Guidehouse
Outwit *Complexity*

Proposal for:

2023 Energy Efficiency Potential and Goals Study Workplan (EM&V Group E Sectors)

Submitted by:

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1. Overview

To ensure continued success of the California's annual ~$1 billion customer investment in EE programs, the CPUC periodically develops savings goals to inform EE program planning efforts undertaken by Energy Efficiency Program Administrators (PAs), including the IOUs. The results of this study directly fulfil these needs. This document provides the detailed work scope for the 2023 Potential and Goals Study. This study is funded out of the EM&V for Group E Sectors contract.

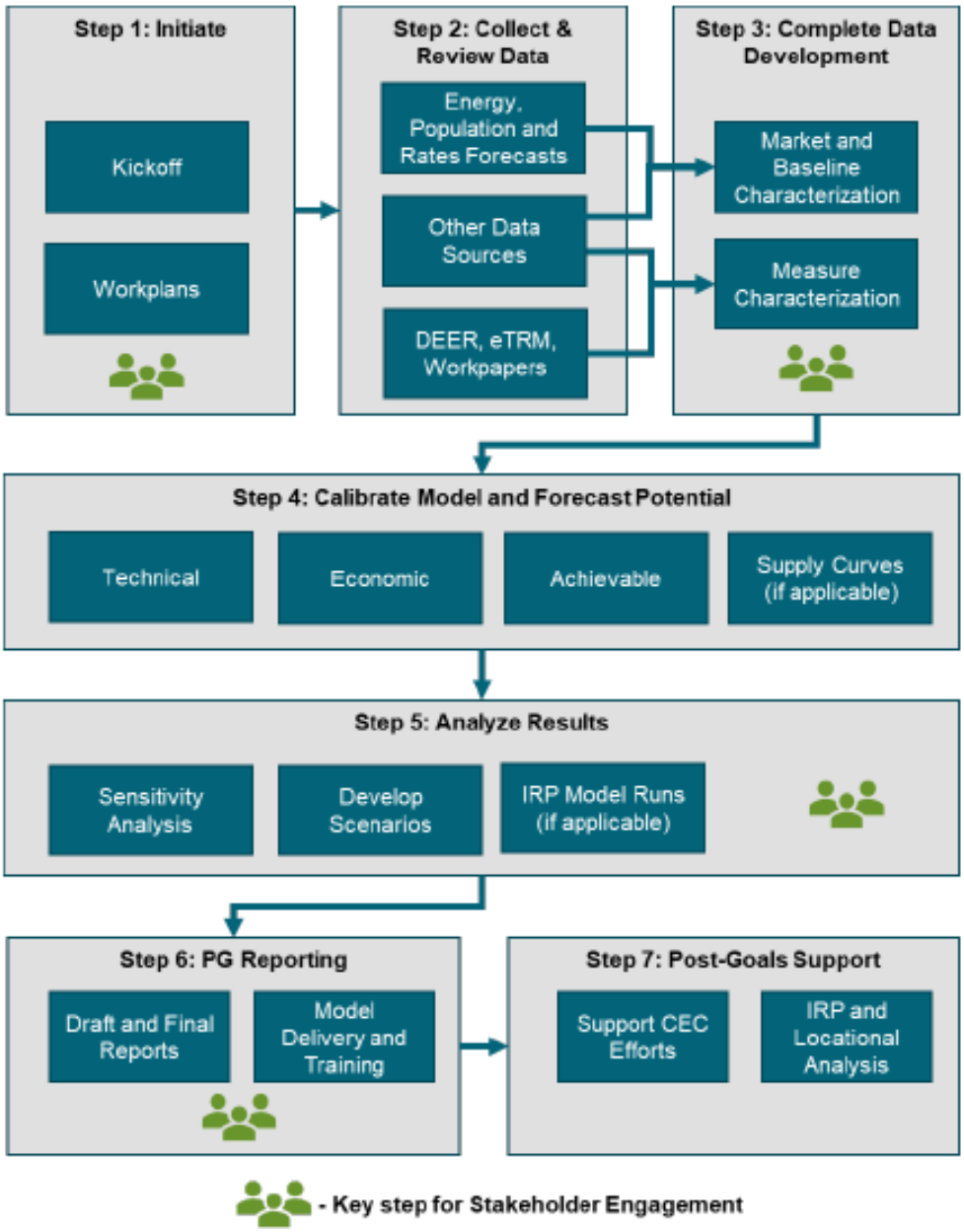
2. Objectives and Approach

The objective of this project is to conduct a Potential and Goals (PG) study in support of the EE program goal setting process and other forecasting and statutory activities.

The approach is designed: 1) to produce results that are consistent with the evidence of historic program achievements and market data, and 2) stretch beyond traditional program delivery mechanisms and past policy assumptions to examine future possibilities that are in line with current statutory activities, including Additional Achievable Energy Efficiency (AAEE) under the California Energy Commission (CEC)'s bi-annual Integrated Energy Policy Report (IEPR) forecasting process, doubling of efficiency aspirations under the SB 350 legislation and target setting process, and comprehensive integration of all energy resources under IRP initiatives.

Figure 1 below illustrates the process and flow of activities planned the implement the various deliverables related to the 2023 PG study over the two-year time horizon for this contract. Each aspect of the chart is summarized below the graphic.

Figure 1. Potential & Goals Study Process



- Step 1 is to launch the project with a kickoff meeting (CPUC Staff and Guidehouse Team), development of a detailed project action plan, and leading two to three internal and external stakeholder workshops to provide a detailed overview of the PG Study process and its objectives to CPUC, outline the planned approach for the 2023 Study, and seek public stakeholder engagement on potential improvements.
- Step 2 is to collect relevant new data that has emerged since the last PG study conducted in 2021. Guidehouse understands that certain baseline market conditions (including load forecasts, floor stock and number of buildings estimates, equipment densities, etc.) have been refreshed through various statewide activities launched by the CEC and others. A draft DEER/eTRM update is also scheduled to be available in September 2022 from the CPUC's ex ante team (and project subcontractor DNV) which will help to inform measure

characteristics[1]. Guidehouse also expects to draw on recently developed PA data sources such as technology measure packages, PA-led market studies, and (if timing allows) Group E market studies.

- Step 3 is to process the data that was collected in the previous step and format the data into various input needs for the PG modeling effort, in particular updating global input files for the model. Further, the project team will refresh the EE measure list to reflect new data sources and information gathered from DEER updates and measure workpapers, etc. Along the way, Guidehouse expects to share the progress of the data development efforts through a series of topic-specific public stakeholder engagement workshops and webinars (e.g., baseline, measure lists, etc.).
- Step 4 is to develop the EE potential forecasts adapting Guidehouse's potential simulation modeling tool, DSMSim™, which is already fully developed and vetted for this study based on our past CPUC PG assignments. Guidehouse will adhere to well-established methodological approaches for estimating technical, economic and market potentials, and incorporate calibration methods to recognize a variety of factors affecting the potential including rolling portfolio budgets, previously accomplished EE results, past PG study results, and anticipated market and policy activities that will affect how EE is carried out. As the various estimates of potential are developed, Guidehouse plans to lead multiple touchpoints with stakeholders to present results, obtain input, and adjust if warranted. Should Task 12 (IRP Supply Curves) be funded, this step will entail developing supply curves to inform the IRP Model.
- Step 5 is to carefully analyze the results by carrying out several what-if sensitivities and running scenarios that would reflect some of the inherent uncertainty associated with specific parameters including adoption and re-adoption algorithms, consumer awareness parameters, and altered program delivery techniques. During the process of conducting these analyses, Guidehouse expects to lead additional public stakeholder engagement sessions to present results, obtain input, and adjust if warranted. Should Task 12 (IRP) be funded, this step will require coordination with the CPUC's IRP contractor to run the IRP Model.
- Step 6 is to draft a PG study report that will be oriented toward a non-technical audience. Guidehouse will also produce several public products related to input and output data for the PG study. The project team will work closely with CPUC Staff to ensure that copy-editing objectives are accomplished and that a sufficient level of peer review is accomplished. Further, Guidehouse will hold 1-2 public stakeholder workshops to present the draft report and seek further input.

Section 3 provides detailed workplans of the tasks to be completed as part of the 2023 Potential and Goals Study.

[1] Final DEER update approval is scheduled to occur in November 2022

3. Potential and Goals Study (Tasks 8a and 8b)

3.1 Task 8a: Potential and Goals Energy Efficiency Adoption Simulation Model

3.1.1 Analytica Model

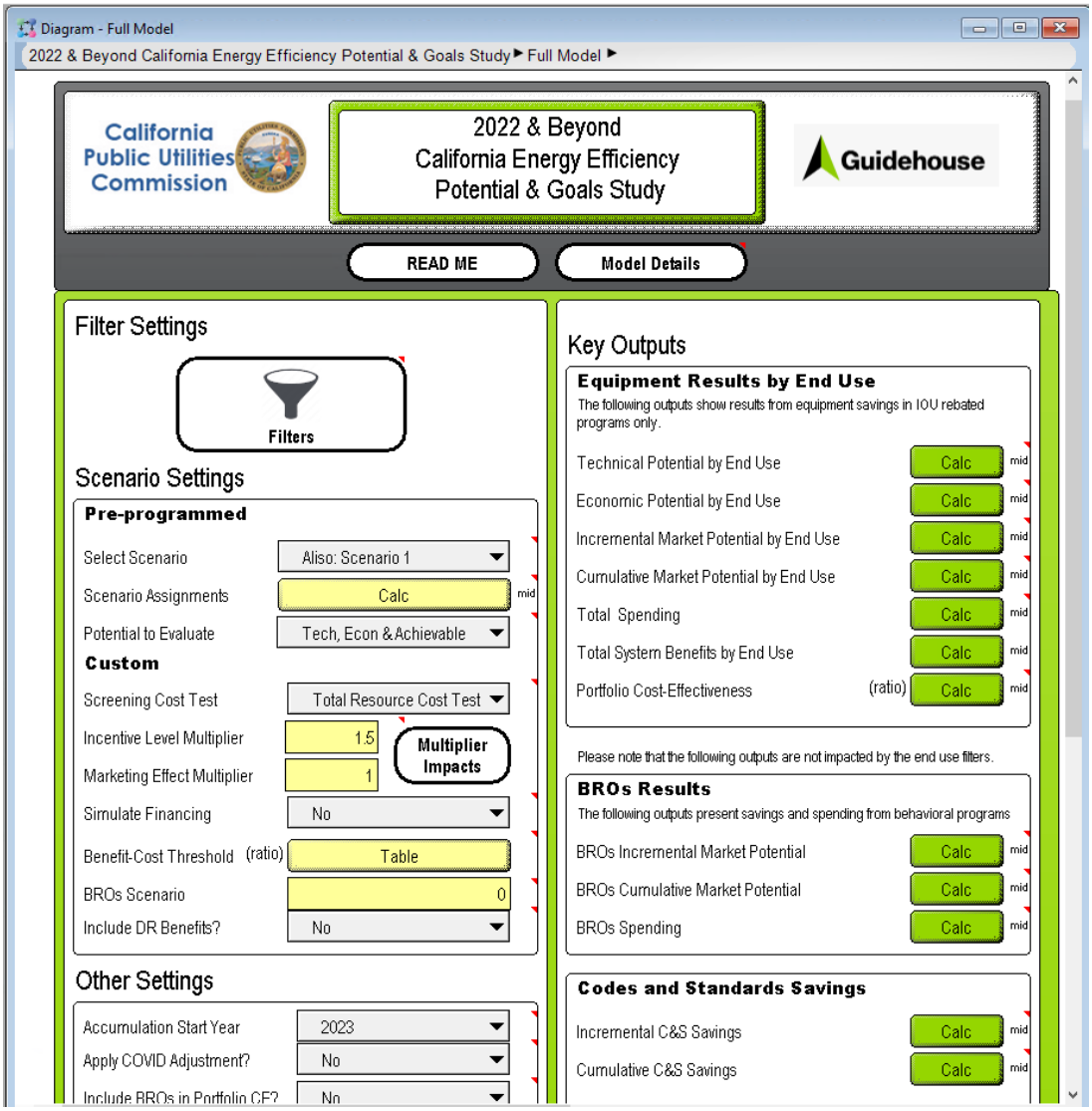
The CPUC's current bottom-up PG model last used in the 2021 PG study was developed by Guidehouse.[2] The CPUC has significantly invested in this model over the last 10+ years and it has ample stakeholder buy-in. Guidehouse will continue to leverage this model and is prepared to modify and update the model to meet emerging requirements. The existing model is already capable of achieving the following key outcomes:

- Providing results with measure-level granularity (a key need expressed by external stakeholders)
- Explicitly modeling fuel substitution and impacts of added DR benefits
- Estimating Technical, Economic and Market Potential
- Assessing cost effectiveness of individual measures and report portfolio cost effectiveness
- Distinguishing between rebate program savings, Codes and Standards savings, and Low-Income program savings
- Outputting annual and cumulative savings, including the total system benefits (TSB) metric
- Outputting supply curves for use in the IRP

The model is built using Analytica, a software platform developed by Lumina. Analytica is a software platform for data analytics, simulation, forecasting, and decision-support, widely used for applications in energy, environment, and economics. Figure 2 shows a screenshot of the model's graphical user interface. This interface contains several features that allow users to easily change inputs and scenario settings, run the model and view outputs.

[2] Model and supporting users guide available at: **https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/energy-efficiency-potential-and-goals-studies/2021-potential-and-goals-study**

Figure 2. Graphical User Interface of 2021 Potential & Goals Study Model



The model will be delivered to the CPUC as an executable file that does not require a license to run. Users may need to install a free version of the Analytica Player software. This is consistent with our delivery of models to the CPUC in the past.
Furthermore, Guidehouse will train CPUC staff on use of the model. For this study, training will be adapted to the needs of CPUC staff and can consist of the following:

- Documents detailing the modeling methodology and approach.
- User guides describing how to import/export data, run the model, navigate through underlying model logic, change settings, and review results, among others.
- Training exercises (structured similarly to practice problems) providing trainees an opportunity to assess their comprehension and aid in knowledge retention.
- Topic-specific recorded webinars.
- Training sessions; and

- Reasonable technical support post model delivery up until the contract end period.

3.1.2 Top-Down Approach

Guidehouse will continue efforts to incorporate "top-down" estimation techniques into its projection of energy efficiency market potential. Previous work conducted by Guidehouse recommended a phased approach to such integration. The tasks summarized in Table 1 below are all elements of the Cycle 1 phase described in Part 2 of Guidehouse's 2022 report on the top-down potential prototype analysis.

CPUC staff have requested that Guidehouse lay out a plan for proceeding through Cycle 1 of the Context and Credibility Pathway[3] and Cycle 1 of the Hybrid Top-Down Pathway, both described in part 2 of Guidehouse's report. A plan for the development of a residential sector building intensity database is not included in the below. To maximize resource efficiency, Guidehouse recommends proceeding initially with only the commercial sector building intensity database and revisiting the question of whether or not to proceed with a residential sector database once preliminary model outputs are generated.

Table 1. Request Activity Summary

Activity	Description	External Resources Required	Estimated Budget
Context & Credibility (Cycle 1 of Context and Credibility Stream)	• Identify "Canonical" Data. What do we reconcile to? • Utility Consumption Data Ingest & Processing • CEDARS Data Ingest & Processing • **Levelized Cost of Energy (LCOE) Comparison.** Do historical and projected LCOEs align? If not why not? • **Savings Comparison (Savings as % of Consumption)**. Do historical and projected relative savings (as % of consumption) and projected values align? Do distributions across end-uses align? If not, why not?	None	$60K - $90K
Commercial Intensity Database	• Procure CRE (Commercial Real Estate data) for Floorspace. CEUS, Dun & Bradstreet, Costar, etc.	Representative database of commercial customer floorspace that	$70K - $120K[4]

[3] CPUC staff asked that Guidehouse consider the development of market reports, part of Cycle 2 of the Context and Credibility Pathway. As these are not direct input elements to the modeling in Cycle 1, no planning for such reports is included here.

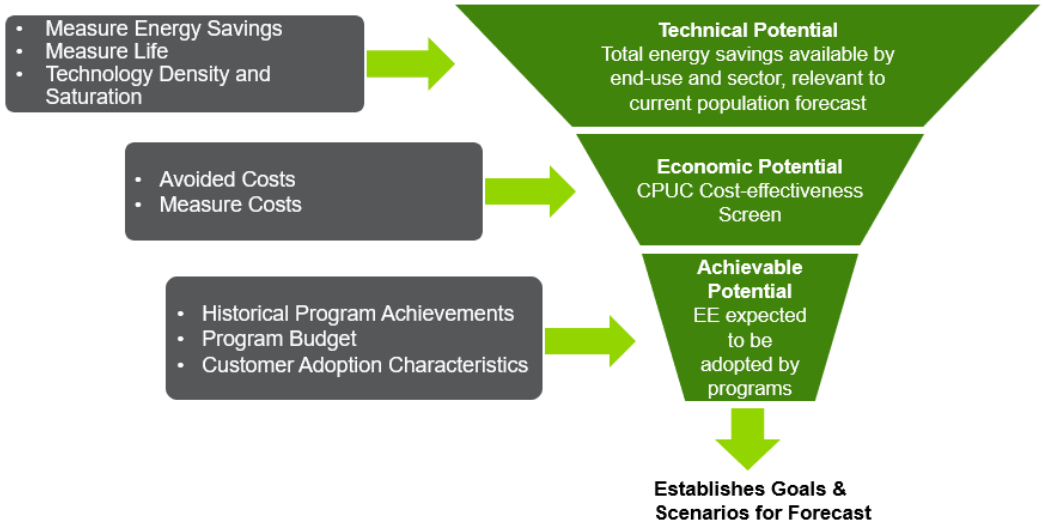
[4] Note that Guidehouse has not yet been able to procure estimates for the cost of purchasing the CRE data required for this piece, so the estimate here is highly uncertain. For reference, GH has, as a placeholder, estimated that the cost of such data will be approximately $30K

Activity	Description	External Resources Required	Estimated Budget
(Cycle 1 of Hybrid Stream)	• **Join, Process, & Reconcile.** QC will be time-consuming given addressed-based matching. • **Demonstration Outputs.** Create some outputs to demonstrate benefits of DB.	can be linked to utility consumption data	
Top-Down Estimate of Potential for Hybrid Example Commercial Scenario (Cycle 1 of Hybrid Stream)	• **Coordinate with DSMSim Team**. Upfront identification of constraints. • **Select "Efficient" Thresholds.** Leverage demonstration outputs from DB creation & develop supporting evidence. • **Review Hybrid Outputs.** Review DSMSim outputs calibrated to deliver hybrid scenario and present analysis of outcome.	None – though commercial intensity database is a prerequisite.	$35K - $55K

3.2 Task 8b: Potential and Goals Study

The EE potential forecast is a core activity that informs the CPUC's investor-owned utilities (IOU) goal setting process for 2023 and beyond. This activity will employ a range of analysis methods to meet the changing landscape of energy efficiency in the state of California. Guidehouse will use the Potential and Goals Energy Efficiency Adoption model described in the previous section to calculate technical, economic, and achievable potential across relevant sectors, building types and end uses over an up to 30-year forecast period. **Error! Reference source not found.** illustrates the key inputs and the layers of the potential modelling approach.

Figure 3. Approach to Achievable Potential Analysis



The main tasks that will be carried out to execute Task 8b are summarized below with additional detail in the following subsections

- Task 8b.1 - Market and Baseline Characterization
  - Obtain market and baseline data. Data will inform total market size, saturation, energy sales, retail rates, avoided costs, etc.
  - Guidehouse staff will obtain data from existing secondary sources: CEC IEPR, CPUC Cost Effectiveness Tool (CET), CA saturation studies, historic program achievements and spending from Program Administrators (PAs)
- Task 8b.2 - Measure Characterization
  - Develop a list of measures to be considered in the potential study, including behavioral, retrocommissioning, and operational (BROs) measures and fuel substitution measures, leveraging the 2021 PG study measure list
  - Vet measure list with stakeholders and finalize measure list
  - Characterize measures, prioritizing CA-specific data sources such as DEER and IOU measure packages, and leveraging other sources where necessary
  - Develop a database of measure characteristics to be used by the model
- Task 8b.3 - Technical Potential
  - Use the existing PG model framework developed by Guidehouse to calculate technical potential
  - Account for competing measures and develop instantaneous and annualized technical potential
- Task 8b.4 - Economic Potential
  - Work with CPUC staff to determine appropriate cost effectiveness tests to apply
  - Use the existing PG model framework developed by Guidehouse to calculate instantaneous and annualized economic potential
- Task 8b.5 - Market Achievable Potential
  - Use the existing PG model framework developed by Guidehouse to calculate market potential
  - Calibrate base market potential using a combination of historic program activity and research on customer adoption factors
  - Work with CPUC staff to develop scenarios beyond the base forecast to model/forecast
  - Provide support integrating results into IRP as appropriate
  - Disaggregate savings as needed: Locational impacts, RENs and CCAs, Disadvantaged communities.
- Task 8b.6 – Develop Hourly Impacts with Load Shape Analysis
  - This task will collect load shape data applicable to EE resources.
  - Data will be sources from the latest CA-specific sources.
- Task 8b.7 - Codes and Standards Potential

  - Using the existing PG model framework which replicates the Integrated Standards Savings Model (ISSM) methods, Guidehouse will forecast C&S savings
  - The team will review and scope potential C&S for inclusion in the study. Scoping will include interviews with IOU program managers and CEC staff as well as a review of DOE public documents
  - For the selected C&S, Guidehouse will collect data and import to the ISSM framework and forecast savings
- Task 8b.8 – Low-Income Potential
  - Characterize the Low-Income sector based on available secondary data
  - Identify applicable measures from Low-Income program data, such as Energy Savings Assistance Program applications, as well as measures suggested by the CPUC, IOUs, and other stakeholders
  - Use the 2021 PG model framework developed by Guidehouse to calculate technical and market potential
- Task 8b.9 - Reporting and Stakeholder Interaction
  - Develop draft deliverable and vet with stakeholders and CPUC staff
  - Revise deliverables based on feedback
  - Provide a model and web-based Results Viewer in addition to the written report

3.2.1 Task 8b.1 – Market and Baseline Characterization

Market and Baseline Characterization refers to information about the size and characteristics of the population that forms the basis for the potential forecast. (This is also referred to as the *global inputs.*) Much of this data already exists in an easy-to-use format, therefore this task is primarily compiling existing data from California-specific data sources.

Guidehouse will conduct the majority of this task prior to measure characterization, with some aspects being conducted in parallel with measure characterization. As part of this task, Guidehouse will research and identify the building types, end uses and the portion of energy sales to be included (i.e., are any customer groups/types to be excluded from the study) in this study. Guidehouse will also collect, and pre-process non-measure specific data required for these segments.

STEP 1: DEFINE SEGMENTS

Guidehouse will define residential, commercial, agricultural, and industrial building segments and end uses to forecast savings potential for in this study. Table 2 lists the building segments Guidehouse plans to analyze if there exists sufficient data to do so, while **Error! Reference source not found.** lists the end uses associated with each sector.

Guidehouse will consider other combinations not included on this list, if sufficient market data is available. For example:

1. Mobile homes in the Low Income sector
2. Public buildings in the Commercial sector. Guidehouse will investigate whether it is feasible to analyze public buildings as a separate building type. Historically, there has been a lack of necessary information, such as building stock data, which would enable this to be separated from the commercial sector.

3. Table 2. Potential & Goals Study Building Types

Sector	Building Types	
Residential	Single Family	Multi-Family
Low-Income	Single Family	Multi-Family
Commercial	College Grocery Health Lodging Office (Large) Office (Small)	Refrigerated Warehouse Restaurant Retail School Warehouse Other
Agricultural	Dairies, Fishing, Hunting Water Pumping	Irrigated Agriculture, Vineyards, Forestry, and Greenhouses
Industrial	Chemicals Electronics Fabricated Metals Food Industrial Machinery Lumber & Furniture Paper Petroleum	Plastics Primary Metals Printing and Publishing Stone-Glass-Clay Textiles Transportation Equipment All Other Industrial

Table 3. Potential & Goals Study End Uses

	Res	Low Income	Com	Ag	Ind	Min
Appliance Plug Loads	●	●	●			
Building Envelope	●	●	●			
HVAC	●	●	●	●	●	
Lighting	●	●	●	●	●	
Water Heat	●	●	●			
Whole Building	●	●	●			
BROS	●		●	●	●	
Commercial Refrig			●			
Data Center			●			
Food Service			●			
Machine Drive				●	●	
Process Heat				●	●	
Process Refrig.				●	●	
Oil Gas Extraction						●

STEP 2: IDENTIFY, COLLECT AND PRE-PROCESS NON-MEASURE SPECIFIC DATA

After identifying the relevant segments applicable to this potential study, the next step in this task is to develop macro-level model inputs that apply to market segments or sectors as a whole, rather than specific measures. Guidehouse will use the global inputs shown in Table 4 as a starting point for this study. Guidehouse will update these inputs based on latest updates to historic sources previously used and/or new sources as recommended by the CPUC and other relevant stakeholders.

Table 4. Potential & Goals Study Global Inputs

Global Input	Description	Historic Sources
Retail Rates *($/kWh, $/therm)*	Forecast of energy costs to customers	CEC - Integrated Energy Policy Report (IEPR) CPUC - California Energy Consumption Database (ECDMS)
Sales Forecasts *(GWh, MW, and MM Therms)*	Forecast of energy sold to customers	
Building Stocks *(households, floor space, consumption)*	Forecast of building and/or sales growth	
Avoided Costs	Forecast of avoided energy and capacity costs to utility	CPUC – Cost Effectiveness Tool
Historic Program Accomplishments	Historic program savings and spending, used for model calibration	CPUC – CEDARS Database (Claims) CPUC Low Income Oversight Board Monthly & Annual Reports IOU Business Plans
Non-Incentive Program Costs		
Inflation Rate	Standard 2% assumption[5]	CPUC's IRP Model
Discount Rate	Utility after-tax WACC	CPUC CET

3.2.2 Task 8b.2 - Measure Characterization

The overall measure characterization approach will leverage the existing measure characterization database developed for the 2021 PG study. The previous measure list included gas and electric energy efficiency (EE) measures; measures that provide both EE and DR benefits; measures that offer potential for electrification (switching from natural gas to electric); and behavioral, retrocommissioning, and operational (BROs) measures. Guidehouse will review the measure list, determine what measures should be added (or removed), and update the database with the most recent energy savings estimates, market saturation, and measure cost data available.

IDENTIFY MEASURES AND DEVELOP LIST

The first step in the measure characterization process is to select a list of representative technologies to include in the potential study. Historically, the selection process entails identifying high impact technologies with significant savings opportunities across multiple end uses, as demonstrated through historic IOU program activity. Guidehouse expects to implement a similar approach in this study, whereby the list will consist of prescriptive and custom energy

[5] Guidehouse recognizes that current/near term inflation in the economy at large is higher. We will confirm with CPUC/stakeholders that the value applied in this study is consistent within the model and with concurrent forecasting and energy models in CA external to this study.

efficiency measures. Guidehouse's approach for this study is to use the previous study's measure list as a starting point, considering additional EE, fuel substitution, and BROs measures that could have a meaningful impact on potential over the planning horizon. Examples include emerging technologies or commercially available measures that may or may not be included within other jurisdictions' portfolios. Guidehouse will schedule check-ins with the DNV team, who is currently engaged with the DEER team to develop 2022 measure package updates, to make sure we are aware of development of major new and emerging measure packages.

Upon completion of this in-depth measure review and identification process, Guidehouse will develop a list of recommended measures to present to the CPUC and other stakeholders for review and comment. Guidehouse recommends that the objective of this process should be to create a concentrated final measure list inclusive of only technologies that are believed to have a significant impact on potential over the study period. Part of this review may consolidate or remove measures that have little to no potential or application to streamline the process and reduce unnecessary complexity in the study.

Upon both internal and external review of the measure list, Guidehouse will begin the measure characterization process. Guidehouse will source consumption, cost and other measure specific data from California specific data sources including but not limited to DEER (as contained in the California eTRM), IOU measure packages, custom measure dispositions, IOU program data, EM&V results, emerging technologies programs, and industrial energy assessments. Where there is insufficient California data for any measures, Guidehouse will consult other technical reference manuals, as well as its extensive database of potential studies performed in other jurisdictions across North America. **Error! Reference source not found.** shows an example data source hierarchy used in the 2021 Potential and Goals Study. This hierarchy will be updated based on the latest available data. Priority of sources may shift based on recency of source and CPUC staff direction. The DNV team will support the identification and prioritization of data sources for the measures, using their thorough knowledge of the DEER, eTRM, and workpaper databases, and other sources of measure data.

Table 5. Example Hierarchy of Data Sources for Energy Use Information

Priority	Source Name	Description	Author	Year
1	DEER (as extracted from California 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	2022 (continuously updated)
2	IOU workpapers (with CPUC disposition)	Approved measure packages containing additional measure information not contained in the eTRM or measures that had not yet been added to the eTRM.	California IOUs	Various
3	IOU program data (evaluated or claims if evaluations are unavailable)	Program year (PY) 2021 and from published evaluation studies or claims in CEDARS database in cases where energy use information was not available from the above listed sources.	CPUC, IOUs	2021 (continuously updated)

	Non-California source examples:	In cases where California specific sources were not available for energy use information:		
4	Regional Technical Forum database	Measure-level savings data from evaluated programs in the Pacific Northwest region, available through the Regional Technical Forum.	Northwest Power and Conservation Council	2021 (continuously updated)
	Guidehouse potential study database	Guidehouse's archive of characterized measure savings from potential studies and projects with other utilities.	Guidehouse	2017-2021

CHARACTERIZE TECHNOLOGIES

From Guidehouse's experience, most potential is driven through a limited number of technologies or measures currently available in the market or expected to be in the market at some point within the planning horizon. Guidehouse expects to source most measure specific data from California specific sources such as the eTRM database. However, where California data is unavailable for specific measures, measure data may be sourced from other sources.

Guidehouse will take a prioritized approach to measure characterization to ensure that measures with the largest impact on savings potential are allocated an appropriately higher level of resources than measures with a negligible level of impact. Level of impact is determined by examining the measure-level results from the 2021 PG study and considering PA claims in CEDARS. Measures may also be classified as "high impact" if they fall under a particular area of focus for the PG study, such as fuel substitution measures. Guidehouse will vet the classification of measures as "high impact" or "low impact" with the CPUC.

The following analysis approach will be taken for each of the following categories of measures:

- For **high impact** measures that are well documented in California specific data sources such as the eTRM or workpapers, Guidehouse will update the measure characteristics from the 2021 PG study using the latest version of the source.
- For **high impact** measures that are not well documented in California data sources (for instance, because they are not included in IOU programs), Guidehouse will review and update the measures if necessary. Savings will be calculated using algorithms that reflect the fundamental physical characteristics of the measures they are intended to represent. When obtaining data from other data sources, Guidehouse will review the sources to ensure that the data is interpreted and applied correctly.
- For **low impact** measures, Guidehouse proposes to review the description and data sources for the measure to verify that they still apply to the measure. If there are no significant changes to the nature of the measure since the previous study, Guidehouse will generally use the measure characterization data from the previous study to streamline the analysis and make funds available for updates to high impact measures.

Next, Guidehouse will produce measure characterization data in a form that can be integrated into the PG model. Key measure characterization fields are expected to include:

- Measure descriptions and baseline assumptions.
- Energy savings (kWh, kW, therms).

- Cost associated with the measure (equipment, operational).
- Lifetime of the measure.
- Applicability factors including initial EE market penetration, total measure saturation, density, and technical suitability.
- Replacement type of measure (normal replacement, accelerated replacement, retrofit add-on, or new construction).
- Documentation of data sources.

Our measure characterization process will also involve assessing current and anticipated Codes and Standards as part of the baseline assessment, as well as cost trends for specific technologies.

CUSTOMISED TECHNOLOGIES

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 customised solutions whose costs and savings are specific to the installation. This is particularly applicable for larger agricultural and industrial customers, where each customer's energy profile is unique to that customer.

Guidehouse will analyze two types of custom measures: characterized custom and generic custom, detailed below. There may be additional potential custom measure types or categorizations that may be incorporated into the model. Guidehouse's planned approach for modeling custom measures is in line with the 2021 PG study, but opportunities to provide additional granularity where possible will be explored.

- **Characterized custom measures** are technologies that can be readily defined at the end-use and sector level. These are rebated via incentive programs using a custom project review instead of a deemed savings value. Examples include custom HVAC equipment upgrades and custom process refrigeration controls. Characterization for these measures follows a similar methodology as used for residential and commercial deemed measures—that is, characterizing the typical savings, cost, lifetime, and other factors described above.
- **Generic custom measures** are unique measures or process improvement measures that tend to be specific to an industry segment or production method. This category also includes measures that contribute a very small percentage of portfolio savings. These are characterized using a top-down approach for calculating achievable potential. Factors characterized for these measures include the eligible population (total sub-sector level energy consumption), sub-sector level applicability, expected energy savings percent, and market penetration rate. Guidehouse will refresh the program data from EEStats and CEDARS to derive measure inputs for the generic custom measure category and will use a similar approach to characterize emerging technologies.

FUEL SUBSTITUTION TECHNOLOGIES

Fuel substitution involves replacing equipment utilizing one regulated fuel with equipment utilizing another regulated fuel. In the context of the PG study, this entails replacing a gas baseline technology with an electric efficient technology. Fuel substitution technologies were newly added to the 2021 PG study, and Guidehouse proposes to leverage the previous measure list and analysis methodology while making additions and improvements where appropriate (Section 5.1 of this document contains further details of the planned Electrification

potential analysis). The 2021 measure list included the fuel substitution measures in the below table. When updating the measure list for this study, Guidehouse will consider fuel substitution measures that pass the Fuel Substitution Test implemented in D19-08-009: namely, eligible measures must not increase source energy nor increase CO_2 emissions relative to the baseline technology. The CPUC and key stakeholders will be consulted to determine if any fuel substitution measures should be added to or removed from this list.

Table 6. Initial Fuel Substitution Measure List

Sector & End-Use	Baseline Measure	Fuel Substitution Measure(s)
Commercial Foodservice	Gas Combination Oven	ENERGY STAR Electric Combination Oven
Commercial Foodservice	Gas Convection Oven	ENERGY STAR Electric Convection Oven
Commercial Foodservice	Gas Fryer	ENERGY STAR Electric Fryer
Commercial Foodservice	Gas Griddle	ENERGY STAR Electric Griddle
Commercial Foodservice	Gas Steamer	ENERGY STAR Electric Steamer
Commercial HVAC	Split or Packaged AC and Gas Furnace	Efficient Packaged Heat Pump
Commercial Water Heating	Gas Storage Water Heater	Heat Pump Water Heater
		DR-enabled Smart Heat Pump Water Heater
Residential AppPlug	Gas Cooking Appliance	Induction Cooking
Residential HVAC	AC and Gas Furnace	Heat Pump
Residential HVAC	Gas Furnace	Heat Pump (Heating Savings Only)
Residential Water Heating	Gas Storage Water Heater	Heat Pump Water Heater
		DR-enabled Smart Heat Pump Water Heater

BEHAVIOR, OPERATIONAL AND RETRO COMMISSIONING (BROS) MEASURES

To estimate the portion of demand and energy savings attributed to behavioral interventions, Guidehouse will work with the CPUC and stakeholders to identify a representative list of behavior and activity-based measures. Guidehouse will start with the 2021 measure list, which included the following BROS measures:

- Home Energy Reports (HERs)
- Web-Based Real-Time Feedback (Web RTF)
- In-Home Display Real-Time Feedback (IHD RTF)
- Small Residential Competitions
- Large Residential Competitions
- Universal Audit Tool (UAT)

- Commercial Competitions
- Business Energy Reports (BERs)
- Building Benchmarking
- Strategic Energy Management (SEM)
- Building Energy Information Management Systems (BEIMS)
- Building Operator Certification (BOC)
- Retro commissioning (RCx)

For each program, Guidehouse will define a set of participation forecast scenarios based on data such as existing levels of program participation, either for the California IOUs for existing programs or the program from which data was drawn and applied to California IOU territories. It is important to highlight that participation is a function of either customer adoption for opt-in programs or the number of customers that the utility wants to engage for opt-out programs. Engagement strategies for opt-out programs typically target high value customers first as these customers tend to result in the highest savings. Engagement often happens in waves and utilities may design the program as a means of experimenting with the effectiveness of different program elements. Some of the key assumptions include:

- A typical participation goal for the first year of implementation (or initial program saturation for existing programs)
- The percentage of residential, commercial, and industrial customers enrolled per year following the launch of the program
- The growth rate in participation over 5, 10, 15, and 20 years

In addition to a participation forecast, Guidehouse will define unit energy savings factors (typically expressed as a % of baseline whole building energy consumption) and unit energy cost factors to characterize each BROs program. These factors will be based on actual California IOU impact evaluations for existing programs or from other sources for which data is available and applied to California IOU territories. We will explore bifurcating HERs into smaller groups (for example waves, or low vs. high energy users) to be able to better reflect the realities of the market.

The methodology described above is subject to change depending on data availability and input from the CPUC and stakeholders.

WATER/ENERGY NEXUS MEASURES

Approximately 7 to 8% of California's electricity is used in the treatment, heating, and conveyance of water. This is known to many as the "Water/Energy Nexus (WEN)." The CPUC has authorized a series of pilot programs designed to establish whether there are energy savings that may be realized through and attributed to water conservation. As part of the 2023 study, Guidehouse will consider several representative measures, such as leak loss detection and enhancement of water systems efficiency, to incorporate into the PG model in a manner consistent with other above detailed energy efficiency measures. Guidehouse will work with CPUC and IOU stakeholders as part of the measure selection process to identify which water conservation measures identified by the eTRM as having embedded energy savings will be included in the model and establish approved energy savings values for these measures. Part of the challenge in characterizing the potential from WEN measures is the lack of market sizing data. Traditional EE measure characterization relies upon market and saturation studies to set

the size of the eligible population. There are limited similar datasets for the California water sector.

3.2.3 Task 8b.3 - 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 energy efficiency were taken, including retrofit measures, replace-on-burnout measures, and new construction measures. Guidehouse's PG model considers the following in forecasting technical potential:

- Technical potential assumes all eligible customers within a technology group adopt the highest level of efficiency available within the technology group, regardless of cost effectiveness.
- Technical potential represents the savings from converting all equipment that is at or below code or standard practice (where applicable and documented) to the highest level of efficiency within a technology group. Technical potential captures cross-measure interactive effects.
- Total technical potential is a 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 as doing so would be duplicative. Technical potential for BROs is undefined in our model.

Technical potential can be reported as both instantaneous and annualized potential, distinguished as follows:

- **Instantaneous:** Potential that is unconstrained by stock turnover in existing buildings in any given year.[6] This is the theoretical maximum savings possible from converting all equipment that is at or below code or standard practice (where applicable and documented) to the highest level of efficiency within a technology group.

Annualized: Potential that is constrained by stock turnover in existing buildings in any given year. This is the theoretical maximum savings possible from converting all equipment that is at or below code or standard practice (where applicable and documented) to the highest level of efficiency within a technology group upon burnout of the baseline technology. **Error! Reference source not found.**The calculation of technical potential differs depending on the assumed measure replacement type, since technical potential is calculated on a per measure basis and includes estimates of savings per unit, measure density (e.g., quantity of measures per home), and total building stock in each service territory. Guidehouse will work with the CPUC and other relevant stakeholders to define replacement types suitable for including in the potential study. The replacement types considered in the 2021 PG study are described below.

EXISTING BUILDINGS

Guidehouse will calculate technical potential for the following replacement types in existing buildings:

- **Normal replacement (NR) (i.e., replace-on-burnout [ROB]):** New equipment needs to be installed to replace 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. Appliance standards

[6] Includes buildings newly constructed in that same year

are applicable to some types of normal replacement equipment and apply to all new purchases.

- **Accelerated Replacement (AR) (i.e. early retirement):** Programs may influence end users to replace equipment with more efficient units prior to the end of its useful life. The 2021 PG Study did not consider AR withing existing buildings. We can consider including AR within the 2023 Study should there be a need and as budget allows.
- **Add-on equipment (AOE):** 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.

Equation 1 shows the formula for calculating technical potential in existing buildings.

Equation 1. Technical Potential in Existing Buildings

$$\textit{Technical Potential}_{\textit{EXISTING BUILDINGS}} = \textit{Existing Building Stock}_{\textit{YEAR}}\ (\textit{e.g., buildings}^{7})\ X\ \textit{Measure Density (e.g., widgets/building) X Savings}_{\textit{YEAR}}\ (\textit{e.g., m}^{3}\textit{/widget) X Technical Suitability (dimensionless)}$$

NEW CONSTRUCTION BUILDINGS

In a newly constructed building, equipment that is installed is always relative to code. New building stock is added to keep up with forecast growth in total building stock and to replace existing stock that is demolished each year. Demolished (sometimes called replacement) stock is calculated as a percentage of existing stock in each year. Equation shows the formula for calculating technical potential in new buildings.

Equation 2. Technical Potential in New Buildings

$$\textit{Technical Potential}_{\textit{NEW BUILDINGS}} = \textit{New Building Stock}_{\textit{YEAR}}\ (\textit{e.g., buildings}^{8})\ X\ \textit{Measure Density (e.g., widgets/building) X Savings}_{\textit{YEAR}}\ (\textit{e.g., m}^{3}\textit{/widget) X Technical Suitability (dimensionless)}$$

TECHNOLOGY GROUPS

Guidehouse's modeling approach recognizes that some efficient technologies will compete against each other in the calculation of potential. The study defines competition as efficient measures competing for the same installation (e.g., SEER 18 AC vs SEER 22 AC) as opposed to competing for the same savings (e.g., window A/C vs. split-system A/C) or for the same budget (e.g., lighting vs. water heating). For instance, condensing water heaters and tankless water heaters would belong to the same competition group because a consumer would install one or the other. General characteristics of competing technologies used to define the competition groups proposed for this study include:

[7] Units for building stock and measure densities may vary by measure and customer segment (e.g., 1,000 square meters (or feet) of building space, number of residential homes, customer-segment consumption/sales, etc.).

[8] Units for building stock and measure densities may vary by measure and customer segment (e.g., 1,000 square meters (or feet) of building space, number of residential homes, customer-segment consumption/sales, etc.).

- Competing efficient technologies share the same baseline technology characteristics, including baseline technology densities, costs, and consumption.
- The total (baseline plus efficient) maximum densities of competing efficient technologies are the same.
- Installation of competing technologies is mutually exclusive (i.e., installing one precludes installation of the others for that application); and
- Competing technologies share the same replacement type.

Table shows an example of a competition group, which sees different insulation efficiency levels competing for the same installation.

Table 7. Example of Technologies within a Technology Group

Competition 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

To address the overlapping nature of measures within a competition group, Guidehouse's analysis only selects one measure per competition group to include in the summation of technical potential across measures (i.e., at the end-use, customer segment, sector, service territory, or total level). The measure with the largest savings potential in each competition group is used for calculating total technical potential of the competition group. This approach ensures double counting is not present in the reported technical potential, though the technical potential for each individual measure is still calculated and reported.

Technology groups may also include fuel substitution measures and measures with DR benefits. Table 8 shows a technology group where efficient gas measures compete with fuel substitution measures, including a measure with DR benefits. In this instance, the customer would choose to install either an efficient gas water heater or an efficient electric water heater instead of a baseline gas water heater.

Table 8. Example of Technology Group Including Fuel Substitution

Technology Group	Technology	Description
Small Gas Water Heaters (normal replacement and New)	Baseline Gas Storage Water Heater	Code Efficiency Level
	Condensing Gas Storage Water Heater	High Efficiency Gas Level
	Instantaneous Gas Water Heater	High Efficiency Gas Level
	Heat Pump Water Heater	High Efficiency Electric Level
	DR-enabled Smart Heat Pump Water Heater	High Efficiency Electric Level

Source: Guidehouse

3.2.4 Task 8b.4 - Economic Potential

Using the results of the technical potential analysis, the economic potential is calculated as the total energy efficiency potential available when limited to only cost-effective measures. All

components of economic potential are a subset of technical potential. In addition to the above considerations in modeling technical potential, the following additional considerations are factored into our calculation of economic potential:

- Economic potential assumes all eligible customers within a technology group adopt the highest cost-effective level of efficiency available within the technology group. The most efficient technology within the group may not be cost-effective.
- Various cost effectiveness screens can be applied; thus, economic potential can vary by scenario. Guidehouse plans to analyze economic potential for up to five cost-effectiveness screens, which may include the following:
    - Total Resource Cost (TRC) Test: a benefit-cost metric that measures the net benefits of measures from the combined stakeholder viewpoint of the utility (or program administrator) and the customers. Metrics included in the TRC calculation include the avoided cost benefits, incremental measure costs, non-incentive program administration costs, and, for fuel substitution measures, the supply cost due to increased electric consumption.
    - Program Administrator Cost (PAC) Test: a benefit-cost metric that measures the net benefits of measures from the viewpoint of the utility (or program administrator). The PAC is similar to the TRC but does not include customer benefits and costs such as incremental measure costs, and includes utility incentive costs.
    - The model is also capable of applying a custom-defined cost effectiveness test, such as a modified TRC test that uses a different set of avoided cost values relative to the reference TRC test.
- Various cost effectiveness thresholds can also be set. For example, if the model is set to require individual measures to have a test result of 1.0, those with a result of 0.99 are excluded from the economic potential. This threshold can be set to any value though typically is limited to a range of 0.85 to 1.25. This threshold can be used as a scenario variable.
- Whole building packages are excluded from the economic potential as they would be duplicative with the individual measures that make up the whole building packages.
- Economic potential for BROs is undefined in our model

Like technical potential, our model can calculate both instantaneous and annualized economic potential.

Our model calculates economic potential leveraging the CPUC's avoided cost data and approximates the CET equations. Many simplifying assumptions are required by the Guidehouse Team to compress the massive, avoided cost dataset into something more manageable for the PG model. This includes averaging avoided cost load shapes across building types and selecting representative load shapes to assign to each end-use. Guidehouse plans to continue with this method that has been used in past studies.

Guidehouse does recognize that the current PG model does not capture avoided cost of refrigerants, a new feature added to CET after the draft 2021 PG study was published. The 2023 PG model will need to be updated to account for this new benefit as well as any other recently added benefits.

3.2.5 Task 8b.5 - Market Achievable Potential

This section demonstrates our approach to calculating market achievable potential, which is fundamentally more complex than the calculation of technical or economic potential. This section covers the following:

1. Total System Benefit Metric
2. Market potential modeling approach
3. Net-to-Gross ratios and free ridership
4. Cumulative savings
5. Savings potential in disadvantaged communities
6. Scenario Analysis
7. IRP support and hourly load shapes
8. Locational impacts
9. Savings potential attributable to RENs and CCAs

TOTAL SYSTEM BENEFIT METRIC

While technical and economic potential only focuses on energy impacts (kWh, kW, therms), an additional metric is calculated as part of the market achievable task: Total System Benefit (TSB). While TSB is not a cost-effectiveness test itself, it is calculated from key components that also feed into the TRC and PAC tests. TSB represents the total net 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. Guidehouse will include TSB as a primary output of the 2023 PG Study.

MARKET POTENTIAL MODELING APPROACH

Guidehouse's PG model employs a stock-turnover-based bass diffusion algorithm to simulate market adoption. The Task 8a section provides details on the implementation of this algorithm in the model. For brevity, a concise, high-level summary of the algorithm is presented here.

Three key steps are involved in simulating market adoption using Guidehouse's PG model:

1. Size population eligible to upgrade equipment in any given year
    a. The model sizes the annual, eligible population for measure specific market adoption using building stock as a starting point.
    b. This eligible population for installation decisions is calculated based on replacement type, using either a measure's burnout rate, number of retrofittable measures, or new building stock.
2. Calculate market share split amongst base and efficient measures for eligible population
    a. The model calculates the market share, or penetration of measures based on customer awareness of the measure and customer willingness to adopt the measure.
    b. Consumer awareness is calculated based on two factors:
        i. Marketing, education and outreach strength
        ii. Word-of-mouth strength
    c. Consumer willingness is calculated using one of two approaches, depending on sector:

i. Multi-attribute-based: Predicts consumer behavior by weighting multiple value factors that customers use to decide whether to adopt a more efficient measure. Examples of value factors include lifetime cost and eco impacts). This approach is used for the commercial and residential sectors and applies to both EE and FS measures.

ii. Payback-based: Compares payback time associated with efficient measure against competing measures. This approach is used for the agricultural and industrial sectors. (However, for large projects undergoing review by the IOUs and/or Program Administrators, Guidehouse will consider accounting for the impact of undergoing the review process on customer willingness to participate.)

3. Calculate savings attributable to utility program intervention

   a. The model calculates savings attributable to utility program intervention by multiplying the number of installations that are cost-effective by each measure's unit energy savings, relative to the appropriate baseline.

   b. In the case of discrete measures, the eligible population in Step 1 is further constrained by the remaining stock available after accounting for whole building installations.

NET-TO-GROSS RATIOS AND FREE RIDERSHIP

Guidehouse's PG model is set up to calculate both gross and net savings attributable to IOU programs. Similar to the 2021 Potential & Goals Study, results from this study will be presented in the form of net savings. Guidehouse will source net-to-gross ratios from appropriate, updated sources such as DEER support tables contained in the eTRM. Guidehouse will discuss the appropriate sources with experts on the DNV subcontractor team, the CPUC and other relevant stakeholders.

CUMULATIVE SAVINGS

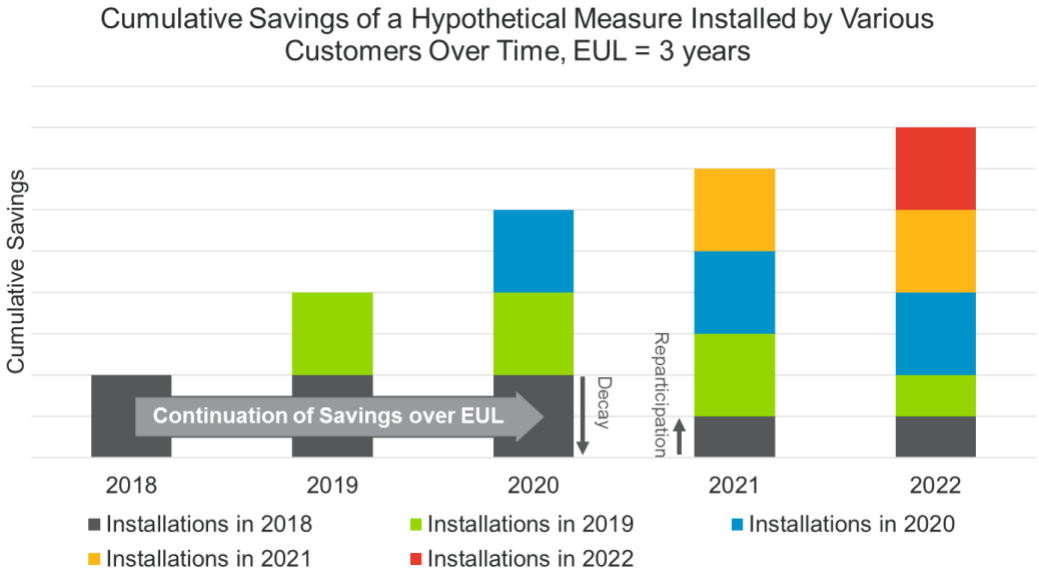
As mentioned in Task 8a, Guidehouse's PG model calculates both incremental and cumulative savings considering direction provided in CPUC adopted methods. Currently, the model is set up to calculate cumulative savings as the total energy efficiency program savings from measures installed since a "start year" and are still "active" in the current year. "Active" savings are calculated by accounting for:

- Cessation of savings (what the CPUC typically refers to as "decay") as measures reach the end of their EUL
- Codes & standards that come into effect over time

The approach to quantifying decay is somewhat debatable. Past CPUC guidance has been to assume 50% of EE savings decay at the end of their EUL. Guidehouse used a modified, stakeholder vetted assumption in the last four potential studies that is based on the market adoption algorithms within the model. Essentially, customers re-enter the decision tree and make their purchase decision based solely on the technology performance and cost rather than experience.

Historically, cumulative savings have primarily been used by the CEC to update their demand forecast (through the AAEE forecast). Going forward it will also be used to inform SB350 targets. For the purposes of AAEE, the model includes savings from re-participants in the cumulative savings calculation. The calculation of cumulative savings is illustrated in Figure 4.

Figure 4. Cumulative Savings Illustration



Source: Guidehouse

SAVINGS POTENTIAL IN DISADVANTAGED COMMUNITIES

Guidehouse will execute this analysis if it identified as a useful output by CPUC staff or stakeholders. Once market potential is forecast by Guidehouse's PG model, Guidehouse can determine the fraction of savings that fall within each IOU's disadvantaged communities (DAC) boundaries. This is a post processing step that will aim to size the market potential attributable to DACs. Guidehouse would leverage Geographic Information System (GIS) data available from the California Office of Environmental Health Hazard Assessment's CalEnviroScreen 3.0 tool to determine geographic boundaries for DACs in each IOU's service territory. This data can be cross layered with locational program savings data (from CEDARS) to factor in historic EE adoption trends between DAC and non-DAC regions.

SCENARIO ANALYSIS

This assessment will develop combinations of economic and market achievable assessments to produce up to four scenarios of potential for goal setting purposes. In previous studies, Guidehouse identified the first 4 variables presented in Table as candidate parameters to vary across scenarios. Additionally, the 2023 study may consider the a cost effectiveness-related screening approach to optimize the portfolio's calculated Total System Benefit.

Table 9. Internally Influenced Variables Considered for Scenario Setting

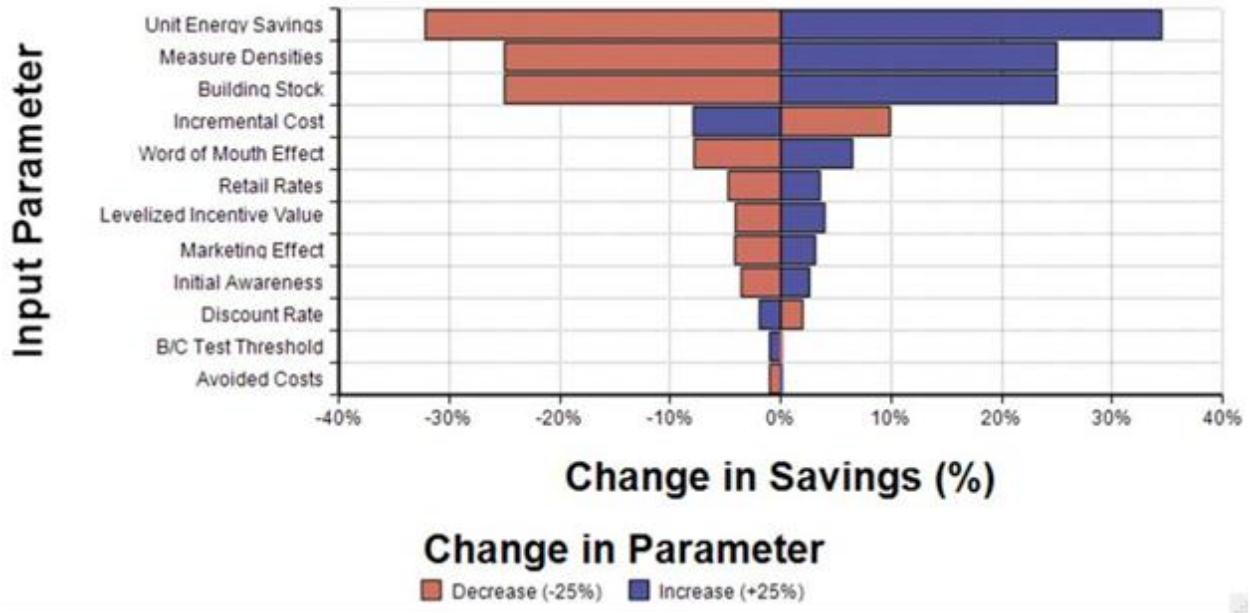
Lever	Description	Potential Impact Applicability	
		Economic	Market
Incentive levels	Varying incentive levels (at a percentage of incremental measure cost) will change the cost effectiveness of measures and their value proposition to customers.	✔	✔
ME&O	Varying marketing and outreach levels impact the rate at which technologies are adopted by customers.		✔
BROs program assumptions	Enrollment in BROs programs is an input vector. Guidehouse can assume a reference or aggressive rollout of BROs programs.		✔
Financing programs	IOU financing programs help reduce the cost burden associated with efficient measure adoption.		✔
Cost effectiveness test	Different cost effectiveness screening tests yield different amounts of economic potential and cause the achievable potential model to incentivize different sets of measures. The cost effectiveness screening test threshold only applies to rebate programs.	✔	✔

Source: Guidehouse

Guidehouse's PG model contains a sensitivity analysis module that accommodates two scenario analysis types:

- **Parametric:** Model changes only one variable and tests the effect of that change on the results. All other variables are held constant. The model produces a Tornado diagram as part of these runs, which quickly illuminate the input assumptions to which results are most sensitive (see Figure 5). Guidehouse will also consider iterating the model to maximize Total System Benefit.
- **Combination:** Model changes one or more variable and tests the combined effect of those changes on the results.

Figure 5. Illustrative Tornado Diagram Showing Sensitivity of Total Savings.



Guidehouse will work with the CPUC to define the reference (or base) scenario for this study (i.e., screening test, avoided cost data, etc.). Guidehouse will calibrate the model using the settings in this reference scenario, and model alternate pathways for up to three additional scenarios, for a total of four. The three additional scenarios will be determined in conjunction with CPUC staff to make sure the results are most useful for policy decision-making. For example, scenarios could be built around different cost effectiveness tests and avoided costs.

INTEGRATED RESOURCE PLANNING (IRP) SUPPORT AND HOURLY LOADSHAPES

Guidehouse is prepared to support the CPUC IRP staff in leveraging the results of this potential study for the next biennial IRP process. Guidehouse's understanding is that forecast cumulative savings that is expected to result from IOU energy efficiency programs will be fed into the IRP Model as a load modifier in an hourly format. As described in Section 3.2.6, Guidehouse will develop hourly load shapes, which will be applied to the annual cumulative savings values from the study to produce inputs for the IRP Model.

LOCATIONAL IMPACTS

Guidehouse is prepared to disaggregate savings at the IOU-level down to the climate zone level, as this is a required step for the CEC's AAEE forecast (Task 9). Our previous PG studies also provided this level of granularity. Further locational disaggregation will be dependent on the research and findings from Task 12.

SAVINGS POTENTIAL ATTRIBUTABLE TO RENS AND CCAS

Similar to DACs, Guidehouse can determine the fraction of savings that fall within the boundaries of RENs and CCAs once market potential is forecast by Guidehouse's PG model. This will require population and adjustments based on data available from historic program activity and other sources. Guidehouse will work with the CPUC and other relevant stakeholders to determine an appropriate methodology for sizing savings attributable to RENs and CCAs.

At this time, Guidehouse does not recommend attributing savings to RENs as the PG model is a technology, sector, and service territory model, not a program model. RENs tend to own

programs with technologies that can overlap with those also offered by the IOUs. Disaggregating savings by programs is very challenging given the construct of the existing PG model.

3.2.6 Task 8b.6 - Develop Hourly Impacts

Disaggregating savings to an hourly basis is a post processing step after the market achievable savings have been calculated. The PG study historically reported peak demand savings based on the DEER definition; the use of load shapes enhances the study's ability to inform a variety of subsequent analyses. Hourly impacts are an important input for IRP modeling as well as AAEE forecast. Hourly disaggregation will be supplement multiple components of this study including Energy Efficiency Market Achievable Potential Assessment (Task 8b.5), C&S Potential (Task 8b.7), and AAEE Scenarios (Task 9). All hourly disaggregation activities across these tasks and deliverables will be coordinated and leverage the same source data for consistency.

Our process for hourly disaggregation will be as follows and detailed below.

- Step 1 – Identify Measures and End Uses of Concern
- Step 2 – Compile Load Shape Data
- Step 3 – Map Load Profiles to Potential and Goals (P&G) study Measures
- Step 4 – Aggregate to End-Use Load Shapes

In Step 1 Guidehouse will identify Measures End Uses of Concern that the analysis will focus on. Our goal will be to address all end uses for energy efficiency savings forecasts inclusive of Rebate Programs, C&S, and BROs and to target load shapes for specific measures where applicable and data is available.

In Step 2, Guidehouse will compile load shape data at the most granular level. Past Guidehouse support for the CPUC and for CEC conducted a similar step and identified over 500 raw unique load profiles that primarily varied by end-use, climate zone, and building type. Ideally, load profiles for individual energy efficiency measures in the PG study for each climate zone will be utilized. However, this level of granularity is not always possible. Guidehouse expects to find more readily available load profiles broken down by:

- Sector
- End-Use (with some load shapes being specifically applicable to key measures)
- Climate Zone

Load shapes will be collected from existing secondary data and prioritized to be specific to California. Guidehouse expects to leverage the following data sources (listed in order of priority):

1. **DEER.** DEER contains a set of load shapes that are used to inform peak energy savings as well as avoided cost calculations. Guidehouse will review the latest DEER database additions to identify recent and reliable load shape data. Load shapes are stored in DEER using the Generalized Load Shape Parameter[9] format to compress each 8760 load shape to 900 parameters.

[9] "Loadshape Data-Deliverable 17-Draft, Loadshape Library Documentation." For CPUC by DNV, July 24, 2020. **https://pda.energydataweb.com/#!/documents/2414/view**

2. **CPUC EM&V Group A Studies.** DNV, a member of our proposed team, is leading EM&V efforts on Group A which is scoped with developing load shapes based on M&V data and resulting from recent DOE-2 building simulations.
3. **CEC's 2019 California Investor-Owned Utility Electricity Load Shapes Study.**[10] This CEC managed project provided a large amount of load shapes relevant to energy efficiency end uses and has been used by Guidehouse for past work to support the CEC. It could be used to fill gaps for CPUC studies. The following level of detail is provided in this dataset:
    - IOUs
    - Forecasting Climate Zones
    - Sectors
    - End Uses (for Residential and Commercial as defined in the IEPR forecast)
    - Building Types (primarily for the Industrial sector)
4. **IOU Rate Class Load Data.**[11] Each IOU reports actual, aggregate 8760 data for key rate classes in their service territory. These are only representative of net whole building energy usage as opposed to specific end uses. Onsite generation impacts this data. It will only be used to fill gaps in absence of additional data. Guidehouse expects select sectors such as Agriculture and Oil & gas extraction to benefit most from this.
5. **NREL's End-Use Load Profiles for the US Building Stock.**[12] NREL and its research partners developed a database of end-use load profiles representing all major end uses, building types, and climate regions in the US commercial and residential building stock. This could be used as a last priority to fill remaining data gaps.

In Step 3 Guidehouse will map the collected load shapes to each PG measure. In most cases this will be a one to many relationships (one load shape applies to many measures) often covering an entire end-use. However, to the extent that specific measure-level load shapes are available (thus multiple load shapes apply to measures within the same end-use) Guidehouse will map and retain this level of granularity.

In Step 4 Guidehouse will aggregate the measure-level load shape data into End Uses. Load shape data will be made available in our Results Viewer and can be applied to our end-use forecast of electricity savings to estimate hourly impacts.

[10] Details available at: **https://www.energy.ca.gov/publications/2019/california-investor-owned-utility-electricity-load-shapes**

[11] Example available at: **https://www.sce.com/regulatory/load-profiles**

[12] **https://www.nrel.gov/buildings/end-use-load-profiles.html**

3.2.7 Task 8b.7 - Codes and Standards Potential

C&S impacts on energy efficiency potential are modeled two ways:

- C&S impacts the code baseline for IOU rebated measures; as C&S becomes more stringent in the future, above-code savings claimable by IOU programs decreases.
- IOUs can claim a portion of savings from C&S that come into effect through the IOU C&S advocacy programs. This component has historically been considered the "C&S Potential." This task describes how the C&S Potential will be calculated. Impacts on rebate programs were described earlier in Task 8b.

C&S Potential refers to the forecast savings from current C&S, planned C&S, as well as a set of C&S that are reasonably expected to come into effect. This savings is most comparable to a market achievable potential. C&S potential does not include an estimate of Technical or Economic Potential. A C&S Technical potential would imply C&S are set to their maximum efficiency levels and 100% of customers would comply with them (i.e., every building is ZNE, every air conditioner is SEER 20+, etc.). A C&S technical potential would completely subsume a utility rebate program technical potential. For this reason, C&S technical potential is neither useful nor something recommended to calculate. Similarly, Economic potential is calculated as a subset of Technical potential, for the same reasoning for not calculate C&S Economic potential.

Our study will calculate the C&S "Achievable" Potential 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 Codes and Standards 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 targets. This informs the CEC forecast (for AAEE and SB350 purposes).
- **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 program goals.

Over the last few cycles of the PG study, Guidehouse has observed CEC staff being the primary user of the C&S savings forecast. While the CPUC sets C&S goals and the PAs use the results to plan their activities, by and large CEC staff make the most detailed use of C&S savings forecasts originating from the PG study. As a results, Guidehouse proposes closely coordinating with CEC staff from the CEC's Energy Assessments Division and Energy Efficiency Division to better understand and accommodate their needs while balancing the budget available for this subtask.

MODELING METHOD TO DEVELOP SAVINGS ESTIMATES

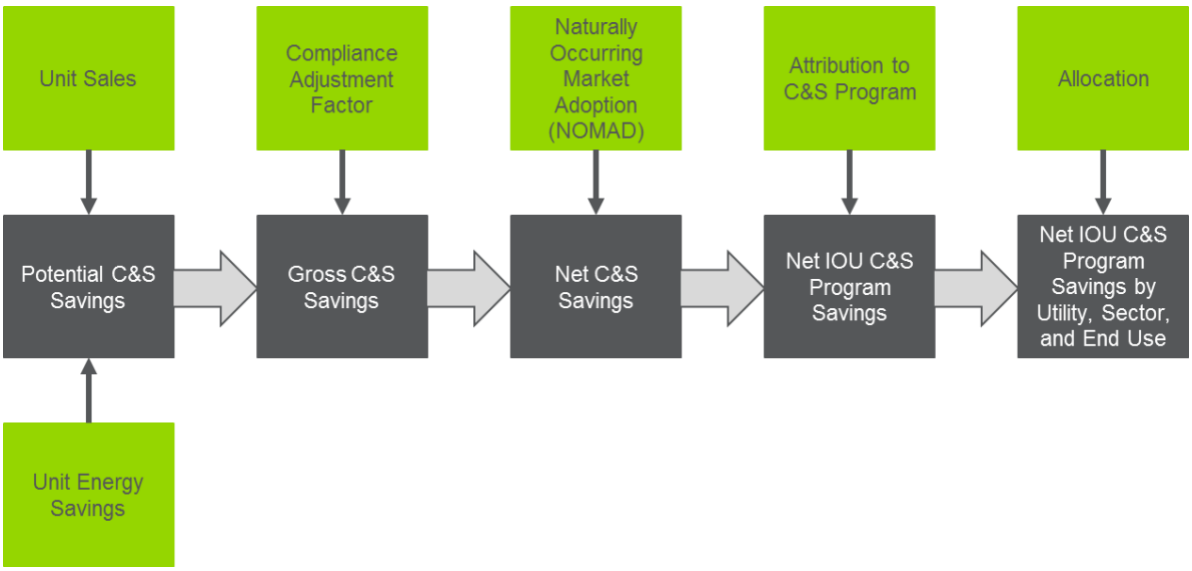
Our model methodology for C&S savings is based on the ISSM[13] developed and used by the CPUC in C&S program evaluation. ISSM follows the evaluation methods outlined in the California Evaluation Protocol. In the previous CPUC potential studies, Guidehouse replicated the methodology of ISSM in the Analytica platform for use in the PG Study. Translating the methodology into Analytica allows a single PG modeling platform, enhanced scenario analysis, and ability to develop more granular results (sector and end-use). Our model has been verified to match the outputs of the ISSM.

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

Guidehouse plans to continue use the existing ISSM based C&S model and update it to reflect any methodological changes in the latest CPUC-approved ISSM. The core process of calculating C&S Potential is illustrated in Figure 6. Key components of the calculation listed in Figure include:

- **Unit Sales –** Unit sales are the assumed baseline units sold each year for each measure. They represent the expected population of code-compliant or standard-compliant equipment adopted.
- **Unit Energy Savings –** Unit energy savings are the energy savings (in kWh, kW, or therms) relative to the previous code or standard for the new compliant equipment.
- **Compliance Adjustment Factor (CAF) –** (CAF) is the baseline assumption for the rate at which the population complies with codes or standards.
- **NOMAD –** The naturally occurring market adoption is the fraction of the population that would naturally adopt the code-compliant or standard-compliant measure in the absence of any code or standard.
- **Attribution –** IOU Attribution is the portion of gross C&S savings in California that can be claimed by IOU Code Support programs.
- **Allocation Factors –** Allocation factors are the fraction of the statewide C&S savings that occur in each IOU territory. Additional allocation factors assumed by Guidehouse break down the savings into sectors and end uses.

Figure 6. C&S Savings Calculation Methodology



Incremental savings for C&S are the new savings generated in each year after the code compliance date due to upgrading older equipment or activity in the new construction market. Cumulative savings is the simple summation of incremental savings over time up until the entire market has turned over.[14] This is marked different from calculating cumulative savings for rebate

[14] For example, a standard that applies to an appliance that has a 7-year EUL will accrue incremental savings for 7 years at which point incremental savings from the retrofit market drops to 0. Savings remain from the new construction market after the 7 years unless the standard is subsumed by a more stringent standard and layering effects are removed.

programs which requires an estimate of decay (i.e., measures reverting to baseline after the EUL). In the realm of C&S, the baseline is the previous code or standard, thus there is no "reversion to the baseline" since consumers cannot even purchase equipment at the old code or standard level.

SCOPING POTENTIAL STANDARDS AND DATA COLLECTION

The California IOUs implement their Codes and Standards Program as one step in a cyclical process that involves supporting emerging technologies, incorporating demonstrated technologies in their standard DSM programs, supporting Codes and Standards for demonstrated technologies so that the entire market is transformed, and then identifying advances in technologies that can be tested through their emerging technology efforts. The IOUs have developed a process of working very closely with the CEC to identify candidate standards that they will develop and support in the adoption process. They meet regularly to scope out opportunities for new Codes and Standards and create strategies for pursuing adoption.

The Guidehouse Team will work with the EDPM, program managers and contractors, CEC and DOE staff, and CPUC Staff and consultants to scope out a list of potential standards to be included in the C&S potential. Table summarizes the planned approach and sources of information.

Table 10. Developing Potential C&S for Analysis

Potential C&S	Information Sources
C&S in effect that have been evaluated	Past CPUC evaluations will be used to develop the list of C&S to consider. These evaluations will also contain data in the ISSM input format for our team to leverage. Guidehouse expects little need to collaborate with external team members other than confirming the latest evaluation data is being used.
C&S in effect that have not been evaluated	IOU C&S claims will be used to develop this list of C&S to consider. Our team will consult the IOU program managers and their contractors to obtain the list; it is possible these claims will have been submitted to CPUC staff. Guidehouse expects these claims to contain data in the ISSM input format for our team to leverage.
Future C&S	Guidehouse proposes to work closely with the Codes and Standards Program administrators, the CEC staff, CPUC Staff, and knowledgeable consultants to monitor code and standard development and adoption plans. This effort will be supplemented with interviews with key parties in other states and regions who have insights into the future of Codes and Standards. Guidehouse's experience working with DOE staff is they will be unlikely to divulge information to the CPUC beyond what is already publicly documented. Thus, Guidehouse plans to rely upon public information on federal standards.

After compiling information from all these sources, Guidehouse will develop a list of Codes and Standards that California might consider in the near- and longer-term. Our team will estimate the probability and timing of adoption and will select the standards with the highest probability of being adopted over a specified timeframe. Guidehouse will then focus its research on this list to develop the technical details required in the savings Potential and Goals analysis.

HOURLY IMPACTS

C&S savings will be disaggregated to an hourly basis at the sector and end-use level. Guidehouse will leverage load shapes developed as part of Task 8b.6.

PRODUCE SAVINGS RESULTS

As mentioned earlier, ISSM requires several inputs to calculate the gross and net savings estimates for individual standards. Guidehouse will use available data sources to develop estimates of annual unit energy savings for each appliance standard and code change and combined code changes in Title 24.

Where gaps exist, Guidehouse will research current appliance market sales and projections, construction projections, and trends and develop market size estimates over the forecast period. Unit savings and market size estimates will be combined to calculate the potential savings from each standard over the forecast period.

Compliance factors will need to be estimated for future C&S. For building codes, historical data at the building level by building type will be used based on the proportion of projected energy savings achieved. For the appliance standards, Guidehouse will review historical compliance rates for similar standards.

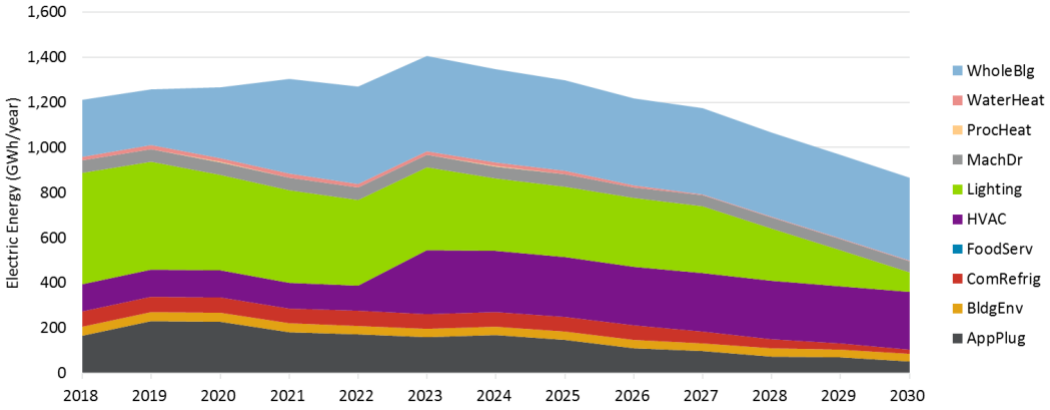
NOMAD factors will also need to be estimated for future C&S. Guidehouse proposes using estimates from prior evaluations in most cases with adjustments to shift the start year as appropriate. For those standards that differ significantly from prior ones, Guidehouse will conduct a Delphi process using knowledgeable experts to develop original estimates.

Once all input values are generated this task will provide savings results with the following granularity:

- Yearly Incremental and Cumulative Savings
- Net Attributable Savings
- Sector
- C&S Measure
- Net Savings
- IOU
- End-Use
- Applicable Hourly Load Shapes

Model inputs and assumptions will be documented and made available for public discussion. Summary results and a database of detailed results will also be produced for public discussion. An example of past summary graphs can be found in Figure 77.

Figure 7. C&S Example Outputs - Incremental Electric Savings



3.2.8 Task 8b.8 - Low Income Potential

In this task, the Guidehouse Team will forecast potential from the Low-Income sector and programs such as the IOUs' Energy Savings Assistance (ESA) programs. The ESA programs provide no-cost weatherization measures and other energy efficiency measures to income qualified customers to alleviate their energy burden while improving health, comfort, and safety. The ESA program also includes energy efficiency education and referrals to other income qualified programs, as well as fuel substitution measures.

The Low-Income potential methodology in the 2021 PG study was significantly different from prior studies. These changes were made to better estimate potential in the Low Income sector. First, the Guidehouse Team worked with CPUC staff to define a measure list specific to the Low Income sector. Guidehouse then used a simplified forecasting approach, leveraging its existing rebate program model to forecast technical and achievable potential from the Low Income sector (specifically from energy efficiency measures eligible to be installed through ESA). Guidehouse proposes to continue with the same basic approach, while improving upon the previous study by, for example, conducting more research to inform measure penetration and adoption, and comparing data with other states' programs.

The proposed approach to calculating Low Income potential consists of the steps outlined in the following subsections. Given the concerns raised in D.21-06-015 by stakeholders regarding the methodology for the Low Income potential analysis in previous PG studies, Guidehouse proposes working collaboratively with stakeholders and CPUC Low Income team to continue improving upon the methodology outlined here.

DEFINING THE MARKET

The Low Income market first needs to be defined. Generally residential customers qualify for ESA programs based on income limits that are listed on the program website. Guidehouse will use this information in conjunction with the most recent IEPR update and RASS data to estimate the proportion of residential building stocks considered as Low Income. Guidehouse will consider separate single family and multifamily subsectors, and may also include mobile homes as its own subsector if there exists adequate data to do so.

Guidehouse followed this approach in the previous study and estimated that approximately 15%-20% of single family households and 30%-40% of multifamily households qualify for Low Income programs. If needed, these and other figures will be refreshed as part of this task if there are any more recent IOU data and Low Income sector evaluation studies.

Once the Low Income market has been identified, it will be separated into its own "sector" distinct from the residential sector in our model. The residential sector will represent the portion of non-Low Income customers that are more likely to participate in traditional utility rebate programs while the Low Income sector will represent the reminder of the population that is eligible for ESA. Each population will be treated separately throughout the potential study.

SELECTING MEASURES

As in the previous study, Guidehouse will work with CPUC staff to identify a list of measures to include in this study. Guidehouse will start with the same measure list as the 2021 Study and build up on by select measures from the following sources in collaboration with CPUC staff and stakeholder inputs:

- Approved ESA measures in the IOU ESA applications for 2021-2026 including fuel substitution measures.

- Any ESA program measures included in the ESA Policy and Procedures (P&P) Manual[15,16] that IOUs did not include on their applications.
- Additional measures informed by CPUC Energy Division Staff and ESA proceeding stakeholders. These will, at a minimum, include the new measures identified in the 2021 Study (Electric water heater timers, gas water heater timers, solar-powered attic ventilation fans, duct insulation, and cool roofs).

Guidehouse will aggregate or disaggregate measures where necessary for analysis. For example, in the previous study, the team characterized High Efficiency Clothes Washers instead of multiple options for different clothes washer efficiencies and different types of washers (top loading, front loading, combo washer dryer, etc.).

CHARACTERIZING MEASURES

Guidehouse will source measure characteristics from two main sources:

- **IOU program activity:** Guidehouse will request a database of year-to date ESA program activity from each IOU. We expect this to provide the vast majority of data we need.
- **2021-2026 IOU applications:** Guidehouse may review approved IOU ESA/California Alternate Rates for Energy (CARE) applications for 2021-2026 if additional data is needed.

Guidehouse will use the most recent data available for each measure. Each measure will be characterized separately for each of the four IOUs; if data is not available from one IOU, Guidehouse will generally use data from other IOUs as a substitute. Guidehouse will collect data from other sources for any measures or data components not included in current or proposed ESA programs. For these measures, Guidehouse will source the information from the Low Income measure workpaper, if one exists, or the most relevant 2023 Study residential measure. Guidehouse will also account for interactive effects (e.g., where measures save one fuel but increase use of another) and measures that increase energy consumption overall but are still included in the IOUs' portfolios because of their quality-of-life benefits.

Guidehouse will characterize the following for each measure:

- Measure name
- Annual unit energy impact (kWh, kW, therms) on a per unit basis
- Measure density and saturation
- Equipment and labor measure expenses as defined in the annual IOU ESA reports17
- EUL

Guidehouse will calculate density and saturation in a similar manner as for the residential sector, but where possible, will use density and saturation values specific to the Low Income sector from the 2019 RASS data filtered for income qualified households, or other data sources as appropriate. Guidehouse will characterize measures for single family and multifamily building types within the Low Income sector, and may consider mobile homes as a separate building type if data is available. The below figure illustrates an example of differences in cooling

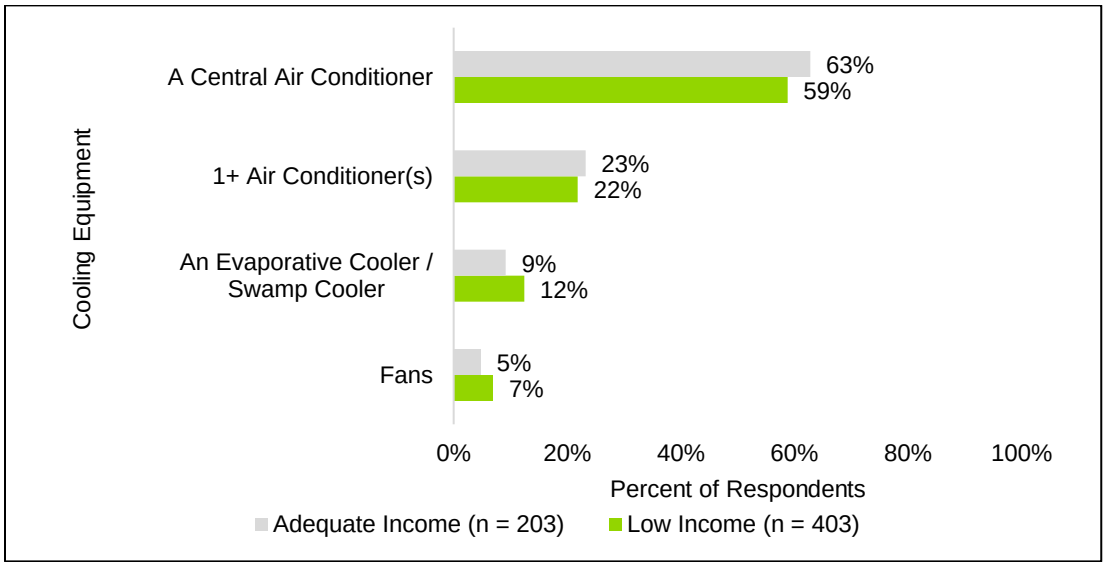
[15] *Statewide Energy Savings Assistance Program 2017-2020 Cycle Policy and Procedures Manual*, revised September 2019.

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

[17] Some utilities report equipment and labor costs separately, while some utilities combine them. Guidehouse to combine equipment and labor expenses together as measure expenses.

equipment types between residential and Low Income sectors, which informs the density of cooling measures within each sector.

Figure 8. Cooling Equipment Types by Income Group



Source: Evergreen Economics, Low Income Needs Assessment (2016)

ASSESSING TECHNICAL AND MARKET ACHIEVABLE POTENTIAL

With a defined population and measure list, Guidehouse will estimate the technical potential for the Low Income sector using the same modeling method as for non-low income programs. This methodology was described earlier in Task 8b.3. Our technical potential approaches are agnostic of market sector, income levels, or historic program activity. They depend purely on market size and measure characteristics.

Guidehouse does not plan to independently assess economic potential for the Low Income sector. Because ESA programs are not required to pass the TRC test, it is possible that historic program savings would be higher than the calculated Economic potential for Low Income Programs. While Low Income Programs may also deliver non-energy benefits (NEBs) that historically have not been easily quantified by typical cost effectiveness tests, there is a NEBs model that IOUs have layered onto the Cost Effectiveness tool output that has been used to derive an ESA Cost-Effectiveness Test (ESACET). If IOUs are able to provide to Guidehouse a list of all ESA measures with an ESACET with 0.3 (a threshold for consideration set by the recent decision), this will be used this as a pre-processing screen so only measures that pass this filter will be included for further modeling. This approach will be discussed further with CPUC staff and relevant stakeholders as necessary during the workplan development.

Guidehouse proposes to calculate achievable potential for Low Income measures as a percentage of the technical potential using a combination of an initial penetration rate and an adoption curve. This is a new methodology that was developed for the 2021 PG study and offers the flexibility to design scenarios that consider the unique program and measure characteristics in the Low Income sector.

- The **initial penetration rate** is calculated as the number of total installations for a measure in the measure's first effective year (i.e., program activity), divided by the calculated potential installations associated with the technical potential. Guidehouse will plan to use the

penetration rate for each measure in the year 2023 or the first year of program activity in the 2021-2026 ESA applications, whichever is earlier.

- The **adoption curve** defines how the penetration rate changes over time. In the 2021 Study, Guidehouse developed three prototypical adoption curves, which represented the range of barriers and measure attributes that are possible in this sector. The curves are independent of building type, ownership type, and climate zone. The adoption curves were developed leveraging historic program participation data and Guidehouse proposes to continue to leverage these curves, but will consider input from CPUC and stakeholders should overall budget allow for a refined or revised approach.

Guidehouse will categorize each measure based on a set of measure criteria: how easy or difficult the measure is to install; whether the measure installation requires property owner or manager approval; and how intrusive the measure installation would be to the resident. In the 2021 Study, all of the measures were grouped 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, non-intrusive

C. Easy to install, does not need property owner or manager approval, non-intrusive

Guidehouse will consider updating the categories as needed based on the mix of measures in this study, in consultation with the CPUC and stakeholders.

Guidehouse will define up to three prototypical adoption curves for each measure category, which will define the base scenario. The base scenario is intended to reflect current program delivery. Guidehouse will consider up to two additional scenarios for the Low Income sector that will adjust the base adoption curves to simulate more aggressive adoption levels than have been historically observed. Guidehouse will develop these scenarios in coordination with CPUC staff and stakeholders.

3.2.9 Task 8b.9 – Reporting and Stakeholder Presentations

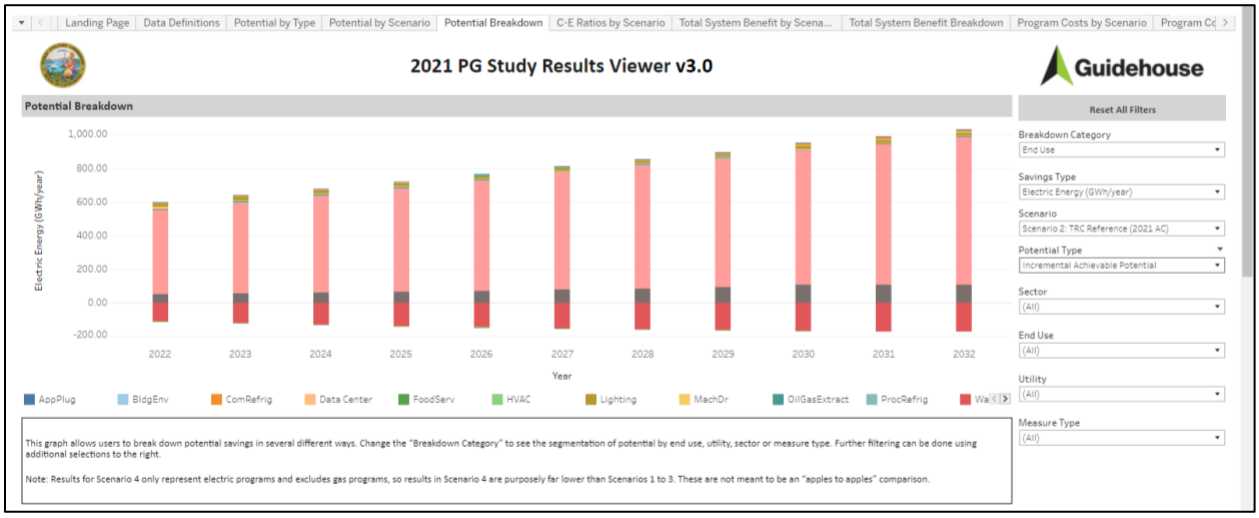
Guidehouse will prepare a draft report for internal and external review once draft results have been vetted. As has been historically done in the past, Guidehouse expects to publish this draft report, along with draft results and the draft model publicly through the appropriate CPUC channels. If possible, Guidehouse will explore delivering preliminary draft results, representing key sectors or results that depart from those of past studies, to stakeholders for review and input in advance of the comprehensive results being distributed. Guidehouse will respond to feedback from external stakeholders and provide a final report.

The approach to engaging stakeholders on draft results is as follows:

- Provide an overview of the scope of the study including what was specifically in scope and out of stope
- Provide clear concise information on the methodology of the study
- Clearly state assumptions and areas of uncertainty
- Provide summary results and discuss the implications and conclusions of these results
- Orient stakeholders will tools/databases, so they are empowered to dive deeper into the results
- Ask pointed questions that encourage stakeholder to provide meaningful feedback

In addition to a written report, this task will also provide a model (discussed Task 8a) and a database of results. Guidehouse understands that model and results delivery is a critical component of this project. Guidehouse has historically presented and circulated results in the form of an Excel-based Results Viewer. The Results Viewer provides stakeholders the ability to manipulate and visualize model outputs. In the 2021 PG study, Guidehouse also provided an online Results Viewer based in Tableau to give the CPUC and stakeholders in a more visually compelling and flexible manner. Guidehouse is prepared to provide this online Results Viewer again if stakeholders and CPUC staff continue to find it valuable in addition to the Excel-based Results Viewer. Figure 9 shows a screenshot of the dashboard Guidehouse developed for the 2021 PG study.[18]

Figure 9. 2021 PG Study Results Dashboard



3.2.10 Schedule and Deliverables

Table 11. Schedule for Task 8b

Subtask	Milestone/Deliverable	Start Date	Completion Date
1	Collect Global Inputs	7/1/2022	8/30/2022
2	Develop Initial Measure List	7/1/2022	7/15/2022
2	Review Measure List with Stakeholders	7/15/2022	7/29/2022
2	Characterize Measures	7/1/2022	9/30/2022
3	Develop Technical Potential	8/26/2022	10/30/2022
4	Determine C-E tests to consider	8/1/2022	9/30/2022
4	Develop Economic Potential	10/1/2022	11/18/2022
5	Develop Base Market Potential	11/18/2022	12/30/2023
5	Develop Scenarios and Produce Results	1/2/2023	1/27/2023
5	Post Process Results – DACs/REN/CCAs	1/2/2023	1/27/2023
5	IRP Coordination	TBD based on IRP needs	

[18] Dashboard can be accessed at: **https://bit.ly/2021PGViewerV3**

Subtask	Milestone/Deliverable	Start Date	Completion Date
6	Develop Hourly Load Shapes	7/1/2022	10/7/2022
7	Develop List of Potential C&S	8/1/2022	8/29/2022
7	Vet C&S List with stakeholders	8/29/2022	9/12/2022
7	Forecast C&S Savings	9/12/2022	11/14/2022
8	Develop Low Income Measure List and Market Data	7/1/2022	8/12/2022
8	Forecast Low Income Potential	8/12/2022	11/11/2022
9	Draft Report and Model		3/1/2023
9	Stakeholder Review	3/1/2023	4/1/2023
9	Final Report and Model		5/1/2023
10	Proposed decision on Goals adoption – 2024 and beyond		Q2/Q3 2023
10	Final decision on Goals adoption – 2024 and beyond		Q3 2023

11 lists the schedule for Task 8b assuming a contract activation date of 7/1/2022 and that key data is available by required dates as outlined in .

Table 11. Schedule for Task 8b

Subtask	Milestone/Deliverable	Start Date	Completion Date
1	Collect Global Inputs	7/1/2022	8/30/2022
2	Develop Initial Measure List	7/1/2022	7/15/2022
2	Review Measure List with Stakeholders	7/15/2022	7/29/2022
2	Characterize Measures	7/1/2022	9/30/2022
3	Develop Technical Potential	8/26/2022	10/30/2022
4	Determine C-E tests to consider	8/1/2022	9/30/2022
4	Develop Economic Potential	10/1/2022	11/18/2022
5	Develop Base Market Potential	11/18/2022	12/30/2023
5	Develop Scenarios and Produce Results	1/2/2023	1/27/2023
5	Post Process Results – DACs/REN/CCAs	1/2/2023	1/27/2023
5	IRP Coordination	TBD based on IRP needs	
6	Develop Hourly Load Shapes	7/1/2022	10/7/2022
7	Develop List of Potential C&S	8/1/2022	8/29/2022
7	Vet C&S List with stakeholders	8/29/2022	9/12/2022
7	Forecast C&S Savings	9/12/2022	11/14/2022
8	Develop Low Income Measure List and Market Data	7/1/2022	8/12/2022
8	Forecast Low Income Potential	8/12/2022	11/11/2022

Subtask	Milestone/Deliverable	Start Date	Completion Date
9	Draft Report and Model		3/1/2023
9	Stakeholder Review	3/1/2023	4/1/2023
9	Final Report and Model		5/1/2023
10	Proposed decision on Goals adoption – 2024 and beyond		Q2/Q3 2023
10	Final decision on Goals adoption – 2024 and beyond		Q3 2023

Critical to executing the above timeline is the timely receipt of key input data. Guidehouse identified timing requirements for several critical model inputs in Table 12 below. These are identified as those for which subsequent tasks have established dependencies, and where delays in receiving or generating final values may impact the overall Study timeline.

Table 122. Critical Model Input Timeline

Input	Required Finalization Date
End Use Load Shapes (informs C-E analysis)	10/7/2022
Historic Program Accomplishments (informs calibration)	11/18/2022
Avoided Cost Data (informs C-E analysis)	10/7/2022
DEER/eTRM updates, measure packages, Primary Data collection studies (saturation studies), and other Measure characterization inputs (informs measure characterization)	8/15/2022

Throughout the PG study Guidehouse plans to engage with stakeholders to collect feedback on key topics. **Error! Reference source not found.** lays out our current plan for stakeholder engagement. Additional opportunities for engagement with stakeholders may be considered; feedback on this matter may be sought via discussion and/or written feedback from stakeholders.

Table 133. Planned Stakeholder Engagement

Stakeholder Meeting	Planned Timing
Work Plan (webinar)	7/14/22
Stakeholder input on measure list and characterization including fuel substitution & EE	7/29/2022
Stakeholder input - Low-Income approach	August 2022
Stakeholder input - primary data collection studies	TBD
Stakeholder input - Cost Effectiveness Alignment	October 2022
Stakeholder input - Preliminary Results & Scenarios	January 2023
Stakeholder input - Post processing tasks	Summer 2023

4. Tasks 9–12: Post Potential & Goals Study Support

These activities will largely occur after the core potential study (Task 8 above) is completed (with the exception of Task 12: IRP supply curves).

4.1 Task 9: Additional Achievable Energy Efficiency Scenarios

The CEC provides a long-term forecast of energy consumption as part of the Integrated Energy Policy Report (IEPR); this forecast is referred to as the California Energy Demand (CED) Forecast.

The CED forecast is updated on a regular basis. In the process of updating the CED, the CEC first issues a baseline forecast which includes historic energy efficiency program and C&S impacts. It also includes some level of future energy efficiency: that which has been "committed." Committed efficiency savings reflect savings from initiatives that have been approved, finalized, and funded, whether already implemented or not.

However, there also exist additional savings from initiatives that are neither finalized nor funded but are reasonably expected to occur though either the IOU programs or C&S. These savings are referred to as achievable and are based on the CPUC bi-annual Potential and Goals Study. Often, a portion of the savings that are quantified in the PG study are already incorporated in the CED baseline forecast, and CEC staff need to estimate the portion of savings from the CPUC potential study that are not accounted for in the baseline forecast. These nonoverlapping savings are referred to as AAEE impacts.

Guidehouse has been supporting the CPUC and the CEC in the development of IOU AAEE scenarios since 2012.

Guidehouse expects to follow a similar process for this study as in years past. This includes:

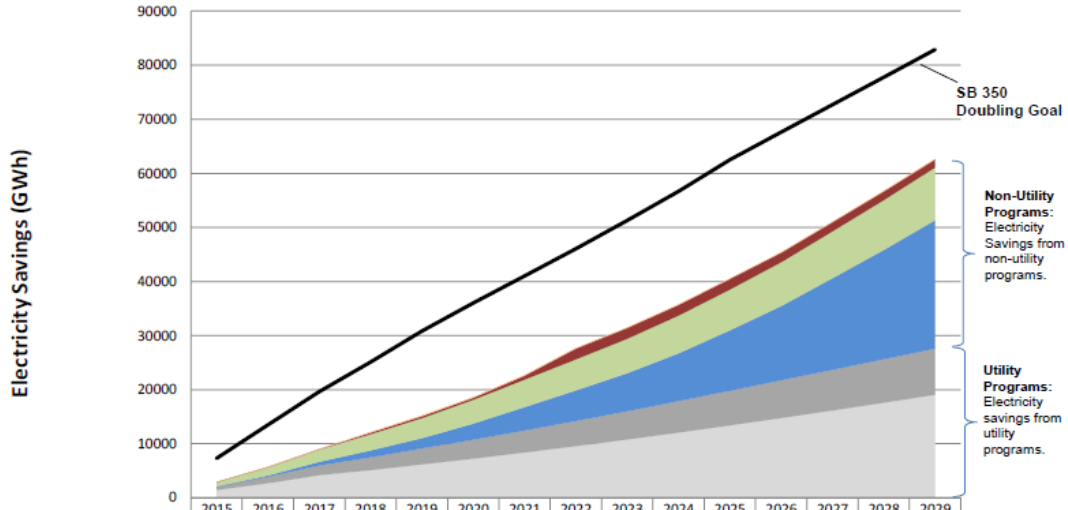
- Holding a series of kickoff and coordination meetings between CPUC, CEC and Guidehouse staff
- Developing a scenario framework that meets the specific needs of the CEC
- Producing scenario results at the level of detail/granularity as requested by the CEC
- Providing guidance on hourly impacts (leveraging load shapes) and locational impact at the climate zone level
- Delivering databases of relevant outputs
- Supporting stakeholder engagement activities
- Feasibility Study for Setting Locational Energy Efficiency Targets
- Potential and Goals Study with Development of Energy Efficiency Supply Curves for IRP

4.2 Task 10: SB 350 IOU Territory Targets Update

Senate Bill 350, the Clean Energy and Pollution Reduction Act of 2015 requires the CEC to establish annual targets that will achieve a cumulative doubling of statewide energy efficiency savings and demand reductions in electricity and natural gas final end uses. This doubling target is relative to the CEC's 2015 mid-case forecast of the AAEE forecast.

In 2017, the CEC published its first report (referred to here as the "SB350 Report") to establish proposed statewide doubling targets that must be achieved by 2030.[19] It proposed "sub targets" for the portion of projected energy efficiency savings that can be achieved through IOU programs, POU programs. and non-utility programs funded through government, private and utility ratepayer sources (illustrated in Figure 40).

Figure 40: Proposed SB 350 Doubling Target and Sub targets (Electricity)



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Agriculture & Industry	2	33	58	95	118	121	116	109	94	83	76	75	82	99	127
Behavioral & Market Trans.	32	39	47	296	366	375	732	2002	1998	1986	1963	1762	1693	1617	1492
Financing	757	1513	2270	2994	3704	4401	5074	5736	6360	6967	7536	8099	8653	9202	9748
Codes & Standards	93	243	673	1280	1899	2980	4325	5655	7037	8841	11172	13729	16948	20215	23746
POU Programs	596	1190	1790	2360	2945	3501	4069	4645	5232	5822	6406	6977	7520	8042	8540
IOU Programs	1427	2685	4179	5112	6169	7230	8373	9550	10768	12052	13385	14748	16145	17580	19050
SB 350 Doubling Goal	7,286	13,46	19,60	25,10	30,81	36,01	41,03	46,04	51,28	56,66	62,51	67,60	72,69	77,78	82,87

Source: CEC, 2017

Task 10 is scoped with updating the IOU sub target to inform the CEC as it moves forward with updating data reported in the SB350 Report. As part of the 2017 PG study, Guidehouse provided the forecast of IOU program savings to the CEC and its contractors that informed the IOU sub targets in the 2017 SB350 Report. As part of the 2019 and 2021 PG studies, Guidehouse provided updated IOU program savings forecasts to the CEC to update its tracking of SB350 savings.

Guidehouse expects to follow a similar process for this study as in years past. This includes:

- Holding a series of kickoff and coordination meetings between CPUC, CEC and Guidehouse staff
- Conducting the analysis including baseline adjustments and attribution adjustments to remove double counting of impacts from Codes & Standards, BROs, Fuel Substitution, and Financing programs.
- Delivering databases of relevant outputs

[19] Jones, Melissa, Michael Jaske, Michael Kenney, Brian Samuelson, Cynthia Rogers, Elena Giyenko, and Manjit Ahuja. 2017. *Senate Bill 350: Doubling Energy Efficiency Savings by 2030.* California Energy Commission. Publication Number: CEC-400-2017-010-CMF.

- Supporting stakeholder engagement activities

4.3 Task 11: Feasibility Study on Setting Locational Energy Efficiency Targets

The purpose of this task is to explore the feasibility of setting energy efficiency targets at the local level. Specifically, the objective is to identify areas that should be prioritized based on a combination of potential for adoption, locational valuation, and equity. Importantly, this task would not propose to change Program Administrator (PA) goals or budgets, and would assess these locational targets within the achievable bounds established by the core potential study detailed in **Section 5.2**. However, the prioritization of where the pre-determined savings/system benefits are sought out throughout the PA's jurisdiction is targeted based a combination of factors including locational valuation.

The proposed approach to this task is driven by three primary objectives:

- Identify the optimal approach to breaking down Potential and Goals to meaningful geographic regions for distribution planning.
- Identify potential cost-effective goals for areas with grid needs and deferral opportunities.
- Identify EE and BE aggregation opportunities to meet grid needs and areas where coordination could minimize the adverse grid impacts of building electrification and possibly facilitate zonal electrification.

The proposed process will include the following steps:

1. Work with the CPUC EDPM to identify one IOU or specific targeted area(s) of focus
2. **Draft the framework** for establishing location specific EE and BE goals.
3. **Finalize the framework** based on comments and submit to the CPUC EDPM.
4. Perform the **analysis** based on the final framework to establish the location specific EE and BE goals in the targeted areas(s).
5. Present analysis results to Stakeholders and solicit feedback.
6. Deliver report inclusive of review and relevant stakeholder input. Develop a **draft report** and submit this report to the CPUC EDPM for review and comment.
7. **Revise the draft report** and then make available for stakeholders review on the EE (R.13-11-005) and CPUC High DER (R.21-06-017) service lists. In addition, Verdant will reach out to additional organizations as identified in Staff Proposal on Data Portals and Community Engagement to ensure to include California citizens that do not always have a voice in these types or proceedings. Verdant will then host a **public webina**r and invite informal comments.
8. **Finalize the report** based on the input and submit to the CPUC EDPM.

4.4 Task 12: Potential and Goals Study with Development of Energy Efficiency Supply Curves for IRP

An IRP[20] is a roadmap for utilities to meet forecast annual peak and energy demand, with consideration of an established reserve margin, through a combination of supply-side and demand-side resources over a specified future period. Senate Bill (SB 350) mandates that the CPUC examine the future of California's energy procurement practices through an IRP process.

Up until late 2017, CPUC's IRP modeling efforts have considered EE as a "baseline resource" (i.e., a resource that is included the model as an assumption with a set magnitude rather than being selected by the model as part of an optimal solution).

Starting in 2017, Guidehouse examined various methods to integrate energy efficiency procurement practices into the IRP optimization process. Guidehouse's analysis included collaborating with the CPUC's IRP contractor to explore changes to the existing IRP Model. This consisted of a technical analysis to explore the feasibility of fully optimizing energy efficiency as supply-side resource, considering pros and cons of options, and present lessons learned. This process led to Guidehouse developing EE supply curves out of the 2018 PG model to provide to the CPUC's IRP modeling team.[21] This exercise was repeated in the 2021 PG study cycle comparing IRP Model results to the bottom-up PG model results.

Our approach to Task 12 for electric measures builds upon our previous support and institutional knowledge of CPUC IRP processes to enhanced modeling and methodology approaches. Our scope and budget assume that Task 12 is conducted overlapping Task 8b as much of the input data and modeling framework to develop supply curves and load modifiers is the same.

The main subtasks that will be carried out to execute Task 12 include:

- Task 12.1 - Market Characterization
- Task 12.3 - Conduct Measure Characterization
- Task 12.3 - Technical Potential
- Task 12.4 - IRP Model Coordination
- Task 12.5 - Technical Achievable Potential
- Task 12.6 - Load Shape Collection and Analysis
- Task 12.7 - Energy Efficiency Supply Curve Development
- Task 12.8 - Load Modifiers
- Task 12.9 - Additional Analyses
- Task 12.10 - Reporting and Stakeholder Interaction

Tasks 12.1 through 12.5 will leverage relevant data and model frameworks from Task 8b.

[20] In this section, the acronym IRP is used to denote either an integrated resource plan or the process of integrated resource planning, depending on the context.

[21] Guidehouse. *Developing EE Supply Curves for IRP Models.* April 27, 2018. http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/Slides%20for%20MAG%20Meeting%202018-04-27%20v2.pdf

5. Task 13: Assessment of Achievable Building Electrification Potential

The purpose of this task is to analyze building electrification potential in more depth than typically afforded by the potential and goals study framework. The PG study is intended to assess achievable potential for IOU portfolios including EE and fuel substitution measures. However, many other factors besides IOU rebate programs may influence trends in building electrification, such as:

- Programs and interventions other than IOU EE portfolios
- Impact of zonal electrification efforts
- Non-measure specific costs of electrification, such as infrastructure costs

Guidehouse plans to research these elements under this task. This research may draw from or feed into the fuel substitution measure potential being calculated in the PG study (task 8a and 8b).

5.1 Impact of Other Electrification Programs

There are several programs and interventions in California that promote building electrification other than the IOU EE portfolios. Examples include, but are not limited to:

- Programs developed with funding from SB 1477, a bill to reduce GHG emissions from buildings:
  - The BUILD Program, which incentivizes the construction of new all-electric Low Income residential buildings; and
  - The TECH initiative, which incentivizes the adoption of electric space and water heating technologies in existing homes, including Low Income and disadvantaged communities
- Rebates for electric heat pump water heaters through the Self-Generation Incentive Program (SGIP)
- POU fuel substitution programs
- Food Production Incentive Program (FPIP), which incentivizes industrial food production facilities to install lower-GHG equipment
- Additional fuel substitution in the industrial and agricultural sectors; e.g., California Air Resources Board (CARB) or Air Quality Management District (AQMD) requirements
- SCE's Clean Energy Optimization Pilot, a performance-based incentive for GHG reduction targeting large customers
- Interventions implemented by CCAs, Regional Energy Networks (RENs), and local government ordinances, such as natural gas bans
- Building electrification achieved by Title 24 building codes

Many of these programs target the same types of equipment—and potentially even the same installations—as the IOU ratepayer funded programs. Guidehouse will estimate the degree to which programs are enrolling customers who would otherwise be applying for rebates through the IOU programs, thus reducing the potential savings for these measures in the PG study.

The result of this subtask will be to quantify any additional achievable potential being delivered by these programs. Guidehouse will use either of the following methods, or a blend of the two:

5.1.1 Bottom-Up Approach

In the bottom-up, technology-based approach, Guidehouse will leverage the core potential study methods (described in Task 8a and Task 8b) to estimate the additional achievable potential for building electrification that the non-IOU programs could deliver. This method could be used for any non-IOU programs that provide incentives for measures that are also rebated through IOU EE programs. For example, the SGIP program incentivizes the installation of heat pump water heaters replacing gas water heaters, which is also an EE program measure. Under this approach, the analysis would use much of the same measure data as was collected in the core potential study because the measures would be essentially the same technologies, but measure data will be updated as necessary. The analysis will account for measure saturation and penetration in the population eligible for the program, as well as employ current utility program data that can inform the calibration based on differences in fuel substitution impacts between different regions.

Under this approach, a similar methodology would also be used for calculating economic and market potential. Guidehouse will define up to four scenarios in collaboration with the CPUC. Guidehouse will consider similar scenario levers as in the EE potential calculation, but would update certain scenario levers with data specific to the programs. Additional levers that are specific to building electrification may also be considered. Some examples of factors that may differ between rebate programs and the non-IOU programs may include:

- **Eligible population:** Some of the non-IOU programs have eligibility criteria that are different from the EE rebate programs. For example, only new construction is eligible for the BUILD program. Guidehouse may explore refining model to account for PG&E's planned electrification with locally-focused (zonal) program delivery, including incorporation of specific ZIP codes or census tracts these efforts are expected to be include.
- **Consumer awareness:** Consumers within the eligible population may have different levels of awareness due to increased program marketing.
- **Consumer willingness:** In the residential and commercial sectors, the EE study uses a multi-attribute-based approach to predicting consumer behavior by weighting multiple value factors that customers use to decide whether to adopt a more efficient measure. Consumers may use different value factors when deciding whether to electrify a technology, or they may weight the value factors differently than they would for an EE measure. This was examined in the 2021 PG study through a primary data collection effort.
- **Incentive levels:** Programs may provide incentives for a particular piece of equipment that also receives incentives through the EE rebate programs. This results in incentive layering, defined as "Financial or nonfinancial incentives being offered to the same market segment, customer, or technology measure at the same time."22 There are several possible ramifications of incentive layering. For example, incentive layering may increase adoption because it would reduce the cost to the consumer of installing the measure. On the other hand, the analysis would have to avoid double counting savings across multiple programs if they were contributing to the same equipment installation. The analysis would also have to

[22] CPUC Incentive Layering Workshop, June 30, 2020, **https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/building-decarb/incentive-layering-workshop_06302020_final.pdf**

determine how to attribute savings to the individual programs. Guidehouse will consult with the CPUC team and stakeholders who are developing the approach to attribute program costs and savings when multiple programs contribute to savings. Guidehouse is leading the impact evaluation of the BUILD and TECH programs under subcontract to Opinion Dynamics and will ensure that we have the most recent data and information on these programs to assist with this analysis.

CPUC has additionally requested Guidehouse consider creating a tool that gives end use customers an easy way to see the potential bill impact of fuel substitution. Guidehouse will explore the development and delivery of this tool, although this will not necessarily improve or impact the Task 13 analysis as it is customer facing.

5.1.2 Top-Down Approach

In the top-down approach, Guidehouse will propose program savings based on program budgets, overall technical potential, and estimated savings per program dollar spent. A top-down approach here does not require Task 8a and 8b to also use a top-down approach. Guidehouse has experience with a similar approach in calculating EE and fuel substitution savings for the CEC as part of a project to calculate Beyond Utility program savings that contribute to meeting SB 350 goals. In that study, Guidehouse forecast future savings from existing programs as well as new savings potential from future initiatives. Guidehouse also subtracted out overlap between the Beyond Utility program savings and the IOU rebate program savings, to avoid double counting.

Guidehouse proposes to leverage the methodology and data from that study, updating data sources where more recent data exists. For example, if the SB 350 study relied upon program savings forecasts for its estimates, Guidehouse will determine if there are updated savings forecasts for each program.

In the top-down approach, Guidehouse will also have the opportunity to leverage work done on the FSSAT for the CEC. Rather than using a stock-turnover-based Bass diffusion algorithm to simulate adoption as the DSMSim™ model does, the FSSAT calculates the amount of fuel substitution given a baseline measure saturation and a user-defined rate of measure adoption. This can be an element of the top-down approach in the assessment of achievable building electrification potential: Guidehouse can construct up to four adoption scenarios and calculate the amount of building electrification that can theoretically be achieved and at what cost. Scenarios could be driven by the amount of funding available from non-IOU programs allowing CPUC to understand what amount of savings is possible for various amounts of program spending. Scenarios could also be constructed around total program spending, and could also consider consumer willingness factors.

5.2 Impact of Zonal Electrification Efforts

Potential within the PG study is calculated at the level of the utility and climate zone, and potential is implicitly assumed to be evenly distributed across each discrete combination. However, PG&E has implemented zonal electrification efforts which would focus its electrification programs on specific locations in order to achieve economies of scale in infrastructure upgrades—for example, avoiding the need to install gas infrastructure entirely in some neighborhoods. Guidehouse will explore refining model to account for PG&E's planned electrification with locally-focused (zonal) program delivery, including incorporation of specific

ZIP codes or census tracts these efforts are expected to be include. These refinements will in turn be used to modify the market achievable potential for electrification measures within the PG study, as needed.

5.3 Non-Measure Specific Electrification Costs

The previous PG study included only costs of electrification that were specific to the equipment being installed (i.e. cost of the equipment itself and any building upgrades directly related to the equipment change, such as adding an electric outlet or capping a gas line to a removed appliance). Measure costs have not historically accounted for non-measure specific upgrades such as the need to upgrade a home's electrical panel. In this subtask, Guidehouse will quantify certain electrification costs:

- Avoided Gas Infrastructure Cost. We will use available cost data from existing CPUC tools.
- Panel Upgrade Cost. We will review data from available studies and request data from utilities on studies they have initiated to quantify this.

5.4 Schedule and Deliverables

Table lists the schedule for Task 13. Guidehouse proposes to conduct this in parallel with Task 8b; however, it is also possible to delay the start of this task until later as it may not have an impact on the IOU goal setting process and may require longer time to collaborate with CPUC staff on the right approach.

Table 14. Schedule for Task 13

Subtask	Milestone/Deliverable	Start Date	Completion Date
13.1	Choose approach for each program	7/1/2022	8/12/2022
13.2	Program data collection	7/1/2022	10/7/2022
13.3	Update technical, economic, and market potential inputs (bottom-up approach)	10/7/2022	12/30/2022
13.4	Develop scenarios and produce results (bottom-up approach)	12/30/2022	1/27/2023
13.5	Top-down analysis	10/7/2022	1/27/2023
13.6	Draft Report		3/1/2023
13.7	Final Report		5/1/2023