NAVIGANT

Workplan for

Energy Efficiency Savings Measurement, Estimation, Program Oversight, and Evaluation of the Group E Sectors

Deliverables 11 - 15

Prepared for:

California Public Utilities Commission

Submitted by:
Navigant Consulting, Inc.
101 California Street
Suite 4100
San Francisco, CA 94111

415.356.7100
navigant.com

Reference No.: 205201
December 20, 2018

Table of Contents

List of Figures and Tables

1. Overview

Navigant Consulting, Inc. along with its partners Cadmus, DNV GL, Jai J. Michell Analytics, Lumina Decision Systems, Opinion Dynamics, and Tierra Resource Consultants, was selected by the California Public Utilities Commission (CPUC) to execute the Energy Efficiency Evaluation Contract for Group E Sectors: Potential and Goals and Industry and Market Studies (Group E). The Group E contract contains two main subcategories of deliverables:

- Potential and Goals Studies (P&G)
- Industry Market Studies (IMS)

This workplan is the first of multiple submissions by Navigant under the Group E contract. This workplan covers a subset of deliverables related to P&G category:

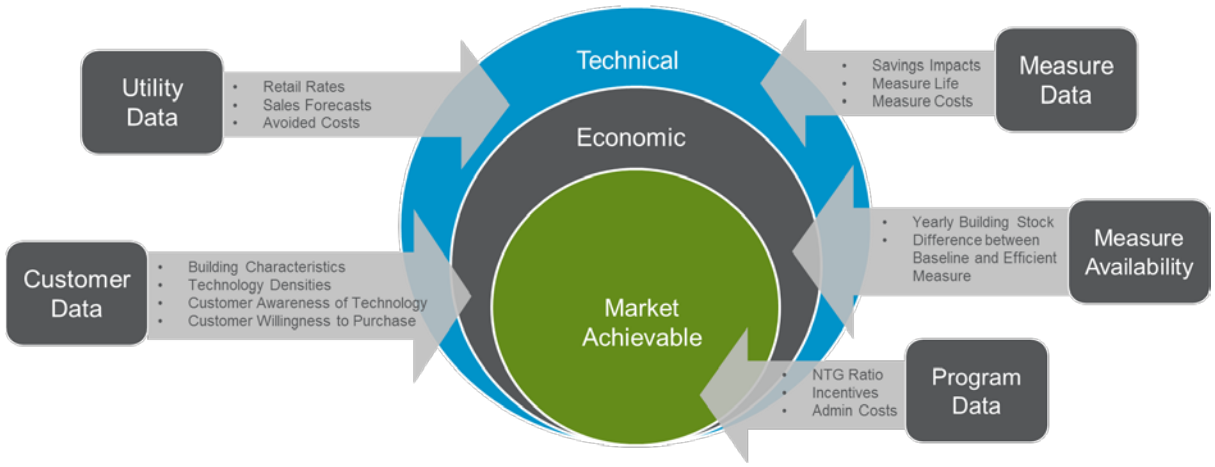
- Deliverable 11 – Potential and Goals Study
- Deliverable 11.1 - Potential and Goals Model and Training
- Deliverable 12 – Additional Achievable Energy Efficiency Scenarios
- Deliverable 13 – SB350 IOU Territory Targets Update
- Deliverable 14 – Feasibility Study Related to the Integrated Resource Plan (IRP)
- Deliverable 15 - Feasibility Study on Setting Locational Energy Efficiency Targets

The Group E contract include scope for up to 10 IMS over the two-year contract. These 10 IMS will be conducted under Deliverables 17-19. IMS will be the subject of a separate workplan to be submitted later by Navigant and its partners.

2. Deliverable 11 (P&G-01) Potential and Goals Study

Like previous P&G Studies, this study will employ a bottom-up approach to size energy efficiency potential in the service territories of the California IOUs. We will primarily leverage the model developed for the 2018 Potential & Goals Study to calculate technical, economic and market potential across relevant sectors, building types and end uses. Figure 1 illustrates the key inputs and the layers of the potential modelling approach.

Figure 1. Approach to Market Potential Analysis



The main tasks that will be carried out to execute Deliverable 11 are summarized below with additional detail in the following subsections.

1. **Task 1 - Market and Baseline Characterization**
    a. Obtain market and baseline data. Data will inform total market size, saturation, energy sales, retail rates, avoided costs, etc.
    b. Navigant staff will obtain data from existing secondary sources: CEC IEPR, CPUC Cost Effectiveness Tool, CA saturation studies, CA PA historic program achievements and spending
2. **Task 2 - Measure Characterization**
    a. Develop a list of measures to be considered in the potential study leveraging the 2018 P&G study
    b. Characterize measures prioritizing CA-specific data sources such as DEER and IOU Workpapers, leverage other sources where necessary
    c. Develop a database of measures to be used by the model
3. **Task 3 - Technical Potential**

a. Use the existing P&G model framework developed by Navigant to calculate technical potential

b. Account for competing measures and develop instantaneous and annualized technical potential

4. **Task 4 - Economic Potential**

   a. Work with CPUC staff to determine appropriate cost effectiveness tests to apply

   b. Use the existing P&G model framework developed by Navigant to calculate instantaneous and annualized economic potential

5. **Task 5 - Market Potential**

   a. Use the existing P&G model framework developed by Navigant to calculate market potential

   b. Calibrate base market potential using a combination of historic program activity and stakeholder input

   c. Work with CPUC staff to develop scenarios beyond the base forecast to model/forecast

   d. Provide support integrating results into Integrated Resource Planning (IRP)

   e. Disaggregate savings as needed: Locational impacts, RENs and CCAs, Disadvantaged communities.

6. **Task 6 - Load Shape Analysis**

   a. This task will collect load shape data applicable to EE resources.

   b. Data will be sourced from the latest CA-specific sources

7. **Task 7 - Codes and Standards Potential**

   a. Using the existing P&G model framework which replicates the ISSM methods, we will forecast C&S savings.

   b. The team will review and scope potential C&S for inclusion in the study.

   c. For the selected C&S, we will collect data and import to the ISSM framework and forecast savings

8. **Task 8 - Low Income Potential**

   a. Characterize the Low-Income subsector based on available secondary data

   b. Identify applicable measures from the master measure list in Task 2

   c. Use the existing P&G model framework developed by Navigant to calculate technical, economic, and market potential

9. **Task 9 - Reporting and Stakeholder Interaction**

   a. Develop draft deliverable and vet with stakeholder and CPUC staff

   b. Revise deliverables based on feedback

   c. Provide a model and web-based results viewer in addition to the written report

2.1 Approach

2.1.1 Task 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. 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.

STEP 1: DEFINE SEGMENTS

Navigant will define residential, commercial, agricultural, industrial, mining and street lighting building segments and end uses to forecast savings potential for in this study. Navigant will use the 2018 Potential & Goals Study building type and end use lists, as shown in Table 1 and Table 2 as a starting point for this study.

Table 1. 2018 Potential & Goals Study Building Types

Res - Single Family	Ind - Petroleum
Res - Multi Family	Ind - Food
Com - College	Ind - Electronics
Com - Grocery	Ind - Stone-Glass-Clay
Com - Health	Ind - Chemicals
Com - Lodging	Ind - Plastics
Com - Office (Large)	Ind - Fabricated Metals
Com - Office (Small)	Ind - Primary Metals
Com - Restaurant	Ind - Industrial Machinery
Com - Retail	Ind - Transportation Equipment
Com - School	Ind - Paper
Com - Warehouse	Ind - Printing & Publishing
Com - Refrig. Warehouse	Ind - Textiles
Com - Other	Ind - Lumber & Furniture
Ag - Post-Harvest Processing	Ind - All Other Industrial
Ag - Dairies	Mining - Oil & Gas Extraction (Stripper Well)
Ag - Wineries and Vineyards	Mining - Oil & Gas Extraction (Regular Well)
Ag - Concentrated Animal Feeding Operation	Mining - Oil & Gas Extraction (Injection Well)
Ag - Greenhouses	Mining - Oil & Gas Extraction (Steam Enhancement)
Ag - Irrigated Agriculture	Street - Lights
	Street - Signs

Table 2. 2018 Potential & Goals Study End Uses

Sector	End Use	Sector	End Use
Res	AppPlug	Ag	Lighting
Res	WaterHeat	Ag	HVAC

Sector	End Use	Sector	End Use
Res	Lighting	Ag	MachDr
Res	BldgEnv	Ag	ProcHeat
Res	HVAC	Ag	ProcRefrig
Res	WholeBlg	Ag	WholeBlg
Com	AppPlug	Ind	Lighting
Com	WaterHeat	Ind	HVAC
Com	Lighting	Ind	MachDr
Com	BldgEnv	Ind	ProcHeat
Com	HVAC	Ind	ProcRefrig
Com	WholeBlg	Ind	WholeBlg
Com	ComRefrig	Min	OilGasExtract
Com	Data Center	Stl	Stl
Com	FoodServ	Ag	Lighting

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 are not specific to any measure. Like the segmentation exercise in Step 1, Navigant will use the 2018 Potential & Goals Study global inputs, as shown in Table 3 and as a starting point for this study. Navigant 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 3. 2018 Potential & Goals Study Global Inputs

Global Input	Description	Sources
Retail Rates *($/kWh, $/therm)*	Forecast of energy costs to customers	CEC - Integrated Energy Policy Report (IEPR)
Sales Forecasts *(GWh, MW, and MM Therms)*	Forecast of energy sold to customers	CPUC - California Energy Consumption Database (ECDMS)
Building Stocks *(households, floor space, consumption)*	Forecast of building and/or sales growth	CEC – Requested from California Energy Commission
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 – EEStats Data
Non-Incentive Program Costs		
Inflation Rate	Assumption: 2.3% assumption	Federal Reserve Bank of Philadelphia – Long-Term Inflation Forecasts
Discount Rate	Utility after-tax WACC	

2.1.2 Task 2 - Measure Characterization

Our overall measure characterization approach is to leverage our existing measure characterization database developed for the 2018 P&G study. We will review the measure list, determine if 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. Given the compressed timeline of this study, we will use the measure list from the previous P&G study as a starting point. Navigant will consider additional measures that could have a meaningful impact on potential over the planning horizon.

Upon finalization of the measure list, Navigant will begin the measure characterization process. Navigant will source consumption, cost and other measure-specific data from primary data sources including but not limited to DEER, non-DEER workpapers, custom measure dispositions, EM&V results, emerging technologies programs, technical reference manuals and industrial energy assessments. Navigant will supplement these primary data sources with secondary data sources, such as potential studies performed in other jurisdictions across North America. Table 4 shows an example data source hierarchy used in the 2018 Potential and Goals Study. This hierarchy will be updated based on the latest available data (i.e. DEER 2020, latest workpapers, etc.). Priority of sources may shift based on recency of source and CPUC staff direction.

Table 4. Example - Hierarchy of Data Sources from Previous P&G Study

Priority	Energy Consumption Source Name	Description	Author
1	DEER (Database of Energy Efficient Resources)	Navigant used information from 2017/2018 DEER updates for obtaining energy use and coincident peak demand for technologies, wherever available. Lighting energy use was calculated using the lighting calculator tool available at DEER.	CPUC
2	Non-DEER Ex Ante Database	Navigant referred to the Non-DEER ex ante database, available from Commission staff, for characterizing technologies that were not included in DEER.	CPUC
3	IOU Workpapers [with CPUC Disposition]	Navigant referred to the inventory of workpapers published by the California IOUs and referred to approved workpapers for technology characterization, wherever applicable.	California IOUs
4	CMUA TRM	Navigant referred to the CMUA TRM for energy use information for applicable technologies.	Cal TF
5	CA IOU Emerging Technology Reports	Navigant reviewed and researched project/technology reports from the ETCC—a collaborative forum with IOUs and leading member organizations for characterization of emerging technologies.	Emerging Technology Coordinating Council (ETCC); IOUs

Priority	Energy Consumption Source Name	Description	Author
6	IOU Program Data	Navigant referred to the 2016 EEStats database[1] and 2014-Q12016 program savings[2] database from CA IOUs, in case energy use information was not available from the above-listed sources.	CPUC, IOUs
7	Non-California source examples: o Regional Technical Forum (RTF) Database	In cases where CA-specific sources were not available for energy use information, Navigant referred to the following sources: • Measure-level savings data from evaluated programs in the Pacific Northwest region, available through the RTF.	Northwest Power and Conservation Council (NPCC)
	o Navigant Potential Study Database	• Navigant's archive of characterized measure savings from potential studies and projects with other utilities.	Navigant

CHARACTERIZE TECHNOLOGIES

From Navigant'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. Navigant expects to source most measure-specific data from primary sources such as the DEER database and IOU workpapers.

Navigant will take a prioritized approach to measure characterization to ensure that measures with the largest impact on savings potential are allocated the appropriate level of resources. Higher impact measures typically receive more attention and scrutiny, while low impact measures initially receive a low impact review only.

Each measure will be vetted and fully characterized for savings, costs, lifetime, and technical suitability. These measures will then be integrated into the Potential & Goals (PG) Model. Key measure characterization fields are expected to include:

- Measure descriptions and baseline assumptions;
- Cost associated with the measure (equipment, operational);
- Applicability factors including initial energy efficiency (EE) market penetration, total measure saturation, density and technical suitability;
- Replacement type of measure; and
- Energy savings (kWh, kW, Therms);
- Lifetime of the measure (EUL and RUL);
- Cross-measure interactive effects;
- Data sources.

[1] http://eestats.cpuc.ca.gov/Views/EEDataPortal.aspx

[2] Navigant obtained the database of IOU programs with savings and cost information from Itron under CPUC's directive.

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

CHARACTERIZING CUSTOMISED TECHNOLOGIES

The measure characterisation process outlined above works well for prescriptive types of measures that represent a piece of equipment. However, many energy efficiency opportunities are realised through customised solutions, that group different individual measures into packages and savings are in effect realised for the package. This is particularly applicable for larger commercial, industrial, and agricultural customers, including heterogeneous customers in the industrial sector where each customer's energy profile is unique to that customer. It is also applicable to whole building packages in the residential and commercial sectors.

Our approach builds from an end use perspective, where we identify specific end use that are more aligned with custom measures. For example, for industrial and agricultural segments, we will focus our customised measure packages toward the process that is most dominant to that segment (e.g., motors, process heating, etc.). For commercial segments, the focus would be on HVAC equipment, HVAC controls, and lighting equipment/controls. For the potential study, we will incorporate our experience and assumptions about which sectors, segments, and end use would be candidates for these customised measure groupings. We will then conduct a customer measure level savings and cost analysis that is separate from these types of analyses for prescriptive measures. Our market characterisation analysis will identify which portions of each of our segments / building types would be candidates for customised measures. Our outputs will show customised measures according to the various end use groupings that were identified at the outset (e.g., industry specific process, HVAC equipment, HVAC controls, lighting equipment/controls).

ADDRESS BEHAVIOR, OPERATIONAL AND RETRO COMMISSIONING (BROS) MEASURES

To estimate energy savings generated by behavioral interventions, Navigant will work with the CPUC and stakeholders to identify a representative list of behavior and activity-based measures. The measure list has historically included the following intervention types:

- Home Energy Reports (HERs);
- In-Home Display Real Time Feedback (IHD RTF);
- Large Residential Competitions;
- Business Energy Reports (BERs);
- Strategic Energy Management (SEM);
- Building Operator Certification; and
- Web-Based Real Time Feedback (Web RTF);
- Small Residential Competitions;
- Commercial Competitions;
- Building Benchmarking;
- Building Energy Information Management Systems (BEIMS);
- Retrocommissioning.

As part of this analysis, Navigant will develop key assumptions, including implementation plans and planned rollout assumptions. These assumptions will be used to define a unique participation forecast for each program. It is important to highlight that participation is a function of either customer adoption for opt-in programs and the number of customers that the utility wants to engage for opt-out programs. Engagement strategies for opt-out programs typically targets 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

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

NEW CONSIDERATIONS IN MEASURE CHARACTERIZATION

There are two additional issues Navigant will research as part of this effort:

- Navigant will identify EE measures that can provide joint EE and DR benefits. The model is not currently set up to forecast both EE and DR potential. Given the compressed schedule of the study and the limited time for stakeholder input on this new topic, research will focus on identifying affected measures, discussing methods for joint modelling, and documenting available data to characterize DR benefits. DR potential will not be forecasted, but the outcome of this effort will help set a foundation for a possible integrated EE-DR potential study in a future cycle.

- Navigant will identify feasible fuel switching measures (e.g., measures that displace existing natural gas or electricity consumption). The measure list already contains key measures that are candidates for fuel switching, though additional measures will be considered. Given the compressed schedule of the study, the limited time for stakeholder input on this new topic, and policy guidance required from CPUC on program eligibility, Navigant will not model fuel switching but will conduct research to set a foundation for integration into a future study cycle. This research will identify candidate measures, identify available data and data gaps, and document a framework for modelling.

2.1.3 Task 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. Navigant's P&G 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 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 are 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.[3] This is the theoretical maximum savings possible from converting all equipment that is at or below code 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 to the highest level of efficiency within a technology group upon burnout of the baseline technology.

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. As a starting point for illustrating how the technical potential calculation differs by replacement type, the five replacement types considered in the 2018 Potential & Goals Study are described below.

EXISTING BUILDINGS

The PG model in its current form is set up to calculate technical potential for four replacement types in existing buildings:

- **Equipment**
  - **Replace on Burnout (ROB) –** New equipment needs to be installed to replace equipment that has reached the end of its useful life, has failed, and is no longer functional. Upon failure ROB equipment is generally not repaired by the customer and instead replaced with a new piece of equipment. Appliance standards are applicable to some types of ROB equipment and apply to all new purchases. An example of an ROB measure is the light bulb.
  - **Accelerated Replacement –** Equipment that is beyond its EUL and is continuing to function in the market (likely because of repairs that a customer has conducted on the equipment to extend its life). The customer is not planning to replace the equipment on a "regular cycle" and thus programs are targeted at the customer to accelerate the equipment's replacement. Appliance standards are applicable to some types of Accelerated Repair equipment but only apply to new purchases (not the repair). Examples include measures such as boilers and chillers.
- **Retrofit**
  - **Retrofit Add-on –** New equipment being 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 overall efficiency of the

[3] Includes buildings newly constructed in that same year

system. These measures are not able to operate on their own as stand-alone equipment and are not required for the operation of the existing equipment or building. Codes or standards may be applicable to some types of Retrofit 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. Examples include measures such as boiler controls, VFDs, and window film.

- **Retrofit Replacement –** Measures that will be replaced not due to equipment failure but rather triggered by building renovation. These measures are those that are installed to replace previously existing equipment that has either not failed or is past the end of its EUL but is not compromising use of the building (such as insulation and water fixtures). Many of these installations are subject to building code but upgrades are not always required by code until a major building renovation (and even then, some may not be required).

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

Equation 1. Technical Potential in Existing Buildings

Technical Potential, $_{EXISTING\ BUILDINGS}$ = Existing Building Stock $_{YEAR}$ (e.g., buildings[4]) X Measure Density (e.g., widgets/building) X Savings $_{YEAR}$ (e.g., m^3/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 forecasted 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 2 shows the formula for calculating technical potential in new buildings.

Equation 2. Technical Potential in New Buildings

Technical Potential, $_{NEW\ BUILDINGS}$ = New Building Stock $_{YEAR}$ (e.g., buildings[5]) X Measure Density (e.g., widgets/building) X Savings $_{YEAR}$ (e.g., m^3/widget) X Technical Suitability (dimensionless)

COMPETITION GROUPS

Navigant's modelling approach recognises 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 15 AC vs SEER 18 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). General characteristics of competing technologies used to define the competition groups proposed for this study include:

- Competing efficient technologies share the same baseline technology characteristics, including baseline technology densities, costs, and consumption;

[4] 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.).

[5] 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.).

- 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.

To address the overlapping nature of measures within a competition group, Navigant'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.

2.1.4 Task 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.
- Various cost effectiveness thresholds can also be set. The previous model used a threshold of 0.85 for passing the TRC test which recognized that measures with TRC below 1.0 were being offered in rebate programs. We propose updating the threshold to 1.0 as new guidance from the CPUC suggests programs should target a portfolio TRC of 1.25.
- Whole building packages are excluded from the economic potential as doing so would be duplicative. Economic potential for BROs are undefined in our model.

2.1.5 Task 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. Market potential modelling approach
2. Net-to-Gross ratios and free ridership
3. Cumulative savings
4. Savings Potential in Disadvantaged Communities
5. Scenario Analysis

6. Integrated Resource Planning (IRP) support and hourly load shapes
7. Locational impacts
8. Savings potential attributable to RENs and CCAs

MARKET POTENTIAL MODELLING APPROACH

Navigant's PG model employs a stock-turnover-based bass diffusion algorithm to simulate market adoption. A high-level summary of the algorithm is presented here.

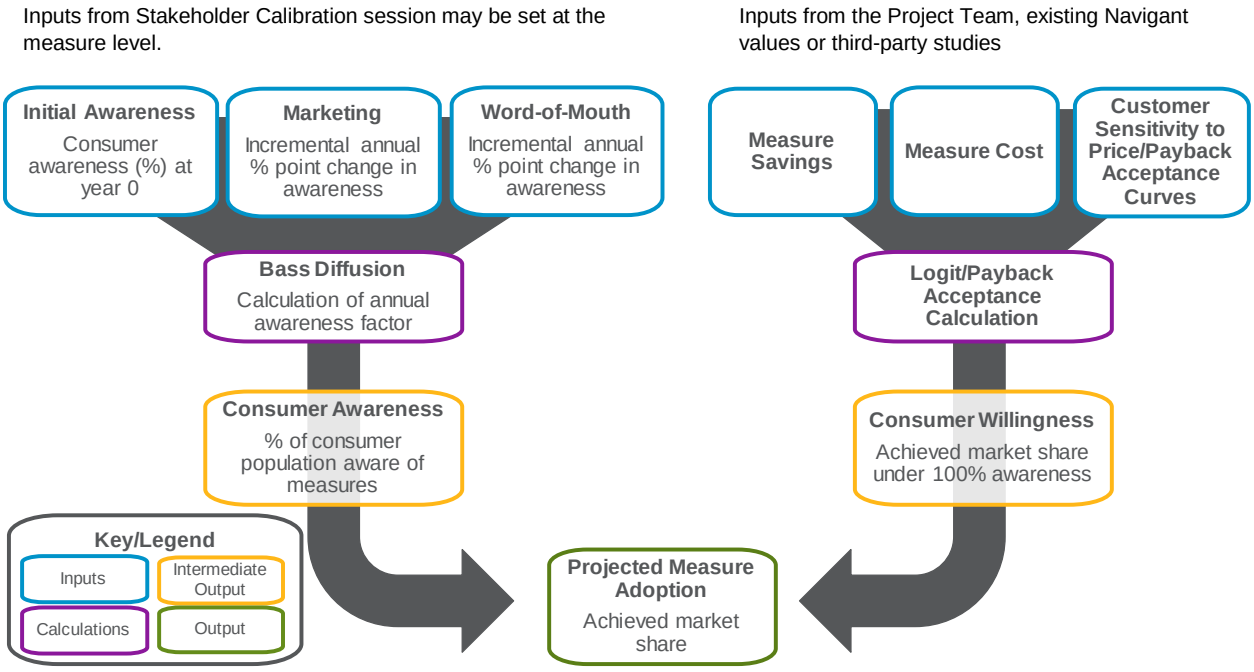
Three key steps are involved in simulating market adoption using Navigant's PG model:

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, post-repair failure rate or number of retrofittable measures.
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. Historically, values for the awareness factors are based on literature and/or calibration to historic program activity.
    d. Consumer willingness is calculated using one of two approaches, depending on data availability:
        i. Logit-based: Compares levelized measure cost of efficient measure against competing measures
        ii. Payback-based: Compares payback time associated with efficient measure against competing measures
    e. Figure 2 shows a flowchart representation of the market share calculation described above.
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.

Figure 2 illustrates the process by which market shares of energy efficiency are calculated within the PG model. To refresh the data inputs for the Bass Diffusion calculations that inform consumer awareness, Navigant will engage stakeholders as part of the calibration process. The stakeholder input will inform the rate of adoption of technology groups by sector.

Figure 2. Flowchart of Market Share Calculation in PG Model

ALL algorithm inputs may be adjusted based on the availability and reliability of data.



To properly define the energy efficiency resource that is available as part of the EE potential analysis, there must be a high level of confidence that the resource will be available in the required timeframe using tested programmatic and policy approaches. Once the market potential estimates are generated, a process of calibration is engaged to ensure that the band of uncertainty is mitigated. The EE potential modeling framework relies on several parameters that will inform development of projected measure adoption rates that will lead to the achievement of EE savings. Many of these parameters are based on rich datasets containing information about measure savings, measure cost and customer sensitivities. Data on parameters centering around the consumer's general level of awareness of EE measures and programs (e.g., initial awareness, marketing efforts and word-of-mouth) are more uncertain and could be subject to contention.

Navigant plans to employ the stakeholder engagement process to collect input on these uncertain or contentious values. Once the initial market potential estimates are generated, Navigant will present the results to stakeholders and identify how changes to each of these uncertain parameters will affect the magnitude of the market potential. In a working session with stakeholders, we will provide context for

each parameter and solicit their input to adjust these parameters. The goal of these parameters adjustments is to ultimately land on a calibrated set of EE market potentials. Stakeholder participants will have the opportunity to weigh in on various adjustments to these parameters. At the end of the process, we will land on market potential estimates that will inform our reference case for EE market potential.

NET-TO-GROSS RATIOS AND FREE RIDERSHIP

Navigant's PG model is set up to calculate both gross and net savings attributable to IOU programs. Similar to the 2018 Potential & Goals Study, the RFP calls for this next study to present results in the form of net savings.

CUMULATIVE SAVINGS

Navigant's PG model calculates both incremental and cumulative savings considering direction provided in commission 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:

- Decay of savings as measures reach the end of their useful lives
- 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. Navigant used a modified, stakeholder vetted assumption in the last two potential studies that is based on the market adoption algorithms within the model. Essentially, customer re-enter the decision tree and make their purchase decision based solely on the technology performance and cost rather than experience. We will review this method to identify and implement possible improvements.

SAVINGS POTENTIAL IN DISADVANTAGED COMMUNITIES

Once market potential is forecasted by Navigant's PG model, Navigant will determine the fraction of savings that fall within each IOU's disadvantaged communities (DAC) boundaries. This will be a post-processing step that will aim to size the market potential attributable to DACs. Navigant proposes to 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 will be cross layered with locational program savings data (from EEStats) to factor in historic EE adoption trends between DAC and non-DAC regions.

SCENARIO ANALYSIS

Navigant will develop combinations of economic and market achievable assessments to produce up to four scenarios of potential for goal-setting purposes. In previous studies, Navigant identified the variables presented in Table 6 as candidate parameters to vary across scenarios.

Table 5. Candidate Scenario Analysis Levers

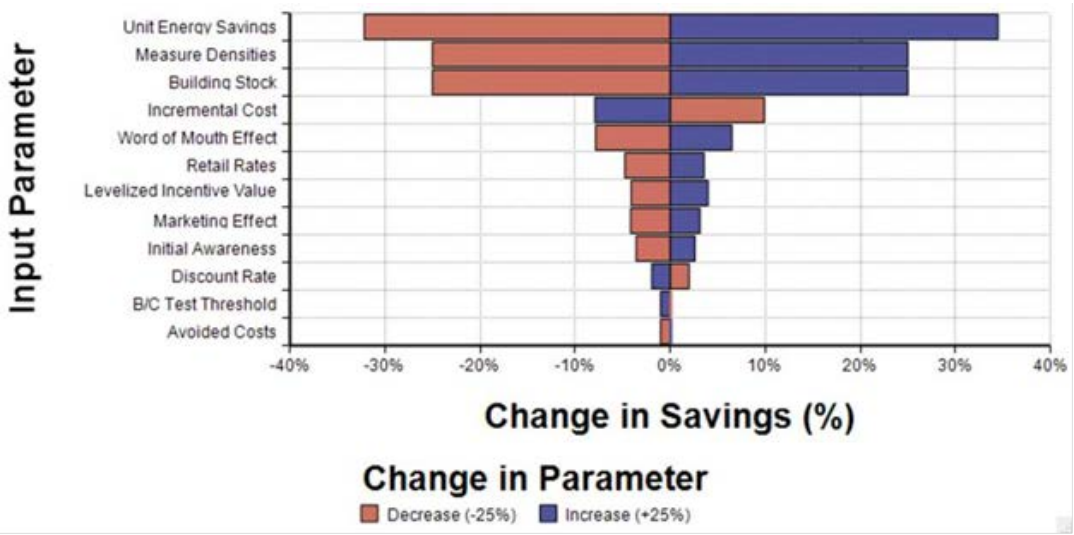
Lever	Description	Potential Impact Applicability	
		Economic	Market
Building Stock Forecast	Typically sourced from the CEC's IEPR forecast, the building stock forecast can follow a range of pathways.	✔	✔

Lever	Description	Potential Impact Applicability	
		Economic	Market
Avoided Cost Forecast	Avoided costs can be modified to include or exclude various components. For example, carbon pricing assumptions based into the avoided cost inputs can vary based on stakeholder interests.	✔ (depending on test)	✔
Measure-level Unit Energy Savings	The model is set up to test the effect of varying unit energy savings and costs by ±X% on potential results.	✔	✔
Measure-level Unit Costs		✔	✔
Cost-Effectiveness (C-E) Test	Different Cost-Effectiveness screening tests and/or thresholds yield different amounts of economic potential and cause the market potential model to incentivize different sets of measures.	✔	✔
C-E Measure Screening Threshold		✔	✔
Incentive Levels	Varying incentive levels will change both the cost-effectiveness of measures and their value proposition to customers.	✔	✔
Marketing & Outreach	Varying marketing and outreach levels impacts the rate at which technologies are adopted by customers.		✔
Retail Rate forecast	Typically sourced from the CEC's IEPR forecast, the retail rate forecast can follow a range of pathways. Each pathway can change the value proposition of measures to customers.	✔ (depending on test)	✔
Financing Programs	Financing programs help reduce the cost burden associated with efficient measure adoption.		✔

Navigant'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 3).
- **Combination:** Model changes one or more variable and tests the combined effect of those changes on the results.

Figure 3. Illustrative Tornado Diagram Showing Sensitivity of Total Savings.



Navigant will work with the CPUC to define the reference (or base) scenario for this study (i.e. screening test, avoided cost data, etc.). Navigant will calibrate the model using the settings in this reference scenario, and model alternate pathways for up to 3 additional scenarios. The three additional scenarios will be determined in conjunction with CPUC staff to make sure the results are most useful for policy decision making.

INTEGRATED RESOURCE PLANNING (IRP) SUPPORT AND HOURLY LOADSHAPES

Navigant is prepared to support the CPUC IRP staff in leveraging the results of this potential study for the 2019 biennial IRP process. Navigant's understanding is that forecasted 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.

LOCATIONAL IMPACTS

Navigant 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. Our previous P&G studies also provided this level of granularity. Further locational disaggregation will be dependent on the research and findings from Deliverable 15.

SAVINGS POTENTIAL ATTRIBUTABLE TO RENS AND CCAS

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

2.1.6 Task 6 - Develop Hourly Impacts

Disaggregating savings to an hourly basis is a post processing step after the market achievable savings have been calculated. This task will develop load shapes that can be used for hourly disaggregation

across multiple components of this study including Energy Efficiency Market Achievable Potential Assessment (Task 4 of Deliverable 11), C&S Potential (Task 6 of Deliverable 11), and Additional Achievable Energy Efficiency Scenarios (Deliverable 12). 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 End Uses of Concern
- Step 2 – Compile Load Shape Data
- Step 3 – Map Load Profiles to P&G study Measures
- Step 4 – Aggregate to End Use Load Shapes

In Step 1 we will identify End Uses of Concern that the analysis will focus on. Our goal will be to address end uses that account for at least 95% of energy efficiency savings forecasts inclusive of Rebate Programs, C&S, and BROs.

In Step 2, Navigant will compile load shape data at the most granular level. We expect readily available load profiles are broken down by:

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

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

1. **CEC's EPIC funded project "California Investor-Owned Utility Electricity Load Shapes".** This CEC managed project under EPIC contract 300-15-013[6] is expected to provide a large amount of load shapes relevant to energy efficiency end uses.
2. **CPUC EM&V Group A Contract, Deliverable 17.** EM&V efforts on Group A Deliverable 17 which is scoped with developing load shapes based on M&V data.
3. **DEER.** DEER contains a set of load shapes that are used to inform peak energy savings as well as avoided cost calculations. We will review the latest DEER database to identify reliable load shape data.
4. **IOU Rate Class Load Data.** 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.

[6] Additional details available at: http://innovation.energy.ca.gov/SearchResultProject.aspx?p=31147&tks=636688161592052322

5. **OpenEI.** OpenEI[7] is a public database containing hourly residential load profiles by end use and climate zone across the United States. It is based on building simulation models run with local water data.

In Step 3 we will map the collected load shapes to each P&G measure. In most cases this will be a one to many relationship (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) we will map and retain this level of granularity.

In Step 4 we 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.

2.1.7 Task 7 - Codes and Standards Potential

Codes and Standards (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 we will calculate the C&S Potential. Impacts on rebate programs were described earlier in Task 2 of Deliverable 11.

C&S Potential refers to the forecasted savings from current C&S, planned C&S, as well as a set of C&S that are reasonably expected to come into effect. 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.

MODELLING METHOD TO DEVELOP SAVINGS ESTIMATES

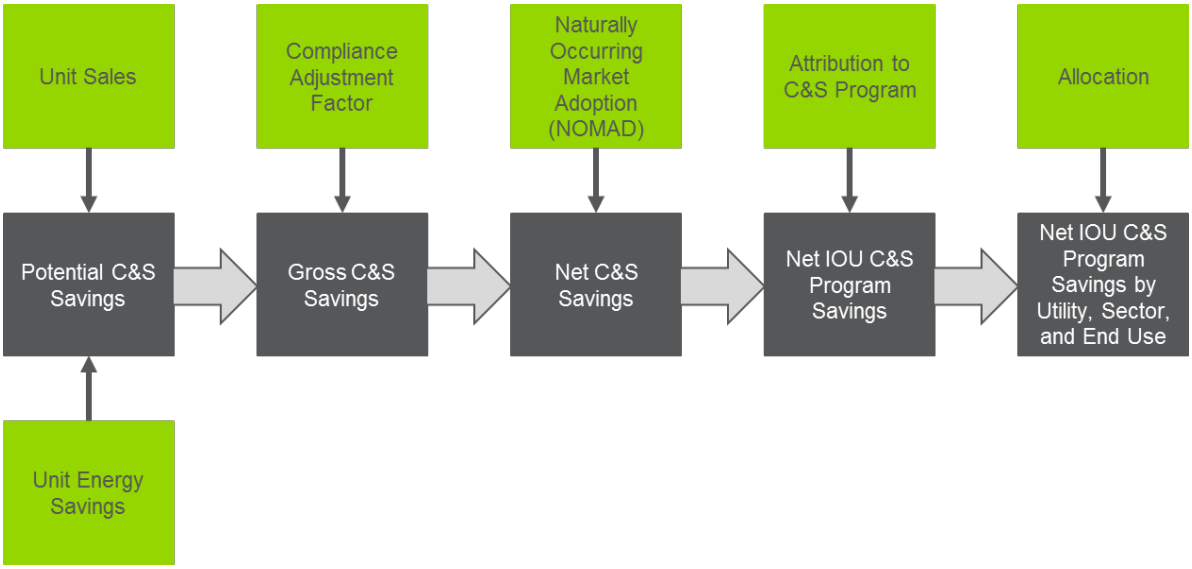
Our model methodology for C&S savings is based on the Integrated Standards Savings Model (ISSM)[8] developed by CADMUS and DNV GL used by the CPUC in C&S program evaluation. We plan to continue use our existing ISSM based C&S model and update it to reflect any methodological changes in the latest approved ISSM.

[7] 8760 hourly load profile data for residential customers at the end-use level available at:
http://en.openei.org/datasets/dataset/commercial-and-residential-hourly-load-profiles-for-all-tmy3-locations-in-the-united-states

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

The core process of calculating C&S Potential is illustrated in Figure 4.

Figure 4. 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.[9] This is marked different from calculating cumulative savings for rebate 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 can't even purchase equipment at the old code or standard level.

SCOPING POTENTIAL STANDARDS AND DATA COLLECTION

The Navigant team will work with the EDPM, program managers and contractors, Commission staff and consultants to scope out a list of potential standards to be included in the C&S potential. Table 7 summarizes our approach and sources of information.

Table 6: 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. We expect little need to collaborate with external team members other than confirming the latest evaluation data is being used.

[9] 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.

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's possible these claims will have been submitted to CPUC staff. We expect these claims to contain data in the ISSM input format for our team to leverage.
Future C&S	We will to work closely with the Codes and Standards Program administrators, the CEC staff, Commission staff, and knowledgeable consultants to monitor code and standard development and adoption plans.

After compiling information from all these sources, we will develop a list of codes and standards that can be reasonably included in the potential study and estimate input parameters based on available secondary data.

HOURLY IMPACTS

C&S savings will be disaggregated to an hourly basis at the sector and end use level. We will leverage load shapes developed as part of Task 6 in Deliverable 11.

PRODUCE SAVINGS RESULTS

As mentioned earlier, ISSM requires several inputs to calculate the gross and net savings estimates for individual standards. We 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, we will research current appliance market sales and projections, construction projections, and trends and develop market size estimates over the forecast period. We will combine the unit savings and market size estimates 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, we use historical data at the building level by building type based on the proportion of projected energy savings achieved. For the appliance standards, we will review historical compliance rates for similar standards.

NOMAD factors will also need to be estimated for future C&S. We propose using estimates from prior evaluations in most cases with adjustments to shift the start year as appropriate.

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

2.1.8 Task 8 - Low Income Potential

In this task, the Navigant team will forecast the Technical, Economic, and Market Achievable potential from the low-income sector and programs. Navigant will leverage its existing rebate program model to be able to forecast Technical, Economic and Market potential from the low-income sector (specifically from

energy efficiency measures eligible to be installed through the Energy Savings Assistance Program (ESA)). The calculation methodologies for Technical, Economic, and Market potential were described earlier in Task 2, 3, and 4 respectively of Deliverable 11.

The following modifications and adaptations will be made to accommodate low income potential.

DEFINING THE MARKET

The low-income market first needs to be defined. Generally residential customers qualify based on income compared to 200 percent of federal poverty guidelines. With this definition (and any additional updates or guidance from CPUC staff), our team will first seek to identify the portion of the residential population that qualifies for Low Income Programs and break it down into single family and multi-family subsectors.

Once the low-income market has been identified, it will be separated into its own "sector" apart from the residential sector in our model. The residential sector will represent non-low-income customers that are more likely to participate in traditional utility rebate programs, while the low-income sector will represent the remainder of the population that is eligible for ESA and the California Alternate Rates for Energy Program (CARE). These two segments of the residential population will be treated separately throughout the potential study.

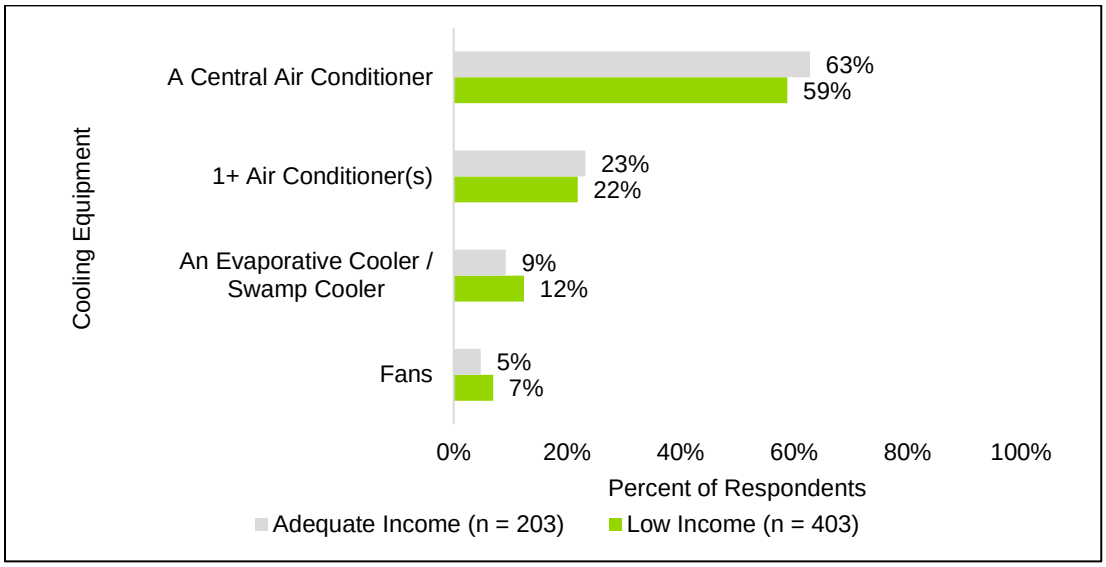
SELECTING AND CHARACTERIZING MEASURES

The Navigant team will identify a set of measures that are applicable to low income customers. Our approach will be to select measures from the broader residential measure list in the P&G study that apply to non-low-income customers. This selection of measures will be informed by the current menu of measures offered in ESA and their historic participation levels.

Several measure characteristics will vary for the low-income sector. Examples include (but are not limited to):

- **Measure Density and Saturation** – We expect low income residential customers to have differing densities of measures (e.g. fraction of homes with ACs) and saturation (i.e. fraction of homes with efficient ACs) than the general population. We will mine available saturation studies and low-income market assessment to determine adjustment factors. An example of available data is illustrated below in Figure 5.
- **Measure Willingness/Applicability** – Although low-income customers may have certain appliances in their home, they may not have decision authority over its replacement if they rent and building owners may not be willing to allow the change. Thus, an applicability factor can be applied to reflect the subset of the population that is not willing or able to make an efficiency upgrade.
- **Net-to-Gross Ratio** – ESA does not apply a NTG value, or rather assumes a NTG of 1.0. Therefore, measures in the low-income sector will use a NTG of 1.0 rather than the deemed or evaluated NTG that applies to traditional programs.

Figure 5. Cooling Equipment Saturation by Income Group



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

ASSESSING TECHNICAL AND ECONOMIC POTENTIAL

With a defined population and measure list, Navigant will estimate the technical and economic potential from the low-income sector using the same modeling method as for non-low-income programs. This methodology was described earlier in Task 2 and 3 respectively of Deliverable 11. Our technical and economic potential approaches are agnostic of market sector, income levels, or historic program activity. They depend purely on market size, measure characteristics, and cost effectiveness test parameters.

Historically, ESA programs were not required to pass a TRC test and do not feed into the overall portfolio cost effectiveness for IOU programs. It is possible that individual measures with ESA, or the ESA program as a whole, has a low TRC test result. In our assessment of Economic potential, we will apply the TRC as written with the appropriate avoided costs. However, when assessing market potential, modifications may be necessary (see below).

ASSESSING MARKET POTENTIAL

Market potential will be assessed using the same basic framework as for non-low-income programs. This methodology was described earlier in Task 4 of Deliverable 11. The following special considerations will be made in executing this method for the low-income sector:

- **Economic Test Screen** – Because ESA programs are not required to pass the TRC test, it is possible that historic program savings are higher than the calculated Economic potential for Low Income Programs. In this case we can remove economic screen tests to allow measures to be included in the market potential. This issue will be discussed with EDPM and relevant stakeholders as necessary.
- **Incentives** – The Low Income Potential forecast will have different incentives assumptions compared to traditional rebate programs. For measures that are installed directly at no cost, the

rebate is essentially 100% of equipment cost. We will mine program data to understand the appropriate incentive levels to apply.

- **Calibration Data** – The Low Income Potential forecast will be calibrated based on historic savings achieved by ESA at the end use level.
- **Re-participation** – Given that CPUC Decision 16-11-022 allows IOUs to seek "retreatment" of Low Income Customers, the model will allow re-participation of measures that reach the end of their useful life.

2.1.9 Task 10 – Reporting and Stakeholder Presentations

Throughout Deliverable 11, Navigant plans to engage with stakeholder to collect feedback on key topics. The below table lays out our current plan for stakeholder engagement.

Stakeholder Meetings	Date	Webinar or In Person
Work Plan and Measure Lists	1/11/2019	In Person at CPUC
AIMS GC/ET	*3rd week of Jan*	Webinar
Scenarios	*1st week of Feb*	Webinar
Stakeholder input on Calibration	*Mid-Feb*	In Person
Low income	*Mid-Feb*	Webinar
REN/CCA/DAC	*1st week of Mar*	Webinar
Draft Results	4/5/2019	In Person

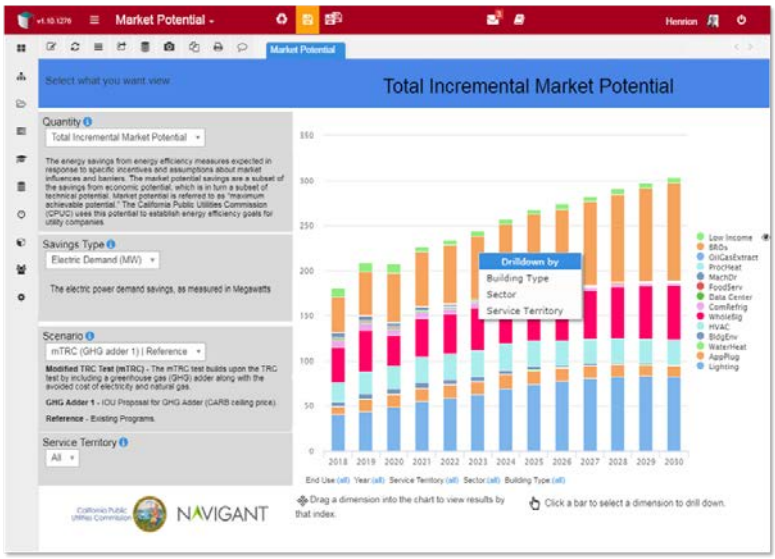
Navigant will prepare a draft report for internal and external review once draft results have been vetted. As has been historically done in the past, Navigant expects to publish this draft report, along with draft results and the draft model publicly through the appropriate CPUC channels. We will respond to feedback from external stakeholders and provide a final report.

In addition to a written report, this task will also provide a model (discussed more in Deliverable 11.1) and a database of results. Navigant has historically presented and circulated results in the form of an Excel-based Results Viewer. However, as several web-based visualization tools are gaining popularity in the industry, Navigant proposes leveraging such tools to deliver results to the CPUC and stakeholders in a more visually-compelling and flexible manner. The CPUC website can contain a link to the dashboard, which users can easily access and manipulate to view results from the study. Navigant proposes pursuing one of two options presented below. Navigant will discuss these options with the CPUC upon kickoff of this project and research them to identify the option that makes the most sense for the CPUC, the project timeline, and relevant stakeholders.

OPTION 1: MODEL FILE AND RESULTS DASHBOARD EMBEDDED IN ANALYTICA CLOUD PLAYER (ACP2)

Under option 1, Navigant proposes to upload both the model and results to Lumina's Analytica Cloud Player (ACP2). ACP2 enables rapid deployment of Analytica models over the web and can provide users with online access to the full PG model and an interactive visualization dashboard in a single platform. Figure 7 shows a screenshot of a sample ACP results dashboard.

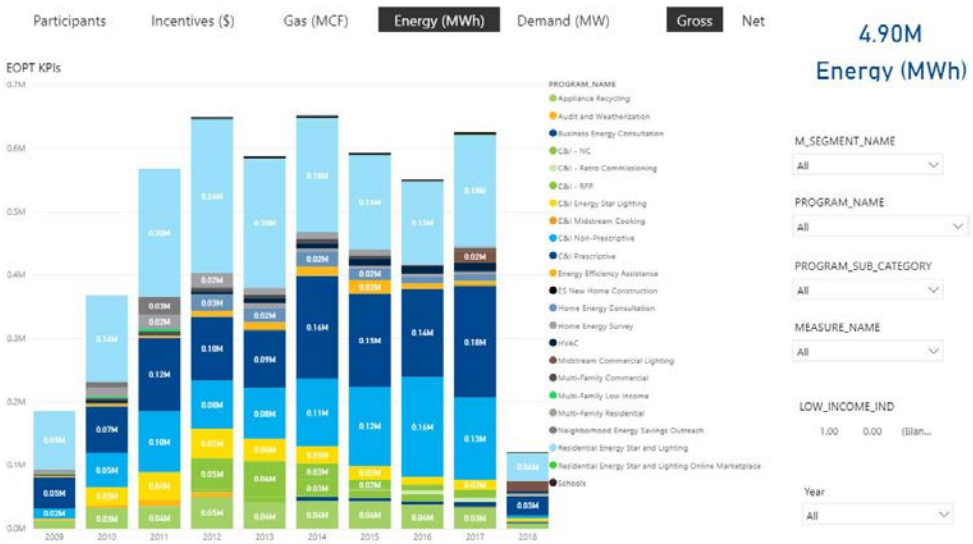
Figure 6. Screenshot of Sample ACP Results Dashboard



OPTION 2: MODEL FILE UPLOAD AND POWERBI RESULTS DASHBOARD

Under option 2, Navigant proposes to upload the model and other supporting files to the CPUC website, as has been done in the past. However, in lieu of an Excel-based Results Viewer, Navigant proposes to develop a Results Dashboard using Microsoft's PowerBI interactive data visualization platform. Figure 6 shows a screenshot of a sample PowerBI results dashboard Navigant developed for a client in the past.

Figure 7. Screenshot of Sample PowerBI Results Dashboard



2.2 Schedule and Deliverables

Table 8 lists the schedule for Deliverable 11.

Table 7: Schedule for Deliverable 11

Task	Milestone/Deliverable	Start Date	Completion Date
1	Collect Global Inputs	10/25/2018	1/1/2019
2	Characterize Measures	10/25/2018	1/1/2019
3	Develop Technical Potential	1/1/2018	2/1/2019
4	Develop Economic Potential	1/1/2018	2/1/2019
5	Develop Base Market Potential	2/1/2019	2/20/2019
5	Stakeholder Input on Calibration	-	2/15/2019
5	Develop Scenarios	1/1/2019	2/1/2019
5	Produce Scenario Results	2/20/2019	3/1/2019
5	Post Process Results – DACs/REN/CCAs	3/1/2019	3/8/2019
5	IRP Coordination	TBD based on IRP needs	
6	Develop Hourly Load Shapes	12/15/2018	2/15/2019
7	Develop List of Potential C&S	1/1/2019	2/1/2019
7	Forecast C&S Savings	2/1/2019	3/1/2019
8	Develop Low Income Measure List and Market Data	1/1/2019	2/15/2019
8	Forecast Low Income Potential	2/15/2019	3/1/2019
9	Draft Report		4/1/2019
9	Stakeholder Review	4/1/2019	4/15/2019
9	Final Report		5/1/2019

2.3 Team

Table 9 lists key staff dedicated to executing Deliverable 11. Amul Sathe will lead the Deliverable and has ten years of experience in developing Energy Efficiency Potential Studies with eight years of experience in conducting potential studies for the CPUC.

Table 8: Key Staff for Deliverable 11

Name	Firm	Role
Amul Sathe	Navigant	Deliverable 11 Manager
Greg Wikler	Navigant	Senior Advisor
Julie Penning	Navigant	Modeling team lead

Will Supple	Navigant	Modeler
Rebecca Legett	Navigant	Res, Com Measure Characterization Lead
Karen Maoz	Navigant	Ag, Ind, Mining, Streetlighting Measure Characterization Lead
John Aquino	Navigant	BROs and Load Shape Lead
Karen Ehrhart-Martinez	Navigant	BROs SME
Floyd Keneipp	Tierra Resource Consultants	Low Income, CCA, REN, Ind/Ag advisor
Brad Rogers	JJ Michell Associates	Modeling Advisor
Allan Lee	Cadmus	C&S Data and ISSM advisor
Megan Campbell	Opinion Dynamics Corp	Low Income data lead

2.4 Budget

Table 10 summarizes the budget and milestones for conducting Deliverable 11.

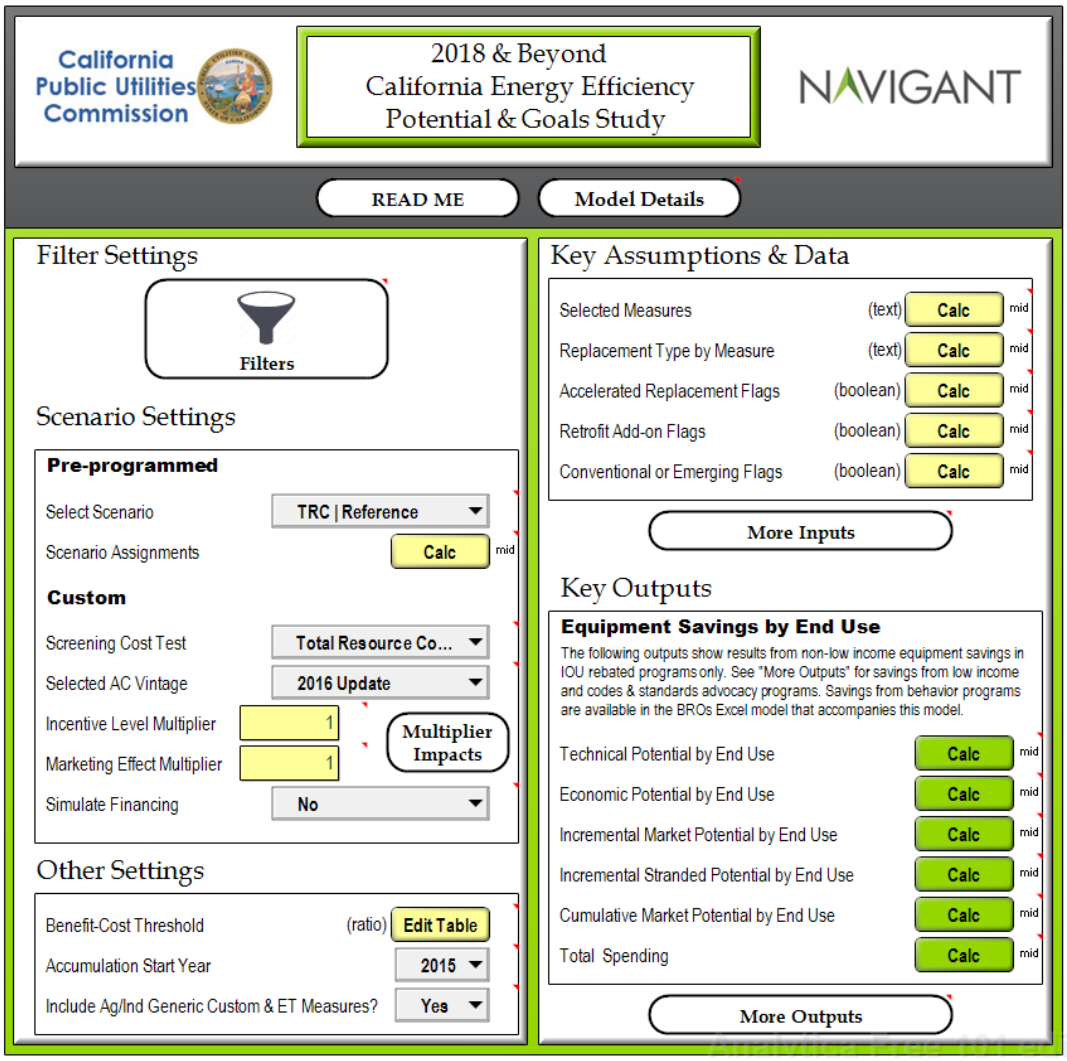
Table 9: Budget for Deliverable 11

Milestone	Completion Date	Budget
Measure Characterization for Res, Com, Ind, Ag, and Mining Complete	Q1 2019	$300,000
Technical and Economic Potential Complete	Q1 2019	$225,000
Base Market Potential Complete	Q1 2019	$225,000
Draft Report Complete	Q2 2019	$150,000
Final Report Complete	Q2 2019	$80,000
Total Budget		$980,000

3. Deliverable 11.1 Potential and Goals Energy Efficiency Adoption Simulation Model

Navigant's PG model is currently 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 8 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. Navigant will modify and update its existing PG model to meet the requirements of this study.

Figure 8. Graphical User Interface of 2018 Potential & Goals Study Model



Additional details on the model platform can be found in the Appendix of this workplan.

3.1 Delivery and Commission Staff Training

The model will be delivered to the CPUC as an executable file that does not require a license to run. Though users may need to install a free version of the Analytica Player software.

Furthermore, Navigant will train CPUC staff on use of the model. Navigant has extensive experience training clients in the use of Analytica models. For this study, training will be adapted to the needs of CPUC staff and can consist of the following:

- Documents detailing the modelling methodology and approach;
- User guides describing how to import/export data, run the model, navigate through underlying model logic, change settings, and review results
- Training exercises (structured similarly to practice problems) providing trainees an opportunity to assess their comprehension and aid in knowledge retention (see example in **Error! Reference source not found.**);
- Topic-specific recorded webinars;
- In-person training sessions; and
- Technical support post model delivery up until the contract end period

3.2 Schedule and Deliverables

Table 11 lists the schedule for Deliverable 11.1.

Table 10: Schedule for Deliverable 11.1

Milestone/Deliverable	Start Date	Completion Date
Draft Model	12/1/2018	4/1/2019
Final Model	4/7/2019	5/1/2019
Training		TBD

3.3 Team Expertise

Table 12 lists key staff dedicated to executing Deliverable 11.1.

Table 11: Key Staff for Deliverable 11.1

Name	Firm	Role
Julie Penning	Navigant	Deliverable 11.1 Manager
Amul Sathe	Navigant	Senior Leadership/Oversight
Max Henrion	Lumina	Model Delivery Advisor

Name	Firm	Role
Kim Mullins	Lumina	Model Delivery Advisor

3.4 Budget

Table 13 summarizes the budget and milestones for conducting Deliverable 11.1.

Table 12: Budget for Deliverable 11.1

Milestone	Completion Date	Budget
Draft Model Delivered	April 1, 2019	$35,000
Final Model Delivered	May 1, 2019	$5,000
CPUC Training Complete	Q2 2019	$10,000
Total Budget		$50,000

4. Deliverable 12 (P&G-02) Additional Achievable Energy Efficiency Scenarios

The California Energy Commission (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 P&G study are already incorporated in the CED baseline forecast, CEC staff need to estimate the portion of savings from CPUC potential study not accounted for in the baseline forecast. These nonoverlapping savings are referred to as Additional Achievable Energy Efficiency (AAEE) impacts.

4.1 Approach

4.1.1 Task 1: Kickoff and Coordination Meetings

Coordination between CPUC staff, CEC Staff and the Navigant team will be essential to efficiently executing this task. We will hold a series of kickoff and coordination meetings between CPUC, CEC and Navigant staff

4.1.2 Task 2: Develop Scenarios

Scenarios for the AAEE will be primarily built around variables that are available in the P&G model. As such, initial coordination mentioned above in Task 1 is key to building in any necessary variables the CEC requests that may not normally be considered in the P&G Study.

Variables that influence savings generally fall in two categories:

- Internally Influenced - policies and program decisions that are under control of the CPUC, IOUs, and other program administrators collectively,
- Externally Influenced - variables that are not controllable by any involved party such as economic and demographic conditions

An example list of internally and externally influenced variables can be found in Table 14.

Table 13. Variables Affecting Energy Efficiency Potential

Internally Influenced	Externally Influenced
• Avoided Costs • Cost-effectiveness (C-E) test • C-E measure screening threshold • Incentive levels • Marketing & Outreach • Behavior, Retro commissioning & Operational (BROs) customer enrollment over time • IOU financing programs	• Economic growth • Population (demographic) changes • Building stock growth • Retail energy price • Measure-level input uncertainties (unit energy savings, unit costs, densities) • Future Federal appliance standards • C&S compliance rates • Non-IOU financing programs

Our experience is that the P&G study focuses scenarios around internally influenced variables while the CED focuses its low, mid, and high demand forecast based on externally influenced variables (primarily economic and demographic conditions). Thus, developing scenarios for AAEE required a combination of variables from both categories.

Two externally influenced variables are core to the CED, they each have a low, mid, and high value that can be used for forecasting: building stock and retail energy price. The CED links these variables in its forecasting such that only three combinations of "Economic/Demographic" data are used:

- High Demand Case – combines a high forecast of building stock with a low forecast of retail energy prices
- Mid Demand Case – combines the mid case for both variables
- Low Demand Case – combines a low forecast of building stock with a high forecast of retail energy prices

Six scenarios will be developed in a collaborative process with CEC and CPUC staff. We will take the following steps:

1. Confirm the Economic/Demographic settings used in the CED Low/Mid/High forecasts and seek feedback from CEC on if these are to continue to play a role in AAEE scenarios going forward
2. Present CEC with a list of internally influenced variables available in the P&G model as well as results from a sensitivity test to inform CEC staff of the sensitivity to each variable
3. Collect initial guidance from CEC staff on the intent of the scenarios.
4. Navigant drafts a framework of scenario variable settings for each of the scenarios (at least 6 in total) based on initial guidance from CEC staff.
5. Review draft scenario framework with CEC staff and collaboratively edit/update to hone in on the final scenario settings.

Once these variables are set, Navigant will progress to the next task and execute the model to produce results.

4.1.3 Task 3: Sector and Climate Zone Forecast Disaggregation

Our proposed P&G model, that will be used in Deliverable 11 and Deliverable 11.1, will be run using the agreed upon scenario framework. Our model produces result with the following granularity:

- IOU/CCA/REN
- Building Climate Zone
- Sector
- End Use
- Measure

Thus, as a default our model will meet the needs of disaggregation to the sector level. However, additional consideration for climate zone needs to be accounted for.

California state agencies including the CEC have two sets of climate zones. CPUC managed datasets such as DEER, workpapers, and IOU program reporting use Building Climate Zones (BCZs). There are 16 BCZs that disaggregate the state into regions with similar weather (i.e. climate). The CEC's Forecasting Climate Zones (FCZ) used in IEPR and differ from the BCZ. FCZs are primarily "political boundaries" as they are based on utility service territory. The IOUs are further broken into smaller forecasting zones

The P&G model will operate using BCZs as many of the key inputs (DEER, saturation studies, etc.) are available at the BCZ level. Historically CEC requested AAEE be disaggregated at the FCZ level, thus a mapping from BCZ to FCZ is needed.

We will to develop this mapping leveraging zip-code level energy consumption data by sector made available by the utilities. Overlaying consumption at the zip code level with BCZs and FCZs, our GIS analysts will be able to develop an accurate mapping of sector populations to translate BCZ level results into FCZ level results for each sector.

Table 14. Translating Building CZ to Forecast CZ - Example

IOU	Forecast Zone	Building Climate Zone 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PG&E	1	0%	0%	80%	90%	0%	0%	0%	0%	0%	0%	0%	38%	0%	0%	0%	0%
PG&E	2	100%	100%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PG&E	3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	45%	0%	0%	0%	0%	58%
PG&E	4	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	55%	58%	0%	0%	0%	31%
PG&E	5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	100%	0%	0%	11%
PG&E	6	0%	0%	17%	10%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PG&E Total		***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***0%***	***0%***	***0%***	***0%***	***100%***	***100%***	***100%***	***0%***	***0%***	***100%***
SCE	7	0%	0%	0%	0%	0%	72%	0%	100%	88%	0%	0%	0%	0%	40%	0%	13%
SCE	8	0%	0%	0%	0%	100%	28%	0%	0%	12%	0%	0%	0%	0%	0%	0%	7%
SCE	9	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	8%	0%	29%
SCE	10	0%	0%	0%	0%	0%	0%	0%	0%	0%	46%	0%	0%	0%	52%	1%	45%
SCE	11	0%	0%	0%	0%	0%	0%	0%	0%	0%	54%	0%	0%	0%	0%	99%	5%
SCE Total		***0%***	***0%***	***0%***	***0%***	***100%***	***100%***	***0%***	***100%***	***100%***	***100%***	***0%***	***0%***	***100%***	***100%***	***100%***	***100%***
SDG&E	12	0%	0%	0%	0%	0%	100%	100%	100%	0%	100%	0%	0%	0%	100%	100%	0%

4.1.4 Task 4: Hourly Disaggregation

We will leverage load shapes developed in Deliverable 11 to support hourly disaggregation of AAEE.

4.1.5 Task 5: Reporting

Navigant will develop draft and final reports for the CPUC EDPM and the CEC to review. These reports will detail data sources, methods, analysis, findings and recommendations. Along with the reports, Navigant will provide:

- An Excel database of scenario results containing cumulative savings at the sector, FCZ and end use level for rebate programs, C&S, Low Income, and BROs
- An Excel based load shape data file and results viewer

4.2 Schedule and Deliverables

Table 16 lists the schedule for Deliverable 12.

Table 15: Schedule for Deliverable 12

Task	Milestone/Deliverable	Start Date	Completion Date
1	Initial Coordination	1/15/2019	-
1	Kickoff Meeting	5/15/2019	-
2	Develop Scenario Framework	5/15/2019	7/1/2019
3	Run Model and Disaggregate to Sectors and FCZs	7/1/2019	8/1/2019
4	Hourly Disaggregation	5/1/2019	9/1/2019
5	Draft Results and Report		9/1/2019
5	Final Results and Report	-	10/1/2019

4.3 Team

Table 17 lists key staff dedicated to executing Deliverable 12.

Table 16: Key Staff for Deliverable 12

Name	Firm	Role
Amul Sathe	Navigant	Deliverable 12 Manager
Julie Penning	Navigant	Model Advisor
Will Supple	Navigant	Modeler
John Aquino	Navigant	Load Shape Analysis

4.4 Budget

Table 14 summarizes the budget and milestones for conducting Deliverable 12.

Table 17: Budget for Deliverable 12

Milestone	Completion Date	Budget
Scenarios Finalized	7/1/2019	$28,333
Draft Results	9/1/2019	$42,500
Final Results	10/1/2019	$14,167
Total Budget		$85,000

5. Deliverable 13 (P&G-03) SB 350 IOU Territory Targets Update

Senate Bill 350, the Clean Energy and Pollution Reduction Act of 2015 requires the California Energy Commission (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 Additional Achievable Energy Efficiency (AAEE) forecast.

In 2017, the CEC published a report (referred to here as the "2017 SB350 Report") to establish proposed statewide doubling targets that must be achieved by 2030.[10] It proposed "sub targets" for the portion of projected energy efficiency savings that can be achieved through IOU programs, publicly owned utilities (POU) programs. and nonutility programs funded through government, private and utility ratepayer sources.

Deliverable 13 is scoped with updating the IOU sub target to inform the CEC as it moves forward with updating data reported in the 2017 SB350 Report. As part of the 2018 P&G study, Navigant provided the forecast of IOU program savings to the CEC and its contractors that informed the IOU sub targets in the 2017 SB350 Report.

5.1 Approach

5.1.1 Task 1: Kickoff and Coordination with CEC staff

Given Deliverable 13 will overlap in timeline with Deliverable 12, we expect synergies between the two (both are producing cumulative savings for use by the CEC). In fact, we propose holding a joint kickoff for Deliverable 12 and 13 as they are very similar and involved similar staff at the CEC.

The Deliverable 13 portion of the kickoff will discuss

- Overview of scope and workplan with the CEC
- Review status of CEC's updated SB350 report
- Discuss possible areas of overlap and double counting
- Deliverables

5.1.2 Task 2: Conduct Analysis

Developing an updated SB 350 IOU Territory Target dataset for the CEC is a relatively straightforward process compared to the other technical analysis required in Deliverables 11-16. The key features of our analysis are described below:

[10] 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.

BASELINE ADJUSTMENTS

SB350 requires a forecast of cumulative net IOU program savings staring in the year 2015 (the "start year" for which SB350 is tracking savings). Our proposed P&G model discussed earlier in Deliverable 11 and 11.1 is built to produce net cumulative savings starting in any forecasted year. For Deliverable 13 we will set the cumulative start year to 2015 (Deliverable 12, the AAEE forecast, will likely use a different start year).

ADJUSTING FOR DOUBLE COUNTING

The P&G study (Deliverable 11) will forecast savings from IOU rebate programs, C&S claimable by IOUs, IOU low income programs, and IOU BROs programs. The 2017 SB350 Report considered C&S, BROs, fuel substitution, and financing savings as "non-utility programs". Therefore, including these savings under "IOU programs" could be double counted. Additional details on each are provided below:

- **C&S.** C&S savings in the P&G studies have focused on just that portion with is attributable/claimable by the IOUs, thus it's been classified as "IOU program savings". C&S savings in the SB350 (and AAEE) context is conducted without applying any attribution factors, thus it is removed from the IOU category and placed in the non-utility category. Navigant will coordinate with the CEC on what is in scope for Deliverable 11 and what is not. For C&S in scope of Deliverable 11, Navigant will provide results and data in an appropriate format under Deliverable 13 (cumulative from 2015, net, prior to utility attribution). For those C&S which are not in scope of Deliverable 11, it will fall on CEC to conduct additional analysis if desired.
- **BROs.** The 2017 SB350 Report only considered a subset of BROs from the 2018 P&G Study and also looked to savings beyond the IOU service territories. Maintaining this approach, Deliverable 11 will produce an updated forecast of BROs savings that can be leveraged once again by the CEC for the SB350 forecast. Navigant will coordinate with the CEC on what BROs are in scope for Deliverable 11 and what is not. For BROs in scope of Deliverable 11, Navigant will provide results and data in an appropriate format under Deliverable 13 (net cumulative from 2015). For those BROs which are not in scope of Deliverable 11, it will fall on CEC to conduct additional analysis if desired.
- **Financing.** The 2018 P&G study included the impacts of financing as a scenario option in its model. However, this variable did not factor into the forecast used to inform IOU goals. The 2017 SB350 Report conducted a separate analysis that considered broader financing programs across the state beyond those run by the IOUs (i.e. PACE, Proposition 39, other state and local grants, etc.). As the scope of financing in the state (and its potential impact) is far broader than the IOU programs, we propose to remove effects of financing in any IOU program targets provided to the CEC under Deliverable 13 and allow the CEC's scope to quantify the full impact of financing.

5.1.3 Task 3: Reporting and Stakeholder Engagement

This task will fully document the analysis conducted in Deliverable 13 and provide results in the required format. The most important component of reporting will be to accurately describe how double counting for each of the savings sources in Task 2 was addressed. Outputs from Deliverable 13 will include sections that can be inserted in the CEC's updated SB350 report as well as public presentation material to support discourse with stakeholders.

Navigant stands ready to also support the EDPM and CEC staff in responding to stakeholder comments regarding the process and outputs of Deliverable 13.

5.2 Schedule and Deliverables

Table 19 lists the schedule for Deliverable 13.

Table 18: Schedule for Deliverable 13

Task	Milestone/Deliverable	Start Date	Completion Date
1	Kickoff	5/15/2019	
2	Conduct Analysis	6/1/2019	8/15/2019
3	Draft Results		8/15/2019
3	Final Results	-	9/1/2018

5.3 Team

Table 20 lists key staff dedicated to executing Deliverable 13. Karen Maoz is going to play a key management role on Navigant's SB350 Technical Support Contract with the CEC. For the CEC, she will oversee the updating of non-IOU sub targets that are due in the summer of 2019. Thus, having her lead Deliverable 13 is a natural fit.

Table 19: Key Staff for Deliverable 13

Name	Firm	Role
Karen Maoz	Navigant	Manager for Deliverable 13
Amul Sathe	Navigant	SB350 Advisor
Julie Penning	Navigant	Model Advisor

5.4 Budget

Table 21 summarizes the budget and milestones for conducting Deliverable 13.

Table 20: Budget for Deliverable 13

Milestone	Completion Date	Budget
Draft Results	8/15/2019	$30,000
Final Results	9/1/2018	$5,000
Total Budget		$35,000

6. Deliverable 14 (P&G-04) Feasibility Study Related to the Integrated Resource Planning

In late 2017 and early 2018 Navigant supported CPUC staff in examining methods to integrate energy efficiency procurement practices into the IRP optimization process. Navigant supported CPUC staff in exploring modifications to the existing IRP capacity expansion model called RESOLVE. This consisted of a technical analysis to explore the technical feasibility of full optimization of energy efficiency as supply side resource. Our approach to Deliverable 14 builds upon this previous support.

6.1 Approach

6.1.1 Task 1: Kickoff

Navigant will hold a Deliverable 14 kickoff meeting to discuss

- Scope and direction for the study
- Review of the latest status of CPUC IRP models (vintage, process, timeline, granularity of input data)
- Stakeholder interaction plan
- Deliverables and direction for the study.

Navigant will defer to the EDPM on the level of engagement with stakeholder required.

6.1.2 Task 2: Develop Integration Options

Navigant will hold collaborative meetings with the CPUC's IRP staff and any relevant CPUC contractors. These meetings will be held in person to collaboratively discuss technical topics such as:

- **Overall Methodologies** – There are multiple ways to integrate energy efficiency as a candidate demand side resource into an IRP model, regardless of the IRP model platform. We will discuss all possible options.
- **Cost Reporting** – Identify the components of resource costs that are included in the IRP model. This will allow EE resources to account for the same cost categories and be placed on "equal footing" with other resources.
- **Locational Granularity** – Current CPUC IRP models are run at a statewide level. Future models could be run at an IOU or sub-IOU.
- **Model Limitations** – Many IRP models have limitations in how EE can be modeled. Understanding these nuances is critical to integration and may require edits to the way EE data is fed into an IRP model.
- **Timestep** – IRP models may have optimized on an annual basis or on a longer term, for example the RESOLVE model has a time step of every 4 years. Understanding these nuances is critical to integration as it impacts the way data is input to the model and the interpretation of results.

- **Value of granularity vs. simplicity** – as in any model, there is a balance between granularity and simplicity. Providing too granular data as an input to the IRP model may "bog down" its run time and processing only to add little value. But too simplistic of an approach may not provide detailed enough output to be actionable.
- **Load Shapes** – Most IRP models make use of load shape data to assess peak electricity needs. These may be required in different formats or with different definitions. For example, the RESOLVE model used hourly shapes on 30+ day types, while other models may require 8670 data.

These collaborative discussions will bring about several options for integration.

6.1.3 Task 3: Select Approach and Test Integration

Navigant will review the integration options with CPUC staff to demine which method should be considered for further testing. The method selected for further testing will be informed by:

- Addressing key policy needs
- Availability of data
- Granularity of analysis
- Ability for IRP model to adapt and process
- Ability for P&G model to produce input data
- Meetings the needs of stakeholders

In this scope, we budget for selecting option from Task 2 for further analysis. Once the appropriate path is selected, Task 3 will:

- Establish an IRP input data template
- Collect relevant data from the P&G study (and other sources if needed)
- Provide IRP model formatted data
- Work with IRP modelers and CPUC staff to interpret results

Analysis will compare IRP modeled results to the result of Deliverable 11. Any notable difference in optimally selected EE from the IRP model and key scenarios from the P&G study will be discussed.

6.1.4 Task 4: Report on Findings and Recommendations

Upon completion of Task 3, Navigant will develop a report on the data sources, methods, analysis, findings and recommendations. As this is a feasibility study, we will seek to answer the following questions:

- Is there sufficient data to reliably conduct the analysis?
- Did the method provide results that fall within a reasonable range of expectations?
- Is the method sensitive to changes in key inputs? Do these sensitivity results make sense?

- What improvements (if any) are needed before the process can be used to reliably set policy?

6.2 Schedule and Deliverables

Table 22 lists the planned schedule for Deliverable 14.

Table 21: Schedule for Deliverable 14

Task	Milestone/Deliverable	Start Date	Completion Date
1	Kickoff	5/2/2019	
2	Collaborative meetings with IRP staff	5/5/2019	6/5/2019
2	Present options to stakeholders		6/15/2019
3	Select Approach and Test Integration	7/1/2019	8/1/2019
4	Final Report	-	9/1/2019

6.3 Team

Table 23 lists key staff dedicated to executing Deliverable 14.

Table 22: Key Staff for Deliverable 14

Name	Firm	Role
Amul Sathe	Navigant	Deliverable 14 Manager
Greg Wikler	Navigant	IRP Advisor
Julie Penning	Navigant	Modeler
John Aquino	Navigant	Supply Curve Development

6.4 Budget

Table 24 summarizes the budget and milestones for conducting Deliverable 14.

Table 23: Budget for Deliverable 14

Milestone	Completion Date	Budget
Stakeholder Presentation Complete	6/15/2019	$20,000
Draft Data Provided to IRP team	8/1/2019	$45,000
Final Report	9/1/2019	$10,000
Total Budget		$75,000

7. Deliverable 15 (P&G-05) Feasibility Study on Setting Locational Energy Efficiency Targets

Setting locational targets implies the overall Program Administrator (PA) goals do not change (meaning PA budgets hold relatively constant); however, the prioritization of where savings are sought out through the PA's jurisdiction is focused based a locational valuation. Pivotal to this analysis is developing a framework for establishing the locational value of energy efficiency savings, obtaining data on locational value, disaggregating PA goals to local areas, and cross checking the ability for the local area to "absorb" that amount of energy efficiency (lest the target exceed the technical potential for the region).

7.1 Approach

7.1.1 Task 1: Kickoff

Navigant will hold a Deliverable 15 kickoff meeting to discuss

- Scope and direction for the study
- Stakeholder interaction plan
- deliverables and direction for the study.

Given this Deliverable will kick off in the summer of 2019, its possible additional resources, direction, or data will be available from the IRP and IDER proceedings that are not available today. The kickoff meeting will also recap the latest insight and status of related CPUC efforts and proceedings.

7.1.2 Task 2: Establish Definition of "Location"

The term "location" is colloquial and can be interpreted to mean a variety of levels of disaggregation. Navigant will develop a list of working definitions (primarily around how granular the locations should be) and review these with the EDPM and other relevant CPUC staff to come to an agreement on the working definition to use for this study.

For the locational value of energy efficiency to be realized, the adoption of the resources must tie to a specific reduction in costs in the grid planning portfolio. This means the load reductions must be trusted accepted by the distribution planning department in a timeframe that allows them to adapt the plan. This requires an important time granularity component to be included in assessing the value.

In selecting a working definition for this study, Navigant will work with the EDPM to account for the following considerations:

- Does the definition align with current or proposed policy?
- Does the definition align with other modeling/analysis efforts in the state?
- Does the definition align with valuation frameworks being considered?
- Is there publicly available at this level of granularity to support analysis?

7.1.3 Task 3: Develop Framework and Methodologies

In Task 3, Navigant will develop and present 2-3 options for methodological frameworks that would allow locational target setting for energy efficiency (at the agreed upon definition of "location"). To arrive at these candidate options, Navigant will:

- Conduct a literature review to learn of methods uses in IOU DRPs and in other jurisdictions.
- Conduct interviews with distribution system experts at the IOUs, CEC, CAISO on existing methods for disaggregation
- Leverage the Navigant team's expertise
- Hold collaborative brainstorming meetings with relevant CPUC staff (staff assigned to IDER, IRP, and DRPs for example)

Based on information gathered in the above process, Navigant will outline the methodology and expected data required for each option. We will then confer with EDPM and relevant CPUC staff reviewing the pros and cons of each option. Navigant will also work with the EDPM to host a stakeholder presentation on the options and collect feedback.

Based on the feedback from stakeholders, Navigant will work with the EDPM to select which approach is best to continue assessing in Task 4 (the data collection and feasibility testing phase).

7.1.4 Task 4: Collect Data and Test Feasibility

In this task, Navigant will seek out available data to implement the selected methodology in a feasibility test. Data collection will be subject to the methodology selected though we expect the following types of data to be considered:

- Customer counts and historic energy consumption at the locational level (aggregated zip code level data is available publicly from IOUs)
- Historic energy efficiency adoption at the locational level (zip code level data is available from CPUC public sources)
- Regional/locational technology saturation to inform remaining technical potential calculations (potentially available from California saturation studies)
- AMI data request through the Energy Data Request Program (established by CPUC Decision 14-05-016) will be considered. Though there is a chance this particular use of the data may not fall within the eligibility of the program.
- Locational avoided cost of energy
- Locational non-energy considerations (CalEnviroScreen, census data)
- Grid Needs Assessment to inform the locational avoided cost of energy and capacity

Once data is collected, the feasibility of the modeling approach will be tested. Feasibility testing implies seeking answers to the following questions:

- Is there sufficient data to reliably conduct the analysis?

- Did the method provide results that fall within a reasonable range of expectations?
- Is the method sensitive to changes in key inputs? Do these sensitivity results make sense?
- Is the method scalable to more or fewer locations should future models need different levels of granularity?

7.1.5 Task 5: Report on Findings and Recommendations

Navigant will report on its findings and recommendations of the analyses. A final report will be produced that discusses:

- Options considered
- Methodology
- Data collected
- Findings/Results
- Recommendations
  - Data gaps that need to be filled
  - Methodological issues that need to be resolved
  - Future improvements to the modeling process

Navigant will prepare a summary presentation to inform stakeholder of the findings and recommendations from this study.

7.2 Schedule and Deliverables

Table 25 lists the schedule for Deliverable 15.

Table 24: Schedule for Deliverable 15

Task	Milestone/Deliverable	Start Date	Completion Date
1	Kickoff		6/1/2019
2	Establish Definition of “Location”	6/1/2019	7/1/2019
3	Develop Framework and Methodologies	7/1/2019	8/1/2019
3	Review with Stakeholders	8/1/2019	9/1/2019
4	Collect Data and Test Feasibility	9/1/2019	11/1/2019
5	Draft Report		11/1/2019
5	Final Report		12/15/2019

7.3 Team

Table 26 lists key staff dedicated to executing Deliverable 15.

Table 25: Key Staff for Deliverable 15

Name	Firm	Role
James Hansell	Navigant	Deliverable 15 Manager
Amul Sathe	Navigant	P&G Study Integration
Julie Penning	Navigant	Modeler
Gil Peach	JJ Mitchell	Advisor

7.4 Budget

Table 27 summarizes the budget and milestones for conducting Deliverable 15.

Table 26: Budget for Deliverable 15

Milestone	Completion Date	Budget
Task 2 Complete	7/1/2019	$20,000
Task 3 Complete	9/1/2019	$30,000
Draft Report	11/1/2019	$55,000
Final Report	12/15/2019	$10,000
Total Budget		$115,000

Appendix A. PG Model Details

MODEL PLATFORM

As previously, mentioned, Navigant's PG model has and will continue to be developed using Analytica. Analytica provides a highly interactive visual environment to support decision-focused collaboration among analysts, their clients, and other decision makers. It provides a comprehensive range of features including:

- **Influence diagrams** that provide intuitive visual way to structure and navigate models, and show the influences among decisions, uncertainties, objectives, and other variables.
- **Integrated documentation** with meaningful names, descriptions, and units for each variable.
- **A declarative language** to define influences among variables, providing a much simpler, more transparent, and reliable way to build models than conventional procedural languages, like Python, VB, C++.
- **Intelligent Arrays™** giving great power and flexibility for handling multiple dimensions, including time, geographic locations, efficiency measures, scenarios, and other indexes of interest.
- **Integrated sensitivity, uncertainty, and scenario analysis** to explore the effects of changing assumptions, and assess risks and uncertainties using efficient Monte Carlo simulation.
- **Scalability** with hierarchical influence diagrams and intelligent arrays to handle models of a size that is impractical with spreadsheets and other conventional tools.
- **Optimization** with powerful solvers to find the best decision strategies or project portfolios even with thousands of decision variables.

MARKET POTENTIAL MODELING ALGORITHM

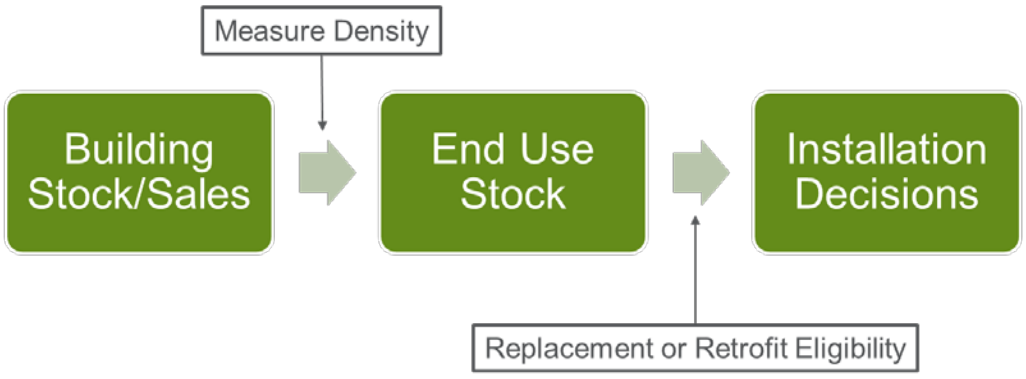
Navigant's PG model employs a stock-turnover-based bass diffusion algorithm to simulate market adoption. Three key steps are involved:

1. Size population eligible to upgrade equipment in any given year
2. Calculate market share split amongst base and efficient measures for eligible population
3. Calculate savings attributable to utility program intervention

STEP1: SIZE ELIGIBLE POPULATION

First, the model sizes the annual, eligible population for measure-specific market adoption using building stock as a starting point. The building stock is multiplied by measure density (e.g. number of bulbs per home) to produce end use stock. In any given year, a subset of this end use stock is eligible for replacement or retrofitting. Figure 9 summarizes this workflow.

Figure 9. Population Sizing for Installation Decisions



This eligible population for installation decisions is calculated based on replacement type, as shown in Table 28.

Table 27. Installation Decisions Eligibility Basis by Replacement Type

Replacement Type		Eligibility Basis	Eligibility Basis Metric
Existing Buildings	Equipment – Replace on Burnout	Number of equipment units that have reached the end of their lifetime	Burnout rate, approximated by equipment lifetime
	Equipment – Accelerated Replacement	Number of repaired equipment units, that are past their lifetime	Post-repair failure rate, approximated by a fixed number of years beyond the equipment's lifetime
	Retrofit	Number of retrofittable measures, which are not governed by equipment failure	
	New Buildings	New end use stock	

STEP 2: DETERMINE MARKET SHARE

Next, the model calculates the market share, or penetration of measures based on customer awareness of the measure and customer willingness to adopt the measure. This market share value is multiplied by the number of installation decisions determined in step 1 to produce the number of installations that occur for each measure. Customer awareness and willingness are calculated as follows:

- **Awareness**
  - **Marketing, education, and outreach** (ME&O) moves customers from the unaware group to the aware group at a consistent rate annually. Unaware customers, as the name implies, have no knowledge of the energy efficient technology option. Aware customers are those that have knowledge of the product and understand its attributes. ME&O is often referred to as the "Advertising Effect" in Bass Diffusion modeling.
  - **Word of mouth** represents the influence of adopters (or other aware consumers) on the unaware population by informing them of efficient technologies and their attributes. This influence increases the rate at which customers move from the unaware to the aware group;

the word-of-mouth influence occurs in addition to the ongoing ME&O. When a product is new to the market with few installations, often ME&O is the main source driving unaware customers to the aware group. As more customers become aware and adopt, however, word of mouth can have a greater influence on awareness than ME&O and leads to exponential growth. The exponential growth is ultimately damped by the saturation of the market, leading to an S-shaped adoption curve, which has frequently been observed for efficient technologies.

- **Willingness** is the key factor affecting the move from an aware customer to an adopter. Once customers are aware of the measure, they consider adopting the technology based on the financial attractiveness of the measure. The PG Model typically applies two distinct approaches to calculate willingness depending on the sector and need:
  - **Levelized Measure Cost/Logit Approach:** For sectors where information on absolute baseline and efficient costs are available (in the 2018 study, these sectors were residential (non-whole building), commercial (non-whole building), mining and streetlighting), and to more appropriately capture the impacts of EE financing on market adoption, a levelized measure cost (LMC)/logit approach is applied. The levelized measure cost is based on the present value of the cost of purchasing and operating the equipment throughout its EUL, discounted using a consumer implied discount rate (iDR)[11]. The equation used to calculate the LMC is shown below.

Equation 3. Levelized Measure Cost Calculation

$$LMC = Upfront\ Cost + PV(Annual\ Operating\ Cost,\ iDR,\ EUL)$$

To calculate long-run market share or willingness as a function of the levelized measure cost for both base and efficient technologies, Navigant employed a logit decision-maker approach.[12] [13] This approach applies best practices in predicting consumer behavior and allows competition of multiple measures with different EULs for each end use.

Equation 4. Logit Decision Model[14]

$$W = \frac{e^{\beta\ LMC1}}{\sum_i^n e^{\beta\ LMCi}}$$

Figure 10 illustrates how consumer willingness changes as a function of the ratio of the efficient to base LMC. In this illustration, a LMC ratio of 1 implies both the efficient and base technologies are at parity and thus the market is split with 50% choosing to adopt the efficient technology. For a LMC ratio of 0.5, which

[11] See 2015 PG Study for details on the iDR

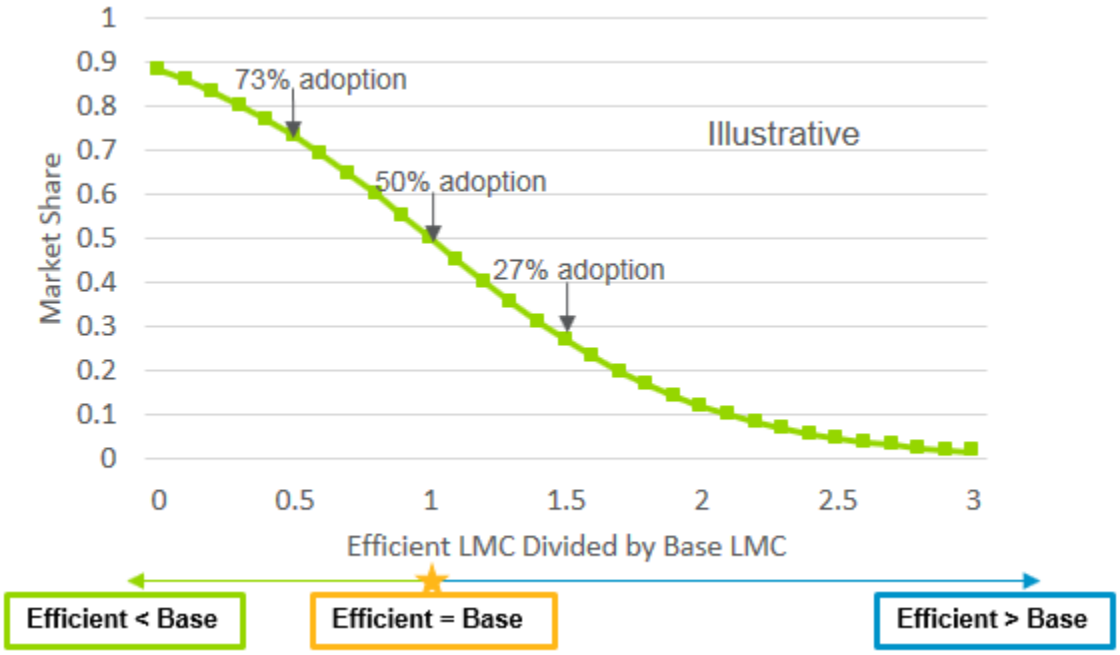
[12] *McFadden, Daniel, Train, K. "Mixed MNL Models for Discrete Response." 2000. Journal of Applied Econometrics, Vol. 15, No. 5, pp. 447-470.*

[13] *Train, Ken. "Discrete Choice Methods with Simulation." 2003. Cambridge University Press.*

[14] In this equation, W is the willingness, β is a sensitivity factor fit to willingness survey results, n is the number of competing technologies, and LMC is the levelized measure cost.

implies the efficient technology is cheaper than the base technology, the curve indicates that 73% would adopt the efficient technology.

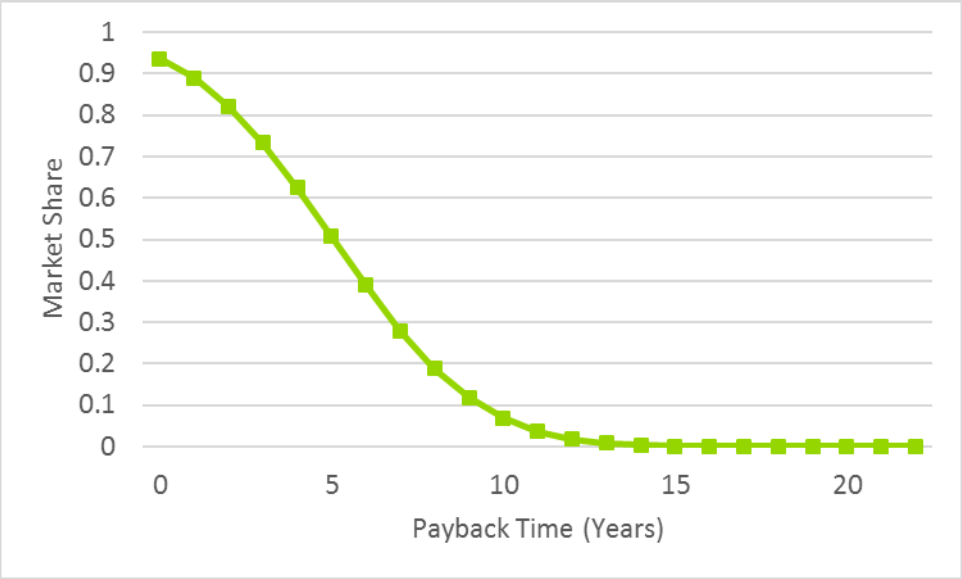
Figure 10. Illustration of Logit Willingness Curve



- **Payback-based Approach:** For sectors where information on absolute baseline and efficient costs are not available (in the 2018 study, these sectors were agricultural and industrial. Residential and commercial whole building measures also fell into this category.), and where there isn't a need to explore the impacts of EE financing, Navigant used a payback-based approach to calculate willingness. Payback time reflects the length of time (years) required for an energy efficiency investment to recover the initial upfront cost in terms of energy savings. After calculating payback time, the model currently relies on "payback acceptance" curves based on Navigant-led primary research in the US Midwest in 2012.[15] To-date, no California specific-data has been readily found to estimate these curves. Navigant will perform due diligence as appropriate to determine if California-specific data can be used in this next cycle of potential studies.

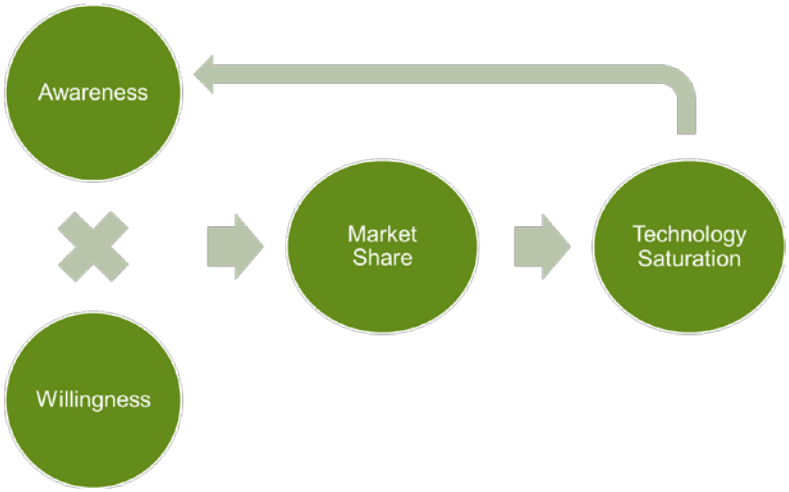
[15] [15] A detailed discussion of the methodology and findings of this research are contained in "Demand Side Resource Potential Study," prepared for Kansas City Power and Light, August 2013.

Figure 11. Payback Acceptance Curve for AIMS sectors



Measure adoption in any given year adds to technology saturation in the market, which in turns increases the awareness rate in the following year. Figure 12 illustrates this feedback loop in the bass diffusion model.

Figure 12. Market Share Feedback Loop in Bass Diffusion Model



STEP 3: CALCULATE SAVINGS ATTRIBUTABLE TO UTILITY PROGRAM INTERVENTION

Finally, 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. These savings are typically inclusive of interactive effects, although this can be modified according to the CPUC's requirements.

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. This is a retroactive adjustment done by the model after first going through steps 1 to 3 above for whole building packages.

SIMULATING REVERSION, RE-ADOPTION AND ADOPTION

As stipulated in the RFP, Navigant's PG model is capable of simulating different decision types and customer behaviors. This includes being able to identify installations attributable to reversion, re-adoption and adoption in any given year. Figure 13 shows the different directions in which a customer can upgrade their existing equipment upon burnout of their baseline equipment. These directions only apply to replace-on-burnout and accelerated replacement measures, which are installed upon failure and/or burnout of the baseline measure. Table 29 summarizes the direction categories associated with the equipment upgrade directions in Figure 13.

Figure 13. Customer Decision Relative to Baseline Equipment for Replace-on-Burnout and Accelerated Replacement Measures

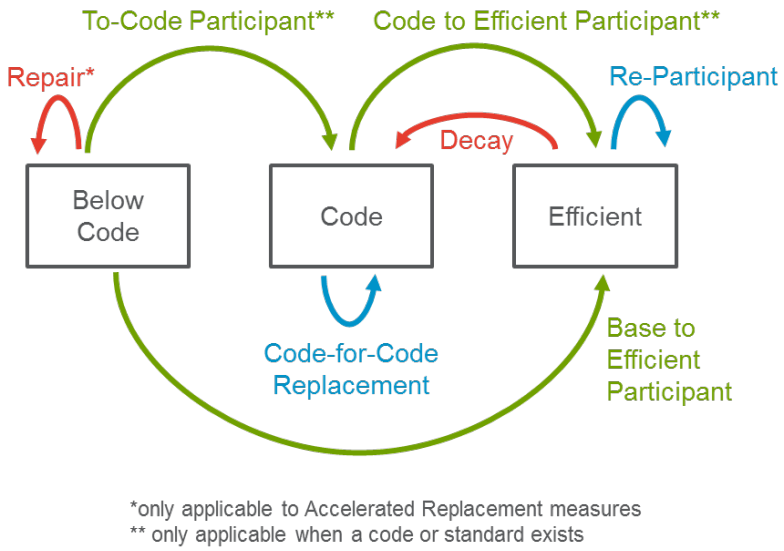


Table 28. Categories Associated with Equipment Upgrade Directions

Replacement Efficiency Level → Burnout Efficiency Level ↓	Below Code	Code	Efficient
Below Code	Repair	Adoption	Adoption
Code	N/A	Re-adoption	Adoption
Efficient	N/A	Reversion	Re-adoption

The model employs user-defined weights that characterize market bias to revert, re-adopt and adopt more efficient measures to quantify the distribution of installations across these direction categories. Table 30 shows how annual market penetration is disaggregated into penetration by direction category based on these weights. Only savings from adoptions are included in the incremental annual savings outputs used to set goals.

Table 29. Attribution of Market Penetration to Equipment Upgrade Direction Categories

	Replacement Measure		
	Below Code	Code	Efficient
Market Penetration	0%	60%	40%
Reversion	0%	1%	0%
Read option	0%	11%	4%
Forward Adoption	0%	48%	36%

where weights:

Reversion = 0.1
Readoption = 0.5
Adoption = 0.4

In the 2018 Potential & Goals Study, the model assumed that no customers revert, and all customers are as likely to re-adopt a measure at the same efficiency level as they are to adopt a more efficient measure (i.e. equal weighting between re-adoption and adoption was assumed). However, as explained above, the model can accommodate assumptions about reversion by setting a non-zero weight for this direction category.

As for retrofit measures, the model distinguishes first-time retrofits from retrofit re-installations by tracking retrofitted and non-retrofitted stock separately. Only savings from first-time retrofits are included in the incremental annual savings outputs used to set goals. The PG model has historically assumed all savings from retrofit measures persist perpetually, so the concept of reversion does not apply to these measures. However, the model can be programmed to assume that a percentage of those savings decay at some point in time due to customers choosing not maintain retrofits to their equipment. Navigant will work with the CPUC and relevant stakeholders to determine if such a modification is warranted in this study.

MODEL USE HISTORY AND PLANNED ENHANCEMENTS

The current PG model was adapted from Navigant's proprietary DSM-Sim™ model, which has been used in numerous potential studies across the country,

The PG model itself is an exclusive, enhanced version of this model, which has advanced built-in functionality to accommodate CPUC-specific requirements for a potential study. It was used to produce results for the 2018 Potential & Goals Study and contains elements and functions that were also used in models built for pre-2018 EE potential studies Navigant has conducted for the CPUC. Navigant will use this model as a starting point for this study.

In addition to modifications required to meet requirements stipulated in the RFP, Navigant plans to improve the model's usability and accessibility. Navigant with work with its partner, Lumina, to identify and test areas for performance improvement.

CUMULATIVE SAVINGS CALCULATION

As discussed in the Deliverable 11 description, Navigant's PG 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. Table 31 provides an example of how this calculation in done in Analytica for a measure with a lifetime of 5 years, whereby an "active savings" matrix is multiplied by a measure's unit energy savings to track cumulative savings over time. In this example, the model simulates "decay" of savings 5 years after the installation year. As mentioned in the Deliverable 11 description, "decay" also accounts for any changes to codes and standards.

Table 30. Active Savings Matrix for Measure with 5-year Lifetime in Model

Savings Year → Installation Year ↓	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
2020	1	1	1	1	1	0	0	0	0	0	0
2021	0	1	1	1	1	1	0	0	0	0	0
2022	0	0	1	1	1	1	1	0	0	0	0
2023	0	0	0	1	1	1	1	1	0	0	0
2024	0	0	0	0	1	1	1	1	1	0	0
2025	0	0	0	0	0	1	1	1	1	1	0
2026	0	0	0	0	0	0	1	1	1	1	1
2027	0	0	0	0	0	0	0	1	1	1	1
2028	0	0	0	0	0	0	0	0	1	1	1
2029	0	0	0	0	0	0	0	0	0	1	1
2030	0	0	0	0	0	0	0	0	0	0	1

Again, going forward, Navigant's PG model is flexible enough to modify the definition and methodology for calculating cumulative savings.

ACCOUNTING FOR PROGRAMMATIC INTERVENTIONS TO ACCELERATE ADOPTION

The market potential algorithm used to simulate adoption of energy efficiency measures in Navigant's PG model accounts for three aspects of utility program interventions:

1. **Incentives:** As described in the Deliverable 11 description, the model calculates customer willingness to purchase using a logit-based or payback-based approach, depending on the availability of data for measures in specific sectors. The availability of incentives provided by a utility to a customer affects customer willingness to purchase as follows:
   a. Logit-based: The logit-based approach compares the levelized measure cost (LMC) of an efficient measure to its baseline measure and all other measures it is in competition with, if applicable. As discussed in the Deliverable 11 description, the LMC of a measure is calculated using Equation 5. If an incentive is made available by the model for a measure, then the incentive reduces the LMC to the customer, as shown in Equation 6. This increases customer willingness to adopt a measure.

Equation 5. Levelized Measure Cost Calculation

$$LMC = Upfront\ Cost + PV(Annual\ Operating\ Cost,\ iDR,\ EUL)$$

Equation 6. Levelized Measure Cost Calculation with Utility Incentive

$$LMC = Upfront\ Cost - Utility\ Incentive + PV(Annual\ Operating\ Cost,\ iDR,\ EUL)$$

b. Payback-based: Payback time reflects the length of time (years) required for an energy efficiency investment to recover the initial upfront cost in terms of energy savings. Similar to the logit-based approach, the availability of an incentive reduces this upfront cost to the customer, and consequently reduces the payback time. This increases customer willingness to adopt a measure.

1. **Cost-Effectiveness:** The availability of incentives for a measure in the model is contingent of that measure being cost-effective. The cost-effectiveness screen is also used to ensure that only savings from cost-effective measures are included in the results used by the CPUC to set goals.

2. **Financing (optional):** California financing programs address some of the market barriers that discourage customers from adopting efficient equipment, such as lack of capital access and liquidity. Navigant's PG model can evaluate the attractiveness of a financing option by looking at the annual cash flows for an efficient measure, compared to an efficient measure that is financed, and comparing the net present value of the options. This lever is listed as an optional lever here, since it is typically only leveraged for a study's scenario analysis. It has historically not been considered in the reference case forecast in previous potential studies.