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SB 350 Doubling Energy Savings by 2030 Methodology Report

Beyond Utility Energy Efficiency Programs

Prepared for: **California Energy Commission**
Prepared by: **Navigant**

NAVIGANT

California Energy Commission

Gavin Newsom, Governor

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ABSTRACT

Senate Bill 350 (SB 350) requires the California Energy Commission (Energy Commission) to set annual targets to achieve a statewide cumulative doubling of energy efficiency savings in electricity and natural gas end uses by January 1, 2030. The Energy Commission also must report biennially to the legislature on progress achieved toward meeting these targets and the effects on disadvantaged communities. This report provides methodology and background information that feeds into the Energy Commission's report to the legislature.

There are three sources of savings quantified in the accounting of energy efficiency. These include the utility programs, codes and standards, and beyond utility programs. This report describes the analysis and assumptions for quantifying beyond utility program savings. Beyond utility programs are programs not administrated or claimed by the investor owned or publicly owned utilities. The beyond utility programs may be educational initiatives, financing strategies, and other mechanisms that may drive California energy users to reduce their energy use.

In 2017, the Energy Commission developed the initial SB 350 methodology, which included a set of analysis workbooks. The scope of this study was centered around updating the 2017 analysis workbooks to enhance the beyond utility savings potential identified in the 2017 report.

This report does not reflect all updates of the beyond utility savings calculations because it was completed before the consulting team handed off the analysis tools to Energy Commission staff for staff's subsequent update for the 2019 SB 350 reporting period. Updates conducted by Energy Commission staff may include new data, program design changes, and reflect current and planned program funding levels not described in this report.

Keywords: California Energy Commission, SB 350, energy efficiency, potential, methodology, beyond utility programs, energy savings, electricity, natural gas, analysis

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EXECUTIVE SUMMARY

Senate Bill 350 (SB 350) requires the California Energy Commission to set annual targets to achieve a statewide cumulative doubling of energy efficiency savings in electricity and natural gas end uses by January 1, 2030. There are three sources of savings quantified in the accounting of energy efficiency. These include the utility programs, codes and standards, and beyond utility programs. This report describes the analysis and assumptions for quantifying beyond utility program savings. Beyond utility programs are programs not administrated or claimed by the investor owned or publicly owned utilities. The beyond utility programs may be educational initiatives, financing strategies, and other mechanisms that may drive California energy users to reduce their energy use.

This report does not reflect all updates of the beyond utility savings calculations because it was completed before the consulting team handed off the analysis tools to Energy Commission staff for staff's subsequent update for the 2019 SB 350 reporting period. Updates conducted by Energy Commission staff may include new data, program design changes, and reflect current and planned program funding levels not described in this report.

The SB 350 savings claims are based on a baseline year of 2015. All program savings claims begin in that year and cumulate to 2030. As part of the analysis, the savings must not overlap with utility program savings (historical and forecasted) and what may be included in the demand baseline forecast provided in the Integrated Energy Policy Report.

Accompanying this report is a set of tools that enables the Energy Commission to calculate historically achieved beyond utility savings and forecast new savings potential from beyond utility initiatives.

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CHAPTER 1: Introduction

Senate Bill 350 (SB 350), the Clean Energy and Pollution Reduction Act (De León, Chapter 547, Statutes of 2015), requires the California Energy Commission (Energy Commission) to set annual targets to achieve a statewide cumulative doubling of energy efficiency savings in electricity and natural gas end uses by January 1, 2030. The Energy Commission also must report biennially to the Legislature on progress achieved toward meeting these targets and the effects on disadvantaged communities. This report provides the methodology and background information that feeds into the Energy Commission's report to the legislature for the biennial programs toward the SB 350 goal.

In 2017,[1] the Energy Commission developed the initial SB 350 methodology, which included a set of analysis workbooks. The scope of this study was centered around updating the 2017 analysis workbooks to enhance the beyond utility savings potential identified in the 2017 report. Relative to the 2017 study, this study provides the following:

- Methodological updates
- Increased scope of programs analyzed
- Recommended areas for future improvement and reporting, even beyond 2030

This report documents the scope of programs, methodological updates and recommendations from the study. This report does not reflect all updates of the beyond utility savings calculations because it was completed before the consulting team handed off the analysis workbooks to Energy Commission staff for staff's subsequent update for the 2019 SB 350 reporting period. Updates conducted by Energy Commission staff may include new data, program design changes, and reflect current and planned program funding levels not described in this report.

The programs included in the SB 350 analysis are beyond utility program savings. These are savings that should not overlap with any savings forecast as part of the investor-owned utilities (IOUs) and publicly owned utilities (POUs) potential studies and savings claims. There are a variety of beyond utility energy efficiency programs that will contribute to meeting the state's doubling target. These programs are grouped into the following categories:

- Codes and standards
- Financing
- Behavior and market transformation
- Sector-level

1 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.

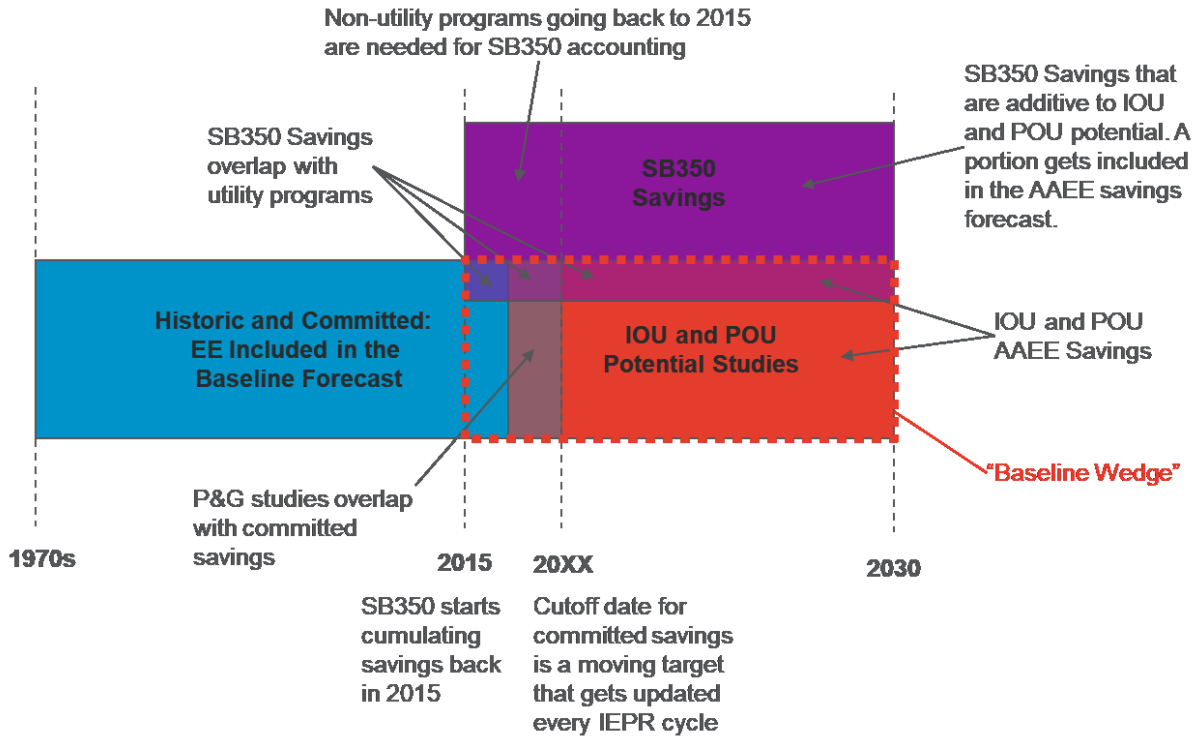
The Energy Commission, other state agencies, local governments, or other entities administer these programs.

This report does not provide results or savings analysis. Instead, this report provides the methodology and program descriptions included in the SB 350 analysis tools.

Savings Accounting

Figure 1 summarizes the different categories of energy efficiency savings considered by the Energy Commission's forecasting efforts and how they relate to each other. The relationships are illustrated as a Venn diagram because savings categories can overlap. Throughout the Energy Commission's forecasting process, every effort is made to not overlap because it is important to not double count savings. The Energy Commission also wants to quantify all acquired savings and potential for future energy use reductions.

Figure 1: Savings Accounting Venn Diagram



Source: Navigant team

Per Figure 1, the savings accounting definitions are as follows:

- **Historic and committed:** This refers to the energy efficiency savings embedded in the baseline forecast of the Integrated Energy Policy Report (IEPR). The IEPR baseline forecast includes energy efficiency savings from historical utility programs and codes and standards (C&S); it also includes savings committed to occur from known C&S. The IEPR forecast also includes savings forecasted from approved utility program budgets.
- **IOU and POU Potential Studies:** Savings forecast in the IOU and POU potential studies, including both rebated equipment and utility C&S advocacy claims. A portion of

IOU and POU potential study savings may overlap with energy efficiency savings in the baseline forecast. Historically, C&S and IOU and POU potential studies were the only source of savings included in the Energy Commission's Additional Achievable Energy Efficiency (AAEE) forecast.

- **IOU and POU Potential Savings:** The savings forecast from IOU and POU programs that are incrementally additive to (not double counted) the baseline forecast.
- **Baseline wedge:** A term specific to the SB 350 analysis. This is forecasted savings from utility with a start date of 2015 per SB 350 accounting policy. This includes overlap with the baseline forecast.
- **SB 350 beyond utility savings:** Savings beyond utility programs calculated for a range of programs that may be counted as part of the AAEE. They may contain some overlap with other historical, committed, or potential savings. As programs develop and quantify claimed and or verified historical program savings, the Energy Commission will update both historical committed savings and forecast savings accordingly.

Beyond Utility Programs

Various beyond utility energy efficiency programs contribute to meeting the state's doubling target. Many do not have long-term guaranteed funding and have historically been excluded from the AAEE.

The SB 350 analysis includes statewide and local government initiatives, financing options, and other initiatives. Some programs exhibit areas of undercounted savings from existing utility programs due to the following example reasons:

- **Misalignment on what is truly is industry standard practice.** The IOUs cannot claim savings or provide rebates for projects that may be deemed industry standard practice (ISP) by the California Public Utilities Commission (CPUC). CPUC treats ISP similar to a code or standard baseline
- **Barriers to program participation.** In some cases, the programs affect end users, but the program participation requirements cause burdens, which may result in unaccounted for savings. (Incentives are not the only drivers to implementing energy efficiency.)
- **Non-program requirements.** The IOUs do not allow projects mandated by other drivers such as California Air Resources Board (CARB) and Air Quality Management District (AQMD) requirements to count towards IOU program savings. These savings should be captured by the SB 350 analysis.

Table 1 lists the programs quantified in the SB 350 analysis of beyond utility program savings. The methodology described in this report captures savings that are either not claimed by utility programs or are outside of utility programs' scopes. Any program previously analyzed has its

original documentation in an appendix to the Final Commission Report *Senate Bill 350: Doubling Energy Efficiency Savings by 2030*.[2]

Codes and Standards

Since the 1970s, the Energy Commission has been responsible for establishing standards for building codes and appliances. Specific codes and standards included in this analysis are Title 24: Building Energy Efficiency Standards (building standards), the California Green Building Standards Code (CALGreen),[3] Title 20: State Appliance Efficiency Regulations (appliance regulations), and federal appliance standards.

Financing Programs

California has several available financing mechanisms for energy efficiency investments. Utility revenue does not fund these programs, which are major contributors to projected energy savings. Some utility programs do include financing, and those programs are excluded from this analysis. Any analysis of savings associated with financing must consider the synergistic benefits of coordinating with utility program participation. This study attempts to quantify any overlap in claimed or potential savings estimates between financing and utility program savings.

Behavior and Market Transformation

The behavior programs described in this category are those associated with energy efficiency savings that result from behavioral changes as opposed to installing a physical measure, like new lighting or equipment controls. These are typically initiated by informing the customer or building owner of energy use patterns. These include benchmarking, energy asset ratings, and applications using smart meter data (smart meter and controls), among others. Market transformation is another opportunity to realize energy savings through accelerating widespread measure adoption. These efforts may provide additional public education, funding, or other approaches to remove barriers.

Sector/Other

Several other programs have potential to deliver significant savings in specific sectors or markets. These programs may require the Energy Commission to explore new avenues to drive the market to change. These include fuel substitution, industrial measures, agricultural measures, and conservation voltage reduction (CVR).

Table 1: SB 350 Programs

Program Category	Program
Codes and Standards (C&S)	Building Standards (Title 24)
	Appliance Regulations (Title 20)

2 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.

3 CALGreen provides voluntary specifications that can be used as model ordinances that allow a city or county to easily establish more stringent building efficiency standards based on local climatic, geological, or topographical conditions.

Program Category	Program
	Federal Appliance Standards
	Local Government Ordinances
Financing	Air Quality Management Districts
	Local Government Challenge
	Proposition 39
	Low Income Weatherization
	Water-Energy Grant
	California Department of General Services Retrofit Program
	Energy Conservation Assistance Act
	Property Assessed Clean Energy
Behavior and Market Transformation	Benchmarking
	Behavioral, Retro-commissioning, Operational Savings
	Energy Asset Rating
	Smart Meter and Controls
Sector/Other	Fuel Substitution
	Agricultural
	Industrial
	Conservation Voltage Reduction

Source: Navigant team

For this study, the Navigant team developed a comprehensive tool that enables the Energy Commission to forecast the savings from beyond utility programs. The analysis for each program listed in Table 1 is stored in its own program workbook and post-processing steps combine the effects of each program and enable scenario analysis. Chapter 2 discusses the overall methodology of the tool, Chapters 3 discusses the methodology for calculating the portion of savings attributable to disadvantaged communities and low income customers, and Chapters 4 –22 detail each program listed in Table 1.

CHAPTER 2:
SB 350 Savings Calculation Methodology

This chapter describes the overall architecture and cross-cutting aspects of the modeling effort the Navigant team used to forecast savings from beyond utility programs for the Energy Commission. The savings calculation framework is grounded in a set of Excel workbooks packaged together to calculate SB 350 savings. Each program described in the following chapters has its own standalone program workbook that feeds into the overall SB 350 –attributed savings to-date and forecast future savings calculations. The tool's intent is to track savings toward the goal and forecast the remaining potential that may achieve or surpass the goal.

SB 350 Tool Objectives

The objectives for the overall SB 350 tool include the following:

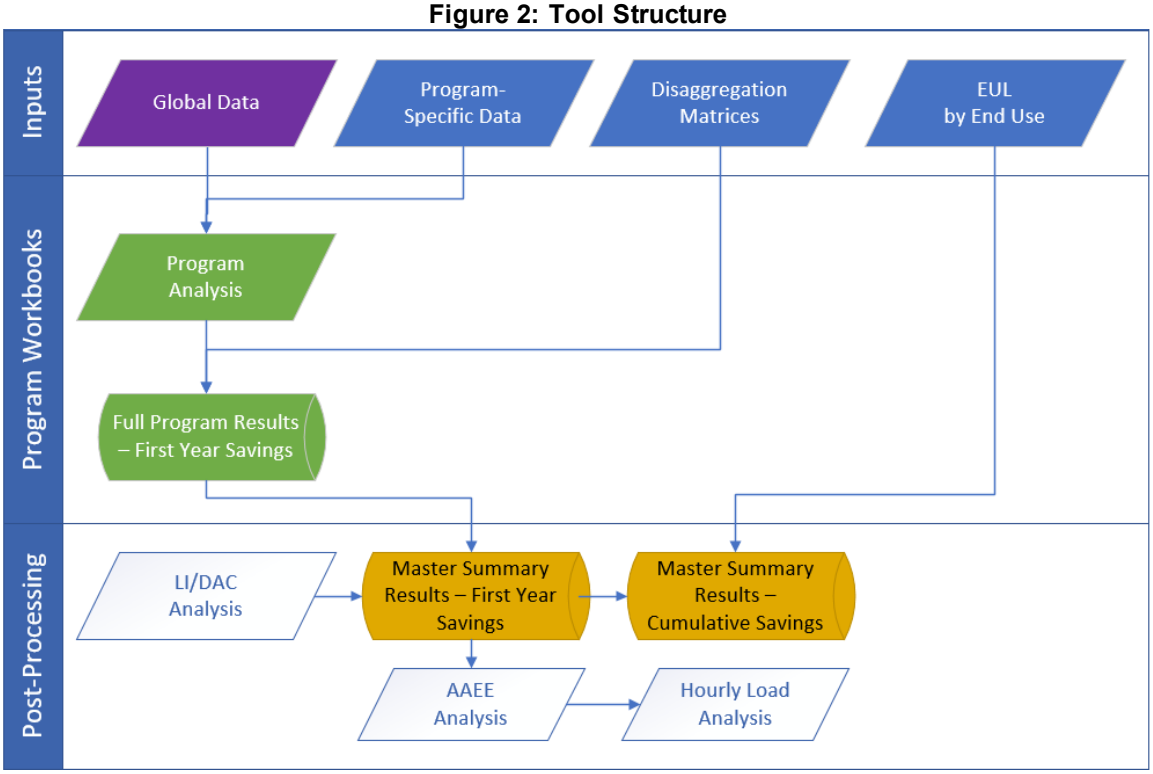
- Allow changes in data inputs that may vary over time
- Capture historic versus forecast data in the individual program workbooks
- Streamline data alignment with POU and IOU potential savings forecasts
- Develop and forecast various scenarios driven by program-specific scenarios and IEPR forecast scenarios

NORESCO with other consultants designed the program workbooks in 2017 to capture a snapshot forecast for the 2017 SB 350 report. The Navigant team migrated these workbooks into a new template to better integrate inputs and results. The team also updated a subset of workbooks identified by the Energy Commission in the process.

The overall SB 350 tool, outlined in Figure 2, has three major components:

- Inputs
- Program Workbooks
- Post-Processing

Figure 2: Tool Structure



Source: Navigant team

Inputs

The Navigant team used certain datasets across more than one program workbook, while others are specific to the analysis of a single program.

Global Data

The datasets from external sources that are common across multiple program workbooks are stored in the Master Input File to ensure consistency.

Program-Specific Data

Each program workbook has its own set of data inputs and assumptions. This data may be from the individual programs themselves or from other sources used to inform forecast assumptions. Two cross-cutting elements are described here.

Utility Overlap

The Navigant team designed the overall SB 350 tool to produce forecasts for the beyond utility programs. Some of these program activities overlap with utility programs, and any potential for double counting must be subtracted out of the forecasts. A utility overlap factor for each program accounts for this dynamic.

Program-Level Scenarios

Each program workbook has its own assumptions that help develop three scenarios: conservative, reference, and aggressive.

Disaggregation Matrices

Program workbooks that do not have the data granularity to support program-specific estimates use default disaggregation matrices when calculating savings. Two matrices distribute statewide program savings across utility territories: one for electricity savings and one for natural gas savings.

Effective Useful Life by End Use

Effective useful life (EUL) informs the decay of first-year savings over time to calculate cumulative savings as part of post-processing. The Navigant team provides default values for EUL by end use. Programs that have measure-level detail that create distinctive EUL values for an end use may alter this matrix in the program workbook.

Program Workbooks

The program workbooks follow a consistent tab structure and data flow while allowing the savings analysis for each program to fit the available data and appropriate forecasting method.

Post-Processing

First-year savings results by utility, end use, and scenario from the individual program workbooks undergo post-processing steps to produce outputs that feed various other analyses.

Low Income and Disadvantaged Communities

Per the SB 350 legislation, the Energy Commission must explore the barriers to and opportunities for expanding LI customers' access to energy efficiency. SB 350 also requires examining opportunities located in DACs. This step determines savings attributable to these populations of interest.

Cumulative Savings

To appropriately calculate savings from an installed measure continuing beyond the first year and decreasing over time due to various factors, the Navigant team applied decay dynamics to each end use based on EUL. The team applied the decay formula at the end use level to account for variations in EUL at this level. Decay does not imply reduced performance of individual pieces of equipment over time but rather the fractional loss each year of a subset of equipment from the originally installed population.

Additional Achievable Energy Efficiency

As described in Chapter 1, certain AAEE scenarios include subsets of the beyond utility SB 350 forecast savings. AAEE becomes part of the savings potential beyond that accounted for in the baseline managed forecast in the IEPR. The baseline forecast includes only historical and committed savings. The SB 350 results must be unpacked by program and scenario to meet the parameters of the AAEE forecast. The post-processing analysis provides the Energy Commission demand forecast team the necessary inputs.

Hourly Impacts Analysis

The Energy Commission uses the AAEE forecasts in combination with representative 8760 hourly load shapes to develop an hourly savings forecast. Subsequent analyses use the hourly savings forecast to define the impact of AAEE savings on system hourly loads. In the hourly impact analysis Navigant leverages best available load shapes at a sector, end use, and utility level and used California-specific shapes where available. Primarily Navigant sourced load shapes from the following sources:

1) **ADM Associates, Inc. Load Shape Study**.[4] As commissioned by the CEC, this study developed load shapes at a commercial, residential, agricultural, and industrial level for an array of end uses.
2) **Navigant 2017 AAEE Load Shapes**.[5] A Navigant-developed load shape library for use in the 2017 AAEE hourly impacts analysis. This library contains load shapes at the sector, investor-owned utility, and end use level.

4 California Investor Owned Utility Load Shapes. ADM Inc. and California Energy Commission, June 2019.

5 2017 AAEE Load Shape Library. Navigant Consulting and California Energy Commission, January 2018.

CHAPTER 3: Disadvantaged Communities and Low Income

DACs and the LI market segment represent a large but hard to reach population. Each represents a distinct subset of the population within a given geographic area, and the characteristics of both groups can make access to energy efficiency programs challenging. This review of forecasting methods for DAC and LI populations has its roots in various definitional and equity concerns and includes the following:

- Defining DAC and LI populations as separate though often comingled groups
- Reviewing datasets of interest in defining DAC and LI populations
- Checking the CalEnviroScreen (CES) variables to identify the criteria for defining populations, including comparing CES populations in poverty to the population of residents eligible for the California Alternative Rates for Energy (CARE) program
- Summarizing differences in DAC and LI population estimates between datasets
- Reviewing the analysis used to develop DAC and LI population metrics and detailing the assumptions used in those analyses

Definitions of Disadvantaged Communities

This study defines DACs according to California state legislation, which characterizes California communities across several criteria including disproportionate exposure to environmental pollution and population characteristics such as unemployment levels or concentrations of LI populations. AB 32, the California Global Warming Solutions Act, and its subsequent expansion (SB 535) resulted in the California Environmental Protection Agency (CalEPA) designating 25 percent of the highest scoring census tracts via the CES tool as DACs.

AB 32. The California Global Warming Solutions Act of 2006[6] directs the state board to, "where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California."

SB 535. In 2012, the Legislature passed SB 535 and directed that, in addition to reducing greenhouse gas (GHG) emissions, 25 percent of the moneys allocated from the Greenhouse Gas Reduction Fund also must go to projects that provide a benefit to DACs (SB 535 (De León), Chapter 830, Statutes of 2012).[7] A minimum of 10 percent of the funds must be for projects located within DACs.[8] CalEPA[9] was given the responsibility to identify DACs for the purposes of

6 https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200520060AB32

7 https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120SB535

8 https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/workshops/calepa-approaches-to-identify-disadvantaged-communities-aug2014.pdf

9 https://calepa.ca.gov/wp-content/uploads/sites/6/2017/04/SB-535-Designation-Final.pdf

this legislation based on geographic, socioeconomic, public health, and environmental hazard criteria. These criteria may include but are not limited to:

- Areas disproportionately affected by environmental pollution and other hazards that can lead to negative public health effects, exposure, or environmental degradation.
- Areas with concentrations of people that are of LI, high unemployment, low levels of home ownership, high rent burden, sensitive populations, or low levels of educational attainment.

Section 39711 of the Health and Safety Code adopted the SB 535 definition of DACs and applied it through the CES tool for communities in the top 25 percentile of CES scores.

Definition of Low Income

The team aligned its definitions of LI populations for this study with CES 3.0 and the US Census Bureau's American Community Survey (ACS) definitions of poverty. The ACS maintains information on the poverty rate in different areas in California based on the federal poverty level (FPL). The FPL defines poverty based on the size of the household and the ages of family members. CES uses this data to determine the percentage of the population with incomes less than two times the federal poverty level based on a 5-year estimate from 2011 to 2015. CES uses a threshold of twice the federal poverty level because California's cost of living is higher than many other parts of the country. The widespread use of this definition allows the study to maintain consistency with publicly available datasets, including CES and CARE reporting, using California's definition of LI. These definitions are also consistent with the income thresholds used to define eligibility for participation in the energy efficiency programs designed to address the needs of LI residents, including the Energy Savings Assistance (ESA) program.

Additionally, the Low Income Home Energy Assistance Program (LIHEAP) defines income thresholds that require an annual household income (before taxes) below 60 percent of the state median income. The LIHEAP threshold generally lines up with CARE threshold for households of six or fewer persons, though LIHEAP income thresholds are lower for households of seven or more persons. Appendix A-1 discusses LIHEAP, including a comparison of income thresholds between CARE and LIHEAP.

This study also includes the area median income level as a poverty metric. Although area median income thresholds are available at the state and county level, more granular data is necessary to forecast at the utility level to address inconsistencies between utility service territories and county boundaries. In this case, the team mapped ZIP codes to utilities. The "Methodology Description" section provides a more detailed discussion of how the analysis used CES census tract, ZIP code, and utility data to define the LI population.

Dataset Reviews

The research design included defining what LI and DACs mean in the context of the modeling work and how different research products and datasets can be combined to characterize completely the energy users and communities that might fall under these definitions and how

energy efficiency projects might be targeted for these populations. The team reviewed the following data sources to identify what single or combined sources accurately define LI and DACs to form a forecast at the utility level. The team selected sources using two criteria:

- Publicly available
- Vetted and maintained over time

Several sources met these criteria:

- **ACS.** The US Census Bureau conducts the ACS every year to provide up-to-date information about the social and economic needs at the community level (by ZIP code). It gathers information previously contained only in the long form of the decennial census. This research used the 2017 ACS update to understand how CES uses the survey data to develop socioeconomic factor indicators.[10]
- **CES.** CES is a mapping tool that helps identify California communities most affected by many sources of pollution and where people are often especially vulnerable to pollution's effects.[11] CES uses environmental, health, and socioeconomic information to produce scores for every census tract in the state. The research for this study used CES to assist in identifying counties that contain DAC and pollution-burdened communities based on the CES characteristics of their aggregated census tracts.
- **CARE.** CARE provides a monthly discount of 20 percent or more on gas and electricity. Participants qualify through income guidelines or if enrolled in certain public assistance programs.[12] CARE is a large, statewide IOU program with a 2017 program budget of $1.27 billion, of which $1.24 billion directly subsidized LI electricity and natural gas customers.[13] CARE is important because it:
    1. Is subject to income verification
    2. Provides service to many California residents
    3. Is reported on to the legislature each year through utility compliance filings

    This research analyzes CARE's overall county-level LI population eligibility and population participation for California's four IOUs. Other utilities, such as the Sacramento Municipal Utility District (SMUD), have similar programs, but these may not be subject to the same reporting requirements as CARE. As such, the application of CARE would likely be limited to LI populations receiving electricity or natural gas from California's IOUs.

Table 2 summarizes how the datasets previously discussed might be combined, including geographic coverage and data specificity. The geographic data specificity is at the most granular

10 https://www.census.gov/programs-surveys/acs/about.html

11 https://oehha.ca.gov/calenviroscreen

12 https://www.pge.com/en_US/residential/save-energy-money/help-paying-your-bill/longer-term-assistance/care/care.page?WT.mc_id=Vanity accessed September 2018

13 California Electric and Gas Utility Cost Report, Public Utilities Code Section 913 Annual Report to the Governor and Legislature. California Public Utilities Commission, Energy Division, April 2018

geographic area provided by the dataset (e.g., county, ZIP code, census tract, etc.). In general, all data sources can be used to define markets in the IOU services territories, followed by county-, city-, and census tract-level analysis. ACS and CES can be used to define markets in all utility service areas in California.

Table 2: Geographic Coverage and Data Specificity of Research Products Analyzed

Acronym	Dataset Geographic Coverage	Geographic Data Specificity
ACS	National	Census tract
CES	California	Census tract
CARE	California IOU territories	County

Source: Navigant team

Applicability of CES

Because CES is often referred to as the key source for defining LI and DACs, it is necessary to provide an interpretation of the CES tool, including how the scoring is defined and calculated and the relationship of CES to the ACS. This report also compares CES to CARE, including what metrics within the CES model might be the most appropriate to use to assess energy efficiency potential.

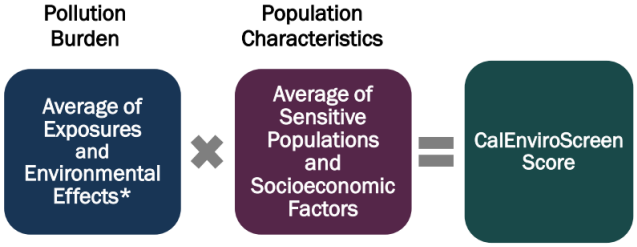
CES Score Formula

CES uses environmental, health, and socioeconomic information to produce a numerical score for each census tract in the state. The CES scores use place-based method of assessing the relative effects of pollution on communities. The model is made up of four components: two pollution burden components and two population characteristics components. Each component is made up of indicators.

- **Indicators:** The model uses 20 indicators (listed in Table 3) of which 12 measure pollution burden and 8 measure population characteristics. Each census tract receives scores for as many of the 20 indicators as possible. For each indicator, the scores are ordered from highest to lowest, allowing a percentile to be calculated for all indicators that have a score in a given census tract. The percentile represents a score relative to other census tracts for the available indicators.
- **Components:** The percentiles are averaged for the set of indicators in each of the four components—exposures, environmental effects, sensitive populations, and socioeconomic factors—to produce a score. The maximum score for all components is 10.
- **Population characteristics:** The population characteristics score is the average of the sensitive populations and socioeconomic components.
- **Pollution burden:** The pollution burden score is the average of the environmental effects and exposures components, where the environmental effects component is weighted by half because CES considers environmental effects to make a smaller contribution to pollution burden than exposures do.

The CES score is the product of the population characteristics score for a census tract and the pollution burden score of that tract. The CES score can also be the product of the average score of a population's exposure and environmental factors and the average score of the sensitive population indicators and socioeconomic factors. Figure 3 shows the formula the analysis team used to calculate the CES score. An area with a high score is one that experiences a much higher pollution burden than areas with low scores. Appendix A-2 further details the equation the analysis team used to provide the CES score at the census tract level.

Figure 3: Formula for Calculating CES Score[14]



* The Environmental Effects component is weighted one-half when combined with the Exposures component.

Source: Navigant team

14 https://oehha.ca.gov/media/downloads/calenviroscreen/report/ces3report.pdf

Table 3: CES Indicators

Pollution Indicators	Population Characteristics
Exposure Indicators	***Sensitive Population Indicators***
Air Quality: Ozone	Asthma
Diesel Particulate Matter	Low Birth Weight Infants
Pesticide Use	Cardiovascular Disease
Traffic Density	
Air Quality: PM2.5	
Drinking Water Contaminants	
Toxic Releases from Facilities	
Environmental Effect Indicators	***Socioeconomic Factor Indicators***
Cleanup Sites	Educational Attainment
Hazardous Waste Generators and Facilities	Linguistic Isolation
Solid Waste Sites and Facilities	Unemployment
Groundwater Threats	Housing Burden
Impaired Water Bodies	Poverty

Source: Navigant team

Relationship between CES and ACS

It is important to understand the relationship between CES and ACS when reviewing datasets and assessing the potential to fully profile DACs and LI populations. CES uses data from ACS for educational attainment, housing-burdened LI households, linguistic isolation, poverty, and unemployment. In other words, all the non-health-related population characteristics are sourced from the annual US Census Bureau survey data. Table 4 compares the CES and ACS metrics most relevant to forecasting energy efficiency on LI and DACs, while a more complete comparison of metrics can be found in Appendix A-5.

Table 4: Comparison of Key CES and ACS Metrics

CES Metric	CES	ACS
M4 Poverty	Percentage of the population living below two times the federal poverty level (5-year estimate, 2011-2015)	Number of individuals below 200 percent of the federal poverty level per census tract for the state of California (2011-2015 survey)

Source: Navigant team

Variations in CES Metrics by County

Table 5 outlines the CES population metrics for several counties to illustratively compare populations in DACs and those in poverty. CES defines the population in poverty as residents earning less than 200 percent of the federal poverty level at the census tract level, regardless of whether they reside in a census tract that is designated as DAC. In many cases, there is a significant disparity in each county between the size of the population in census tracts that are designated DACs and the size of the LI population in poverty.

The team identified this discrepancy in the sample of six counties provided in Table 5:. In those counties, 18 percent of census tracts are designated as DAC,[15] accounting for 24 percent of the total population. In contrast, 47 percent of residents are LI. This is notably higher than the 24 percent living in DAC census tracts when defining the census tract population in poverty based on the CES poverty[16] metric (i.e., the percentage of the population within a census tract that is living at or below two times the federal poverty level). . This implies that when forecasting energy efficiency potential within a county, the CES poverty metric defines a larger pool of eligible participants than if the population is defined only as those residents living in disadvantaged census tracts. Note that this research reviewed only six out of California's 58 counties and is not intended to present a state-level view.

Table 5: Example of County CES Statistics

County	Total Population	Total No. of CTs	% CTs* DAC	DAC CT Population	% DAC Population	Population in Poverty	% Population in Poverty	Difference in DAC Population and Population in Poverty
Butte	220,000	51	4%	8,674	4%	97,554	44%	88,880
Humboldt	134,623	30	0%	0	0%	60,735	45%	60,735
Kern	839,631	151	45%	403,918	48%	397,647	47%	-6,271
Marin	252,409	55	0%	0	0%	48,292	19%	48,292
Mendocino	87,941	20	0%	0	0%	39,109	45%	39,109
Santa Barbara	423,895	89	0%	0	0%	155,512	37%	155,512
Total	**1,706,090**	**396**	**18%**	**412.592**	**24%**	**798,849**	**47%**	**386,257**

*CT = census tract

Source: Navigant team

Comparison of CES and CARE

Table 6 compares CES and CARE, which can be used to assess the applicability of either dataset when identifying LI populations. The CES tool maps pollution hazards to allow for assessing

15 As defined as adopted as Section 39711 of the Health and Safety Code and is applied through the CES tool to communities in the top 25 percentile of CES scores.

16 See Table 4.

vulnerabilities to such hazards in communities across California. The CARE program, further defined in Appendix A-3, was designed to address the needs of LI households by offering a discount to retail electricity and natural gas rates for residents with income at 200 percent of federal poverty level or less. Both datasets provide methods to define LI and DAC populations, which are useful in forecasting energy efficiency potential.

Table 6: Comparison of CES and CARE

Component	CES	CARE
Geographic area	Uses percentiles to assign relative scores for each of the indicators in a given geographic area (census tract).	Statewide income thresholds that are periodically updated to follow national guidelines.
Data reliability	Uses ACS data for non-health-related population characteristics; relies on adequate sampling that is national is scope.	California-specific for IOU territories; income verified and audited.[17]
Minority Representation	None inherent: analysis does shows clear disparities with respect to the racial makeup of the communities with the highest pollution burdens and vulnerabilities. One in three Latino and one in three African Americans are likely to live in a tenth decile tract compared to one in 14 white people.[18]	None inherent: depends on income and household size. Some relationship between household size and race.[19]
Risk	Accounts for socioeconomic and sensitivity factors as effect modifiers for environmental pollutants and health risk.	Addresses socioeconomic status.
Intended Use	Designed primarily to address health risk and environmental quality.	Designed primarily to allocate rate discounts for energy and as a qualifying criterion for participation in energy efficiency and related programs.

Source: Navigant team

Comparison of LI Population Metrics

17 Public Utilities Code Sections 382, 739.1, 900, and 2790 require the Energy Commission to establish and manage the CARE program in the most efficient and cost-effective way, including the determination of utility administrative and outreach expenditures, and the development of discount rates, penetration goals, and enrollment methods. A variety of related Energy Commission decisions and best practice criteria (such as found in the State Administrative Manual) also speak to similar goals and administrative objectives for the program.

18 https://oehha.ca.gov/media/downloads/calenviroscreen/document-calenviroscreen/raceageces3analysis.pdf

19 https://www.ppic.org/content/pubs/report/R_201BRR.pdf

Table 7 compares county populations defined by the CES poverty metric and the population eligible for CARE;[20] the table also shows LI population estimates varied for each county, with a range from -17 percent to 28 percent. At the total sample level, the CES population in poverty estimate was approximately 3 percent higher than the estimated CARE eligible population.

Table 7: Comparisons of CES and CARE Populations

County	Total Population	CES Population in Poverty	Eligible CARE Population	% of CES Population in Poverty to Eligible CARE Population
Butte	220,000	97,554	117,998	83%
Humboldt	134,623	60,735	71,543	85%
Kern	839,631	397,647	361,485	110%
Marin	252,409	48,292	56,217	86%
Mendocino	87,941	39,109	44,851	87%
Santa Barbara	423,895	155,512	121,029	128%
Total	**1,706,090**	**798,849**	**773,123**	**103%**

Source: Navigant team

Summary of Population Metrics Analysis

The following summarizes observations from the preceding discussions:

- In developing a forecasting method for disadvantaged and LI communities, defining the population of households that may qualify for LI market interventions varies depending on the dataset used or the specific metrics selected within a specific dataset.
- Using the CES DAC definition alone as the criteria resulted in a significantly smaller population of LI residents than the estimated CES population in poverty or eligible CARE population.
- For a sample of six counties reviewed, the CES population in poverty estimate was approximately 3 percent higher than the estimated CARE-eligible population; the variance at the county level ranged from -17 percent to 28 percent.
- In considering which definition to use in forecasting energy efficiency impacts on LI populations:
    - Data availability at the appropriate level varies, and consistency with other state programs for energy efficiency and addressing LI and DAC needs is a priority.
    - The CARE-eligible population is a California-specific estimate based on a process that includes income verification and periodic audits to confirm accuracy. Qualifying for

20 Further defined in Appendix A-4. CARE Population Estimates

CARE is a criterion required to participate in the ESA program, California's primary LI-focused energy efficiency program.

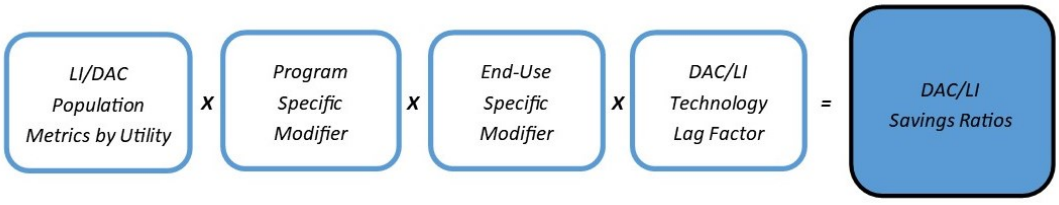
- The CES population estimates are based primarily on ACS data, which is based on an ongoing survey conducted by the US Census Bureau. It regularly gathers information previously contained only in the long form of the decennial census.

Methodology Description

The Navigant team designed the savings estimates for the SB 350 workbooks to produce several forecast breakouts based on characteristics such as utility and forecasting scenario. As a post-processing element of the overall tool, the DAC and LI elements interact with three of these variables—utility, program, and end use—while accommodating future updates based on data availability. Producing savings estimates for LI and DAC populations involves incorporating four distinct ratios (as shown in the simplified formula in Figure 4), the results of which are then applied to the products of the program workbooks. The following sections:

- Describe the method used to attribute CES poverty and DAC data to utilities using ZIP code databases that define utility territories, and how this allocation relies on the specific utility list involved in the study.
- Discuss the application of LI modifiers to residential program workbooks and DAC modifiers to the full suite of program workbooks, including how this process addresses overlap between the populations.
- Explain how the analysis team used technology adoption lag among LI populations and DACs to address the lack of specific data for details of how program- and end use-specific modifiers to savings, and how these assumptions can be modified in the future. The team addressed estimates which can be altered in the future.

Figure 4: Simplified LI/DAC Savings Ratio Formula



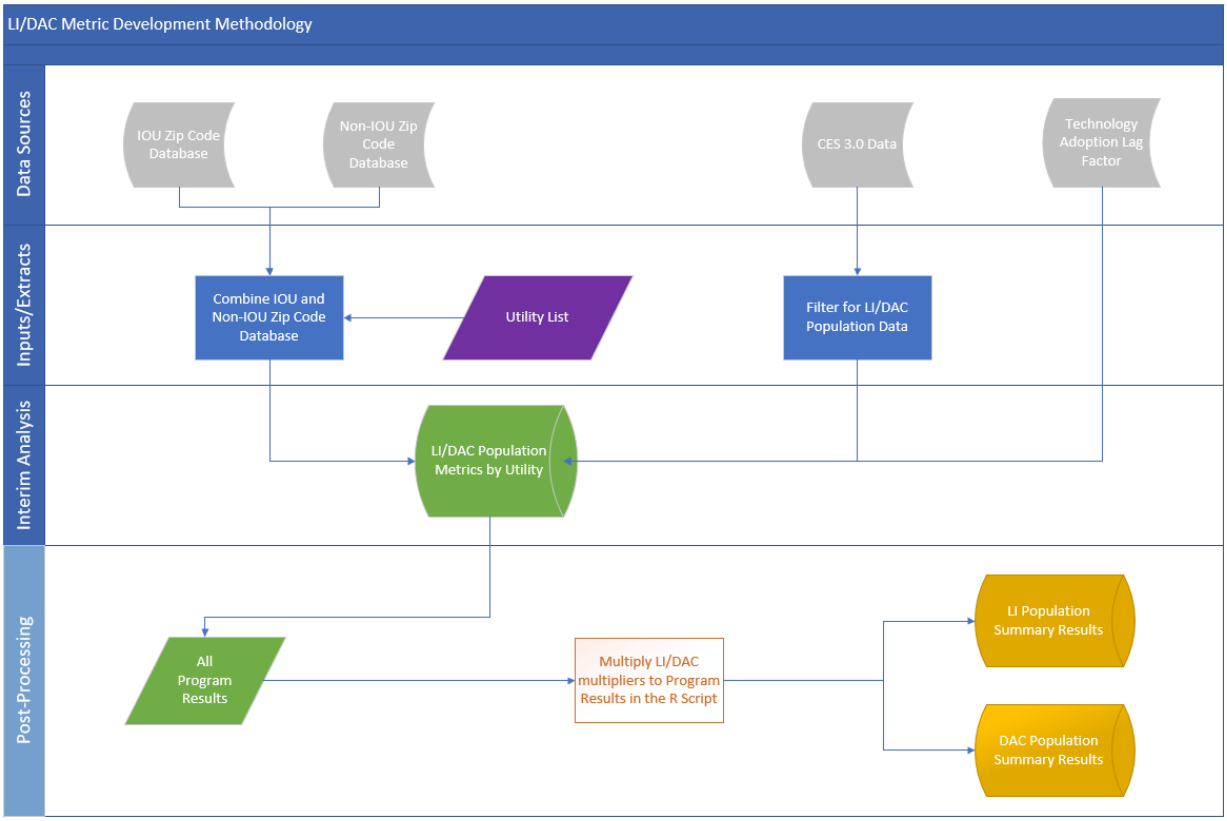
Source: Navigant team

Using ZIP Code Data

The Navigant team derived the aggregated LI/DAC population proportion metrics by utility from CES data. Figure 5 summarizes the database inputs and overall process to produce the values for aggregated utility LI/DAC population proportion ratios. Although CES data is available down to the census tract level, utility service territories could only be mapped down to the ZIP code level. The team paired CES census tracts with their corresponding utilities using databases of IOU and non-IOU service areas by ZIP code. These databases were then reviewed to ensure that non-IOU electricity providers not examined in this study were treated consistently. For example, if a POU was coded in the database for a municipality, the corresponding IOU for that service area was

instead attributed to that ZIP code. The team used the resulting dataset of CES census tracts, DAC designations, poverty metrics, and corresponding gas and electric utilities to produce aggregated utility population proportions for LI populations and DAC population metrics, which were then modified according to the above formula (Figure 4).

Figure 5: Aggregated Utility Population Proportion Methodology Diagram



Source: Navigant team

Technology Adoption Lag

The beyond utility SB350 program-workbooks include savings by specific technology end uses. The team applied the end use-specific modifiers to LI/DAC energy efficiency savings. It is widely acknowledged that there are structural and policy barriers to technology adoption among DAC and LI populations.[21] In the context of energy efficiency program adoption and in particular, technology end use adoption, substantive data regarding the rate of adoption is not available. To address the expected variation in end use adoption and program participation for these populations, this study's approach addresses general technology adoption rates and trends for DACs and LI populations with a modifier. The team labeled this modifier the LI/DAC technology adoption lag factor. The lag factor incorporates analysis of data observed across several technologies, with adoption rate of LI individuals at a given time typically being less than general

21 https://efiling.energy.ca.gov/getdocument.aspx?tn=214830

adoption rates by between 30 and 50 percent. Applying the lag factor relies on two key assumptions:

- First, the approach assumes that similar barriers to technology adoption exist for technologies unrelated to energy efficiency.
- Second, it assumes the rate at which technologies are adopted by LI populations and DACs will lag that of other populations at a constant level.

In support of these assumptions, this approach examines data regarding differential technology adoption related to age disparity,[22] rural and urban communities,[23] and the trend of higher income adults adopting digital technology earlier than their lower income counterparts (see Figure 6).[24] Several of the structural barriers identified by the SB 350 Barriers Study[25] (low home ownership rate, lack of capital and credit, financing, and living in remote communities), were reflected in well-supported demographic trends. Furthermore, the rate of lag among these populations does not vary significantly over time; it tends to stay at a fixed rate below general adoption rates. Taken together, these trends support using a static lag factor rather than attempting to adjust adoption metrics in the absence of supporting data. Nonetheless, the analysis team included program- and end use-specific modifiers in the methodology to incorporate future data relating to LI and DAC savings lag and to maintain consistency with the other program workbooks. In the case of end use-specific modifiers, all were given a value of one, while program-specific modifiers varied, as detailed in the "Addressing Program Sector" below.

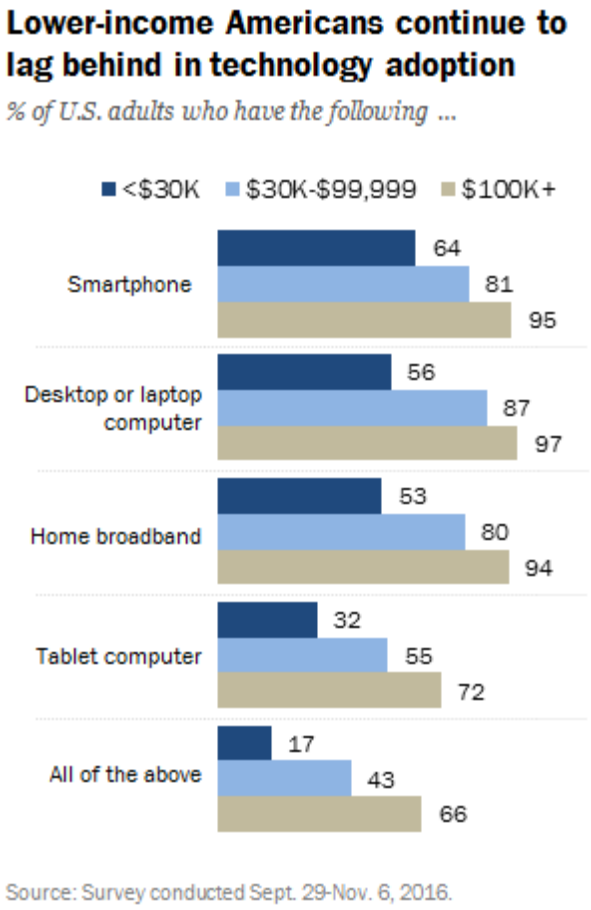
22 https://www.pewinternet.org/2014/04/03/older-adults-and-technology-use/

23 https://www.pewresearch.org/fact-tank/2017/05/19/digital-gap-between-rural-and-nonrural-america-persists/

24 https://www.pewresearch.org/fact-tank/2017/03/22/digital-divide-persists-even-as-lower-income-americans-make-gains-in-tech-adoption/

25 Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities https://efiling.energy.ca.gov/getdocument.aspx?tn=214830

Figure 6: Digital Technology Adoption Trends



Source: Pew Research Center

Addressing Program Sector

The team also considered the sectoral relevance of the LI and DAC definitions to the specific SB 350 program workbooks. Those programs exclusively serving nonresidential sectors will not directly affect LI populations living in a given census tract. Rather, LI populations will be affected by programs targeting residential savings, while DACs will be affected by any activities occurring within the community. This approach accomplishes several things:

- It acknowledges the place-based nature of the DAC designation by accounting for nonresidential and residential programs' effects to a community as a whole. Conversely, forecasts for LI populations will not overestimate savings based on programs with minimal to nonexistent residential impacts.
- It addresses overlap between DAC populations and LI populations while retaining a sufficiently broad population sample, the need for which is discussed in the "Summary of Population Metrics Analysis" section.

Conclusions on Methodology

The discussion throughout this section aims to clarify the definitions of LI and DAC—two distinct, though overlapping groups—and establish the methods the analysis team used to apply these

definitions to the SB 350 forecasting tool framework. The section also addresses the treatment of specific programs, end uses, and utilities according to these definitions and discusses the applicability and availability of datasets to support the LI and DAC definitions.

CHAPTER 4: Codes and Standards – Building Standards (Title 24)

Title 24, Part 6 (Title 24) is the California Building Energy Efficiency Standards,[26] which contains the regulations that govern building construction in California. Title 24 covers regulated energy uses in buildings by setting energy design standards for residential and nonresidential buildings. The Energy Commission establishes and revises the code on a three-year cycle. The most recently implemented version being 2016 (as applicable for the SB 350 beyond utility analysis, effective January 1, 2017 through December 3, 2019). Future versions relevant to this analysis will be 2019, 2022, 2025, 2028, and possibly 2031 (as it relates to early adoption, for example). For each update of the building standards, the Energy Commission proposes new efficiency measures and improvements to existing measures.[27]

Program Overview

The IOUs claim C&S savings quantified in the potential and goals (PG) studies and via evaluation, measurement, and verification (EM&V) reports. The difference between the total C&S Title 24 estimated savings and the utility-reported savings from PG studies is the incremental savings for the SB 350 calculated Title 24 savings. Projected savings from the 2016 and 2019 new construction and 2019 building standards for additions and alterations are included in the baseline forecast estimates for utility programs and begin delivering savings once they have gone into effect. Older vintages of the building standards are not included in this analysis because they are assumed to be covered in the baseline.

Energy savings projections presented in this section include the 2016, 2019, 2022, 2025, and 2028 building standards. In accordance with the CPUC's 2020 and 2030 zero net energy goals, the 2019 and 2028 standards will consider the new zero net energy requirements for residential and nonresidential buildings, respectively. The 2022 standards will examine low-rise and high-rise multifamily buildings and the potential for establishing efficiency measures specific to multifamily buildings distinct from other residential and nonresidential buildings. Local ordinances, such as those meeting targets prescribed in CALGreen, complement the statewide standards and ensure California consumers fully realize the benefits of advancements in energy

26 The California Building Code (Title 24, California Code of Regulations) is a collection of codes covering various elements such as electrical, mechanical, plumbing, fire, historic buildings, and so forth. The code also includes the Energy Commission's Building Energy Efficiency Standards (California Energy Code, Title 24, Part 6) and the California Green Building Standards (Title 24, Part 11).

27 Public Resources Code Section 25402(b)(1).

efficiency.[28] However, voluntary beyond-code programs are not included in this estimate; these are captured in the Local Governmental Ordinances workbook described in Chapter 7.

Title 24 affects the following building markets:

- Residential and nonresidential buildings, excluding certain building types and end uses, such as industrial buildings and non-covered processes including refrigerated warehouse loads and data center uninterruptible power supply (UPS) power.
- All cases in which an application for a building permit or renewal of existing permit is required; Requirements are different for new construction than for additions or alterations to existing buildings.

Updates Relative to Previous Study

For the 2019 SB 350 update, the analysis team made updates to output savings estimates by code cycle year and report savings by end use as calculated by the building models. Results from the Publicly Owned Utility Potential Study[29] were also added to the utility overlap calculation. No other significant changes were made to the previous study. However, to finalize the SB 350 2019 reporting, the Energy Commission should review and revise, where necessary, key inputs and assumptions regarding market uptake, compliance rates, and end use assumptions when disaggregating energy results. The previous study performed extensive energy simulations to produce modeled savings estimates that can be adjusted through this post-processing spreadsheet analysis in future iterations of SB 350 analysis. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A1 Title 24, for more details on the analysis conducted for this program.

Methodology Description

Savings contributions to the SB 350 goals for Title 24 use an energy modeling approach, applying the results of a large set of energy simulations for a set of building types and measures for each of the 16 California building climate zones to project energy savings through the 2028 code cycle. Energy savings per building of each type is converted to a total electricity and gas savings by mapping the existing and new construction building stock to the climate zones. The team estimated savings for each year by interpolating the results in between code updates and scaling the energy savings for the given year.

The savings estimates for Title 24 as it applies to new construction may be reported and updated by code cycle, an enhancement from the previous study. Energy savings results from other data sources (such as the Energy Commission impact analysis) can be compared against these results, and the energy savings can be adjusted at a high level for each code cycle.

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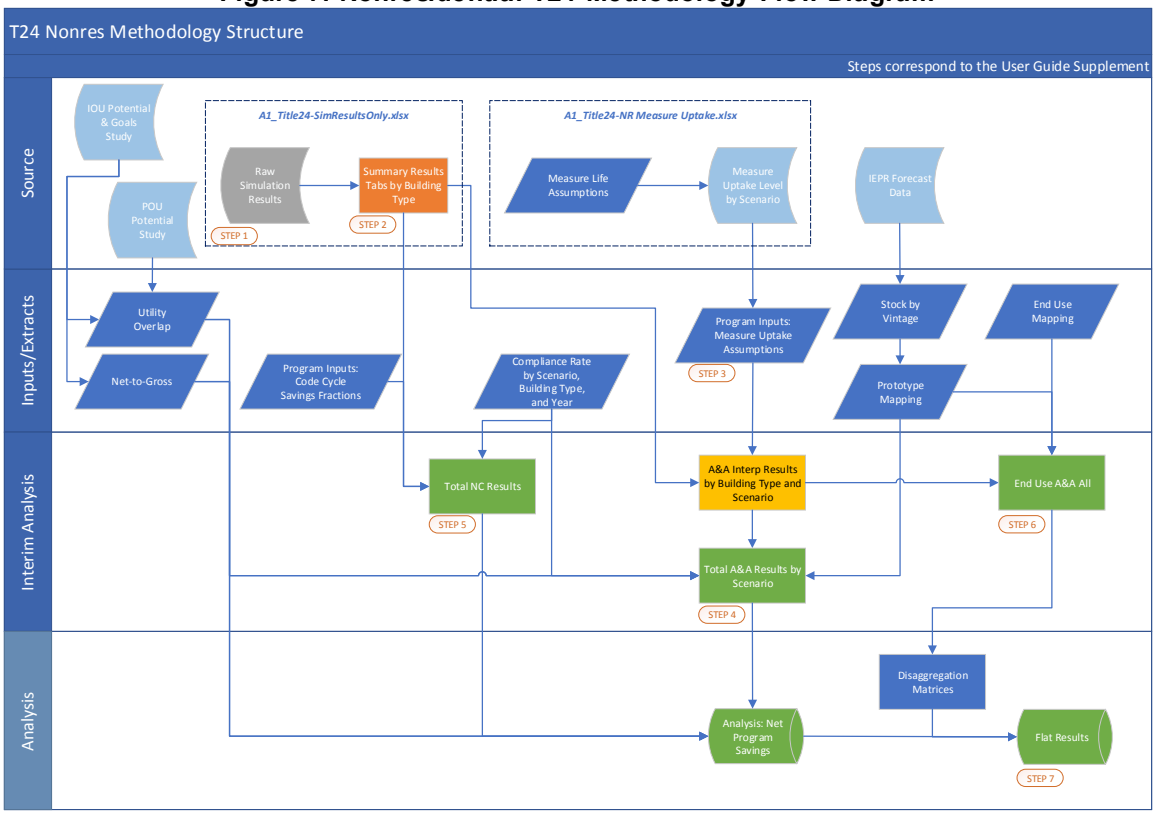
28 Local jurisdictions adopting Local Ordinances exceeding Title 24 must file findings of the local condition(s) justifying the ordinance and the adopted local building standard(s) with the California Building Standards Commission to become effective. For Local Ordinances exceeding the building energy efficiency standards set forth in Title 24, Part 6, a demonstration of energy savings and cost-effectiveness must be submitted to the Energy Commission and approved by the Commission under Title 24, Part 1 administrative regulations found in 10-106 before they can be enforced.
29 Sathe, Amul (Navigant), Wikler, Greg (Navigant), Cullen, Gary (Anchor Blue LLC), Penning, Julie (Navigant) 2018. Publicly Owned Utility Electricity Savings Projections. California Energy Commission.

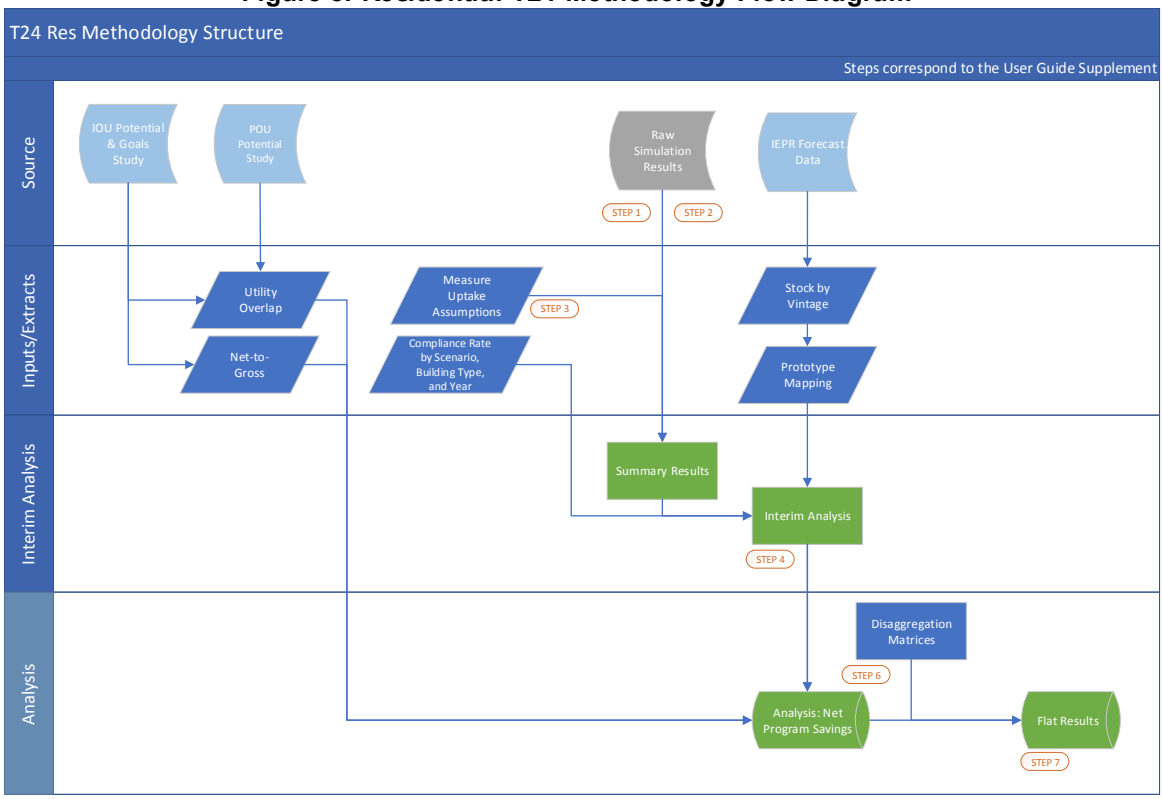
Figure 7 and Figure 8 show the overall flow of the methodology of this workbook for nonresidential and residential, respectively, highlighting the movement of data and calculations throughout the workbook.

Figure 7: Nonresidential T24 Methodology Flow Diagram



Source: Navigant team

Figure 8: Residential T24 Methodology Flow Diagram



Source: Navigant team

New Construction

The Title 24 workbooks track savings for new construction by code cycle (i.e., 2019, 2022, 2025, and 2028). The methodology starts with a 2016 code-compliant building and ends with an estimated 2028 code-compliant building. Working backwards from 2028, the analysis builds in assumptions that estimate savings per code cycle as a fraction of the 2028 total estimated savings with current assumptions shown in Table 8.

Residential Title 24 savings for new construction are not included because the code is anticipated to be near net zero with renewable energy sources; moreover, most of the improvements beyond 2020 not provided by renewable generation will be met by Title 20 (i.e., lighting and appliances).

Table 8: New Construction Code Cycle Year Savings as a Percentage of 2028 Savings

Title 24 Code Cycle	Percentage of 2028 Savings
2019	33%
2022	50%
2025	67%
2028	100% (max. potential)

Source: Navigant team

While the percentage assumptions were based on engineering judgment when they were first established in 2017, they can be trued up against better estimates of the savings as each code version becomes available. Savings data for true-up purposes can be extracted from any study that estimates Title 24 savings for residential versus nonresidential building sectors and for new construction versus additions and alterations; such studies include the Title 24 Impact Analysis or IOU evaluation studies. This requires comparing the savings potential suggested by the Title 24 Impact Analysis of that code cycle against the modeled 2028 savings estimate. This comparison will refine the percentage assumptions of savings potential by code cycle, and consequently, the savings projections associated with new construction for the Title 24 program under SB 350 .

In updating SB 350 projections, the Navigant team proposes using a relative approach based on another source (such as the Title 24 impact analysis) to true up the incremental savings between code cycles and modify the projected savings for future code cycles.[30] An increase in savings in one code cycle would likely have the effect of decreasing savings for subsequent code cycles. The program workbook estimates total energy savings based on efficiency measure package assumptions in the simulation models. The workbook provides a high level means of adjusting the savings to match forecast expectations, but does not allow the Energy Commission to increase or decrease expected efficiency gains at the building type level (e.g., office, retail, hospital, etc.).[31]

The impact analysis estimates cannot be directly input to the SB 350 tool because the SB 350 tool uses a different set of assumptions and a different methodology from the Title 24 impact analysis approach. Truing up the two estimates would require aligning the assumptions of the two approaches. Some of the key differences include the following:

- This analysis uses a maximum technical potential and associated EUI endpoint of 2030 for future energy savings predictions, while the Title 24 impact analysis looks at one code cycle at a time.
- This analysis applies specific net-to-gross (NTG) assumptions and code compliance rates, which do not match impact analysis assumptions.

30 This may require reviewing the program workbook assumptions on uptake, net-to-gross (NTG), etc. to make sure they align with the assumptions from the other data source. For instance, the impact analysis uses a NTG of one and a code compliance rate of 100 percent.

31 A building type or end use adjustment would require constructing a new building model.

- This analysis incorporates measures for end uses that are not regulated by Title 24 (commercial refrigeration, plug loads).

The team recommends using future impact analysis updates to adjust the SB 350 estimate by adjusting the estimate in proportion to increases or decreases in total savings (GWh or Therms) and adjusting future code cycle estimates to track toward the specified 2030 target efficiency levels from one code cycle to the next.

Existing Buildings

For existing buildings, the analysis approach used a 2028 package of discrete measures applied to each building vintage for each building type and each of the 16 building climate zones. The analysis estimates electricity and gas savings between this 2028 code snapshot and a 2016 code snapshot. It applies a set of measure uptake assumptions to determine what percentage of buildings at each existing building vintage are upgraded to newer codes and spreads this total savings amount evenly across the years from 2017 to 2030 .

Forecasting Scenarios

The analysis team made the following assumptions for the reference, conservative, and aggressive scenarios. Compliance rate is one dimension adjusted to differentiate the scenarios. The current levels for the conservative, refernce, and aggressive scenarios are 75 percent, 85 percent, and 95 percent. The compliance rates are also adjustable at the following dimensionality:

- Sector
- Building Scope (new construction versus additions and alterations)
- Building Type

Scenarios for additions and alterations savings are also adjustable through the measure uptake assumptions.

- Reference scenario assumes typical equipment turnover rates for estimating addition and alteration savings.
- Conservative scenario assumes a 10 percent reduction in equipment turnover rates compared to the reference case.
- Aggressive scenario assumes a 30 percent increase in equipment turnover rates compared to the reference case.

Areas to Improve

The team recommends that future iterations of the SB 350 savings potential analysis include further research on calibrating savings by code cycles and utility savings overlap .[32] Specific recommendations include the following:

32 Savings overlap may occur with other programs within utility portfolios and not just the C&S analysis.

- **Compliance rates:** Provide data-driven inputs on compliance rates for the three scenarios with as much granularity as available.
- **Measure uptake:** Review and provide updated values on measure uptake.
- **Review 2030 target efficiency levels:** Review measure package assumptions and verify that forecast nonresidential new construction efficiency levels align with Energy Commission goals and forecasts.
- **Calibration of savings estimates:** Update new construction estimates for each code cycle as more specific impact analysis estimates become available. Provide a reliable means for comparing energy savings estimates from the impact analysis so program estimates can be appropriately updated.

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CHAPTER 5:
Codes and Standards – Appliance Regulations (Title 20)

Title 20, known as the California Appliance Efficiency Regulations, contains the efficiency standards that establish the minimum performance for listed appliances to be sold or offered for sale in California. The code includes performance and design requirements for the energy and water use of appliances. The Energy Commission, which develops and implements Title 20, is not required to update the code on any specific interval; the Energy Commission updates individual standards after receiving sufficient data to support new or amended efficiency standards or test procedures for individual appliances. The scope of Title 20 is limited by federal appliance standards developed or implemented by the US Department of Energy (DOE) under the Energy Policy and Conservation Act of 1975 and its amendments. The federal appliance statute states that no individual state can adopt appliance standards for products if there is a national standard; however, there are some specific exceptions for individual appliances or situations or if a waiver of preemption on a specific appliance to an individual state is granted. Therefore, Title 20 can generally only regulate appliances outside the scope of DOE appliance standards.

Program Overview

The Energy Commission is responsible for establishing and enforcing Appliance Efficiency Regulations (appliance regulations) that set minimum efficiency standards and test procedure, marking, and disclosure requirements for both federally and non-federally regulated appliances.[33] The appliance regulations include the requirement that a regulated appliance may not be sold or offered for sale in California unless it is certified to comply with the standards. Well-designed mandatory energy efficiency standards transform markets by removing inefficient products to increase the overall economic welfare of most consumers without seriously limiting their choice of products.

Updates Relative to Previous Study

The analysis team did not make significant changes to the methodology from the previous study. The current spreadsheet includes capabilities to increase analysis sophistication, as described in the "Methodology Description" section. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. The previous study performed a measure-level analysis. This team did not update this analysis but future can be adjusted in future iterations of SB 350 analysis. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A2 Title 20, for more details on the analysis conducted for this program.

33 Title 24, Sections 1601-1609, California Code of Regulations.

Methodology Description

The analysis team derived Title 20 program savings for SB 350 using a bottom-up extrapolation approach to determine the savings potential for viable Title 20 standards based on available studies and discussion with members from the Appliance Standard Awareness Program (ASAP) and the California IOU Statewide C&S team, both of which are looking into future appliance standards at the federal and state levels.

The team developed a list of potential Title 20 measures that are viable to develop and include into the Title 20 standards through 2029. This included any known measures that are identified but not included in the 2018 IOU PG study,[34] any known or expected long-term future measures that are in guiding documents from the Energy Commission or other sources, and additional measure opportunities identified from data collection and discussed with IOU C&S staff. The team relied on current analyses and studies as well as information the Energy Commission provided regarding expected rulemakings.

The current program workbook includes some capability enhancements. While capabilities have been added to increase the sophistication of the analysis, the core methodology approach remains largely the same as the SB 350 analysis conducted in 2017. The capability enhancements include the following:

- **Measure EUL:** This permits the measure to persist for a defined period and then expire. This is applied at the end use level. In the previous spreadsheet, the analysis team assumed the measure EUL to be permanent (the measure never ends).
- **Individual measure sunset date:** This, along with the implementation date, defines the total number of years that the measure will be active. This will permit the sequencing of measure tiers in the list, presuming there is an expectation for when the first, second, and so on tiers are going to be implemented. Most of the measures do not have a specifically designed next tier planned; however, if there are more in the future, the tool will accommodate. If this is not defined, the measure EUL is applied (or whichever one defines the shortest time).
- **Normally occurring market adoption (NOMAD) curve capability:** This permits an actual NOMAD curve, as defined by annual NOMAD, through the life of the measure. Previously, this was fixed as a constant, but now, it is possible for this to be a more common S curve for NOMAD. This is set to the previous fixed values.
- **Tracking of measures by sector, end use, and start date:** This permits more detailed tracking of the measures than previously possible and enables the Flat Results tab to reflect higher resolution in the measures.

Forecasting Scenarios

Based on this information, the team made the following assumptions for a reference, conservative, and aggressive savings scenario.

34 https://www.cpuc.ca.gov/General.aspx?id=6442452619

- **Reference case:** The reference case assumes that the Energy Commission will adopt updates to current Title 20 standards, where feasible, and adopt new standards for currently unregulated appliances and products, with consideration of federal preemption. The compliance factor, which represents the proportion of the market that will comply with the standard at the time it goes into effect, is set at 85 percent, aligning with the PG study assumption. This equates to an average of approximately one new standard adopted every 2 years.
- **Conservative case:** In the conservative case, the team assumes that the Energy Commission will adopt updates to current Title 20 standards where feasible and new standards for currently unregulated appliances and products they have interest in, as shown on the Energy Commission Pre-Rulemaking Title 20 docket. The compliance factor is set at 85 percent, aligning with the PG study assumptions. This equates to an average of approximately one new standard adopted every 4 years, resulting in a smaller number of possible measures included in this scenario.
- **Aggressive case:** The aggressive case assumes that the Energy Commission will adopt updates to current Title 20 standards where feasible as well as new standards for currently unregulated appliances and products, with consideration to federal preemption. The compliance factor is set at 100 percent as requested by the Energy Commission.

Areas to Improve

The team recommends that future iterations of the SB 350 savings potential analysis include further research on calibrating savings and utility savings overlap.

Specific recommendations include the following:

- **Utility savings overlap:** Confirm that the subtractions made to account for overlap with Navigant's 2018 PG analysis are appropriate.[35]
- **Code updates:** Appropriately track data availability for new standards, including potential energy savings, timeline of standard adoption and effective dates, compliance rates, and NOMAD.

35 Savings overlap may occur with other programs within utility portfolios and not just the C&S analysis.

CHAPTER 6:
Codes and Standards – Federal Appliance Standards

Starting with the Energy Policy and Conservation Act of 1975, the US DOE is directed to develop and update energy efficiency standards and test procedures for certain appliances, equipment, lighting, and consumer products. The federal standards set the minimum energy efficiency requirement for products. The DOE is required by Congressional legislation to review each standard at least once every 6 years for potential revisions and to set appliance efficiency standards at levels that achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified.[36] DOE establishes and updates the standards according to the deadlines established in the federal appliance statute on a rolling basis. The national standards program covers the energy requirements of 60 categories of products.

Program Overview

The federal appliance standards program requires manufacturers to comply, thus affecting any market sector where the products are installed or used. Federal appliance standards, based on mandatory deadlines in the federal appliance law, have a preemptive effect on state standards, with some exceptions.[37]

As a result, California cannot set standards for products already covered under the federal appliance standards.[38] California typically participates in federal rulemakings to ensure that stringent standards that save Californians money on the utility bill are adopted. The SB 350 savings estimates include measures from the 2015 beyond utility energy efficiency savings potential, new measures from 2017 through 2029, and any measures that can be updated to provide additional savings.

Future savings from new federal standards are focused on high energy consumption appliances, including heating and cooling equipment, domestic hot water systems, battery chargers, commercial clothes washers, and lighting.[39] Federal appliance standards are not unique or specific to any building type.

Updates Relative to Previous Study

36 US Department of Energy. "Federal Appliance Standards." Accessed in May 2017. Available online at: https://energy.gov/savings/federal-appliance-standards

37 The federal Energy Policy and Conservation Act of 1975, as amended by the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007.

38 Under the general rules of federal preemption, states that set standards prior to federal enactment may enforce their state standards until the federal standards become effective. States that have not set standards for a product category now enforced by the federal government are subject to the federal standard immediately.

39 The analysis of California and federal appliance standards was coordinated to eliminate potential overlap, especially for emerging technologies and appliances not federally regulated.

The analysis team did not make significant changes to the methodology from the previous study except some capability enhancements in the spreadsheet tool. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A3 Federal Appliance Standards, for more detail on the analysis conducted for this program.

Methodology Description

The analysis team derived the federal appliance standards program savings for SB 350 using a bottom-up measure-level approach to determine the savings potential for viable Federal Appliance Standards based on goals set by the DOE's Building Technology Office (BTO) to reduce building energy consumption by 30 percent compared to 2010 energy consumption through 2029.[40]

To estimate energy savings potential for future federal appliance standards—both new standards and updates to current standards—the team made high level estimates based on DOE BTO goals and then refined savings estimates based on measure by measure data or estimates based on available sources indicated in the program workbook. The analysis used the following information:

- DOE energy reduction goals
- List of measures or groups of measures expected to be adopted
- Building sector, as applicable, for each expected measure
- Timeline of expected measure adoption/effective date and updates (six-year cycle per standard)
- Unit energy savings estimates
- California sales estimates (or scaled by population)
- Compliance rate for each standard
- NOMAD at time standard goes into effect

The analysis team established a high level savings estimate for future updates to current federal appliance standards and future new appliance standards. The team based estimates on goals set by the DOE BTO to reduce building energy consumption by 30 percent compared to 2010 energy consumption through 2029.[41] To support this, the BTO set a goal to reduce energy use per square foot in buildings by 20 percent by 2025 through appliance and equipment standards. The team estimated California-specific savings by establishing 2010 building EUIs and reducing energy consumption per building by 20 percent by 2025. The analysis applied the savings to new construction and expected alteration and retrofit square footage in California through 2029. The

40 US DOE Building Technology Office, *Multi-Year Program Plan: Fiscal Years 2016-2020*. https://energy.gov/eere/buildings/downloads/multi-year-program-plan
41 U.S. DOE Building Technology Office Multi-Year Program Plan: Fiscal Years 2016-2020. https://energy.gov/eere/buildings/downloads/multi-year-program-plan

resulting savings affect both electricity and natural gas usage. The following approach established the high-level estimates:

- Estimated California building EUI for nonresidential and residential buildings in California using Commercial Buildings Energy Consumption Survey (CBECS),[42] Commercial End-Use Survey (CEUS),[43] and Residential Appliance Saturation Study (RASS)[44] data. The team found the following datasets to be the most recent at the time of this report. As newer data becomes published, the team recommends the methodology and program workbook be updated accordingly.
    - Aligned 2010 EUIs with the BTO reduction goals.
    - Identified trends in nonresidential building consumption using the 2003 and 2012 national CBECS.
    - Used the trending to adjust 2006 California CEUS data to estimate nonresidential building kWh and therms consumption per square foot (EUI) in 2010. The CBECS and CEUS data does not include identical building types; therefore, the most relevant CBECS building type was applied to the CEUS data. For example, CBECS does not differentiate between small and large office buildings like CEUS does, so the office building trend data was used for both.
    - Collected 2009 RASS data to use for residential kWh and therms use per square foot.[45]
- Estimated energy reduction from 2010 to 2025 based on the BTO goal of 20 percent reduction by 2025. To achieve 20 percent, the team estimates that appliance standards will reduce energy consumption by 2 percent to 4 percent every 2 years until 2024.[46]
- Identified affected square footage uses Energy Commission Energy Demand Forecast new construction and building stock estimates. Appliance standards affect all new construction and equipment replacement or retrofit in existing buildings. The team assumed an EUL of 15 years to estimate the affected existing building square footage, meaning a replacement or retrofit will occur every 15 years. The analysis team divided existing building square footage for each year by 15 to estimate affected square footage.
- Estimated energy savings by applying the reduced EUI per year to the affected new construction and existing building square footage per year. The analysis reduced the 2010 EUIs by 2 percent to 4 percent every 2 years and applied the savings to the applicable square footage from 2015 through 2029.
- Assumed that savings will be realized beginning in 2011 and must end by 2024 to achieve 20 percent by 2025; however, the team only included savings starting in 2015 under the

42 US Energy Information Administration. Available online at: "2003 CBECS Survey Data." Available online at: https://www.eia.gov/consumption/commercial/data/2003/

43 Itron. California Commercial End-use Survey. May 2017. Available online at: http://capabilities.itron.com/CeusWeb/Default.aspx

44 DNV-GL. "California Statewide Residential Appliance Saturation Study." 2010. Available online at: https://webtools.dnvgl.com/rass2009/

45 The Energy Commission funded the study and began administering the survey in 2009; therefore it is called the 2009 RASS study.

46 Reductions only occur through 2024 because the BTO goal is to achieve 20 percent reduction by 2025.

assumption that prior savings are captured in previous PG and beyond utility savings potential studies. The team considered the limitations for the estimates, including:

- Estimated savings based on BTO goals without identifying appliances and equipment standards that will contribute to the savings.
- Used the 2010 EUIs as the best available estimates based on survey data.

Similar to the Title 20 program workbook, the current Federal Appliance Standards program workbook includes some capability enhancements, but the core methodology approach remains largely the same as the SB 350 analysis conducted in 2017. The capability enhancements include the following:

- **Measure EUL:** This permits the measure to persist for a defined period and then expire. This is applied at the end use level
- **Individual measure sunset date:** This, along with the implementation date, defines the total number of years that the measure will be active. This will permit the sequencing of measure tiers in the list, presuming there is an expectation for when the first, second, and so on, tiers are going to be implemented. Most of the measures do not have a specifically designed next tier planned; however, if there are more in the future, the tool will accommodate. If this is not defined, the measure EUL is applied (or whichever one defines the shortest time).
- **NOMAD curve capability:** This permits an actual NOMAD curve, as defined by annual NOMAD, through the life of the measure. Previously, this was fixed as a constant, but now, it is possible for this to be a more common S curve for NOMAD. This is set to the previous fixed values.
- **Tracking of measures by sector, end use, and start date:** This permits more detailed tracking of the measures than previously possible and enables the Flat Results tab to reflect higher resolution in the measures.

Forecasting Scenarios

Based on this information, the team made the following assumptions for the reference, conservative, and aggressive scenarios.

- The reference scenario assumes that DOE will adopt updates to current Federal Appliance Standards where feasible and will also adopt standards for appliances and products that were out for public review but not fully completed under the Obama Administration.[47] As of January 2017, the DOE published a 5-year draft plan[48] for Federal Appliance Standards, with expected legislative due dates through 2024. However, there

47 At the end of 2016, rulemakings for some standards were out for review but are currently still in the final rulemaking process during the change in presidential administrations. These are identified in ASAP's US DOE Appliance Standards Rulemakings Schedule- 2017: https://appliance-standards.org/sites/default/files/DOE_Schedule_by_Date_2.pdf.

48 DOE. Draft 5-year Appliance Standards Rulemaking Schedule. January 18, 2017. https://www.energy.gov/sites/prod/files/2017/01/f34/5-year_current_and_future_rulemakings_asrac_01.18.2017.pdf

has not been an update on rulemaking for standards since the 2017 publications.[49] The compliance factor, which represents the proportion of the market that will comply with the standard at the time it goes into effect, is set at 85 percent in alignment with the PG assumption.

- In the conservative scenario, the team assumes that DOE will not adopt updates to current Federal Appliance Standards or adopt new standards, but it will adopt standards for appliances and products that were out for public review but not fully completed prior to 2017. The compliance factor is set at 85 percent in alignment with the PPG assumptions.
- The aggressive scenario assumes that DOE will adopt updates to current Federal Appliance Standards where feasible and will also adopt new standards for currently unregulated appliances and products. The compliance factor is set at 100 percent.

Areas to Improve

The team recommends that future iterations of the SB 350 savings potential analysis include further research on calibrating savings and utility savings overlap. Specific recommendations include the following:

- **Utility savings overlap:** Confirm the subtractions made to account for overlap with Navigant's 2018 PG study analysis are appropriate.
- **Code updates:** Appropriately track data availability for new standards, including potential energy savings, timeline of standard adoption and effective dates, compliance rates, and NOMAD.

49 DOE. Plans and Schedules. https://www.energy.gov/eere/buildings/plans-and-schedules

CHAPTER 7:
Codes and Standards – Local Government Ordinances

Jurisdictions within California develop and adopt local ordinances requiring that select or all new construction or additions, alterations, and repairs projects improve energy efficiency beyond Title 24, Part 6. Jurisdictions often adopt these ordinances when a new version of Title 24 , Building Energy Efficiency Standards, goes into effect. The main drivers for these ordinances are for cities or counties to achieve goals set in their climate action plans, such as GHG emissions reductions targets, carbon neutrality, and reduced energy consumption.

Program Overview

Each jurisdiction can determine which building types, construction, and market sectors are appropriate and feasible to include for their goals. Local ordinances may include:

- Residential and nonresidential, excluding certain building types if exempt in the ordinance (e.g., hospitals, industrial).
- New construction and additions, alterations, and repairs. Requirements for new construction may differ from those for additions, alterations, or repairs to existing buildings.
- Private and public buildings.

Updates Relative to Previous Study

The analysis team did not make any changes to the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030 , Appendix A4 Local Government Ordinances, for more detail on the analysis conducted for this program.

Methodology Description

The analysis team derived local government ordinances program savings for SB 350 using a top-down extrapolation approach. The team assumed that jurisdictions that adopted a local government ordinance above 2016 Title 24 will continue to adopt local government ordinances for future versions of Title 24. The methodology took the approach of estimating the square footage that will likely be impacted by future local government ordinances in each of these jurisdictions and applied the estimated energy savings for future Title 24 code updates.

To estimate potential electricity and natural gas savings for local government ordinances, the analysis team estimated the percentage of new construction affected by a local government ordinance and the estimated energy savings for a local government ordinance in each jurisdiction. The savings from the local government ordinance are achieved until the next version of Title 24

goes into effect. At that point, the team assumed that each jurisdiction would adopt a new reach code in line with the next version of Title 24; therefore, no overlap occurs between local government ordinances and Title 24.

The team used the same projected Title 24 efficiency improvements as those used for the Title 24 program analysis for each future cycle of Title 24 from 2019 through 2028. The team gathered data on the jurisdictions that will likely adopt a local government ordinance requiring energy efficiency improvement over Title 24 baselines based on historical data from the Energy Commission.[50] This data helps determine savings per square foot. The team calculated the impacted square footage based on publicly available permit data from jurisdictions that have adopted, intend to adopt, or are expected to adopt a local ordinance.

The team used the following steps to estimate potential energy savings:

- **Established baseline:** The team used expected energy efficiency improvements for 2019, 2022, 2025, and 2028 Title 24 as the baseline for future local government ordinances.
- **Determined the portion of affected California construction:** Based on Energy Commission data of previously adopted local ordinances, the analysis team assumed the same jurisdictions will continue to implement local government ordinances. The team calculated the estimated square footage based on available issued permit data in these jurisdictions and Energy Commission forecast construction data. The team reduced the eligible square footage in each jurisdiction based on historical participation rates for IOU/POU above-code incentive programs, such as Savings by Design, (the utility new construction program that requires buildings to be above code) to account for utility overlap.
- **Estimated energy savings:** The analysis team assumed that jurisdictions will adopt local ordinances that require whole building performance in line with the expected efficiency improvement for the next version of Title 24. For example, local ordinances adopted for 2016 Title 24 will require performance equivalent to the expected efficiency improvements for 2019 Title 24. Although local government ordinances are localized requirements, the team applied the statewide energy savings estimates from the Title 24 program analysis.
- **Determined total potential energy savings:** Using the affected square footage and the expected future Title 24 energy efficiency levels, the analysis team estimated the total potential energy savings for local government ordinances.

Forecasting Scenarios

The team made the following assumptions for the reference, conservative, and aggressive scenarios.

50 California Energy Commission. "Local Ordinances Exceeding the 2016 Building Energy Efficiency Standards." Accessed in May 2017. Available online at: http://www.energy.ca.gov/title24/2016standards/ordinances/ The Energy Commission provides data on local ordinances requiring efficiency above 2016 Title 24.

- **Reference case:** The reference case assumes that jurisdictions that have historically adopted or most recently adopted local government ordinances for 2016 Title 24 will continue to propose and adopt ordinances for future cycles of Title 24. According to floor area weighting, this is expected to generate savings equivalent to 0.7 percent of what is expected for the next iteration of Title 24 (updating according to typical code cycles).
- **Conservative case:** The conservative case assumes that some jurisdictions that have previously adopted local government ordinances will not continue to pursue ordinances for future Title 24, assuming that it will no longer be cost-effective in their climate zone(s) at that time. According to floor area weighting, this is expected to generate savings equivalent to 0.3 percent of what is expected for the next iteration of Title 24 (updating according to typical code cycles).
- **Aggressive case:** The aggressive case assumes that more jurisdictions than those that have historically adopted local government ordinances will pursue adoption of ordinances. This may be supported by ongoing Energy Commission and California Statewide IOU C&S program work to develop tools for local governments to streamline ordinance adoption. According to floor area weighting, this is expected to generate savings equivalent to 2.0 percent of what is expected for the next iteration of Title 24 (updating according to typical code cycles).

Areas to Improve

The team recommends that future iterations of the SB 350 savings potential analysis include further research on calibrating savings by code cycles and utility savings overlap. Specific recommendations include the following:

- Develop a network of local governments, implementers, and stakeholders willing to contribute to the efforts of this program analysis through different methods, such as data sharing, review and verification, focus groups, and surveys.
- Track future adoption (or termination) of local government ordinances across the state and update market penetration assumptions as appropriate.

CHAPTER 8: Financing – Air Quality Management Districts

California AQMDs may require or encourage lead agencies under the California Environmental Quality Act (CEQA) to address environmental impacts of air pollution from buildings. AQMDs and air pollution control districts (APCDs) consider energy efficiency measures at the building level that exceed the building standards to qualify. These measures may include programmable thermostat timers, upgrading lighting, and installing energy efficient appliances.[51] Other mitigation efforts could include using energy efficiency measures, such as HVAC retrofits, retro-commissioning, envelope upgrades, and other whole building measures on existing buildings. These types of requirements or encouragement have the potential to capture energy savings and GHG emissions reductions by 2030.

Program Overview

CEQA requires state and local agencies within California to follow a protocol of analysis and public disclosure of environmental impacts of proposed projects and adopt all feasible measures to mitigate those impacts. In California, there are 35 different air districts tasked with enforcing the requirements of CEQA: 23 APCDs and 12 AQMDs.

Where any project under CEQA's jurisdiction is identified as having potentially significant environmental impacts, the relevant APCD or AQMD is tasked with identifying mitigation measures and alternatives by preparing an environmental impact report. Environmental impact is assessed according to a variety of different environmental resource factors:

- Agricultural resources
- Air quality
- Biological resources
- Cultural resources
- Geology and soils
- GHGs
- Hazards and hazardous materials
- Hydrology and water quality
- Land use and planning
- Mineral resources
- Noise
- Population and housing
- Public services
- Recreation
- Transportation and traffic
- Utilities and service systems

Guidelines published by individual air quality districts identify energy efficiency measures that can be applied to reduce GHGs and other criteria air pollutants to below the threshold values established by CEQA, or the discretion of the district. CEQA applies to nearly all projects in

51 California Air Pollution Control Officers Association. Quantifying Greenhouse Gas Mitigation Measures: A Resource for Local Government to Assess Emission Reductions From Greenhouse Gas Mitigation Measures. August 2010. https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/capcoa_quantifying_ghg_measures.pdf.

California. All public agencies are required to mitigate or avoid significant effects on the environment of projects they carry out or approve whenever it is feasible to do so. Additionally, CEQA applies to all private projects that require a government permit or other entitlement for use. While specific guidance about ensuring CEQA compliance varies from district to district, all districts are tasked with enforcing the same set of CEQA requirements.

Updates Relative to Previous Study

The analysis team did not make any changes to the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A5 Air Quality Management Districts, for more detail on the analysis conducted for this program.

Methodology Description

The analysis team derived AQMD program savings for SB 350 using a top-down extrapolation approach to determine the savings potential. The analysis team assumed that AQMD requirements could result in an additional 5 percent of electricity and gas savings beyond the savings projected for Title 24, starting with the 2016 code cycle and continuing through 2030 for SB 350.

AQMD criteria pollutant mitigation aligns more closely with C&S than with financing or rebate programs. CEQA establishes requirements and the air quality districts are tasked with enforcing those requirements. Accordingly, the savings estimation approach for AQMD uses savings developed for relevant C&S (i.e., Title 24). While the PG study provides much of the data for C&S analysis, there is no expectation that the study will include savings potential associated with regional air quality districts.

Compliance with applicable building and appliance standards will contribute significantly to meeting CEQA requirements, the team's literature review indicates that meeting code-minimum requirements for a new construction or alteration project is not expected, in general, to fully satisfy CEQA requirements. A memo published by the law firm Shute, Mihaly & Weinberger, LLP[52] indicates that Title 24 "does not extend beyond the buildings themselves" and, therefore, "does not address many of the considerations required under Appendix F of the CEQA Guideline." Indeed, CEQA Appendix F highlights a number of potentially significant energy implications that extend beyond the scope of Title 24:

- Energy-consuming equipment and processes that will be used during construction, operation, or removal of the project
- Total estimated daily vehicle trips to be generated by the project and the additional energy consumed per trip by mode

52 Shute, Mihaly & Weinberger, LLP. "Don't Forget the Energy Implications of New Projects – CEQA Guidelines Appendix F". http://www.smwlaw.com/files/CEQA_Guidelines_Appendix_F.pdf

- The effects of the project on peak and base demand periods for electricity and other forms of energy

Where a project is anticipated to exceed environmental impact thresholds established by CEQA, mitigation is required. While a wide range of action can contribute to mitigation, energy efficiency interventions factor prominently into recommended strategies. The Bay Area Air Quality Management District's Air Quality Guidelines specifically identify exceeding the energy efficiency requirements of Title 24 as a potential approach to mitigation.

AQMD requirements are assumed to result in an additional 5 percent of electricity and gas savings projected for iterations of Title 24 starting in 2016 and continuing through 2028. The Energy Commission suggested that the proposed program would require projects to pay a fee to address mitigation requirements. This approach would have multiple benefits, including reducing the schedule and resource burden imposed on individual projects by pollution mitigation requirements; and enabling money to be pooled into a larger fund that could be used to address large-scale pollution concerns across a district.

Whether mitigation is applied at the project level or a fee equal to the mitigation requirements is applied to reduce pollution at another location, the net effect should be about the same with respect to pollution/energy consumption averted per mitigation dollar spent. While it could be argued that program yield would be higher if funds are applied to targeted sources of pollution as opposed to whatever mitigation can be implemented within the constraints of a project, given the overall uncertainty around expected program impact, it seems appropriately conservative to keep savings projections at high levels.

Forecasting Scenarios

The team made the following assumptions for the reference, conservative, and aggressive scenarios.

- **Reference case:** The reference case assumes that mitigation requirements will result in annual energy savings equivalent to 5 percent of what is projected to be achieved by Title 24.
- **Conservative case:** The conservative case assumes that mitigation requirements will result in annual energy savings equivalent to 1 percent of what is projected to be achieved by Title 24 in the reference case.
- **Aggressive case:** The aggressive case assumes that mitigation requirements will result in annual energy savings equivalent to 10 percent of what is projected to be achieved by Title 24 in the reference case.

Areas to Improve

For financing programs in general, the analysis team recommends further research on funding projections, utility savings overlap, and market saturation. For the AQMD program, specific recommendations include the following:

- Develop a network of AQMD agencies, local jurisdictions, and stakeholders willing to contribute to the efforts of this program analysis through different methods, such as data sharing, review and verification, focus groups, and surveys.
- Conduct targeted outreach to AQMD agencies and stakeholders that are most prominent and active in implementing and regulating local AQMD requirements.
- Obtain district-specific funding and project data to evaluate the impact that AQMD requirements and related funding have on energy savings.
- Project energy savings potential using program data provided by AQMD agencies and expected funding data.

CHAPTER 9:
Financing – Local Government Challenge

The Local Government Challenge (LGC) is a grant program designed to help the state meet the targets set by SB 350 and AB 802.[53] The LGC uses remaining funds from the American Recovery and Reinvestment Act (ARRA) to encourage local jurisdictions to implement new energy efficiency projects, update climate action plans, and address other energy/climate issues. The projects funded by LGC are proposed to reduce statewide electricity consumption, increase self-generation capacity, and improve the conditions of facilities and equipment. The program is divided into two parts: the Small Government Leadership Challenge and the Energy Innovation Challenge. Depending on the awardee of the grant, various building sectors will be affected.

Program Overview

This program consists of four awarded energy innovation grants to local governments and several small government grants, primarily directed toward climate action plans, in response to Energy Commission solicitation GFO-16-404. The program awarded energy innovation grants to the following projects:

- Marin Clean Energy – Building Efficiency Optimization Project
- City of San Diego – Smart City Open Urban Platform (SCOUP)
- City of San Leandro – Innovative Energy Efficiency and Renewable Energy Deployment Project
- Stop Waste Energy Council – Accelerating Multifamily Building Upgrades

The program awarded the small government leadership challenge awards to the following:

- City of Del Mar – Civic Center Energy Efficiency Enhancements
- Gateway Cities Council of Governments – Climate Action Planning (CAP) Framework
- San Bernardino Council of Governments – Sub-Regional Greenhouse Gas Reduction Plan Update
- County of San Luis Obispo – EnergyWise Plan Energy Section Update including Zero Net Energy Neighborhood Feasibility, Design, and Implementation Study
- City of Santa Cruz – Deep Energy Efficiency at Municipal Facilities through Advanced Building Controls
- Ventura County Regional Alliance – Central Coast Energy Plan
- Marin General Services Authority – Marin Climate and Energy Partnership/Resilient Neighborhoods Grassroots Climate Action
- City of Galt – City of Galt Climate Action Plan, Corridor Plan, and Master Plan
- City of Santa Barbara – City of Santa Barbara, ZNE Roadmap and Implementation Plan

53 Williams, Chapter 590, Statutes of 2015

The energy savings estimate will be limited to the projects listed above.

Updates Relative to Previous Study

The analysis team did not make any changes to the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A6 Local Government Challenge, for more details on the analysis conducted for this program.

Methodology Description

The analysis team performed the following calculations and assumptions to project the energy savings potential from 2015 through 2029 using a top-down extrapolation approach. However, new data is expected to become available as projects are installed and verified. The Navigant team recommends that the Energy Commission check with the LGC program administrators to obtain new data for future SB 350 updates.

The team categorized the Energy Innovation grant projects into projects (1) with specific energy efficiency measures or targets, and (2) with general GHG reduction goals. For programs with specific performance targets, the team extracted electricity and gas savings from relevant project narratives or converted GHG reduction goals. For converting GHG reductions to energy savings, the team assumed a 80 percent electricity and 20 percent gas split for small municipalities. Although this was an assumption, data on nonresidential buildings show a similar split for nonresidential and residential buildings.

The SB 350 savings estimates do not include PV systems or other renewable or storage technologies. The team did not deem projects for Del Mar and Marin Clean Energy was relevant to this savings estimate because they deal with PV generation and supply-side distributed energy resources (DER) management.

For climate action plans available at the city or county level, the analysis team used the following approach:

- Developed estimates of GHG reduction per capita, either from program data or from a representative city. The team selected the City of Pleasanton Climate Action Plan[54] as the representative model.[55] This plan includes detailed projections of energy savings and GHG reductions by sector. Estimates of existing energy consumption or GHG production for the awarded cities were not available during this analysis.
- Converted GHG reduction targets to energy savings targets and broke down the energy consumption among the buildings, transportation, waste treatment, and industrial sectors from the City of Pleasanton Plan. While this will vary among local jurisdictions,

54 City of Pleasanton 2011. City of Pleasanton Climate Action Plan, December 2011. Available online at: http://www.cityofpleasantonca.gov/civicax/filebank/blobdload.aspx?BlobID=24757

55 Note that the City of Pleasanton was not awarded LGC funding.

the team considers this a fair starting point for an estimate. The fraction of planned GHG savings that are due to building energy efficiency is approximately 50 percent of the total GHG planned reductions.
- Applied conversions between electricity and gas use and avoided CO_2 emissions based on the methodology used in the Pleasanton Climate Action Plan, as that was deemed reasonable by the analysis team.
- Applied an estimate of the fraction of the energy savings target that can be attributed to the Climate Action Plan itself.

As part of the savings estimate calculation for other projects, the team determined project baselines. The analysis team collected the proposals and project narrative information from local government officials and used city census estimates and energy use comparisons with similar local governments where information was not available. For San Luis Obispo County, because neither baseline energy usage nor energy savings targets were available, the analysis first estimated the residential population that live in LI areas as 20 percent of the county. The analysis then approximated an EUI and home size based on the reasonable assumption that most of the local jurisdiction would allocate the grants from this program to assist LI family energy updates. The team also assumed that 25 percent of single-family homes in this category could potentially receive efficiency upgrades through 2029.

The team evaluated each of the projects through an attribution matrix that considered the following mitigating factors:

- **Solar PV:**
    - Broad PV goals set PV savings to 25 percent
    - PV was the only identified measure, set to 100 percent
    - Where targeted measures identified with specific savings targets without any use of PV, PV contribution set to 0 percent
- **IOU/POU overlap:** To align with other program methodologies, the overlap from any IOU and POU programs was fixed at 10 percent. For these programs, aggressive goals with building-level energy target reductions exceed many focused IOU and POU programs, so the anticipated overlap is limited.
- **Non-building fraction:** Many climate action plans addressing GHG reduction identify measures well outside of building energy efficiency programs (street lights, transportation, city planning, etc.). The analysis team estimated the fraction of planned savings attributed to measures outside of buildings based on the project narratives and a review of program data.
- **Attribution factor:** The percentage of the potential targeted building stock that would likely be directly affected by the program. For programs that are targeting specific buildings, the attribution factor is 100 percent. For others, it is assumed to be 25 percent.

A combination of each of these factors yields a potential rate, which is the fraction of potential target savings that can be directly attributed to the program. For more detail on the methodology of the adjustment factors, refer to the LGC program workbook.

Additionally, in setting program savings targets, the team used two approaches: use the specific building targets with specific savings targets as the savings estimate when available and apply a savings multiplier of 33 percent across all programs without a specific target.

Finally, the team calculated the annual incremental savings. For projects with many buildings, the projects savings ramp up in scope steadily from 10 percent of targeted savings in 2021 to 100 percent through 2029.

The team did not adjust for market saturation, as the savings potential of the building sectors relevant to this program likely will not saturate through 2029.

Forecasting Scenarios

The team made the following assumptions for a reference, conservative, and aggressive savings scenario.

- **Reference case:** Savings level for projects remains steady at 10 percent of targeted savings per year according to the baseline savings embedded in the workbook analysis.
- **Conservative case:** For the conservative case, the team retained the project savings level at 10 percent with different baseline savings embedded in the workbook analysis.
- **Aggressive case:** For the aggressive case, the team assumed that two additional rounds of funding would take place every 3-4 years, resulting in an aggregate program iteration savings level similar to the current round of awarded projects. Essentially, this estimates a doubling of the reference case savings beginning in 2025 and then a tripling of the reference case savings beginning in 2028.

Areas to Improve

For financing programs in general, the Navigant team recommends further research on funding projections, utility savings overlap, and market saturation. For the LGC program specifically, the team recommends the following improvements:

- Develop a network of local governments, implementers, and stakeholders willing to contribute to the efforts of this program analysis through different methods, such as data sharing, review and verification, focus groups, and surveys.
- Obtain estimates of baseline energy consumption or specifics on the applicable building stock for all or some of the projects.
- Conduct further outreach to local governments and associated consultants to collect sufficient information on individual projects to evaluate energy savings.
- Confirm the fraction of planned activities for solar PV and non-building activities for newly awarded projects.
- Determine if there could be future iterations of the program beyond the awarded projects and if the projects could be scalable or replicable in other jurisdictions.

CHAPTER 10:
Financing – Proposition 39

The California Clean Energy Jobs Act, also known as Proposition 39 (Prop 39), provides funding for planning and installing energy efficiency upgrades and clean energy generation at schools. The initiative changed California's corporate income tax code and allocates projected revenue to the general fund and the Clean Energy Job Creation Fund for five fiscal years (2013-2014 to 2017-2018).[56] The fund awarded local educational agencies (LEAs), including K-12 school districts, county offices of education, charter schools, state special schools, and California community colleges (CCCs) to upgrade existing facilities. The types of energy efficiency upgrades varied greatly. Some examples of the measures include lighting, HVAC, solar PV, and cool roofs.

Program Overview

Prop 39 provides funding for planning and installing energy efficiency upgrades and clean energy generation at schools. A small percentage of the Prop 39 funds is appropriated for other components of the program, including financing, technical assistance, workforce development, and energy planning services. All 5 years of funding (2013-2018) have been committed to eligible LEAs. In the K-12 system, funds are allocated to specific LEAs according to average daily attendance (85 percent weighting) and number of students eligible for free and reduced-price meals (15 percent weighting) applicable to a funding year. In the CCC system, funds are allocated according to number of full-time equivalent students.

In general, Prop 39 funds can be applied to energy efficiency retrofits and clean energy installations. Additionally, funds can be appropriated to hire energy managers and provide relevant energy-related staff training. The use of funds must comply with two factors: loading order and cost-effectiveness. Projects applying for Prop 39 funding shall be sequenced according to California's loading order of energy resources. Energy efficiency and demand response projects are first priorities, followed by renewable energy generation, distributed generation, combined heat and power applications, and clean and efficient fossil-fired generation. Projects are also evaluated by the cost-effectiveness criteria, calculated in terms of savings to investment ratio, based on the total energy savings and net project costs over the project life-cycle.

Additionally, Prop 39 funds can be combined with other project financing and funding mechanisms such as utility incentives, utility on-bill financing programs, and the Energy Conservation Assistance Act (ECAA) loan programs. The Energy Commission published a Progress Report[57] in January 2017 that indicates the appropriation of Prop 39 funds from 2013 to

56 SB 110 (Committee on Budget and Fiscal Review, Chapter 55, Statutes of 2017) has modified the Prop 39 program and extended it. This bill also allocated an additional $100 million of unspent Prop 39 money to Energy Conservation Assistance Act (ECAA)-Ed. The bill also made ECAA-Ed competitive.

57 California Energy Commission. The California Clean Energy Jobs Act: Proposition 39. Sacramento, California. January 2017. http://www.energy.ca.gov/2017publications/CEC-400-2017-001/CEC-400-2017-001-CMF.pdf

2017. Navigant recommends that the Energy Commission and the CPUC work closely to identify potential utility program savings overlap.

The building sectors affected by this program are nonresidential, existing construction only, including:

- K-12 school facilities
- County offices of education facilities
- Charter school facilities
- State special school facilities
- CCC facilities

To give LEAs an opportunity to use any unrequested Prop 39 K-12 program grant funds, the Senate passed SB 110[58] in June 2017. This bill created three additional grant programs and allocated funds for loans and technical assistance. Although, a continuation of the Proposition 39 K-12 Program was also authorized in SB 110, there were insufficient funds for the program. Any additional program funding is subject to appropriation in the annual Budget Act.

Updates Relative to Previous Study

The analysis team did not make any changes to the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data, such as changes in program funding levels, to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A7 Proposition 39, for more detail on the analysis conducted for this program.

Methodology Description

The analysis team performed a top-down extrapolation approach with the following calculations and assumptions to project the energy savings potential from 2015 through 2029.

- For K-12, the first-year data for 2013-2014 demonstrates a relatively slow ramp-up in projects and funding requests. Subsequent years in the program data show an increase in projects and funding requests that align more closely with allocated funding.
- For CCC, the data covers only up to 2016, with partial project data available for 2015-2016. There is no information for 2016-2017 published in the workbook at the time of the 2017 analysis for SB 350. However, Navigant expects the Energy Commission to publish the new annual data and may be incorporated into future iterations of SB 350 analysis.
- The published savings data included both energy efficiency and self-generation projects. The team removed the self-generation projects from projections.
- For savings projections, the team normalized the funding amount for kWh savings and therm savings per dollar of funding.

58 California Legislative Information. "SB-110, Clean Energy Job Creation Program and Citizen Oversight Board." July 11, 2017. Available online at: http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB110

- Using the normalized energy savings estimates along with the known funding amounts for 2013-2017 and the estimated funding amount for 2017-2018, the analysis extrapolated the available project data to generate annual funding and energy savings data for all 5 years of the current program cycle (2013-2018).
- The analysis team evaluated the estimated five-year data for trends. However, the results did not reveal any clear patterns of energy savings or funding levels. Data seems to primarily vary by the approved funding amount, which is dependent on state budget approval. It appears that energy savings potential may fluctuate based on budget variance for each year.
- The analysis team calculated an average annual funding level based on the five-year estimates. Previously, the forecast assumed that the funding level will remain constant from 2015 through 2029 as the baseline savings level, and further savings adjustments were applied under different forecasting scenarios. However, no new funding is in place for future years.
- Publicly available data is limited to the information from K-12 and CCC workbooks.

For future Prop 39 savings analysis, the team expects that more project savings will be reported through 2021 as more projects are verified for completion. The legislation requires that all projects funded by Prop 39 be completed by 2021; however, project implementation delays may be expected as the deadlines have extended multiple times since 2013. The actual funding and energy savings data will better correspond to the approved budget as more data is reported. Averaging funding and energy savings data by normalization can serve as a preliminary method for savings projections, despite many variables yet to be considered.

Forecasting Scenarios

The Energy Commission will need to adjust the scenarios to address the Prop 39 program funding level changes. The team made the following assumptions:

- **Reference**: The team estimated savings for the reference case according to the analysis approach described above by assuming that Prop 39 program funding will continue indefinitely beyond 2018, as enabled by SB 110. This scenario scales back energy savings projections by 10 percent each year beginning in 2019 to account for a potential funding decrease through 2029.
- **Conservative**: To calculate a more conservative scenario, the team assumed that Prop 39 program funding will continue indefinitely beyond 2018, as enabled by SB 110. However, the energy savings projections are scaled back by 10 percent each year beginning in 2019 to account for a potential funding decrease and additionally by 30 percent annually to account for market saturation based on team analysis and assumptions.
- **Aggressive**: To calculate a more aggressive program savings estimate, the team removed the potential funding decrease adjustment from the reference case and assumed that the current savings rate will persist through 2029 unimpeded.

Areas to Improve

For financing programs in general, the team recommends further research on funding projections, utility savings overlap, and market saturation. For the Prop 39 program, the team recommends the following:

- Engage the Energy Commission and Chancellor's Office Prop 39 teams to better understand market potential, market saturation, and future adoption rate.
- Track implementation of SB 110,[59] which extended funding subject to the state budget, for Prop 39 indefinitely; collect future data on annual funding level, project adoption rate, and energy savings.
- Collect actual program data and corresponding utility incentive tracking to minimize overlap errors.
- Consider including more disaggregated data of completed projects by utility and end use.

59 California Legislative Information. "SB-110 Clean Energy Job Creation Program and citizen oversight board." July 11, 2017. Available online at: http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB110

CHAPTER 11:
Financing – Low-Income Weatherization

Multiple elements of the Greenhouse Gas Reduction Fund (GGRF) result in energy savings, but only two are included in this study: the Low-Income Weatherization (LIW) program (discussed in this chapter) and the Water-Energy Grant (WEG) program (further discussed in the next chapter).[60] LIW is a statewide program funded through California cap and trade auction proceeds. The program aims to implement energy efficient measures in LI single-family and multifamily complexes in DACs, including PV installations, solar hot water heaters, and other energy-reducing projects.

The LIW program has three overarching goals:

- Reduce GHG emissions in DACs
- Create jobs and provide training for members of DACs
- Reduce the energy bills of the LI households served

The LIW program received $75 million in funding through the 2014-15 budget approved by the state legislature to implement these goals. The program estimates that 17,700 households will benefit from this program.

Program Overview

Three government statutes directed proceeds from the California cap and trade program into the GGRF. A portion of the GGRF budget is used to fund programs that save energy through installation of more energy efficient appliances and weatherization of LI homeowners' properties.

The federal weatherization program supplements the GGRF funds for LIW. The federal program, administered by the Department of Community Services and Development, targeted different subsets of LI households in DACs.[61] The Single Family / Small Multi-Family Energy Efficiency and Solar Water Heating subprogram provides single-family and small multifamily LI homes with weatherization and energy efficiency measures.[62]

The Large Multi-Family Energy Efficiency and Renewables subprogram provides multifamily, LI properties with technical assistance and incentives for weatherization and energy efficiency measures. Program participants receive a home energy assessment to generate a list of

60 There also exists the State Water Efficiency Enhancement Program which mostly focuses on the Agricultural sector.

61 The three programs include (1) Single Family/Small Multi-Family EE and Solar Water Heating; (2) Single-Family Solar Photovoltaics; and (3) Large Multi-Family EE and Renewables.

62 The Department of Community Services and Development's Low-Income Weatherization Program serves low income homes. Specifically, it seeks to help households in disadvantaged communities as identified by CES 2.0, which calculates if someone qualifies as disadvantaged or low-income in the state.

recommended measures to improve the energy efficiency of the home. The program expects energy savings from lighting, ceiling fans, appliances, insulation, and microwaves.

The residential sector is the only building sector affected by this program. This program specifically targets 100 percent of the households located in DACs, as identified by CES 2.0.

Updates Relative to Previous Study

The analysis team did not make any changes to the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A8 GGRF Low Income Weatherization, for more detail on the analysis conducted for this program.

Methodology Description

The team performed a top-down extrapolation approach with the following calculations and assumptions to project the energy savings potential from 2015 through 2029.

- Identified only one full year of historical savings data for 2015. The lack of data for additional years prohibited applying data trends or average values. Additional data may be available to derive savings claims for past LIW program participants.
- Used 2015 project savings data to determine total electricity and natural gas savings for the entire program year. The team then applied the total savings from 2015 as the savings projections for 2015-2029.
- Assumed annual growth of savings and funding level remain the same as the 2015 values.

Because this program targets LI housing in DACs, the team assumes little to no natural construction turnover in the absence of additional financing. As such, the 2017 analysis of SB 350 savings assumed 0 percent of program savings overlap with 2018 PG study C&S estimates.[63] The team recommends further evaluating utility savings overlap by exploring any overlap between this program and other LI programs funded by the IOUs.

Assuming 2.2 million[64] of 12.3 million[65] households qualify as LI and that each project achieves 15 percent electricity savings on average, the team estimates that the calculated savings projection through 2029 would result in approximately one-third of LI households being improved through 2029. Given this estimate, the analysis team did not account for market saturation.

Forecasting Scenarios

Based on this information, the team made the following assumptions for the scenarios:

63 California Public Utilities Commission. "2018 Potential & Goals Study." June 2017. Available online at: http://www.cpuc.ca.gov/General.aspx?id=6442452619

64 http://www.csd.ca.gov/Portals/0/Documents/LIWP%20Public%20Hearing%20Presentation%20Final.pdf

65 California Energy Commission. Integrated Energy Policy Report (IEPR) Building Stock Data. 2016

- **Reference case:** This scenario assumes that new funding does not significantly change savings levels and all savings from 2015 through 2029 will continue to be claimed by the baseline IEPR demand forecast.
- **Conservative case:** This scenario assumes all savings up to 2018 are captured by the baseline IEPR demand forecast, with no SB 350 savings.
- **Aggressive case:** This scenario assumes that beginning in 2019, additional funding will contribute to a 30 percent increase in savings attributable to SB 350, beyond the baseline IEPR demand forecast.

Areas to Improve

For financing programs in general, the team recommends further research on funding projections, utility savings overlap, and market saturation. For the LIW program, the team recommends the following:

- Partner with the regulatory agency of this program to agree on data parameters that will be made available to support future SB 350 analyses.
- Collect more years of measure-level data detailing savings, funding allocation, or cost-effectiveness data; if measure data is not available, gather annual project data that better supports trending methods.
- Collaborate with the CPUC to identify any additional utility savings overlap with LI programs funded by IOUs.
- Address changes in funding levels over time.

CHAPTER 12:
Financing – Water-Energy Grant

The Water Energy Grant (WEG) program, administered by the Department of Water Resources (DWR), aims to improve water and energy efficiency and reduce GHG emissions of residential and commercial buildings through measures such as clothes washers, dryers, and dishwashers. Energy savings resulted primarily by installing measures to reduce hot water use, which decreases the energy needed to heat water.

Program Overview

The WEG, funded by the GGRF and operated by the DWR, is a statewide program to promote reduced GHG emissions, primarily in the residential and nonresidential sectors and particularly in DACs. Proceeds from the California cap and trade program are allocated each year to the WEG program to fund projects that reduce GHG emissions in California, while also delivering economic, environmental, and public health benefits for Californians, particularly benefits to DACs. Another key objective of the WEG program is to establish an incentive structure for making climate investments through clean technologies and innovative solutions. Water reduction or conservation is the main criterion for program eligibility, but energy use and GHG reduction are also prioritized.

Updates Relative to Previous Study

The analysis team did not change the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A9 GGRF Water Energy Grants, for more detail on the analysis conducted for this program.

Methodology Description

The team performed a top-down extrapolation using the following calculations and assumptions to project the energy savings potential from 2015 through 2029.

- The historical dataset provides a full year of savings data for 2014 and a partial year of savings data for 2016.
- The funding amount for 2016 and 2017 came from research of publicly available data.
- The team calculated the projected savings for this program by taking the average of electricity and gas savings from the 2014 and 2016 historical savings data. The average savings from 2014 and 2016 were then applied as the savings projections for 2015-2029 due to a lack of more granular historical data.
- Annual growth of savings and funding level remained the same as the average of the 2014 and 2016 values.

There is no indication from the program dataset that solar thermal projects are included. As such, the team did not correct for savings due to renewable generation.

Because this program targets DACs, the team assumes little to no natural construction turnover in the absence of additional financing. As such, the 2017 analysis of SB 350 savings assumed 0 percent of program savings overlap with 2018 PG[66] C&S estimates. The team recommends further evaluating utility savings overlap by exploring any overlap between this program and other LI programs funded by the IOUs.

The team estimated that 2.2 million[67] of 12.3 million[68] households, approximately 18 percent, qualify as LI. By extending this ratio to DACs, biasing toward building types that consume the most water (restaurants, schools, hospitals, and dwellings), and assuming that each project achieves 10 percent[69] electricity savings on average, the team estimates that the calculated savings projection through 2029 would result in approximately 40 percent of LI households being improved through 2029. Given this estimate, the analysis team did not account for market saturation.

Forecasting Scenarios

Based on this information, the team made the following assumptions for the scenarios:

- **Reference case:** This scenario assumes that program funding will persist at the same level, resulting in a steady increase in cumulative savings.
- **Conservative case:** Due to the uncertainty of funding after 2016, this scenario assumes that program funding will decrease by 50 percent after 2016, resulting in a smaller increase in cumulative savings from 2017 through 2029.
- **Aggressive case:** Due to the lack of policy or funding projects after the 2016 funding year, this scenario assumes that program funding will increase by 50 percent after 2016, resulting in a larger increase in cumulative savings from 2017 through 2029.

Areas to Improve

For financing programs in general, the team recommends further research on funding projections, utility savings overlap, and market saturation. For the WEG program, the team recommends the following:

- Partner with DWR to agree on a set of data parameters that will be made available to support future SB 350 analyses.

66 California Public Utilities Commission. "2018 Potential & Goals Study." June 2017. Available online at: http://www.cpuc.ca.gov/General.aspx?id=6442452619

67 http://www.csd.ca.gov/Portals/0/Documents/LIWP%20Public%20Hearing%20Presentation%20Final.pdf

68 California Energy Commission. Integrated Energy Policy Report (IEPR) Building Stock Data. 2016

69 Note that this is less than the 15 percent estimate applied to other retrofit programs because only domestic hot water generation is affected.

- Collect more years of measure-level data detailing savings, funding allocation, or cost-effectiveness data; if measure data is not available, gather annual project data that better supports trending methods.
- Collaborate with the CPUC to identify any additional utility savings overlap with LI programs funded by IOUs.

CHAPTER 13: Financing – California Department of General Services Retrofit Program

The Energy Retrofit Program operated by the Department of General Services (DGS) uses energy service companies to implement energy upgrades in state buildings. DGS funds loans that are paid back by the realized savings from the retrofit. The common types of measures funded by the loan include upgrading lighting, installing energy efficient HVAC systems, and retro-commissioning. An initial $25 million payment from the Energy Commission provided the seed money to begin the Energy Retrofit Program.

Program Overview

The Energy Retrofit Program, administered by the DGS, provides funding to state agencies to fund energy efficiency retrofits in their buildings through the program's loan fund. The funds for this program were originally supplied by the Energy Commission under ARRA. The funding is expected to be paid back from the energy savings that result from the retrofit projects; at that point, the funds will be replenished and become available for subsequent projects.

There are several remaining energy efficiency projects in the current funding cycle, but most have been completed. A new funding cycle has been approved.

Updates Relative to Previous Study

The analysis team did not change the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A10 DGS Energy Retrofit Program, for more detail on the analysis conducted for this program.

Methodology Description

The analysis team used a top-down extrapolation approach to determine the savings potential for the DGS Energy Retrofit program. There are several variables that may impact how this program will continue in the future. Assuming the current funding remains available and the program continues to replenish the funds from energy savings, it is possible to calculate the weighted average simple payback for the projects to determine the rate at which funds are recycled into new projects. Combining this with a calculation of the annual kWh or therm savings for the projects that have occurred will provide a reasonable estimate for future efficiency savings through this program.

Additionally, the team applied adjustment factors to the energy savings projections to account for opportunities that may be front-loaded in the priority list and newer technologies and techniques

that will be adopted in the future. DGS should conduct future program evaluation to verify the savings opportunities and implementation.

The analysis team used the savings and annual growth of savings from the Annual Legislative Report and other DGS-supplied information, assuming the program parameters and funding levels remain the same. At this time, the team used the DGS estimates for future annual savings from the program rather than based on historical trends. The analysis employed the following assumptions:

- Other utility incentive programs for equipment replacement claim approximately 50 percent of the savings in this program. Utility incentive claims will decrease in the future as the oldest buildings are retrofitted and less attractive projects are available for future retrofits; however, the claims may increase (as a percentage) as incentives become available and the buildings approach zero net energy.
- Feedback from Energy Commission staff indicates investment levels are expected to drop as the revolving fund is paid back and becomes available for new projects. Based on input from the Energy Commission, the team assumed 2 GWh annual savings beginning in 2018.
- Beyond the initial drop in funding, the annual funding rate will be maintained, as the fund is assumed to be managed sustainably into the future.
- The savings of natural gas will track comparably with electricity, and the team did not adjust for electrification.
- For cumulative savings, the team assumed all projects have an EUL equal to 15 years. The most recent program reporting document[70] showed the program measures as interior and exterior lighting upgrades, HVAC upgrades, and envelope measures—all of which have an EUL of at least 15 years. This analysis also assumed no savings from renewable energy because no renewable energy measures (e.g., solar PV) were shown in the program reporting document.

The team conducted initial outreach to the DGS energy efficiency revolving loan fund program manager to request additional program information including future funding, projected savings, expected overlap with utility incentive programs, and other factors that would affect program savings. The DGS program manager emphasized that all projections in funding and energy savings were rough estimates. Current funding levels should continue for the next 3-4 years (until approximately 2020). After 2020, funding drops by approximately one-third, although the DGS program manager reported that more funding could become available. In the past, DOE programs have ended and provided their remaining funds to the DGS program. Consequently, funding could decrease, increase, or remain approximately the same in the future. The DGS program manager reported that even under steady funding levels, project flows may not be constant, and some customers that complete applications ultimately do not complete a project or put the project on hold. Thus, the team notes that all projections should be viewed as high level estimates,

70 Department of General Services. "DGS ESCO_EE_data_current workbook." Sourced by the Energy Commission. April 12, 2017.

particularly beyond 2020. The team updated the savings estimates accordingly based on the DGS response.

Because this program targets public buildings, the team assumes little to no natural construction turnover in the absence of additional financing. As such, the 2017 analysis of SB 350 savings, 0 percent of program savings assumed to overlap with 2018 PG[71] C&S estimates. The team recommends further evaluating utility savings overlap between this program and savings claimed by the IOUs.

The 2015 Existing Buildings Energy Efficiency Action Plan[72] indicates that DGS reports about 125 million square feet of state leased or owned floor space. Additionally, DGS reports[73] about 20 million square feet of state leased floor space. Given the size of the potential market and assuming that program projects achieve 15 percent savings of baseline electricity consumption on average, the team estimates the calculated savings projection through 2029 would result in less than 10 percent of state-owned buildings being improved through 2029.

Forecasting Scenarios

Based on this information, the team made the following assumptions for the different scenarios:

- **Reference case:** The team assumed that current trends would continue. The DGS program manager reported this was the most likely outcome, although both increasing and decreasing funds are distinct possibilities.
- **Conservative case:** Building off the reference case, this scenario assumed that funding would decline by 11 percent beginning in 2020 and that energy savings (both GWh and therms) would decline proportionally by the same factor as funding decreases.
- **Aggressive case:** This scenario assumed that funding would increase by 11 percent starting in 2020 and that energy savings (both GWh and therms) would increase accordingly. This scenario also assumes that project participation will increase, including from Department of Corrections and Rehabilitation (DCR) projects because the DGS project manager identified DCR facilities as having a significant energy efficiency savings opportunity.[74]

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71 California Public Utilities Commission. "2018 Potential & Goals Study." April 2017. Available online at: http://www.cpuc.ca.gov/General.aspx?id=6442452619

72 California Energy Commission. "California's Existing Buildings Energy Efficiency Action Plan." September 2015. http://www.energy.ca.gov/2015publications/CEC-400-2015-013/CEC-400-2015-013-D.pdf

73 Department of General Services. "Real Estate Leasing and Planning Section - Private Sector Leases." April 2017. Available online at: http://www.dgs.ca.gov/resd/Programs/LeasingandPlanning.aspx

74 The team conducted a brief telephone interview with a DCR staff member that focuses on energy efficiency projects. The DCR staff member confirmed that the department often conducts energy efficiency projects, particularly because most of its 39 functioning correctional facilities operate lighting continuously (8,760 hours annually). DCR projects can also include mechanical upgrades and other non-lighting projects. While DCR projects often leverage the IOUs' on-bill financing program, because of the financing cap ($1 million-$2 million, depending on utility), the DGS program often contributes most of the financing for large projects. In addition, approximately half of DCR projects are outside of IOU territory. The list of projects for the 2015-2017 DGS program includes one DCR project for $3 million, for which DGS provided 100 percent of the financing. DCR staff reported they would soon submit another DGS application for a $4 million project outside of IOU territory.

Areas to Improve

For financing programs in general, the team recommends further research on funding projections, utility savings overlap, and market saturation. For the DGS Energy Retrofit program, the team recommends the following:

- Partner with DGS to better understand market potential, market saturation, and future adoption rate.
- Estimate future biannual funding levels while accounting for slow project payback or changes in reinvestment of the funding.
- Revisit the need to account for end use measure life depending on assumptions made in future iterations of this program analysis.

CHAPTER 14: Financing – Energy Conservation Assistance Act

The ECAA loan program administered by the Energy Commission delivers revolving loans to schools, cities, counties, state hospitals, and special districts to finance projects with proven energy or cost savings. Funds for ECAA loans come from repayment of previous funds with additional infusions from allocations by the legislature and ARRA funds.[75]

The ECAA financing program is designed to ease the adoption of energy projects through a simple process that does not involve credit approval, collateral, or fees. There are two types of loans offered through this program. Education facilities, except universities and colleges, qualify for a 0 percent interest loan, whereas cities, counties, and colleges and universities qualify for a 1 percent interest loan. Loans are often used to upgrade the building envelope, electrical systems, HVAC, lighting, or a combination thereof.

Program Overview

The ECAA program is a revolving loan program administered by the Energy Commission. The program supports energy efficiency and energy generation projects pursued by public institutions. ECAA provides loans up to $3 million per application. The program is designed to facilitate energy project adoption through a simple process that does not involve credit underwriting, collateral, or fees. To be eligible for a loan, projects must demonstrate energy savings over the loan repayment period. ECAA loans must be repaid in energy cost savings within 20 years, including principal and interest, which is equivalent to a maximum of 20 years of simple payback for 0 percent loans and a maximum of 17 years for 1 percent loans. Project guidelines require that energy projects must be cost-effective and technically feasible to qualify.

Public agencies are eligible to receive ECAA funds; the bulleted list below indicates which types of public agencies are eligible for 0 percent loans and which are eligible for 1 percent interest rate loans. Residential, commercial, or private non-profit institutions are not eligible for these funds.

- Eligible for 0 percent interest rate loans:
    - School districts
    - Charter schools
    - County offices of education
    - State special schools
- Eligible for 1 percent interest rate loans:
    - Cities
    - Counties

75 The 1 percent loan was developed separately as ECCA-Ed funds. Proposition 39: California Clean Energy Jobs Act, K-12 Program and Energy Conservation Assistance Act 2015-2016 Progress Report, California Energy Commission, 2016.

- Special districts
- Public colleges or universities (except community college districts)
- Public care institutions/public hospitals
- University of California
- California State University
- Community college districts

Updates Relative to Previous Study

The analysis team did not change the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A11 ECAA, for more detail on the analysis conducted for this program.

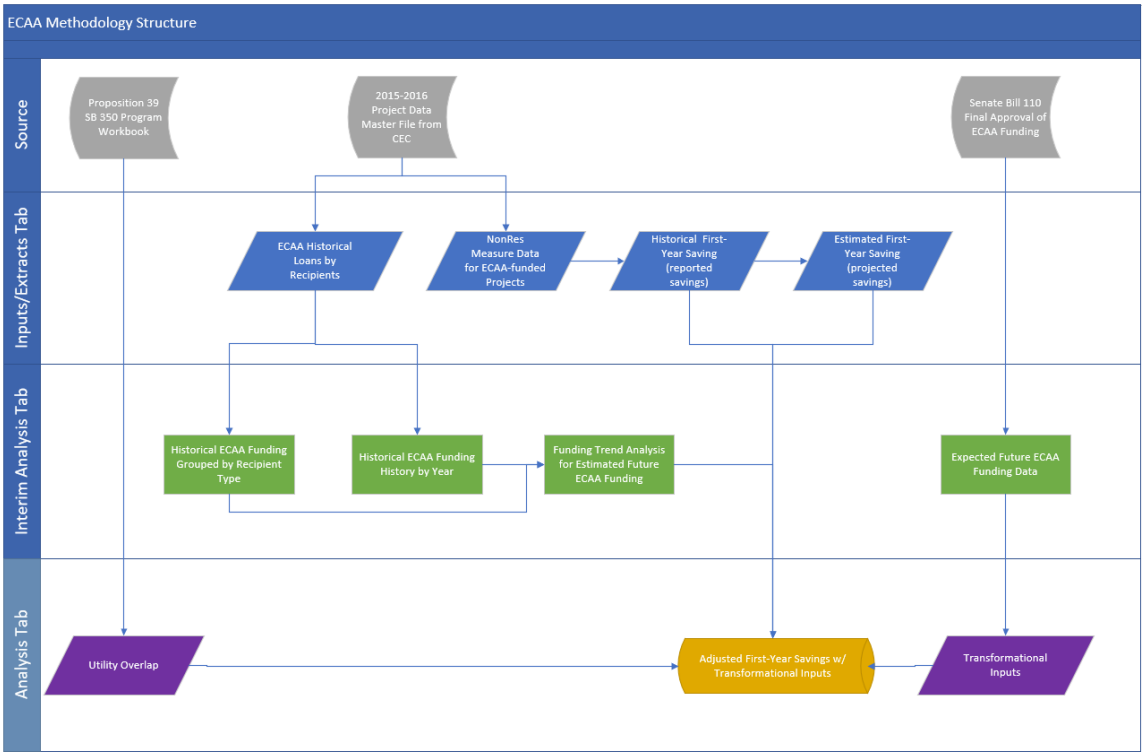
Methodology Description

The team performed a top-down extrapolation approach using the following calculations and assumptions:

- There is no annual budget funding limit; however, the loan limit per application is $3 million.
- There is no data on utility rebates applied to the measures in the dataset.
- Since the ECAA datasets include both energy efficiency and self-generation projects, this analysis extracted the energy efficiency-only data to serve as the basis for the savings projections.
- Analysis included using historical data based on project year. The analysis checked for electrical and gas savings data project trends for future savings assumptions. There was no clear trend in the data, so instead the team calculated an average value to project out through 2029.
- The analysis tools provided to the Energy Commission show no ECAA savings claimed for the reference scenario because it uses the previous study assumption that savings projections have been captured by the IEPR baseline demand forecast. This may change depending on funding availability and can be updated by Energy Commission staff.

Figure 9 depicts the flow of data that supports the methodology of this workbook.

Figure 9: ECAA Methodology Flow Diagram



Source: Navigant team

Forecasting Scenarios

The team made the following assumptions for scenarios.

- **Reference case:** This scenario assumes that SB 110 provides additional ECAA-Ed funding. It is unclear if the additional funding has been approved. Since this program is administered by the Energy Commission, the final funding level is best verified by staff administering the ECAA program. The analysis team was unable to estimate annual funding additions to the program. Conservatively, the reference case assumes that about 10 percent of the total program savings affects SB 350 savings claims, beginning in 2019 when the SB 110 funding contributes to the ECAA program. In this scenario, all energy savings from 2015 through 2018 remain captured in the Demand Forecast with no incremental savings for SB 350, per conversation with the AAEE staff from the Energy Commission.
- **Conservative case:** This scenario assumes that the additional funding from SB 110 will not significantly increase the savings level beyond the current funding level and that all savings after 2018 will continue to be claimed by the Demand Forecast.
- **Aggressive case:** The scenario assumes that with SB 110 providing additional funding, there may be a significant increase in ECAA loans that achieve energy savings attributable to SB 350. Beginning in 2019 and through 2029, the aggressive case estimates that approximately 30 percent of the program savings may go beyond the historical average claimed in the Demand Forecast and can be captured as SB 350 savings potential.

Areas to Improve

For financing programs in general, the team recommends further research on funding projections, utility savings overlap, and market saturation. For the ECAA Financing program, the team recommends the following:

- Track implementation of SB 110,[76] which is estimated to provide up to $100 million of additional funding to the ECAA-Ed program; collect future data on annual funding level, project adoption rate, and energy savings. It is unclear if the additional funding has been approved. Because this program is administered by the Energy Commission, it is best if the staff administering the program verify the final funding level and then update the program workbook accordingly.
- Understand participation with utility programs and possible utility rebate savings overlap.

76 California Legislative Information. "SB-110 Clean Energy Job Creation Program and citizen oversight board." July 11, 2017. Available online at: http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB110

CHAPTER 15:
Financing – PACE

In 2007, the California legislature's AB 811 enabled Property Assessed Clean Energy (PACE) financing for energy efficiency and renewable energy projects in the residential and commercial markets. There are 14 active PACE providers in California, with financing over $2 billion in energy efficiency and renewable energy improvements including hard and soft costs. [77]

Program Overview

PACE financing programs provide property owners with financing for energy efficiency, water efficiency, resiliency, and renewable energy projects on existing and, in some cases, new residential and commercial structures through a voluntary special tax assessment on their properties. These financing programs are offered by private lenders—known as PACE providers—and do not rely on public funding. In some instances, customers may choose to combine PACE financing with other incentives such as utility rebate programs.

PACE financing programs do not require a down payment or payment of the full or partial upfront capital cost of the improvement. However, measures installed through PACE must perform better than California Title 24 building codes. The fundamental mechanism of PACE relies on the existing framework of building property taxes whereby the entire loan, including principal and interest, can be repaid through a special tax assessment made on the property where the energy projects are implemented. Property owners can amortize loan payments for a period of up to 20 years, with an option to extend the payback period as necessary. By leveraging property taxes, the property improvements funded through PACE are associated with the physical properties rather than the borrowers. In addition, the property owner can transfer the loan when the property is sold or ownership is transferred.

The statutory frameworks, Improvement Act of 1911 (Improvement Act) as amended by AB 811, also known as the Mello-Roos Act under a city's charter authority or as amended under SB 555, provide guidance on how PACE financing programs are set up and administered. Both the Improvement Act and the Mello-Roos Act authorize the creation of special tax districts for voluntary contractual agreements for financing between authorized entities and property owners. Properties residing in cities and counties that have adopted these special tax districts are able to apply for financing from designated PACE providers. Consequently, not all jurisdictions in California have access to PACE financing, and many jurisdictions have only approved a handful of providers to operate in their territory. This patchwork of programs across the state makes it difficult to accurately track PACE investment geographically.

77 https://pacenation.us/pace-in-california/

Despite the potential wide reach of PACE financing, PACE providers have not been required by law to publish any loan or project data. However, in October 2017, SB 242[78], which included data reporting clauses, became law. This bill (details provided in Appendix B) requires PACE providers to submit biannual reports to the public agency of each program they administer, detailing various metrics including estimated total energy saved and the percentage of PACE assessments represented by energy efficiency. However, the bill is limited; it "applies exclusively to residential properties with four or fewer units" and is not applicable to "any public agency that does not use a program administrator to administer a PACE program."[79] Despite its limitations, the bill can make energy savings modeling efforts in future years easier and more precise since the Energy Commission will be able to collect the data reported to local jurisdictions.

Updates Relative to Previous Study

The previous SB 350 report used a top-down approach to estimate the savings potential for the program. Given the lack of project savings data, this update is built upon previously available analysis and refined top-down estimates of the savings potential from 2015 through 2029.

Methodology Description

The 2017 SB 350 analysis applied the following methodologies to the savings analysis for the PACE program:

- Estimated total annual savings in electricity and gas from the aggregate savings data published by the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) PACE Loss Reserve Program (LLR), which only covers residential programs enrolled in the program as of June 30, 2016. [80]
- Extrapolated total annual savings in electricity and gas for the entire residential market by applying data statistics about residential PACE providers provided by the Center for Sustainable Energy (CSE).[81]
- Extrapolated nonresidential savings by using the market data published by PACENation,[82] coupled with the residential data derived from the CAEATFA reports.[83]

The team further adjusted the savings estimates for ratepayer program overlap assumptions. According to the CPUC, the utilities do not claim savings from this program. However, the projects funded by this program likely receive utility incentive and may be claimed by an IOU/POU as ratepayer savings. Due to the lack of utility incentive information in the data sources, this analysis assumed that the ratepayer savings overlap will be 4 percent based on the

78 Skinner, Chapter 484, Statutes of 2017

79 Senate Rules Committee – Senate Floor Analysis. *Property Assessed Clean Energy program: program administrator*. Sept. 2017. https://leginfo.legislature.ca.gov/faces/billAnalysisClient.xhtml?bill_id=201720180SB242

80 California Alternative Energy and Advanced Transportation Financing Authority. *Property Assessed Clean Energy (PACE) Loss Reserve Program*. March 2018. https://www.treasurer.ca.gov/caeatfa/pace/activity.asp

81 Center for Sustainable Energy. Property Assessed Clean Energy Programs. Visited April 2019. http://energycenter.org/policy/property-assessed-clean-energy-pace

82 PACENation. *Residential and Commercial PACE Market Data*. https://pacenation.us/pace-market-data/

83 California Alternative Energy and Advanced Transportation Financing Authority. *Property Assessed Clean Energy (PACE) Loss Reserve Program Enrollment Activity*. March 2018. https://www.treasurer.ca.gov/caeatfa/pace/activity.asp

project data from Prop 39. Therefore, the savings estimates for this program subtracted 4 percent from the raw projections prior to further adjustments. As more overlap data becomes available for this program, the Energy Commission shall update results accordingly.

Changes to Data Inputs and Assumptions

Due to a lack of actively enforced statewide reporting mandates, there are limited public data sources on PACE financing programs. The most detailed publicly available data is from the following two sources:

- PACENation's nationwide and regional reporting on total principal and project type for commercial and residential programs
- CAETFA LLR's reported biannual total enrolled principal, biannual principal from new financing, and self-reported energy savings for California's enrolled residential program providers

The updated methodology relies heavily on these two sources. However, the analysis team changed the data inputs used to extrapolate savings during this cycle, including:

- **Foregoing of the use of CSE data.** As of January 31, 2018, the previously used public data is not being updated, with the webpage now referring visitors to PACENation for market data. It is vital to use regularly updated publicly available information for the core inputs and assumptions as much as possible so that additional savings calculations can be updated more easily by the Energy Commission over time.
- **Using CAEATFA's new financing data to calculate residential savings.**[84] The analysis team found several issues after reviewing the residential energy savings by program listed on the CAEATFA LLR's website (the only publicly reported savings estimates available):
    - Self-reported savings with inaccessible methodologies due to most program providers classifying them as confidential
    - Inconsistent reporting format, resulting in many programs providing kWh savings without identifying the share attributable to energy efficiency and renewables
    - Savings being reported based on the entire enrolled portfolio without a way to identify first-year savings occurring from new efficiency improvements

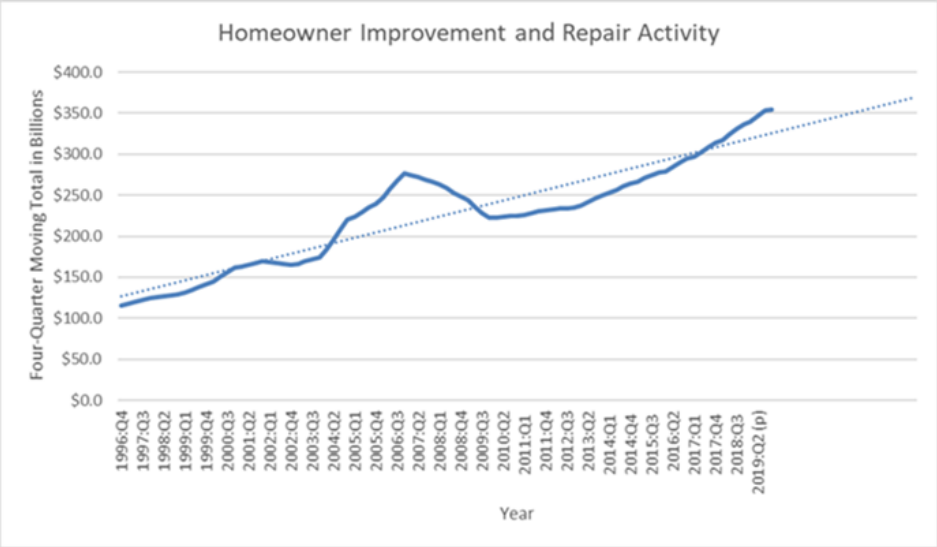
  Until standardized statewide reporting mandates allow access to credible historical annual savings estimates, the team extrapolates savings from reported principal amounts because residential investment is submitted biannually to CAEATFA using a standardized reporting framework and includes a breakout of new financings, which can be used to calculate first-year savings.
- **Using PACENation's principal in western states to calculate commercial savings.**[85] PACENation's commercial data is reported in principal and does not include

84 CAETFA. *Property Assessed Clean Energy (PACE) Loss Reserve Program Enrollment Activity*. March 2018. https://www.treasurer.ca.gov/caeatfa/pace/activity.pdf
85 PACENation. *Residential and Commercial PACE Market Data*. https://pacenation.us/pace-market-data/

any reported energy savings. Although the market data on PACENation is not filterable by state, estimating California's share of annual commercial principal is possible using the various metrics they report. These metrics include the percentage of investment attributable to energy efficiency (35 percent), annual commercial investment in western states ($105 million invested in 2017), and total commercial investment that has occurred in California ($236.6 million, or 95 percent of cumulative investment in western states).

- **Extrapolating savings from loan principal amount using private and publicly available studies.** Due to the lack of quality savings being reported publicly, the team decided that until such data is available that savings should be extrapolated from historical principal using savings units (kWh or therms) per dollar of principal invested. The team sourced units per dollar of principal invested using data from an under-development Lawrence Berkeley National Laboratory (Berkeley Lab) study. This detailed three-year Berkeley Lab project is analyzing PACE data from energy efficiency projects with a final report pending late summer of 2019. This study will report annual kWh and therm savings by Berkeley Lab measure category and the average statewide dollar principle per loan by measure category selected by Berkeley Lab. Until this publicly available report is published, the team opted to temporarily use the results of a private detailed energy savings analysis of a single PACE program to determine units per dollar of principal invested by Berkeley Lab measure category.
- **Forecasting PACE investment using homeowner improvement and repair activity trends.** The proportion of PACE financing used for energy efficiency measures is a subcomponent of the retrofit market. As such, the analysis team used the Joint Center for Housing Studies' Leading Indicator of Remodeling Activity's (LIRA) to project future PACE investment. LIRA measures trends in national spending for improvements and repairs to owner-occupied homes and is benchmarked to historical estimates of remodeling spending based on data from the Department of Housing and Urban Development's American Housing Survey. Figure 10 is a graph using LIRA data that shows improvement and repair activity over time.

Figure 10: LIRA's Historic and Forecast of National Improvement and Repair Activities



Source: Joint Center for Housing Studies of Harvard University. *Historical_LIRA_Benchmark_Data_and_Input_Correlations_and_Weights_2018_Q4* (Excel File). Downloaded March 2019. https://www.jchs.harvard.edu/research-areas/remodeling/lira

The forecast of PACE investment assumes that PACE maintains its current share of the energy efficiency financing market, and future energy efficiency savings follow the trend in improvement and repair activity found in LIRA. As illustrated in Figure 10, improvement and repair activities appear to increase over time as the building stock increases and equipment turns over—with drops where recessions occur. Note that LIRA does not track commercial improvement and repair activities. Consequently, in these calculations, the team assumes that the commercial market follows the same trend as the residential market on the premise that the commercial market developed at the same time as the residential market and, therefore, renovation rates are similar.

- **Updating ratepayer program overlap assumption.**[86] The PY 2014 Finance Residential Market Baseline Study Report, prepared under the direction of the CPUC, included a homeowner general population survey to capture a snapshot of the overall landscape for energy efficiency financing for homeowners in California prior to the rollout of the residential statewide finance pilots. The survey results documented a baseline for key metrics as defined in the 2013-2014 EM&V Finance Roadmap related to energy efficiency financing for residential customers. Extrapolating the results of this survey to the homeowner population in California found that "about one-fourth of the 7.4 percent of homeowners who made an upgrade and used financing received an IOU rebate – which means 1.9 percent of California homeowners used financing and received an IOU rebate for their upgrades (Note that this excludes homeowners who used only credit cards as their source of financing)." The team opted to replace last cycle's 4 percent utility overlap assumption from Prop 39 data with the 1.9 percent figure from this study. As new studies are published, the analysis team expects this assumption will be updated.

86 CPUC, Opinion Dynamics & Dunsky Energy Consulting. *PY2014 Finance Residential Market Baseline Study Report (Volume II)*. March 2016.

Extrapolation Approach

Using the data inputs and assumptions described in the previous section, the team used a top-down extrapolation approach to estimate incremental savings. For the residential market, the team's approach consisted of the following steps:

1. Applying the percentage of energy efficiency funding to the annual incremental principal to estimate total principal spent on energy efficiency.[87]
2. Extrapolating historical first-year savings by applying the percentage of total principal per Berkeley Lab measure category and the units (kWh/Therm) saved per principal by Berkeley Lab measure category to the estimated total principal spent on energy efficiency in the previous step.[88]
3. Forecasting future investment and future savings by applying a growth rate based on a linear trend line from LIRA's historical improvement and repair activity data.[89]
4. Adjusting historical first-year savings from step two and forecast savings in step three for overlap with utility incentive programs to produce adjusted first-year savings.[90]

The team's approach to forecasting the commercial market consisted of the following:

1. Estimating California's yearly energy efficiency financing by calculating the product of annual commercial PACE financing in western states, California's share of commercial PACE financing in Western states, and the percentage of overall energy efficiency investment.[91]
2. Extrapolating historical first-year savings by applying the percentage of total principal per Berkeley Lab measure category and the units (kWh/therm) saved per principal by Berkeley Lab measure category to the estimated total principal spent on energy efficiency in the previous step.[92]
3. Forecasting future investment and future savings by applying a growth rate based on a linear trend line from LIRA's historical improvement and repair activity data. In these calculations, the team assumes that the commercial market follows the same trend as the residential market on the premise that improvement and repair activities are primarily

87 PACENation. *Residential and Commercial PACE Market Data*. https://pacenation.us/pace-market-data/

88 Private PACE Program Study.

89 Joint Center for Housing Studies of Harvard University. *Historical_LIRA_Benchmark_Data_and_Input_Correlations_and_Weights_2018_Q4* (Excel File). Downloaded March 2019. https://www.jchs.harvard.edu/research-areas/remodeling/lira

90 CPUC, Opinion Dynamics & Dunsky Energy Consulting. *PY2014 Finance Residential Market Baseline Study Report (Volume II)*. March 2016.

91 PACENation. *Residential and Commercial PACE Market Data*. https://pacenation.us/pace-market-data/

92 Ibid. PACENation. *Residential and Commercial PACE Market Data*.

driven by the health of the economy; these activities steadily increase over time as the building stock increases and equipment turns over, with drops when recessions occur.[93]

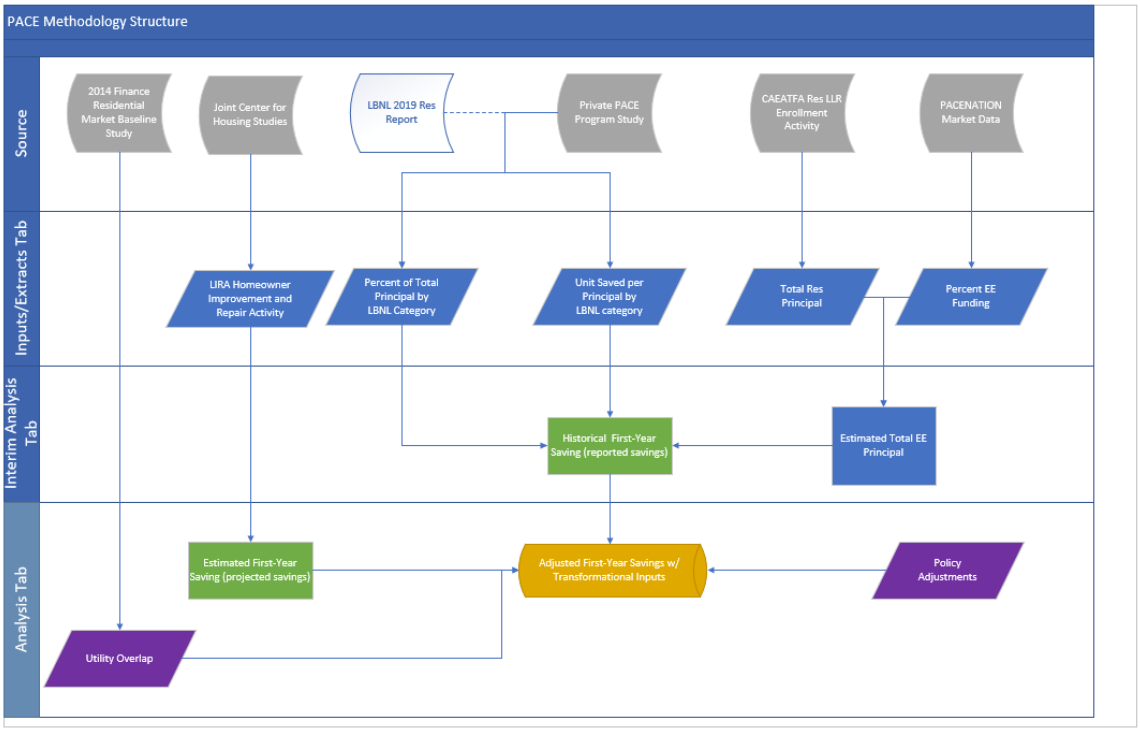
4. Adjusting historical first-year savings from step two and forecast savings in step three for overlap with utility incentive programs to produce adjusted first-year savings.[94]

Figure 11 outlines how this extrapolation approach is configured in the program workbook. It shows the flow of data and information throughout the workbook.

93 Joint Center for Housing Studies of Harvard University. *Historical_LIRA_Benchmark_Data_and_Input_Correlations_and_Weights_2018_Q4* (Excel File). Downloaded March 2019. https://www.jchs.harvard.edu/research-areas/remodeling/lira

94 CPUC, Opinion Dynamics & Dunsky Energy Consulting. *PY2014 Finance Residential Market Baseline Study Report (Volume II)*. March 2016.

Figure 11: PACE Program Analysis Methodology Diagram



Source: Navigant team

Forecasting Scenarios

The conservative and aggressive scenarios for PACE financing attempt to model potential changes in energy savings from changes in public policy by applying a modifier to the reference scenario. At this time, it is impossible to predict with a high degree of accuracy whether the legislature will make further adjustments to the recently passed PACE consumer protection laws or how these laws will affect PACE investment in the future given that only investment data from the first half of 2018 is available. The team's literature review concluded that PACE administrators are actively in discussions with legislative representatives on how to curtail the effects of this legislation. based on the limited data available, it appears to be having a greater negative effect on investment than what was forecast. Consequently, the modifiers used to determine energy savings under the conservative and aggressive scenarios should be adjusted as necessary when more 2018 data becomes available and when more is known about whether the legislature is willing to curtail these consumer protection laws. Below is a description of the assumptions made for each SB 350 forecasting scenario using what 2018 data is available and the understanding of the current legislative landscape.

- **Reference:** Residential and nonresidential savings, extrapolated from 2015-2017 principal data, will follow the retrofit market represented by the LIRA historic home improvement and repair activity trend line data.
- **Conservative:** PACE as a financing vehicle for residential and nonresidential properties will be reduced by the recent consumer protection legislation, which makes PACE lending

more restrictive. A 30 percent modifier is applied to the reference case and was determined by the difference in investment from the first half of 2017 and the first half of 2018.

- **Aggressive:** PACE as a financing vehicle for residential and nonresidential properties will be increased by a curtailment of the consumer protection legislation currently limiting the use of PACE; the result is PACE will be more widely adopted in the residential and nonresidential markets. A 20 percent modifier is applied to the reference case and assumes that PACE's total market share would increase at an aggressive but still far lower rate than pre-consumer protection legislation.

Areas to Improve

The team identified several areas for improvement for the Energy Commission to consider in the next SB 350 update:

- **Improved reporting of savings from PACE providers.** This analysis reveals that the PACE financing program has large potential to achieve energy savings attributable to SB 350. This reporting cycle's estimates are an order of magnitude lower than the last cycle due to the absence of a statewide standardized energy efficiency savings reporting structure and consequently, low visibility in the components (i.e., Berkeley Lab energy efficiency measure categories versus savings from solar) included in historical savings available at the time of the last update.
- **Standardized estimates of measure savings from PACE providers.** To improve future estimates of incremental savings, publicly available and verifiable savings data from the PACE providers is necessary. The forecast would benefit from a common engineering approach used across PACE providers to estimate measure-level savings and report these savings consistent with the Berkeley Lab measure categories.
- **Ongoing assessment of regulatory impacts.** The recent policy changes regarding consumer protection may stagnate or continue to decrease energy efficiency investment through PACE if the results in the 2018 data are the beginning of a long-term decline in PACE origination. However, with only six months of data at this time, there is no significant historical data to accurately determine if these trends will continue. It is yet to be seen if PACE administrators and legislators will work out a compromise that corrects the larger than expected decline in PACE origination seen in the early 2018 data. Future updates will need to re-examine the policy landscape and determine what, if any, adjustments are warranted from these recently passed policies as well as any legislation that emerges before the next update.
- **Including other financing programs when they are determined to be viable in the market.** There are additional energy efficiency financing programs recently launched by the CAEATFA or that are in the development process. Although they are not mature enough to be considered now, future updates should examine whether these programs are producing enough savings to be added to the analysis. As such, the

following CAEATFA California Hub for Energy Efficiency Financing Pilot Programs[95] warrant ongoing tracking for future inclusion consideration:

- Residential Energy Efficiency Loan Assistance Program
- Commercial Loans, Leases, and Energy Service Agreements Program
- Affordable Multifamily Finance Program

95 CAEATFA. *California Hub for Energy Efficiency Financing Pilot Programs*. Accessed March 2019. https://www.treasurer.ca.gov/caeatfa/cheef/index.asp

CHAPTER 16:
Behavioral and Market Transformation – Benchmarking

AB 802 directs the Energy Commission to create a mandatory benchmarking and public disclosure program for certain commercial and multifamily residential buildings; it also requires making certain building-level energy use information available to building owners, agents, and operators upon request.[96] The Energy Commission has proposed regulations that would implement the benchmarking and public disclosure provisions of AB 802.

The program will assist in achieving energy savings by providing better information about buildings to prospective buyers or lessees, allowing policymakers and planners to be better informed and helping energy service companies target their services. As local ordinances with requirements exceeding the statewide requirements (e.g., by requiring audits or retro-commissioning, or by including smaller buildings) become more common, energy efficiency savings can increase.[97]

Program Overview

The Benchmarking and Public Disclosure (AB 802[98]) program contains provisions requiring utilities to provide whole building energy use data access to building owners on request and directing the Energy Commission to develop regulations for benchmarking and public disclosure of energy performance data for certain buildings; these regulations are under development. Giving decision makers access to actionable building performance data (along with a clear metric for energy performance, such as the ENERGY STAR score in the US Environmental Protection Agency's ENERGY STAR Portfolio Manager[99]) is expected to result in cost-effective energy efficiency improvements via behavioral, operational, and building improvements. Mandatory statewide benchmarking first appeared in California in 2007 with the passage of AB 1103.[100] AB 1103 required the owner or operator of a nonresidential building to disclose benchmarking information for the building to a prospective buyer, lessee, or lender. AB 802 repealed this requirement. Other provisions in AB 802 shift the way utilities provide rebates and claim energy efficiency savings by allowing programs to incentivize all energy savings, including those resulting

96 An earlier benchmarking program established under of AB 1103 (Saldaña, Chapter 533, Statutes of 2007) required the owner or operator of a nonresidential building to disclose the benchmarking information of that building to a prospective buyer, lessee, or lender.

97 At this time, San Francisco, Berkeley, and Los Angeles have local ordinances requiring benchmarking, reporting, and audits. The increased access to building-level energy use information provided by AB 802 will make it easier for more jurisdictions to create local ordinances.

98 Williams, Chapter 590, Statutes of 2015

99 ENERGY STAR. Portfolio Manager. April 2019. Available online at: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

100 Saldana, Chapter 533, Statutes of 2007

from a building being brought up to code,[101] and energy efficiency achieved through behavioral and operational efficiency interventions. AB 802 also allows the Energy Commission to receive account-level energy use data from utilities.

Proposed Regulations

The Energy Commission proposed regulations that would implement the benchmarking and public disclosure provisions of AB 802. The regulations would require the owners of most commercial and residential buildings larger than 50,000 square feet to report building-level energy performance information to the Energy Commission annually; commercial buildings would begin in 2018 and residential in 2019. The Energy Commission would publish this information on a public website. The increased availability of energy performance information would help:

- Potential buyers and lessees better understand buildings they are considering purchasing or leasing
- Policy makers and planners make better-informed decisions
- Energy service companies target their services

Under the proposed regulations, local jurisdictions with benchmarking and public disclosure ordinances would be allowed to apply to the Energy Commission for a determination that would exempt building owners who report to a local jurisdiction from also reporting to the Energy Commission.

Assessment and Opportunities for Improvement

Once the program has been implemented, the Energy Commission will analyze the results and consider program enhancements, which could include the following:

- Expanding the population of buildings included in the program—e.g., by decreasing the minimum building size (currently 50,000 square feet).
- Requiring action beyond benchmarking and reporting—e.g., by requiring building owners to complete energy audits. San Francisco, Berkeley, and Los Angeles[102] all require energy audits in addition to benchmarking. Other cities, such as Long Beach and Santa Monica, routinely conduct energy audits for municipal buildings and operations, but they are not necessarily required to do so by legislation.[103]

Support for Local Programs

San Francisco, Berkeley, and Los Angeles have ordinances requiring benchmarking, reporting, and audits. Energy savings from these early adopters are not estimated in this report but will be

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101 Prior to AB 802, utility rebate programs could only claim savings for above-code improvement in repair-eligible equipment.

102 kW Engineering. Energy Benchmarking, It's the Lawin California. Here's What you need to know. May 4, 2018. http://www.kw-engineering.com/energy-benchmarking-california-ab802/

103 US Mayors. Energy Audits – Municipal and Commercial Buildings. January 2018. http://www.usmayors.org/wp-content/uploads/2018/01/Energy-Audits-_-Municipal-and-Commercial-Buildings.pdf

considered in future updates. Increased access to building-level energy use information will make it easier for jurisdictions to create their own ordinances. As local ordinances with requirements exceeding the statewide requirements (for example, by including smaller buildings or by requiring audits or retro-commissioning) become more common, the Energy Commission's role could shift from the implementer of the statewide program to an advisor to local governments on the following matters:

- Designing and implementing a benchmarking and disclosure program
- Aligning data transfer protocols with state and national standards
- Encouraging building owners to go beyond what is required for compliance (benchmarking or completing an audit) to performing retro-commissioning or implementing cost-effective improvements to buildings and equipment

Buildings Affected

The program will require the owners of commercial buildings larger than 50,000 square feet and residential and mixed-use buildings larger than 50,000 square feet with more than 16 utility accounts to report building and energy use information to the Energy Commission annually.

Updates Relative to Previous Study

The analysis team did not change the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030, Appendix A13 Benchmarking, for more detail on the analysis conducted for this program.

Methodology Description

The analysis team derived benchmarking program savings for SB 350 using a top-down extrapolation approach to determine the savings potential. It is not straightforward to estimate the savings attributable to the benchmarking program because the proposed regulations do not require building owners to take any action to reduce energy use; the regulations would only require building owners to report energy performance information to the Energy Commission. However, the increased visibility of building energy performance the program provides may drive building owners and tenants to reduce energy use, either by making behavioral and operational changes or through building improvements.

The team used the following steps to quantify potential energy savings:

- Quantified IOU electricity sales as a portion of statewide electricity sales[104] to estimate the portion of statewide energy consumption in commercial and residential buildings[105] in IOU territories.
- Quantified energy savings from IOU efficiency programs.[106]
- Divided energy savings by consumption to estimate percent savings from current participation in efficiency programs.
- Assumed that participating in the benchmarking program would cause a doubling of the savings expected from participating in IOU energy efficiency programs in those buildings subject to the statewide benchmarking and public disclosure program not already subject to a local mandatory benchmarking and public disclosure ordinance. These local mandatory benchmarking and public disclosure ordinances have more stringent requirements than the proposed statewide program.
- Estimated affected floor area based on the proposed regulations; the regulations only include commercial buildings larger than 50,000 square feet and residential buildings larger than 50,000 square feet with more than 16 utility accounts.
- Calculated consumption expected to be avoided due to the statewide program.
- Multiplied the estimated savings rate by the estimated consumption in buildings subject to the program but not to local programs.

Forecasting Scenarios

Based on this information, the team made the following assumptions for the three scenarios:

- **Reference case:** The team estimated savings by first aligning savings with Energy Commission projections through 2021. Beyond 2021, an aggregate whole building savings rate increases by 2 percent per year. This savings rate is an aggregate rate of savings that can be expected to be attributed to the benchmarking program. This savings rate is somewhat lower than other recent studies[107,108] due to expected overlap between programs and difficulties with attributing savings to benchmarking as distinguished from other programs. This is somewhat conservative compared to other studies in other cities and jurisdictions, which show confirmed savings levels of 6 percent or higher.
- **Conservative case:** The team assumed a whole building average savings rate of 1 percent.
- **Aggressive case:** The team assumed that year-over-year savings improvements could increase after certain durations of participation in the program; whole building savings

104 California Electric Utility Service Areas. July 18. 2017http://www.energy.ca.gov/maps/serviceareas/electric_service_areas.html

105 US Energy Information Administration. California Portfolio Overview. July 18, 2017. Available online at https://www.eia.gov/state/?sid=CA#tabs-2

106 California Energy Efficiency Statistics. Rolling Portfolio. July 18, 2017. Available online at http://eestats.cpuc.ca.gov/Views/EEDataPortal.aspx

107 Meng, Ting, D. Hsu and A. Han 2016. "Measuring Energy Savings from Benchmarking Policies in New York City," 2016 ACEEE Summer Study Proceedings, American Council for an Energy Efficiency Economy, Washington, D.C.

108 Mims, Natalie, et. al. 2017. "Evaluation of U.S. Building Energy Benchmarking and Transparenc7y Programs: Attributes, Impacts and Best Practices," Lawrence Berkeley National Laboratory, April 28, 2017.

are increased to 4 percent. This increase is based on a scenario in which, given more time to assess the opportunities suggested by benchmarking data, building owners and operators would be better equipped to make more aggressive, more impactful decisions, which could lead to increased energy savings.

Areas to Improve

For benchmarking and market transformation programs in general, the team recommends more data collection and monitoring of these programs at different stages, including the first year and the first 3 years, and subsequently tracking progress throughout program maturity. This category of programs may also require extra care to properly account for savings overlap to ensure that benchmarking and public disclosure savings are not double counted. For the Benchmarking (AB 802) program, the team recommends the following:

- As the results of benchmarking and data disclosure requirements become available, compare to initial estimates and update savings projections as appropriate.
- Verify the current approach to savings allocation. All savings anticipated to be generated through benchmarking and data disclosure requirements are currently allocated to the benchmarking program itself. In practice, much of those savings are expected to be realized through other analyzed programs. In particular, a high percentage of benchmarking savings are expected to be realized through the implementation of behavioral, retro-commissioning, and operational savings (BROS) measures.
- Leverage more California-specific building stock data and assumptions.

CHAPTER 17: Behavioral and Market Transformation – Behavioral, Retro-commissioning, Operational Savings

The idea behind Behavioral, Retro-commissioning, Operational Savings (BROS) is to give energy customers greater accessibility to their energy data to better understand their energy usage and influence them to become more energy efficient. Energy customers can accomplish this through energy efficiency improvements, such as purchasing more efficient technologies, or by changing behavior that affects building energy usage, including shifting appliance and equipment use to off-peak hours[109] and turning off energy measures when not needed. Changes in behavior have been shown to provide quantifiable effects on energy consumption.

Retro-commissioning (RCx) is checking that equipment was installed correctly, like the ducts of an HVAC system. It helps discover ways to capture energy savings in existing buildings. Operational savings improve the operation of a building's equipment by offering certifications and training. Effective building operations have a significant impact on energy use for multifamily and commercial buildings

Program Overview

The BROS category consists of energy efficiency measures that achieve energy savings through behavioral, retro-commissioning, and operational savings as defined in the 2018 PG study.[110] BROS programs target changes that result in energy savings (e.g., changes in thermostat setpoints), improvements that result in accomplishing the same work more efficiently (e.g., space cooling), or reducing/eliminating energy use without relying on installing new energy efficient technologies.

BROS affect all market sectors depending on the specific program target. Existing buildings are targeted more than new construction, where operational changes can result in energy savings without requiring expensive retrofits or equipment upgrades.

Updates Relative to Previous Study

The analysis team did not change the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill

109 Load shifting may save energy, too, such as pre-cooling.

110 California Public Utilities Commission. "2018 Potential & Goals Study." June 2017. Available online at: http://www.cpuc.ca.gov/General.aspx?id=6442452619

350: Doubling Energy Efficiency Savings by 2030 report, Appendix A14 BROs, for more detail on the analysis conducted for this program.

Methodology Description

The team performed a top-down extrapolation approach using the following energy savings analysis to attribute to BROS measures. This analysis assumed no gas savings from POU programs because almost all POUs (including Los Angeles Department of Water and Power, LADWP and SMUD) provide electricity only.[111] For POU electricity savings, the analysis consisted of the following:

- This analysis assumed no savings from BROS programs until 2018 because most of the POUs (including the two largest, LADWP and SMUD) do not yet have many BROS programs, such as Building Energy Management and Information Systems (BIEMS) or Business Energy Reports (BERs).
- For 2018 and 2019, this analysis assumed savings from Home Energy Reports (HERs), Building Operator Certification (BOC), and Industrial Strategic Energy Management (SEM) in alignment with the POU Potential Study's assessed program list.[112]
- For 2020-2030, this analysis assumed that all POU BROs programs would have similar savings as IOU BROs, adjusted for population—i.e., multiplied by 0.33 based on 25 percent of the population in POU territories and 75 percent in IOU territories.[113]

Forecasting Scenarios

Based on this information, the team made the following assumptions for the reference, conservative, and aggressive scenarios.

- **Reference case:** This analysis identified the following sources of BROs:
    - Savings from POU programs using the same BROS measures as the 2018 PG study, as described above.
- **Conservative case:** The conservative scenario reduced savings from all programs compared with the reference scenario by 50 percent by 2029, starting from year 2021. This scenario reflects the possibility that BROS energy savings will decline per customer in the future because other SB 350 initiatives will reduce total energy use.
    - Assumed the same savings as the reference scenario from 2015 to 2020, because many SB 350 initiatives are projected to be ramping up until 2020.
    - By 2029, assumed that savings would be 50 percent of the energy savings from the BROS reference prediction for 2029. Using industry judgement, this analysis

111 The City of Palo Alto Utilities (CPAU) provides gas, but this utility is relatively small. For example, CPAU's electricity savings made up 1 percent of POU savings (Energy Efficiency in Public Power, 2017), so approximately 0.25 percent of statewide savings.

112 Sathe, Amul (Navigant), Wikler, Greg (Navigant), Cullen, Gary (Anchor Blue LLC), Penning, Julie (Navigant) 2018. *Publicly Owned Utility Electricity Savings Projections*. California Energy Commission

113 CPUC presentation, "Customer and Retail Choice in California," Nicolas Chaset, May 10, 2017. Available at: http://energy.nv.gov/uploadedFiles/energynvgov/content/Programs/TaskForces/2017/Agenda%20item%204%20-%20California%20Presentation.pdf

selected 50 percent to represent the lower limit of what was considered to be feasible for reduced energy savings opportunities for BROS.
    - Developed a smooth curve for energy savings from 2021 through 2029 using the difference in BROs from 2020 through 2029 and dividing this value by 10 years.
- **Aggressive case:** This analysis identified the following:
    - For the POUs, this analysis assumed that BROS would increase at the same rate as IOU BROS. For each year, the team took the ratio of IOU savings under the aggressive scenario to IOU savings in the reference scenario and multiplied this ratio by BROS from POUs under the reference scenario.
    - Additional savings from HER (beyond the 2018 PG savings) from increasing the penetration rate by an additional 12.5 percent statewide (from 37.5 percent to 50 percent) through a smaller control group

Areas to Improve

For market transformation programs in general, the team recommends more data collection and monitoring of these programs at different stages, including the first year and the first 3 years, and subsequently tracking progress throughout program maturity. This category of programs may also require extra care to properly account for savings overlap to ensure that other programs or savings reductions are not double counted. For the BROS program, the team recommends the following:

- As BROS measures become more widely available, update market penetration estimates as appropriate.
- Refine assumptions on program implementation and uptake rates, as several of the potential BROS efficiency measures are not available in California.
- Collect more data on IOU and POU programs with measures pertaining to BROS implementations.
- Change the analysis if programs become part of the utility program savings portfolio.

CHAPTER 18:
Behavioral and Market Transformation – Energy Asset Rating

The Energy Commission Existing Buildings Energy Efficiency Action Plan calls for standardized energy asset ratings for both residential and nonresidential buildings.[114] An asset rating is a method of quantifying the efficiency potential of a building itself, independent of the number of occupants and their behavioral choices. By including an asset rating as part of real estate listings or information for a building owner, one can factor the behavior-independent energy costs of a building into their decision-making and amend their behavior to achieve their full energy efficiency potential. The factors affecting underlying efficiency potential include the envelope; the heating, cooling, ventilation, and hot water systems of the building; the installed lighting and major appliances; and any offsetting electrical power produced by onsite renewable systems. Energy savings that can be directly attributed to an energy asset rating are behavioral, whereas any measures implemented due to knowing and acting on the rating is attributable to that specific program.

Program Overview

The Energy Asset Rating program consists of two similar but separately funded programs: the California Home Energy Rating System (HERS) Whole House program and the Nonresidential Energy Asset Rating program (a potential program not currently established). Both programs are designed to determine an asset rating of new and existing buildings that measures building performance decoupled from operational details such as operating hours and building controls. Energy asset ratings characterize the major energy uses of the building through surveying and energy modeling. The program also provides some level of information on recommended efficiency measures to improve building performance.

While the residential HERS Whole House program has been active for several years, the Nonresidential Energy Asset Rating program completed a pilot phase but was not fully rolled out to the marketplace. The rating aspects of the residential HERS program are assumed to be captured in existing Demand Forecast estimates; therefore, the residential HERS savings are not included in the SB 350 incremental savings for the reference case. The measure-specific aspects of HERS such as duct sealing and other tests are included in the Title 24 program estimates.

There are national programs, such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers' Building Energy Quotient (eQ) program, and Ireland, Portugal, and

114 California Energy Commission. 2016 Existing Buildings Energy Efficiency Action Plan Update - Final. Strategy 1.4, Adopt Uniform Asset Ratings to Compare Building Properties. December 2016. http://docketpublic.energy.ca.gov/PublicDocuments/16-EBP01/TN214801_20161214T155117_Existing_Building_Energy_Efficency_Plan_Update_Deceber_2016_Thi.pdf

other countries have developed and implemented programs to develop asset ratings for commercial buildings.

Nonresidential Energy Asset Rating

As part of a comprehensive program (to achieve greater energy savings in existing residential and nonresidential buildings, The Energy Commission, as part of the AB 758[115] comprehensive program developed and implemented a pilot program in 2012 to develop a protocol for asset ratings. The program had several goals:

- Rate the inherent energy efficiency of the commercial building's envelope, lighting, and HVAC systems relative to code and existing commercial building stock
- Provide a metric relating to the financial implications of a building's energy efficiency
- Communicate the importance of zero net energy buildings as a reference point for California's energy policy
- Communicate a building's potential for an improved energy efficiency infrastructure by comparing performance to other buildings of similar type and location
- Be a reasonably priced rating for building owners to obtain

The program complements an operational rating, such as ENERGY STAR. ENERGY STAR bases ratings on actual energy performance (bills), while the Nonresidential Energy Asset Rating is intended to normalize for operational effects and provide insights to relative building performance and potential energy efficiency capital improvement projects. The team estimated savings for Energy Asset Rating to be a very small percentage of the entire building sector; as such, any overlap with benchmarking savings is assumed to be negligible.

A key distinction between energy asset ratings and other efficiency programs is that onsite PV and cogeneration systems could potentially be considered an asset, as they provide persistent savings. For this estimate, the analysis only considers energy efficiency aspects; however, the program may have additional benefits. The program was suspended after the pilot due to funding availability but shows promise and is well-aligned with other programs and Energy Commission goals.

The Nonresidential Energy Asset Rating Program would affect most commercial building types, except for some buildings with process loads, including labs, data centers, and likely refrigerated warehouses, grocery stores, and hospitals. Mixed-use buildings could fall into the scope but would require additional research to adequately define the reference point and the required building inputs. Table 9 shows the planned scope of the nonresidential energy asset rating program.

Table 9: Proposed Nonresidential Energy Asset Rating Building Type Classification

Proposed Building Types	Use Existing DOE Reference Building	Use Modified DOE Reference Building	New Modeling Prototype Required

115 AB 758, Skinner, 2009. Energy Audit.
https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100AB758

Large Office	X		
Medium Office	X		
Small Office	X		
Data Processing/Computer Center		X	
Lab/R&D Facility			X
Quick Service Restaurant	X		
Full Service Restaurant	X		
Bar/Tavern/Nightclub/Similar		X	
Supermarket	X		
Convenience Store		X	
Standalone Retail	X		
Strip Mall	X		
Refrigerated Warehouse		X	
Unconditioned Warehouse		X	
Conditioned Warehouse		X	
Small Hotel	X		
Large Hotel	X		
Primary School	X		
Secondary School	X		
College or University		X	
Religious Assembly			X
Health/Fitness Center			X
Theater/Performing Arts			X
Library/Museum			X
Conference/Convention Center			X
Other Recreational/Public Assembly			X
Service			X
Assembly/Light Mfg.			X
Police/Fire Stations			X

Source: Crowe, Elliot, et. al. 2012. California's Commercial Building Energy Asset Rating System (BEARS): Technical Approach and Design Considerations, ACEEE 2012 Summer Study Proceedings.

The program would exclude some buildings due to the lack of available protocols necessary to establish the 100 point reference on the scale. The precise scope of the program would depend on the willingness of the different building sectors to embrace the rating program.

Using a cross-reference comparison between the IEPR building stock and the included building type, the commercial asset rating program would affect an estimated 90.7 percent of commercial building stock greater than 50,000 square feet. The team used this estimate to normalize savings against AB 802 program savings. The analysis applied a similar area estimate to the building stock less than 50,000 square feet, which applies to the asset ratings program but not the AB 802 regulation.

Residential Energy Asset Rating

The HERS program consists of two functions: to provide a certified authority to perform field verification of code requirements for Title 24 new construction, and to conduct the necessary field data gathering and energy modeling to generate a whole house rating for the building. Because the whole house rating element is voluntary and not required for new construction or for existing buildings or at the time of sale, the team expects the participation rate for the rating aspect to be low. The benefits of HERS field verification for building attributes such as duct sealing, air leakage tests, and HVAC system tests are assumed to be wholly incorporated in the Title 24 program benefits.

For this analysis, a participation rate for residential ratings, combined with the energy savings level, is estimated to be 50 percent of the participation rate for commercial energy asset rating programs. If the Energy Commission modified the program in the future to require ratings, the participation rate would be much higher. With the lack of available data, the analysis estimates the savings rate per building in the same manner as the commercial asset rating program described above, combined with the Energy Commission's benchmarking assumptions and calculations. Because the program is voluntary and affects the homeowner primarily for newly constructed buildings, is the team analysis assumes that existing buildings will not receive a rating.

The HERS program affects only newly constructed single-family buildings. Through interviews with HERS raters, the analysis team determined that the whole house rating is not typically performed for existing buildings, even at time of sale.

Updates Relative to Previous Study

The analysis team did not change the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030 report, Appendix A15 Energy Asset Rating, for more detail on the analysis conducted for this program.

Methodology Description

The team performed a top-down extrapolation approach using the following calculations and assumptions to project the energy savings potential from 2015 through 2029:

- Determined the floor area applicable to the asset ratings program by analyzing the existing building stock by end use and comparing it to the total building stock used in the Energy Commission's AB 802 program assumption. This results in an estimated 90.7 percent of the building stock applicable to the asset ratings.
- Assumed the weighted average building stock EUI matches the AB 802 program assumptions.
- Identified affected building types and building stock. The estimate includes office, retail, restaurant, warehouse, school, and hotel buildings and excluded high rise residential,

grocery, hospital buildings, and other buildings with significant process loads (labs, data centers).

- Collected the distribution of nonresidential floor area by building type and size from the 2012 CBECS[116] to determine what fraction of floor area by building type is expected to be contained within buildings larger than 50,000 square feet.
- Extracted nonresidential building electricity and gas EUIs from the CEUS.[117] To account for the age of the CEUS data, the team updated the values according to the ratio of energy use data captured by the 2012 CBECS and 2003 CBECS[118] for each combination of fuel and building type.
- Assumed for buildings larger than 50,000 square feet, for which benchmarking and data disclosure will be required by AB802, that Nonresidential Energy Asset Rating would increase ENERGY STAR-predicted savings by 50 percent (assumption is that savings would increase but at a diminishing rate due to benchmarking data already being available).
- Assumed for buildings between 25,000 square feet and 50,000 square feet that Nonresidential Energy Asset Rating would be the only form of benchmarking and estimated savings equivalent to ENERGY STAR-predicted savings.
- Calculated that the savings rate for the commercial building stock due to asset ratings will be 50 percent of the savings rate of AB802.
- Calculated that the savings rate for the commercial building stock not subject to AB802 will twice that of the buildings that overlap with AB802.
- Assumed only new construction residential building stock is applicable for the HERS program, as there is no established process in place for linking ratings to time of sale or other existing buildings.[119]
- For residential ratings, estimated an average EUI of 29 kBtu/square feet for California single-family construction[120] distributed to 80 percent electricity and 20 percent gas.
- Assumed a 2 percent program uptake rate for the full market potential.
- Assumed the savings rate effectively incorporates the overlap between asset ratings and other programs.

Forecasting Scenarios

Based on this information, the team made the following assumptions for the reference, conservative, and aggressive scenarios.

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116 US Energy Information Administration. "2012 CBECS Survey Data." Available online at: https://www.eia.gov/consumption/commercial/data/2012

117 Itron. California Commercial End-use Survey. May 2017. Available online at: http://capabilities.itron.com/CeusWeb/Default.aspx

118 US Energy Information Administration. Available online at: "2003 CBECS Survey Data." Available online at: https://www.eia.gov/consumption/commercial/data/2003/

119 Interview with Brian Selby, experienced HERS rater with in-depth knowledge and experience at the building department level.

120 Energy Information Administration. 2009. Household Energy Use in California, https://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/ca.pdf.

- **For all scenarios:** The team assumed that the building types affected do not include restaurants, grocery, refrigerated warehouses, and hospitals, adjusting the total building stock to 90.7 percent of the AB 802 commercial building stock. The aggregate building EUI across the building stock matches the Energy Commission's AB 802 assumptions.
- **Reference case:** The team applied similar assumptions to the AB 802 analysis for savings rate across the building stock. The asset ratings program is complementary to the AB 802 benchmarking program, so the savings rate for buildings that overlap with AB 802 (greater than 50,000 square feet, affected building types) is assumed to be 50 percent that of AB 802 for the reference case. For buildings less than 50,000 square feet where there is no overlap, the saving rate (percent) per square foot of building stock is assumed to be equal that of AB 802. The team assumed a 2 percent per year uptake in the program savings due to increased adoption and more effective realization of program savings through implementing capital improvement projects. For HERS system whole house ratings, to estimate savings potential for the rating itself independent from Title 24, Part 6 code requirements, the team assumed an effective penetration rate that increases at 2 percent per year beginning in 2018.
- **Conservative case:** The team assumed that the uptake rate reduces from 2 percent to 1 percent year over year to reflect a more conservative adoption rate. Moreover, the program savings are not expected to begin until 2020, as opposed to 2018 for the reference case. The conservative case reduced the implementation rate for HERS ratings as well. For residential ratings, the team reduced the penetration rate.
- **Aggressive case:** The team assumed there is a 5 percent per year uptake in the program savings due to increased adoption and more effective realization of program savings through implementing capital improvement projects. The team assumed that the savings rate for buildings applicable to the asset rating program is 75 percent of the AB 802 savings rate. For residential ratings, the team increased the penetration rate.

Areas to Improve

For market transformation programs in general, the team recommends more data collection and monitoring of these programs at different stages, including the first year and the first 3 years, and subsequently tracking progress throughout program maturity. This category of programs may also require extra care to properly account for savings overlap to ensure that benchmarking and public disclosure savings are not double counted. For the Energy Asset Rating program, the team recommends the following:

- Compare any collected data to initial estimates and update savings projections as appropriate.
- Determine the likelihood and timeline that the Nonresidential Energy Asset Rating program will be implemented.
- Establish a procedure to link asset rating scores with voluntary efficiency upgrades driven by this program.
- Collaborate with stakeholders from the real estate market to address known concerns and identify potential issues and resolutions.

- Determine if asset ratings will have an effect on property valuation.
- Determine how receptive the building owners are to applying building asset ratings to their building stocks.

CHAPTER 19:
Behavioral and Market Transformation – Smart Meter and Controls

Utilities have begun deploying advanced metering infrastructure (AMI) to enable two-way communications with their customers. There are numerous aspects of AMI that can contribute to energy savings, including what are referred to as smart meters. The smart meter may be able to communicate through the internet with devices in the building that are connected as part of the Internet of Things (IoT). For example, the air conditioner can be sent a signal to operate minimally when the electricity rates are above a threshold, or the clothes dryer can be set to run as soon as the electricity rate drops below a desired level. This communication would result in both load shifting and energy savings.

Although smart meters have been widely installed across California, they have not been the focus of specific energy efficiency programs, and much of the potential of these devices remains unrealized.[113] Most of the energy savings from using smart meter data are captured in the previous category of behavioral and market transformation programs. The focus of this section is automating appliances and other loads in a building by communicating with a smart meter.

Program Overview

The smart meter and controls program is intended to use the smart meters that have been installed in California to encourage reduced energy consumption by providing consumers with real-time information on the costs associated with energy consumption at that time. As energy is reduced during peak load periods, some of the load may be shed to lower periods, saving the consumer money and saving energy consumption via a direct, IoT, or otherwise-connected device. Smart meters can be installed on electric, gas, and water meters.

While not an established program, there is supporting evidence to suggest that implementing a smart meter and controls program can result in energy savings. As of 2015, over 80 percent of meters in California are listed as AMI electricity meters. These meters enable variable rate structures, demand response, and improved customer feedback and control.[121]

As the smart meter market develops, there is potential for feedback to include historical baseline information and the control of energy consumption in a way that reflects the time dependent valuation (TDV) of the energy consumed. This communication will be automatic, but the decision-making will initially be made by the consumer rather than the utility. Utilities, however, have chosen to incentivize this through programs to encourage reduced demand peaks, lower overall energy consumption, and lower overall TDV for the consumption profile in some

121 Walton, Robert. "How smart meters are changing energy efficiency in California." Utility DIVE. December 9, 2015. http://www.utilitydive.com/news/how-smart-meters-are-changing-energy-efficiency-in-california/410489/

circumstances. PG&E uses this to encourage peak reduction through its SmartRate rate plan,[122] with an incentive of lower overall rates predicated on the consumer reducing electricity usage on certain days of peak demand; the utility is limited to selecting 15 peak demand days per year.[123]

Smart meters are effectively the enabling technology needed to create behavioral programs. This means there is a potential for substantial overlap with the BROs program. For this reason, the team has adopted a narrow interpretation of smart metering; that is, the employment of a direct, IoT, or otherwise-connected device. Energy efficiency opportunities that involve semi-active or ongoing participant decision-making fall outside the scope of this definition (such opportunities are included in the BROs program). Additionally, as part of this analysis, the team only considered smart meter-based interventions that reduce energy consumption (not interventions that only shift demand).

Residential buildings are candidates for smart meter savings because they generate a relatively high level of discretionary energy consumption. There is opportunity for smart meter savings in nonresidential buildings as well. For example, a facility manager may choose to reduce light levels when the energy cost crosses a threshold, even if there is not a demand response event occurring. In some cases, building automation system (BAS) controls may facilitate action that enables automated smart meter savings; in other cases, BAS capabilities may determine the necessary efficiency intervention without the need for smart meter input at all.

Updates Relative to Previous Study

The analysis team did not change the methodology from the previous study. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030 report, Appendix A16 Smart Meter and Controls, for more detail on the analysis conducted for this program.

Methodology Description

The team performed a top-down extrapolation approach using the following calculations and assumptions to project the energy savings potential from 2015 through 2029.

- Evaluated smart meter and controls potential for buildings of all types and sizes. The source of expected energy savings is reduced consumption associated with the automatic response of IoT or otherwise connected devices to smart meter feedback.
- Extracted floor area data by building type from the IEPR building stock data. For multifamily buildings, IEPR data captures the number of households. To convert the number of multifamily households, the analysis team followed the same assumptions

122 https://www.pge.com/en_US/residential/rate-plans/rate-plan-options/smart-rate-add-on/smart-rate-add-on.page

123 PG&E. "Discover SmartRate: Determine if SmartRate is right for you." Accessed in May 2017. Available online at: https://www.pge.com/en_US/residential/rate-plans/rate-plan-options/smart-rate-add-on/discover-smart-rate/discover-smart-rate.page?

used by the 2016 impact analysis report:[124] 26 percent of multifamily households are high rise units with a floor area of 1,248 square feet; the remaining households are contained within 6,960 square feet, two-story, 8 dwelling buildings (870 square feet per unit). For single-family homes, 45 percent are assumed to be 2,100 square feet and 55 percent are assumed to be 2,700 square feet.

- Extracted commercial building electricity and gas EUIs from the CEUS.[125] To account for the age of CEUS data, values were updated according to the ratio of energy use data captured by the 2012 CBECS[126] and 2003 CBECS.[127] The analysis calculated ratios for each combination of fuel and building type.
- Extracted residential building electricity and gas EUIs from the California statewide RASS for 2009.[128]
- Made assumptions due to the lack of data availability related to the potential for smart meter and controls, as well as the general indication that demand and time-of-use response interventions are the focus area for the technology.
    - Energy savings from smart meter and controls will not begin to be realized until 2020.
    - Approximate savings will increase to approximately 0.5 percent for electricity and 0.25 percent for natural gas for 5 years then flatten out after that. A logarithmic fit is applied to determine savings by year.
    - Starting in 2020, an additional 2 percent of buildings will begin to realize savings via smart meter and controls each year.
- The team assumed one year for the EUL of real-time programs, so cumulative savings were the same as annual savings.
- Real-time feedback primarily affects electricity savings because California's AMI infrastructure has been installed for electricity. However, some electricity-savings measures can provide small ancillary gas savings. The team used the 2018 PG assumptions for gas savings for the two programs included in that study: zero for the in-home display program and 1.5 million therms by 2029 (under the reference scenario) for the web-based portal program.

The team analyzed energy savings attributed to smart meter and controls primarily based on results from the BROs program. This analysis delineated energy savings that have been captured

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124 NORESCO; Nittler, Ken. "Impact Analysis: 2016 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings," 2015.

125 Itron. California Commercial End-use Survey. May 2017. Available online at: http://capabilities.itron.com/CeusWeb/Default.aspx

126 US Energy Information Administration. "2012 CBECS Survey Data." Available online at: https://www.eia.gov/consumption/commercial/data/2012

127 US Energy Information Administration. Available online at: "2003 CBECS Survey Data." Available online at: https://www.eia.gov/consumption/commercial/data/2003/

128 DNV-GL. "California Statewide Residential Appliance Saturation Study." 2010. Available online at: https://webtools.dnvgl.com/rass2009/

by the 2018 PG study, which are assigned to the AAEE baseline, from the energy savings that can be counted as incremental for SB 350.

Forecasting Scenarios

Based on this information, the team made the following assumptions for the reference, conservative, and aggressive scenarios.

- **Reference case:** This analysis assigned 2018 PG reference savings from IOU real-time programs to the baseline forecast. The 2018 PG study includes two residential programs: in-home display real-time feedback and web-based portal real-time feedback. For the SB 350 incremental savings, the team added savings from POU programs based on the assumption that POUs would launch similar real-time programs as the IOUs beginning in 2019.
    - For 2019 through 2029, this analysis assumed the POUs' savings were the same as the IOUs' RCx savings, adjusted by population—i.e., multiplied by 0.33 based on 25 percent of the population in POU territories and 75 percent in IOU territories.[129]
    - The team did not include other real-time programs (beyond those in the 2018 PG study) because of the potential for overlap with other residential behavioral programs or overlap with commercial BROs programs.
- **Conservative case:** This analysis modeled real-time measures that reduce energy savings through conservation efforts such as reducing hours of operation and changes in setpoints (e.g., higher temperature setpoints for air conditioning). As other SB 350 measures increase energy efficiency, operational energy declines and the energy savings from real-time measures declines. The team considered how real-time measure savings would decline in the future as follows:
    - Assumed the same savings as the reference scenario from 2015 to 2020, when other initiatives are projected to be ramping up until 2020.
    - Assumed that savings would be 50 percent of the energy savings from the reference prediction for real-time programs through 2029. This analysis selected 50 percent using industry judgement to represent the lower limit of what the team considered feasible for reduced energy savings opportunities.
    - Developed a smooth curve for energy savings from 2021 through 2029, using the difference in real-time savings from 2020 through 2029 and dividing this value by 10 years.
- **Aggressive case:** This analysis assigned 2018 PG aggressive savings from the two IOU real-time programs to the AAEE baseline. For the SB 350 incremental savings for the POUs, this analysis assumed that smart meter savings would increase at the same rate as IOU smart meter savings.

129 CPUC presentation, "Customer and Retail Choice in California", Nicolas Chaset, May 10, 2017. Available at: http://energy.nv.gov/uploadedFiles/energynvgov/content/Programs/TaskForces/2017/Agenda%20item%204%20-%20California%20Presentation.pdf

- Calculated for each year the ratio of IOU savings under the aggressive scenario to IOU savings in the reference scenario and multiplied this ratio by smart meter savings from POUs under the reference scenario.
- Added the savings from enhanced smart meter programs based on a meta-analysis conducted by the American Council for an Energy Efficient Economy (ACEEE). The ACEEE study estimated savings from advanced metering initiatives that provide real-time feedback, either through an online portal or an in-home display[130]. The savings documented in the ACEEE study from real-time feedback programs (4-7 percent) were higher than the savings estimated for the real-time programs in the 2018 PG (approximately 1-2 percent).
- Incorporated enhanced billing with household-specific information and advice (to achieve an average of 4 percent savings) to achieve additional savings with smart meters. Additional savings may occur from web-based energy audits with information provided on an ongoing basis (to achieve an average of 7 percent savings).[131]
- Because California is a mild climate compared with the rest of the US (including a lower cooling load), the team assumed 3 percent savings total from AMI real-time feedback.
- Because the 2018 PG assumed 1-2 percent savings from real-time feedback programs, the team assumed an incremental savings of 1 percent. For participation assumptions, the team used the 2018 PG assumption for in-home display programs of 4 percent because this is more conservative than the assumption of 10 percent for online portals.
- The team assumed average household electricity use of 6,296 kWh/year based on the California statewide RASS for 2009. This is used for estimating AMI savings for aggressive case.

Areas to Improve

For market transformation programs in general, the team recommends more data collection and monitoring of these programs at different stages, including the first year and the first 3 years, and subsequently tracking progress throughout program maturity. This category of programs may also require extra care to properly account for savings overlap to ensure that benchmarking and public disclosure savings are not double counted. For this program, the team recommends:

- As the program is developed and implemented, compare any collected data to initial estimates and update savings projections as appropriate.
- Take steps to isolate savings automatically generated through this program from those resulting from benchmarking and data disclosure requirements.

130 Advanced Metering Initiatives and Residential Feedback Programs: A Meta-Review for Household Electricity-Savings Opportunities. Available at: https://www.smartgrid.gov/files/ami_initiatives_aceee.pdf, 2010.
131 Meng, Ting, D. Hsu and A. Han 2016. "Measuring Energy Savings from Benchmarking Policies in New York City," 2016 ACEEE Summer Study Proceedings, American Council for an Energy Efficiency Economy, Washington, D.C.

- Refine assumptions on program implementation and uptake rates, as several of the potential smart meter and controls efficiency measures are not available in California.
- Collect more data on IOU and POU programs with measures pertaining to smart meter and controls implementations.

CHAPTER 20: Behavioral and Market Transformation – Fuel Substitution

There are few utility fuel substitution programs. Fuel substitution can include measures for space heating, water heating, clothes dryers, and possibly additional residential and nonresidential measures. The requirements of SB 350 allow measures such as appliance electrification, which is substituting a natural gas appliance with an electric appliance. Advances in heat pump technology have made substituting natural gas with electricity for heating systems more viable and offer increased efficiency compared to traditional resistance heating devices such as electric clothes dryers. Most buildings in California use natural gas for water and space heating. Substituting natural gas with electricity-consuming devices could reduce both energy consumption and GHG emissions.

Program Overview

The fuel substitution category captures energy savings that can be achieved at the site level by substituting one utility-supplied fuel for another—i.e., substituting electricity for natural gas or vice versa. Because it is not anticipated that substituting natural gas for electricity would result in net site energy savings given that the energy consumption level may remain the same, electrification will be the main area of focus for this program.

For this analysis, the savings are the reduced site energy usage for any commercial or residential new construction or retrofit project by replacing existing natural gas-powered equipment with electrical equivalents. Because there is no specific program in place, the current approach is to not limit the potential savings to any particular building sector or funding mechanisms (grants, standard loans, no interest loans, on-bill financing, etc.).

Updates Relative to Previous Study

The team did not change the methodology from the previous study, but changes will occur in future Energy Commission analysis. The Energy Commission can use the updated program workbook to incorporate any new program data that may be used to update the savings estimates for this program. Refer to the previous Senate Bill 350: Doubling Energy Efficiency Savings by 2030 report, Appendix A17 Fuel Substitution, for more detail on the analysis conducted for this program.

Methodology Description

The analysis team derived program savings using a top-down extrapolation approach. The team estimated the energy savings potential for a statewide fuel substitution program by analyzing the additional natural gas heating load that is expected to be added to the utility grid from 2018

through 2029. Based on data presented in Palo Alto's Electrification Work Plan,[132] the team estimated the fraction of this additional natural gas load that would serve space and water heating needs. The team assumed that, on average, a fuel substitution program would replace 80 percent efficient natural gas combustion equipment with 3.0 coefficient of performance (COP) heat pump equivalents. The team assumed that a fuel substitution could impact 10 percent of the new construction (both residential and nonresidential) market moving forward, starting in 2018. Because electrification replaces natural gas load with electricity load, the net effect is a decrease in natural gas consumption and a corresponding increase in electricity consumption (although, based on the efficiency assumption, a net reduction in both site and source energy is expected to be achieved).

While the team had anticipated pursuing a bottom-up energy modeling analysis, subsequent investigation revealed that energy modeling was not likely to result in a substantially more accurate savings estimate. While energy modeling could provide a slightly more accurate indicator of seasonal performance for heat pump technology and better predict the variation in the fraction of natural gas use that could be offset for each combination of building type and climate zone, the effect of such refinements would be in the noise compared to the impact of relevant market uptake assumptions. The Energy Commission will develop a bottom-up approach for the next iteration of fuel substitution impacts.

The key questions that determine potential market impact are:

1. Would an electrification program target existing buildings or only new construction?
2. What fraction of the target market could be expected to implement electrification through 2029?

To facilitate the analysis, the team assumed that major fuel substitution efforts would be largely limited to new construction due to potential infrastructure limitations for retrofit cases. Analysis scaled back the market penetration assumption, delaying any penetration until 2020 and then ramping up gradually to 10 percent penetration (for the reference case) through 2029. The analysis team did not conduct market analysis to verify the electrification penetration but recommends it for future SB 350 updates.

Forecasting Scenarios

Based on this information, the team made the following assumptions for the reference, conservative, and aggressive scenarios.

- **Reference**: This case assumes that fuel substitution program(s) would impact residential and nonresidential new construction starting at a penetration rate of 1 percent in 2020 and ramping up linearly to a rate of 10 percent through 2029.
- **Conservative**: To account for a potential scenario in which fuel substitution does not become cost-effective through 2029, the conservative case assumes no savings.

132 http://www.cityofpaloalto.org/civicax/filebank/documents/48443

- **Aggressive**: The aggressive case assumes that fuel substitution program(s) would affect residential and nonresidential new construction starting at a penetration rate of 2.5 percent in 2020 and ramping up linearly to a rate of 25 percent through 2029.

Areas to Improve

For benchmarking and market transformation programs in general, the team recommends more data collection and monitoring of these programs at different stages, including the first year and the first 3 years, and subsequently tracking progress throughout program maturity. For this program, the team recommends the following:

- Define fuel substitution more clearly to determine what types of projects should be included. For a program or project to fall under the category of fuel substitution, does a natural gas configuration always define the reference cost case? If a project can qualify for a utility rebate by comparing high efficiency heat pump equipment against an electric baseline (by indicating that natural gas is not available onsite), would it then be ineligible for consideration as a fuel substitution project?
- Conduct further research on cost-effectiveness and establish an appropriate baseline for the existing penetration of natural gas or electricity.
- When fuel substitution programs start to achieve traction throughout the state, update the market penetration assumptions as appropriate.
- Refine assumptions for efficiency improvement and fraction of natural gas load offset as data become available.
- Include retrofit savings potential.

CHAPTER 21:
Sector – Industrial and Agricultural

The industrial and agricultural sectors represent a large opportunity for energy savings through energy efficiency measure deployment. These sectors use a large amount of energy and are often underserved by utility energy efficiency programs. This chapter identifies the gap that exists in the market between what utilities are currently achieving and what could be achieved through additional program activity.

Program Overview

California is one of the top 10 largest economies in the world.[133] Manufacturing and other industrial production play a major part in maintaining California's economic success, contributing nearly 11 percent of the state's gross domestic product.[134] California leads the US in electronics and computer manufacturing.[135] The industrial sector has diverse customer types, sizes, and operations. Industries in this sector include oil refineries, oil and gas extraction industries, printing plants, plastic injection molding facilities, component fabrication plants, lumber and paper mills, cement plants and quarries, metal processing plants, chemical industries, assembly plants, water and wastewater treatment plants, and food processing, among others. Over the past two decades, the composition of industry in California has been changing, with a decrease in heavy manufacturing and energy-consuming industries and the rise of light manufacturing and less energy-intensive industries.[136] In spite of the decrease in heavy industry, the industrial sector still consumes a significant amount of energy in the state.

California's industrial sector consumes about 15 percent of electricity and 38 percent[137] of natural gas consumption statewide. This sector has significant untapped potential for energy savings. A central challenge in tapping those savings is that each industry has unique situations and proprietary information.

California is also home to the nation's largest and most diversified agricultural and food processing sector. California's agricultural abundance includes more than 400 commodities grown on 77,500 farms and ranches and collectively valued at over $50 billion in 2017.[138] The state's largest irrigated crops by acreage are nuts (almonds, pistachios, and walnuts), grapes, tomatoes, broccoli, and lettuce. Although food processing occurs throughout the state, these

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133 California is at approximately $2.9 trillion GDP. https://www.cbsnews.com/news/california-now-has-the-worlds-5th-largest-economy/, http://statisticstimes.com/economy/projected-world-gdp-ranking.php

134 https://www.nam.org/Data-and-Reports/State-Manufacturing-Data/State-Manufacturing-Data/January-2018/Manufacturing-Facts---California/

135 Pacific Gas and Electric Company. *Energy Efficiency Business Plan 2018-2025*. January 2017.

136 De la Rue du Can, Stephane, Ali Hasanbeigi, and Jayant Sathaye. Lawrence Berkeley National Laboratory. *2011 ACEEE Summer Study on Energy Efficiency in Industry*. https://aceee.org/files/proceedings/2011/data/papers/0085-000057.pdf#page=1

137 https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_fuel/html/fuel_use_ng.html&sid=US&sid=CA

138 https://www.cdfa.ca.gov/statistics/

industries are concentrated in the Central Valley. The valley is home to more than 3,000 factory sites, including the world's largest facility for processing milk, milk powder, and butter (California Dairies, Inc.); cheese (Hilmar Cheese Company); wine (E & J Gallo); and poultry (Foster Farms). This sector has common loads likely to lend themselves to efficiency improvements, such as refrigeration. Statewide, the agricultural sector uses slightly less than 7 percent of electricity and about 1 percent of natural gas. Agricultural electricity usage is primarily for water pumping.

There are a mix of POU and IOU programs serving the industrial and agricultural sectors. Utility program activities identified by the POU and IOU potential studies may not be capturing the full energy efficiency activity conducted by the industrial and agricultural sectors. Therefore, this analysis attempts to capture energy efficiency activities that are occurring beyond utility claimed savings. Some examples of activities not part of the utility studies include the following:

- Requirements set by CARB and the AQMDs
- Facility actions that may be considered industry standard practice which are not considered as eligible utility savings
- Operational improvements that happen organically or via education and training programs
- Other energy efficiency activity that do not meet the utility program requirements or selection of facilities to not participate

Industrial and agricultural facilities can achieve beyond utility energy efficiency savings in these sectors by implementing process improvements, standard energy efficiency retrofits, and operational and behavioral changes through ISO 50001[139] and similar approaches. There are barriers preventing or slowing down the market adoption of the interventions available to these sectors. These barriers include the following:

- **Lack of knowledge:** Sites do not know or believe energy efficiency is real and are not taking any action.
- **Financial**: Sites have tight budgets and believe energy efficiency is not cost-effective; consequently, they will not invest. In many cases, this is an excuse site representatives use, when cost-effective measures often exist at most sites.
- **Safety and product quality:** Sites are uncomfortable with changing things that work. Trusted experts are needed, and building trust with sites is key to the long-term success of these programs. This means programs need to take a long-term approach: installing slowly over time, gradually building trust so that sites are willing to install more expensive and more impactful measures. Trust is slow to build and fast to break, so this is a difficult barrier to overcome.
- **Continuous operation cycles and seasonality:** Site operation makes it difficult to install measures. When an operation is seasonal, it makes measures less cost-effective, as load hours may be less typical. Much like the previous barrier, a long-term approach must

139 ISO 50001 (International Organization for Standardization) is a voluntary standard for designing, implementing, and maintaining an energy management system.

be developed if change is going to happen. Detailed knowledge of the operation is required to understand what should be installed, when it can be installed, and if it is cost-effective to install it.

- **Organizational barriers:** Industry can be hierarchical, and it can be difficult to complete anything without support from all levels of the operation. Again, the theme is relationship building. It can be difficult to get full support, but it starts at the top. Through group training, clear communication, and long-term planning, change can occur. That training can lead to a change in energy culture, which is important for long-term success.

Education with long-term support, either financially or otherwise, plus buy-in from the top of the organization can lead to increased penetration of efficiency potential.

Additional tactics and new measure development can help promote future savings adoption. One specific area is the promotion and acceptance of strategic energy management (SEM). SEM, per CPUC and California IOU design, is a continuous improvement approach that focuses on changing business practices to enable companies to save money by reducing energy consumption and waste through a comprehensive approach to managing energy use. SEM programs are designed to support industrial companies by focusing on several high-level objectives:

- Implementing energy efficiency projects and saving energy, primarily from savings in operations and maintenance.
- Establishing the energy management system or business practices that help a facility to manage and continuously improve energy performance.
- Normalizing, quantifying, and reporting facility-wide energy performance.
- Getting peers to talk to one another. SEM measures by nature are low cost or no cost measures identified through training and intentional detailed audits of the sites. The goal of the program is to train the sites to commission their own processes, internally identifying opportunities for improvement each day, week, and year. Savings are calculated at a whole building level, so it is difficult to estimate individual measure contributions. However, on average, the program saves around 3 percent of total usage.

For emerging technologies, there is ongoing development for new applications and technologies. These technologies have demonstrated energy benefits to the industrial and agricultural sectors but are not yet widely adopted in the market. The team evaluated emerging technologies at varying stages along the path to market readiness. Some were demonstrated in a laboratory or research setting, while others proved effective through pilot tests and are in early commercial adoption.

Updates Relative to Previous Study

The previous SB 350 target analysis did not include analysis on the industrial and agricultural savings potential.

Methodology Description

The analysis team used the same methodology for both sectors to estimate the potential energy savings from activities not funded through utility programs. For this analysis, the team used the 2018 PG study[140] results and historical utility program savings as the committed savings. The analysis took the difference between the theoretical technical savings potential and the committed savings to calculate the incremental difference to determine the SB 350 forecast.

The team initially considered two general approaches to investigate the potential energy savings in these sectors. The theoretical considerations started with the industrial sectors since it is more heavily researched and understood than the agricultural sector.

- The first was a **top-down approach** that would use total sector savings estimates and apply them to the sector energy use. A variety of sources were reviewed including the International Energy Agency (IEA), the US Energy Information Administration (EIA), the DOE's Office of Energy Efficiency and Renewable Energy (EERE), and market reports such as McKinsey[141]. These reports included a range of energy savings potential from 1 percent to 3 percent for overall sector usage. After reviewing the data sources, the analysis team decided that this approach lacked the detail needed to fully understand the actual potential in these sectors. It was also unclear what amount of this potential savings could be achievable and over what period.
- The second was a **bottom-up approach**. The foundation of data varies between the two sectors. The industrial analysis uses measure data from the Industrial Assessment Center (IAC)[142] as a key resource. The IAC database includes the results of thousands of industrial audits that are completed each year. During these audits, cost-effective measures are identified and analyzed as part of an audit report delivered to each site. All measure calculation results have been recorded in the database since the late 1970s. Identified energy savings opportunities are categorized at the building type and end use level. Agricultural analysis are based on engineering assumptions.

To estimate the savings for this sector, the team performed the following steps:

- The analysis team used IAC data to create savings potential specific to building type and end use. These savings were translated into percentages to reflect the maximum amount of capturable savings per building type and end use. The team weighted these percentages by building type to establish what fraction of overall building consumption a particular end use should be contributed to.
- The team used North American Industry Classification System (NAICS) historical data to estimate the average percentage of consumption by building type for each IOU.

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140 Navigant, *Energy Efficiency Potential and Goals Study for 2018 and Beyond*, Prepared for the California Public Utilities Commission, June 2017.

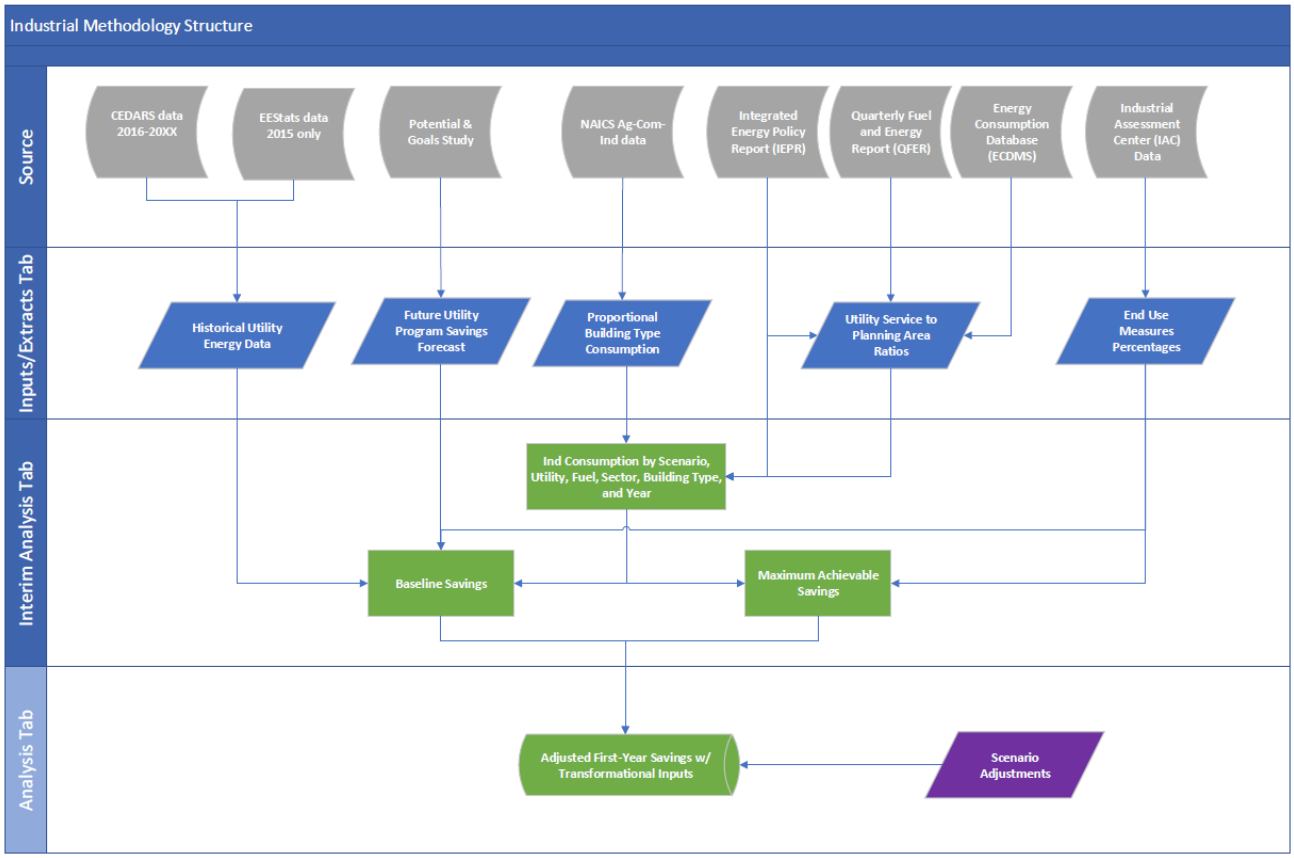
141 https://www.iea.org/topics/energyefficiency/industry/, https://www.eia.gov/consumption/, https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/Sustainability/PDFs/A_Compelling_Global_Resource.ashx

142 The Industrial Assessment database can be found online here: https://iac.university

- The analysis team applied the weighted savings ratios and building type ratios to the historical and potential study forecast to establish the baseline committed savings.
- The team then applied the maximum savings potential and building type ratios to forecast IEPR data for the industrial sector to estimate maximum achievable savings by building type and end use.
- Finally, the analysis team calculated the difference between the maximum achievable savings and the baseline savings to identify the gap that exists between the savings occurring and the maximum savings possible. This gap is the potential SB 350 savings for the industrial sector.

Figure 12 depicts the overall flow of the Industrial savings methodology the occurs in the workbook. Specifically, the high-level flow of data and information throughout the structure of the workbook.

Figure 12: Industrial Methodology Diagram

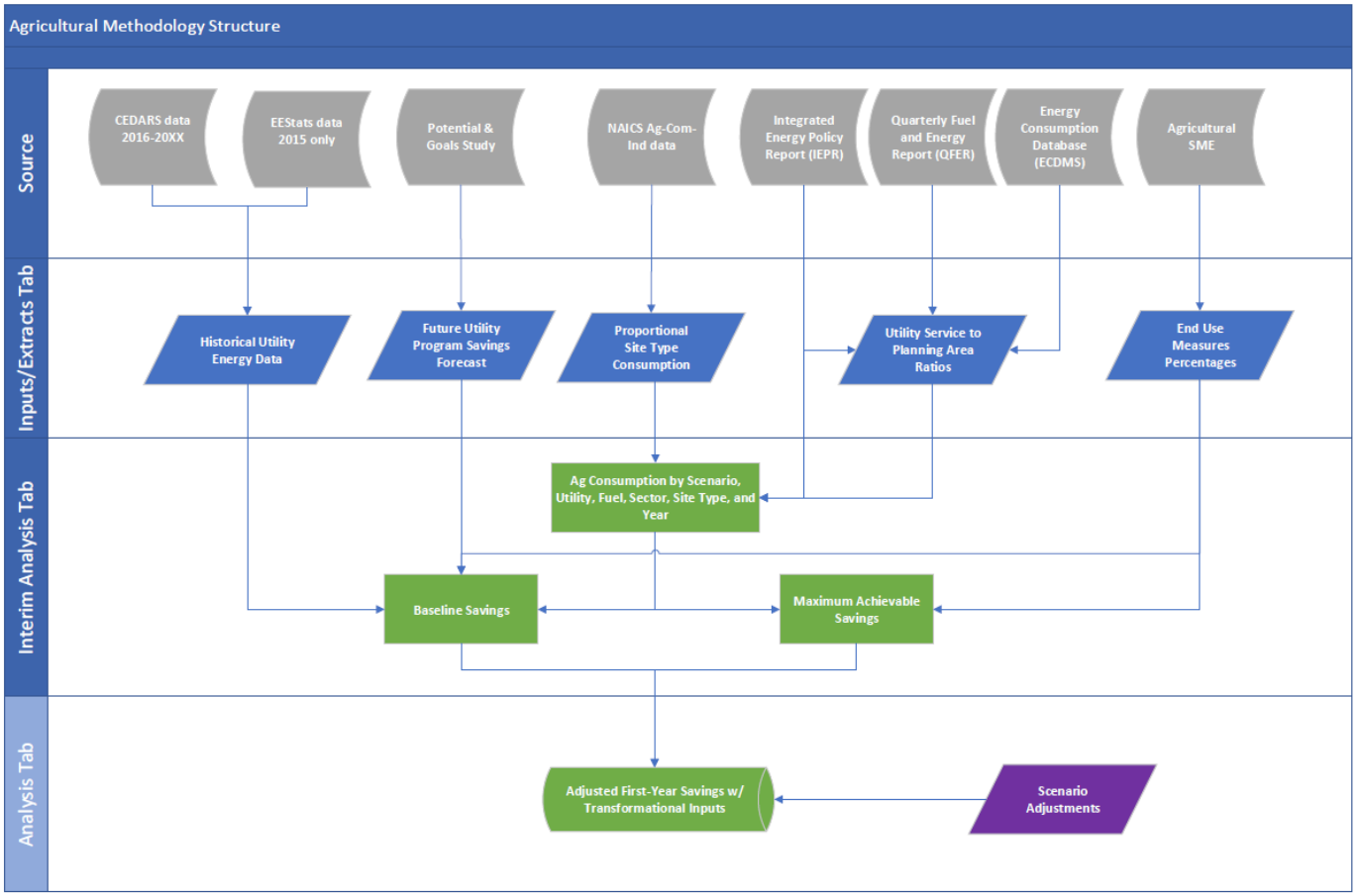


Source: Navigant team

The analysis team calculated the agricultural SB 350 savings in a similar way, except for the savings potential by building type and end use. The agricultural sector was not included in the IAC database, and the team did not identify any other major source of agricultural energy savings. The team calculated savings at the end use and building type level using engineering estimates from its agricultural subject matter experts.

In addition to the end use-level measures identified by the analysis team, measures were created to represent emerging technology and SEM based on the PG study. The impact of these measures became the target technical potential. Figure 13 depicts the flow of the methodology for the agricultural workbook.

Figure 13: Agricultural Methodology Diagram



Source: Navigant team

Major Data Assumption

The program workbook provides the calculation documentation including specific assumptions regarding the calculation methodologies, but the team made the following general assumptions for this analysis:

- **Measures are cost-effective and ready to install.** During the IAC audits, the auditors identify many measure opportunities are and discuss them with the customers. The IAC team only analyzes measures
- once both the auditor and customer agree that they are opportunities that could be reasonably acted on and are cost-effective.
- **Opportunities identified are not regionally specific.** The IAC audits are completed throughout the US—they are not limited to California. The analysis team felt it was appropriate to assume that industrial energy opportunities such as air compressor upgrades and motor controls would not greatly differ from one region to another. Although some measures are weather-dependent, industrial heating and cooling load is primarily driven by production needs and is less impacted by region-specific weather.

- **Opportunities, as a percentage of consumption, remain relevant over time.** Although California has aggressive energy efficiency programs compared to other states, the analysis team assumed that the industrial and agricultural sectors would still have a large amount of opportunity left due to the difficulty of completing projects, evolving technologies, and changing processes as well as the relative lack of focus on energy efficiency common in these sectors.

Forecasting Scenarios

This section details the assumptions made for each SB 350 forecasting scenario. The conservative scenario provides the minimal scenario, in which no savings outside of current efforts are being achieved, equivalent to a zero savings gap. The reference and aggressive scenarios take the maximum savings gap and distribute it across varying timelines, while simultaneously incorporating the effects of a tech-to-market ratio.

- **Conservative**: There exists no savings gap between what is currently be achieved and what could potentially be achieved.
- **Reference**: The achievable savings gap by building type and end use is achieved in 15 years, with a straight-line projection and an 80 percent technical to market adoption ratio.
- **Aggressive**: The maximum achievable savings by building type and end use is achieved in 10 years, with a straight-line projection and an 80 percent technical to market adoption ratio.

In the above scenarios, the straight-line projection represents constant savings magnitude per year. The time period, constant savings, and technical-to-market adoption ratio are estimated values that reflect plausible future circumstances. However, they are simply projections, subject to change and manipulation in response to how the industrial and agricultural markets actually perform.

Areas to Improve

The team has identified areas for improvement that should be considered for the next SB 350 update:

- **POU data:** The IEPR data used for industrial consumption is IOU-only data; the POU energy savings performance is predicted based on the IOU performance. Incorporating more POU data could allow for increased precision in POU savings forecasting.
- **Forecast consumption data:** The IEPR forecasting data only projects consumption to 2030. The building type analysis is only available for historical consumption. The industrial and agricultural sectors are sensitive to market trends and tying the forecast to the building type can help with more accurate analysis.
- **Distribution and reallocation of savings to reflect performance:** Savings distribution is projected over a finite period at a constant rate; however, this is subject to variation. This methodology is complex—it estimates the maximum savings as a

percentage, a static ratio rather than a finite amount, and the amount of absolute savings can vary based on consumption. If the savings target for a particular year is not met, the subsequent savings may be readjusted to reach the maximum savings percentage.

- **Large customer savings**: Future savings estimates should consider the effects of large facilities. One facility can result in a high energy use reduction that can surpass the potential and be significant to the overall state's goals. Tracking large customers and their energy use patterns can provide further insight into achievements and potential.
- **Historical savings:** There is no method to document or verify savings achieved for beyond utility interventions.

CHAPTER 22:
Other – Conservation Voltage Reduction

While CVR has been around for decades, it was included explicitly within the activities listed in PRC 25310(d)[143] that may be used to satisfy SB350 energy efficiency goals. Utilities have engaged in various pilots, but there is potential to expand programs in pursuit of the state's energy efficiency goals.

Program Overview

CVR programs work on the principle that certain electric loads consume less power when operated at a lower voltage. While electric service providers are required to maintain end customer voltage within a certain tolerance of nominal, operating at the lower end of this range has the potential for energy and peak savings. For CVR, this lowering of voltage is achieved by changing the settings of distribution system devices, usually at the substation. The degree to which voltage can be lowered is constrained by both the lowest customer voltages on the circuit and by the ability of the distribution system devices to move to lower settings.

Equation 1. High Level CVR Impact Calculation

$$CVR\ Impact_{Load\ Type} = Load_{Load\ Type} * Voltage\ Reduction * CVR\ Factor_{Load\ Type}$$

Three major components are included in the calculation:

- $Load_{Load\ Type}$: Amount of load of a given type
- VoltageReduction: How much the voltage serving that load can be lowered
- CVR Factor: Measured value of the relative decrease in load per decrease in voltage

Updates Relative to Previous Study

The previous SB350 target analysis did not include CVR potential.

Methodology Description

To produce the initial top-down estimate of CVR potential, the team identified the amount of load in each service territory and conducted a literature review to determine the following:

- **Appropriate CVR factors for each region.** The team reviewed the available literature for real-world measurements of the differences in impacts of voltage reduction on residential, commercial, and industrial loads but did not find that specific data. However, the team did identify region-specific values from reports by several California utilities, shown in Table 10. If values were not available for a particular utility, the team

143 PRC 25310(d), https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=PRC&division=15.&title=&part=&chapter=4.&article=

mapped the value from the geographically closest utility. The identified California values were in line with other studies around the country.

- **Reduction amount for individual distribution circuit voltage while staying within the required band.** Utilities are already attempting to perform voltage reduction to the extent possible,[144] but it is expected that there is further room to improve on existing practical applications. If detailed circuit voltage data is unavailable, the team identified expected voltage reduction percentages from previous studies.

Table 10: Identified Voltage Reduction Potential and CVR Factors

Data Name	Utility	Value	Source
Average Voltage Reduction	PG&E	3.05%	Report on Voltage and Reactive Power Optimization (2016)[145]
Average Voltage Reduction	SCE	1.58$	Irvine Smart Grid Demo Project Report (2015)[146]
Average Voltage Reduction	SMUD	1.7%	Analysis of SMUD CVR (2015)[147]
Average Voltage Reduction	Glendale Water & Power (W&P)	3.13%	Glendale W&P Report (2018)[148]
Average Voltage Reduction	SDG&E	*1.58%*	*Not available, using SCE*
Average Voltage Reduction	LADWP	*1.58%*	*Not available, using SCE*
Average Voltage Reduction	Turlock Irrigation District	*3.05%*	*Not available, using PG&E*
Average Voltage Reduction	Imperial Irrigation Districty	*1.58%*	*Not available, using SCE*
CVR Factor	PG&E	0.7	Report on Voltage and Reactive Power Optimization (2016)

144 PG&E Rules 2, Sheet 4 states "...for the purposes of energy conservation, distribution line voltage will be regulated to the extent practicable to maintain service voltage... on residential and commercial circuits between 114 V and 120 V." https://www.pge.com/tariffs/tm2/pdf/ELEC_RULES_2.pdf

145 https://www.pge.com/nots/rates/tariffs/tm2/pdf/ELEC_4990-E.pdf

146 https://www.energy.gov/sites/prod/files/2017/01/f34/ISGD%20Final%20Technical%20Report_20160901_FINAL.pdf

147 https://www.epri.com/#/pages/product/000000003002004930/?lang=en-US

148 https://www.ci.glendale.ca.us/government/council_packets/CC_HA_121818/CC_8f_121818.pdf

Data Name	Utility	Value	Source
CVR Factor	SCE	1.0	Irvine Smart Grid Demo Project Report (2015)
CVR Factor	SMUD	0.6	Analysis of SMUD CVR (2015)
CVR Factor	Glendale W&P	0.8	Glendale W&P Report (2018)

Source: Navigant team analysis

In reviewing the CVR factors, the team investigated whether the reported voltage reductions and CVR factors were based on circuits selected for optimal characteristics or to be representative of the service territory. The circuits in the studies were optimistic candidates. For example, the PG&E Volt-VAR Optimization study[149] estimated that the maximum benefit/cost ratio would occur for a deployment across 15 percent of its territory.

As the primary actor to implement these methods will be the distribution utility, modeling adoption is different than other energy efficiency programs. Limited data was available on the extent to which CVR would be economically or technically feasible. Until further information is available, a linear adoption rate will be assumed at 3 percent, 5 percent, or 8 percent of the calculated potential (using above formula, Equation 1) per year for 10 years, depending on the scenario evaluated.

Forecasting Scenarios

The team considered three different IEPR load scenarios, along with three different rates of CVR adoption. As more data is available about the rate of adoption and as load forecasts are updated, the projected savings can be adjusted as well.

- **Reference:** Utilities implement 5 percent of the total estimated potential for CVR per year for 10 years.
- **Conservative:** Utilities implement 3 percent of the total estimated potential for CVR per year for 10 years.
- **Aggressive:** Utilities implement 8 percent of the total estimated potential for CVR per year for 10 years.

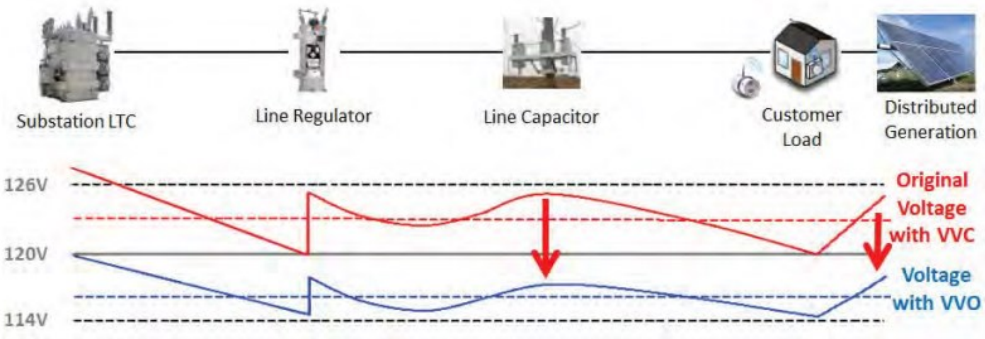
Areas to Improve

While a more complex bottom-up approach was not feasible for this iteration of the savings potential calculation, this description provides the data requirements and methodology if this type of granular analysis is desired in the future. It also allows for analysis of more complex voltage regulation schemes using additional distribution grid devices to modulate the voltage at many points around a circuit in a coordinated fashion or schemes involving customer-owned

149 PG&E Final Voltage and Reactive Power Optimization Report (2016)

smart inverters for maximal control of the voltage. As shown in Figure 14 from PG&E's Final Report on Voltage and Reactive Power Optimization,[150] controlling the voltage at additional points down the distribution circuit can enable the average voltage to be further reduced.

Figure 14: PG&E Volt/VAR Control vs. Optimization



Source: PG&E study151

At the first level, these analyses would require the absolute minimum or lowest 1 percent of voltage on each distribution circuit to better assess the voltage reduction value in the above formula. As the voltage is sensitive to the total loading on the circuit, the amount voltage lowered may be greater in seasons where the maximum load is smaller. It may be possible to have voltage reduction schemes that take advantage of these differences more aggressively rather than being based on an annual calculation. Having customer-level data provides a better sense for how much voltage can be reduced, as opposed to just measuring at the circuit head.

The Energy Commission could request customer AMI data under Title 20 to fully assess the degree to which voltage can be lowered and to conduct a more granular assessment of the different categories of load. If this data was available, the bottom-up approach would use the same equation as above, but with individual circuit annual energy and voltage reduction potential. This would allow a more precise calculation of the amount voltage that can be reduced on the circuit rather than just measuring at the substation and applying a heuristic value.

A circuit-specific CVR factor would use the values assessed for the top-down approach because it is difficult to measure that value. Table 11 describes additional data required to make a more granular, bottom-up calculation of CVR potential. The ideal data request includes a full set of 8,760 hourly annual profiles for all customers; however, the analysis can use sampling and include a significantly reduced set of profiles to save on data transfer, storage, and analysis costs. To reduce sensitivity to outliers, the first percentile of voltage reads could be used rather than the absolute minimum of the voltage reads to set the allowable floor.

Table 11: Potential Bottom-Up Data Needs

150 PG&E Final Voltage and Reactive Power Optimization Report (2016), https://www.pge.com/nots/rates/tariffs/tm2/pdf/ELEC_4990-E.pdf

151 PG&E Final Voltage and Reactive Power Optimization Report (2016), https://www.pge.com/nots/rates/tariffs/tm2/pdf/ELEC_4990-E.pdf

Data Name	Data Description
Customer voltage	First percentile of customer voltage measured across each circuit each season.
Customer load by circuit	Estimate of total energy by circuit to go along with calculated circuit-level voltage reduction potential.
Breakdown of customer load types	If CVR factors are identified or calculated for different types of customer loads, the corresponding breakdown of total energy by load type would also be required.
Rate of utility implementation	If the utility has better information than the linear technical potential assumption, then the Energy Commission should adopt the utility analysis.

Source: Navigant team

The CVR scheme, with direct distribution operator cooperation, can operate similar to a demand response impact when turning voltage regulation on and off in a coordinated fashion. This coordinated operation would require both usage and voltage interval readings from the customer AMI data. Other factors can potentially limit the CVR benefit:

- Substation devices are already at their lowest possible settings
- Circuit does not have the required hardware

The large variability in potential existing conditions and outcomes merit a more granular assessment if the required datasets are available.

APPENDIX A:
DAC AND LI

Appendix A-1. California Low Income Home Energy Assistance Program (LIHEAP)[152]

Program Description

The LIHEAP block grant is funded by the federal Department of Health and Human Services and provides two basic types of services. Eligible LI persons, via local governmental and nonprofit organizations, can receive financial assistance to offset the costs of heating or cooling dwellings, or have their dwellings weatherized to make them more energy efficient. This is accomplished through these program components:

- The Weatherization program provides free weatherization services to improve the energy efficiency of homes, including attic insulation, weather stripping, minor housing repairs, and related energy conservation measures.
- The Energy Crisis Intervention Program (ECIP) provides payments for weather-related or energy-related emergencies.

Program Requirements

To qualify for this benefit program, applicants must be a resident of California and need financial assistance for home energy costs; they also must also have an annual household income (before taxes) that is below 60 percent of the state median income. Table 12 compares the LIHEAP and CARE[153] qualifying income levels.

Table 12: Comparisons of LIHEAP and CARE Qualifying Incomes

	LIHEAP	CARE
Household Size	Maximum Income Level (Per Year)	Total Gross Annual Household Income
1	$25,103	$32,920 or less
2	$32,827	$32,920 or less
3	$40,551	$41,560 or less
4	$48,275	$50,200 or less
5	$55,999	$58,840 or less
6	$63,723	$67,480 or less
7	$65,171	$76,120 or less

152 https://www.benefits.gov/benefit/1540

153 Before taxes based on current income sources. Valid through May 31, 2019.

Household Size	LIHEAP	CARE
	Maximum Income Level (Per Year)	Total Gross Annual Household Income
8	$66,619	$84,760 or less

Appendix A-2. CES Scoring Formula

CES scores combine four metrics: exposure, environmental effects, sensitive populations, and socioeconomic factors to rank the pollution burden experienced by a given population according to the following formula, Equation 2.

Equation 2. CES Score

$$CES\ Score = \frac{(x + 0.5y)}{2} \times \frac{(a + b)}{2}$$

Where:

x = exposure

y = environmental effects

a = sensitive populations

b = socioeconomic factors

The CES score can also be the product of the average score of a population's exposure and weighted (by 50 percent) environmental factors, with the average score of sensitive population indicators and socioeconomic factors.

Appendix A-3. CARE Program Overview

The CARE program is a rate discount program authorized by CPUC decisions and supporting legislation, which provides rate discounts in the range of 30 percent-35 percent to qualifying LI participant households on electricity bills and 20 percent on natural gas bills. Both the large IOUs and smaller multi-jurisdictional utilities in California are required to maintain CARE or similar programs to assist qualifying LI residents. CARE is funded by non-participating utility customers through a public purpose program charge on ratepayer energy bills.

Although the CPUC itself does not manage the finances of the CARE program (since fees for electricity and natural gas services are collected directly by each participating utility), the agency does review and approve the budget applications, which are submitted every 3 years by the utilities. Staff also submit data requests, analyze legislative proposals, review advice letter filings related to the program, and advise decision makers on policy and program implementation. The

staff of the Energy Division – Residential Demand Programs Section is responsible for budgets, policies, and overall administration of the CARE program for the CPUC.[154]

Table 13: Annual Estimates of CARE Eligible Customers[155]

County	Utility	Total Households	Demographic Eligibility Rate[156]	Eligible Households	Participating CARE Households	Estimated CARE Penetration Rate
ALAMEDA	PG&E	565,730	23%	130,442	119,094	91%
ALPINE	PG&E	566	48%	274	6	2%
AMADOR	PG&E	17,385	34%	5,961	4,247	71%
BUTTE	PG&E	95,096	43%	41,045	36,632	89%
CALAVERAS	PG&E	26,923	34%	9,218	5,138	56%
COLUSA	PG&E	8,163	37%	2,982	3,343	112%
CONTRA COSTA	PG&E	405,693	20%	81,321	84,984	105%
EL DORADO	PG&E	64,776	22%	14,572	10,961	75%
FRESNO	PG&E	314,365	44%	137,157	152,045	111%
GLENN	PG&E	10,844	49%	5,351	4,666	87%
HUMBOLDT	PG&E	56,113	41%	22,823	17,616	77%
KERN	PG&E	225,588	41%	93,488	106,846	114%
KINGS	PG&E	19,634	41%	7,959	9,171	115%
LAKE	PG&E	32,644	48%	15,786	12,089	77%
LASSEN	PG&E	598	48%	289	172	59%
MADERA	PG&E	48,679	41%	19,984	21,893	110%
MARIN	PG&E	104,516	19%	19,771	12,253	62%
MARIPOSA	PG&E	9,376	38%	3,536	2,196	62%
MENDOCINO	PG&E	36,245	41%	14,970	9,832	66%

154 Internal Audit Unit California Alternate Rates for Energy (CARE) Program. California Public Utilities Commission, November 2016.

155 Compliance Filing of Pacific Gas and Electric Company (U 39-M), On Behalf of Itself, Southern California Gas Company (U 904-G), San Diego Gas and Electric Company (U 902-M), and California Edison Company (U 338-E), Regarding Annual Estimates of CARE Eligible Customers and Related Information. California Public Utilities Commission February 9, 2018.

156 Income at 200 percent of federal poverty guidelines.

County	Utility	Total Households	Demographic Eligibility Rate[156]	Eligible Households	Participating CARE Households	Estimated CARE Penetration Rate
MERCED	PG&E	81,413	46%	37,815	40,397	107%
MONTEREY	PG&E	133,503	32%	42,568	42,540	100%
NAPA	PG&E	53,245	23%	12,252	10,434	85%
NEVADA	PG&E	37,771	31%	11,687	8,901	76%
PLACER	PG&E	139,502	21%	29,004	20,096	69%
PLUMAS	PG&E	9,494	33%	3,179	1,756	55%
SACRAMENTO	PG&E	441,722	31%	138,729	101,566	73%
SAN BENITO	PG&E	18,502	28%	5,132	4,831	94%
SAN BERNARDINO	PG&E	803	46%	372	281	76%
SAN FRANCISCO	PG&E	339,962	20%	67,859	62,044	91%
SAN JOAQUIN	PG&E	232,688	36%	82,835	88,546	107%
SAN LUIS OBISPO	PG&E	114,101	25%	28,678	17,963	63%
SAN MATEO	PG&E	266,474	17%	44,636	32,951	74%
SANTA BARBARA	PG&E	55,793	32%	17,751	17,522	99%
SANTA CLARA	PG&E	596,208	19%	111,180	100,063	90%
SANTA CRUZ	PG&E	94,982	28%	26,370	19,256	73%
SHASTA	PG&E	64,687	39%	25,217	19,064	76%
SIERRA	PG&E	919	28%	254	134	53%
SISKIYOU	PG&E	36	49%	18	7	39%
SOLANO	PG&E	155,395	26%	40,057	42,356	106%
SONOMA	PG&E	195,541	22%	43,724	39,024	89%
STANISLAUS	PG&E	154,833	37%	57,454	49,271	86%
SUTTER	PG&E	33,497	40%	13,530	13,880	103%
TEHAMA	PG&E	26,967	45%	12,095	11,561	96%
TRINITY	PG&E	1,139	47%	540	286	53%
TULARE	PG&E	15,429	56%	8,567	9,653	113%

County	Utility	Total Households	Demographic Eligibility Rate[156]	Eligible Households	Participating CARE Households	Estimated CARE Penetration Rate
TUOLUMNE	PG&E	29,944	35%	10,551	6,872	65%
YOLO	PG&E	76,358	33%	24,892	20,455	82%
YUBA	PG&E	26,391	44%	11,680	11,502	98%
FRESNO	SCE	2,654	11%	302	40	13%
IMPERIAL	SCE	409	50%	206	68	33%
INYO	SCE	5,260	36%	1,893	1,064	56%
KERN	SCE	72,330	43%	31,162	23,124	74%
KINGS	SCE	22,991	33%	7,652	9,090	119%
LOS ANGELES	SCE	1,777,845	33%	582,609	516,794	89%
MADERA	SCE	7	41%	3	0	0%
MONO	SCE	12,135	19%	2,302	794	34%
ORANGE	SCE	858,019	23%	196,111	155,609	79%
RIVERSIDE	SCE	603,359	33%	198,782	172,746	87%
SAN BERNARDINO	SCE	654,025	38%	250,989	226,106	90%
SAN DIEGO	SCE	9	12%	1	1	94%
SANTA BARBARA	SCE	74,348	28%	20,684	9,442	46%
TULARE	SCE	129,992	46%	60,291	55,097	91%
VENTURA	SCE	276,416	25%	69,237	52,551	76%
FRESNO	SCG	22,138	50%	10,995	10,877	99%
IMPERIAL	SCG	36,196	45%	16,320	15,201	93%
KERN	SCG	109,737	38%	41,321	38,272	93%
KINGS	SCG	35,426	35%	12,520	13,863	111%
LOS ANGELES	SCG	2,705,312	35%	933,817	826,114	88%
ORANGE	SCG	900,979	21%	192,448	149,073	77%
RIVERSIDE	SCG	704,462	33%	235,320	204,424	87%
SAN BERNARDINO	SCG	471,177	36%	168,453	161,297	96%

County	Utility	Total Households	Demographic Eligibility Rate[156]	Eligible Households	Participating CARE Households	Estimated CARE Penetration Rate
SAN LUIS OBISPO	SCG	90,111	25%	22,122	14,278	65%
SANTA BARBARA	SCG	125,160	30%	37,155	26,678	72%
TULARE	SCG	121,759	47%	57,657	58,562	102%
VENTURA	SCG	248,490	24%	59,948	45,487	76%
ORANGE	SDG&E	107,583	17%	18,048	10,509	58%
SAN DIEGO	SDG&E	1,122,186	27%	303,275	271,719	90%

Appendix A-4. CARE Population Estimates

CARE eligibility is defined at the household level. To translate this into population estimates, the analysis team multiplied CARE-eligible household estimates by an average household size of 2.9 persons.

Table 14: CARE Population Estimates

County	CARE Eligible Households	% Population in CARE	Average Household Size 2009-2013	Estimated CARE Pop
Butte	40,689	54%	2.9	117,998
Humboldt	24,670	53%	2.9	71,543
Kern	93,114	32%	2.9	270,031
Marin	19,385	22%	2.9	56,217
Mendocino	15,466	51%	2.9	44,851
Santa Barbara	41,734	29%	2.9	121,029

Appendix A-5. Full Comparison of Key CES and ACS Metrics

Table 15: Full Comparison of Key CES and ACS Metrics

CES Metric	CES	ACS
M1 Educational Attainment	Percentage of the population over age 25 with less than a high school education (5-year estimate, 2011-2015).	From the 2011-2015 ACS estimates, a dataset containing the percentage of the population over age 25 with a high school education or higher was

CES Metric	CES	ACS
		downloaded by census tracts for California. This percentage was subtracted from 100 to obtain the proportion of the population with less than a high school education.
M2 Housing Burdened LI Households	Percentage of households in a census tract that are both LI (making less than 80 percent of the HUD area median family income) and severely burdened by housing costs (paying greater than 50 percent of their income to housing costs). 5-year estimates, 2009-2013.	The team leveraged the 2009-2013 HUD Comprehensive Housing Affordability Strategy dataset containing cost burdens for households by percent HUD-adjusted median family income (HAMFI) category by census tract for California. For each census tract, the analysis estimated the number of households with household incomes less than 80 percent of the county median and renter or homeowner costs that exceed 50 percent of household income. The team then calculated the percentage of the total households in each tract that are both LI and housing-burdened.
M3 Linguistic Isolation	Percentage of limited English-speaking households.	From the 2011-2015 ACS, a dataset containing the percentage of limited English-speaking households was downloaded by census tracts for California. This variable is referred to as "linguistic isolation" and measures households where no one speaks English well.
M4 Poverty	Percentage of the population living below two times the FPL (5-year estimate, 2011-2015).	From the 2011-2015 ACS, a dataset containing the number of individuals below 200 percent of

CES Metric	CES	ACS
		the FPL was downloaded by census tracts for California.
M5 Unemployment	Percentage of the population over the age of 16 that is unemployed and eligible for the labor force. Excludes retirees, students, homemakers, institutionalized persons except prisoners, those not looking for work, and military personnel on active duty (5-year estimate, 2011-2015).	From the 2011-2015 ACS, a dataset containing the unemployment rate[157] was downloaded by census tracts for California.

APPENDIX B:
PACE PROGRAM: EXCERPT FROM SB 242

Below is the excerpt from SB 242 Chapter 29.1, Part 3, Division 7, Streets and Highways Code § 5954,[158] which outlines the future data collection provisions included in this bill:

(a) For each PACE program that it administers, a program administrator shall submit a report to the public agency no later than February 1 for the activity that occurred between July 1st through December 31st of the previous year, and another report no later than August 1 for the activity that occurred between January 1st through June 30th of that year. Those reports shall contain the following information, along with all methodologies and supporting assumptions or sources relied upon in preparing the report:

(1) The number of PACE assessments funded, by city, county, and ZIP Code.

(2) The aggregate dollar amount of PACE assessments funded, by city, county, and ZIP Code.

(3) The average dollar amount of PACE assessments funded, by city, county, and ZIP Code.

(4) The categories of installed efficiency improvements whether energy or water efficiency, renewable energy, or seismic improvements, and the percentage of PACE assessments represented by each category type, on a number and dollar basis, by city, county, and ZIP Code.

157 Unemployment is defined by the Bureau of Labor Statistics as people who do not have a job, have actively looked for work in the past four weeks, and are currently available for work

158 Senator Skinner. "SB-242 Property Assessed Clean Energy Program." California Legislative Information. February 6, 2017. Available online at https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB242

(5) The definition of default used by the program administrator.

(6) For each delinquent assessment:

(A) The total delinquent amount.

(B) The number and dates of missed payments.

(C) ZIP Code, city, and county in which the underlying property is located.

(7) For each defaulted assessment:

(A) The total defaulted amount.

(B) The number and dates of missed payments.

(C) ZIP Code, city, and county in which the underlying property is located.

(D) The percentage the defaults represent of the total assessments within each ZIP Code.

(E) The total number of parcels defaulted and the number of years in default for each property.

(8) The estimated total amount of energy saved, and the estimated total dollar amount of those savings by property owners by the efficiency improvements installed in the calendar year, by city, county, and ZIP Code. In addition, the report shall state the total number of energy savings improvements, and number of improvements installed that are qualified for the Energy Star program of the United States Environmental Protection Agency, including the overall average efficiency rating of installed units for each product type.

(9) The estimated total amount of renewable energy produced by the efficiency improvements installed in the calendar year, by city, county, and ZIP Code. In addition, the report shall state the total number of renewable energy installations, including the average and median system size.

(10) The estimated total amount of water saved, and the estimated total dollar amount of such savings by property owners, by city, county, and ZIP Code. In addition, the report shall state the total number of water savings improvements, the number of efficiency improvements that are qualified for the WaterSense program of the United States Environmental Protection Agency, including the overall average efficiency rating of installed units for each product type.

(11) The estimated amount of greenhouse gas emissions reductions.

(12) The estimated number of jobs created.

(13) The average and median amount of annual and total PACE assessments based on ZIP Code, by city, county, and ZIP Code.

(14) The number and percentage of homeowners over 60 years old by city, county, and ZIP Code.

(b) All reports submitted pursuant to this section shall include only aggregate data, and shall not include any nonpublic personal information.

(c) A public agency that receives a report pursuant to this section shall make the data publicly available on its Internet Web site.

(d) This section does not limit another governmental or regulatory entity from establishing reporting requirements.