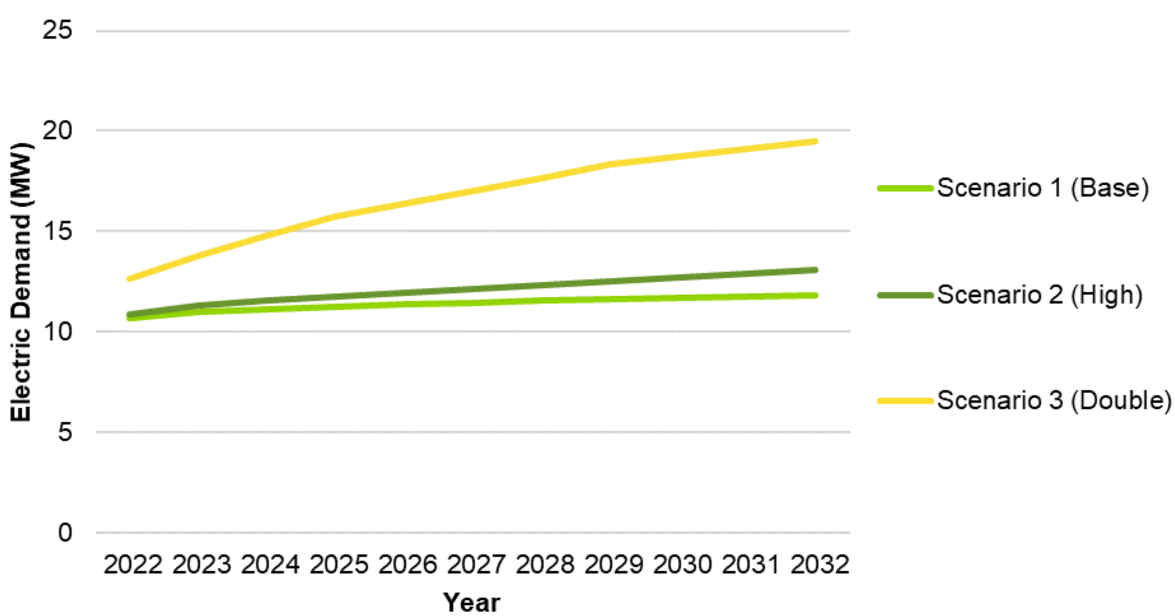
Guidehouse calculated achievable potential for three scenarios: Base, High, and Double the Base. For more discussion of this methodology, please see Section 2.5. Figure 2 to Figure 4 show the total achievable potential results for each scenario on one chart for easy comparison.

Figure 2. Incremental Statewide Achievable Electric Savings Potential by Scenario



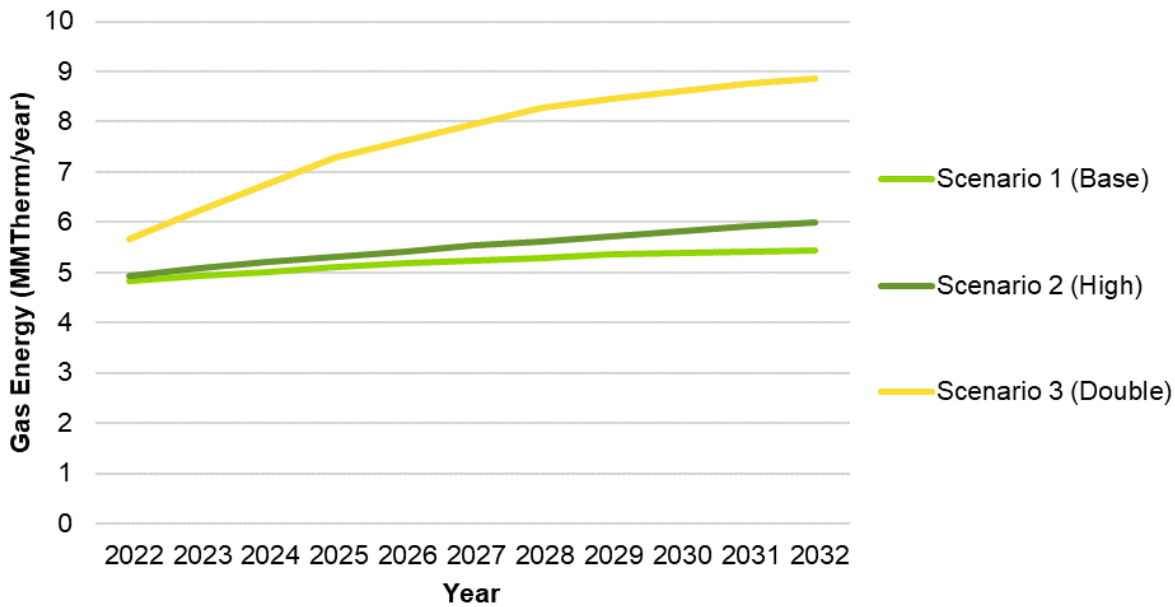
Source: Guidehouse

Figure 3. Incremental Statewide Achievable Peak Demand Savings Potential by Scenario



Source: Guidehouse

Figure 4. Incremental Statewide Achievable Gas Savings Potential by Scenario



Source: Guidehouse

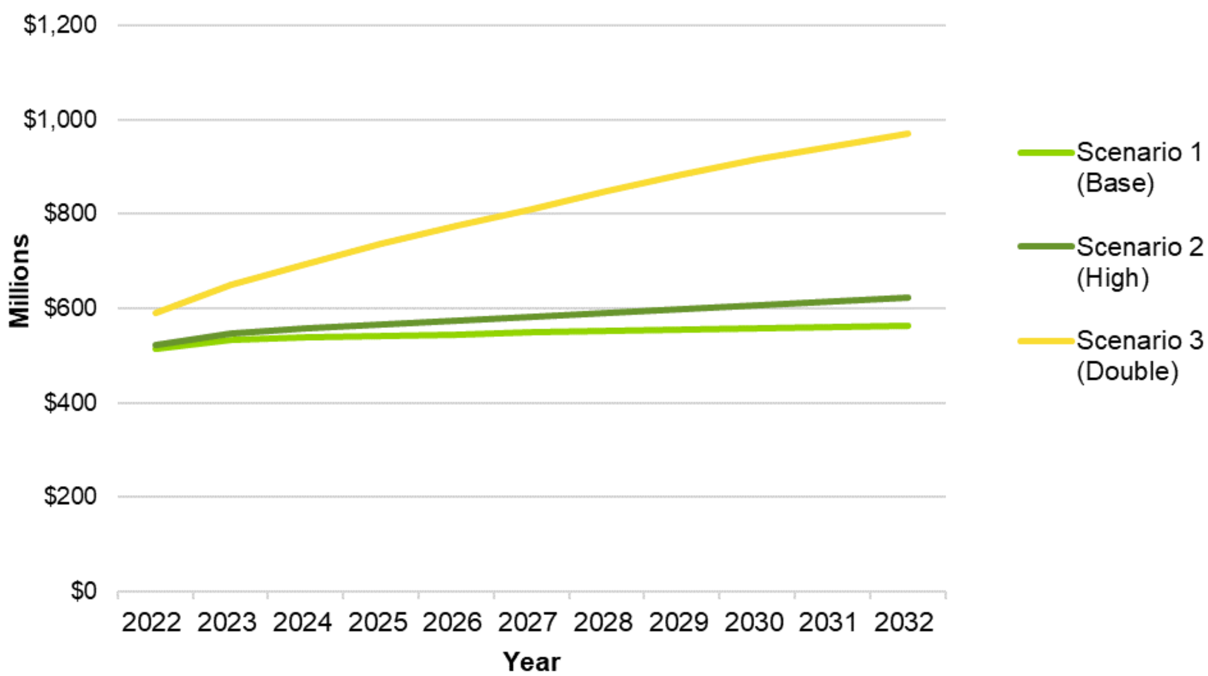
The Base scenario represents Guidehouse's estimated most likely scenario based on the IOU applications and historical program activity. The team used the 2021-2026 ESA applications as a benchmarking tool to calibrate achievable potential results in the Base scenario. While the team did not intend to closely match the proposed savings in the applications, the IOUs' proposals were useful to tune the initial penetration rate[5] and adoption curves. In some cases, the Guidehouse Low Income Model predicts less potential for certain measures—notably A-lamp LEDs—than the IOUs proposed. In other cases, the Guidehouse Low Income Model shows that more potential is available for certain measures than proposed by the IOUs' applications.

Program Budget Analysis

Guidehouse calculated two components of program budgets: measure costs and program costs. The team created program budgets for achievable potential for all versions and all scenarios. Figure 5 shows the total program budgets for each scenario.

[5] Ideally, a baseline study would identify the penetration of high efficiency equipment that can be used for the initial penetration rate as a percentage of the technical potential. Guidehouse determined that value only based on historical activity. Guidehouse did adjust this value as deemed appropriate to address any unknowns of the market conditions.

Figure 5. Total Program Budgets by Scenario ($ Millions)



Source: Guidehouse

Recommendations

The 2021 Low Income Potential Study had a different approach and methodology than previous iterations. These changes were made to better estimate potential in the low income sector as compared to previous studies. Because this year's study had a new methodology, Guidehouse makes the following recommendations for future low income studies:

- Benchmark program data to other states' low income EE programs
- Expand research on equipment saturation data
- Improve the adoption curves by better understanding customer barriers to installation or measure refusal
- Further investigate outlier initial penetration rates

Further discussion of these recommendations can be found in Section 4.

1. Introduction

1.1 Context of the 2021 Energy Savings Assistance Program Potential Study

The 2021 Low Income Program Potential Study (2021 Low Income Study) forecasts energy efficiency (EE) potential for investor-owned utility (IOU) Energy Savings Assistance (ESA) programs for 2022-2032. The results of this study are used by California Public Utilities Commission (CPUC) staff to inform the low income proceeding.

Prior EE potential studies also forecast the potential from low income programs. The 2021 Study analysis changed significantly from these prior studies. In the 2017 Study,[6] Guidehouse forecast low income EE potential through a simple top-down analysis. The 2019 Study[7] conducted a bottom-up Bass diffusion forecast of low income sector savings using the same measure list as the residential sector but with low income-specific market characterization data (household counts, consumption, rebates, and retail rates). The 2021 Study represents a major departure from the prior two studies by using a measure list developed specifically for the low income sector and a simplified forecasting approach to develop achievable potential. Section 2 describes this approach in detail.

1.2 Types of Potential

The 2021 Low Income Study forecasts EE potential at two levels for low income programs:

- **Technical potential:** Technical potential 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. Technical potential in existing buildings represents the immediate replacement of applicable equipment-based technologies regardless of the remaining useful life of the existing measure and cost of the replacement measure.
- **Achievable potential:** The final output of the potential study is a program potential analysis, which calculates the EE savings that could be expected in response to program intervention and customer adoption based on historical uptake of measures; it also includes a forward looking analysis for how existing and new measures might penetrate the low income sector.

Achievable potential is represented in the 2021 Low Income Study as incremental first-year savings. Incremental savings represent the annual energy and demand savings achieved by the set of programs and measures 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 EE programs will produce. The incremental savings has historically been the basis for ESA program

[6] Guidehouse (as Navigant). *Energy Efficiency Potential and Goals Study for 2018 and Beyond*. September 2017. ftp://ftp.cpuc.ca.gov/gopher-data/energy_division/EnergyEfficiency/DAWG/2018_Potential%20and%20Goals%20Study%20Final%20Report_092517.pdf.

[7] Guidehouse (as Navigant). *2019 Energy Efficiency Potential and Goals Study*. July 2019. ftp://ftp.cpuc.ca.gov/gopher-data/energy_division/EnergyEfficiency/DAWG/2019%20PG%20Study%20Report_Final%20Public_PDFA.pdf.

reporting and goals. Guidehouse used the best available current market and program knowledge to calibrate achievable potential for low income programs.

1.3 Scope of this Study

The 2021 Low Income Study forecasts the EE potential for the low income sector in IOU territories. The scope included the following tasks:

- **Measure selection and characterization:** Select low income-specific measures and characterize these measures using sector-specific market data.
- **Technical potential analysis:** Calculate remaining untapped technical potential based on the most recently available measure and market data.
- **Achievable potential analysis:** Forecast potential that is achievable through low income program interventions.
- **Program budget analysis:** Forecast total low income program budgets associated with technical and achievable potential.

Because low income programs are not required to be cost-effective, the study omits a cost-effectiveness analysis. The following is a full list of components considered out of scope of this study:

- Cost-effectiveness analysis
- Fuel substitution
- EE-demand response (DR) co-modeling
- Savings in new construction building vintages
- Savings within regional energy networks (RENs) or community choice aggregators (CCAs)
- Reporting savings using a total system benefit metric

1.4 Contents of this Report

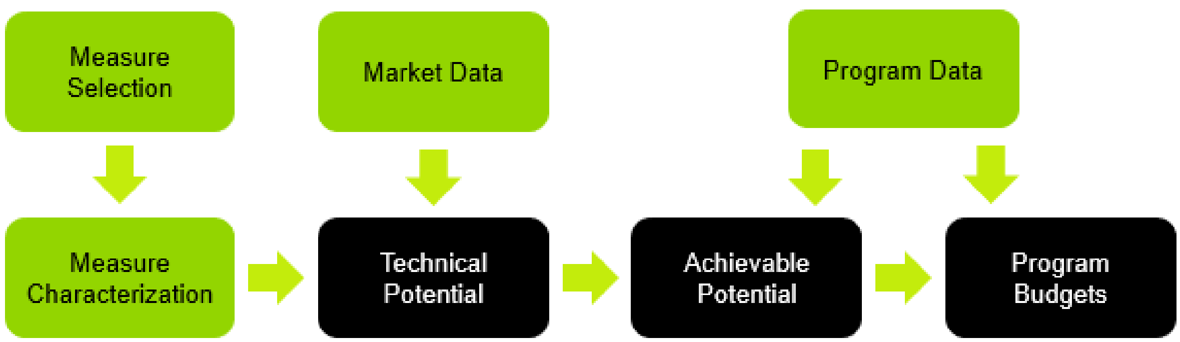
This report documents the data sources for and the results of the 2021 Low Income Study.

- **Section 2** provides an overview of the methodology for each key area of the study.
- **Section 3** provides the study's results on a statewide basis.
- **The appendices** provide further details on the characterized measures, Policy and Procedures (P&P) Manual measure eligibility, and results for achievable potential scenarios.

2. Study Methodology and Input Data

The 2021 Low Income Study methodology follows a similar approach as the residential rebate program portion of the broader 2021 Study with a few exceptions. Figure 2-1 illustrates the methodological process at a high level highlighting the key input data and analysis steps. Guidehouse aggregated measure characterization and market data to model technical potential. The team then used historical program data to forecast realistic adoption percentages levels. These percentages, when applied to technical potential, calculate this study's achievable potential results. After calculating achievable potential, the team calculated total measure costs based on the number of installations multiplied by the measure unit costs. The team then calculated total program budgets by applying an IOU-specific ratio of historic program budgets to measure costs. Each key input data and analysis step is described in greater detail in the following subsections.

Figure 2-1. 2021 Low Income Study Input Data and Analysis Flow



Source: Guidehouse

This study operates under the following assumptions:

- Low income buildings include single-family homes and multifamily units. Mobile homes are part of the single-family home segment.
- While much of the low income program delivery includes measure eligibility driven by specific building types and climate zones,[8] the Guidehouse analysis for technical and achievable potential did not include program-defined limits. To disaggregate results into program-defined limits, the team further processed the results after the modeling using ratios of historical program activity in specific building types and climate zones.
- Guidehouse assumed that IOU ESA applications have the most up-to-date savings and cost information for eligible ESA measures.

[8] California is divided into 16 climate zones are based on energy use, temperature, and weather to provide for the diversity in the state to accurately model energy consumption and savings.

2.1 Measure Selection and Characterization

Measure characterization is the process of collecting input data for each EE measure that is necessary for calculating potential. The measure characterization process includes the following (each described in greater detail in this subsection):

- **Measure selection:** Developing the list of measures to include in the study and vetting it with CPUC staff.
- **Measure characterization:** Identifying the sources of data for quantifying measure savings, cost, and life. This step requires developing these quantities on a unit basis (e.g., savings per bulb, cost per refrigerator, lifetime of a water heater).
- **Density and saturation:** Identifying data that characterizes the current state of equipment in the low income market. Specifically quantifying what fraction of the population has what kinds of equipment and of that population what fraction has low vs. high efficiency equipment.

Table 2-1 shows the sources of the measure characterization data and their use in the study.

Table 2-1. Measure Data Sources

Data Source	Use in this Study	Author
ESA Applications Program Year (PY) 2021-2026	Measure savings and cost data	IOUs
2020 Year-to-Date ESA Savings Reports	Measure savings and cost data	IOUs
2019 Residential Appliance Saturation Survey (RASS)*	Measure density and saturation calculations	DNV GL
Supplementary Measure Data	Measure savings and cost data	IOUs, Lawrence Berkeley National Laboratory (Berkeley Lab), and RHA Energy Partners
2021 Potential & Goals Study	Measure savings and cost data when unavailable from IOUs	Guidehouse

* The team received an advance copy of the 2019 RASS data from DNV GL. The RASS study was not published at the time of the analysis.

Source: Guidehouse

2.1.1 Measure Selection

Guidehouse worked with CPUC staff to identify a list of measures to include in this study. The measure list includes only one representative measure from a group of potential measures. For example, the team characterized High Efficiency Clothes Washer instead of multiple options for different clothes washer efficiencies and different types of washers (top loading, front loading, combo washer dryer, etc.).

The final measure list (provided in Appendix A) includes 61 unique measures derived from the following sources:

- Proposed ESA measures in the IOU ESA applications for 2021-2026.[9] Guidehouse included all measures from the 2021-2026 applications, including those that have not yet been approved, such as floor insulation. The team excluded multifamily common area and fuel substitution measures.
- Any ESA program measures included in the ESA P&P Manual[10,11] that IOUs did not include on their applications.
- Additional measures informed by CPUC Energy Division staff and ESA proceeding stakeholders. Guidehouse sought suggestions from the CPUC, IOUs, and other stakeholders on including five new measures absent from the applications. The five new measures are:
  - Electric water heater timers: Measure and data information from RHA Energy Partners
  - Gas water heater timers: Measure and data information from RHA Energy Partners
  - Solar-powered attic ventilation fans: Measure data and information from Pacific Gas and Electric (PG&E)
  - Duct insulation: Measure data and information from PG&E
  - Cool roofs: Measure data and information from Berkeley Lab

Guidehouse aggregated or disaggregated measures where necessary for analysis. This affected certain water heating measures, measures within a competition group, and dual fuel measures:

- For a group of water heating measures, certain utilities bundled them together into a combined measure called Other Hot Water, while some provided the measures to customers as either a standalone piece or in various combinations. For consistency, the team aggregated faucet aerators, showerheads, and water heater blankets into one measure called Other Hot Water. In this study, Other Hot Water represents any combination of one or more of those three water heating measures together.
- To avoid competition within technology groups, Guidehouse only characterized the most efficient measure in each category. For example, the applications included both Furnace Replacement and High Efficiency Forced Air Unit Furnace Replacement; the analysis only included High Efficiency Forced Air Unit Furnace Replacement measures.
- For measures where an individual residence's fuel source for applicable end uses would be only gas or only electric, the team split each measure group into unique measures for the respective fuel sources. The fuel-specific characterization affected high efficiency clothes washers, clothes dryers, and water heating measures where the IOU reported savings for both fuels in one line item.

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[9] *Energy Savings Assistance (ESA), California Alternative Rates for Energy (CARE), and Family Electric Rate Assistance (FERA) Programs and Budgets Application for the 2021-2026 Program Years,* November 4, 2019. Proceeding numbers A1911003, A1911004, A1911005, and A1911006.

[10] *Statewide Energy Savings Assistance Program 2017-2020 Cycle Policy and Procedures Manual*, revised September 2019.

[11] Sources from the monthly and annual reports on the Low-Income Oversight Board website: http://liob.cpuc.ca.gov/Pages/monthlyAnnualReport.html

2.1.2 Measure Characterization

Once the measure list was set, Guidehouse collected measure characteristics from two main sources:

- **IOU data request:** Requested data in October 2020 for a comprehensive database of 2020 year-to-date ESA program activity from each IOU.
- **2021-2026 IOU applications:** Reviewed submitted IOU ESA/California Alternate Rates for Energy (CARE) applications for 2021-2026 (submitted by the IOUs to the CPUC on November 4, 2019).

The team used the most recent data available for each measure. For example, if a specific measure had different values in the IOU-provided year-to-date ESA program activity and the 2021-2026 ESA applications, Guidehouse used the application data for measure characterization. For the five measures not included in current or proposed ESA programs, the team collected data from other sources for each measure, as noted earlier in Section 2.1.1.

Guidehouse collected data to quantify the following for each measure:

- Measure name
- Annual unit energy impact (kWh, kW, therms) on a per-unit basis
- Equipment and labor measure expenses as defined in the annual IOU ESA reports[12]
- Effective useful life (EUL)

If any specific data component was unavailable in the IOU sources, the team sourced the information from the most relevant broader 2021 Study residential measure. For example, Southern California Edison (SCE) included dishwashers on its applications but did not include a dishwasher's EUL. For this measure, the team used the broader 2021 Study's EUL for dishwashers (11 years).

Certain measures included interactive effects or increased energy consumption in the non-primary fuel type. For example, whole house fans saved electric energy but increased gas energy consumption. In these cases, Guidehouse included the interactive effects to fully model each measure's impact.

Certain measures, such as microwaves and air purifiers, actually increase energy consumption; however, they are still included in the IOUs' portfolios because of their quality-of-life benefits. The team modeled these measures to account for the low income programs' full energy impact.

Guidehouse characterized each measure separately for each of the four IOUs: PG&E, Southern California Gas (SCG), SCE, and San Diego Gas & Electric (SDG&E). When data was not available from one of these utilities for a given measure, the team used the average of the available data from other utilities as a substitute.

[12] Some utilities reported equipment and labor costs separately, while some utilities combined them. For this report, we combined equipment and labor expenses together as measure expenses.

Guidehouse characterized the efficient version of the measure with the electric energy, gas energy, and peak demand savings. Any climate zone-specific data was aggregated for the analysis.

The team calculated equipment cost per unit (in dollars) using total equipment cost for the program from the applications and number of proposed units installed.

2.1.3 Measure Density and Saturation

Density and saturation are two essential technology characterization calculations. This study uses the same approach as the 2021 Potential and Goals Model (PG Model). The measure characterization units may not align with the scaling basis to calculate potential across the sector. For this study, the density definition adjusts the measure scaling basis to align to a per-household basis. Additionally, the study defines the existing saturation levels of the efficient equipment.

- **Density** is a measure of the number of 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 low income sectors) 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 (for example): units/home, bulbs/home, 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.

For the 2021 Low Income Study, Guidehouse calculated density from the 2019 RASS[13] data in conjunction with the CARE income guidelines. The team calculated measure density and saturation using the detailed RASS datasets, filtering specifically for households that would qualify for the CARE program. In rare cases where the RASS did not include applicable information for a certain measure or did not have a large enough low income sample size, the team used corresponding density and saturation information for the residential sector in the broader 2021 Study.

2.2 Market Data

This section describes the macro-level data sources used for Guidehouse's analysis. This data is not measure-specific. The team primarily relied 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.

While measure characterization relied mostly on IOU ESA/CARE applications, other data sources used in the low income analysis are listed in Table 2-2**.**

[13] DNV GL, *2019 Residential Appliance Saturation Survey (RASS).* Accessed September 2020.

Table 2-2. Low Income Market Characterization Data Sources

Analysis Component	Data Source
Building stocks and consumption forecast *(Households, GWh, MMTherms consumption)*	California Energy Commission (CEC), *2019 Integrated Energy Policy Report (IEPR) Update and Demand Forecast Forms*. Adopted Feb. 2020. DNV GL, *2019 Residential Appliance Saturation Survey* (RASS). Accessed Sep. 2020.

Source: Guidehouse

The consumption forecasts for the broader 2021 Study are based on IOU-level data from the CEC's IEPR.[14] 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, so an adjustment is needed. Further discussion of this adjustment can be found in the broader 2021 Study report.

Guidehouse obtained the 2019 RASS data prior to its public release. The team used this data, in conjunction with the income limits set on the CARE website,[15] to establish percentages of energy consumption by low income households. Table 2-3 shows the ratio of energy consumption in each IOU territory.

Table 2-3. Low Income Proportion of Total Residential Energy Consumption

Utility	Electric Energy (kWh) Consumption	Gas Energy (Therms) Consumption
PG&E	22%	17%
SCE	23%	N/A
SCG	N/A	24%
SDG&E	18%	16%

Source: Guidehouse analysis of the 2019 RASS

Like consumption, Guidehouse leveraged the 2021 Study's IEPR data analysis for the single-family and multifamily building stocks. The team also used the 2019 RASS data to establish ratios for building stocks among the residential sector. For this analysis, mobile homes are considered a subset of single-family homes. Table 2-4 shows the proportion of residential building stocks considered as low income in each IOU territory by fuel type.

[14] CEC, *2019 Integrated Energy Policy Report (IEPR) Update and Demand Forecast Forms*. Adopted February 2020.
[15] CPUC, California Alternate Rates for Energy (CARE), effective June 1, 2020 to May 31, 2021. Accessed December 2020.

Table 2-4. Low Income Proportion of Total Residential Building Stocks

Utility	Fuel Type	Single-Family Homes	Multifamily Homes
PG&E	Electric	18%	31%
	Gas	17%	30%
SCE	Electric	21%	42%
SCG	Gas	21%	43%
SDG&E	Electric	15%	31%
	Gas	15%	27%

Source: Guidehouse analysis of the 2019 RASS

2.3 Program Data

This section describes the program-level data sources used for Guidehouse's analysis. This data is not measure-specific. The team primarily relied on utility-reported data as listed in Table 2-5.

Table 2-5. Low Income Program Data Sources

Analysis Component	Data Source
Historical ESA program installation activity for 2013-2019	IOU program data
Non-incentive program costs *(administration)*	2021-2026 IOU ESA/CARE applications

Source: Guidehouse

Guidehouse requested historical ESA program activity from 2013 to 2019 from each IOU to establish trends for each measure forecast. This data informed the creation of adoption curves to calculate achievable potential as a percentage of technical potential. Section 2.4 discusses this process in detail.

Guidehouse also considered program costs, which represent the sum of the following:[16]

- Training center
- Inspections
- Marketing and outreach
- Statewide marketing, education, and outreach
- Measurement and evaluation studies
- Regulatory compliance
- General administration
- CPUC Energy Division

[16] 2021-2026 PG&E ESA/CARE Applications

The team calculated program costs by assuming that all program costs scale proportionally with measure costs. Guidehouse defined measure costs as the sum of labor and equipment unit costs for each measure.

Guidehouse calculated ratios of program costs to measure costs in the 2021-2026 IOU ESA program applications and then applied these ratios to each IOU's total measure costs for technical and achievable potential to calculate program costs. Table 2-6 shows the ratio of program costs to measure costs applied for the total program costs calculations in each IOU territory. Three of the four IOUs have relatively similar program cost ratios while SDG&E's is nearly double.

Table 2-6. Historical Ratio of Program Costs to Measure Costs

Utility	Program Costs Ratio
PG&E	13%
SCE	14%
SCG	14%
SDG&E	27%

Source: Guidehouse analysis of 2021-2026 ESA applications

2.4 Technical Potential Analysis

Technical potential 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. The technical potential is the theoretical maximum savings possible from converting all equipment that is at or below code to high efficiency. Technical potential can be distinguished as instantaneous potential that is unconstrained by stock turnover in any given year. However, this study calculated annualized technical potential by limiting the available potential based on stock turnover.

Equation 2-1 shows the general formula for calculating technical potential.

Equation 2-1. Annualized Technical Potential

$$
\begin{aligned}
Technical\ Potential \\
&= Existing\ Builidng\ Stock_{year} * \ Measure\ Density \\
&* \ (1 - Efficiency\ Technology\ Saturation) * \ Unit\ Energy\ Impact_{year} \\
&* \ Technical\ Suitability * 1/EUL
\end{aligned}
$$

Where:

- **Building Stock** is in units of households.
- **Measure Density** is in units of widgets per home.
- **Efficiency Technology Saturation** is a percentage.
- **Unit Energy Impact** is in units of energy impact per widget.
- **Technical Suitability** is a dimensionless factor.
- **EUL** is the effective useful life.

The technical suitability factor is a catchall adjustment that can be used to reflect situations where there is reason to believe the density is not reflective of the opportunity. It is typically set to 1.0 but it can be adjusted lower on rare occasions. For example, if density data is only available for the total number or square footage of windows per home and it does not specify those that are on the first floor, then the measure characterization requires a technical suitability factor of less than 1.0.[17] Another example is for solar water heaters. Solar water heaters need sufficient roof access, and some residences do not have sufficient space or roof access. Adjusting technical suitability can account for those homes to appropriately capture technical potential.

Guidehouse calculated technical potential for each individual measure selected in the study for every fuel-applicable IOU. For example, a gas-only measure would not apply to SCE but would be modeled for PG&E, SCG, and SDG&E. As a result, technical potential may dictate measure installations in IOU territories that have not previously offered that specific measure. The team calculated technical potential at the following levels of granularity: IOU, building type, and measure. Once the analysis was complete, the team post-processed the data to further disaggregate results into climate zones and ownership types. Full technical potential results can be found in Section 3.1. Further information can be found in Appendix C.

2.5 Achievable Potential Analysis

Guidehouse's approach defines achievable potential as a percentage of technical potential in each forecast year. The team defines this percentage value as a penetration rate—that is, what fraction of the technical potential can be achieved in a given year.

To calculate achievable potential in each year, Guidehouse:

1. Used the full technical potential assuming no limitations on the measures governed by the P&P Manual.
2. Multiplied the measure's initial penetration rate by its measure category's adoption curve in that specific year.
3. Multiplied the measure's year-specific initial penetration rate of technical potential.

The team only calculated achievable potential for each measure's penetration rate effective year and subsequent years. For example, PG&E only forecast pool pumps to be included in its portfolio in 2022 and later. For PG&E's pool pumps achievable potential, the team applied a multiplier of 0% to technical potential to any years prior to 2022. Equation 2-2 demonstrates this process.

[17] The ESA Installation Standards state the following criteria as non-feasible for window replacement: "Window is above the first floor of a structure and installation will present unsafe working conditions."

Equation 2-2. Achievable Potential

$$Achievable\ Potential_{Year} = Initial\ Penetration\ Rate_{measure} * Protypical\ Adoption\ Curve_{year} * \ Total\ Technical\ Potential_{year}$$

Where:

- **Initial Penetration Rate** is specific to each measure and utility and has a specific effective year.
- **Prototypical Adoption Curve** is based on the scenario and measure category.
- **Total Technical Potential** is the calculated technical potential.

To use this methodology, Guidehouse required the following items:

- **Initial penetration rate:** The penetration rate in the year 2019 (or the first year of program activity in the 2021-2026 ESA applications) that defines the starting point of the forecast.
- **Adoption curves:** A set of curves that defines how the penetration rate changes over time.

Guidehouse capped achievable potential at 100% of technical potential. Some lighting measures, such as diffuse A-lamps, had close to or above 100% of technical potential for the study's calculated initial penetration rate. Because of the way technical potential is calculated, the team believes technical potential is the total energy savings potential available in an IOU territory for these measures (see Equation 2-1) based on existing saturation and density data. These measures had total 2019 installs in excess of the calculated total technical potential installs and, therefore, were capped at 100% technical potential for their achievable potential (see Appendix B for which measures were capped).

The team calculated achievable potential at the following levels of granularity: IOU, building type, and measure. The aggregated results are calibrated to the aggregate historical market activity and proposed activity on the 2021-2026 IOU ESA applications.

The purpose of this study is to calculate the full available achievable potential regardless of existing program policy and procedure manuals and what is included in the IOU applications. While the reasons for the existing restrictions are valid, Guidehouse wanted to account for possible measure opportunities outside the scope of current restrictions as well as the proposed measures IOUs had included on their 2021-2026 applications. If the study had been limited to the current restrictions, many of these new measures and opportunities would not be accounted for in the potential analysis. The team also produced secondary results that consider current policy and program rollout limitations. This data is discussed in Section 3.4.

The following sections discuss how Guidehouse determined each measure's initial penetration rate and prototypical adoption curve.

2.5.1 Initial Penetration Rate

Guidehouse calculated an initial penetration rate for each measure. Where possible, the team obtained the total installations in 2019 for each measure for each utility. If this did not exist (or the program activity in 2019 did not represent future forecast program activity in the 2021-2026 ESA applications), the team used the measure installations in the first forecast year of program activity for each utility. The first forecast program activity year also represented the penetration rate effective year. To calculate the penetration rate, Guidehouse divided the total installations for the referenced year by the total potential installations to arrive at the initial penetration rate. For this process, the team assumed annual technical potential installations to be representative of the total potential installations in that time period. The team calculated these penetration rates at the measure and utility levels. Equation 2-3 demonstrates this process.

Equation 2-3. Initial Penetration Rate

$$Initial\ Penetration\ Rate = Total\ Program\ Installations_{year}/Total\ Potential\ Installations_{year}$$

Where:

- **Total Program Installations by year** are the number of installations per measure—in other words, the program activity for a certain year.
- **Total Potential Installations by year** is the calculated installations associated with the technical potential for a certain year.

There are two sets of measures where the standard calculation for the initial penetration rate is different: new measures and outliers.

- **New measures** do not have historical installations. As a result, Guidehouse needed to estimate the initial saturation of the efficient technology in the first year the measure will be implemented. For the new measures (measures with technical potential but no historical IOU installations or forecast program activity), the team applied a uniform 0.5% initial penetration rate effective in 2022. This 0.5% initial penetration rate is on the lower end of the observed range in the historical data. The new measure initial penetration rate included new measures such as gas water heater timers as well as measures that were included in one IOU’s portfolio but not others, such as dishwashers.
- Upon calculating initial penetration rates, the team observed some clear **outliers** in 2019 program activity when compared to proposed program activity in 2021-2026. For example, two utilities had uncharacteristically high air sealing measure installations in 2019. In this case, the team chose program activity in 2020 to be the reference program activity and the numerator when calculating initial penetration rates. In another case, one utility had uncharacteristically low smart thermostat installations in 2019. In this case, the team chose 2021 to be the reference program activity year.

2.5.2 Base Adoption Curve Development

Given that low income programs deliver measures at no cost to participants, the forecast needs to consider barriers to adoption beyond cost including hassle factor, lack of information to understand the benefits, property owner or manager approval, and others. To account for these other factors and barriers, Guidehouse developed three prototypical adoption curves to represent the range of barriers and measure attributes possible in the sector; these curves—independent of building type, ownership type, and climate zone—were subsequently applied to the studied measures and represent how penetration rate changes over time.

The team developed these adoption curves leveraging historical program participation data. Guidehouse assembled data from program participation databases provided by each of the four utilities; this database showed the historical number of unit installations for each measure. The team then aggregated all the measures installations onto one list for total installations for each year from 2013 through 2019. Due to slight differences in naming conventions across different years, some measures with different names were combined based on the team's assumptions.

Once this database was developed, Guidehouse categorized each measure with a binary indicator for the following measure characteristics:

- **Ease of installation:** Defined difficult to install as measures that required a professional to install and easy to install as measures that could be installed by the end user. The team acknowledges that the ESA program is a full direct install program with all measures installed by contractors, but using the above definition was still useful in helping assess the ease of installation for each measure by considering which measures *could* be installed by an end user without contractor help.
- **Requiring property owner or manager approval:** Measures that required property owner or manager approval—for example, water heaters, HVAC systems, insulation, and equipment that could impact the property value.
- **Intrusiveness:** Measure installations that would disrupt the day-to-day of the residences' occupants. For example, a refrigerator may require a professional to install and property owner or manager approval, but its installation is usually quick. In contrast, a heat pump water heater's installation may require more time and the resident to be inconvenienced for longer.

The team then grouped the measures into the following three categories:

A. Difficult to install, needs property owner or manager approval, intrusive

B. Difficult to install, needs property owner or manager approval, nonintrusive

C. Easy to install, does not need property owner or manager approval, nonintrusive

Group A included measures such as large HVAC installations, indoor water heaters, and other intrusive measures that need property owner or manager approval. Group B measures included large appliances such as refrigerators and clothes washers that would still require property owner or manager approval but would be a quick installation and less intrusive. Group C measures included easy-to-install measures such as showerheads and light bulbs. In rare cases where measures did not fall into one of the three groups, Guidehouse staff made assumptions to map the measures to a specific group. Appendix B provides the assigned category for each measure and includes both existing measures and new measures.

Using the database of historical adoption, Guidehouse examined historical program installation activity across the three categories. The team then plotted year-over-year percent change for installations of each measure from 2013 through 2019. Guidehouse observed these historical trends and identified the following for the three measure categories:

- Group A had relatively flat changes in program activity.
- Group B had mild growth across the historical years.
- Group C had larger growth than the other two groups.

Using this historical data, the team developed adoption curves for 2020-2032 for each grouping category that continued the growth trends observed in the historical program adoptions. These became the three prototypical adoption curves for the Base scenario.

2.5.3 Scenario Development

Table 2-7 describes the assumptions used to develop each scenario. The Base scenario reflects current program delivery and uses the base adoption curves developed as described in Section 2.5.2. The two additional scenarios apply factors to adjust these base adoption curves to simulate more aggressive adoption levels than have been historically observed. The three scenarios thus represent a base adoption scenario, a high adoption scenario, and a scenario that doubles the base scenario (more aggressive than high). Guidehouse developed these scenarios in coordination with CPUC staff.

- **Base:** This scenario reflects the status quo of adoption trends for measures categorized as A, B, or C observed in 2013-2019 and proposed program activity for 2021-2026.
- **High:** This scenario is more aggressive than the base curve, with adoption outpacing that of historical scenarios or proposed activity on the applications.
- **Double:** This scenario linearly approaches 200% of the initial penetration rate by a specific target year depending on the measure group. This scenario represents a very aggressive adoption scenario compared to historical program activity.

The percentages provided in Table 2-7 represent the percentage of the initial penetration rate (see Equation 2-3) and do not necessarily reflect absolute percentage values of achievable potential growth.

Table 2-7. Prototypical Adoption Curves Description

Scenario	Measure Category	Description*
Base	A	Flat curve (no growth)
	B	Mild growth at 2% per year
	C	4% growth per year, flattening in year 7
High	A	1% growth per year
	B	3% growth rate per year
	C	5% growth per year and then 3.5% starting in year 6
Double	A	Linearly approaches 200% of initial penetration rate by the end of the modeling timeframe
	B	Linearly approaches 200% of initial penetration rate over the first 10 years, capping at 200%
	C	Linearly approaches 200% of initial penetration rate over the first 6 years, capping at 200%

*Percentages apply to the initial penetration rate. In other words, 2% growth equivalent to multiplying the initial penetration rate by 1.02.

Source: Guidehouse

Table 2-8 lists the prototypical adoption curves by scenario and measure category. The percentages listed in the table are multiplied by an individual measure's initial penetration rate. Thus, 100% in the table represents 100% of the initial penetration.

Table 2-8. Prototypical Adoption Curves by Scenario and Measure Category

Scenario	Base			High			Double		
Measure Category→ Year ↓	A	B	C	A	B	C	A	B	C
0	100%	100%	100%	100%	100%	100%	100%	100%	100%
1	100%	102%	104%	101%	103%	105%	107%	110%	117%
2	100%	104%	108%	102%	106%	110%	114%	120%	133%
3	100%	106%	112%	103%	109%	115%	121%	130%	150%
4	100%	108%	116%	104%	112%	120%	129%	140%	167%
5	100%	110%	120%	105%	115%	125%	136%	150%	183%
6	100%	112%	124%	106%	118%	129%	143%	160%	200%
7	100%	114%	128%	107%	121%	132%	150%	170%	200%
8	100%	116%	130%	108%	124%	136%	157%	180%	200%
9	100%	118%	132%	109%	127%	139%	164%	190%	200%
10	100%	120%	134%	110%	130%	143%	171%	200%	200%
11	100%	122%	135%	111%	133%	146%	179%	200%	200%
12	100%	124%	136%	112%	136%	150%	186%	200%	200%
13	100%	126%	137%	113%	139%	153%	193%	200%	200%
14	100%	128%	138%	114%	142%	157%	200%	200%	200%

Source: Guidehouse

As an example, PG&E refrigerators have an initial penetration rate of 1.6%, an effective year of 2019, and are grouped into measure category B. The initial penetration rate was multiplied by the prototypical adoption curve (shown in Table 2-8) for each year, starting in 2019. Table 2-9 shows how the penetration rate of PG&E's refrigerators changes across the modeling period in the Base scenario.

Table 2-9. Example Penetration Rate Calculation: PG&E Refrigerators – Base Scenario

<table>
<tr><th>Steps</th><th colspan="2">Calculation</th></tr>
<tr><td>1. Identify effective year</td><td colspan="2">2019</td></tr>
<tr><td>2. Calculate penetration rate in effective year</td><td colspan="2">2019 installations/total technical potential installations = 1.6%</td></tr>
<tr><td>3. Identify measure category</td><td colspan="2">B</td></tr>
<tr><td>4. Multiply initial penetration rate x adoption curve</td><td>1.6% x</td><td><table><tr><th>Year</th><th>B</th></tr><tr><td>0</td><td>100%</td></tr><tr><td>1</td><td>102%</td></tr><tr><td>2</td><td>104%</td></tr><tr><td>3</td><td>106%</td></tr><tr><td>4</td><td>108%</td></tr><tr><td>5</td><td>110%</td></tr><tr><td>6</td><td>112%</td></tr><tr><td>7</td><td>114%</td></tr><tr><td>8</td><td>116%</td></tr><tr><td>9</td><td>118%</td></tr><tr><td>10</td><td>120%</td></tr><tr><td>11</td><td>122%</td></tr><tr><td>12</td><td>124%</td></tr><tr><td>13</td><td>126%</td></tr><tr><td>14</td><td>128%</td></tr></table></td></tr>
<tr><td>5. Final Annual Penetration Rate</td><td colspan="2"><table><tr><th>2019</th><th>2020</th><th>2021</th><th>2022</th><th>2023</th><th>2024</th><th>2025</th></tr><tr><td>1.6%</td><td>1.7%</td><td>1.7%</td><td>1.7%</td><td>1.8%</td><td>1.8%</td><td>1.8%</td></tr></table><table><tr><th>2026</th><th>2027</th><th>2028</th><th>2029</th><th>2030</th><th>2031</th><th>2032</th></tr><tr><td>1.9%</td><td>1.9%</td><td>1.9%</td><td>1.9%</td><td>2.0%</td><td>2.0%</td><td>2.0%</td></tr></table></td></tr>
</table>

Source: Guidehouse

2.6 Program Budget Analysis

Program budgets contain two components with separate estimates: measure costs and program costs.

Guidehouse calculated measure costs by multiplying the number of annual adoptions of each technology by the sum of its deemed equipment and labor expenses. The deemed equipment and labor expenses can be found in the MS Excel workbook results viewer. Guidehouse calculated the budget for both technical and achievable potential annual adoptions.

The team calculated program costs by assuming they scale proportionally with measure costs, which are further described in Section 3.3.1. Table 2-6 shows these ratios. Guidehouse summed the measure costs with the program costs to arrive at total program budgets for technical and achievable potential.

3. Results

3.1 Technical Potential

Technical potential should be considered aspirational and is the foundation for defining the maximum achievable with no market and economic constraints. Technical potential includes every measure selected for the study that has non-zero potential in electric energy savings, gas energy savings, and electric peak demand savings for every applicable utility. Table 3-1 shows the total incremental full technical potential by utility for 2022-2032. Some equipment the ESA program installs betters living conditions but increases load.

Table 3-1. Low Income Annualized Technical Potential by Utility

Utility	Fuel Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
PG&E	Electric (GWh/Year)	670	668	666	664	662	660	659	657	655	653	651
	Demand (MW/Year)	273	272	271	270	270	269	268	268	267	266	265
	Gas (MMTherm/ Year)	200	200	199	199	198	198	197	197	196	195	195
SCE	Electric (GWh/Year)	1,210	1,206	1,203	1,200	1,196	1,193	1,190	1,186	1,183	1,180	1,177
	Demand (MW/Year)	162	162	161	161	160	160	159	159	158	158	158
SCG	Gas (MMTherm/ Year)	326	326	325	324	323	322	321	320	320	319	318
SDG&E	Electric (GWh/Year)	243	242	241	241	240	240	239	238	238	237	236
	Demand (MW/Year)	43	43	43	42	42	42	42	42	42	42	42
	Gas (MMTherm/ Year)	43	43	43	43	42	42	42	42	42	42	42
Total	**Electric (GWh/Year)**	**2,122**	**2,116**	**2,110**	**2,104**	**2,099**	**2,093**	**2,087**	**2,081**	**2,076**	**2,070**	**2,064**
	Demand (MW/Year)	**478**	**476**	**475**	**474**	**472**	**471**	**470**	**468**	**467**	**466**	**464**
	Gas (MMTherm/ Year)	**570**	**568**	**567**	**565**	**564**	**562**	**561**	**559**	**558**	**556**	**555**

Source: Guidehouse

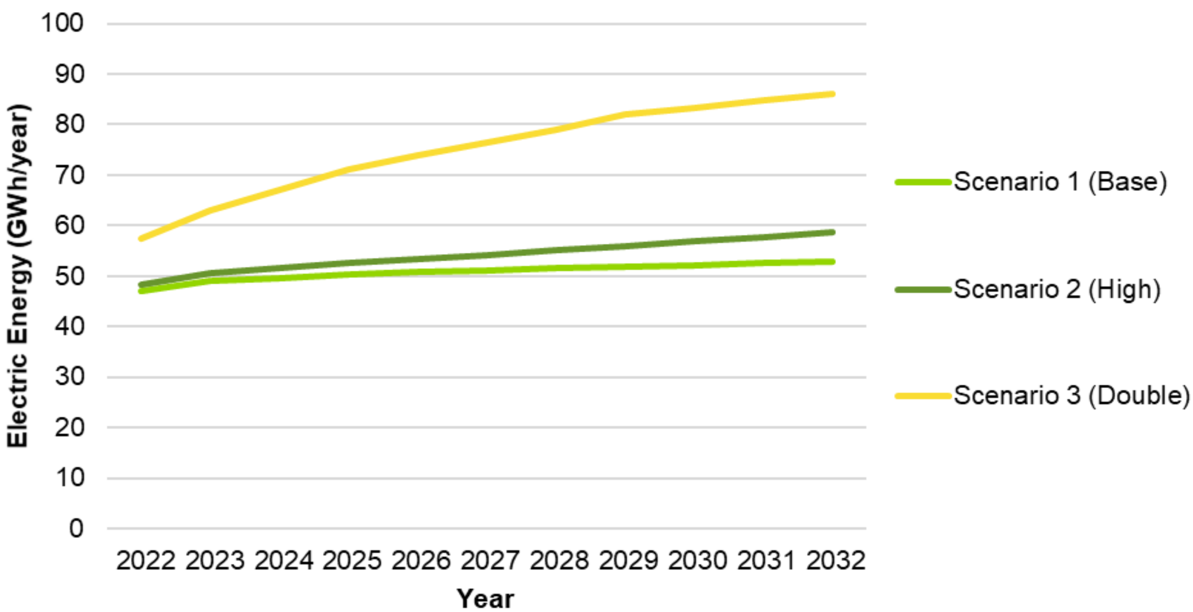
Electric savings are led by SCE, and gas savings are led by SCG. These result tracks the 2021-2026 ESA applications filings and shows SDG&E has a much smaller technical portfolio than PG&E, the other dual fuel IOU.

3.2 Achievable Potential

The achievable potential analysis calculates the EE savings that could be expected in response to ESA program delivery and assumptions about existing CPUC policies, market influences, and barriers. While Guidehouse did account for current program restrictions and measure eligibility, achievable potential in this report includes all *possible* achievable potential and is not limited to current program restrictions. For data that only reflects current program restrictions as specified by the P&P Manual, please see Appendix C.

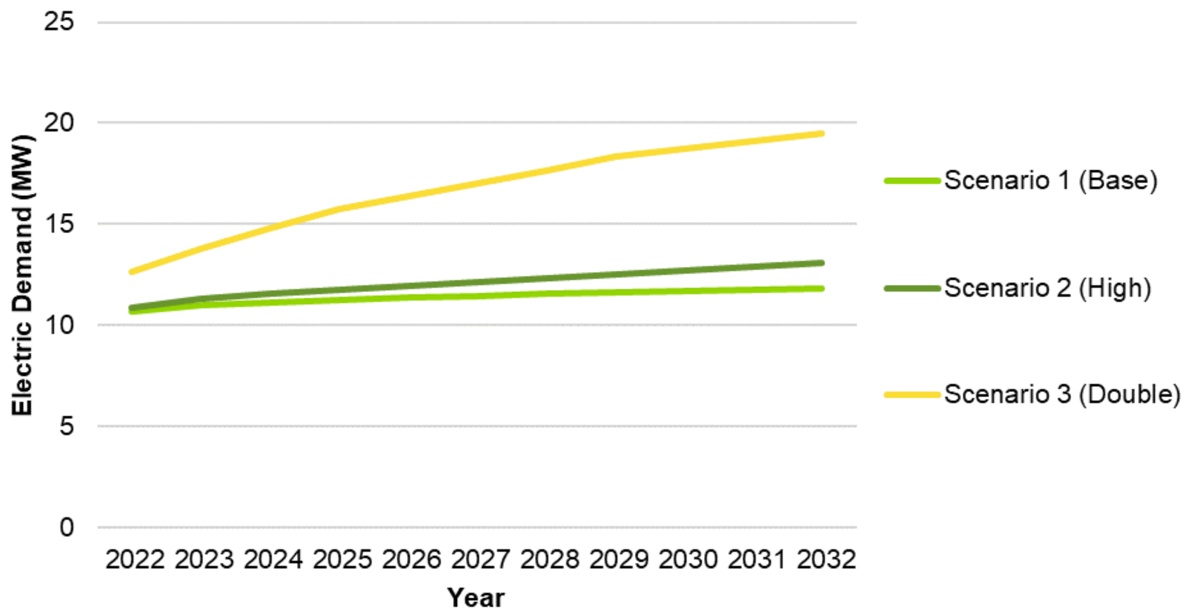
Guidehouse calculated achievable potential for three scenarios: Base, High, and Double the Base potential. For more discussion of this methodology, please see Section 2.5. The main body of this report discusses only the Base scenario. Further discussion of the remaining two scenarios can be found in Appendix C, the Excel results viewer. However, Figure 3-1 to Figure 3-3 show the total achievable potential results for each scenario on one chart for easy comparison.

Figure 3-1. Incremental Statewide Achievable Electric Savings Potential by Scenario



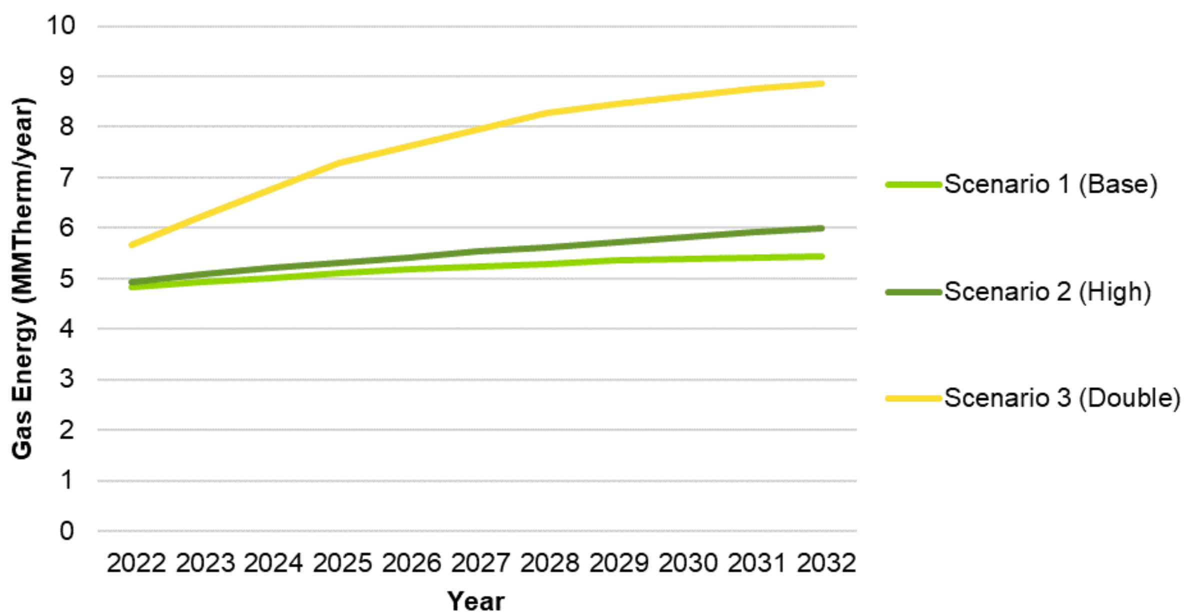
Source: Guidehouse

Figure 3-2. Incremental Statewide Achievable Peak Demand Savings Potential by Scenario



Source: Guidehouse

Figure 3-3. Incremental Statewide Achievable Gas Savings Potential by Scenario



Source: Guidehouse

The Base scenario represents Guidehouse's estimated most likely scenario based on the IOU applications and historical program activity. The team used the 2021-2026 ESA applications as a benchmarking tool to calibrate achievable potential results. While the team did not intend to closely match the proposed savings in the applications, the IOUs' proposals were useful to tune the initial penetration rate[18] and adoption curves. In some cases, the Guidehouse Low Income Model predicts less potential for certain measures—notably A-lamp LEDs—than the IOUs proposed. In other cases, the Guidehouse Low Income Model shows that more potential is available for certain measures than proposed by the IOUs' applications. Table 3-2 shows the full annualized incremental achievable potential by utility for the Base scenario.

Table 3-2. Incremental Achievable Potential by Utility – Base Scenario

Utility	Savings Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
PG&E	Electric (GWh/Year)	18.85	19.63	19.82	20.00	20.18	20.33	20.48	20.63	20.80	20.97	21.14
	Demand (MW/Year)	4.91	5.06	5.12	5.17	5.23	5.28	5.33	5.38	5.42	5.46	5.50
	Gas (MMTherm/ Year)	2.22	2.27	2.31	2.35	2.39	2.42	2.45	2.48	2.50	2.52	2.54
SCE	Electric (GWh/Year)	24.72	25.74	26.06	26.38	26.70	26.88	27.07	27.25	27.38	27.51	27.64
	Demand (MW/Year)	5.16	5.33	5.39	5.45	5.51	5.55	5.58	5.61	5.64	5.67	5.69
SCG	Gas (MMTherm/ Year)	2.29	2.33	2.37	2.40	2.43	2.46	2.48	2.50	2.51	2.52	2.52
SDG&E	Electric (GWh/Year)	3.59	3.73	3.80	3.86	3.92	3.95	3.99	4.02	4.05	4.08	4.11
	Demand (MW/Year)	0.59	0.61	0.61	0.62	0.63	0.63	0.64	0.64	0.65	0.65	0.65
	Gas (MMTherm/ Year)	0.33	0.34	0.34	0.35	0.35	0.36	0.36	0.37	0.37	0.37	0.37
Total	**Electric (GWh/Year)**	**47.16**	**49.11**	**49.68**	**50.24**	**50.80**	**51.17**	**51.53**	**51.90**	**52.23**	**52.56**	**52.89**
	Demand (MW/Year)	**10.66**	**10.99**	**11.12**	**11.25**	**11.37**	**11.46**	**11.55**	**11.63**	**11.71**	**11.78**	**11.85**
	Gas (MMTherm/ Year)	**4.84**	**4.94**	**5.02**	**5.10**	**5.18**	**5.24**	**5.29**	**5.35**	**5.38**	**5.41**	**5.44**

Source: Guidehouse

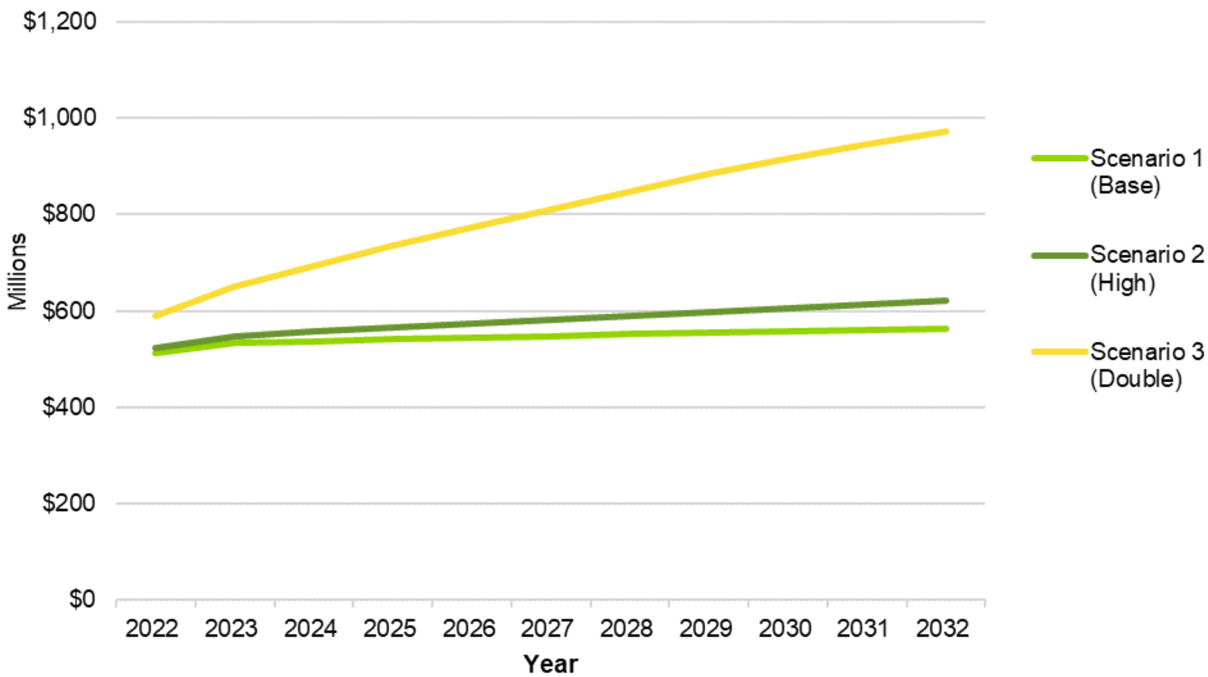
3.3 Program Budget Analysis

Guidehouse calculated two components of program budgets: measure costs and program costs. The team created program budgets for achievable potential for all versions and all

[18] Ideally, a baseline study would identify the penetration of high efficiency equipment that can be used for the initial penetration rate as a percentage of the technical potential. Guidehouse determined that value only based on historical activity. Guidehouse did adjust this value as deemed appropriate to address any unknowns of the market conditions.

scenarios. Figure 3-4 shows the total program budgets for each scenario. Table 3-3 shows the budgets for achievable potential for each utility in the Base scenario. Details for the other two scenarios can be found in the Excel workbook results viewer, as referenced in Appendix C.

Figure 3-4. Total Program Budgets by Scenario



Source: Guidehouse

Table 3-3. Base Scenario Achievable Potential Total Program Budgets by Utility (Millions)

Utility	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
PG&E	$200.08	$208.45	$210.22	$211.99	$213.75	$215.26	$216.76	$218.25	$219.54	$220.81	$222.08
SCE	$108.43	$115.45	$116.23	$117.01	$117.79	$118.49	$119.18	$119.87	$120.49	$121.10	$121.71
SCG	$160.46	$163.31	$164.33	$165.35	$166.37	$167.12	$167.87	$168.61	$169.20	$169.79	$170.38
SDG&E	$44.05	$46.20	$46.60	$46.99	$47.35	$47.66	$47.95	$48.25	$48.49	$48.73	$48.98
Total	**$513.02**	**$533.40**	**$537.39**	**$541.35**	**$545.25**	**$548.53**	**$551.76**	**$554.98**	**$557.71**	**$560.44**	**$563.14**

Source: Guidehouse

3.3.1 Measure Costs

To calculate measure costs, Guidehouse divided the total potential by the unit energy savings for each measure to obtain total installations. The team then multiplied each measure's total installs by their respective equipment and labor costs. Table 3-4 shows the measure costs by utility for achievable potential.

Table 3-4. Base Scenario Achievable Potential Measure Costs by Utility (Millions)

Utility	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
PG&E	$177.06	$184.47	$186.04	$187.60	$189.16	$190.50	$191.83	$193.14	$194.28	$195.41	$196.53
SCE	$95.11	$101.27	$101.96	$102.64	$103.32	$103.93	$104.54	$105.15	$105.69	$106.23	$106.76
SCG	$140.75	$143.25	$144.15	$145.05	$145.94	$146.60	$147.25	$147.90	$148.42	$148.94	$149.45
SDG&E	$34.69	$36.38	$36.69	$37.00	$37.29	$37.53	$37.76	$37.99	$38.18	$38.37	$38.57
Total	**$447.61**	**$465.37**	**$468.85**	**$472.29**	**$475.70**	**$478.56**	**$481.38**	**$484.19**	**$486.57**	**$488.95**	**$491.31**

Source: Guidehouse

3.3.2 Program Costs

Program costs consist of any costs associated with the Low Income program that do not include equipment and labor costs. These costs include program administration, training, outreach, due diligence activities, and other components. Guidehouse calculated program costs by using the historical ratio of program costs to measure costs in the 2021-2026 ESA applications. Table 2-6 shows these ratios at the utility level, and Table 3-5 shows the program costs by utility for achievable potential Base scenario.

Table 3-5. Base Scenario Achievable Potential Program Costs by Utility (Millions)

Utility	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
PG&E	$23.02	$23.98	$24.18	$24.39	$24.59	$24.76	$24.94	$25.11	$25.26	$25.40	$25.55
SCE	$13.32	$14.18	$14.27	$14.37	$14.46	$14.55	$14.64	$14.72	$14.80	$14.87	$14.95
SCG	$19.71	$20.06	$20.18	$20.31	$20.43	$20.52	$20.62	$20.71	$20.78	$20.85	$20.92
SDG&E	$9.37	$9.82	$9.91	$9.99	$10.07	$10.13	$10.19	$10.26	$10.31	$10.36	$10.41
Total	**$65.40**	**$68.04**	**$68.55**	**$69.05**	**$69.55**	**$69.97**	**$70.38**	**$70.79**	**$71.14**	**$71.49**	**$71.83**

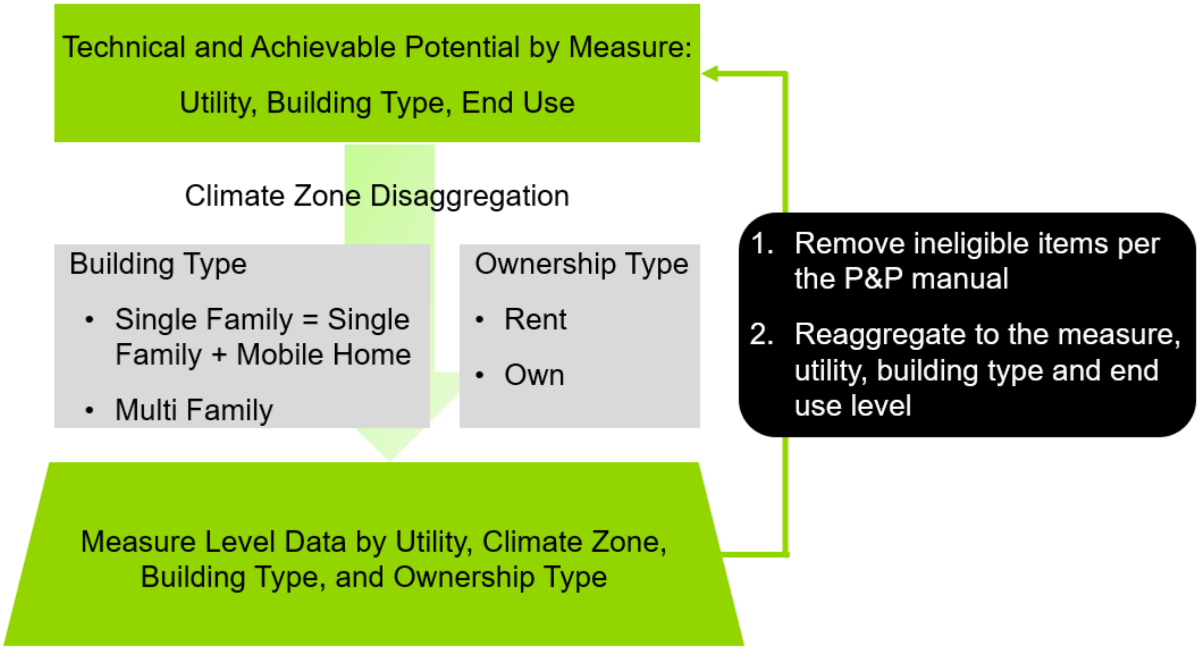
Source: Guidehouse

3.4 Climate Zone, Building Type, and Ownership Type Disaggregation

Guidehouse calculated the technical and achievable potential (in GWh, MW, and MMTherms) for each utility, end use, and measure. The team calculated the potential by climate zone,[19] building type, and ownership type for each measure with post-processing steps for the disaggregation to allow for P&P Manual measure requirements analysis of potential. Disaggregation was conducted using the current ratios of population falling into each climate zone, building type, and ownership type. Figure 3-5 provides a graphical overview of the disaggregation analysis. Results are reported at the utility, building type, and end use level and not at the climate zone and ownership type level.

[19] Certain measures are not eligible in every climate zone.

Figure 3-5. Potential Disaggregation Analysis to Climate Zone, Building Type, and Ownership Type Level



Source: Guidehouse

Guidehouse calculated savings potential for each measure based on applicable climate zones, ownership types, and building types as specified in the Statewide ESA P&P Manual. For example, room AC replacements are available for single-family PG&E customers in climate zones 11-14, whereas they are available for all SCE customers in climate zones 10, 13, 14 and 15. This separate dataset would only include the potential for those applicable climate zones, and thus, appears as a reduced value when compared to total achievable potential.

While the historical activity and applications data did not differentiate between climate zones, ownership types, or building types, Guidehouse assumed that the IOUs included only their plans for eligible populations and climate zones into their projections. As a result, the calibration process occurred at the utility and end use levels. A post-processing analysis was required to produce data that adheres to current program restrictions.

The team developed climate zone weights for each utility using total household counts and total household ESA eligible counts by ZIP code.[20] The team then used the previously calculated potential from each utility to disaggregate technical and achievable potential per climate zone, where applicable.

Guidehouse used the 2019 RASS data to further disaggregate the technical potential results into realistic splits among building types. For the modeling process, the team considered mobile homes to be a part of single-family homes. Using the RASS data, Guidehouse obtained a ratio of mobile homes to total single-family homes in California and then applied that ratio to total single-family home savings. This split initial single-family results into true single-family energy savings and mobile home energy savings. The P&P Manual includes applicability information

[20] The CPUC requested from the IOUs climate zone level data for ESA eligible households. The original county-level data originated from the 2019 Athens Research Study. Filing docket A.14-11-007 updated 3/17/20.

that differentiates between single-family homes and mobile homes. In the full results viewer, results are split between the two building types according to P&P Manual applicability.

For analysis purposes, the team also used the 2019 RASS to determine the ratio of rented properties versus owned properties in the low income sector by applicable building type. Those ratios determine the amount of technical potential available to renters versus owners in the low income sector. The results can be found in the full results viewer.

The above incremental achievable potential in Table 3-2 does not include the program limitations associated with the P&P Manual. When the disaggregated data is limited to the applicable climate zones, building types, and ownership by measure, Table 3-6 provides the resulting potential forecast.

Table 3-6. Incremental Achievable Potential Constrained by P&P Manual Applicability by Utility – Base Scenario

Utility	Fuel Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
PG&E	Electric (GWh/Year)	14.13	14.33	14.52	14.71	14.90	15.06	15.21	15.37	15.51	15.64	15.78
	Demand (MW/Year)	2.84	2.88	2.92	2.96	2.99	3.02	3.05	3.08	3.10	3.12	3.14
	Gas (MMTherm/ Year)	1.57	1.60	1.63	1.65	1.68	1.70	1.71	1.73	1.74	1.75	1.76
SCE	Electric (GWh/Year)	18.00	18.34	18.69	19.03	19.37	19.57	19.78	19.98	20.12	20.25	20.39
	Demand (MW/Year)	3.06	3.12	3.18	3.24	3.29	3.33	3.36	3.39	3.41	3.43	3.45
SCG	Gas (MMTherm/ Year)	1.04	1.06	1.08	1.10	1.12	1.13	1.13	1.14	1.14	1.14	1.15
SDG&E	Electric (GWh/Year)	3.53	3.60	3.67	3.74	3.81	3.85	3.89	3.93	3.96	3.99	4.02
	Demand (MW/Year)	0.53	0.55	0.56	0.57	0.58	0.58	0.59	0.60	0.60	0.61	0.61
	Gas (MMTherm/ Year)	0.10	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Total	**Electric (GWh/Year)**	**35.66**	**36.27**	**36.88**	**37.48**	**38.08**	**38.48**	**38.88**	**39.28**	**39.58**	**39.89**	**40.19**
	Demand (MW/Year)	**6.43**	**6.54**	**6.65**	**6.76**	**6.87**	**6.93**	**7.00**	**7.07**	**7.11**	**7.16**	**7.20**
	Gas (MMTherm/ Year)	**2.72**	**2.77**	**2.82**	**2.87**	**2.91**	**2.94**	**2.96**	**2.99**	**3.00**	**3.02**	**3.03**

Source: Guidehouse

The impact of applying program-defined eligibility to the achievable potential results is lower savings. Table 3-7 provides the percent change in the calculated incremental achievable potential.

Table 3-7. Percent Change in Savings in Total Incremental Achievable Potential versus Constrained by P&P Manual for Base Scenario

Fuel Type	2022	2023	2024	2025	2026
Electric (GWh/Year)	-19%	-24%	-26%	-26%	-25%
Demand (MW/Year)	-28%	-40%	-40%	-40%	-40%
Gas (MMTherm/ Year)	-18%	-44%	-44%	-44%	-44%

Source: Guidehouse

The differences are fueled by measures added to the potential study that were not included in the applications or the P&P Manual. In addition, the achievable potential Base scenario calibration focused on the statewide and utility level top-line savings as compared to the applications. As previously stated, the applications did not differentiate by building type, ownership type, or climate zone for each measure.

4. Recommendations for Future Low Income Potential Studies

The 2021 Low Income Potential Study had a different approach and methodology than previous iterations. These changes were made to better estimate potential in the low income sector as compared to previous studies. Because this year's study had a new methodology, Guidehouse makes the following recommendations for future low income studies:

- Benchmark program data to other states' low income EE programs
- Expand research on equipment saturation data
- Improve the adoption curves by better understanding customer barriers to installation or measure refusal
- Further investigate outlier initial penetration rates

Benchmark program data to other states' low income EE programs: IOUs should consider the low income programs in other states that have long-established programs (e.g., Illinois, Massachusetts, and Michigan) when considering which measures to include rather than limiting the measures to California program-only measures and California stakeholder-suggested measures. The benchmark research could provide analysis into measures that could provide additional energy savings but are not currently offered or considered in California. Additional benchmarking efforts should include program scale as delivered in other jurisdictions to assess appropriate size and scale.

Expanded research for equipment saturation data: For this study, Guidehouse used a combination of the 2019 RASS data and the residential measure data in the broader 2021 Study to calculate market saturation for the energy efficient technology. While the 2019 RASS was extensive, it did not have specifics on certain LED lamp types or more specific measures common to low income programs, such as thermostatic shower valves. A low income-specific saturation study may provide more accurate insights into market saturation for measures in this sector and could provide a more precise estimate of technical potential.

Improve the adoption curves by better understanding customer barriers to installation or measure refusal: Guidehouse recommends further CPUC investigation into measure installation barriers to appropriately assign measures to adoption curves. The findings could help in future grouping of measures for achievable potential forecasting by providing valuable information into the disruptiveness and ease of installation.

Further investigate outlier initial penetration rates: Guidehouse recommends further CPUC investigation into the initial penetration rates of highly saturated measures, such as lighting. In the calculation of initial penetration rates, 2019 equipment installs were considered. For certain measures, such as diffuse LED A-lamps, the 2019 installs exceeded the total technical potential installations calculated. Possible explanations could be light bulbs being installed into sockets where the existing CFL or LED is still functioning or equipment turning over faster than what the study assumes.

Guidehouse also recommends further investigation into the best data to use to develop future program adoption curves for achievable potential in the low income sector. This study used historical program activity, but there might be other sources of information available—for example, peer low income programs or primary data collection (market surveys, customer surveys, implementer surveys, etc.).

Appendix A. List of Measures Characterized

Table A-1. Full List of Measures Characterized

End Use	Measure	Fuel Type	Included in IOU 2021-2026 ESA Applications
AppPlug	Cold Storage	Electric & Gas	Yes
AppPlug	Dishwashers	Electric	Yes
AppPlug	Electric Panel Upgrade	Electric	Yes
AppPlug	Freezers	Electric	Yes
AppPlug	High Efficiency Electric Clothes Washer	Electric	Yes
AppPlug	High Efficiency Gas Clothes Dryers	Gas	Yes
AppPlug	High Efficiency Gas Clothes Washer	Gas	Yes
AppPlug	Inductive Range	Electric	Yes
AppPlug	Microwaves	Electric	Yes
AppPlug	Pool Pumps	Electric	Yes
AppPlug	Refrigerators	Electric	Yes
AppPlug	Second Refrigerators	Electric	Yes
AppPlug	Tier 1 Smart Power Strips	Electric	Yes
AppPlug	Tier 2 Advanced Power Strips	Electric	Yes
BldgEnv	Air Sealing / Envelope	Electric & Gas	Yes
BldgEnv	Attic Insulation	Electric & Gas	Yes
BldgEnv	Cool Roof	Electric & Gas	No
BldgEnv	Diagnostic Driven Air Sealing	Electric & Gas	Yes
BldgEnv	Floor Insulation	Electric & Gas	Yes
HVAC	Air Filter Replacement	Electric	Yes
HVAC	Air Purifier	Electric	Yes
HVAC	Blower Motor Retrofit	Electric	Yes
HVAC	Central A/C Replacement	Electric	Yes
HVAC	Central A/C Tune-up / Services	Electric	Yes
HVAC	Central Heat Pump Replacement	Electric	Yes
HVAC	Cooling HVAC Maintenance	Electric	Yes
HVAC	Duct Insulation	Electric & Gas	No
HVAC	Evaporative Coolers	Electric	Yes
HVAC	Fan Controller	Electric	Yes
HVAC	Forced Air Unit Standing Pilot Light Conversion	Gas	Yes
HVAC	Furnace Clean and Tune	Gas	Yes
HVAC	Furnace Repair	Gas	Yes
HVAC	High Efficiency Furnace Repair/Replace	Gas	Yes
HVAC	Portable AC	Electric	Yes
HVAC	Prescriptive Duct Sealing	Gas	Yes
HVAC	Room A/C Replacement	Electric	Yes
HVAC	Smart Thermostats	Electric & Gas	Yes
HVAC	Solar-Powered Attic Ventilation Fan	Electric	No
HVAC	Whole House Fan	Electric	Yes
Lighting	Exterior Hard-wired LED Fixtures	Electric	Yes
Lighting	Interior Hard-wired LED Fixtures	Electric	Yes
Lighting	LED Diffuse A-Lamp	Electric	Yes
Lighting	LED Night Light	Electric	Yes
Lighting	LED Reflector Bulb	Electric	Yes

End Use	Measure	Fuel Type	Included in IOU 2021-2026 ESA Applications
Lighting	LED Torchieres	Electric	Yes
Lighting	Vacancy Sensor	Electric	Yes
WaterHeat	Electric Combined low-flow Showerhead and Thermostatic Shower Valve	Electric	Yes
WaterHeat	Electric Other Hot Water	Electric	Yes
WaterHeat	Electric Thermostatic Shower Valve	Electric	Yes
WaterHeat	Electric Thermostatic Tub Spout / Tub diverter	Electric	Yes
WaterHeat	Electric Water Heater Pipe Insulation	Electric	Yes
WaterHeat	Electric Water Heater Timer	Electric	No
WaterHeat	Gas Combined low-flow Showerhead and Thermostatic Shower Valve	Gas	Yes
WaterHeat	Gas Other Hot Water	Gas	Yes
WaterHeat	Gas Thermostatic Shower Valve	Gas	Yes
WaterHeat	Gas Thermostatic Tub Spout / Tub diverter	Gas	Yes
WaterHeat	Gas Water Heater Pipe Insulation	Gas	Yes
WaterHeat	Gas Water Heater Timer	Gas	No
WaterHeat	Heat Pump Water Heater	Electric	Yes
WaterHeat	Solar Water Heating	Gas	Yes
WaterHeat	Water Heater Repair/Replacement	Gas	Yes

Source: Guidehouse

Appendix B. Categorization and Penetration Rates for Each Measure

Table B-1 includes the adoption curve category and the initial penetration rate for each characterized measure. Only measures with non-zero technical potential received an initial penetration rate.

Table B-1. Initial Penetration Rates by Measure and Utility

Measure Name	Adoption Curve	PG&E	SCE	SCG	SDG&E
Air Filter Replacement	B	0.0%	10.2%		0.0%
Air Purifier	C	1.0%	0.0%		0.0%
Air Sealing / Envelope	A	7.2%	0.0%	5.6%	7.5%
Attic Insulation	A	1.9%	0.5%	1.8%	0.3%
Blower Motor Retrofit	A	2.8%	0.0%		0.0%
Central A/C Replacement	A	11.1%	33.0%		0.0%
Central A/C Tune-Up / Services	B	9.0%	0.4%		0.0%
Central Heat Pump Replacement	A	9.6%	6.9%		0.0%
Cool Roof	B	0.0%	0.0%	0.0%	0.0%
Cooling HVAC Maintenance	A	0.0%	3.1%		0.0%
Diagnostic Driven Air Sealing	A	0.1%	0.0%	0.0%	0.0%
Dishwashers	B	0.0%	3.3%		0.0%
Duct Insulation	B	0.0%	0.0%	0.0%	0.0%
Electric Combined Low-Flow Showerhead and Thermostatic Shower Valve	C	0.0%	0.0%		0.0%
Electric Other Hot Water	C	50.4%	0.0%		21.7%
Electric Thermostatic Shower Valve	C	0.0%	0.6%		5.4%
Electric Thermostatic Tub Spout / Tub Diverter	C	0.1%	0.0%		0.1%
Electric Water Heater Pipe Insulation	C	2.8%	0.0%		
Electric Water Heater Timer	C	0.0%	0.0%		0.0%
Evaporative Coolers	A	10.5%	30.7%		0.0%
Exterior Hard-Wired LED Fixtures	B	100.0%	24.1%		89.1%
Fan Controller	B	2.5%	0.6%		0.2%
Floor Insulation	A	0.0%	0.0%	0.0%	0.0%
Forced Air Unit Standing Pilot Light Conversion	B	0.0%		0.0%	0.0%
Freezers	B	0.0%	0.0%		0.0%
Furnace Clean and Tune	B	0.0%		8.8%	5.6%
Furnace Repair	A	0.0%		0.0%	0.0%
Gas Combined Low-Flow Showerhead and Thermostatic Shower Valve	C	0.0%		0.0%	0.0%
Gas Other Hot Water	C	15.3%		15.1%	21.7%
Gas Thermostatic Shower Valve	C	0.0%		19.5%	0.0%
Gas Thermostatic Tub Spout / Tub Diverter	C	0.1%		0.7%	0.1%

Measure Name	Adoption Curve	PG&E	SCE	SCG	SDG&E
Gas Water Heater Pipe Insulation	C	2.8%		0.3%	0.3%
Gas Water Heater Timer	C	0.0%		0.0%	0.0%
Heat Pump Water Heater	A	1.6%			1.3%
High Efficiency Electric Clothes Washer	A	0.9%	0.0%		0.4%
High Efficiency Furnace Repair/Replace	A	23.0%		34.8%	50.8%
High Efficiency Gas Clothes Dryers	B	0.0%		0.0%	1.7%
High Efficiency Gas Clothes Washer	A	0.9%		0.8%	0.4%
Inductive Range	B	0.0%	0.1%		0.0%
Interior Hard-Wired LED Fixtures	A	100.0%	0.0%		100.0%
LED Diffuse A-Lamp	C	100.0%	100.0%		82.5%
LED Reflector Bulb	C	11.1%	1.3%		3.9%
LED Torchieres	C	1.9%	0.4%		3.0%
Microwaves	C	15.1%	0.0%		4.7%
Pool Pumps	B	14.3%	2.6%		0.0%
Portable AC	C	0.5%	0.1%		0.0%
Prescriptive Duct Sealing	A	3.8%		1.1%	0.1%
Refrigerators	B	1.6%	1.3%		0.7%
Room A/C Replacement	B	1.1%	0.2%		0.5%
Second Refrigerators	B	0.0%	0.0%		0.0%
Smart Thermostats	B	9.4%	0.6%	0.2%	15.2%
Solar-Powered Attic Ventilation Fan	A	0.0%	0.0%		0.0%
Solar Water Heating	B	0.0%		0.0%	0.0%
Tier 1 Smart Power Strips	C		0.1%		1.0%
Tier 2 Advanced Power Strips	C	0.6%	2.4%		1.2%
Vacancy Sensor	B	0.0%	0.0%		0.0%
Water Heater Repair/Replacement	A	0.3%		1.8%	0.2%
Whole House Fan	A	0.0%	0.0%		0.3%

Source: Guidehouse

Appendix C. Microsoft Excel Workbook Results Viewer

In a Microsoft Excel workbook results viewer, Guidehouse provided the different iterations of technical and achievable calculations, including by climate zone, building type, and ownership type. The analysis can be further broken down into differentiating what is in the program applications, alignment to the P&P Manual, and more. The workbook viewer has the following features:

- Total technical potential and the three scenarios for achievable potential (utility, building type, and measure level)
- Technical and achievable potential
    - Including or excluding any measures not included on IOU ESA applications
    - Aligned or not aligned with the P&P Manual with specific applicability for building types, ownership type, and climate zones
    - Removing or not removing any measures that increase consumption across all impact types