Raiders of the Lost Potential – Understanding Energy Efficiency Potential Relative to Existing Conditions Baseline

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ABSTRACT

Current energy efficiency (EE) measure savings and maximum incentive levels for utility EE programs in California are derived using code or industry standard practice baselines. These programs and policies as designed have not been able to motivate all customers to adopt all EE, a large portion of which is theorized to reside below-code in existing buildings. New, more stringent codes are exacerbating this problem leaving little above-code savings to justify large enough incentive levels to capture all savings through cost-effective EE programs. California Assembly Bill 802 (Williams, 2015) was recently passed to require the state to create EE programs that will bring existing buildings up to or exceed code, considering "the overall reduction in normalized metered energy consumption as a measure of energy savings". Stated differently, EE programs can be broadened to include to-code measures. This creates new challenges for California's EE goal setting process. Regulators have a monumental task as there is little policy precedence and few historic evaluation datasets on which to base a goal setting process.

This paper presents the results of a comprehensive EE potential study that tackles the data and policy issues related to below code savings. Two key questions this paper informs are:

1. What portion of savings from AB802 are incremental to existing actions and what portion of savings could be double counted with existing actions?
2. What are the implications of AB802 on utility program spending?

The results of this study will inform the ongoing evolution of energy efficiency policy in California.

Introduction

California Assembly Bill 802 (AB802) has the potential to significantly shift the way California energy efficiency Program Administrators (PAs) rebate and claim energy savings from energy efficiency programs. Historically, Investor Owned Utilities (IOU) programs have been limited to seeking, rebating and claiming energy efficiency savings for equipment that exceeds current code or standard. Furthermore, in most cases, the only energy savings that could be claimed was the difference between code or standard and the high-efficiency installation; this is referred to as "above-code savings".[1] However, AB802 shifts away from this paradigm to allow and incentivize a broader range of energy savings (including those that are "below-code").[2] Furthermore, AB802 instructs that energy efficiency be achieved not only though equipment installations, but also through behavior and operational-efficiency interventions. The bill states:

[1] "Above code savings" also refers to savings from energy efficiency equipment that exceeded the minimum efficiency appliance standards. "Above code" thus means "above building code or appliance standard"
[2] "Below code" is synonymous with "to code" throughout this document. They can be used interchangeably.

the commission… shall, by September 1, 2016, authorize electrical corporations or gas corporations to provide financial incentives, rebates, technical assistance, and support to their customers to increase the energy efficiency of existing buildings based on all estimated energy savings and energy usage reductions, taking into consideration the overall reduction in normalized metered energy consumption as a measure of energy savings. Those programs shall include energy usage reductions resulting from the adoption of a measure or installation of equipment required for modifications to existing buildings to bring them into conformity with, or exceed, the requirements of Title 24 of the California Code of Regulations, as well as operational, behavioral, and retrocommissioning activities reasonably expected to produce multiyear savings.

Historically, the California Public Utilities Commission (CPUC) adopted IOU program goals for rebate programs focusing on above-code savings from equipment rebate programs. The CPUC has used forecasts and potential studies to inform the goals setting process for EE programs since 2004. The passing of AB802 now requires the CPUC to consider multiple changes to program policy and planning choices which include a technical assessment of the impact of AB802 on energy efficiency potential and IOU goals. AB802 opens the door to a new source of savings that can be counted towards energy efficiency programs goals.

As part of its role in the PG study, Navigant developed a methodology, collected supporting data, and conducted a preliminary analysis of the savings potential related to the below-code, operational efficiency and behavioral initiatives targeted in AB802. This technical analysis focuses on two sources of savings:

1. Equipment Upgrade Savings in the residential and commercial sectors
2. Operational Efficiency (OE) and Behavior Savings in the commercial sector

This paper is a summary of the first technical analysis since the passage of AB802, and represents the first significant analysis of below-code savings in a California potential study (Navigant, 2016). The CPUC staff and Navigant anticipated many challenges at the outset of the study, thus the scope was set with the following objectives:

- Develop a set of nomenclature required to categorize and define below-code savings.
- Consider different classes of measures and develop metrics to help understand where the additional potential lies and where it doesn't.
- Consider if all below-code savings is truly additional potential or if a portion of it is already counted elsewhere.
- Develop a robust modeling methodology that serves as an initial basis to simulate the savings that lies below code.
- Collect as much reliable secondary data as is available that can inform a preliminary forecast.
- Continue to forecast savings based on the list of measures used in the 2015 PG study.
- Test the updated methodology in the PG model by developing a preliminary forecast of the amount of additional EE potential that could be captured due to AB802.
- Identify data gaps that require further research and understanding.

The CPUC staff and Navigant recognize that this analysis is not all encompassing of the below-code savings opportunities. The primary focus of this analysis was to develop a robust methodology that can forecast the lost potential. This methodology was tested using a limited set of measures, however it has been built into a modeling framework that can accommodate an expanded list of measures for future consideration.

Historic Context of the California Potential Studies

Navigant conducted three Potential and Goals (PG) studies for the CPUC in recent years referred to as the 2015 PG Study, the 2013 PG study and the 2011 PG Study (Navigant 2015, Navigant, 2014, Navigant, 2012). The primary purpose of the California PG study is to provide the CPUC with information and analytical tools to engage in goal setting for IOU energy efficiency portfolios. This study also informs forecasts used for procurement planning and greenhouse gas reduction targets. The PG study forecasts potential energy savings from a variety of sources within six distinct sectors: Residential, Commercial, Agricultural, Industrial, Mining, and Street Lighting. Historically the IOU goals considered savings from the following sources: conventional technologies, emerging technologies, behavior programs, low income programs, and state and federal codes and standards (C&S).

The PG studies historically forecasted technical, economic, and market achievable potential. To estimate the market potential for conventional and emerging technologies, the model employs a bottom-up dynamic stock turnover model with Bass Diffusion algorithms that simulate market adoption of efficient measures. Key components of the historic modeling approach include:

- Assuming regular turnover of equipment in the market based on equipment measure lives
- Simulating consumer's decision at the time of equipment turnover: does the consumer install minimum efficiency or high efficiency?
- Simulating consumer's decision based on the levelized cost of equipment options (including upfront costs, rebates, and annual energy cost over the life of the equipment)
- Calibrating consumer's willingness to adopt based on historic program participation.

This core model represents one of the more sophisticated EE forecasting models in the industry. It serves as a strong basis for further methodology modifications to quantify the below code savings potential. The core methodology is fully explained in 2013 PG study (Navigant, 2014).

Methodology

The impacts of AB802 can manifest in multiple ways. AB802 has the potential to generate savings that fall into three categories:

- **Stranded Potential** – Stranded Potential is defined as the opportunities for EE that are not currently captured by either rebate programs or C&S. Stranded Potential is below-code savings that is not materializing in the market because there is no incentive for the customer to upgrade their existing equipment given current program rebate policy.[3] Thus, this savings is "lost" or "stranded" given current policies. Under AB802, program administrators could start offering rebates for bringing existing equipment up to

[3] Past California policy allowed programs to seek out limited below-code savings from select programs in the past targeting certain equipment for "early retirement". For example the Appliance Recycling Program offered incentives to customers with the objective of preventing the continued operation of older, inefficient appliances. (KEMA, 2014). Past potential studies included such approved programs, approved deemed savings estimates were calculated relative to existing baseline. This analysis broadens the view of measures eligible for below code savings.

minimum efficiency standards thus motivating a whole new subset of customers to install energy efficiency and capturing this stranded potential.

- **Operational Efficiency** - Operational efficiency (OE) saves energy by changing how equipment is operated. Operational efficiency reduces energy use by doing less work and generally involves changing the load shape throughout a machine or system's operating cycle. AB802 encourages the industry to seek out additional OE savings.
- **Double Counted Savings** – These are the below-code savings generated from rebated equipment that would be realized even in the absence of utility rebate programs. This savings would occur as equipment would naturally turn over and be replaced with standard minimum efficient equipment. These savings are already embedded and accounted for in the California Energy Commission's (CEC) Demand Forecast, thus further decrementing the forecast with this savings would be double counting.

Navigant made incremental methodology changes to the previous PG study model to accommodate the analysis of the three categories of savings described above.[4] The rest of this section focuses on those incremental changes.

Stranded Potential Methodology

Stranded potential exists because a subset of customers maintain certain types of equipment well beyond the equipment's expected useful life. Evidence has been provided by stakeholders pointing to cases in which equipment remains in the market well beyond its expected useful life (Mejia, 2015). We hypothesize these long-lived measures exist for two reasons:

1. The equipment is repairable and customers have been repairing the equipment rather than replacing the equipment when it fails (e.g., boilers and chillers). We call these measure types "Repair Eligible". The repair allows measure to extend their EUL.
2. There is no catastrophic system failure that triggers the customer to repair or replace the entire system (e.g., insulation and commercial lighting fixtures). We call these measure types "Retrofit Replacement".

Influencing customers to replace long-lived equipment rather than keeping them in place results in real, below-code savings. This intervention has not previously been modeled on a large scale as it has only been allowed in limited fashion as a program in California.[5] For analysis of the stranded potential, Navigant modified the PG model to simulate the possibility of long lived

[4] The modeling methodology used for this analysis was selected because of its ability to adapt the existing PG 2015 model and leverage available data. Modeling methodology may change in the future depending on: 1) further definition of the policy framework for implementing AB802 programs, 2) further definition of how normalized metered energy savings are to be utilized in reporting savings, 3) additional market data previously unavailable, 4) further insight and understanding of how below code savings can be integrated into the CEC's demand forecast.

[5] In a series of decisions (CPUC Decision 11-07-030 and 12-05-015), the CPUC recognized that moving equipment replacements forward in time is a type of energy efficiency savings referred to as "early retirement". If the program administrator shows that their programs have induced the early retirement of functioning equipment, then CPUC credits them with savings using the "dual baseline treatment". The dual baseline treatment uses an existing conditions baseline for the number of years the replaced equipment would have continued to function – the remaining useful life (RUL) – and then uses the code baseline for the remaining years of the new measure's expected useful life (EUL).

measures and the decisions these customers are faced with in the real world. Modifications to the modeling methodology include:

- Classifying select measures as Repair Eligible or Retrofit Replacement
- Allowing for additional data on Repair Eligible and Retrofit Replacement measures including:
    - Fraction of the equipment in the market beyond its expected useful life
    - Average efficiency level of equipment that exceeds is useful life
    - Cost of repairing (rather than replacing) equipment as well as how long the repair lasts
- Modifying the consumer decision algorithm allowing the possibility that customers have the option to repair rather than replace equipment
- Modifying how the model allocates rebates for measures including offering rebates for below code savings and use of a tiered rebate structure offering high rebates to customers that exceed code.

Navigant used the modified model and applied it to the measures considered in the 2015 PG study. Data was collected from a variety of sources including California saturation studies, U.S. Department of Energy analyses, and stakeholder submitted data. It's important to note that the 2015 PG study has a set list of measures that were initially selected based on their ability to produce cost effective, above-code savings. Thus, our preliminary results for the stranded potential have a limited scope. Future updates to the PG study can consider new measures as new sources of below-code savings.

Operational Efficiency Methodology

The 2015 PG study included behavioral efficiency savings from Home Energy Reports (HER) in the residential sector and building operator certification and training (BOC) programs in the commercial sector across the four investor owned utilities (IOUs) in California. This analysis expands upon savings in the commercial sector by considering further Operational Efficiency (OE) savings sources and their costs.

In the commercial sector, the OE continuum is broken into the three categories of actions that generate energy savings: Enhancement of Equipment Functionality, Optimization of Equipment Operations, and Shifting of Individual and Organizational Actions.

The types of programs that would be representative of the activities included in the OE continuum are closely associated with the concept of *Building Performance Optimization* (BPO). BPO has the goal of achieving optimal design and operation of the holistic performance of buildings and their energy systems. Examples of programs that might make up a BPO initiative include:

1. Building Operator Certification
2. Lighting Controls
3. Building Information and Energy Management Systems
4. Tenant Engagement

Building Operator Certification was included in the 2015 PG Study. This analysis focuses on the other three initiatives listed above. Additional information on the methodology employed can be found in the full AB802 Technical Analysis report (Navigant, 2016).

Double Counted Savings Methodology

Double counted savings are those savings that could be counted two places:

1. These savings are already counted within the CEC's baseline demand forecast
2. PAs could claim these savings in their energy efficiency rebate programs.

These double counted savings would happen due to C&S even in the absence of utility programs. The savings are only double counted if the customer receives a rebate or incentive for the equipment and the PAs claim the measure towards their program accomplishments.[6] This is to say that programs could be designed to minimize double counted savings.

Navigant estimated the double counted savings; it is not currently possible to forecast the actual amount that will occur in the real world. The estimate produces two views of double counted savings. An "Upper Limit" to the amount of double counted savings and a "Best Estimate" of the double counted savings.

The estimate of the Upper Limit includes all possible double counted savings from all sectors, end uses, measures, and all possible market activity. This assumes that any customer taking on any action to reduce their building's energy consumption will apply for a utility rebate and the utility will grant that rebate. This means in the extreme case and under the broadest interpretation of AB802, almost any replacement of equipment in a building could be claimed as energy efficiency towards utility programs. However, this is not the likely outcome in the real world.

Our Best Estimate of double counted savings makes several downward adjustments to constrain the scope to what is most likely to occur in the real world. Double counted savings are most likely to occur at times when the "reduction in normalized metered energy consumption" method is used (as opposed to a deemed savings approach) for quantifying energy savings. This method is most likely to be employed during whole building renovations (rather than "one-off" equipment purchases). Our Best Estimate narrows double counted savings down to a select number of end uses and measures within the HVAC, Building Envelope, Lighting and Water Heating end uses. Even after narrowing the scope down, the results could still be an overestimate as it still assumes all buildings will apply for a utility-rebated during any sort of energy reducing renovation. In reality, a subset of customers are not likely to apply for rebates. Additional details on the methodology can be found in the full AB802 Technical Analysis report (Navigant, 2016).

Results

Results are presented for the combined California IOU service territories. Results are considered "preliminary" in that they are not to be used for formal goal setting but are still used to inform other policy direction. Thus, this paper focuses on the impacts of AB802 on California's energy demand forecast as well as on utility program budgets. Reasons why these results are considered "preliminary" are documented in our Limitations and Caveats section.

The results of this study were used by CPUC staff to inform a white paper on how existing conditions baseline should be applied to estimate utility energy efficiency program savings (CPUC, 2016).

[6] Double counted savings could occur regardless of the program delivery mechanism.

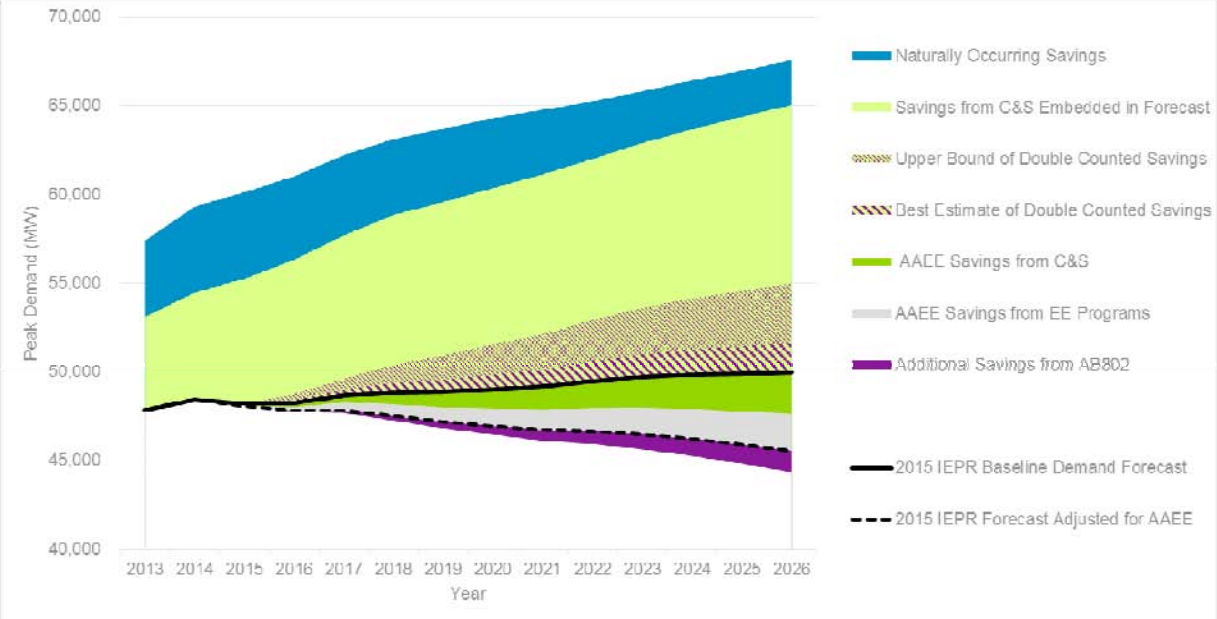
Impacts on the CEC Demand Forecast

Examining the impacts of AB802 on the CEC demand forecast helps answer the question: "What portion of savings from AB802 are incremental to existing actions and what portion of savings could be double counted with existing actions?"

The CEC develops the California Energy Demand Forecast, a 10-year forecast for electricity consumption, retail sales, and peak demand for each of five major electricity planning areas and for the state.[7] The demand forecast includes the effects of multiple sources of EE including building codes, appliance standards, and voluntary EE programs. Embedded in the baseline forecast are historic C&S and utility programs implemented in 2015 and prior. Incremental to the baseline forecast, the Additional Achievable Energy Efficiency (AAEE) is accounted to develop the Adjusted Demand Forecast. The AAEE consists of planned programs and C&S starting in 2016 and going into the future. The 2015 AAEE savings forecast was derived from the 2015 PG study (prior to any consideration of AB802). This section presents the estimated impacts of AB802 on the demand forecast.

Figure 1 illustrates the various impacts of AB802 on the CEC peak demand forecast and focuses on the mid-case results. The solid black line in Figure 1 shows the CEC's 2015 Baseline Demand Forecast. All components above the solid black line represent savings that are already embedded in the Baseline Forecast. All components below the solid black line are incremental savings to the Baseline Forecast. The dashed black line shows the CEC's 2015 Adjusted Demand Forecast, calculated by subtracting the 2015 AAEE forecast from the 2015 Baseline Forecast. All components that fall below the dashed black line represent incrementally new savings within the scope of our analysis that are attributed to AB802. The "hashed" wedges illustrating double counted savings are also attributed to AB802 but do not act to reduce California's peak demand.

Figure 1: Savings Considered in the CEC Demand Forecast

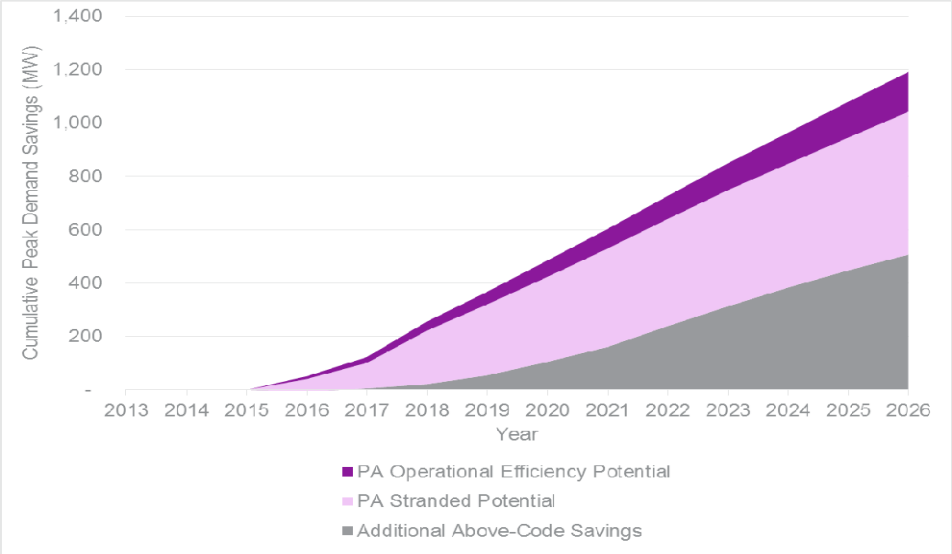


[7] Kavalec, Chris, Nick Fugate, Cary Garcia, and Asish Gautam. 2016. *California Energy Demand 2016-2026, Revised Electricity Forecast.* California Energy Commission. Publication Number: CEC-200-2016-001-V1

Source: Navigant Analysis

Incrementally new savings due to AB802 are reflected by the purple wedge that falls below the dashed black line in Figure 1. These new savings come from three sources as further broken down in Figure 2.

Figure 2: Incrementally New Savings from AB802



Source: Navigant Analysis

In total the combined incremental potential from these three sources is forecasted to add 1,192 MW of savings in 2026.[8]

- **Additional Above-Code Savings** – The measures that make up this savings wedge are measures for which PAs have been historically[9] rebating and claiming savings. The availability of incentives based on an existing conditions baseline framework are expected to drive more participation in above code measures (as even these measures would see larger rebates). These savings are reflected in Figure 2, which represents the additional market activity and amounts to 507 MW of savings in 2026.
- **Stranded Potential** – This wedge consists of below code savings from repair eligible and retrofit measures. These savings would not have happened in the absence of AB802 and are thus new, incremental savings. This wedge is constrained to only consider the potential from measures that were included in the 2015 PG study. We recognize that there are other possible actions that can be taken to capture below code savings that are not included in our analysis such as building envelope and commercial refrigeration measures. Therefore, the stranded potential could be larger than the scope of our analysis allows it to be. The stranded potential modeled in this study is forecasted to add 535 MW of savings in 2026.

[8] We present peak demand savings only as it is the primary driver of procurement and generation planning decisions in California.
[9] Prior to the passage of AB802

- **Operational Efficiency Potential** – This wedge consists of new savings from three representative commercial operational efficiency programs (Lighting Controls, Tenant Engagement, and Building Information & Energy Management Systems). These are newly modeled programs that produce incrementally new savings. We recognize that there are other possible actions that can be taken beyond the three representative programs modeled. Thus, operational efficiency potential could be larger but we lack data on the feasibility and scope at this time. The operational efficiency potential modeled in this study is forecasted to add 150 MW of savings in 2026.

The authors further investigated if the stranded equipment potential is truly incremental savings and is not already embedded in the Baseline Forecast. If the CEC's demand forecast model uses equipment turnover rates that are faster than those used in the PG Model, it would imply that a portion of the stranded potential is already embedded in the forecast. The authors held a discussion with CEC's staff to understand the stock turnover assumptions used. The CEC model does allow for long lived equipment and has similar assumptions about the mean life of equipment compared to the deemed EULs used by the PG model. At this time the authors see no need to decrement the stranded potential, however the relationship of modeled assumptions and real market conditions should be further investigated.

Double Counted savings are presented in two wedges in Figure 1: the Best Estimate and the Upper Bound. The actual amount of double counted savings in the real world depends on the number of customers that apply for rebates and the types of measures included in their building renovation. Our Best Estimate of double counted savings amounts to 1,680 MW in 2026 while the Upper Bound amounts to 5,040 MW in 2026. While both of these values eclipse the forecasted 1,192 MW of incrementally new potential, it's important to note that the double counted savings in this **preliminary analysis** is likely overestimated while the incrementally new savings from AB802 is likely underestimated (discussed further in our Limitations and Caveats section). As this analysis shows, there is great uncertainty in the results.

Lighting and HVAC end uses account for the majority of Stranded Potential analyzed in this study; however they also account for the majority of double counted savings. Thus, program administrators and policy makers should be careful to truly target functional equipment beyond its useful life in these end uses. Double counted savings opportunities, by the fact that they represent natural turnover, will be naturally lower cost and easier to capture than truly stranded potential. If such targeting is not implemented, there is higher risk of double counted savings and the possibility that no new stranded potential will actually be captured. Furthermore, a non-targeted approach could lead to significant amounts of spending on savings that would have happened anyway (leading to low net-to-gross ratios) reducing the amount of funding available for projects that would have produced real new savings.

On the other hand, our analysis of the Stranded Potential was not able to include certain measures (such as building envelope and commercial refrigeration equipment) measures due to the scope of our study. Analysis including measure characterization are needed to better understand additional Stranded Potential from measures not included in this study.

Impacts on Utility Program Budgets

Utility program budgets are typically planned on an annual basis. Program costs include the sum of incentives paid to customers as well as non-incentive costs required to run the program. Program costs modeled in this analysis exclude non-resource programs and budget for

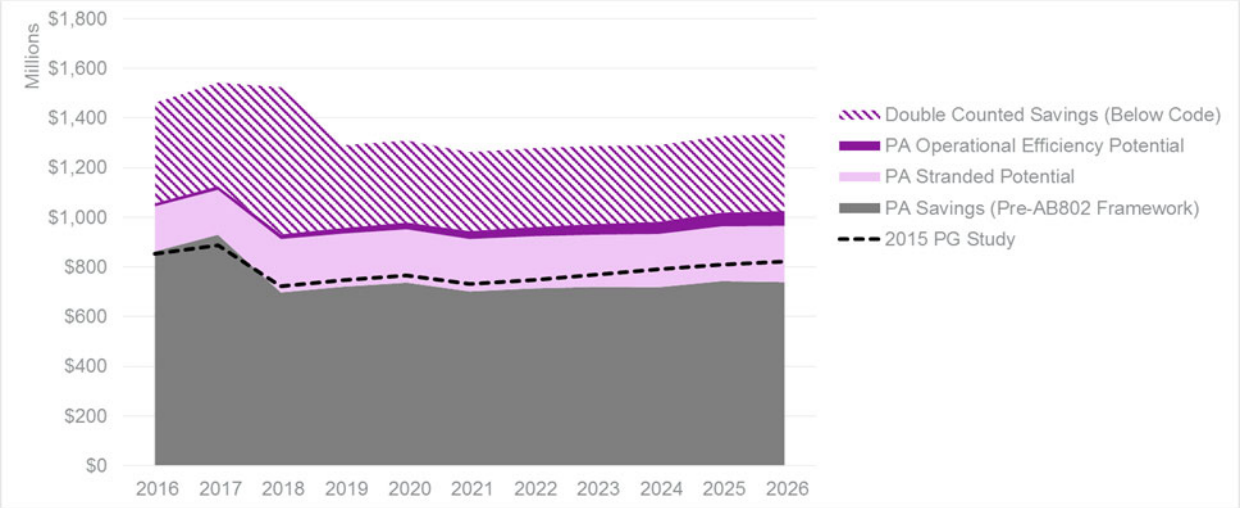
IOU C&S advocacy efforts. The budget forecast consists of the required budget to achieve all electric, demand, and gas savings.

Figure 3 shows the annual budget forecast for all Program Administrators (PAs) to run their programs under AB802. The budget is broken down into four components: PA Savings (Pre-AB802 framework)[10], PA Stranded Potential, PA Operational Efficiency Potential, and Double Counted Savings (Best Estimate). The black dotted line reflects the budget that would be needed to achieve the savings that the 2015 PG Study forecasted (absent AB802) and is consistent with current EE program spending in California.

The solid colors (grey, light purple and dark purple) in Figure 3 indicate spending of well targeted programs that fund only above code savings, stranded savings, and operational efficiency savings. In this case, total program budget would increase approximately 24% relative over what was forecasted in the 2015 PG Study.

The pattern filled purple shaded area called as "Double Counted Savings (Below Code)" demonstrates the amount of budget that the PAs could spend on the savings that would happen due to C&S even in the absence of PA programs. This potential risk is estimated to be $4 billion cumulative from 2016 to 2026. This is to say, if programs are not properly designed and targeted at the true stranded potential, PAs could spend up to $4 billion on measures that would have been installed even without the rebate over the forecast period.

Figure 3: Annual Energy Efficiency Program Budget by Savings Category



Source: Navigant Analysis

Limitations and Caveats

As previously mentioned, the scope of this study was primarily to develop an updated methodology that allows for the analysis of the impacts of AB802. Navigant then used the

[10] The savings that PAs were allowed to claim for their rebate programs prior to the passing of AB802. This includes all above-code savings as well as some below code savings (from early retirement and retrofit programs that were previously allowable). These savings have been the primary subject of the 2015 PG study and all prior California potential studies

updated modeling methodology to develop a primary estimate of the impacts of AB802 based on readily available market data.

1. **There is likely more stranded potential than what this preliminary forecast captures.** This preliminary forecast is limited in scope to the same measures considered in the 2015 and 2013 PG study. We believe additional stranded potential lies in building envelope measures and commercial refrigeration measures. Additional stranded potential may reside in the industrial and agriculture sectors though further investigation is needed to validate.
2. **There may be more operational efficiency potential than what this preliminary forecast captures, albeit uncertain.** This preliminary forecast considers three representative commercial sector operational efficiency programs. The analysis is based on limited available data and professional judgement by Navigant. We recognize additional operational efficiency potential likely resides in the industrial sector.
3. **Double Counted Savings is highly uncertain.** We are uncertain about the level of double counted savings at this time as there is no overall program guidance around customer eligibility. Furthermore, double counted savings is based on an estimate of renovation activity that occurs in existing buildings; there was limited data to inform this estimate.
4. **Assumptions about program incentive structures are those of Navigant's given limited input from Program Administrators.** It is unclear what utility rebate programs will ultimately look like under AB802. Without known rebate policies and program budgets to calibrate to, the forecast may not be an accurate representation of modified programs under AB802.
5. **Data informing the estimate of the stranded potential is uncertain.** This analysis initially developed a short list of commercial and residential measures that were hypothesized to have uncaptured stranded potential. After collecting and reviewing available market data it became apparent there are data gaps. Small sample sizes prevent a robust determination of the true amount of equipment that is "very old". Limited data were available on the cost to repair and the added lifetime a repair offers.

Key Recommendations

To better inform future updates to the potential study, Navigant identified a list areas for further research and consideration. Some of the data gaps identified could be filled through existing or future EM&V or market studies. These recommendations are described in further detail the full AB802 Technical Analysis report (Navigant, 2016).

1. **Characterize Additional Residential and Commercial Equipment.** We recommend further research and measure characterization for building envelope (insulation, roofing, windows, air sealing, etc.) and commercial refrigeration equipment.
2. **Characterize Below Code Savings Opportunities in the Agriculture and Industrial Sectors.** Below-code savings exists in the industrial and agriculture sectors, however they were not quantified through this study. Additional clarity is needed regarding CPUC baseline policy these sectors.
3. **Expand Saturation Studies to Consider a Broader List of Technologies and End Uses.** A dataset on distribution of age of all commercial equipment would more easily allow us to identify where the stranded potential truly lies.

4. **Further Research to Inform the Double Counted Savings.** Additional data collection and analysis will be needed to develop a more refined estimate of double counted savings. The most useful data would be a better understanding of the number of building alterations that occur in California and the amount of to-code activities that naturally occurs through these alterations.
5. **Comparison and Alignment to CEC Demand Forecast.** A more robust comparison and alignment of assumptions between used by this study and the CEC demand forecast is needed before the AAEE can be updated.
6. **Further Research to Inform Operational Efficiency Savings.** Consider further research in multiple areas including additional interventions, persistence, and industrial sector opportunities.
7. **Collect Data on Equipment Removed by Program Participants.** As new programs seeking below-code savings are implemented, program administrators should carefully document the age, type, and condition of equipment that is being replaced by program participants. These data could inform future studies.

References

CPUC. *Staff Whitepaper on Energy Efficiency Baselines for Implementation of AB802.* April 2016

Kavalec, C., N. Fugate, C. Garcia, and A. Gautam. *California Energy Demand 2016-2026, Revised Electricity Forecast*. California Energy Commission. Publication Number: CEC-200-2016-001-V1. 2016

KEMA. *Appliance Recycling Program Impact Evaluation Volume 1: Report Work Order 35*. October 2014.

Mejia. A. *Crosscutting Technical Position Paper No. 1: Savings to Code Subcommittee*. California Technical Forum. November 2015

Navigant. *2013 California Energy Efficiency Potential and Goals Study*. February 2014

Navigant. *AB802 Technical Analysis - Potential Savings Analysis*. March 2016

Navigant. *Analysis to Update Energy Efficiency Potential, Goals, and Targets for 2013 and Beyond - Track 1*. May 2012.

Navigant. *Energy Efficiency Potential and Goals Study for 2015 and Beyond*. September 2015.

Williams. *Assembly Bill No. 802*. October 8, 2015.