DOCKETED

Docket Number:	17-IEPR-03
Project Title:	Electricity and Natural Gas Demand Forecast
TN #:	222431
Document Title:	Investor Owned Utilities 2017 Additional Achievable Energy Effeciency Savings Methodology Documentation
Description:	Prepared for: California Public Utilities Commission
Filer:	Raquel Kravitz
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	2/5/2018 11:35:08 AM
Docketed Date:	2/5/2018

Investor Owned Utilities 2017 Additional Achievable Energy Efficiency Savings: Methodology Documentation

Prepared for:

California Public Utilities Commission

Submitted by:
Navigant Consulting, Inc.
1 Market Street
Spear Tower, Suite 1200
San Francisco, CA 94105

415-356-7100
navigant.com

Reference No.: 174655
January 30, 2018

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

Figures

Appendix Figures

Tables

DISCLAIMER

This report was prepared by Navigant Consulting, Inc. (Navigant) for the California Public Utilities Commission. The work presented in this report represents Navigant's professional judgment based on the information available at the time this report was prepared. Navigant is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report. NAVIGANT MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED. Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings and opinions contained in the report.

1. INTRODUCTION

1.1 Background

The California Energy Commission (CEC) provides a long-term forecast of energy consumption as part of the Integrated Energy Policy Report (IEPR), this forecast is referred to as the California Energy Demand (CED) Forecast. The CED forecast is updated on a regular basis to include the latest trends in the California energy market, including forecasts of the impacts of Investor Owned Utility (IOU) energy efficiency rebate programs and the impacts of future Codes and Standards (C&S) on building and appliance energy consumption.

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

However, there also exist additional savings from initiatives that are neither finalized nor funded but are reasonably expected to occur though either the IOU programs or C&S. These savings are referred to as achievable. Resource and transmission planners thus require an adjustment to the CED baseline forecasts (which include only committed savings) to account for these likely impacts.

Achievable savings estimates begin with a comprehensive efficiency potential study, as provided in the California Energy Efficiency Potential and Goals Studies, issued by the California Public Utilities Commission. The CPUC potential studies estimated energy efficiency savings that could be realized through IOU-sponsored utility programs as well as C&S within the IOU service territories for both a historical calibration period and a future forecast period. Because a portion of these savings are already incorporated in the CED baseline forecast, CEC staff need to estimate the portion of savings from CPUC potential study not accounted for in the baseline forecast. These nonoverlapping savings are referred to as Additional Achievable Energy Efficiency (AAEE) impacts.

The CEC routinely develops a forecast of AAEE with the assistance of the CPUC and the CPUC’s contractors. Navigant has supported the CPUC in the development of energy efficiency potential and goals efforts since 2011. Navigant’s scope includes supporting the CEC to develop IOU-based AAEE estimates.[1] This report described the process used to translate the 2018 Potential and Goals Study (PG Study) into the CED 2017 AAEE forecast and support the interpretation of AAEE results.

1.2 The 2018 PG Study

The purpose of the 2018 PG Study is to develop estimates of energy and demand savings potential in the service territories of California’s major investor-owned utilities (IOUs) during the post-2017 energy efficiency (EE) rolling portfolio planning cycle.[2] A key component of the 2018 PG Study is the Potential and Goals Model (PG Model), which provides a single platform in which to conduct robust quantitative

[1] Analysis of energy efficiency savings in publicly owned utility service territories is not part of the scope of this effort.

[2] Navigant. *Energy Efficiency Potential and Goals Study for 2018 and Beyond.* September 2017. Available at: http://www.cpuc.ca.gov/General.aspx?id=6442452619

scenario analysis that reflects the complex interactions among various inputs and policy drivers. The study period spans a 10+ year time horizon (2018-2030) based on the direction provided by CPUC and focuses on current and potential future drivers of energy savings in IOU service areas.

The 2018 PG model forecasts potential energy savings from a variety of sources within six distinct sectors: Residential, Commercial, Agricultural, Industrial, Mining, and Street Lighting. Within some or all the sectors, sources of savings include:

- **Rebated Technologies:** Discrete mass market technologies that are incentivized and provided to IOU customers in the Residential, Commercial, Industrial, Agricultural, Mining, and Street-lighting sectors.
- **Whole Building:** Whole building retrofits seeking deep energy savings as well as Zero Net Energy buildings. Whole building initiatives are modeled for the Residential and Commercial sectors.
- **Custom Measures and Emerging Technologies:** This study defines Custom Measures as improvements to processes specific to the industrial and agricultural sectors, the measures themselves are not individually defined and rather represent a wide array of, niche technologies. Similarly, Emerging Technologies are represented as a wide array of technologies and not individually defined.
- **Behavior, Retrocommissioning, Operational Efficiency (BROs):** For the purposes of this study, the Navigant team defines behavior-based initiatives as those providing information about energy use and conservation actions, rather than financial incentives, equipment, or services. Savings from BROs are modeled as incremental impacts of behavior and operational changes beyond equipment changes.
- **Low Income:** Savings from income-qualified energy efficiency programs in the residential sector.
- **Codes and Standards (C&S):** Codes regulate building design, requiring builders to incorporate high-efficiency measures. Standards set minimum efficiency levels for newly manufactured appliances. Savings are forecasting from C&S that went into effect starting in 2006.
- **Financing:** Financing has the potential to break through several market barriers that have limited the widespread market adoption of cost-effective energy efficiency measures. The PG Model estimates the effects of introducing energy efficiency financing on market potential in the residential and commercial sector and how shifting assumptions about financing affect the potential energy savings.

The 2018 Study forecasts energy efficiency potential at four levels for rebated technologies:

1. **Technical Potential:** Technical potential is defined as the amount of energy savings that would be possible if the highest level of efficiency for all technically applicable opportunities to improve energy efficiency were immediately taken (regardless of cost), including retrofit measures, replace-on-burnout measures, and new construction measures.
2. **Economic Potential:** Using the results of the technical potential analysis, the economic potential is calculated as the total energy efficiency potential available when limited to only cost-effective

measures.[3] All components of economic potential are a subset of technical potential. Like technical potential, economic potential can be represented as instantaneous or annualized. Economic potential screens considered in this study include the following cost-effectiveness tests: Total Resource Cost (TRC), Modified TRC (mTRC)[4] and Program Administrator Cost (PAC).

3. **Market Potential:** The final output of the potential study is a market potential analysis, which calculates the energy efficiency savings that could be expected in response to specific levels of incentives and assumptions about existing CPUC policies, market influences, and barriers. All components of market potential are a subset of economic potential. Some studies also refer to this as "achievable potential." Market potential is used to inform the utilities' energy efficiency goals, as determined by the CPUC. Market potential has historically been used by the CPUC to inform the goal-setting process.
4. **Stranded Potential** is a subset of the Market Potential. These savings are defined as the opportunities for EE that have not historically been captured by either EE program administrator (PA) rebate or C&S programs. 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. Under AB802, PAs are permitted to offer rebates for bringing existing equipment up to code thus potentially motivating a whole new subset of customers to install EE measures and thus capture the Stranded Potential.

Market potential is represented in the 2018 PG Study two different ways; each is based on the same data and assumptions though each serve separate needs and provide necessary perspectives.

1. **Incremental Savings** represent the annual energy and demand savings achieved by the set of programs and measures in the first year that the measure is implemented. It does not consider the additional savings that the measure will produce over the life of the equipment. A view of incremental savings is necessary to understand what additional savings an individual year of energy efficiency programs will produce. This has historically been the basis for IOU program goals.
2. **Cumulative Savings** represent the total savings from energy efficiency program efforts from measures installed since 2015 including the current program year, and are still active in the current year. It includes the decay of savings as measures reach the end of their useful lives and the continuation of savings as customer re-install high efficiency equipment that has reached the end of its EUL. Cumulative savings also account for the timing effects of codes and standards that become effective after measure installation. Cumulative savings is the basis for AAEE. The PG report issued an erratum in January 2018 updating cumulative savings results.[5] The AAEE analysis incorporates these latest results.

Additional details on the modeling methodology and data sources can be found in the 2018 PG Study under Section 2.[6]

[3] The default assumption for this study includes all non-emerging technologies with a C-E test result of 0.85 or greater; emerging technologies are included if they meet a threshold of 0.5 in a given year and also achieve the threshold for non-emerging technologies (0.85) within ten years of market introduction.

[4] Builds upon the TRC test by including a GHG adder to the avoided cost of electricity and natural gas.

[5] Navigant. *Energy Efficiency Potential and Goals Study for 2018 and Beyond - Errata to the Final Public Report*. January 2018

[6] Navigant. *Energy Efficiency Potential and Goals Study for 2018 and Beyond- Final Public Report*. September 2017

1.3 Scope of AAEE Analysis

The analysis to produce CED 2017 AAEE focuses on translating the results of the 2018 PG Study into a usable format for the CED forecast as well as aligning and adjusting model assumptions and scenarios to fit the needs of the forecast. Furthermore, the CED 2017 AAEE accounts for additional sources of energy efficiency savings beyond the scope of what is included in the 2018 PG Study. For this, CEC staff referenced the recent CEC report: *Senate Bill 350: Doubling Energy Efficiency Savings by 2030* (CEC SB350 Report).[7]

Navigant assisted the CEC in the following:

- Developing a set of six scenarios for use in the AAEE analysis. Scenarios were based on the initial scenarios developed in the 2018 PG Study but further modified. (Discussed further in Section 2 of this report)
- Assisted CEC staff in reviewing and accounting for potential overlap between the 2018 PG Study and CEC's SB 350 Report to avoid double counting (discussed further in Section 3 of this report).
- Adjusting the PG model such that cumulative savings start accumulating in the year 2018 (as opposed to the default year of 2015 in the model).
- Developing load shapes that can be used in peak demand analysis (discussed further in Section 4 of this report).
- Supporting the CEC in disaggregation of the statewide results to more granular locational data (discussed further in Section 5 of this report).

[7] CEC. *Senate Bill 350: Doubling Energy Efficiency Savings by 2030.* October 2017.

2. DEVELOPMENT OF AAEE SCENARIOS

2.1 Background: Scenarios in the 2018 PG Study

Scenarios in the 2018 PG Study were primarily built around policies and program decisions that are under control of the CPUC and IOUs collectively, these are referred to as "internally influenced" variables. Variation in "externally influenced" variables (such as economic and demographic conditions) were not considered in the goals study but are considered in the AAEE scenarios. A list of example internally and externally influenced variables can be found in Table 1 below. Additional details on each of the internally influenced variables can be found in the study team's presentation to the Demand Analysis Working Group (DAWG) on December 12, 2016.[8]

Table 1. Variables Affecting Energy Efficiency Potential

Internally Influenced	Externally Influenced
• Cost-effectiveness (C-E) test • C-E measure screening threshold • Incentive levels • Marketing & Outreach • Behavior, Retro commissioning & Operational (BROs) customer enrollment over time • IOU financing programs	• Building stock forecast • Retail energy price forecast • Measure-level input uncertainties (unit energy savings, unit costs, densities) • Non-IOU financing programs

The 2018 PG Study ran five scenarios listed in Table 2 based on feedback from CPUC staff. CPUC staff's intent was to keep the number of scenarios manageable but still provide a range of alternatives to bound market potential. The cost effectiveness (C-E) screen was the primary variation across scenarios to allow CPUC staff to observe the impacts of changing C-E policies. Program engagement captured remaining internally influenced variables other than C-E related items. Externally influenced variables were held constants across all scenarios.

Table 2. Final Scenarios for Energy Efficiency Potential – Summary

Scenario	Cost Effectiveness Screen	Program Engagement
1: TRC | Reference	TRC test using 2016 Avoided Costs	Reference
2: mTRC (GHG Adder #1) | Reference	TRC test using 2016 Avoided Costs + IOU proposed GHG Adder	Reference
3: mTRC (GHG Adder #2) | Reference	TRC test using 2016 Avoided Costs + Commission staff proposed GHG Adder	Reference
4: PAC | Reference	PAC test using 2016 Avoided Costs	Reference
5: PAC | Aggressive	PAC test using 2016 Avoided Costs	Aggressive

The TRC | Reference scenario represents "business as usual" and the continuation of current policies. Three of the alternate scenarios continue to assume similar program design but apply different cost

[8] Slides available at: http://demandanalysisworkinggroup.org/event/energy-savings-pup-cpuc-2018-beyond-ee-potential-goals-study-model-calibration-and-forecasting-scenarios/?instance_id=445

effectiveness tests and avoided costs. The final scenario (PAC | Aggressive) is meant to show an upper bound of the combination of program engagement and cost-effectiveness screens. The CPUC ultimately adopted Scenario 2 as the IOU goals through Decision 17-09-025.

2.2 Scenarios for AAEE

Scenarios for AAEE consider both internal and externally influence variables. Two externally influenced variables are core to the IEPR demand forecast, they each have a low, mid, and high value that can be used for forecasting:

- Building Stock
- Retail Energy price

While there are three possible values for each of these two variables resulting in nine combinations, the CEC 's IEPR demand forecast links these variables in its forecasting such that only three combinations of "Economic/Demographic" data are used.

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

The 2018 PG Study ran all five of its scenarios using the Mid Demand Case Economic/Demographic data. Initial discussions for AAEE included consideration of running the five scenarios that were part of the 2018 PG Study, along with the high and low Economic/Demographic data. This would have resulted in a grand total of 15 scenarios. However, CPUC and CEC staff concluded that this would be an unreasonable approach given the large number and nature of scenarios.

Ultimately CEC and CPUC staff chose to follow an approach to develop five scenarios based around the adopted goals (similar to the approach used in the 2015 AAEE analysis) with the addition of a sixth scenario designed to model aggressive levels of energy efficiency. This approach allows the AAEE to express a range of possible outcomes that can easily be compared to the baseline forecasts contained within the CED. Four of the six scenarios produce AAEE results that can be subtracted from the CED Mid-case reference forecast. The other two scenarios correspond to the CED Low and High reference forecasts.

Table 3 below lists the key variables as they were modeled in each of the six AAEE scenarios. Further discussion on each scenario follows the table. Note that Navigant only provided results to the CEC that were derived from the 2018 PG Study. CEC staff extracted information from the CEC SB350 report to add to the PG Study results.

Table 3. Final Scenarios for CEC 2017 AAEE

			Sceanrio					
			1	2	3	4	5	6
Category	Source	CEC Demand Case:	High	Mid	Mid	Mid	Low	Mid
		Savings Case:	Low 1	Low 2	Mid	High	High	High Plus
Econ/ Demo	2018 PG Study	Building Stock	High Demand Case	Mid Demand Case	Mid Demand Case	Mid Demand Case	Low Demand Case	Mid Demand Case
		Retail Prices	High Demand Case	Mid Demand Case	Mid Demand Case	Mid Demand Case	Low Demand Case	Mid Demand Case
Rebated Equipment		Res/Com ETs	50% of model Results	50% of model Results	100% of model results	150% of model results	150% of model results	150% of model results
		AIMS ETs	Reference	Reference	Reference	Reference	Reference	Aggressive
		Incentive Level	Reference	Reference	Reference	Reference	Reference	Aggressive
		C/E Threshold	1	1	0.85	0.75	0.75	0.75
		ET C/E Threshold	0.85	0.85	0.5	0.4	0.4	0.4
		Cost-Effectiveness Test	mTRC(GHG Adder #1)	mTRC(GHG Adder #1)	mTRC(GHG Adder #1)	mTRC(GHG Adder #1)	mTRC(GHG Adder #1)	PAC
		Marketing Effect	Reference	Reference	Reference	Aggressive	Aggressive	Aggressive
		Financing	Reference	Reference	Reference	Aggressive	Aggressive	Aggressive
BROs		BROs Interventions	Reference	Reference	Reference	Reference	Reference	Aggressive
Low Income		Low Income	First Time + 50% Retreatment	First Time + 50% Retreatment	First Time + Retreatment	First Time + Retreatment	First Time + Retreatment	First Time + 150% Retreatment
Codes and Standards		Compliance Reduction	20% Compliance Rate Reduction	20% Compliance Rate Reduction	No Compliance Reduction	No Compliance Reduction	No Compliance Reduction	No Compliance Reduction
		Standards Compliance	No Compliance Enhancements	No Compliance Enhancements	No Compliance Enhancements	Compliance Enhancements	Compliance Enhancements	Compliance Enhancements
		Title 24	No additional Codes	2019 T24 NC (R/NR) + R A&A	2019 T24 NC (R/NR) + R A&A	2019 T24 NC (R/NR) + R A&A	2019 T24 NC (R/NR) + R A&A	2019 T24 NC (R/NR) + R A&A
		Title 20	2018 T20	2018 T20	2018-2024 T20	2018-2024 T20	2018-2024 T20	2018-2024 T20
		Federal Standards	On-the-books	On-the-books	On-the-books	On-the-books	On-the-books	On-the-books
	CEC SB350 Report	Title 24			2019 T24 NR A&A	2019 T24 NR A&A, plus T24 NC ratchets	2019 T24 NR A&A, plus T24 NC ratchets	2019 T24 NR A&A, plus T24 NC ratchets
		Title 20				SB 350 T20 < 2025 start	SB 350 T20 < 2025 start	SB 350 T20 < 2025 start
		Federal Standards				SB 350 Fed < 2025 start	SB 350 Fed < 2025 start	SB 350 Fed < 2025 start
Addnl SB 350 Programs		Additional SB 350 Programs						Savings from additional SB 350 programs that are not utility programs or standards that are considered likely

Internally Influenced
Externally Influenced

Notes:
NC = New Construction, R = Residential, NR = Non-Residential, A&A = Additions and Alterations,

A description of each scenario follows. Note that scenarios are not described in numerical order for ease of explanation:

- **Scenario 3:** Variable settings in this scenario align with the those used to set IOU goals. The cost effectiveness screen used in this scenario matches that used to set IOU goals: the modified TRC with GHG adder #1. Mid-case economic/demographic data are used so that Scenario 3 AAEE results may be subtracted from the CED Reference Mid-case forecast. Scenario 3 adds additional savings from 2019 Title 24 non-residential additions and alterations based on the CEC's SB350 analysis. Although the variable assumptions in this scenario match those used for goal setting, actual results will vary since the PG Study reported cumulative savings relative to a start year of 2015 and AAEE uses a start year of 2018.

- **Scenario 4:** Scenario 4 is a more aggressive version of scenario 3. It lowers the C-E threshold for rebate programs, assumes 50% more Res/Com emerging technology savings, assumes increased code compliance, assumes more aggressive program design, and adds additional codes and standards savings from the CEC's SB350 analysis.

- **Scenario 5:** Scenario 5 uses the same settings as scenario 4 except Low Demand Case economic demographic variables are applied. This AAEE scenario is meant to apply to CED Reference Low-case forecast. Combining a low forecast of baseline energy demand and an aggressive forecast of energy efficiency, yields a scenario representative of the low end of statewide energy consumption.

- **Scenario 2:** Scenario 2 is a less aggressive version of scenario 3. It increases the C-E threshold for rebate programs, assumes 50% less Res/Com emerging technology and Low-Income re-treatment savings, assumes decreased code compliance, and excludes CEC's SB350 analysis.

- **Scenario 1:** Scenario 1 uses the same settings as scenario 2 except High Demand Case economic demographic variables are applied and 2019 T24 savings are removed. This AAEE scenario is meant to apply to CED Reference High-case forecast. Combining a high forecast of baseline energy demand and a less aggressive forecast of energy efficiency, yields a scenario representative of the high end of statewide energy consumption.

- **Scenario 6:** Scenario 6 is the most aggressive scenario of the six. Different from all the other scenarios, it uses the PAC test for cost effectiveness screening. It pushes all internally influenced variables to their high/aggressive levels and adds additional codes and standards savings from the CEC's SB350 analysis. Scenario 6 is run using the Mid-case economic/demographic data such that its applicable to the CED Reference Mid-case forecast.

3. OVERLAP WITH SB350 ANAYLSIS

CEC staff separately conducted an analysis of potential savings from non-IOU programs that could contribute towards meeting the goals of SB350. The technical analysis for these programs was conducted by the CEC's contractor, NORESCO. Findings from this technical analysis as well as CEC staff interpretation of the results were published in the previously mentioned CEC SB350 Report.

Navigant was asked to review select components of the NORESCO analysis (primarily related to codes and standards savings) to determine to what extent (if any) there is overlap between the two studies. CEC staff needed to ensure any savings included in AAEE from the CEC SB350 Report were truly additive and not double counted with the 2018 PG Study results. Review for potential double counting focused on possible double counting between C&S savings in the NORESCO analysis and:

1. the 2018 PG Study's C&S savings
2. the 2018 PG Study's rebated equipment
3. the 2018 PG Study's whole building measures.

3.1 Overlap with the 2018 PG Study's C&S Savings

Navigant's reviewed the scope of C&S contained in the NORESCO analysis. This review compared the individual C&S presented in the results of the NORESCO analysis to those included in the 2018 PG Study. These incremental C&S included:

- 26 appliance standards under Title 20 with effective dates of 2020 and beyond
- 25 Federal appliance standards with effective dates of 2024 and beyond
- 4 future levels of Title 24 new construction building code (2019, 2022, 2025, 2028)
- Title 24 additions and alterations for both residential and non-residential segments

Navigant's review found:

- NORESCO analyzed incremental appliance standards (both Federal and Title 20) not already contained within the PG Study, thus no adjustments here were needed.
- NORESCO analyzed slightly different assumptions than the PG Study regarding 2019 T24 new construction code. However, in NORESCO's net savings analysis, an overlap adjustment was made to remove possible double counting with the 2018 PG Study.
- NORESCO's residential Title 24 alterations analysis overlaps with savings already accounted for in the 2018 PG Study. Thus, the AAEE only considered incremental savings from non-residential additions and alterations.

3.2 Overlap with the 2018 PG Study's Rebated Equipment

Navigant compared the scope of the measures in the 2018 PG Study with the C&S analyzed by NORESCO. The purpose of this comparison is to identify if any of the incremental C&S would have a significant impact on the baseline of rebated equipment savings claims thus reducing savings from IOU rebate programs.

Navigant identified 36 technologies in the PG study that may be impacted by the Federal and Title 20 appliance standards evaluated by NORESCO. Navigant next assessed the magnitude of the potential overlap in savings. The cumulative savings in 2030 from these 36 measures is summarized below in Table 4. As illustrated the amount of savings from measures at risk of being double counted is in the range of 2-5% for electricity and 10-12% for gas (percentage is calculated relative to savings from all measures).

Table 4. 2030 Cumulative Savings Potentially Impacted by Future C&S

Savings Type	2018 PG Study Scenario	Savings from Measures Potentially Impacted by Future Standards		Total	Savings from All Measures	Percent of Savings
		Federal	T20			
GWH	mTRC (GHG adder 1) | Reference Scenario	49	3	52	851	6.1%
	PAC | Aggressive	45	6	51	1027	5.0%
MW	mTRC (GHG adder 1) | Reference Scenario	3	0	3	188	1.7%
	PAC | Aggressive	10	1	12	284	4.1%
MMTherms	mTRC (GHG adder 1) | Reference Scenario	3	0	3	29	10.9%
	PAC | Aggressive	5	0	5	42	11.4%

The actual magnitude of potentially double counted saving will be less than that listed in Table 4. Savings from measures modeled in the PG Study are a result of installing significantly higher levels of efficiency than what current standards require. However, appliance standards tend to increase in efficiency level modestly relative to the previous standard; they rarely jump to the higher levels of efficiency currently being rebated by utilities. Since the savings in Table 4 represent savings from high levels of efficiency, we believe only a fraction of the savings are actually overlapping.

Determining the exact amount of overlap was not pursued by Navigant given mutual discussion and agreement with CEC staff. This was done for several reasons: 1) NORESCO analysis did not readily document the assumed higher efficiency levels of standards assumed, 2) the amount of savings at risk of overlapping are relatively small (on the order of 5-10% as indicated in Table 4), and 3) the amount of time available to the team was limited. As a result, no adjustments were made.

3.3 Overlap with the 2018 PG Study's Whole Building Measures

The 2018 PG Study includes voluntary savings from commercial ZNE buildings relative to 2019 T24 code. The 2018 PG Study did not forecast the added savings from T24 beyond 2019, thus the study did not assume the baseline for commercial ZNE buildings changed over time. The NORESCO SB350 analysis added future levels of T24 new construction codes. This implies the baseline for commercial ZNE new construction increases over time and voluntary savings would decrease.

Navigant developed a savings adjustment vector to apply to the ZNE measure results in a post processing step. The adjustment vector is based on the NORESCO analysis indicating how future levels of T24 will compare to previous. The following information was derived from the NORESCO documentation and discussions with the NORESCO team that conducted the analysis:

- 2022 T24 complaint building will consume 5% less energy than 2019 T24 complaint buildings
- 2025 T24 complaint building will consume 5% less energy than 2022 T24 complaint buildings
- 2028 T24 complaint building will consume 10% less energy than 2025 T24 complaint buildings

This information was combined with data from the 2018 PG Study that provided average building consumption for a 2019 T24 compliant building and a ZNE building. The data was translated from building consumption to unit energy savings of a ZNE relative to code. Unit energy savings data was then translated into a savings reduction vector that can be applied to the output of the PG study for ZNE measures. This vector (illustrated below in Table 5) de-rates ZNE savings to reflect the new code baseline.

Table 5. Commercial ZNE Savings Adjustment Vector

Year	Savings Adjustment Vector
2018	100%
2019	100%
2020	100%
2021	100%
2022	100%
2023	84%
2024	84%
2025	84%
2026	68%
2027	68%
2028	68%
2029	39%
2030	39%

The vector is equal to 100% up until 2022, implying that savings data in the PG study is valid until 2022, after which is needs to be adjusted downwards for the new codes.

4. LOADSHAPE RESEARCH AND DEVELOPMENT

The CEC is currently researching electricity load shapes through an EPIC funded project under agreement number 300-15-013.[9] However, results from the study were not available in time to inform the AAEE analysis. In its absence, Navigant updated the load shape analysis conducted in the 2015 AAEE analysis.[10]

In general, the approach used to select, source, and aggregate load profiles for the 2018 AAEE analysis follows the approach taken for the 2015 AAEE analysis. The 2018 AAEE load profile analysis leverages the most current data available for energy efficiency potential savings and associated primary and simulated load data. This section provides a detailed review of the load profile research and development conducted in this analysis.

4.1 Approach

Based on the scope of work for this effort, Navigant completed five steps to develop normalized 8760 load shapes for AAEE savings:

- Step 1 – Select High Impact (Named) End Uses
- Step 2 – Source Load Shape Data
- Step 3 – Map Load Shape Profiles to PG study Measures
- Step 4 – Shift Normalized Load Shape Data to a Representative Year
- Step 5 – Aggregate Measure Load Shapes to End Use Load Shapes

4.1.1 Step 1: Select High Impact (Named) End Uses

CEC staff prioritized sectors and end uses for this analysis. This involved first quantified cumulative AAEE savings from 2018 to 2030 by sector and end use. These savings included those from IOU rebate programs as well as Codes and Standards. CEC staff then identified high impact end uses to develop a preliminary list of named end uses based on the following criteria:

1. End use savings were more than 10 percent of sector savings.
2. Where end use category did not meet the above criterion, end use savings were more than 3 percent of total savings.

Table 6 shows the final named end use list, which covers approximately 96.6 percent of total cumulative AAEE savings from 2018 to 2030. Several exceptions to the above criteria for selecting high impact end uses were to include commercial appliance plug loads and agricultural machine drives. The remaining AAEE savings were lumped together into a “residual” end use category. Not listed in Table 6 is residential behavioral programs for which Navigant also provided a load shape.

[9] Additional information available at: http://innovation.energy.ca.gov/SearchResultProject.aspx?p=31147&tks=636523101755413302

[10] Report available at: http://www.energy.ca.gov/2016publications/CEC-200-2016-007/Attachment_01.pdf

Table 6: Named End Use List – Rebated Equipment

Sector	Use Category	Share of 2030 Cumulative Market Potential	
		Sector Savings	Total Savings
Residential	Lighting	42.9%	6.2%
	Appliance Plug	26.9%	3.9%
	Whole Building	16.7%	2.4%
	HVAC	10.3%	1.5%
Commercial	Lighting	65.9%	42.1%
	Whole Building	14.8%	9.4%
	HVAC	8.7%	5.5%
	Commercial Refrigeration	6.9%	4.4%
	Appliance Plug [a]	1.0%	0.7%
Agricultural	Whole Building	72.2%	5.8%
	Process Refrigeration	10.9%	0.9%
	Machine Drives [b]	2.4%	0.2%
Industrial	Whole Building	38.5%	2.9%
	Lighting	33.3%	2.5%
	Machine Drives	22.7%	1.7%
	HVAC	3.9%	0.3%
Mining	Oil & Gas Extraction	100.0%	0.5%
Streetlighting	Streetlighting	100.0%	5.7%
		Total:	96.6%
		Residual:	3.4%

4.1.2 Step 2: Source Load Shape Data

Navigant performed a load shape data search to compile representative 8760 load profiles for measures in the named end use categories. Where possible, Navigant sourced the most current, California-specific load shapes directly. For certain commercial end uses where no metered California load shapes were available, Navigant modeled load profiles using the calculation engine, *EnergyPlus.* Load profiles developed using *EnergyPlus* leveraged building models developed by the federal Depart of Energy (DOE) and further refined by Navigant and California weather data. Load profiles that could not be updated from California metered data or *EnergyPlus* building models are sourced from the 2015 AAEE load profile study. Section 4.2 provides a more detailed description of load profile sources by end use.

4.1.3 Step 3: Map Load Profiles to PG Study Measures

The mapping of load profiles to PG study measures was based upon work Navigant previously completed in the 2015 AAEE study. With load profiles already mapped to measures and end uses, this analysis focused on updating data.

4.1.4 Step 4: Shift Normalized Load Profile Data to a Representative Year

In order to develop end use load shapes, the weekdays and weekends of different load shapes from different data sources had to match each other. Therefore, Navigant needed to shift these load shape profiles to a representative year. Navigant selected 2016 as the representative year to align with the most recent utility metered data. 2016 is a leap year and thus also provides relevant data for shifting to both leap and non-leap years. Load profiles developed using *EnergyPlus* building models used California weather data for 2016 and thus did not have to be shifted. Load profiles leveraged from the 2015 AAEE analysis were shifted from 2013 to 2016. All the load profiles provided in the deliverable are for 2016. CEC can apply these load shapes to savings in any given year by shifting the load shapes as needed.

4.1.5 Step 5: Aggregate Measure Load Shapes to Named End Use Load Shapes

Navigant developed an aggregate load shape for each named end use category identified in Table 1, for each IOU, by weighting the individual, normalized load shapes mapped to the measures within each sector based upon the weights defined in the 2015 AAEE load profile analysis. This weighted averaging resulted in 54 unique load shapes for the named end use category. Navigant determined the whole building behavioral load profiles to be conservatively represented by the residential whole building load profiles and are thus duplicated in this analysis; further detail is provided in section 4.2.1. For the residential and commercial residual load shapes, Navigant duplicated the residential and commercial whole building load shapes from the named end use category. For the industrial and agricultural residual load shapes, Navigant simply sourced and normalized each IOU’s publicly available 8760 large commercial/industrial and agricultural load data respectively. This resulted in 12 unique load shapes for the residual category. In all, a total of 69 load shapes are being provided to the CEC.

4.2 Data Sources

Navigant performed an extensive load shape data search to compile representative 8760 load profiles for measures in the named end use categories. Where possible, Navigant sourced California-specific load shapes. Where California-specific data was not available, Navigant leveraged additional secondary resources to fill gaps using load shapes from other states. This was done only if the measure in question was not weather-sensitive. Table 7 summarizes the load profiles sourced for each PG Study end use.

Table 7: Load Profile Data Sources

Sector	Use Category	Source(s)	Year of Data
Residential	Lighting [a]	DEER 2011 - Indoor_CFL_Ltg OpenEI - General:ExteriorLights:Electricity	1991 Common Year [b]
	Appliance Plug [a]	DEER 2011 - Res_ClothesDishWasher DEER 2011 - RefgFrzr_HighEff DEER 2011 - RefgFrzr_Recyc-Conditioned OpenEI - Appl:InteriorEquipment:Electricity	1991 1991 1991 Common Year [b]
	HVAC [a]	DEER 2011 - HVAC_Eff_AC DEER 2011 - HVAC_Duct_Sealing DEER 2011 - HVAC_Refrig_Charge	1991
	Whole Building	IOU Data – PG&E E1 Rate Class IOU Data – SCE DOM – S/M Rate Class IUO Data – SDG&E Residential Rate Class	2016
	Whole Building – Behavioral	IOU Data – PG&E E1 Rate Class IOU Data – SCE DOM – S/M Rate Class IUO Data – SDG&E Residential Rate Class	2016
	Residual	IOU Data – PG&E E1 Rate Class IOU Data – SCE DOM – S/M Rate Class IUO Data – SDG&E Residential Rate Class	2016
Commercial	Lighting	*EnergyPlus* Building Model Output	2016
	Whole Building	IOU Data – PG&E A10 Rate Class IOU Data – SCE GS2 Rate Class IOU Data – SDG&E Med Com/Ind Rate Class	2016
	HVAC [a]	DEER 2011 – HVAC Chillers DEER 2011 – HVAC Refrig Charge DEER 2011 – HVAC Split-Package AC DEER 2011 – HVAC Duct Sealing DEER 2011 – HVAC Split-Package HP	1991
	Commercial Refrigeration	*EnergyPlus* Building Model Output	2016
	Appliance Plug	*EnergyPlus* Building Model Output	2016
	Residual	IOU Data – PG&E A10 Rate Class IOU Data – SCE GS2 Rate Class IOU Data – SDG&E Med Com/Ind Rate Class	2016
Agricultural	Whole Building [a]	IOU Data – PG&E AG1B Rate Class IOU Data – SCE PA2 Rate Class IOU Data – SDG&E Agr Rate Class	2016 2013 2016
	Process Refrigeration [a]	IOU Data – PG&E AG1B Rate Class IOU Data – SCE PA2 Rate Class [c]	2016 2013
	Machine Drives [a]	IOU Data – PG&E AG1A Rate Class IOU Data – SCE PA2 Rate Class [c]	2016 2013
	Residual	IOU Data – PG&E AG1B Rate Class IOU Data – SCE PA2 Rate Class IOU Data – SDG&E Agr Rate Class	2016 2013 2016

Sector	Use Category	Source(s)	Year of Data
Industrial	Whole Building	IOU Data – PG&E E19 Rate Class IOU Data – SCE GS2 Rate Class IOU Data – SDG&E Lrg Com/Ind Rate Class	2016
	Lighting [a]	Northeastern Utility	2013
	Machine Drives [a]	Canadian Utility	2013
	HVAC [a]	DEER 2011 (Non-Res) – HVAC Split-Pack AC	1991
	Residual	IOU Data – PG&E E19 Rate Class IOU Data – SCE GS2 Rate Class IOU Data – SDG&E Lrg Com/Ind Rate Class	2016
Mining	Oil & Gas Extraction	IOU Data – PG&E AG5B Rate Class [d]	2016
Streetlighting	Streetlighting	IOU Data – PG&E LS1 Rate Class IOU Data – SCE St-Ltng Rate Class	2016

a. Measure is sourced directly from the 2015 AAEE analysis. The source provided is the source used in that previous study.
b. January 1 is a Sunday.
c. SCE's load shape was used for SDG&E
d. PG&E's load shape was used for SCE and SDG&E

4.2.1 Residential Measures

Residential load profiles were primarily leveraged from the 2015 AAEE Load Study. Most residential load profiles in the prior study were sourced from California's Database for Energy Efficient Resources (DEER) and OpenEI[11]. DEER contains 12 normalized residential load shapes by IOU. Of these, 7 were used in the 2015 analysis. These load shapes represent around half of measures that make up AAEE savings in the residential sector. For remaining measures such as exterior lighting and home electronics, Navigant sourced load shape data from OpenEI, a public database containing hourly residential load profiles by end use and climate zone. In prior work, Navigant found that these end use profiles do not vary by California climate zones. Thus, Navigant simply sourced a common load profile for these measures. For residential appliance plugs, Navigant leveraged pool pump load data from a Southwestern utility. The data sourced originally in the 2015 study from DEER, OpenEI, and the Southwestern utility were once again leveraged to provide load profiles in the 2018 AAEE load study.

For whole building end uses, Navigant sourced each IOU's publicly available 8760 residential load data. Navigant also researched behavioral measures to identify the appropriate treatment of their load profiles. There is some information available from Lawrence Berkeley National Labs (LBNL)[12] that suggests behavior savings have a higher percent saving during peak hours then off peak, but given the limited data Navigant did not develop a method to translate this to an 8760-format load profile. For this iteration of the AAEE load study, Navigant used the whole building load profile as a proxy for behavioral measures that can be used to conservatively estimate peak savings. However, there is opportunity to research and develop a unique profile for behavioral measures in future work.

[11] 8760 hourly load profile data for residential customers at the end-use level available at: http://en.openei.org/datasets/dataset/commercial-and-residential-hourly-load-profiles-for-all-tmy3-locations-in-the-united-states

[12] LBNL studies available at:

https://emp.lbl.gov/sites/default/files/lbnl-6598e.pdf

https://emp.lbl.gov/sites/default/files/lbnl-182663.pdf

4.2.2 Commercial Measures

Load profiles for commercial measures were developed using a combination of *EnergyPlus* building models, IOU metered load data, and 2015 AAEE Load Study profiles.

Specifically, load profiles for commercial measures that apply to the lighting, appliance plug, and commercial refrigeration loads were modeled using *EnergyPlus* modelling software. The 8760 load profiles output of the *EnergyPlus* model is based upon DOE developed building models that Navigant has refined over years of experience. The building models are used in tandem with California weather data to produce load profiles by end use.

The load profiles for commercial measures that apply to whole building and residual loads were sourced from each IOU's publicly available 8760 commercial load data. Where more than one load shape was available for the commercial sector, Navigant chose load data for customer with medium demand.

Finally, load profiles for commercial measures that apply to HVAC loads were sourced from California's DEER database. California's DEER database contains 7 normalized non-residential load shapes by IOU.

4.2.3 Agricultural, Industrial, Mining and Street Lighting (AIMS) Measures

For the industrial and agricultural residual load shapes, Navigant simply sourced and normalized each IOU's publicly available 8760 large commercial/industrial and agricultural load data respectively. This resulted in 12 unique load shapes for the residual category.

4.3 Final Load Profile Data

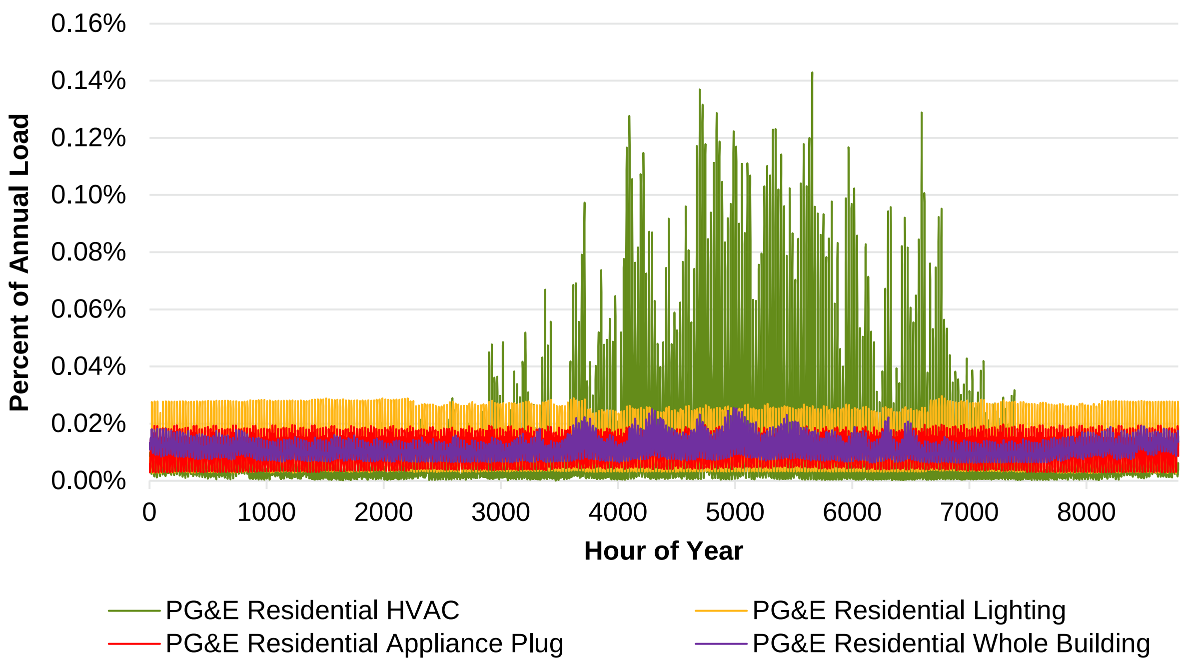
An excel spreadsheet that accompanies this memo contains a repository of the final 67 load profiles, which together represent three IOUs, six sectors, ten named end uses and four residuals. The spreadsheet includes a load shape viewer tool that the CEC can use to dynamically view each load shape by IOU and sector-end use combination any given time period during the representative year.

4.3.1 Summary of Load Shapes

The following paragraphs discuss the final 8760 load shapes for PG&E's named end uses by sector to provide some insight into the outcome of this analysis. All the trends discussed in this section for PG&E also apply to SCE and SDG&E. Graphs similar to those shown in this section for PG&E can be found for SCE and SDG&E in Appendix A.

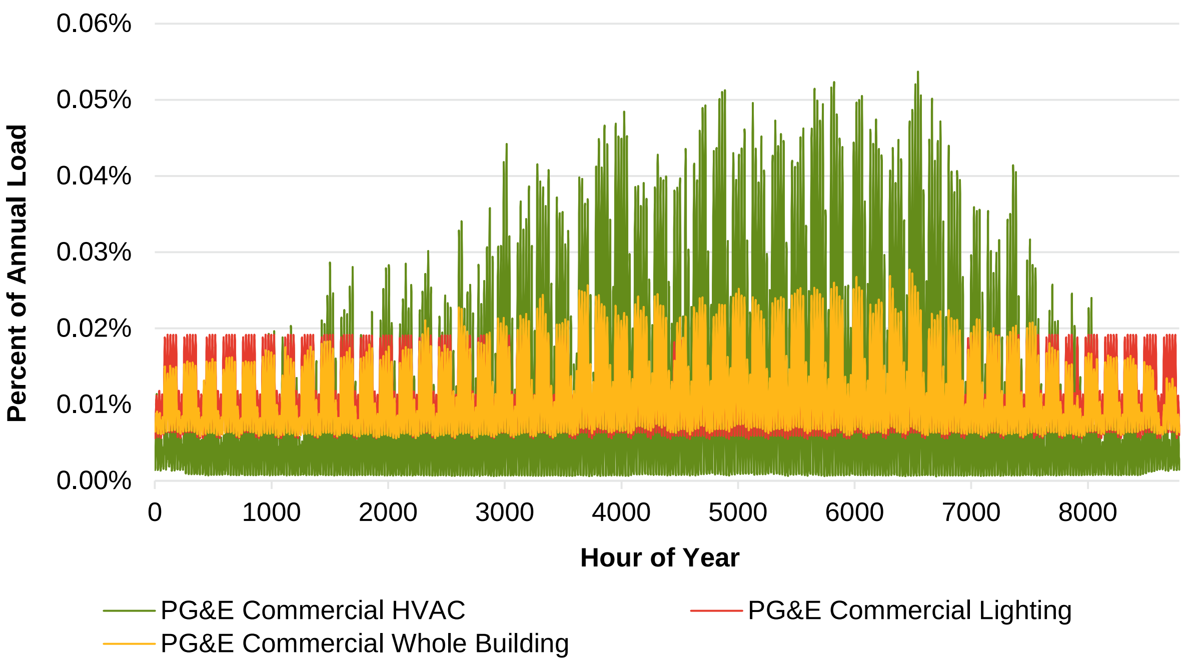
Figure 1 shows the named end use 8760 load shapes for the residential sector. In general, Navigant observed limited variance between weekdays and weekends for all the named end use load shapes in the residential sector. Navigant found that savings from HVAC measures have the highest impact on demand changes throughout the year, whereas lighting and Plug Loads (AppPlug) stay generally flat. This observation is especially important as it confirms that the same amount of annual energy savings for two different end uses have significantly peak grid impacts. Comparing HVAC to Plug Loads and lighting in this case reveals that the percent of annual energy savings attributable to the peak demand reduction would be significantly higher for HVAC. This is assuming that the system peak occurs during the summer.

Figure 1: PG&E 8760 Load Shapes for Named End-uses in the Residential Sector



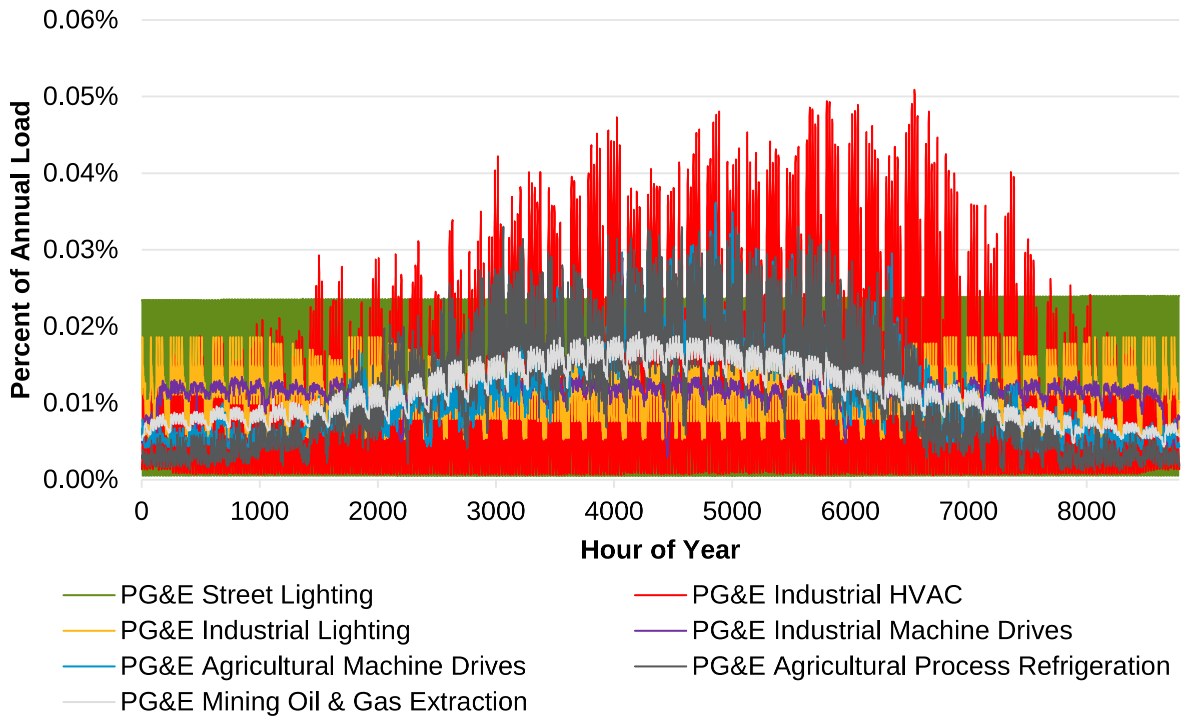
Navigant plotted a similar graph for PG&E's commercial sector, as shown in Figure 2. In general, Navigant observed some variance between weekdays and weekends for all the named end use load shapes in the commercial sector. Similar to the residential sector, the HVAC load shape significantly spikes during the summer. However, in commercial sector the effect of this spike during summer months seems to be relatively lower compared to residential sector. Comparing residential to commercial HVAC in this case reveals that the percent of annual energy savings attributable to the peak demand reduction would be significantly higher for residential HVAC, once again assuming that the system peak occurs during the summer.

Figure 2: PG&E 8760 Load Shapes for Named End-uses in the Commercial Sector



Navigant plotted the named end use load shapes for AIMS sectors, as shown in Figure 3. This figure shows more seasonally variable load shapes compared to the Residential and Commercial sectors. In general, savings for most AIMS end uses are incurred during the summer months. Exceptions to this are Industrial Lighting and Machine Drive profiles, which are generally flat, and the street lighting profile, which shows no seasonal difference.

Figure 3: PG&E 8760 Load Shapes for Named End-uses in the AIMS Sectors



4.3.2 Comparison of Peak-to-Energy Ratios

CEC staff processed load shape data to estimate peak demand savings for the AAEE scenarios. In processing this data, CEC staff noticed peak demand savings results from application of load shapes are generally lower than those reported by the PG study. This subsection discusses those discrepancies using an example utility (SCE). In CEC staff's analysis, SCE's peak is modeled to occur September 27, 2030 during the hour ending at 2pm.

CEC staff use peak to energy ratios (MW/GWh) from different results as a comparison. Table 8 below compares peak to energy ratios for SCE in 2030 under the Mid-Mid AAEE Scenario settings from three different calculations:

- PG Study (Total) – This includes all energy and demand savings extracted from the PG study that inform the IOU AAEE. Sources of savings are rebated equipment, C&S, BROs, and low-income programs.
- PG Study (Rebated Equipment Only) – This includes only energy and demands savings from rebated equipment in the PG study

- CEC Staff Load Shape Analysis – This is the peak-to-energy ratio that results from applying load shapes to the total energy savings from each sector and end use combination.

Table 8: Peak to Energy Ratio Results

Sector	End Use	PG Study (Total)	PG Study (Rebated Equipment Only)	CEC Staff Load Shape Analysis
Ag	MachDr	0.000	0.000	0.180
Ag	ProcRefrig	0.000	0.000	0.167
Ag	WholeBlg	0.195	0.195	0.180
Ag	Residual	0.253	-	0.180
Com	AppPlug	0.196	0.192	0.155
Com	ComRefrig	0.185	0.132	0.149
Com	HVAC	0.476	0.309	0.494
Com	Lighting	0.235	0.239	0.185
Com	WaterHeat	0.232	0.270	0.235
Com	WholeBlg	0.501	0.234	0.235
Com	Residual	0.158	-	0.235
Ind	Lighting	0.179	0.123	0.121
Ind	MachDr	0.086	0.063	0.108
Ind	WholeBlg	0.195	0.195	0.211
Ind	Residual	0.158	-	0.211
Min	OilGasExtract	0.114	0.114	0.119
Res	AppPlug	0.192	0.325	0.131
Res	HVAC	0.386	0.630	1.091
Res	Lighting	0.133	0.047	0.135
Res	WholeBlg	0.566	0.395	0.228
Res	WholeBlg - Behavior	0.191	-	0.228
Res	Residual	0.379	-	0.228
Stl	Stl	0.000	0.000	0.000
Total	**Total**	0.293	0.235	0.240

Table 8 shows the total peak-to-energy ratio from the load shape analysis is 0.240; this is lower than that extracted from the PG Study for all savings sources (0.293). The peak-to-energy for PG Study rebated measures (0.235) only is much closer to the results from the load shape analysis. This implies that peak-to-energy ratios for C&S savings (the dominant savings source other than rebated equipment) are higher in the PG Study than load shapes would predict. Navigant and CEC staff observed these same trends in the 2015 AAEE analysis. The following points shed further light on these issues:

- Demand savings for rebated equipment are largely based on DEER and IOU workpapers. These peak savings are calculated by taking the average of demand savings from a total of nine hours that consist of hours between 2pm-5pm during the peak demand day and the day before and the day after the peak demand day not including weekends or holidays.[13] CEC staff's analysis chose 2pm as the peak time in September which generally aligns with the DEER definition. Thus, we expect reasonable alignment between the PG study rebated measures and the results of the load shape analysis. However, in a future where the definition of system peak may be shifting later hours of the day (5-9 pm), the DEER definition may no longer be valid.

- C&S savings in AAEE are from those C&S that are not yet evaluated, many do not have CASE studies. Often the CEC and U.S. Department of Energy analysis focuses on energy savings rather than demand saving so most demand savings from C&S in AAEE are estimated by the PG Study relied upon. These estimates are likely using coincident peak to energy ratios but the sources are unknown. CEC staff has observed in the past that the PG model has higher peak to energy ratios for C&S compared to IOU programs. Load shape analysis to determine peak demand savings will provide a more accurate result.
- Savings from the Residential and Commercial Whole Building end use come predominantly from C&S. C&S peak-to-energy ratios for whole building are almost twice as high as the result that comes from load shapes. Thus, the PG Study shows overall a higher peak-to-energy for this end use.

Despite these discrepancies, Navigant suggests using the 8760 approach for determining peak savings as the results of the 8760 approach are more rigorous than the PG Model. It will furthermore allow the CEC to understand how peak demand savings will change in the future as the timing of the system peak moves to later in the day.

4.3.3 Additional Notes and Observations

Navigant notes the following caveats to these load profile analysis:

- Several load profiles sources from IOU published data needed to be cleaned as several data anomalies were observed:
    - The pumping load shape mapped to PG&E's Agricultural Machine Drive measures showed a linear increase in meter readings during the month of January. Navigant replaced this data with data from February. Navigant ensured that days between the months aligned, and renormalized the load shape.
    - Meter readings for PG&E's residential and commercial load dropped to zero on March 14th at 4AM. Navigant assumed this was the result of either an outage, logging software failure, or routine meter shutdown and replaced this data with data from 3AM on the same day before renormalizing the load shape.

---

[13] To determine the electric demand impacts of measures, DEER uses the average kWh reduction over a 9-hour window. The nine-hour window is from 2p.m. to 5 p.m. over a three-day "heat wave" that is determined for each climate zone. The three-day demand periods for the new (2009) weather data is chosen based on these criteria:

- occurs between June 1st and September 30th,
- does not include weekdays or holidays,
- has the highest value for
    - average temperature over the three-day period,
    - the average temperature from noon to 6 p.m. over the three-day period,
    - the peak temperature over the three-day period.

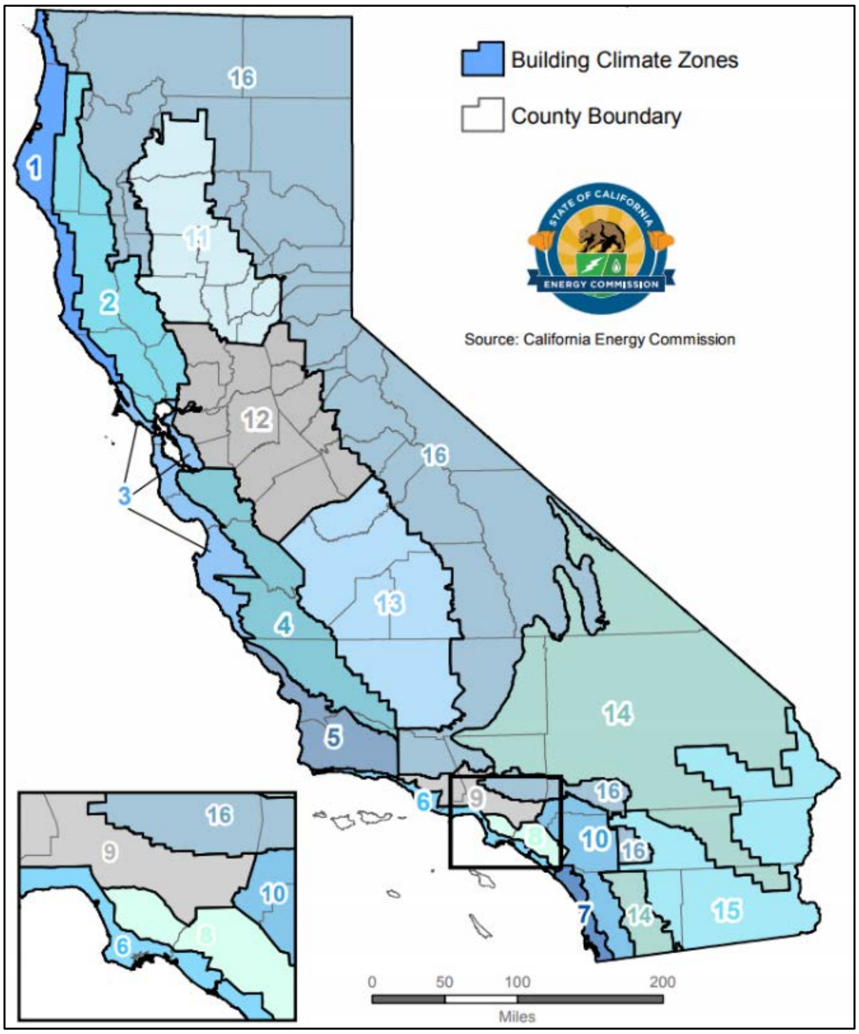
Source: Codes and Standards Update for the 2013-14 Cycle. DEER, 2014: http://deeresources.com/files/DEER2013codeUpdate/download/DEER2014UpdateDocumentation_2-12-2014.pdf

- The Industrial Machine Drive load shape was sourced from a Canadian utility. Navigant recognizes that holidays in the United States and Canada are different, but did not correct for this as the load shape is generally flat, which should not compromise the approximation of peak demand savings for this end use.
- For some measures (such as equipment controls) the actual load profile of savings can be different than that of the end-use or sector consumption. Such load shapes were unavailable for this analysis. Thus, the load profile for the end use or sector are used as an approximation.

5. LOCATIONAL POTENTIAL FOR AAEE

The 2018 PG Study reports savings at the IOU service territory level. For the purposes of supporting statewide locational planning, Navigant provided the CEC with factors to disaggregate IOU service territory savings into Building Climate Zones (illustrated below in Figure 4).[14] Building climate zones differ from the CEC's Forecasting Climate Zones used in IEPR.

Figure 4: California Building Climate Zones



Outputs varying by climate zone (CZ) are a function of key input data; building stock and unit energy savings (UES) are the key inputs in the 2018 PG Study that vary by CZ. CZ variation in building stock comes from the CEC's Demand Analysis office (further discussed in section 3.1.2 of the 2018 PG Study report[15]). CZ variation in unit energy savings comes from measure inputs from sources approved by the

[14] Navigant recognizes locational planning often entails more detailed granularity than Climate Zones. Based on scope of the PG Study, Climate Zones are the most detailed level of granularity the study produces.

[15] Navigant. *Energy Efficiency Potential and Goals Study for 2018 and Beyond- Final Public Report*. September 2017

CPUC (primarily DEER and IOU workpapers). Not all unit energy savings values vary by CZ as illustrated in Table 9.

Table 9. Climate Zone Variation for Unit Energy Savings

Sector	End Use	UES Varies by CZ
Commercial	AppPlug	Only for freezer and pool Cover
	BldgEnv	Yes
	ComRefrig	Yes
	Data Center	No
	FoodServ	No
	HVAC	Yes
	Lighting	No
	WaterHeat	Yes
Residential	AppPlug	Only for refrigerators/freezers and pool pumps
	BldgEnv	Yes
	HVAC	Yes
	Lighting	No
	WaterHeat	Yes
Agriculture	All	No
Industrial	All	No
Mining	All	No
Streetlighting	All	No

The 2018 PG Model was modified to conduct this analysis. The 2018 PG Model as published contains IOU-wide average savings values for all weather sensitive measures. These average savings values were calculated by weighting UES in each CZ by the building stock in each CZ. As a result, the IOU-wide average tends to represent the largest CZs by population. For the AAEE analysis, Navigant reimported measure input data at the climate zone level (prior to the weighted averaging exercise) to be able to run the model at the climate zone level instead of the aggregate IOU level.

Navigant ran the model for weather sensitive end uses (listed above in Table 9) for AAEE Scenario 3 to produce results that show the percent distribution of savings for each sector and end use combination across the CZs within an IOU territory. Savings disaggregation factors for non-weather sensitive measures simply match CZ building stock distributions. These disaggregation factors can be multiplied by the AAEE scenario results to approximate the potential in each climate zone within each IOU. Navigant provides one set of disaggregation factors that are applicable to all AAEE scenarios and all years of the forecast.

Disaggregation factors were provided in a spreadsheet to CEC staff for integration into forecasting and planning activities.

APPENDIX A. SUMMARY OF LOAD SHAPES – SCE AND SDG&E

Figure A-1: SCE 8760 Load Shapes for Named End-uses in the Residential Sector

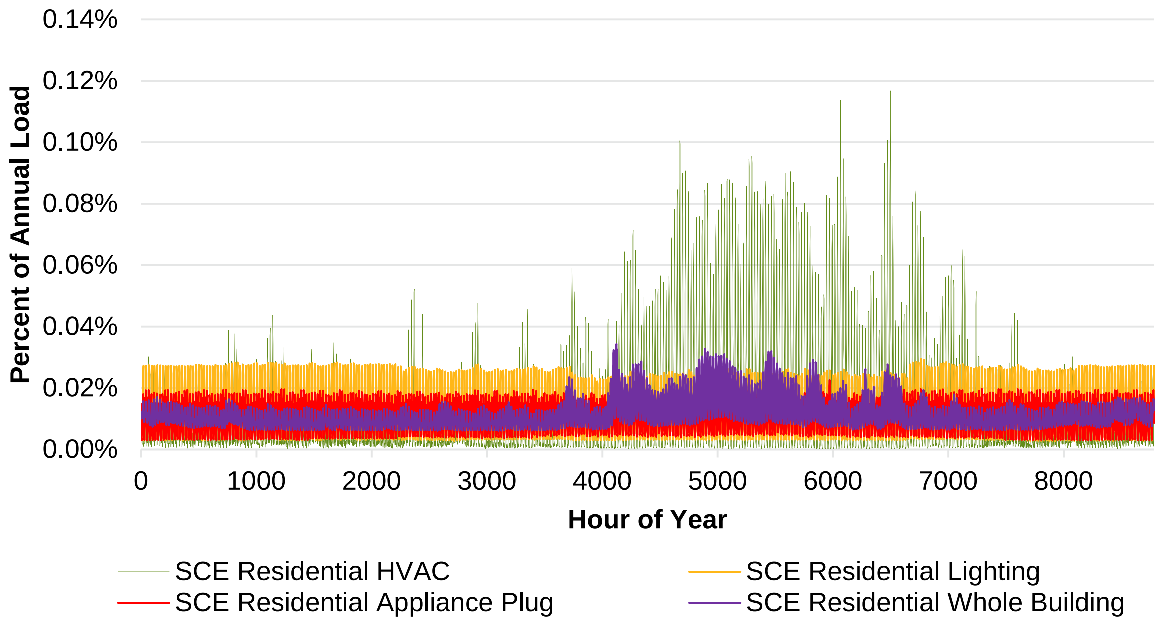


Figure A-2: SCE 8760 Load Shapes for Named End-uses in the Commercial Sector

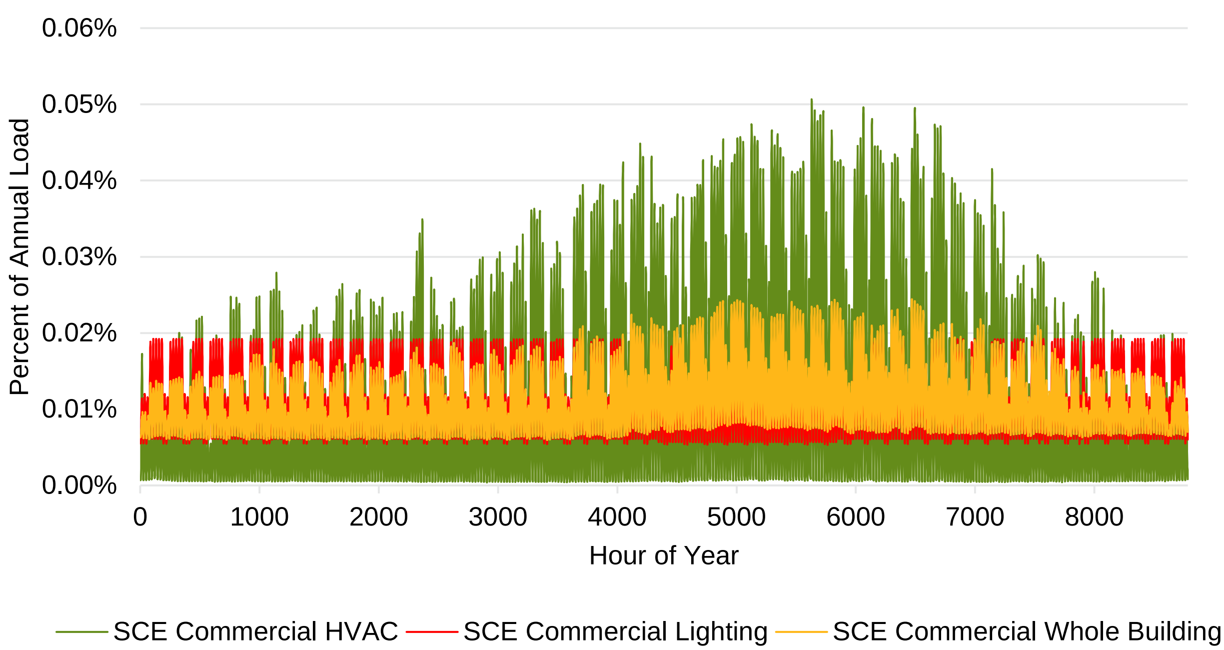


Figure A-3: SCE 8760 Load Shapes for Named End-uses in the AIMS Sectors

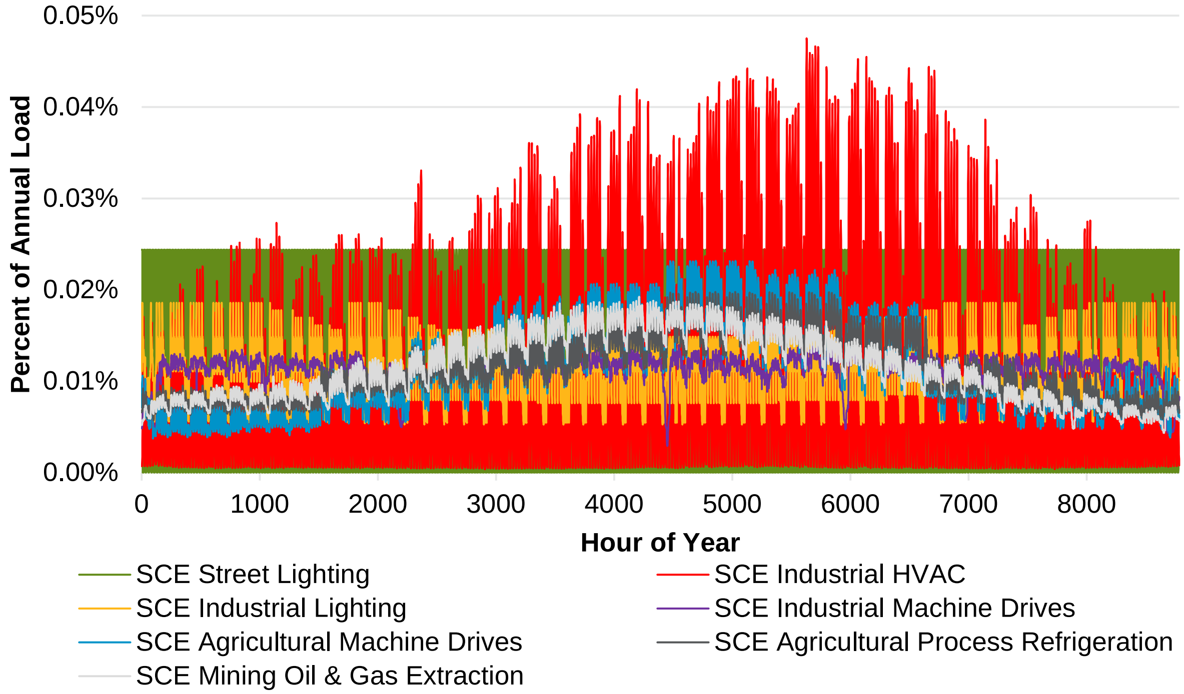


Figure A-4: SDG&E 8760 Load Shapes for Named End-uses in the Residential Sector

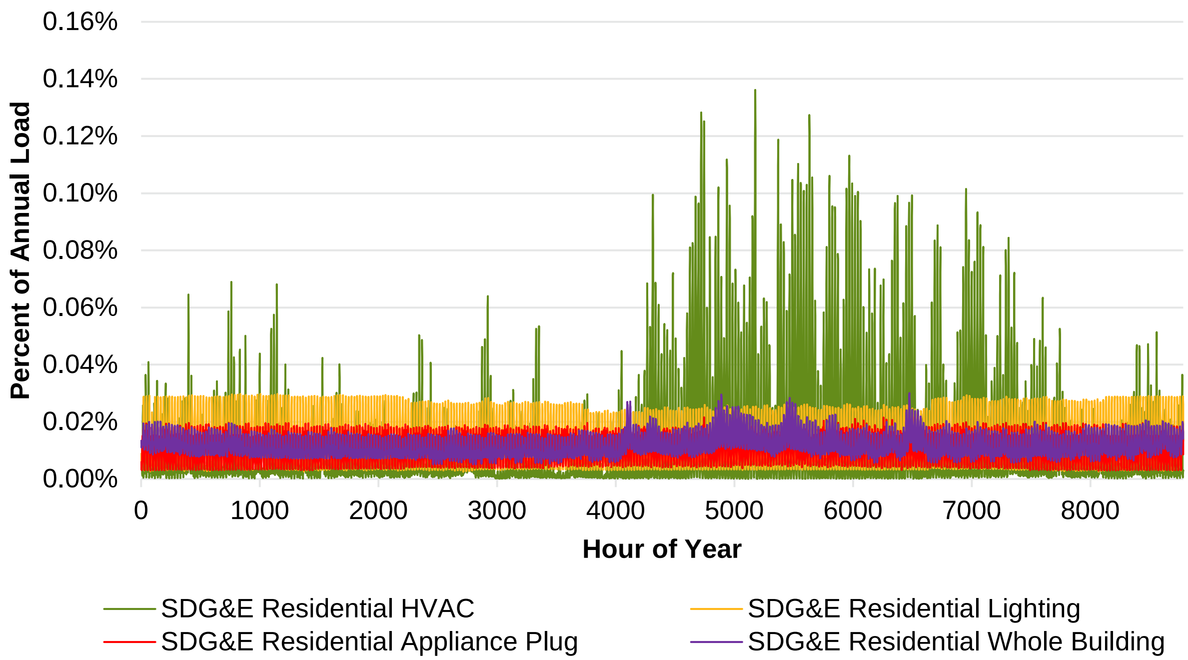


Figure A-5: SDG&E 8760 Load Shapes for Named End-uses in the Commercial Sector

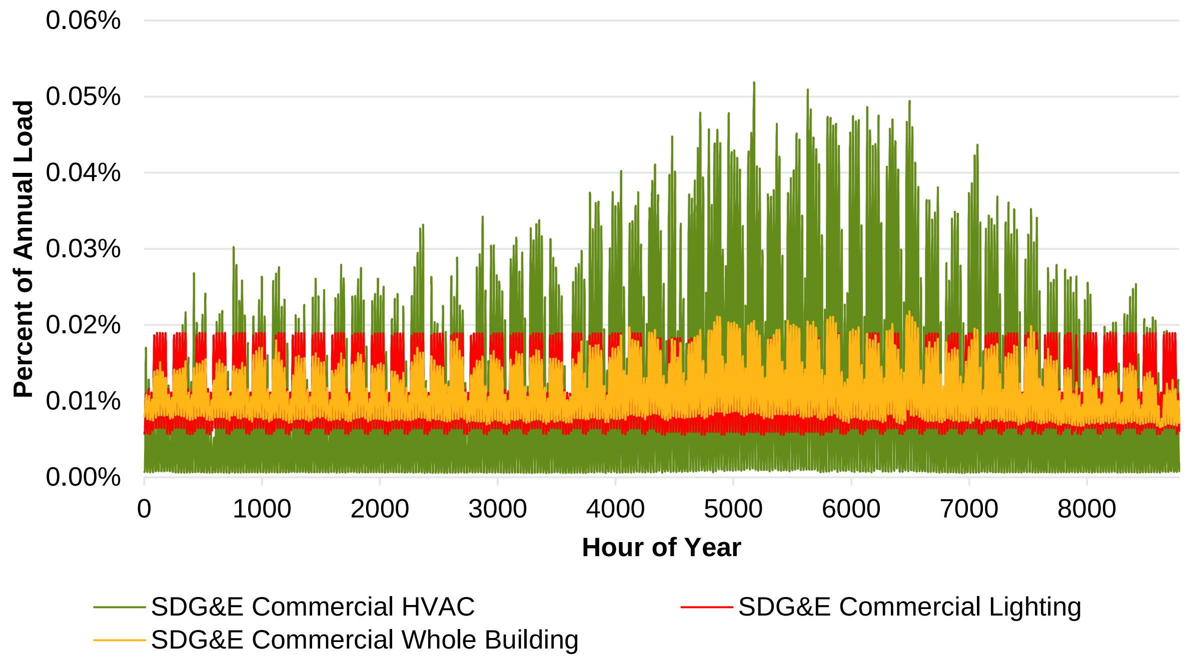


Figure A-6:SDG&E 8760 Load Shapes for Named End-uses in the AIMS Sectors