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# Arkansas Energy Efficiency Potential Study

## Final Report

**Prepared for:**

**Arkansas Public Service Commission**


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# Executive Summary

This executive summary provides a high-level overview of the work performed and the findings of the Arkansas Investor Owned Utility Energy Efficiency Potential Study developed by Navigant (Potential Study). More detailed discussions and results are included in the main body of the report.

## *ES.1 Introduction and Background*

Navigant was retained by the Arkansas Public Service Commission's (Commission) General Staff and the Investor-Owned Utilities (IOUs or utilities) in the State of Arkansas to develop an estimate of the potential for energy efficiency (EE) and demand response (DR) for the IOUs over the next ten years in Arkansas. The utilities, parties to EE proceedings before the Commission, and other interested individuals and organizations in Arkansas work together through a collaborative working group, referred to as the ***Parties Working Collaboratively*** (PWC). The PWC involves the seven IOUs (3 gas[1] and 4 electric[2]) operating in the state, Evaluation, Measurement & Verification (EM&V) contractors, program implementers, intervener parties, and other interested individuals or organizations. The ***Independent Evaluation Monitor*** (IEM) works with the PWC to identify issues regarding EE initiatives in Arkansas, with the goal of ultimately presenting such issues, along with recommendations, to the Commission for approval.

Navigant has worked with the PWC and IEM to develop information on current levels and patterns of energy use in Arkansas, characterize potential measures which could be implemented to increase EE in the state and develop an estimate of EE potential. The technical, economic and achievable potential for EE was modeled using Navigant's proprietary Demand Side Management Simulator (**DSMSim**™) model, while the potential for demand reductions was modeled using Navigant's Demand Response Simulator (**DRSim**™) model.

## *ES.2 Approach*

This section describes the overall approach to the Potential Study, including the approach to base case forecast, measure identification and characterization, and estimating technical, economic and achievable potential. The overall approach to the Potential Study is illustrated in Figure ES-1. In general, the Potential Study begins with a detailed assessment of Arkansas-specific data sources from the seven IOUs in the state. Those sources then are supplemented with primary field data collection complemented by secondary sources. The specific sectors (residential and C&I) and the various segments within those sectors are assessed, differences in the four climate zones with in the state are assessed from an EE measure perspective, and impacts are reviewed for both electric and gas measures as well as measures that result in savings for both fuels. All of this information is imported into the DSMSim™ model and

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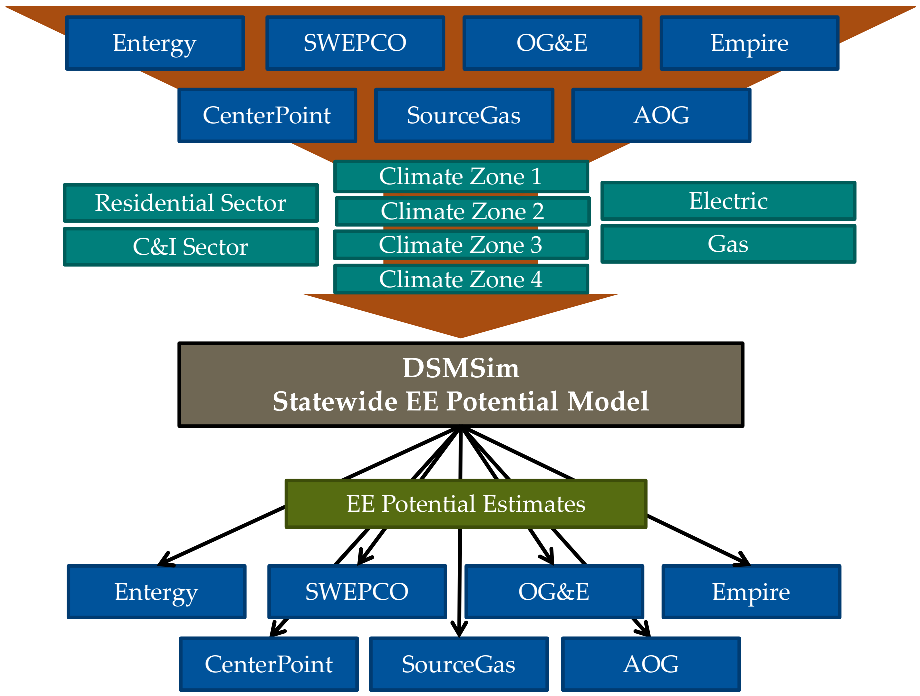
[1] CenterPoint Energy Arkansas Gas (CenterPoint); SourceGas Arkansas, Inc. (SourceGas); and Arkansas Oklahoma Gas Corporation (AOG).

[2] Entergy Arkansas, Inc. (Entergy); Southwestern Electric Power Company (SWEPCO); Oklahoma Gas and Electric (OG&E); and The Empire District Electric Company (Empire).

statewide estimates of EE potential are generated. Those estimates then are allocated across the seven IOUs in the state in order to represent EE potential estimates that are specific to each utility.

**Figure ES-1. Project Approach**




### ES.2.1 Data Sources

For this project, the PWC chose to include an enhanced data collection process that included a review of existing secondary data and primary data collection process to supplement those secondary sources. Navigant used Arkansas-specific data provided from the utilities wherever possible, supplementing that data with information available from neighboring and comparable jurisdictions and other sources such as the U.S. Energy Information Administration (EIA). This approach resulted in the use of primary data collection to supplement the available secondary data as required.

Table ES-1 lists some of the data required and the type of data Navigant used in characterizing the measures. In the table, existing Arkansas data refers to data provided to Navigant by the utilities, primary data refers to information that was collected through customer surveys, and secondary non-AR data refers to utility studies, previous baselines and potential studies in neighboring jurisdictions and other sources (as discussed above).

**Table ES-1. Characterization Data Required**

| Data Required for Measure & Market Characterization | Existing Arkansas Data Sources | Primary Data Collection | Secondary Non-Arkansas Data Sources |
|---|---|---|---|
| For Base and Efficiency Measures | | | |
| • Measure lifetime | ✓ | ✓ | ✓ |
| • Measure Costs | ✓ | | ✓ |
| • Energy Consumption (gas or electric) | ✓ | | ✓ |
| • Coincident Peak Demand (electric only) | ✓ | | ✓ |
| O&M Savings (if applicable) | | | ✓ |
| Measure Density (Base + EE measures) | ✓ | ✓ | ✓ |
| Technical Suitability (Ability to implement EE measure) | ✓ | ✓ | ✓ |
| Initial Saturation of Baseline Measures | ✓ | ✓ | ✓ |
| Customer Acceptance of EE Measures | ✓ | ✓ | ✓ |

For the primary data collection efforts, Navigant used a combination of surveys and interviews of end-use customers regarding electricity and natural gas markets in Arkansas. A survey process was employed to obtain primary information about equipment stocks, efficiency levels and decision-making processes. Surveys were set up to collect this information from up to 2,000 residential customers and 500 commercial and industrial (C&I) customers. The goal of this effort was to achieve confidence levels of 90 percent with a +/- 10 percent margin of error for each sector. The process was designed to obtain the highest possible level of confidence across utilities and customer segments. Another survey effort was initiated for up to 50 medium and large C&I customers to better understand their decision-making processes with regard to equipment replacement practices and their willingness to invest in EE products.

### ES.2.2 Base Case Forecast

Navigant obtained forecasts of electricity and natural gas demand from each of the utilities involved in the Potential Study. The utilities were requested to provide forecasts which excluded sales to customers who have opted out of utility EE programs and which did not include the effect of these programs on future energy sales. Navigant developed projections of residential building stocks and commercial floor area for the Potential Study period. The potential for EE was then modelled based on the resulting stocks and the changing proportion of new and existing buildings. Navigant did not develop an independent forecast of electricity and natural gas energy requirements.

### ES.2.3 Measure Identification and Characterization

The Commission has approved a Technical Reference Manual (TRM) which specifies how deemed savings for a number of EE measures are to be calculated in Arkansas. Navigant reviewed all of the measures included in the most recent version of the TRM (TRM Version 4.0) available at the time of the

Potential Study as well as a number of other measures identified as potentially applicable in Arkansas over the period of the Potential Study.

The review process resulted in a list of 48 residential and 65 commercial measures, which were summarized and presented to the PWC for review. These measures were then characterized for each segment where they could be applied. Weather sensitive measures were also characterized for each climate zone in the state.

### ES.2.4 Estimation of Potentials

For this resource assessment, Navigant employed its proprietary DSMSim™ potential model to estimate the technical, economic, and achievable potential for gas savings. DSMSim™ is a bottom-up technology diffusion and stock tracking model implemented using a System Dynamics[3] framework. The DSMSim model explicitly accounts for considerations impacting retrofit, replace-on-burnout and new construction measures. For each of the replacement types, technical, economic, and achievable potential was determined and is reported in aggregate by sector, customer segment and end use.

Technical potential is defined as the energy savings that can be achieved assuming that all installed measures can immediately be replaced with the efficient measure, wherever technically feasible, regardless of the cost, market acceptance, or whether a measure has failed (or "burned out") and is in need of being replaced. Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but limiting the calculation only to those measures that have passed the benefit-cost test chosen for measure screening, which in this case the Total Resource Cost (TRC) test. Achievable potential is a subset of economic potential, but further considers the likely rate of EE acquisition, which is driven by a number of factors including the rate of equipment turnover (a function of measure's lifetime), simulated incentive levels, budget constraints, consumer willingness to adopt efficient technologies, and the likely rate at which marketing activities can facilitate technology adoption.

All savings reported in this Potential Study are gross, rather than net, meaning that the effect of possible free ridership is not included in the reported savings[4]. Gross savings, rather than net, are included in this report for a number of reasons. First, there was a desire that the results of this report be compatible with different net-to-gross (NTG) assumptions in the future, permitting separate calculation of net results as NTG assumptions are updated. Second, there was a desire to be able to easily compare the results of this study with the prior Potential Study conducted by the American Council for an Energy Efficient Economy (ACEEE), which also reported only gross savings. Third, NTG assumptions can change with different assumptions regarding the program design, which is a scope that is outside of this Potential Study. We note that Navigant requested the utilities to provide forecasts of future sales which did not include anticipated reductions from demand-side management (DSM) programs, however, we expect that naturally occurring conservation or change in energy intensity are included in those forecasts.

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[3] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill. 2000 for detail on System Dynamics modelling. Also see http://en.wikipedia.org/wiki/System_dynamics for a high-level overview.

[4] For the natural gas utilities potential was not estimated for transportation volumes.

Navigant also conducted sensitivity analyses as part of this Potential Study, modelling the sensitivity of the achievable potential to different funding scenarios (i.e., high and low) and the inclusion of a carbon cost in the avoided cost calculations.

## *ES.3 Energy Efficiency Potential Findings*

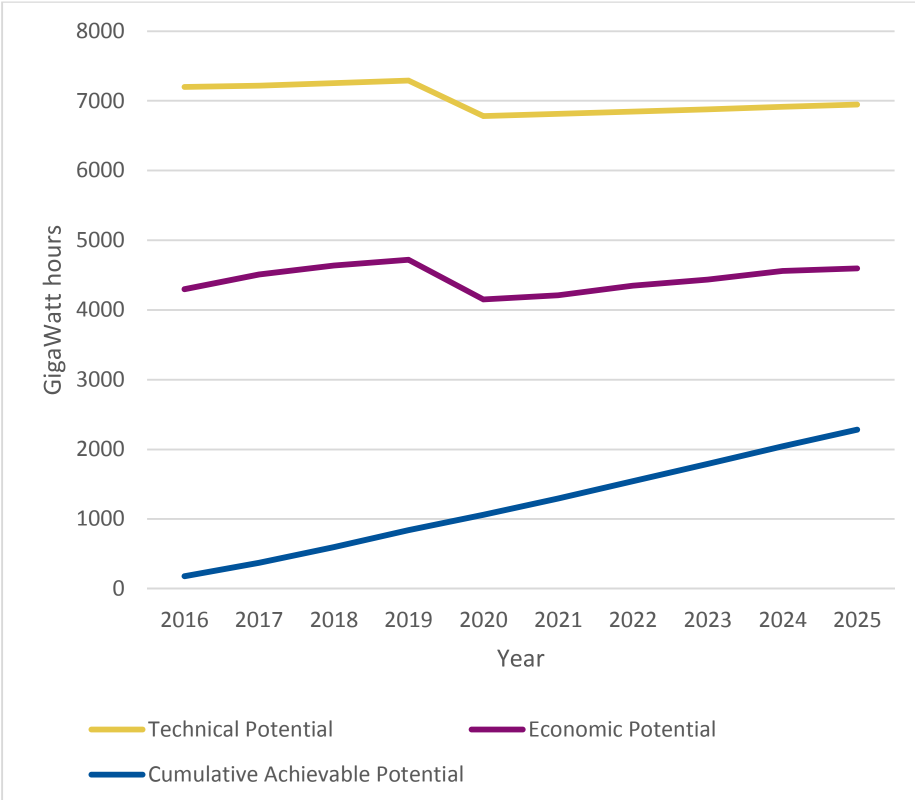
### ES.3.1 Summary of Potentials

Using the DSMSim™ model, Navigant found that 6,948 GWh of electricity and 104.5 million Therms of natural gas total technical savings potential will be available in the service territories of the seven IOUs by 2025, as shown in Figure ES-2 and Table ES-2 for electric potential and Figure ES-3 and Table ES-3 for gas potential. Roughly 66 percent of the electric technical potential and 62 percent of the gas technical potential was found to be economic, meaning that it met or exceeded a TRC ratio of 1.0 for all EE measures covering the residential and C&I sectors. Electric economic potential in 2025 is projected to be 4,594 GWh while gas economic potential in 2025 is projected to be 86.6 million Therms. Technical and economic potential are relatively flat over the time horizon, with growth driven by increases in forecast building stock and electricity consumption.

The achievable potential shown below (and in most figures throughout this report, except where budget scenarios are presented) is for the "mid funding" budget scenario. Since achievable potential factors in the rate of EE acquisition (technical and economic potential do not), forecast achievable potential grows over the 10-year forecast horizon, reaching 2,282 GWh of electricity savings and 41.7 million Therms of natural gas savings by 2025.[5]

[5] Note that the achievable savings reported in Figure ES-2 represent cumulative savings over the forecast horizon, which is the cumulative sum of each year's incremental savings. There are other sections of this report where incremental achievable savings are reported. When achievable savings are reported, there will be a clear indication as to whether those savings are cumulative or incremental.

**Figure ES-2. Electric EE Potential (GWh/year)**



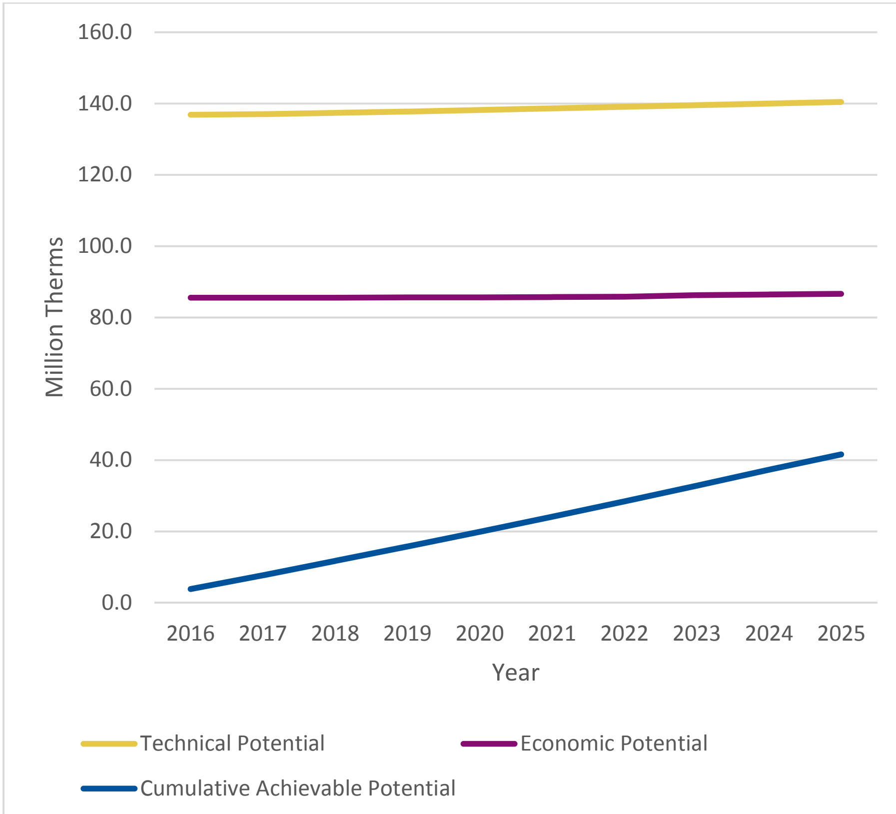

*Source: Navigant analysis, 2015*

**Table ES-2. Electric EE Potential (GWh/year)**

| Year | Technical | Economic | Cumulative Achievable | Incremental Annual Achievable |
|---|---|---|---|---|
| **2016** | 7,198 | 4,297 | 178 | 178 |
| **2017** | 7,220 | 4,510 | 373 | 195 |
| **2018** | 7,256 | 4,638 | 597 | 224 |
| **2019** | 7,292 | 4,719 | 839 | 242 |
| **2020** | 6,781 | 4,152 | 1,062 | 224 |
| **2021** | 6,812 | 4,212 | 1,296 | 233 |
| **2022** | 6,845 | 4,347 | 1,542 | 246 |
| **2023** | 6,879 | 4,434 | 1,792 | 251 |
| **2024** | 6,913 | 4,559 | 2,042 | 249 |
| **2025** | 6,948 | 4,594 | 2,282 | 240 |

*Source: Navigant analysis, 2015*

**Figure ES-3. Gas EE Potential (Million Therms/year)**




*Source: Navigant analysis, 2015*

**Table ES-3. Gas EE Potential (Million Therms/year)**

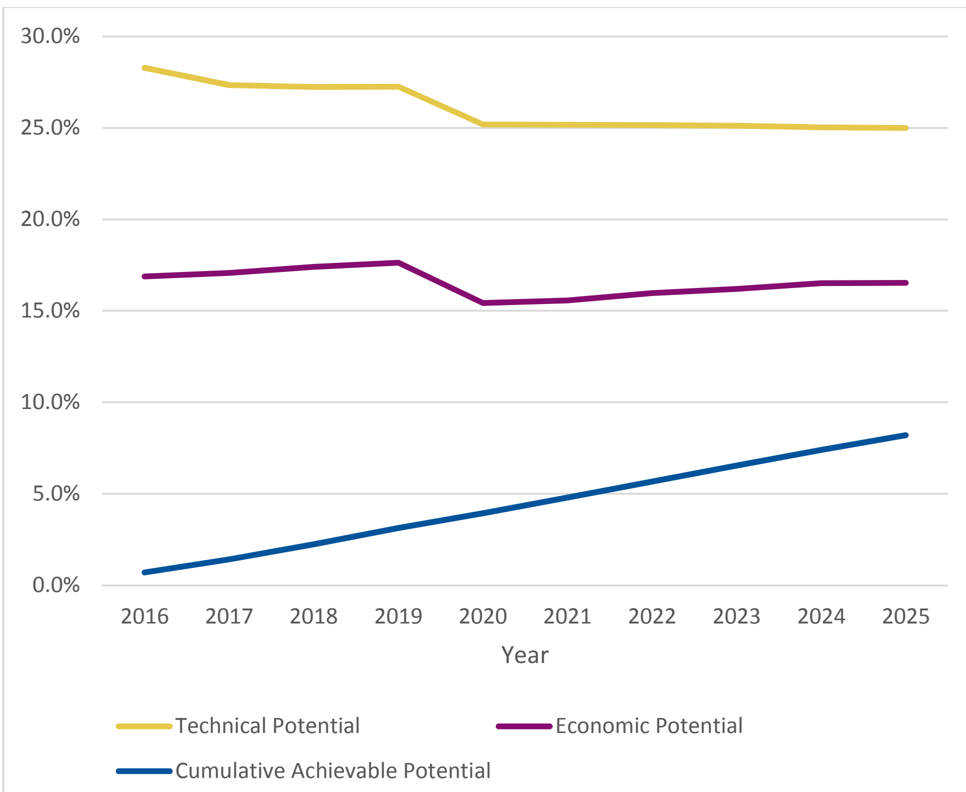
| Year | Technical | Economic | Cumulative Achievable | Incremental Annual Achievable |
|---|---|---|---|---|
| **2016** | 136.8 | 85.5 | 3.9 | 3.9 |
| **2017** | 137.0 | 85.5 | 7.8 | 3.9 |
| **2018** | 137.4 | 85.6 | 11.7 | 4.0 |
| **2019** | 137.8 | 85.6 | 15.8 | 4.0 |
| **2020** | 138.2 | 85.7 | 19.9 | 4.1 |
| **2021** | 138.6 | 85.8 | 24.1 | 4.2 |
| **2022** | 139.0 | 85.8 | 28.5 | 4.3 |
| **2023** | 139.5 | 86.2 | 32.9 | 4.4 |
| **2024** | 140.0 | 86.5 | 37.3 | 4.4 |
| **2025** | 140.5 | 86.6 | 41.7 | 4.4 |

*Source: Navigant analysis, 2015*

### ES.3.2 Potential as a Percentage of Sales

Figure ES-4 and Table ES-4 shows technical, economic, and achievable potential as a percentage of forecast electric sales. Figure ES-5 and Table ES-5 shows technical, economic and achievable potential as a percentage of the forecast gas sales. Cumulative electric achievable potential, which accounts for the rate of EE acquisition, grows to 8.2 percent of forecast electric sales net of self-direct customers in 2025, or 0.8 percent/year on average over the 10-year study horizon, under the Mid Funding achievable potential scenario. For gas, the cumulative achievable potential grows to 7.2 percent of forecast gas sales net of self-direct customers in 2025, or 0.7 percent/year on average over the 10-year study horizon. This degree of achievable potential is consistent with Navigant's observations of savings levels in other jurisdictions it has studied, providing a degree of confidence that the results are reasonable. As is shown later in the report, higher savings are ultimately achievable with higher budget assumptions.

**Figure ES-4. Electric Potential as a Percent of Electric Sales**



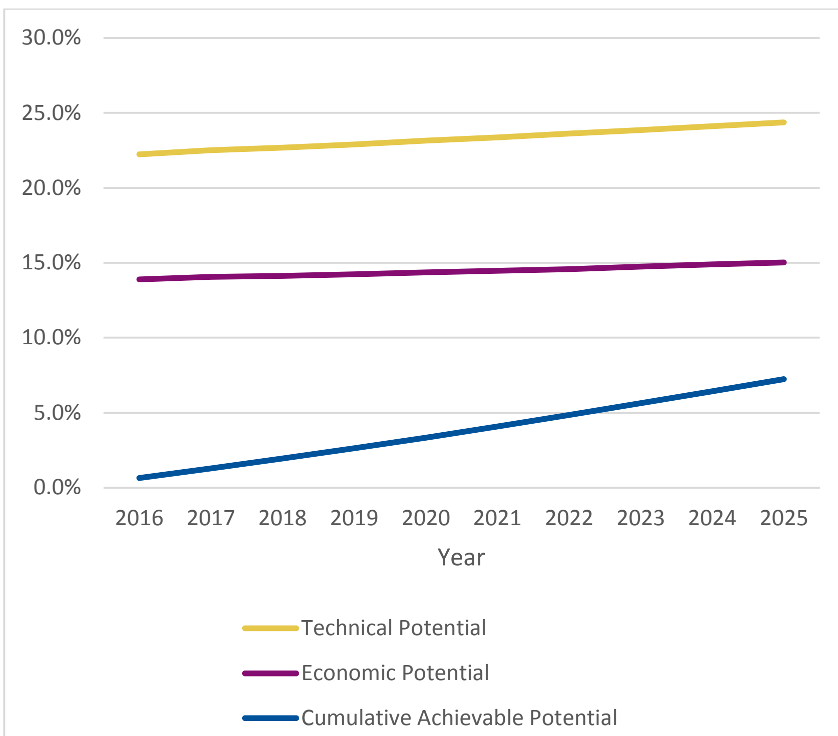

*Source: Navigant analysis, 2015*

**Table ES-4. Electric Potential as a Percent of Electric Sales***

| Year | Technical (Net) | Economic (Net) | Incremental Achievable (Net) | Incremental Achievable (Gross) | Cumulative Achievable (Net) | Cumulative Achievable (Gross) |
|---|---|---|---|---|---|---|
| **2016** | 28.3% | 16.9% | 0.70% | 0.66% | 0.7% | 0.6% |
| **2017** | 27.3% | 17.1% | 0.71% | 0.67% | 1.4% | 1.3% |
| **2018** | 27.2% | 17.4% | 0.83% | 0.78% | 2.2% | 2.1% |
| **2019** | 27.2% | 17.6% | 0.89% | 0.84% | 3.1% | 3.0% |
| **2020** | 25.2% | 15.4% | 0.81% | 0.77% | 3.9% | 3.7% |
| **2021** | 25.2% | 15.6% | 0.84% | 0.80% | 4.8% | 4.5% |
| **2022** | 25.1% | 16.0% | 0.88% | 0.83% | 5.7% | 5.3% |
| **2023** | 25.1% | 16.2% | 0.88% | 0.83% | 6.5% | 6.2% |
| **2024** | 25.0% | 16.5% | 0.85% | 0.80% | 7.4% | 7.0% |
| **2025** | 25.0% | 16.5% | 0.82% | 0.77% | 8.2% | 7.7% |

** Net represents sales net of self-direct customers. Gross represents total sales inclusive of all customers, including self-directs.*
*Source: Navigant analysis, 2015*

**Figure ES-5. Gas Potential as a Percent of Gas Sales**




*Source: Navigant analysis, 2014*

**Table ES-5. Gas Potential as a Percent of Gas Sales***

| Year | Technical (Net) | Economic (Net) | Incremental Achievable (Net) | Incremental Achievable (Gross) | Cumulative Achievable (Net) | Cumulative Achievable (Gross) |
|---|---|---|---|---|---|---|
| **2016** | 22.2% | 13.9% | 0.63% | 0.37% | 0.6% | 0.4% |
| **2017** | 22.5% | 14.1% | 0.65% | 0.51% | 1.3% | 1.0% |
| **2018** | 22.7% | 14.1% | 0.66% | 0.52% | 1.9% | 1.5% |
| **2019** | 22.9% | 14.2% | 0.69% | 0.54% | 2.6% | 2.1% |
| **2020** | 23.1% | 14.3% | 0.71% | 0.57% | 3.3% | 2.7% |
| **2021** | 23.4% | 14.5% | 0.74% | 0.59% | 4.1% | 3.2% |
| **2022** | 23.6% | 14.6% | 0.76% | 0.61% | 4.8% | 3.9% |
| **2023** | 23.9% | 14.7% | 0.79% | 0.63% | 5.6% | 4.5% |
| **2024** | 24.1% | 14.9% | 0.80% | 0.64% | 6.4% | 5.2% |
| **2025** | 24.4% | 15.0% | 0.81% | 0.65% | 7.2% | 5.8% |

** Net represents sales net of self-direct customers. Gross represents total sales inclusive of all customers, including self-directs.*
*Source: Navigant analysis, 2015*

### ES.3.3 Achievable Potential by IOU

Table ES-6 summarizes the electric incremental achievable potential under the medium funding scenario by year over the Potential Study time horizon. As can be seen from the table, the bulk of the savings potential is expected to come from Entergy. This is an expected outcome since Entergy sells more than three-quarters of the total IOU electricity in the state.

Table ES-7 summarizes the gas incremental achievable potential under the medium funding scenario by year over the Potential Study time horizon. As can be seen from the table, the bulk of the savings potential is expected to come from CenterPoint. This is an expected outcome since CenterPoint sells more than half of the total IOU gas in the state.

**Table ES-6. Electric Incremental Achievable Potential by IOU, Mid Funding Scenario (GWh)**

| Year | Entergy | SWEPCO | OG&E | Empire | Electric Savings by Gas Utilities* | Total |
|---|---|---|---|---|---|---|
| **2016** | 126.4 | 25.9 | 16.7 | 0.7 | 8.4 | 178.1 |
| **2017** | 140.9 | 26.6 | 17.3 | 0.7 | 9.4 | 195.0 |
| **2018** | 163.7 | 29.9 | 19.0 | 0.8 | 10.4 | 223.7 |
| **2019** | 177.3 | 31.9 | 20.4 | 0.9 | 11.3 | 241.8 |
| **2020** | 161.6 | 29.7 | 19.0 | 1.0 | 12.2 | 223.6 |
| **2021** | 168.4 | 30.8 | 20.2 | 1.0 | 13.0 | 233.5 |
| **2022** | 178.4 | 31.8 | 20.9 | 1.1 | 13.8 | 245.9 |
| **2023** | 180.4 | 33.4 | 21.5 | 1.1 | 14.6 | 250.9 |
| **2024** | 178.5 | 33.2 | 21.6 | 1.1 | 15.0 | 249.3 |
| **2025** | 171.9 | 31.6 | 20.7 | 1.0 | 15.1 | 240.4 |

** These are the savings attributable to gas EE measures that result in electrical savings.*
*Source: Navigant analysis, 2015*

**Table ES-7. Gas Incremental Achievable Potential by IOU, Mid Funding Scenario (Million Therms)**

| Year | CenterPoint | SourceGas | AOG | Gas Savings by Electric Utilities* | Total |
|---|---|---|---|---|---|
| **2016** | 2.4 | 1.3 | 0.1 | 0.0 | 3.9 |
| **2017** | 2.4 | 1.3 | 0.2 | 0.0 | 3.9 |
| **2018** | 2.4 | 1.4 | 0.2 | 0.0 | 4.0 |
| **2019** | 2.4 | 1.4 | 0.2 | 0.0 | 4.0 |
| **2020** | 2.5 | 1.5 | 0.2 | 0.0 | 4.1 |
| **2021** | 2.5 | 1.5 | 0.2 | 0.0 | 4.2 |
| **2022** | 2.5 | 1.5 | 0.2 | 0.0 | 4.3 |
| **2023** | 2.6 | 1.6 | 0.3 | 0.0 | 4.4 |
| **2024** | 2.6 | 1.6 | 0.3 | 0.0 | 4.4 |
| **2025** | 2.6 | 1.6 | 0.3 | 0.0 | 4.4 |

** Note that the gas savings attributable to electric EE measures were minimal.*
*Source: Navigant analysis, 2015*

### ES.3.4 Achievable Potential Funding

Navigant developed estimates of EE program funding needed to support the various levels of achievable potential to be obtained during the study period. Table ES-8 presents the estimated funding levels for incentives, program administration and total for electric and gas under the mid-funding scenario. These estimates were simulated through the DSMSim™ model. The incentive budgets were simulated based on the measures that make up the achievable potential estimates. Incentive values grow over time due changes in the mix of EE measures and cost inflation. The administration budgets are based on historical expenditures for administration reported by the utilities. Administration values grow over time due to cost inflation.

**Table ES-8. Estimated EE Program Funding, Mid Funding Scenario**

| Year | Electric | | | Gas | | | Total Funding |
|---|---|---|---|---|---|---|---|
| | Incentive | Administration | Total | Incentive | Administration | Total | |
| **2016** | $26.8 | $28.8 | $55.6 | $4.4 | $5.5 | $10.0 | $65.6 |
| **2017** | $32.8 | $29.4 | $62.2 | $4.7 | $5.6 | $10.3 | $72.5 |
| **2018** | $41.1 | $30.0 | $71.1 | $5.0 | $5.7 | $10.8 | $81.9 |
| **2019** | $44.5 | $30.6 | $75.0 | $5.4 | $5.9 | $11.3 | $86.3 |
| **2020** | $46.8 | $31.2 | $78.0 | $5.8 | $6.0 | $11.8 | $89.8 |
| **2021** | $49.4 | $31.8 | $81.3 | $6.1 | $6.1 | $12.2 | $93.5 |
| **2022** | $56.2 | $32.5 | $88.7 | $6.4 | $6.2 | $12.6 | $101.3 |
| **2023** | $59.3 | $33.1 | $92.4 | $6.7 | $6.3 | $13.1 | $105.5 |
| **2024** | $60.9 | $33.8 | $94.7 | $6.9 | $6.5 | $13.4 | $108.1 |
| **2025** | $62.1 | $34.5 | $96.5 | $7.1 | $6.6 | $13.7 | $110.3 |

*Source: Navigant analysis, 2015*

As can be seen from the table, the total simulated funding that corresponds with the mid-funding achievable potential scenario is $65.6 in 2016, growing to over $110 million by 2025. Nearly 85% of the funding is attributable to electric EE program efforts.

### ES.3.5 Achievable Potential Scenarios

In addition to modelling the base case scenario, Navigant also modelled achievable potential and costs for two other budget scenarios – High and Low. Increasing adoption of efficient technologies can be accomplished in a number of different ways. Often, potential studies simply increase the assumed level of incentives in conducting these sensitivity analyses. While this is certainly one way of increasing adoption, it is not the only way, and relying solely on increased incentives will tend to result in costly increases in achieved potential. Since Navigant's technology diffusion model includes other parameters beyond simple economics (e.g., marketing effectiveness), it has the ability to simulate increases in program participation from more aggressive program marketing as well. In this sensitivity analysis, Navigant increased both the assumed "marketing effectiveness" parameter of the diffusion logic in conjunction with an increase in incentives to provide a more realistic representation of the likely cost required to achieve increased savings.[6] Table ES-9 shows the electric achievable potential, the percent reduction, and the annual budget in 2016 and 2025 for the three alternative scenarios analyzed in this Potential Study: High-Funding, Low-Funding and Carbon Cost. Table ES-10 shows the comparable information for the gas achievable potential.

**Table ES-9. Electric Achievable Potential and Budget by Scenario**

| Year | Incremental Achievable Savings (GWh) | Percent of Electric Sales Net of Self-Direct | Percent of Gross Electric Sales | Electric Annual Budget (Million $) |
|---|---|---|---|---|
| **High Funding Scenario** | | | | |
| **2016** | 225 | 0.88% | 0.81% | $82.7 |
| **2017** | 253 | 0.93% | 0.90% | $94.3 |
| **2018** | 290 | 1.07% | 1.01% | $107.3 |
| **2019** | 313 | 1.16% | 1.09% | $113.7 |
| **2025** | 265 | 0.89% | 0.84% | $130.0 |
| **Low Funding Scenario** | | | | |
| **2016** | 128 | 0.50% | 0.46% | $33.6 |
| **2017** | 136 | 0.50% | 0.48% | $36.3 |
| **2018** | 157 | 0.58% | 0.55% | $40.2 |
| **2019** | 172 | 0.64% | 0.60% | $42.4 |
| **2025** | 203 | 0.69% | 0.65% | $54.5 |
| **Carbon Cost Scenario** | | | | |
| **2016** | 216 | 0.85% | 0.78% | $74.1 |
| **2017** | 227 | 0.83% | 0.81% | $76.8 |
| **2018** | 248 | 0.92% | 0.86% | $81.2 |
| **2019** | 267 | 0.99% | 0.93% | $85.8 |
| **2025** | 268 | 0.91% | 0.86% | $108.4 |

*Source: Navigant analysis, 2015*

As Table ES-9 shows, under the High Funding scenario, electric achievable potential is estimated to be 225 GWh in 2016, rising to 265 GWh in 2025. This represents a 26 percent increase in the 2016 electric savings relative to the estimated achievable potential of 178 GWh under the Mid Funding scenario.

[6] More specifically, Navigant first increased the estimated marketing effectiveness parameter by 100%, up to a maximum of 0.06, a value deemed to be on the high end of the realistic values for this parameter (the 75th percentile of this parameter is 0.055 across many technologies --See Mahajan, V., Muller, E., and Wind, Y. (2000). New Product Diffusion Models. Springer. Chapter 12). At the same time, Navigant increased the "threshold incentive value" for each sector by a multiplicative factor (up to 2X the base case value) until the output budgets spanned the desired range.

Under the Low Funding scenario, electric achievable potential is estimated to be 128 GWh in 2016, rising to 268 GWh in 2025. This represents a nearly 30 percent decrease in the 2016 savings relative to the estimated achievable potential of 178 GWh under the Mid Funding scenario. The table also reports on the percent savings relative to electric sales, and indicates the corresponding changes in those values for both the High and Low Funding scenarios. The corresponding electric budget for the High Funding scenario would be $82.7 million, which represents a 26 percent increase relative to the $65.6 million budget under the Mid Funding scenario. For the Low Funding scenario, the electric budget would be $33.6 million, which represents a nearly 50 percent decrease relative to the $65.6 million budget under the Mid Funding scenario. Finally, Table ES-9 shows that electric achievable potential under the carbon scenario is estimated to be 216 GWh in 2016, rising to 268 GWh in 2025. This represents a 21 percent increase in electric savings relative to the Mid Funding scenario for 2016. The corresponding budget under the carbon scenario would be $74.1 million.

**Table ES-10. Gas Achievable Potential and Budget by Scenario**

| Year | Incremental Achievable Savings (Million Therms) | Percent of Gas Sales Net of Self-Direct | Percent of Gross Gas Sales | Gas Annual Budget (Million $) |
|---|---|---|---|---|
| **High Funding Scenario** | | | | |
| **2016** | 5.53 | 0.90% | 0.52% | $18.7 |
| **2017** | 5.77 | 0.96% | 0.94% | $20.1 |
| **2018** | 6.02 | 1.00% | 0.80% | $21.6 |
| **2019** | 6.23 | 1.05% | 0.84% | $22.9 |
| **2025** | 5.08 | 0.95% | 0.78% | $23.7 |
| **Low Funding Scenario** | | | | |
| **2016** | 3.30 | 0.54% | 0.31% | $6.9 |
| **2017** | 3.31 | 0.55% | 0.54% | $7.3 |
| **2018** | 3.36 | 0.56% | 0.45% | $7.7 |
| **2019** | 3.45 | 0.58% | 0.47% | $8.1 |
| **2025** | 4.00 | 0.74% | 0.60% | $10.7 |
| **Carbon Cost Scenario** | | | | |
| **2016** | 4.15 | 0.68% | 0.39% | $11.6 |
| **2017** | 4.20 | 0.70% | 0.69% | $12.0 |
| **2018** | 4.28 | 0.71% | 0.57% | $12.6 |
| **2019** | 4.39 | 0.74% | 0.59% | $13.3 |
| **2025** | 4.79 | 0.88% | 0.72% | $16.1 |

*Source: Navigant analysis, 2015*

As Table ES-10 shows, under the High Funding scenario, gas achievable potential is estimated to be 5.5 Million Therms in 2016, and 5.1 Million Therms in 2025. This represents a 31 percent increase in the 2016 savings relative to the estimated gas achievable potential of 3.9 Million Therms under the Mid Funding scenario. Under the Low Funding scenario, achievable potential is estimated to be 3.3 Million Therms in 2016, rising to 4 Million Therms in 2025. This represents a 15 percent decrease in the 2016 gas savings relative to the estimated achievable potential of 3.9 Million Therms under the Mid Funding scenario. The table also reports on the percent savings relative to gas sales, and indicates the corresponding changes in those values for both the High and Low Funding scenarios. The corresponding budget for the High Funding scenario would be $18.7 million, which represents a significant increase in funding relative to the $10 million gas budget under the Mid Funding scenario. For the Low Funding scenario, the gas budget would be $6.9 million, which represents a 31 percent decrease relative to the $65.6 million budget under the Mid Funding scenario. Finally, Table ES-10 shows that gas achievable potential under the carbon scenario is estimated to be 4.15 Million Therms in 2016, rising to 4.79 Million Therms in 2025. This represents a 6 percent increase in gas savings relative to the Mid Funding scenario for 2016. The corresponding budget under the carbon scenario would be $11.6 million.

## *ES.4 Demand Response Potential Findings*

In this report, Navigant provides comprehensive DR potential estimates for each of the four electric IOUs. Navigant conducted the analysis using its DRSim™ model[7], which it has developed over several years and used in a number of DR potential estimation engagements. Data to support the Potential Study was taken from a combination of the results from the EE potential study data collection efforts, state-level work published by the Federal Energy Regulatory Commission (FERC) in its *National Assessment of Demand Response Potential*,[8] Navigant's in-house expertise assessing DR potential for other similar utilities, and a limited review of secondary resources.

Using the DRSim™ model, Navigant assessed the following DR resource types: direct load control for residential and small commercial customers, Auto-DR, manual DR curtailment for C&I customers and DR using distributed generation resources. The model is designed to identify the critical component variables of peak demand impact, realistic and maximum achievable customer participation,[9] participant costs (e.g., value of service lost), technology costs, administrative costs, and incentive costs. DRSim™ also calculates the benefit-cost ratios for each of the various programs and utilities automatically as part of its output, including the TRC benefit-cost tests.

Figure ES-6 shows the results of the Potential Study for both the maximum and realistic achievable potential scenarios. Navigant estimates that just under 900MW and approximately 600MW are achievable by 2025 for the maximum and realistic scenarios, respectively.

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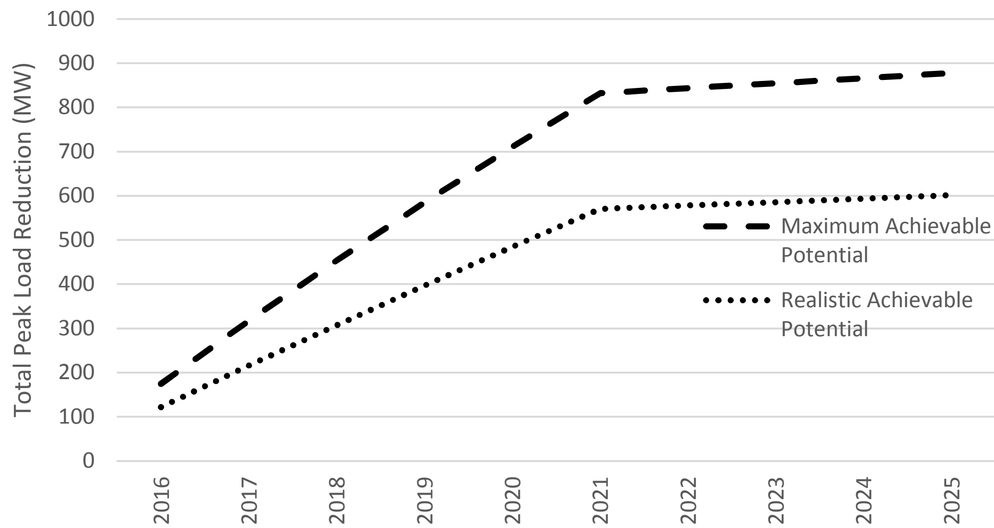
[7] This model is based on the Analytica™ modeling platform, which is used extensively by Navigant.

[8] FERC, *A National Assessment of Demand Response Potential*. Prepared by The Brattle Group, June 2009.

[9] Realistic achievable potential represents the level of demand reduction assuming there are budget constraints set by the implementing entity as a result of regulatory or policy limits. The maximum achievable represents the upper-boundary of the peak demand reduction that could be achieved if there were no budget constraints and all customer barriers to participation were eliminated.

**Figure ES-6. Total Peak Load Reduction Potential by Scenario for the Electric Utilities**




## *ES.5 Caveats and Limitations*

There are several caveats and limitations associated with the results of this Potential Study, which are outlined in more detail in Section 1.2 of the report.

# 1 Introduction

This section provides an overview of the Potential Study, including background and study goals, a discussion of the report's organization and key caveats and limitations of the Potential Study.

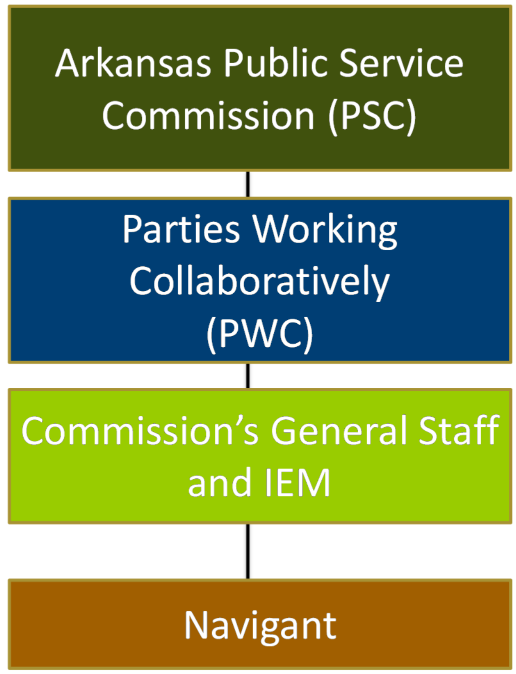
## 1.1 *Context and Study Goals*

Navigant was retained by the Commission's General Staff and the IOUs in the State of Arkansas to develop an estimate of the potential for EE and DR for the IOUs over the next ten years in Arkansas. The utilities, parties to Commission EE proceedings, and other interested individuals and organizations in Arkansas work together through a collaborative working group, referred to as the PWC. The PWC involves the seven investor-owned gas and electric utilities operating in the state, EM&V contractors, program implementers, intervener parties to Commission EE proceedings, and other interested individuals and organizations. The IEM works with the PWC to identify issues regarding EE initiatives in Arkansas, with the goal of ultimately presenting such issues, along with recommendations, to the Commission for approval. Figure 1-1 indicates the reporting relationships were in place for this project.

Navigant has worked with the PWC and IEM to develop information on current levels and patterns of energy use in Arkansas, characterize potential measures which could be implemented to increase EE in the state and develop an estimate of EE potential. The technical, economic and achievable potential for EE was modeled using Navigant's proprietary **DSMSim**™ model, while the potential for demand reductions was modeled using Navigant's **DRSim**™ model.[10]

[10] Each model was presented to the PWC in a webinar on April 7, 2015. Appendix A contains materials that were presented at the webinar.

**Figure 1-1. Reporting Relationships**




The resulting Potential Study will assist the Commission in setting future targets for EE in Arkansas. The primary research goal is to "*Inform the Commission of reasonable and appropriate, bottom-up, achievable, cost-effective energy efficiency savings targets*." The PWC will use the Study to inform the Commission of reasonable and appropriate bottom-up achievable, cost effective EE savings targets. The study will also inform the development of future program planning, implementation and independent evaluation of the EE programs.

The objective of the Potential Study is to estimate the EE and DR potential for the electricity and gas customers served by the seven IOUs in Arkansas. The estimate of EE potential is limited to the customers of these utilities who have not "opted out" of the EE programs offered by the utilities.[11] The scope includes the identification of appropriate EE and demand reduction measures, the collection of primary data to inform the characterization of those measures, and modelling of both EE and DR potential. Table 1-1 summarizes the various elements of the project scope.

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[11] Under Arkansas statutes and the Commission's Rules for Conservation and Energy Efficiency Programs, large customers may choose to "opt out" of EE programs. These customers do not to pay the Energy Efficiency Cost Recovery rider and are not eligible to participate in utility EE programs.

**Table 1-1. Summary of Project Scope**

| Element | Dimensions |
|---|---|
| Forms of Energy | Electricity<br>Natural Gas |
| Type of Potential | Technical, Economic & Achievable<br>Energy & Demand Response |
| Sectors | Residential<br>Commercial<br>Industrial |
| Weather Zone | 4 Climate zones<br>*(from 2,672 to 3,726 Heating Degree Days)* |
| Time Horizon | Year 2016 to 2025 |
| Utilities | <u>Electric</u><br>Entergy, SWEPCO, OG&E, Empire<br><u>Natural Gas</u><br>CenterPoint, SourceGas, AOG |

Navigant developed a Project Plan that outlined the planned approach to conducting the Potential Study which it reviewed with the PWC. The Project Plan included the elements described as Core elements in Navigant's initial proposal as well as optional elements selected by the PWC.

This report is organized as follows:

» Chapter 2 describes the approach to developing a base case projection of stocks and energy consumption, primary data collection efforts, and measure identification and characterization.

» Chapter 3 describes the approach taken to analyzing the technical potential for EE measures, including a summary of results by sector, segment, end use and measure.

» Chapter 4 describes the approach taken to analyzing the economic potential for EE measures, including a summary of results by sector, segment, end use and measure.

» Chapter 5 discusses the approach taken to analyzing the achievable potential for EE measures, including a summary of results by sector, segment, end use and measure. Results of the Potential Study for achievable potential, including sensitivity analyses on achievable potential under different budget and other assumptions are also presented in this chapter.

» Chapter 6 describes the approach to estimating the achievable potential for DR initiatives and presents the results of that analysis.

» The report also includes a number of Appendices, which provide additional information on:
   A. Overview of DSMSim™ and DRSim Models™
   B. Residential Survey Results
   C. C&I Survey Results
   D. Medium/Large C&I Interview Results
   E. Measure Characterization Data
   F. DR Potential Model Inputs and Detailed Results

## 1.2 Caveats and Limitations

There are several caveats and limitations associated with the results of this study, as detailed below.

The first is to note that while the report refers to the potential for EE in Arkansas as a shorthand the Potential Study actually estimates the EE potential for the seven IOUs operating in the state. Each IOU actively participates with the PWC. The utility participants in the PWC serve the majority of Arkansas customers, but do not serve all regions of the state. In addition, not all of the customers served by the utilities are included in the potential analysis.

Large customers have the option of "opting out" of utility EE programs. Most large industrial customers in Arkansas have chosen to opt-out of the EE programs offered by the utilities; this is referred to as the Self-Direct option. The study does not include the EE potential associated with loads of these opt-out customers.

### 1.2.1 Forecasting Limitations

Navigant obtained forecasts from the seven participating utilities of their future energy sales excluding the impacts of DSM programs and opt-out customers. Each of these forecasts contains a number of assumptions and may use different methodologies. Navigant used these utility forecasts as the basis for developing stock projections and did not develop independent forecasts for each utility for the modeled period.

EE potential studies must make assumptions about the adoption of technologies that inevitably come with a degree of uncertainty. While techniques such as use of payback acceptance curves and technology diffusion models are considered to provide reasonable aggregate estimates of savings potential, such techniques (which must be applied to dozens or in some cases hundreds of EE measures) are limited in their ability to accurately predict adoption for specific measures or in specific customer segments. Model calibration steps (e.g., comparing forecast results with achieved results) seek to ground the forecasts in the real world, but inaccuracies are bound to exist the further one drills into any particular technology or segment, even if the aggregate results are considered to be reasonable. One reason that aggregate results can in many cases be more reliable than individual technology or segment results is that forecasting inaccuracies, at the measure-level will exhibit a pooling effect when aggregated up to the portfolio (whereby positive or negative differences at a finer level of aggregation can help to offset each other in an aggregate result). While more in-depth technology adoption techniques do exist (e.g., discrete choice analysis) to improve the forecast accuracy for any given technology, application of these techniques to the quantity of measures analyzed in studies such as this are not typically warranted considering the dramatic increase in costs one would have to incur to calibrate a different adoption model for every single measure.

### 1.2.2 Program Design

The results of this study provide a big picture view of the likely potential for savings for the utilities in Arkansas. However, this Potential Study is not intended to provide, nor does it have information on detailed program design. Different program designs and delivery mechanisms would inevitably result in different levels of adoption of efficient technologies, which also means that the output of this study is by no means a prediction of what will occur, but rather an estimate of what could be achieved under the specific set of assumptions outlined in this study. Program design is typically a separate activity and is outside the scope of this study.

### 1.2.3 Measure Characterization

Efficiency potential studies employ a variety of different primary data collection techniques (e.g., customer surveys, on-site equipment saturation studies, etc.), which can enhance the accuracy of the results, though with an associated cost and time requirements. The scope of this study included some data collection through telephone surveys but also relied on a number of secondary data sources (e.g., the Arkansas TRM, studies from other jurisdictions, etc.) for estimates of measure savings, costs and market presence (e.g., saturations and densities). Primary, Arkansas-specific data was used wherever possible. Where Arkansas-specific data was not available the best available data was used. Details of secondary data sources relied upon are provided in Chapter 2.

Furthermore, we note that while we consider the measure list used in this study to appropriately focus on those technologies likely to have a material impact on savings potential over the Potential Study horizon, there is always the possibility that emerging technologies may arise that could increase savings opportunities over the forecast horizon. In addition, broader societal changes may impact levels of energy use in ways not anticipated in the Potential Study.

### 1.2.4 Measure Interactions

EE measures in this study are modelled independently. As a result, the total EE potential may be different from actual potential, depending on the extent to which multiple measures are implemented by the same customer. Interaction effects most commonly occur when multiple measures are implemented affecting the same end use; however, they may also occur between end uses. An example of the first type of interaction (within an end use) would occur if a customer implements a program to review and maintain steam traps and also installs a more efficient boiler. To the extent that the steam trap program reduces heating requirements at the boiler, the savings from installing a more efficient boiler would be reduced. Interactions between end uses would be expected to occur if a homeowner purchased a top-loading washing machine or low-flow showerhead and also installed a more efficient water heater. The reduction in water heating demand would result in lower savings from the new water heater. Interactions may both decrease and increase savings depending on circumstances. For instance, if a homeowner installed a tankless water heater and also installed a more efficient furnace, the reduction in internal heat gain from eliminating the water heater tank would be provided more efficiently by the new, more efficient furnace.

Navigant has accounted for interactive effects by employing the following methods:

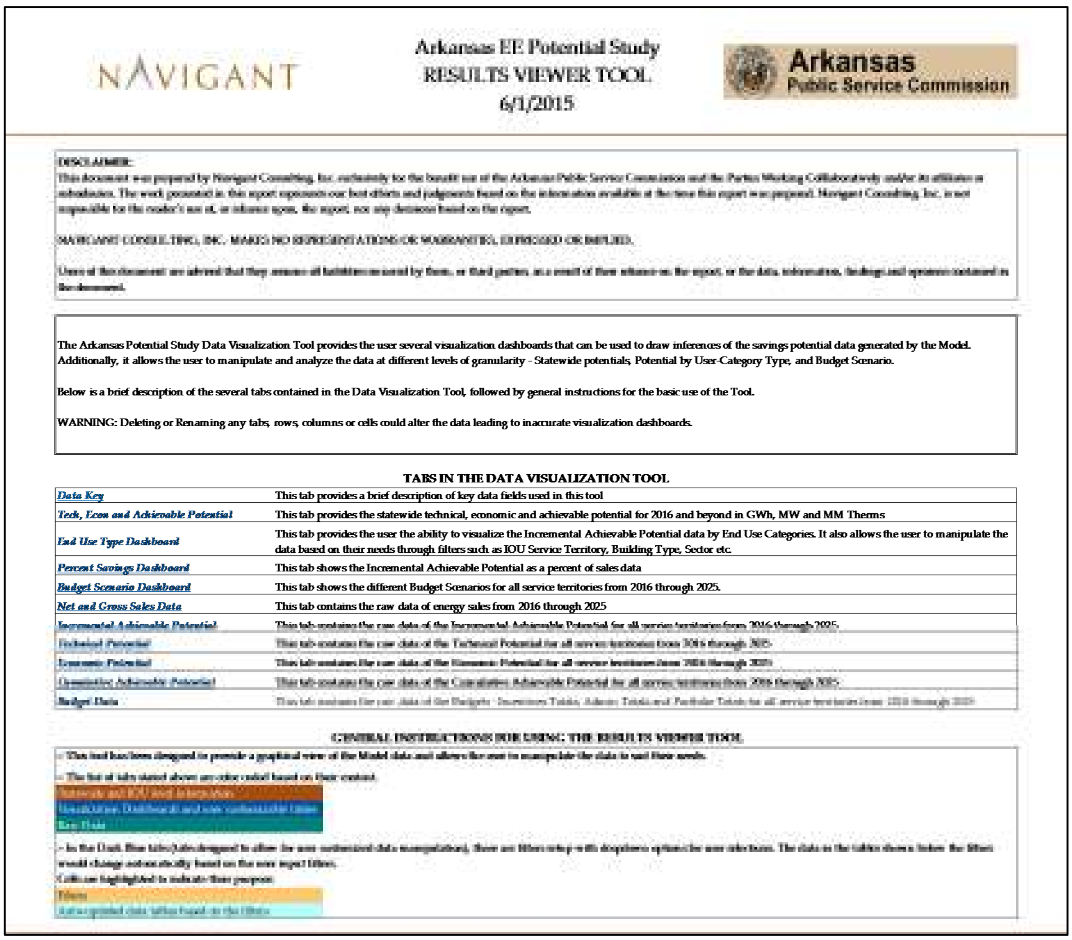
» Where measures clearly compete for the same retrofit application, we have created competition groups to ensure we do not double-count potential savings;

» For measures where we recognized that there could be significant interactions (e.g., industrial process/boilers), we adjusted applicability percentages to reflect some degree of interaction between measures.

### 1.2.5 Interpreting Results

The detailed results presented in this report are aggregated up the statewide level. Detailed estimates at the utility level were not presented in this report due to the sheer volume of information. However, these details are available for review and assessment. Navigant has created an interactive excel tool that summarizes the outputs for each EE potential scenario that was assessed as part of this Potential Study. Along with this final report which summarizes results aggregated to the statewide level, this downloadable excel tool, the 2015 Arkansas EE Potential Study Results Viewer Tool (Results Viewer), provides access to all detailed results from the DSMSim™ model. The Results Viewer provides the ability to manipulate and visualize model outputs from the high-level statewide standpoint all the way down to the granular IOU-specific sector, segment, end-use and measure level. The Results Viewer is structured with multiple tabs to view summary results as well as detailed model outputs, as seen in Figure 1-2.

**Figure 1-2. Results Viewer Main Page**



NAVIGANT

Arkansas EE Potential Study
RESULTS VIEWER TOOL
6/1/2015

Arkansas Public Service Commission

The Arkansas Potential Study Data Visualization Tool provides the user several visualization dashboards that can be used to draw inferences of the savings potential data generated by the Model. Additionally, it allows the user to manipulate and analyze the data at different levels of granularity - Statewide potentials, Potential by User-Category Type, and Budget Scenario.

Below is a brief description of the several tabs contained in the Data Visualization Tool, followed by general instructions for the basic use of the Tool.

WARNING: Deleting or Renaming any tabs, rows, columns or cells could alter the data leading to inaccurate visualization dashboards.

TABS IN THE DATA VISUALIZATION TOOL

| | |
|---|---|
| *Data Key* | This tab provides a brief description of key data fields used in this tool |
| *Tech, Econ and Achievable Potential* | This tab provides the statewide technical, economic and achievable potential for 2016 and beyond in GWh, MW and MM Therms |
| *End Use Type Dashboard* | This tab provides the user the ability to visualize the Incremental Achievable Potential data by End Use Categories. It also allows the user to manipulate the data based on their needs through filters such as IOU Service Territory, Building Type, Sector etc. |
| *Percent Savings Dashboard* | This tab shows the Incremental Achievable Potential as a percent of sales data |
| *Budget Scenario Dashboard* | This tab shows the different Budget Scenarios for all service territories from 2016 through 2025. |
| *Net and Gross Sales Data* | This tab contains the raw data of energy sales from 2016 through 2025 |

# 2 Base Case Forecast

The following section describes the approach taken by Navigant in developing a base case forecast of electricity and natural gas sales over the Potential Study period, including the segmentation of sales by customer segment, the approach to collecting primary and secondary data, as well as the approach to characterizing the EE measures used in the analysis. The discussion provides a description of the information available regarding electricity and natural gas use for each sector and how this information was used in characterizing both the measures and the markets in order to estimate the potential for improved EE.

## 2.1 *Approach to Forecasting Base Case*

To estimate the EE potential within Arkansas, Navigant requested energy and customer forecasts from each of the utilities. Utilities were requested to provide their forecasts excluding sales to opt-out customers and without the impact of EE programs. The base case developed by Navigant included projections of housing and commercial building stocks based on the utility's forecasts.

Navigant divided electricity and natural gas customers into "segments" with similar patterns of energy use and efficiency opportunities. In each sector (residential, commercial, and industrial) new construction savings opportunities were modelled as a function of forecast new building stock and gas sales in each segment. Table 2-1 shows the segmentation used for the Potential Study:

» Navigant divided residential customers into three segments, based on the type of structure (single family, multi-family and manufactured homes).

» The commercial sector was divided into 13 segments, with the office segments further broken into small and large offices and the retail segment split between food and non-food retail. Industrial customers were included in the commercial sector as most large industrial customers have opted out of the utility's efficiency programs.

**Table 2-1. Customer Segments by Sector[12]**

| Residential | Commercial / Industrial |
|---|---|
| Single Family | Colleges/Universities |
| Multi-Family | Healthcare |
| Manufactured Home | Lodging |
| | Office-Large |
| | Office-Small |
| | Restaurants |
| | Retail (Non-Food) |
| | Retail - Food |
| | Schools |
| | Warehouses |

[12] These segments are only comprised of customers that have not opted out of the Arkansas EE programs.

| Residential | Commercial / Industrial |
|---|---|
| | Other Commercial |
| | Industrial |
| | Agriculture |

*Source: Navigant*

Energy use within each customer segment was also divided by end-use as shown in Table 2-2. End use allocations for gas and electricity were developed for each segment.

**Table 2-2. End Uses by Sector**

| Residential | Commercial / Industrial |
|---|---|
| Appliances | Compressed Air |
| Electronics | Cooking |
| Hot Water | Fans |
| Space Heating | Hot Water |
| Space Cooling | Lighting |
| Ventilation | Motors and Drives |
| Lighting | Office Equipment |
| Other | Other |
| | Pumps |
| | Process Heat |
| | Space Cooling |
| | Space Heating |
| | Ventilation |

### 2.1.1 Base Case Forecast

To estimate the potential for EE over the next decade, Navigant developed projections of residential building stocks, and C&I floor area for the Potential Study period. The potential for EE was then modelled based on the resulting stocks and the changing proportion of new and existing buildings. Navigant used the long term sales forecasts provided by the utilities (net of opt out customers) as well as other information to develop stock projections that matched with the utilities' expectations. Figure 2-1 provides the electricity forecast combined for the four electric IOUs in the state. Figure 2-2 provides the gas forecast combined for the three gas IOUs in the state.

Figure 2-1. Electricity Forecast – Combined for All Utilities

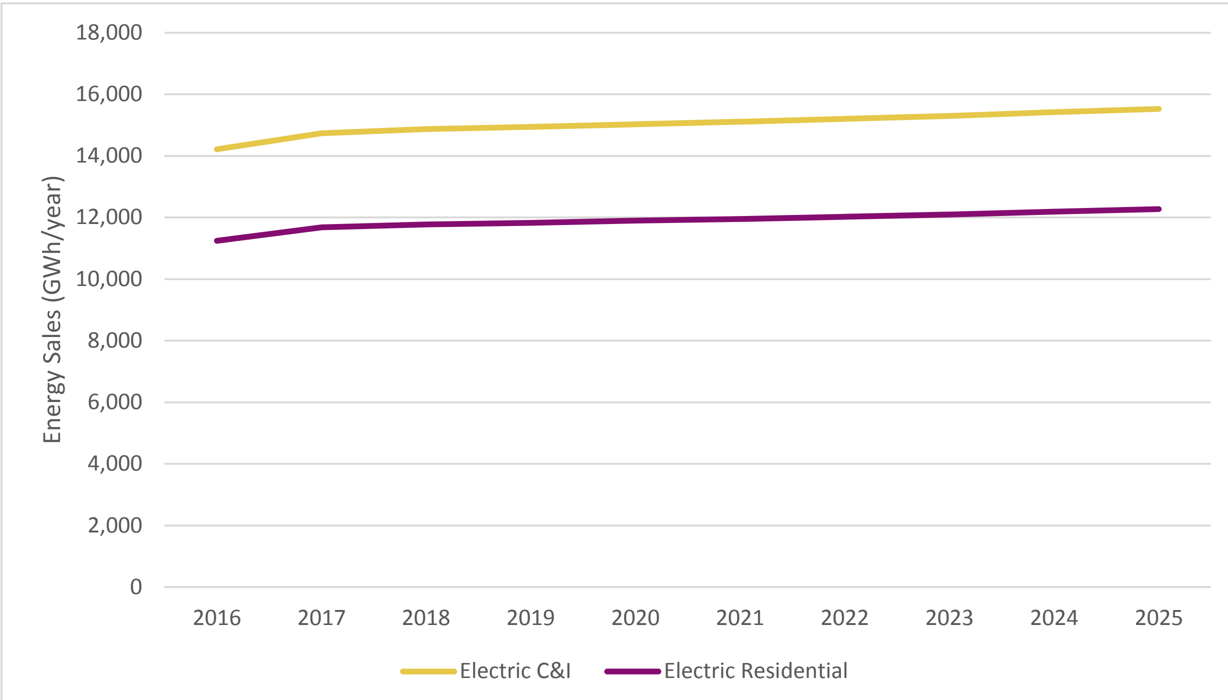
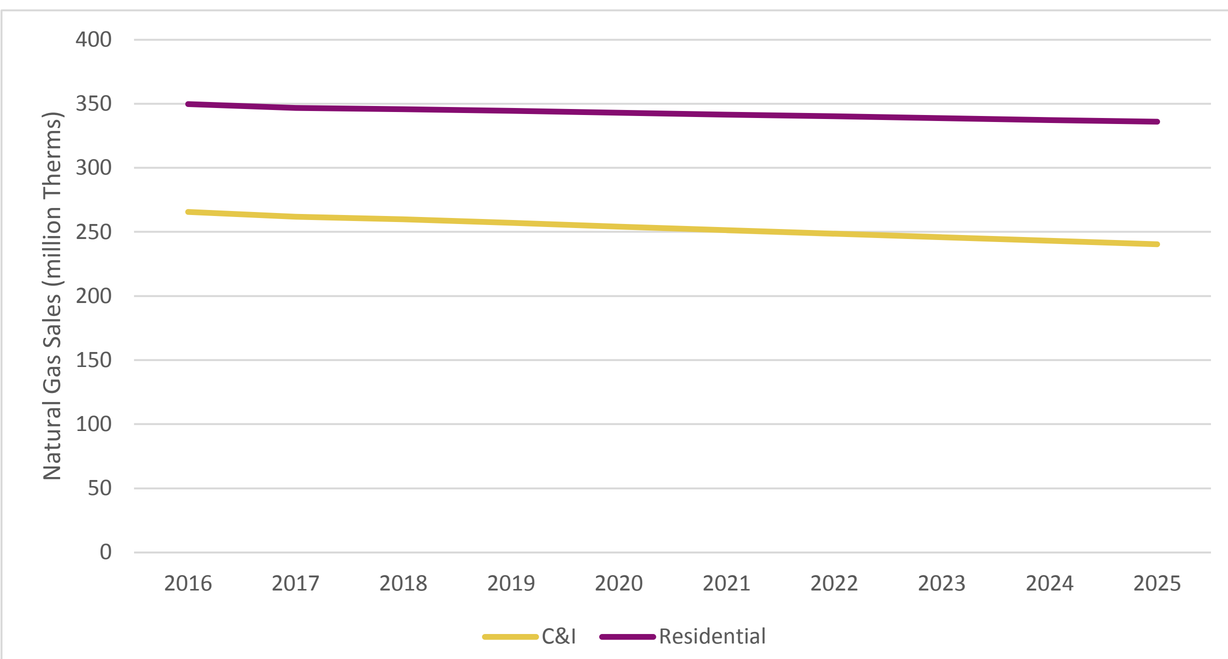


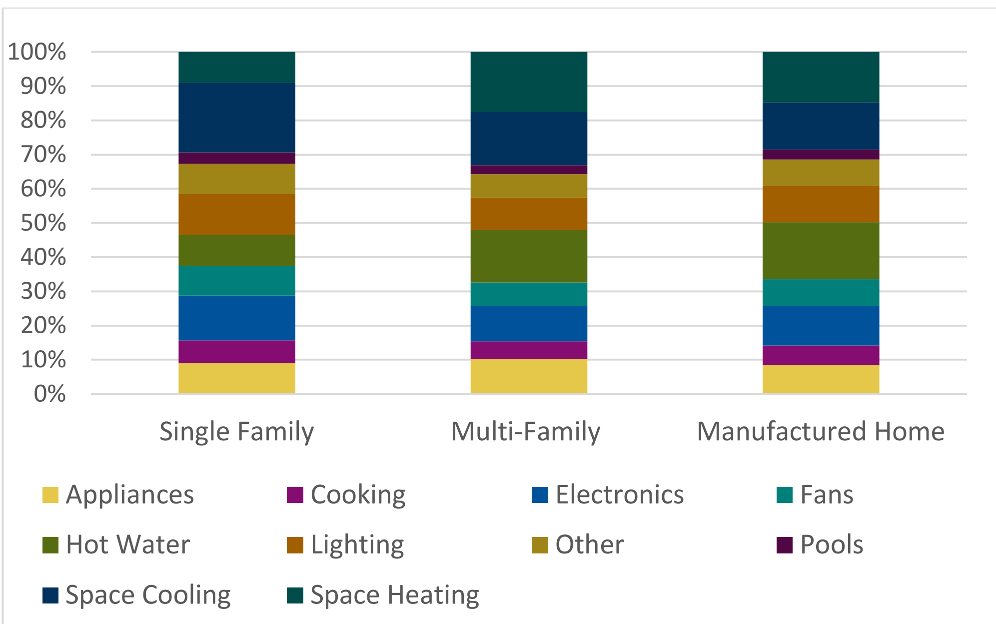

Figure 2-2. Natural Gas Forecast – Combined for All Utilities



Navigant selected floor area as the most appropriate driver for the commercial sector. As a result, an estimate of commercial floor area by segment was required. Navigant used information from the US Energy Information Administration Commercial Building Energy Consumption Survey (CBECS) to estimate commercial floor area for Arkansas. Navigant used the resulting baseline floor area as the basis for a forecast of floor area by segment over the Potential Study period. Navigant assumed a stock demolition rate of 0.5 percent per year. The resulting changes to the stock of commercial floor area were used to estimate the potential for new construction versus retrofit or replacement measures.

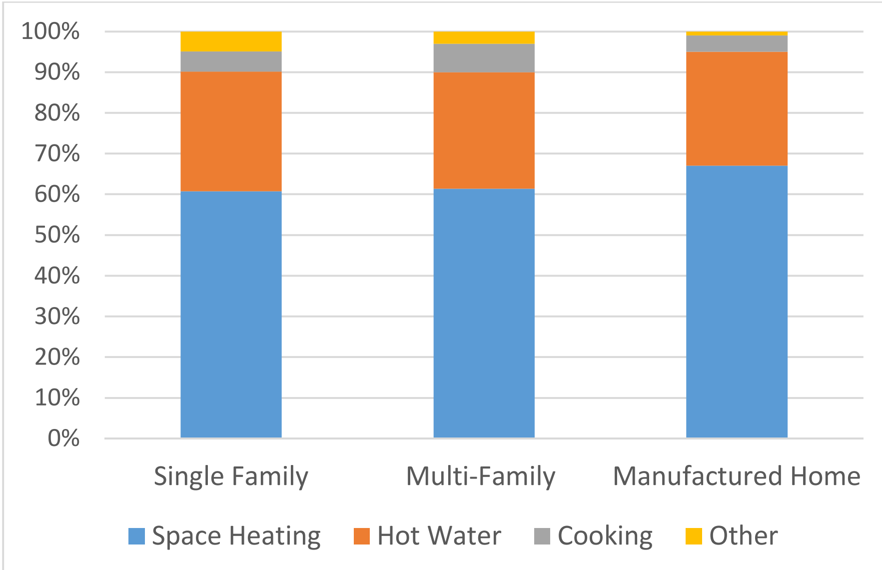
End use energy was allocated by end use based on information from the EIA. For the residential sector, information from the Residential Energy Consumption Survey (RECS) for the West South Central division was used[13]. Figure 2-3 provides the allocation of electric energy use by end-use for each of the three customer segments in the residential sector. Figure 2-4 provides the allocation of gas energy use by end-use for each of those same three residential customer segments.

**Figure 2-3. Residential Electricity Use - Allocation by End Use**




[13] The West South Central division includes data for Arkansas, Louisiana, and Oklahoma. Data for Texas is included in the district but is broken out from the other states.

**Figure 2-4. Residential Natural Gas Use - Allocation by End Use**




The allocation of energy use by end use, shown in Figure 2-5 and Figure 2-6 was based on the EIA's Commercial Institutional Building Energy Survey (CIBECS) database with some adjustments based on Arkansas-specific studies provided by the utilities.

**Figure 2-5. C&I Electricity Use - Allocation by End Use**

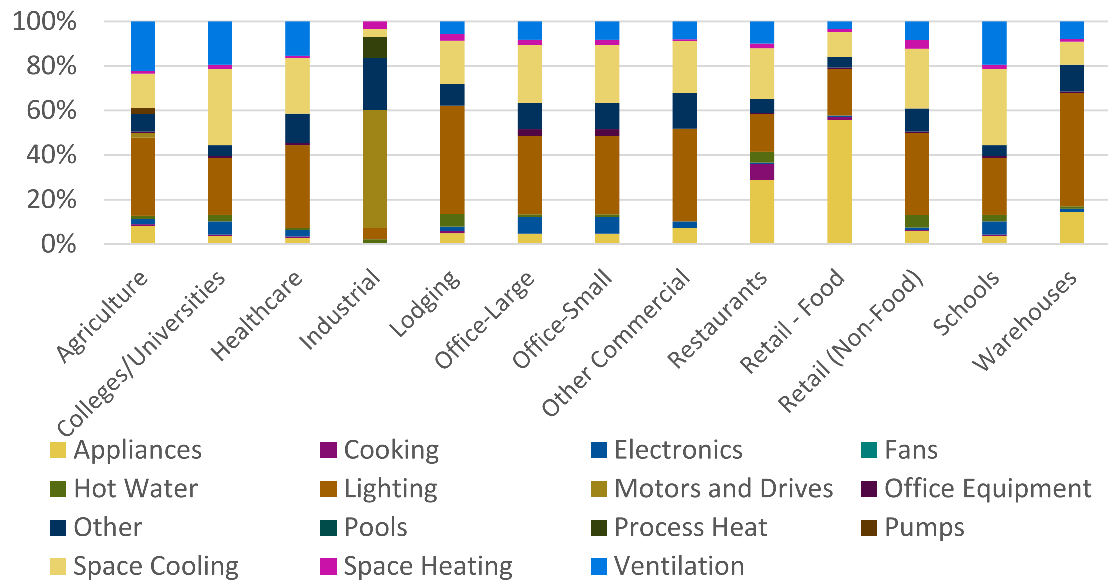
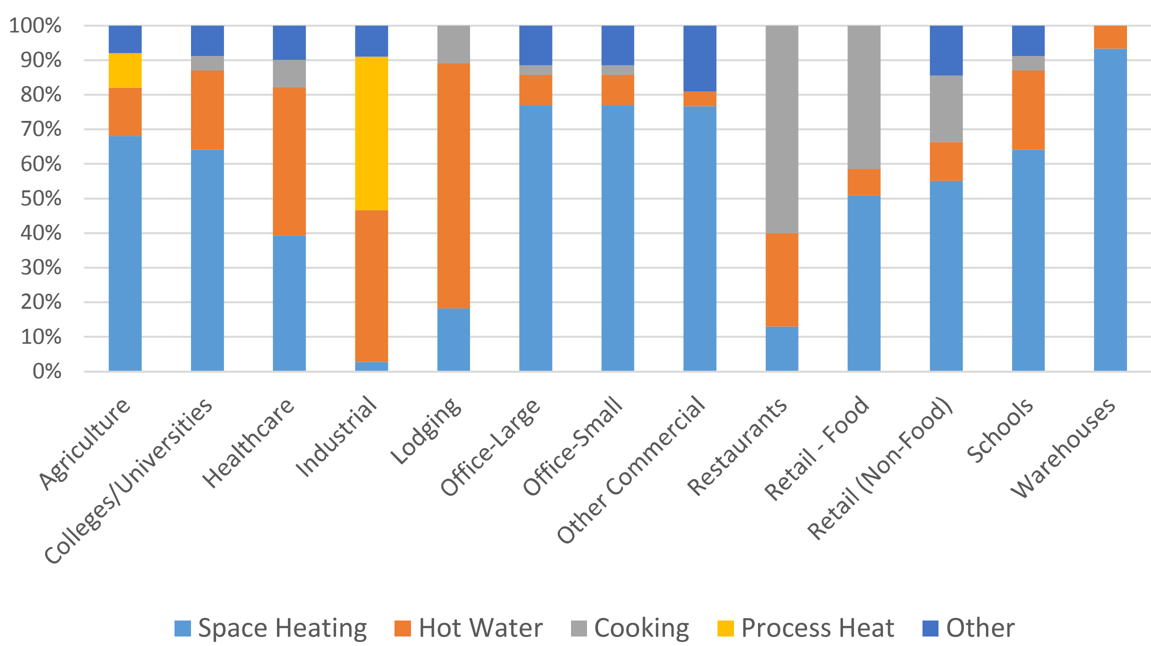



**Figure 2-6. C&I Natural Gas Use - Allocation by End Use**



## 2.2 *Primary Data Collection*

Industry practice in developing market characterizations for EE and DSM assessments is to utilize utility-specific baseline analyses and studies where possible. Where such information is not available, comparable data is utilized from utilities located in neighboring states or other secondary sources. Information sources such as EIA's most recent RECS micro-data and the most recent regional breakouts from the Commercial Buildings Energy Consumption Survey (CBECS) and Manufacturing Energy Consumption Survey (MECS) are often used.

For this project, the PWC chose to include an enhanced data collection process that included a review of existing secondary data and primary data collection process to supplement those secondary sources. Navigant used Arkansas-specific data provided from the utilities wherever possible, supplementing that data with information available from neighboring and comparable jurisdictions and other sources such as the EIA. This approach resulted in the use of primary data collection to supplement the available secondary data as required.

The PWC's feedback regarding the Project Plan included a number of welcome suggestions regarding past reports, including lighting studies, that had recently been conducted and which could inform the measure characterization process. Navigant reviewed the available reports and studies to identify the best information available for the Potential Study.

Wherever possible, Navigant reviewed and applied existing good quality information that could inform the question of major electric and gas equipment saturations. Secondary data, such as Arkansas customer surveys,[14] lighting evaluation studies completed for SWEPCO and Entergy, results from past DSM programs and other utility and state-specific information were reviewed and used wherever possible. Secondary data from EE potential studies recently completed by Navigant for Kansas City Power & Light (KCP&L), Philadelphia Electric, and the California Public Utilities Commission were also reviewed for potential application to Arkansas.

The Navigant team used information such as available Arkansas-specific surveys and reports and assumptions from relevant past potential analyses in nearby jurisdictions; such as the study completed by Navigant for KCP&L, to generate first draft baseline estimates. The survey data from Arkansas were then used to modify, fill in information gaps, or confirm the first draft assumptions.

### 2.2.1 Approach to Primary Data Collection

Navigant used a combination of surveys and interviews to collect primary data regarding electricity and natural gas markets in Arkansas. A survey process was designed to survey 2,000 residential and 500 commercial customers; with a goal of achieving a confidence level of 90 percent with a +/- 10 percent margin of error for each sector (see Table 2-3).[15] The process was designed to obtain the highest possible level of confidence across utilities and customer segments.

[14] Customer surveys have been provided by some of the utility members of the PWC.

[15] Note that limitations on the sample size available from utilities or panel size for on-line surveys may limit the ability to achieve these targets.

**Table 2-3. Primary Research Summary**

| Research Approach | Sample Size (*Target No. of Completed Surveys*) | Target Confidence Level | Actual Number of Completed Surveys |
|---|---|---|---|
| Residential Customer Online Survey | 2,000 residential customers | 90% +/- 10% | 1,692 |
| C&I Customer Telephone Survey | 500 C&I customers | 90% +/- 10% | 500 |
| C&I In-depth Telephone Interviews | 50 medium/large C&I customers | Qualitative | 44 |

Based on an assessment of the information gaps after reviewing available secondary data, Navigant developed survey instruments and conducted surveys and interviews to collect primary data to support the characterization of the Arkansas market and potential EE measures. The types of information collected in this process included:

1. Home or facility type, size, age, occupancy, usage patterns, demographics and firmographics.
2. Major electric and gas equipment saturations, including lighting, HVAC equipment, office and electronic equipment, water heaters, refrigeration and cooking equipment, motors, air compressors, process equipment, and other major equipment types. Some of this information was used to verify information available from other sources.
3. Equipment ages and DSM measure saturations for each major end use.
4. Information on recent energy use decisions, including new additions or change-outs of energy using appliances or installations of energy conservation measures. This information was used to inform the modeling of potential.
5. Customer awareness of major DSM measures and current DSM programs offered in Arkansas.
6. Major barriers to customers purchasing DSM measures, by major measure type, as well as which barriers are the primary barriers for each measure type. Data on customer barriers was collected as part of the surveys for the residential and commercial sectors, as well in in-depth interviews with medium and large customers.

The design of the survey instruments was focused on the list of measures to be included in the Potential Study, as agreed to with the PWC. The surveys questions were based on a careful review of information available from prior studies and an assessment of the appropriate application of these types of surveys. Navigant recognizes the limitations on the type of information that can realistically be gathered from customer surveys and developed research questions and survey instruments to be used in the primary research effort with those limitations in mind.

The potential model requires information on measure lifetimes, costs, energy savings and the density of the application and baseline measures, and the technical ability to implement the EE measure. Table 2-4 lists some of the data required and the type of data Navigant used in characterizing the measures. In the table, existing Arkansas data refers to data provided to Navigant by the utilities, primary data refers to information that was collected through the customer surveys, and secondary non-AR data refers to utility studies, previous baselines and potential studies in neighboring jurisdictions and other sources (as discussed above).

**Table 2-4. Characterization Data Required**

| Data Required for Measure & Market Characterization | Existing Arkansas Data Sources | Primary Data Collection | Secondary Non-Arkansas Data Sources |
|---|---|---|---|
| For Base and Efficiency Measures | | | |
| • Measure lifetime | ✓ | ✓ | ✓ |
| • Measure Costs | ✓ | | ✓ |
| • Energy Consumption (gas or electric) | ✓ | | ✓ |
| • Coincident Peak Demand (electric only) | ✓ | | ✓ |
| O&M Savings (if applicable) | | | ✓ |
| Measure Density (Base + EE measures) | ✓ | ✓ | ✓ |
| Technical Suitability (Ability to implement EE measure) | ✓ | ✓ | ✓ |
| Initial Saturation of Baseline Measures | ✓ | ✓ | ✓ |
| Customer Acceptance of EE Measures | ✓ | ✓ | ✓ |

As the table shows, information from multiple sources was used in characterizing some aspects of the measures. For example, measure density or saturation levels (i.e. the number of refrigerators per home or percentage of homes using electric heat) were derived from existing Arkansas data sources, primary data collection or secondary non-AR sources. In some instances, the survey data was used to adjust estimates obtained from other jurisdictions for use in Arkansas. For example, an estimate of appliance life from a baseline study in an adjoining state may be adjusted if the survey indicates different conditions in Arkansas. Initial saturation of baseline measures were based on information from studies completed in Arkansas (i.e. recent residential lighting studies), baselines in nearby states, or other non-Arkansas secondary sources. Where information from other jurisdictions was used, Navigant adjusted the data as appropriate to reflect conditions in the Arkansas market based on information from the surveys or other Arkansas data sources.

Data collection efforts were designed to provide information to support the realistic modelling of the EE potential in each of the customer segments and end uses. The sample design for each survey was developed based on data received at that time from the utilities.

### 2.2.2 Residential Online Survey

The utilities participating in the PWC serve the majority of residential customers in Arkansas. Navigant determined that the best, most effective and economic method for collecting data from residential customers was to use an on-line survey drawing on a pre-qualified and representative panel of Arkansas residents who have agreed to participate in on-line surveys.

Navigant selected ***qSample***[16] to conduct the residential survey using their residential panel for this project. qSample provided the survey to a sample of pre-qualified Arkansas residential customers in order to obtain 2,000 completed surveys. The sample was selected to match 2010 census distributions with respect to population distribution across the state, income, and employment. Matching the geographic distribution of residential customers across Arkansas was selected as the best method to obtain a representative sample for each of the utility territories.[17] Quotas were set for survey completion to ensure that a representative sample by utility was obtained. A total of 1,692 surveys was ultimately completed by ***qSample***, reaching 85 percent of the original quota.

Residential customers were asked about equipment saturations and energy types used, equipment characteristics, decision making processes, including willingness to pay for EE measures, and barriers to participation. This information was then used to help develop estimates of equipment saturations for residential equipment and EE measures. The approach taken in the survey was to focus on questions which residents can realistically answer, rather than asking more technical questions about efficiency levels. Information on equipment age and characteristics helped to inform estimates of equipment efficiency levels in combination with the secondary data discussed above. The survey instrument was provided to the PWC for review prior to being implemented.

The detailed results for the residential survey are presented in Appendix B.

### 2.2.3 C&I Telephone Survey

C&I customers were approached through a telephone survey and through in-depth telephone interviews with medium and large customers. C&I customers served by the seven utilities, excluding those which have opted out of participating in EE programs, were ranked in terms of their annual energy consumption. A sample of customers in the top quartile of energy consumption was selected as potential candidates for in-depth interviews. The remaining population, including those in the top quartile not selected for the initial sample, was then used to select the sample for the telephone survey.

Each of the utilities provided Navigant with a listing of their respective C&I customers, using a secured data transfer process. Navigant reviewed the customer lists in order to eliminate duplication between lists provided by natural gas and electric utilities, customers with multiple sites, etc. and selected the samples described below. The resulting list of customers included in the sample was then provided to each utility so that they could provide an introductory letter or e-mail to request the customer's participation in the survey.

Table 2-5 shows the initial estimate of the sample size required for the C&I telephone survey. The sample design oversampled some utilities in order to provide the number of completed surveys desired for the target confidence level. For Empire, SWEPCO and AOG, Navigant over sampled the C&I customers with a goal of obtaining a reasonable number of completed surveys per utility.

[16] http://www.qsample.com/

[17] Note that while this approach was taken for the state as a whole (ultimately including customers who are not served by one of the IOUs) to ensure geographic diversity, qSample was directed to only count surveys where the respondent was an IOU customer.

**Table 2-5. C&I Telephone Survey Sample Size**

| Utility | Est. Total Customers | Number of C&I Customers* | Target Completed C&I Surveys - Proportional Sampling | Proportional Number of Customers (based on total customers) | Sample Request |
|---|---|---|---|---|---|
| Entergy | 695,393 | 113,046 | 232 | 3,476 | 3,476 |
| SWEPCO | 113,659 | 17,890 | 38 | 566 | 566 |
| OG&E | 65,227 | 9,310 | 22 | 326 | 600 |
| Empire | 4,334 | No Info | 2 | 23 | 200 or census |
| CenterPoint | 425,000 | No Info | 142 | 2,123 | 2,123 |
| SourceGas | 151,451 | 18,405 | 51 | 758 | 188 |
| AOG | 46,040 | 3,330 | 15 | 229 | 500 |
| ***Total*** | ***1,501,104*** | | ***500*** | ***7,500*** | ***7,653*** |

** Based on information provided to Navigant by the utilities as of 10/8/2014.*

Working with the ***Blackstone Group, LLC*** (Blackstone), a market research firm, C&I customers were surveyed by telephone to collect information on equipment saturations, decision making processes, barriers to participation and the efficiency level of end uses. As with the residential survey, the questions were designed to elicit information which respondents can confidently provide regarding equipment types, energy sources used, and equipment age, as well as information regarding their firm and facilities. Blackstone was able to complete 500 surveys, achieving 100 percent of the quota.

The detailed results for the C&I survey are presented in Appendix C.

### 2.2.4 Medium & Large C&I Customer Interviews

To supplement the broader C&I survey, Navigant conducted in-depth interviews with medium/large C&I customers. The purpose of these interviews was to gain a more detailed understanding of the various barriers that these customers face when deciding whether to adopt EE measures, and explore what it would take to overcome those barriers. This information was used to help refine the estimates of customer acceptance as part of the potential modeling process.

Assessing market barriers with larger customers is best done through telephone interviews with customers, as such interviews allow the surveyor to probe the answers to questions, and solicit participant reactions to possible solutions to the hurdles they face to installing DSM measures. For example, the “first cost” barrier is often suggested by customers as an important reason why they have not installed EE measures, however, customer participation in utility DSM financing programs is often quite modest indicating that other factors may be at play. This illustrates the necessity of phrasing questions in ways to elicit the most valid and actionable responses. In conducting the interviews we leveraged our experience and secondary data sources to assess market barriers. Market barriers were also be explored with small and medium-sized commercial and industrial customers in the C&I survey.

The interviews with large C&I customers were conducted by experienced Navigant research staff. A total of 44 completed interviews were ultimately completed, achieving 88 percent of the original quota.

Detailed results for the Medium/Large C&I customer interviews are presented in Appendix D.

## 2.3 *Energy Efficiency Measure/Technology List*

The Commission has approved a TRM which specifies how deemed savings for a number of EE measures are to be calculated in Arkansas. Navigant reviewed all of the measures included in the most recent version of the TRM (TRM version 4.0) available at the time of the Potential Study as well as a number of other measures identified as potentially applicable in Arkansas over the study period.

The review process resulted in a list of 48 residential and 65 commercial measures, which were summarized and presented to the PWC for review. These measures were then characterized for each segment where they could be applied. Weather sensitive measures were also characterized for each climate zone in the state.

The resulting lists of measures are presented in the following sections describing the characterization of measures for each sector. Appendix E contains the detailed spreadsheets which provide all of the details behind the measure characterizations for each of the EE measures that were analyzed in this study.

### 2.3.1 Approach to Measure Characterization

The Arkansas TRM specifies the effective useful life (EUL) and how energy savings are to be calculated for each of the measures listed. It does not provide information on implementation costs or the market characteristics of the measure. For each of the measures in the TRM, Navigant developed estimates of implementation costs, estimates of measure density, baseline density and technical applicability in addition to calculating per unit savings based on the TRM. As part of the characterization process, the impacts on other resources were also estimated (i.e. if implementation of a natural gas measure increased or decreased electricity use). In characterizing the measures, we include all changes to energy use that result from the measure including savings of one energy form resulting in an increase in other forms of energy use.

Information regarding the allocation of end use energy, energy intensities, the existing saturation of energy-efficient devices, etc. required to estimate the EE potential for each measure was derived from a variety of sources, as described in more detail below. The approach taken in developing these characterizations was to use information specific to Arkansas wherever possible. Where state-specific information was not available, preference was given to information from nearby states. Where data from other states was used, it was reviewed to determine if adjustments were required in order to apply the data to Arkansas.

Other considerations were addressed during the measure characterization process. In particular, below are descriptions of how Navigant addressed changing codes and standards and emerging technologies.

#### *2.3.1.1 Codes and Standards Adjustments*

As future codes and standards become effective, the energy savings from existing measures subjected to the codes and standards will diminish. Navigant accounted for the impact of codes and standards by baseline energy and cost multipliers which reduced the baseline equipment consumption starting from the year when particular codes and standards begin to take effect.

The U.S. Department of Energy (DOE) Technical Support Documents (TSD)[18] contains information on energy and cost impact of each appliance standard. Engineering analysis is available in Chapter 5 of the TSD; energy use analysis is available in Chapter 7, and cost impact is available in Chapter 8. Navigant sourced the codes and standards multipliers from the DOE's analysis and/or assumptions.

In general, Navigant compares the new standard requirements with the current baseline to determine the energy reduction and refer to the relative EE mark up to determine the cost increase due to codes and standards. Foreseeable standards will affect residential domestic water heaters and general service lamps.

#### *2.3.1.2 Emerging Technologies*

The goal of the Emerging Technologies Overlay is to establish a range of possible savings from emerging technologies. Emerging technology is defined as any technology that meets at least one of the following criteria:

- Is currently not commercially available but expected to become so during the time span of the analysis
- Is expected to achieve significant efficiency or cost improvements over the forecast time horizon

Light-emitting diode (LED) lighting and solar hot water heaters are expected to have significant efficiency and cost improvements over the model horizon. These emerging technologies are characterized using similar criteria and resources as conventional technologies but with an estimated time-series profile for several inputs.

Navigant developed the following multipliers (where appropriate) to characterize changes in measure characteristics over time:

- **Market Availability Profile:** This value is used to identify whether a product is commercially available (a value of 0 indicates not commercially available; a value of 1.0 indicates that it is commercially available).
- **Energy Consumption Multiplier:** This value adjusts the efficient technology energy consumption over time to reflect changes due to technology improvement.
- **Cost Multiplier:** This value adjusts the efficient technology cost over time due to technology improvement.

[18] Appliance standards rulemaking notices and TSDs can be found at: http://energy.gov/eere/buildings/current-rulemakings-and-notices

### 2.3.2 Residential Measures

Navigant reviewed a range of measures that could contribute to the EE potential for Arkansas based on the Arkansas TRM, prior potential studies completed in comparable jurisdictions and a review of emerging technologies which could impact energy markets over the period of the Potential Study. For the residential sector, 61 measures were reviewed and presented to the PWC. Of these 48 were selected for inclusion in the analysis. Of these, 35 were based on information in the TRM and 13 were additional measures put forward by Navigant. Table 2-6 lists the measures modeled for the residential sector and indicates the main energy type impacted by each measure (electricity or natural gas) as well as the source of the measures (TRM or Navigant).

**Table 2-6. Residential EE Measures Included in Study**

| End Use | Measure | Energy Type | Source |
|---|---|---|---|
| Appliances | ENERGY STAR Clothes Washer | Electric | TRM 4.0 |
| | ENERGY STAR Dishwasher | Electric | TRM 4.0 |
| | ENERGY STAR Refrigerator | Electric | TRM 4.0 |
| | Advanced Power Strips | Electric | TRM 4.0 |
| | ENERGY STAR Freezer | Electric | Navigant |
| | Cooking Oven - Convection or Combination | Electric | Navigant |
| | Induction Cooking | Electric | Navigant |
| | Clothes Dryer - High Efficiency | Electric | Navigant |
| Electronics | ENERGY STAR TV | Electric | Navigant |
| | ENERGY STAR Home Computer - Laptop or Desktop | Electric | Navigant |
| | Power Supplies - 80 Plus | Electric | Navigant |
| Hot Water | Tankless Electric Water Heater | Electric | TRM 4.0 |
| | Heat Pump Water Heater | Electric | TRM 4.0 |
| | Tankless Gas Water Heater | Gas | TRM 4.0 |
| | ENERGY STAR Solar Water Heater | Both | TRM 4.0 |
| | Water Heater Jackets | Both | TRM 4.0 |
| | Water Heater Pipe Insulation | Both | TRM 4.0 |
| | Faucet Aerators | Both | TRM 4.0 |
| | Low-Flow Showerheads | Both | TRM 4.0 |
| Lighting | Compact Fluorescent Lamps | Electric | TRM 4.0 |
| | Specialty Compact Fluorescent Lamps | Electric | TRM 4.0 |
| | ENERGY STAR Directional LEDs | Electric | TRM 4.0 |
| | ENERGY STAR Omni-directional LEDs | Electric | TRM 4.0 |

| End Use | Measure | Energy Type | Source |
|---|---|---|---|
| | Indoor/Outdoor Linear Fluorescents | Electric | TRM 4.0 |
| | Controls - Occupancy Sensors | Electric | Navigant |
| Other | Home Energy Reports (Behavior) | Both | Navigant |
| Space Cooling | Central Air Conditioner Tune-Up | Electric | TRM 4.0 |
| | Central Air Conditioner Replacement | Electric | TRM 4.0 |
| | Central Heat Pump Replacement | Electric | TRM 4.0 |
| | Room Air Conditioner - Window or Split | Electric | TRM 4.0 |
| | Smart/Programmable Thermostat | Electric | Navigant |
| Space Heating | Attic Knee Wall Insulation | Both | TRM 4.0 |
| | Ceiling Insulation | Both | TRM 4.0 |
| | Wall Insulation | Both | TRM 4.0 |
| | Floor Insulation | Both | TRM 4.0 |
| | Radiant Barriers | Both | TRM 4.0 |
| | ENERGY STAR Windows | Both | TRM 4.0 |
| | Air Infiltration | Both | TRM 4.0 |
| | Add Storm Windows | Both | Navigant |
| | Crawlspace/Basement Wall Insulation | Both | Navigant |
| | Gas Furnace Replacement | Gas | TRM 4.0 |
| | Gas Furnace Tune-Up | Gas | TRM 4.0 |
| | Hydronic Heating | Gas | TRM 4.0 |
| | Boiler - High Efficiency | Gas | Navigant |
| | Ground Source Heat Pump | Electric | TRM 4.0 |
| Ventilation | Direct Vent Heaters | Gas | TRM 4.0 |
| | Duct Insulation | Both | TRM 4.0 |
| | Duct Sealing | Both | TRM 4.0 |

*Source: Navigant analysis, 2015*

Navigant characterized the savings for residential measures based on information from the Arkansas TRM and other past analyses. Table 2-7 outlines the various sources of information that was used in identifying measure costs, current market conditions and measure densities. Throughout the Potential Study, Arkansas specific data was used as the preferred data sources wherever possible. Detailed references to data sources can be found in the measure characterization data sheet (Appendix E).

**Table 2-7. Data Sources for Residential EE Measure Characterization Parameters**

| Measure Input | Data Sources |
|---|---|
| Measure Costs | On-line reviews of retail and other costs, reviews of past potential analyses and studies in comparable jurisdictions. |
| Measure Savings | Arkansas TRM 4.0, measure data from other nearby jurisdictions, reviews of past potential analyses and studies in comparable jurisdictions, Navigant engineering analysis. |
| Measure Densities & Baseline Conditions | Arkansas primary data collection efforts, measure data utilized by Navigant for recent potential studies involving DSMSim™ modeling, Navigant engineering analysis. |

*Source: Navigant analysis, 2015*

### 2.3.3 C&I Measures

As in the residential sector, Navigant reviewed a range of measures for possible inclusion in the Potential Study. In total, 103 measures were reviewed and presented to the PWC. Of these 65 measures were selected for inclusion in the analysis. Of these 46 measures were based on the TRM and 19 were proposed by Navigant. The list of measures for the commercial sector used the analysis, broken out by end use, is presented in Table 2-8.

**Table 2-8. C&I EE Measures Included in Study**

| End Use | Measure | Energy Type | Source |
|---|---|---|---|
| Compressed Air | Compressed Air Retrofits | Electric | Navigant |
| Cooking | Combination Ovens | Both | TRM 4.0 |
| | Commercial Fryers | Both | TRM 4.0 |
| | Commercial Griddles | Both | TRM 4.0 |
| | Commercial Ovens | Both | TRM 4.0 |
| | Commercial Steam Cookers | Both | TRM 4.0 |
| Hot Water | ENERGY STAR Commercial Dishwashers | Both | TRM 4.0 |
| | Low-Flow Pre-Rinse Spray Valves | Both | TRM 4.0 |
| | Low-Flow Showerheads | Both | TRM 4.0 |
| | Water Heater Jackets | Both | TRM 4.0 |
| | Water Heater Pipe Insulation | Both | TRM 4.0 |
| | Water Heater Replacement | Both | TRM 4.0 |
| | Water Heater Thermostat Setback | Both | Navigant |
| Lighting | Exit Sign - LED | Electric | Navigant |
| | Light Emitting Diode (LED) Traffic Signals | Electric | TRM 4.0 |
| | Lighting Controls | Electric | TRM 4.0 |
| | Lighting Density Reduction | Electric | Navigant |
| | Lighting Efficiency | Electric | TRM 4.0 |
| Motors and Drives | Electronically Commutated Motors for Refrigeration and HVAC Applications | Electric | TRM 4.0 |
| | Premium Efficiency Motors | Electric | TRM 4.0 |
| Office Equipment | Computer Power Management | Electric | TRM 4.0 |
| Other | Advanced Power Strips | Electric | TRM 4.0 |
| | Commercial Refrigeration Retrofits | Electric | Navigant |

| End Use | Measure | Energy Type | Source |
|---|---|---|---|
| | Door Heater Controls for Refrigerated Display Cases (Retrofit Only) | Electric | TRM 4.0 |
| | Energy-Efficient Dehumidifier | Electric | Navigant |
| | High Efficiency Refrigeration Upgrades | Electric | Navigant |
| | Vending Machine Occupancy Controls | Electric | TRM 4.0 |
| Space Cooling | Air or Water Cooled Chilling Equipment (Chillers) | Electric | TRM 4.0 |
| | Central Air Conditioner Tune-Up | Electric | TRM 4.0 |
| | Comprehensive Retro Commissioning | Electric | Navigant |
| | High Efficiency Comprehensive New Construction | Both | Navigant |
| | HVAC Control Upgrades | Electric | Navigant |
| | Occupancy-Based PTAC/PTHP Controls | Electric | TRM 4.0 |
| | Packaged Terminal AC/HP (PTAC/PTHP) Equipment | Electric | TRM 4.0 |
| Space Heating | Boiler Cut-Out Control | Gas | TRM 4.0 |
| | Boiler or Furnace Vent Damper | Gas | TRM 4.0 |
| | Boiler Reset Control | Gas | TRM 4.0 |
| | Boiler Tune-Up | Gas | TRM 4.0 |
| | Burner Replacement for Commercial Boilers | Gas | TRM 4.0 |
| | Ceiling Insulation (Converted Residence Only) | Both | TRM 4.0 |
| | Ceiling Insulation (Small Commercial) | Both | TRM 4.0 |
| | Commercial and Industrial Boilers | Gas | TRM 4.0 |
| | Commercial Furnaces | Gas | TRM 4.0 |
| | Comprehensive Retro-Commissioning | Both | Navigant |
| | Cool Roofs | Both | TRM 4.0 |
| | Direct Vent Heaters (Small Commercial and Converted Residences) | Gas | TRM 4.0 |
| | Duct Efficiency Improvements | Both | TRM 4.0 |
| | Duct Insulation (Converted Residences Only) | Both | TRM 4.0 |
| | Duct Insulation (Small Commercial) | Both | TRM 4.0 |
| | HVAC Control Upgrades | Both | Navigant |
| | HVAC Heat Recovery | Gas | Navigant |
| | Infiltration (Converted Residences Only) | Both | TRM 4.0 |
| | Infrared Heaters | Both | Navigant |

| End Use | Measure | Energy Type | Source |
|---|---|---|---|
| | Radiant heaters | Both | Navigant |
| | Roof Deck Insulation (Small Commercial) | Both | TRM 4.0 |
| | Steam Trap Replacement | Both | TRM 4.0 |
| | Unitary and Split System AC/HP Equipment | Electric | TRM 4.0 |
| | Wall Insulation (Converted Residences Only) | Both | TRM 4.0 |
| | Window Awnings (Small Commercial Only) | Both | TRM 4.0 |
| | Window Film (Converted Residences Only) | Both | TRM 4.0 |
| | Window Film (Small Commercial Only) | Both | TRM 4.0 |
| Ventilation | Demand Controlled Ventilation | Electric | Navigant |
| | High Efficiency Fans | Electric | Navigant |
| | HVAC Control Upgrades | Both | Navigant |
| | Variable Speed Ventilation | Electric | Navigant |

*Source: Navigant analysis, 2015*

**Treatment of T12 Retrofits**

A key consideration for the C&I EE measure analysis is the savings attributable to retrofitting T12 linear fluorescent lamp systems with T8 systems. These retrofits have been integral to successful and productive EE programs, and code changes – including the Energy Policy Act of 2005 (EPAct 2005) and Energy Independence and Security Act of 2007 (EISA 2007) - introduced increased efficacy requirements that temper the impact of these measures. These acts included specific requirements with respect to fluorescent lighting systems.

EPAct 2005 laid out a timeline for phase out of magnetic ballasts. EISA 2007 included requirements for increased efficacy of fluorescent lighting. Although magnetic ballasts have a fairly long EUL and code changes do affect the baseline for new construction, the critical date for most EE programs was July 14, 2012. This was the date specified by EISA 2007 that essentially bans the manufacture or importing of virtually all 4′ T12 lamps and 700-series T8 lamps (known as commodity F32T8, standard F32T8, or SP F32T8) by setting new efficacy standards for general purpose fluorescent lamps. Most T12 lamps and 700-series T8's cannot pass these standards. Therefore, after July 14, 2012, if a T12 lamp or 700-series T8 lamp burns out, a customer will only be able to purchase a replacement lamp while existing stocks last, after which the fixture ballast and lamps will need to be upgraded. Based on this information, Navigant assumed a standard T8 baseline (800 series) from the first year of the forecast (2016) onward.

Navigant characterized the savings for C&I measures based on information from the Arkansas TRM and other past analyses. Table 2-9 outlines the various sources of information that was used in identifying measure costs, current market conditions and measure densities. Throughout the Potential Study, Arkansas specific data was used as the preferred data sources wherever possible. Detailed references to data sources can be found in the measure characterization data sheet (Appendix E).

**Table 2-9. Data Sources for C&I EE Measure Characterization Parameters**

| Measure Input | Data Sources |
|---|---|
| Measure Costs | On-line reviews of retail and other costs, reviews of past potential analyses and studies in comparable jurisdictions. |
| Measure Savings | Arkansas TRM 4.0, measure data from other nearby jurisdictions, reviews of past potential analyses and studies in comparable jurisdictions, Navigant engineering analysis. |
| Measure Densities & Baseline Conditions | Arkansas primary data collection efforts, measure data utilized by Navigant for recent potential studies involving DSMSim™ modeling, Navigant engineering analysis. |

*Source: Navigant analysis, 2015*

# 3 Technical Potential Forecast

This section describes the technical savings potential for Arkansas. The technical potential represents the upper bound on potential in that it does not take either the economics of the measures or the rate of stock turnover into account. This chapter first explains Navigant's approach to calculating technical potential and then presents the baseline results for technical potential.

## 3.1 *Approach to Estimating Technical Potential*

Technical potential is defined as the energy savings that can be achieved assuming that all installed measures can *immediately* be replaced with the "efficient" measure/technology, wherever technically feasible, regardless of the cost, market acceptance, or whether a measure has failed and must be replaced.

Navigant used its DSMSim™ model to estimate the technical savings potential for EE resources in the Arkansas IOU's service territories. DSMSim™ is a bottom-up technology-diffusion and stock-tracking model implemented using a System Dynamics framework.[19]

Navigant's modelling approach considers an EE measure to be any change made to a building, piece of equipment, process, or behavior that could save energy. The savings can be defined in numerous ways, depending on which method is most appropriate for a given measure. Measures like condensing water heaters are best characterized as some fixed amount of savings per water heater; savings for measures like commercial automated building controls are typically characterized as a percentage of customer segment consumption; and, lastly, measures like industrial ventilation heat recovery are well-suited for estimating energy savings as a percentage of end use consumption. The DSMSim model can appropriately handle savings characterizations for all three methods.

The calculation of technical potential in this study differs depending on the assumed measure replacement type. Technical potential is calculated on a per-measure basis and includes estimates of savings per unit, measure density (e.g., quantity of measures per home) and total building stock in each service territory. The Potential Study accounts for three replacement types, where potential from retrofit and replace-on-burnout measures are calculated differently from potential for new measures. The formulae used to calculate technical potential by replacement type are shown below.

***New Construction (NEW) Measures***

Similar to replace-on-burnout measures, the cost of implementing new measures is incremental to the cost of a baseline (and less efficient) measure. However, new construction technical potential is driven by equipment installations in new building stock rather than by equipment in existing building stock.[20]

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[19] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill. 2000 for detail on System Dynamics modelling. Also see http://en.wikipedia.org/wiki/System_dynamics for a high-level overview.

[20] In some cases, customer-segment-level and end use-level consumption/sales are used as proxies for building stock. These consumption/sales figures are treated like building stock in that they are subject to demolition rates and stock-tracking dynamics.

New building stock is added to keep up with forecast growth in total building stock and to replace existing stock that is demolished each year. Demolished (sometimes called replacement) stock is calculated as a percentage of existing stock in each year, and this study uses a demolition rate of 0.5 percent per year. New building stock (the sum of growth in building stock and replacement of demolished stock) determines the incremental annual addition to technical potential which is then added to totals from previous years to calculate the total potential in any given year. The equations used to calculate technical potential for new construction measures are provided below.

<u>Annual Incremental Technical Potential (AITP)</u>:

$AITP_{YEAR}$ = New $Buildings_{YEAR}$ (e.g., buildings/year[21]) X Measure Density (e.g., widgets/building) X $Savings_{YEAR}$ (e.g., kWh or Therms/widget) X Technical Suitability (dimensionless)

<u>Total Technical Potential (TTP)</u>:

$$TTP_Y = \sum_{YEAR=2015}^{YEAR=2024} AITP_{YEAR}$$

***Retrofit (RET) and Replace-On-Burnout (ROB) Measures***

RET measures, commonly referred to as advancement or early-retirement measures, are replacements of existing equipment before the equipment fails. RET measures can also be efficient processes that are not currently in place and that are not required for operational purposes. RET measures incur the full cost of implementation rather than incremental costs to some other baseline technology or process because the customer could choose not to replace the measure and would therefore incur no costs. In contrast, ROB measures, sometimes referred to as lost-opportunity measures, are replacements of existing equipment that have failed and must be replaced, or they are existing processes that must be renewed. Because the failure of the existing measure requires a capital investment by the customer, the cost of implementing ROB measures is always incremental to the cost of a baseline (and less efficient) measure.

RET and ROB measures have a different meaning for technical potential compared with NEW measures. In any given year, the entire building stock is used for the calculation of technical potential.[22] This method does not limit the calculated technical potential to any pre-assumed rate of adoption of retrofit measures. Existing building stock is reduced each year by the quantity of demolished building stock in that year and does not include new building stock that is added throughout the simulation. For RET and ROB measures, annual potential is equal to total potential, thus offering an *instantaneous* view of technical potential. The equation used to calculate technical potential for retrofit measures is provided below.

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

[22] In some cases, customer-segment-level and end use-level consumption/sales are used as proxies for building stock. These consumption/sales figures are treated like building stock in that they are subject to demolition rates and stock-tracking dynamics.

Annual/Total Gas Savings Potential:

Total Potential = Existing Building Stock $_{YEAR}$ (e.g., buildings[23]) X Measure Density (e.g., widgets/building) X Savings $_{YEAR}$ (e.g., $m^3$/widget) X Technical Suitability (dimensionless)

***Competition Groups***

Navigant's modelling approach recognizes that some efficient technologies will compete against each other in the calculation of potential. The study defines "competition" as efficient measures competing for the same installation as opposed to competing for the same savings (e.g., windows vs. furnaces) or for the same budget (e.g., lighting vs. water heating). For instance, a consumer may install a condensing or near-condensing boiler. These measures would be included in the same competition group, as only one of these could be installed in a particular facility. General characteristics of competing technologies used to define competition groups in this study include the following:

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

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

## 3.2 *Technical Potential Results*

This sub-section provides DSMSim™ results pertaining to natural gas and electricity total technical potential at different levels of aggregation. Results are shown by sector, customer segment, and end use as well as for the measures with the highest-impact.

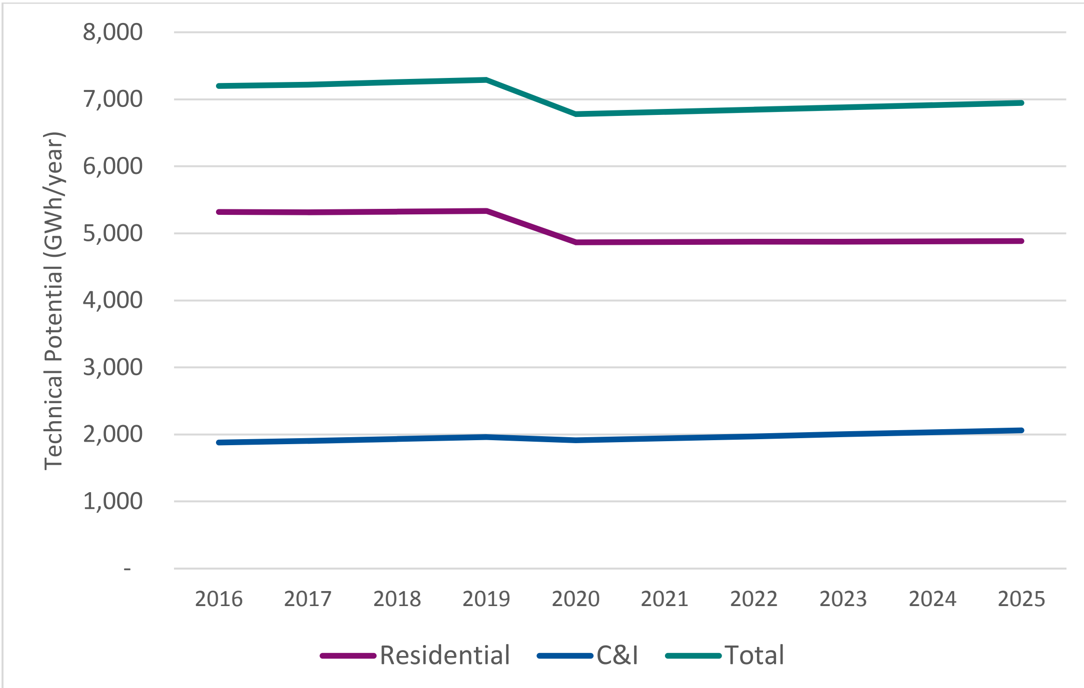
### 3.2.1 Results by Sector

Figure 3-1 and Table 3-1 shows the electric technical potential by sector. Figure 3-2 and Table 3-2 provide the comparable information for the gas technical potential. The allocation of technical potential among sectors is comparable with the allocation of forecasted sales among sectors. As previously noted, all savings reported in this study are gross, rather than net, meaning that the effect of possible free ridership

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

is not included in the reported savings[24].

**Figure 3-1. Electric Technical Potential by Sector (GWh/year)**




*Source: Navigant analysis, 2015*

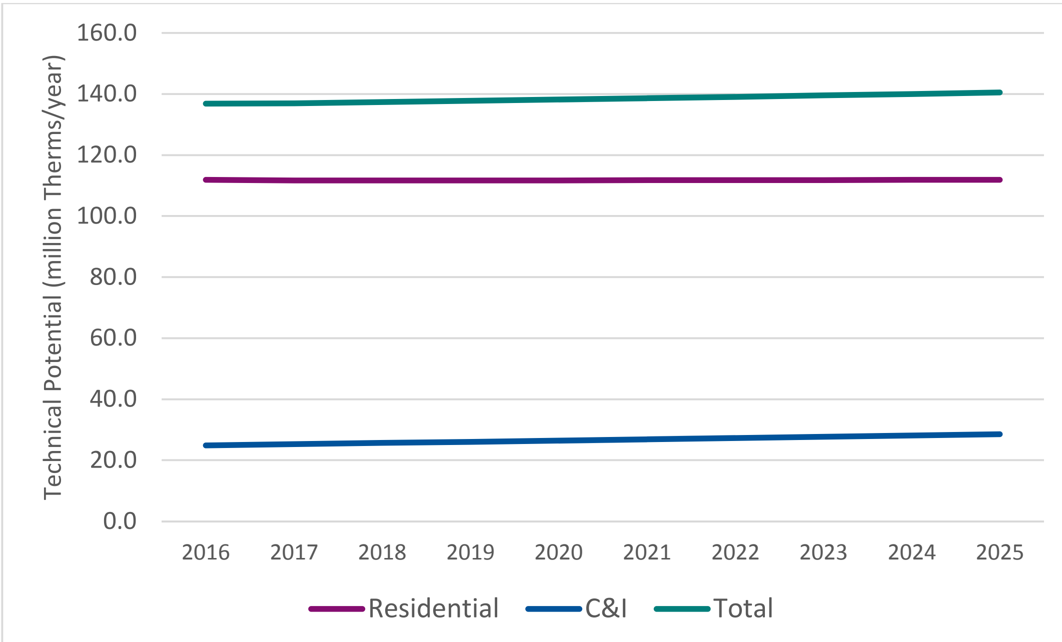
**Table 3-1. Electric Technical Potential by Sector (GWh/year)**

| Year | Residential | C&I | Total |
|---|---|---|---|
| **2016** | 5,321 | 1,877 | 7,198 |
| **2017** | 5,315 | 1,905 | 7,220 |
| **2018** | 5,324 | 1,932 | 7,256 |
| **2019** | 5,333 | 1,959 | 7,292 |
| **2020** | 4,867 | 1,914 | 6,781 |
| **2021** | 4,870 | 1,942 | 6,812 |
| **2022** | 4,873 | 1,971 | 6,845 |
| **2023** | 4,877 | 2,002 | 6,879 |
| **2024** | 4,881 | 2,032 | 6,913 |
| **2025** | 4,885 | 2,062 | 6,948 |

*Source: Navigant analysis, 2015*

[24] For the natural gas utilities potential was not estimated for transportation volumes.

**Figure 3-2. Gas Technical Potential by Sector (Million Therms/year)**




*Source: Navigant analysis, 2015*

**Table 3-2. Gas Technical Potential by Sector (Million Therms/year)**

| Year | Residential | C&I | Total |
|---|---|---|---|
| **2016** | 111.9 | 24.9 | 136.8 |
| **2017** | 111.7 | 25.3 | 137.0 |
| **2018** | 111.7 | 25.7 | 137.4 |
| **2019** | 111.7 | 26.1 | 137.8 |
| **2020** | 111.7 | 26.5 | 138.2 |
| **2021** | 111.7 | 26.9 | 138.6 |
| **2022** | 111.8 | 27.3 | 139.0 |
| **2023** | 111.8 | 27.7 | 139.5 |
| **2024** | 111.8 | 28.1 | 140.0 |
| **2025** | 111.9 | 28.6 | 140.5 |

*Source: Navigant analysis, 2015*

Table 3-3 provides the technical electric savings potential as a percentage of sector sales. Table 3-4 provides the same information for the technical gas savings potential. This perspective shows that the residential sector has the greatest technical potential as a percentage of sales for both electric and gas. Additionally, the commercial sector's savings as a percentage of sales stays the same (electric) or slightly declines (gas) over time due to the changing mix of new and existing building stock, even though the technical potential grows in absolute terms.

**Table 3-3. Electric Technical Potential as a Percentage of Sector Sales**

| Year | Residential | C&I | Total |
|---|---|---|---|
| **2016** | 47.3% | 13.2% | 28.3% |
| **2017** | 45.5% | 12.9% | 27.3% |
| **2018** | 45.2% | 13.0% | 27.2% |
| **2019** | 45.1% | 13.1% | 27.2% |
| **2020** | 40.9% | 12.7% | 25.2% |
| **2021** | 40.8% | 12.9% | 25.2% |
| **2022** | 40.5% | 13.0% | 25.1% |
| **2023** | 40.3% | 13.1% | 25.1% |
| **2024** | 40.0% | 13.2% | 25.0% |
| **2025** | 39.8% | 13.3% | 25.0% |

*Source: Navigant analysis, 2015*

**Table 3-4. Gas Technical Potential as a Percentage of Sector Sales**

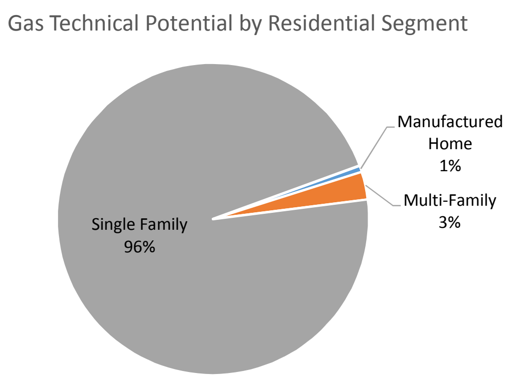
| Year | Residential | C&I | Total |
|---|---|---|---|
| **2016** | 32.0% | 9.4% | 22.2% |
| **2017** | 32.2% | 9.7% | 22.5% |
| **2018** | 32.3% | 9.9% | 22.7% |
| **2019** | 32.4% | 10.1% | 22.9% |
| **2020** | 32.6% | 10.4% | 23.1% |
| **2021** | 32.7% | 10.7% | 23.4% |
| **2022** | 32.9% | 11.0% | 23.6% |
| **2023** | 33.0% | 11.3% | 23.9% |
| **2024** | 33.2% | 11.6% | 24.1% |
| **2025** | 33.3% | 11.9% | 24.4% |

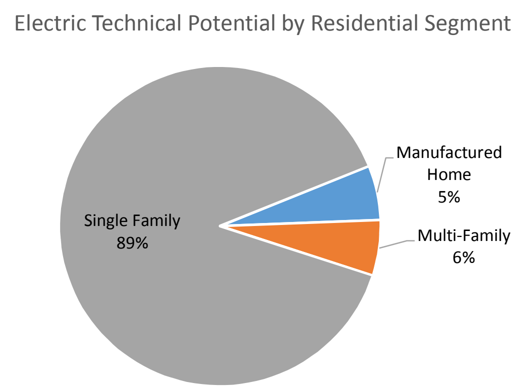
*Source: Navigant analysis, 2015*

### 3.2.2 Results by Customer Segment

The residential electric and gas technical potentials shown in Figure 3-1 and Figure 3-2, respectively, are broken out for each of the three residential customer segments. For the electric and gas technical potentials, the dominant segment is single family homes. This is due to residential electric and gas sales being largely driven by this customer segment, which is consistent with their comparably large contribution to savings potential. Table 3-5 provides the magnitude of the residential electric technical potential for each customer segment for 2016-2025. Table 3-6 provides comparable information for gas technical potential.

**Figure 3-3. Technical Potential by Residential Customer Segment in 2025 (Electric and Gas)**

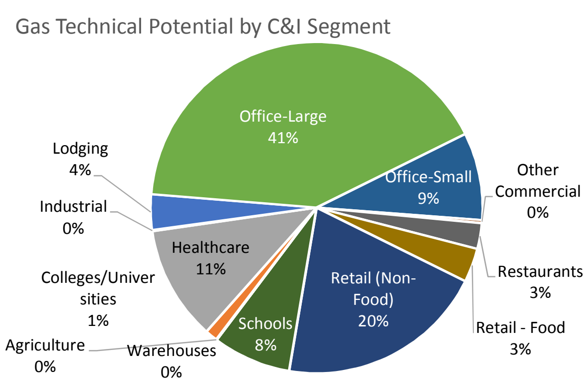


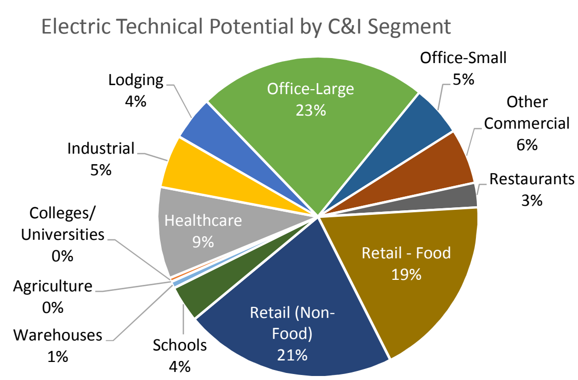




*Source: Navigant analysis, 2015*

The C&I electric and gas technical potentials shown in Figure 3-1 and Figure 3-2, respectively, are broken out for each of the 13 C&I customer segments. The three customer segments providing the most technical potential for both electric and gas are offices, retail, healthcare segments. These customer segments also account for the greatest forecast gas sales in the commercial sector by 2025, which is consistent with their comparably large contribution to savings potential. Table 3-7 provides the magnitude of the C&I electric technical potential for each customer segment for 2016-2025. Table 3-8 provides comparable information for gas technical potential.

**Figure 3-4. Technical Potential by C&I Customer Segment in 2025 (Electric and Gas)**




*Source: Navigant analysis, 2015*

**Table 3-5. Electric Technical Potential by Residential Customer Segment (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Single Family** | 2,957 | 2,958 | 2,959 | 2,960 | 2,961 | 2,962 | 2,963 | 2,964 | 2,965 | 2,966 |
| **Multi-Family** | 297 | 296 | 297 | 298 | 270 | 270 | 271 | 272 | 273 | 274 |
| **Manufactured Home** | 290 | 288 | 290 | 292 | 260 | 262 | 264 | 265 | 267 | 269 |
| **Totals** | 3,545 | 3,543 | 3,547 | 3,551 | 3,491 | 3,495 | 3,498 | 3,502 | 3,505 | 3,509 |

*Source: Navigant analysis, 2015*

**Table 3-6. Gas Technical Potential by Residential Customer Segment (Million Therms/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Single Family** | 108.1 | 107.9 | 107.8 | 107.8 | 107.8 | 107.8 | 107.8 | 107.9 | 107.9 | 107.9 |
| **Multi-Family** | 3.1 | 3.1 | 3.1 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 |
| **Manufactured Home** | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| **Totals** | 111.9 | 111.7 | 111.7 | 111.7 | 111.7 | 111.7 | 111.8 | 111.8 | 111.8 | 111.9 |

*Source: Navigant analysis, 2015*

**Table 3-7. Electric Technical Potential by C&I Customer Segment (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Colleges/Universities** | 5.8 | 6.1 | 6.5 | 6.8 | 7.0 | 7.3 | 7.5 | 7.8 | 8.0 | 8.3 |
| **Healthcare** | 147.0 | 153.1 | 159.3 | 165.6 | 158.0 | 164.3 | 170.8 | 177.3 | 183.9 | 190.6 |
| **Lodging** | 80.6 | 82.3 | 83.9 | 85.5 | 84.6 | 86.1 | 87.6 | 89.2 | 90.7 | 92.3 |
| **Office-Large** | 396.4 | 405.9 | 415.6 | 425.3 | 418.4 | 428.4 | 439.9 | 451.9 | 463.8 | 475.6 |
| **Office-Small** | 106.7 | 106.9 | 107.2 | 107.5 | 102.9 | 103.2 | 103.8 | 104.4 | 105.0 | 105.6 |
| **Restaurants** | 51.7 | 52.3 | 53.0 | 53.6 | 48.1 | 48.7 | 49.4 | 50.0 | 50.6 | 51.2 |
| **Retail (Non-Food)** | 418.3 | 422.2 | 426.0 | 430.0 | 420.4 | 424.6 | 428.8 | 433.1 | 437.4 | 441.8 |
| **Retail - Food** | 353.8 | 356.8 | 359.9 | 363.1 | 364.5 | 367.7 | 371.0 | 374.3 | 377.8 | 381.2 |
| **Schools** | 66.9 | 68.7 | 70.1 | 71.3 | 71.9 | 72.9 | 73.7 | 74.5 | 75.3 | 76.0 |
| **Warehouses** | 15.7 | 15.8 | 15.8 | 15.8 | 13.6 | 13.7 | 13.7 | 13.8 | 13.8 | 13.9 |
| **Other Commercial** | 119.9 | 120.6 | 121.2 | 121.9 | 112.0 | 112.6 | 113.2 | 113.8 | 114.4 | 115.1 |
| **Industrial (net of opt-out)** | 113.8 | 113.3 | 112.9 | 112.5 | 112.1 | 111.7 | 111.4 | 111.0 | 110.6 | 110.2 |
| **Agriculture** | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| **Totals** | 1,877.1 | 1,904.5 | 1,931.9 | 1,959.3 | 1,914.0 | 1,941.7 | 1,971.2 | 2,001.5 | 2,031.9 | 2,062.3 |

*Source: Navigant analysis, 2015*

**Table 3-8. Gas Technical Potential by C&I Customer Segment (Million Therms/year)**

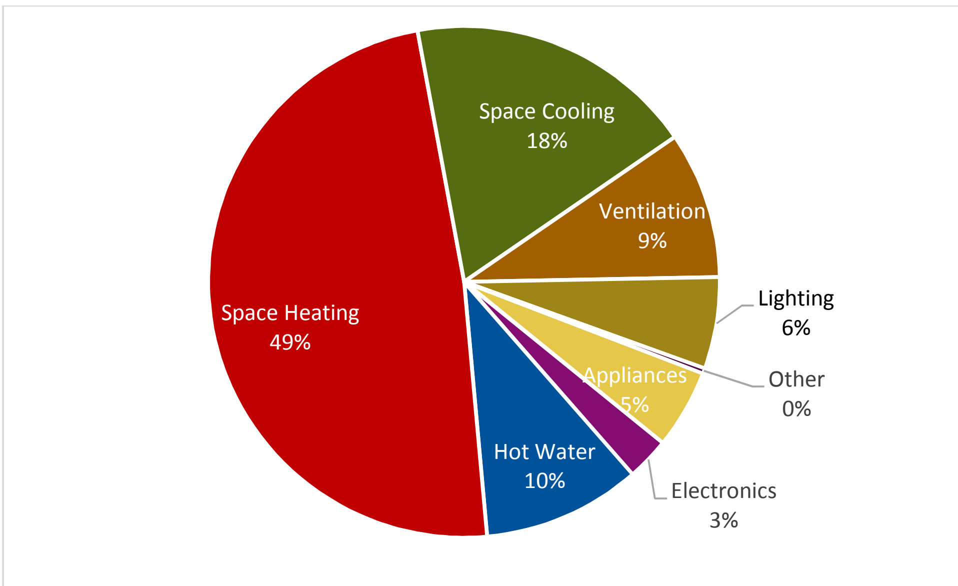
| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Colleges/Universities** | 0.33 | 0.33 | 0.33 | 0.33 | 0.34 | 0.34 | 0.34 | 0.34 | 0.35 | 0.35 |
| **Healthcare** | 2.32 | 2.41 | 2.51 | 2.60 | 2.70 | 2.79 | 2.89 | 2.99 | 3.09 | 3.19 |
| **Lodging** | 0.68 | 0.72 | 0.75 | 0.78 | 0.81 | 0.85 | 0.88 | 0.92 | 0.95 | 0.99 |
| **Office-Large** | 10.76 | 10.87 | 10.98 | 11.09 | 11.21 | 11.33 | 11.45 | 11.57 | 11.69 | 11.82 |
| **Office-Small** | 2.32 | 2.33 | 2.34 | 2.35 | 2.37 | 2.38 | 2.40 | 2.41 | 2.42 | 2.44 |
| **Restaurants** | 0.64 | 0.65 | 0.66 | 0.67 | 0.68 | 0.69 | 0.69 | 0.70 | 0.71 | 0.72 |
| **Retail (Non-Food)** | 5.03 | 5.11 | 5.20 | 5.28 | 5.36 | 5.45 | 5.54 | 5.63 | 5.72 | 5.81 |
| **Retail - Food** | 0.60 | 0.64 | 0.68 | 0.71 | 0.75 | 0.79 | 0.83 | 0.87 | 0.90 | 0.94 |
| **Schools** | 2.08 | 2.09 | 2.10 | 2.11 | 2.12 | 2.13 | 2.14 | 2.15 | 2.16 | 2.17 |
| **Warehouses** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Other Commercial** | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| **Industrial (net of opt-out)** | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| **Agriculture** | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| **Totals** | 24.90 | 25.28 | 25.67 | 26.07 | 26.47 | 26.88 | 27.29 | 27.71 | 28.14 | 28.57 |

*Source: Navigant analysis, 2015*

### 3.2.3 Results by End Use

Technical potential for electric is broken out by residential end use in Figure 3-5 and Table 3-9. The same information is provided for residential gas in Figure 3-6 and Table 3-10. Cooling, heating and ventilation measures account for just under three-fourths of the residential electric technical potential. Lighting and hot water measures make up another fifth while appliances and electronics make up the balance of technical potential. On the gas side, heating and ventilation also make up nearly two-thirds of the residential gas technical potential, while water heating accounts for roughly the other third. A comparatively small percentage of gas technical savings are achieved by the "appliances and other" and the "cross-cutting and behavioral" end uses.

**Figure 3-5. Electric Technical Potential by Residential End Use in 2025**



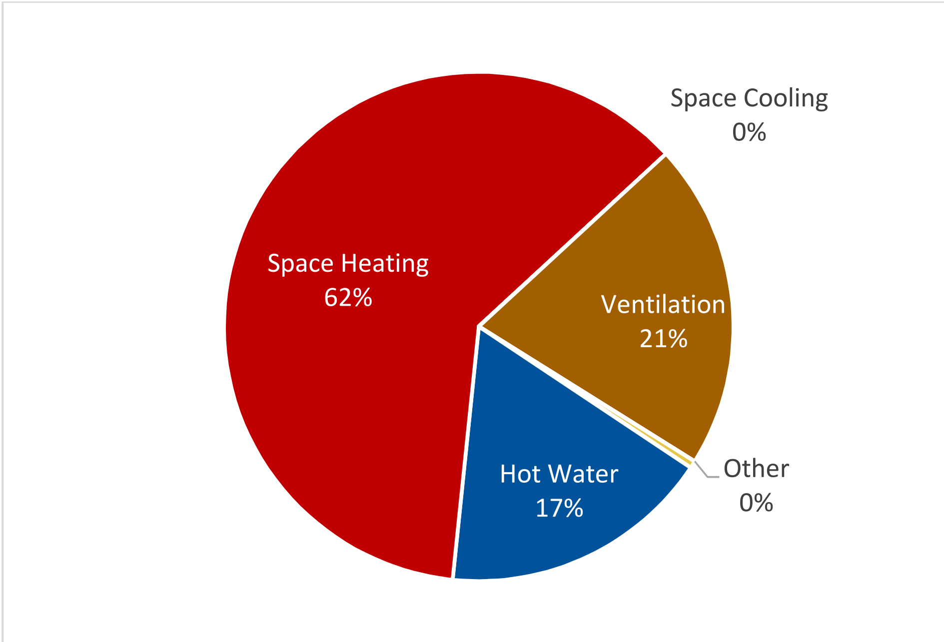

*Source: Navigant analysis, 2015*

**Table 3-9. Electric Technical Potential by Residential End Use (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Appliances** | 230 | 219 | 222 | 225 | 229 | 232 | 235 | 238 | 241 | 245 |
| **Electronics** | 129 | 130 | 130 | 130 | 131 | 131 | 131 | 132 | 132 | 133 |
| **Hot Water** | 443 | 448 | 453 | 458 | 463 | 468 | 473 | 478 | 483 | 489 |
| **Space Heating** | 728 | 726 | 723 | 721 | 719 | 717 | 715 | 713 | 711 | 709 |
| **Space Cooling** | 836 | 842 | 849 | 855 | 861 | 868 | 875 | 882 | 888 | 896 |
| **Ventilation** | 2,213 | 2,201 | 2,190 | 2,180 | 2,169 | 2,158 | 2,147 | 2,136 | 2,126 | 2,115 |
| **Lighting** | 724 | 732 | 739 | 746 | 279 | 280 | 281 | 281 | 282 | 283 |
| **Other** | 18 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| **Total** | 5,321 | 5,315 | 5,324 | 5,333 | 4,867 | 4,870 | 4,873 | 4,877 | 4,881 | 4,885 |

*Source: Navigant analysis, 2015*

**Figure 3-6. Gas Technical Potential by Residential End Use in 2025**




*Source: Navigant analysis, 2015*

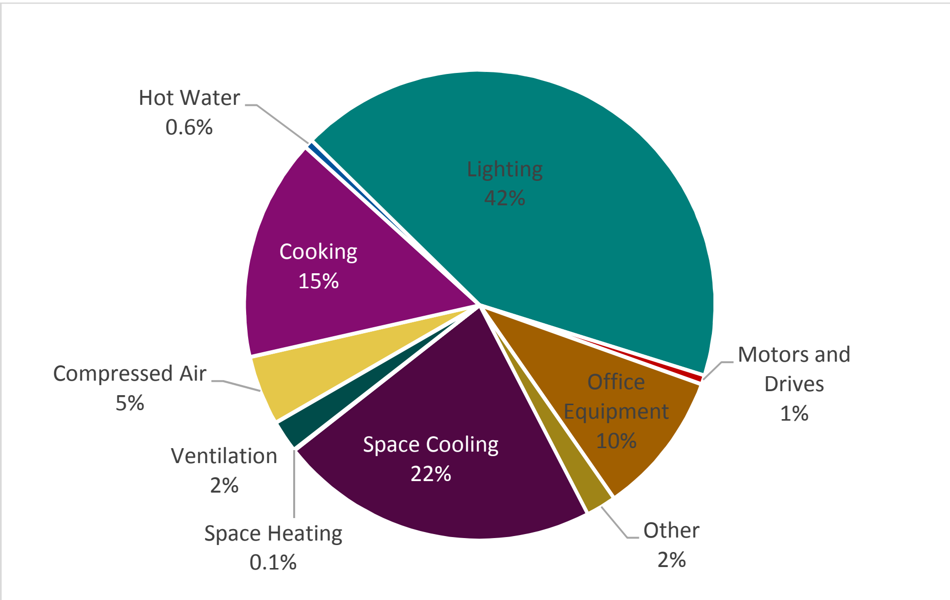
**Table 3-10. Gas Technical Potential by Residential End Use (Million Therms/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Appliances** | 0.7 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| **Hot Water** | 17.1 | 17.3 | 17.5 | 17.8 | 18.0 | 18.3 | 18.5 | 18.8 | 19.1 | 19.3 |
| **Space Heating** | 69.9 | 69.8 | 69.6 | 69.5 | 69.4 | 69.3 | 69.2 | 69.0 | 68.9 | 68.8 |
| **Ventilation** | 24.3 | 24.2 | 24.0 | 23.9 | 23.8 | 23.7 | 23.6 | 23.4 | 23.3 | 23.2 |
| **Total** | 111.9 | 111.7 | 111.7 | 111.7 | 111.7 | 111.7 | 111.8 | 111.8 | 111.8 | 111.9 |

*Source: Navigant analysis, 2015*

Figure 3-7 and Table 3-11 present the electric technical potential summarized by C&I end use category. Comparable information for gas is provided in Figure 3-8 and Table 3-12. The lighting and space cooling end uses make up nearly two-thirds of the C&I technical potential. Cooking and office equipment measures make up the bulk of the remaining technical potential on the electric side. For gas, space heating and cooking end uses are responsible for the vast majority of gas potential in the C&I sector.

**Figure 3-7. Electric Technical Potential by C&I End Use in 2025**



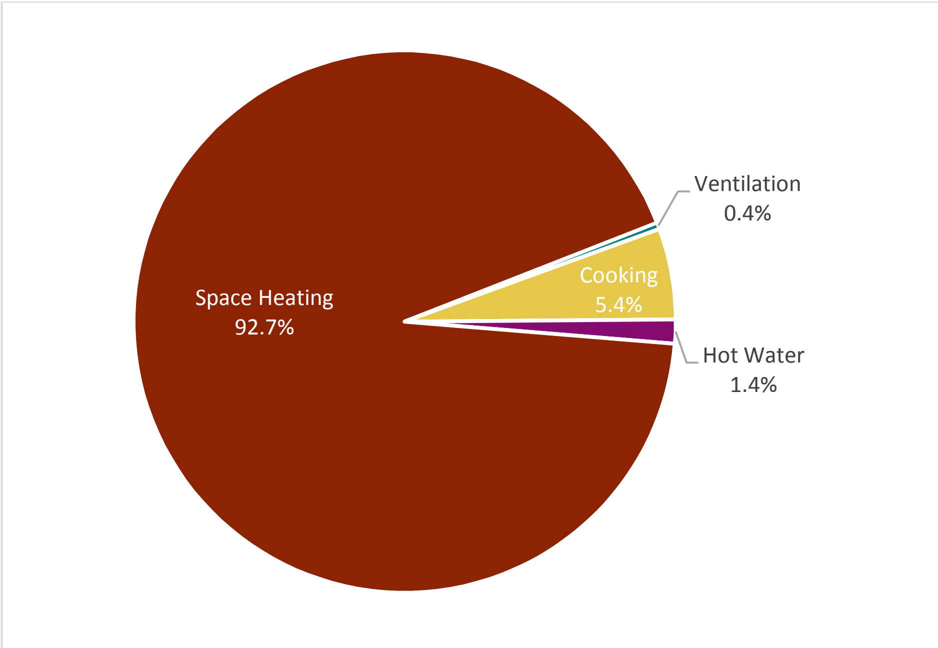

*Source: Navigant analysis, 2015*

**Table 3-11. Electric Technical Potential by C&I End Use (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Compressed Air** | 103 | 103 | 102 | 102 | 101 | 101 | 100 | 100 | 99 | 99 |
| **Cooking** | 321 | 320 | 319 | 319 | 318 | 317 | 317 | 316 | 316 | 315 |
| **Hot Water** | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 |
| **Lighting** | 913 | 917 | 920 | 924 | 854 | 857 | 862 | 867 | 871 | 876 |
| **Motors and Drives** | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 |
| **Office Equipment** | 207 | 207 | 206 | 206 | 206 | 205 | 205 | 204 | 204 | 204 |
| **Other** | 38 | 38 | 39 | 40 | 40 | 41 | 41 | 42 | 42 | 43 |
| **Space Cooling** | 227 | 252 | 276 | 300 | 325 | 350 | 376 | 401 | 427 | 453 |
| **Space Heating** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Ventilation** | 43 | 43 | 43 | 43 | 44 | 44 | 44 | 45 | 45 | 45 |
| **Total** | 1,877 | 1,905 | 1,932 | 1,959 | 1,914 | 1,942 | 1,971 | 2,002 | 2,032 | 2,062 |

*Source: Navigant analysis, 2015*

**Figure 3-8. Gas Technical Potential by C&I End Use in 2025**




*Source: Navigant analysis, 2015*

**Table 3-12. Gas Technical Potential by C&I End Use (Million Therms/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cooking** | 1.4 | 1.4 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 |
| **Hot Water** | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| **Space Heating** | 23.4 | 23.7 | 24.1 | 24.5 | 24.9 | 25.2 | 25.6 | 26.0 | 26.4 | 26.8 |
| **Ventilation** | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| **Total** | 25.3 | 25.7 | 26.0 | 26.4 | 26.8 | 27.2 | 27.7 | 28.1 | 28.5 | 28.9 |

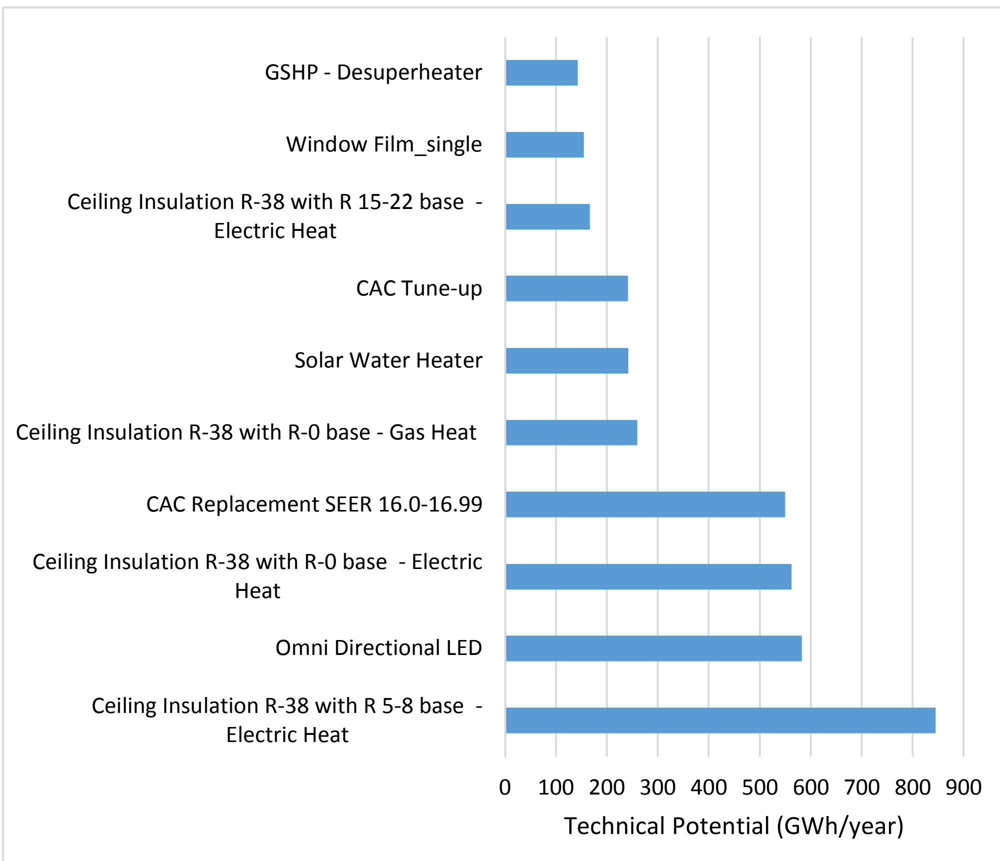
*Source: Navigant analysis, 2015*

### 3.2.4 Results by Measure

The measure-level electric and gas technical potential shown in this section are prior to adjustments made to competition groups. Some of these measures are not included in the customer segment, end use, sector and portfolio totals because they are not the measures with the greatest savings potential for their respective competition group.

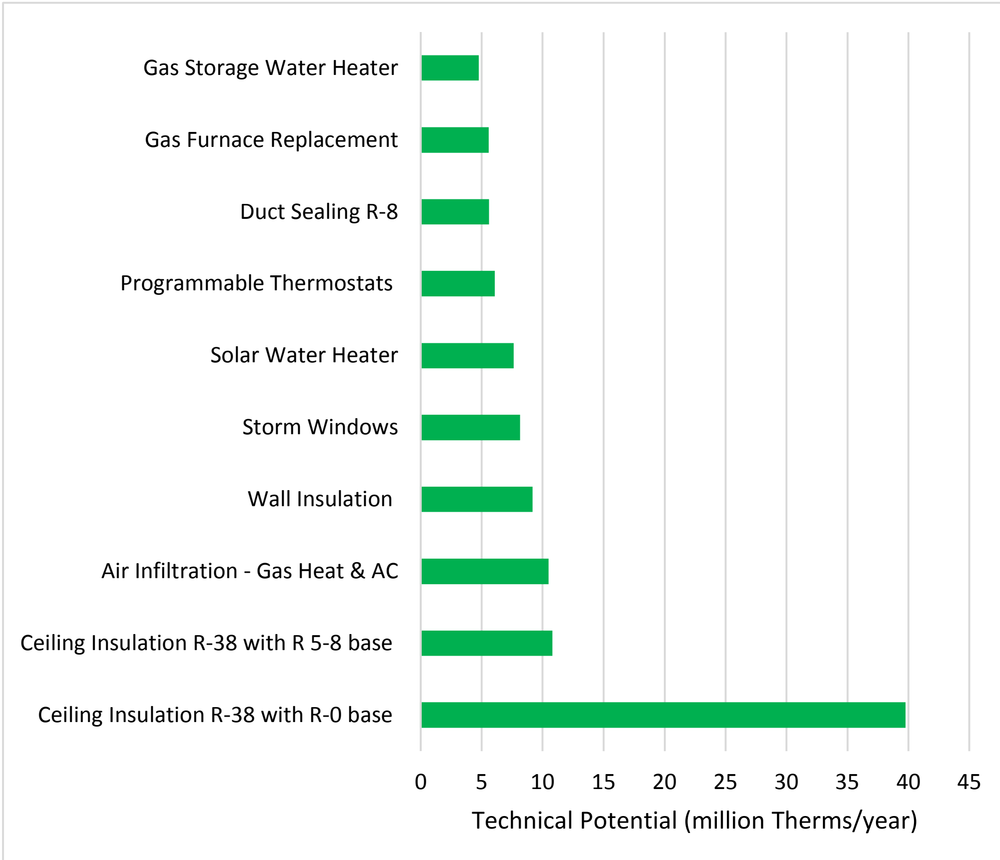
Figure 3-9 shows the top ranking electric residential measures along with their technical potential in 2016. Figure 3-10 shows the comparable information for gas residential measures. The highest impact electric measures for technical potential include ceiling insulation, LEDs, and high efficiency central AC. On the gas side, ceiling insulation, air infiltration, wall insulation, storm windows, and solar waters account for the majority of the residential gas technical potential savings.

**Figure 3-9. Top Residential Measures for Electric Technical Potential (GWh/year) - 2016**




*Source: Navigant analysis, 2015*

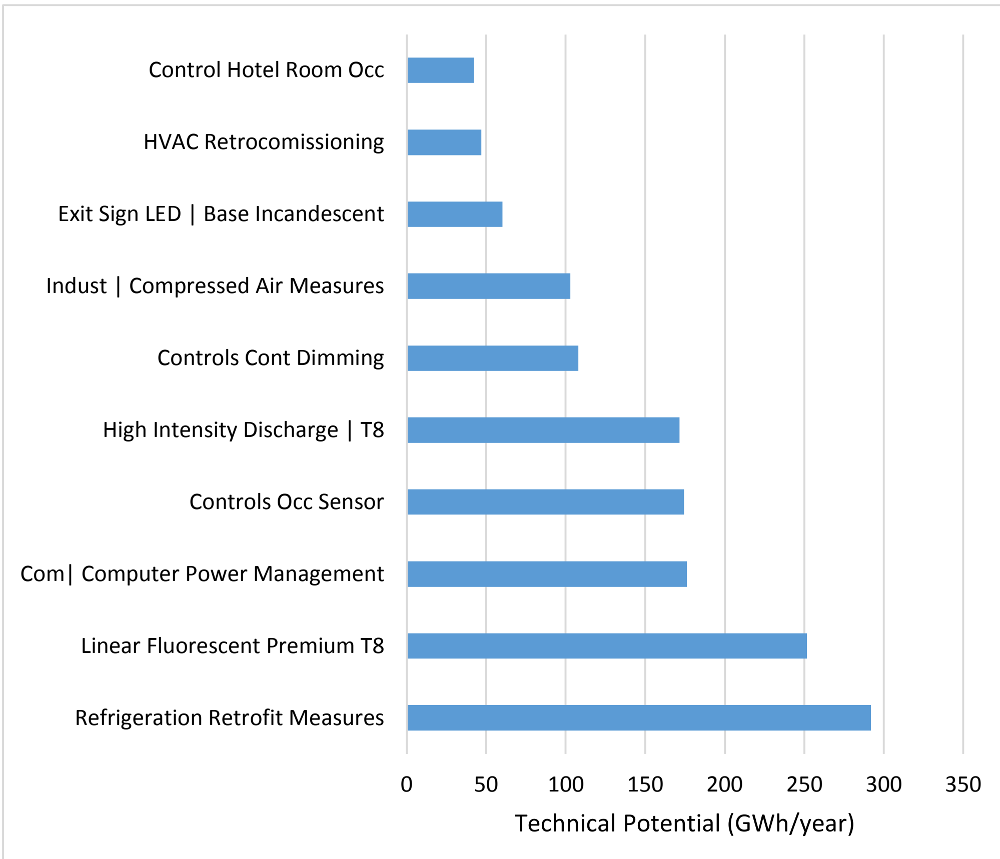
**Figure 3-10. Top Residential Measures for Gas Technical Potential (Million Therms/year) - 2016**




*Source: Navigant analysis, 2015*

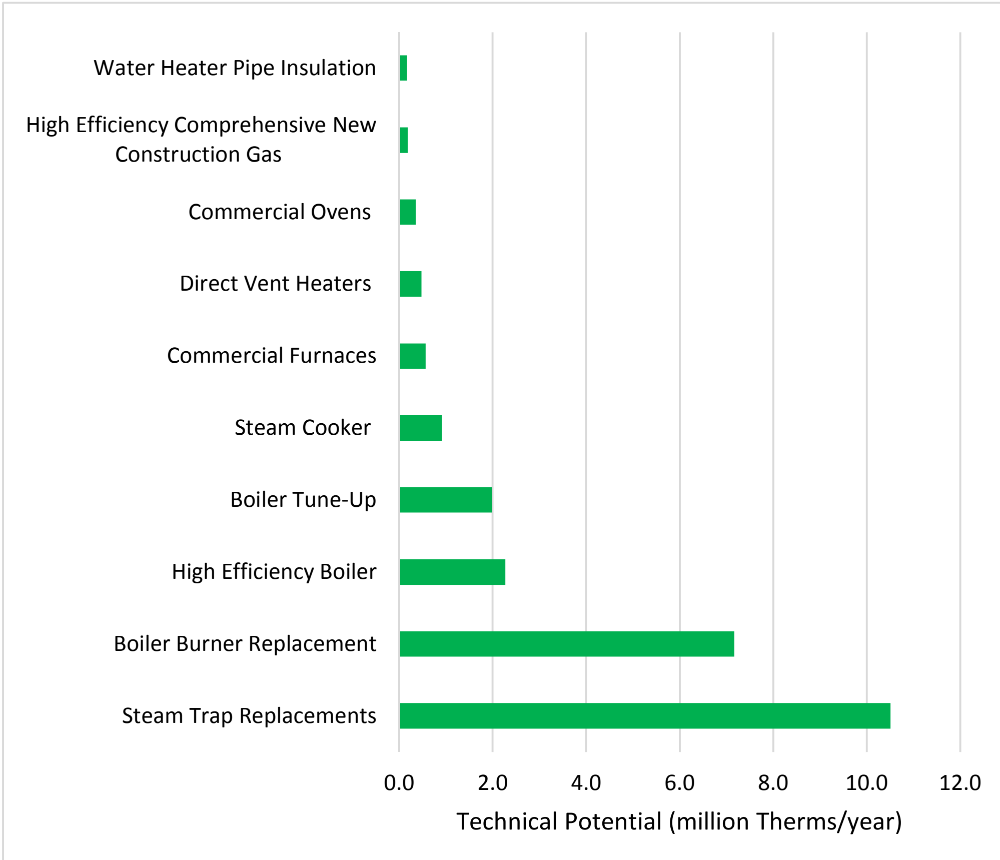
Figure 3-11 shows the top electric C&I measures ranked in order of their technical potential in 2016. Figure 3-12 shows the comparable information for gas C&I measures. For electric, the top measures for C&I technical potential include refrigeration retrofits, high efficiency fluorescent, computer power management, occupancy sensors, and HID lighting. For gas, the top measures include steam trap replacements and boiler burner replacements.

**Figure 3-11. Top C&I Measures for Electric Technical Potential (GWh/year)**




*Source: Navigant analysis, 2015*

**Figure 3-12. Top C&I Measures for Gas Technical Potential (Million Therms/year)**




*Source: Navigant analysis, 2015*

# 4 Economic Potential Forecast

This section describes the economic potential, which is potential that meets a prescribed level of cost effectiveness, available in the Arkansas IOU's service territories. The section begins by explaining Navigant's approach to calculating economic potential. It then presents the results for economic potential.

## 4.1 *Approach to Estimating Economic Potential*

Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but including only those measures that have passed the benefit-cost test chosen for measure screening (in this case the TRC test). The TRC ratio for each measure is calculated each year and compared against the measure-level TRC ratio screening threshold of 1.0. A measure with a TRC ratio greater than or equal to 1.0 is a measure that provides monetary benefits greater than or equal to its costs. If a measure's TRC meets or exceeds the threshold, it is included in the economic potential.

The TRC test is a cost-benefit metric that measures the net benefits of EE measures from the viewpoint of an entire service territory. The TRC benefit-cost ratio is calculated in the model using the following equation:

$$TRC = \frac{PV(Avoided\ Costs + O\&M\ Savings)}{PV(Technology\ Cost + Admin\ Costs)}$$

where:

*PV( )* is the present value calculation that discounts cost streams over time.

*Avoided Costs* are the net monetary benefits resulting from gas, electric and water savings (e.g., avoided costs of infrastructure investments, as well as avoided commodity costs due to energy and water conserved by efficient measures).

*Technology Cost* is the net incremental equipment cost to the customer.

*Administrative Costs* are the gross administrative costs incurred by the utility or program administrator. These costs typically include marketing, program staff, equipment, overhead, etc.

Navigant calculated TRC ratios for each measure based on the present value of benefits and costs (as defined above) over each measure's life. IOU-specific avoided costs,[25] discount rates, and other key data inputs used in the TRC calculation were provided by the utilities and are considered commercially confidential. Effects of free ridership are not present in the results from this study, so an NTG factor (100

[25] The IOU-specific avoided costs were classified as proprietary information. The IOUs provided their propriety avoided costs to Navigant under confidentiality provisions in the contract for this Potential Study. As such, IOU-specific values are not disclosed in this report. However, Navigant did rely on these avoided costs to conduct IOU-specific EE measure level screens which was an essential element in determining the economic and achievable potential estimates for each individual utility.

percent minus the free ridership rate) of 100 percent was applied. Gross savings, rather than net, are included in this report for several reasons. First, there was a desire that the results of this report be compatible with different NTG assumptions in the future, permitting separate calculation of net results as NTG assumptions are updated. Second, NTG assumptions can change with different assumptions regarding the program design, which is a scope that is outside of this study. Navigant expects that each of the utilities will calculate net savings separately, post Potential Study completion.
Although the TRC equation includes administrative costs, these costs are not considered during the economic screening process at the *measure-level*, because we are concerned with an individual measure's cost effectiveness "on the margin." Rather, administrative costs are only included in economic potential calculations when aggregating multiple measures into a program or portfolio. Administrative costs[26] are included in the TRC calculations used to determine achievable potential. Navigant's approach is consistent with the methodology described in the *California Standard Practice Manual*.[27]

Similar to technical potential, only one "economic" measure (meaning that its TRC meets the threshold) from each competition group is included in the summation of economic potential across measures (e.g., at the end use, customer segment, sector, service territory or total level). If a competition group is composed of more than one measure that passes the TRC test, then the economic measure that provides the greatest electric or gas savings potential is included in the summation of economic potential. This approach ensures that double-counting is not present in the reported economic potential, though economic potential for each individual measure is still calculated and reported.

## 4.2 *Economic Potential Results*

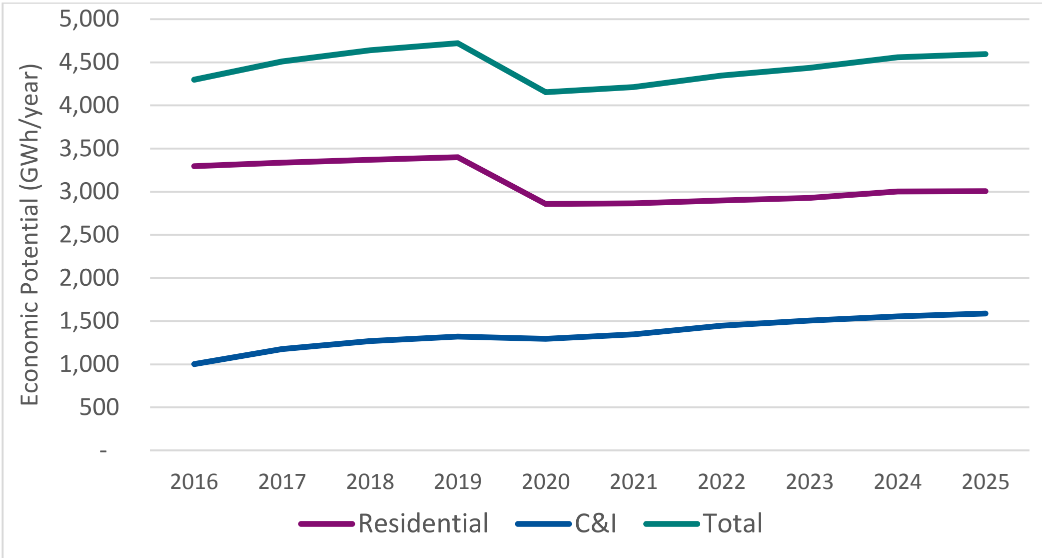
This sub-section provides DSMSim™ results pertaining to total economic potential at different levels of aggregation. Results are shown by sector, customer segment, end use and by highest-impact measures, and are reported for electric and gas.

### 4.2.1 Results by Sector

Figure 4-1 and Table 4-1 shows the electric economic potential by sector. Figure 4-2 and Table 4-2 provide the same information for the gas economic potential. The allocation of economic potential among sectors is comparable with the allocation of forecasted sales among sectors. As previously noted, all savings reported in this Potential Study are gross, rather than net, meaning that the effect of possible free ridership is not included in the reported savings.

[26] Administrative Costs are the gross administrative costs incurred by the utility or program administrator. These costs typically include marketing, program staff, equipment, overhead, etc.
[27] See *California Standard Practice Manual, Economic Analysis of Demand-Side Programs and Projects*. October, 2001, available at http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF

**Figure 4-1. Electric Economic Potential by Sector (GWh/year)**



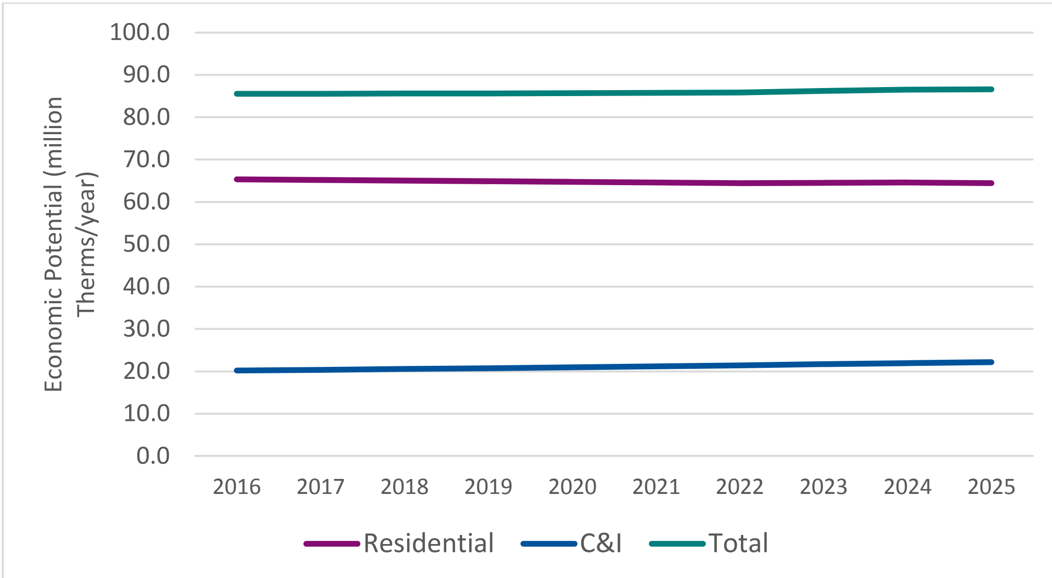

*Source: Navigant analysis, 2015*

**Table 4-1. Electric Economic Potential by Sector (GWh/year)**

| Year | Residential | C&I | Total |
|---|---|---|---|
| **2016** | 3,297 | 1,000 | 4,297 |
| **2017** | 3,335 | 1,175 | 4,510 |
| **2018** | 3,370 | 1,268 | 4,638 |
| **2019** | 3,398 | 1,321 | 4,719 |
| **2020** | 2,857 | 1,295 | 4,152 |
| **2021** | 2,867 | 1,346 | 4,212 |
| **2022** | 2,900 | 1,447 | 4,347 |
| **2023** | 2,927 | 1,507 | 4,434 |
| **2024** | 3,003 | 1,556 | 4,559 |
| **2025** | 3,006 | 1,588 | 4,594 |

*Source: Navigant analysis, 2015*

**Figure 4-2. Gas Economic Potential by Sector (Million Therms/year)**




*Source: Navigant analysis, 2015*

**Table 4-2. Gas Economic Potential by Sector (Million Therms/year)**

| Year | Residential | C&I | Total |
|---|---|---|---|
| **2016** | 65.4 | 20.2 | 85.5 |
| **2017** | 65.2 | 20.4 | 85.5 |
| **2018** | 65.0 | 20.5 | 85.6 |
| **2019** | 64.9 | 20.7 | 85.6 |
| **2020** | 64.7 | 21.0 | 85.7 |
| **2021** | 64.6 | 21.2 | 85.8 |
| **2022** | 64.4 | 21.4 | 85.8 |
| **2023** | 64.5 | 21.7 | 86.2 |
| **2024** | 64.6 | 21.9 | 86.5 |
| **2025** | 64.4 | 22.2 | 86.6 |

*Source: Navigant analysis, 2015*

Table 4-3 provides the electric economic potential as a percentage of sector sales net of self-directs. Table 4-4 provides comparable information for the gas economic potential. This perspective shows that the residential sector has the greatest economic potential as a percentage of sales for both electric and gas.

**Table 4-3. Electric Economic Potential as a Percentage of Sector Sales**

| Year | Residential | C&I | Total |
|---|---|---|---|
| **2016** | 29.3% | 7.0% | 16.9% |
| **2017** | 28.6% | 8.0% | 17.1% |
| **2018** | 28.6% | 8.5% | 17.4% |
| **2019** | 28.7% | 8.8% | 17.6% |
| **2020** | 24.0% | 8.6% | 15.4% |
| **2021** | 24.0% | 8.9% | 15.6% |
| **2022** | 24.1% | 9.5% | 16.0% |
| **2023** | 24.2% | 9.9% | 16.2% |
| **2024** | 24.6% | 10.1% | 16.5% |
| **2025** | 24.5% | 10.2% | 16.5% |

*Source: Navigant analysis, 2015*

**Table 4-4. Gas Economic Potential as a Percentage of Sector Sales**

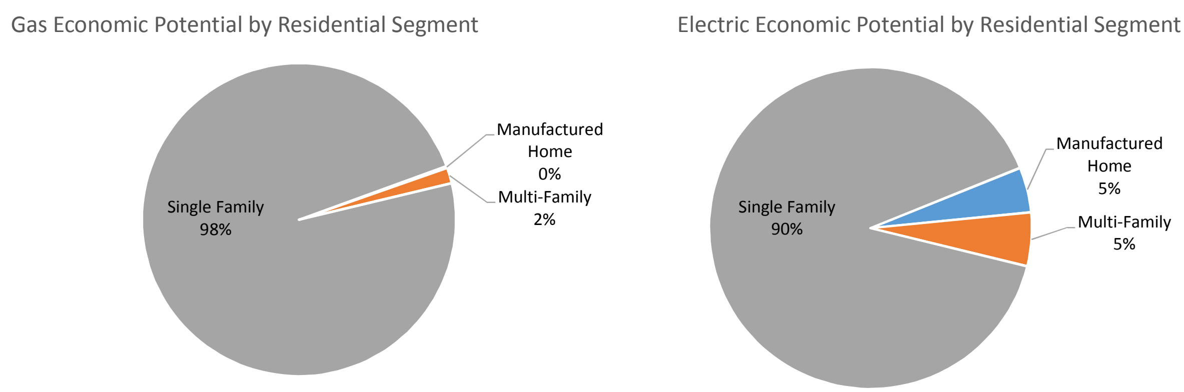
| Year | Residential | C&I | Total |
|---|---|---|---|
| **2016** | 18.7% | 7.6% | 13.9% |
| **2017** | 18.8% | 7.8% | 14.1% |
| **2018** | 18.8% | 7.9% | 14.1% |
| **2019** | 18.8% | 8.1% | 14.2% |
| **2020** | 18.9% | 8.2% | 14.3% |
| **2021** | 18.9% | 8.4% | 14.5% |
| **2022** | 18.9% | 8.6% | 14.6% |
| **2023** | 19.0% | 8.8% | 14.7% |
| **2024** | 19.1% | 9.0% | 14.9% |
| **2025** | 19.2% | 9.2% | 15.0% |

*Source: Navigant analysis, 2015*

### 4.2.2 Results by Customer Segment

The residential electric and gas economic potentials shown in Figure 4-1 and Figure 4-2, respectively, are broken out for each of the three residential customer segments in Figure 4-3. For the electric and gas economic potentials, the dominant segment is single family homes. This is due to residential electric and gas sales being largely driven by this customer segment, which is consistent with their comparably large contribution to potential. Table 4-5 provides the magnitude of the residential electric economic potential savings for each customer segment for 2016-2025. Table 4-6 provides comparable information for gas economic potential.

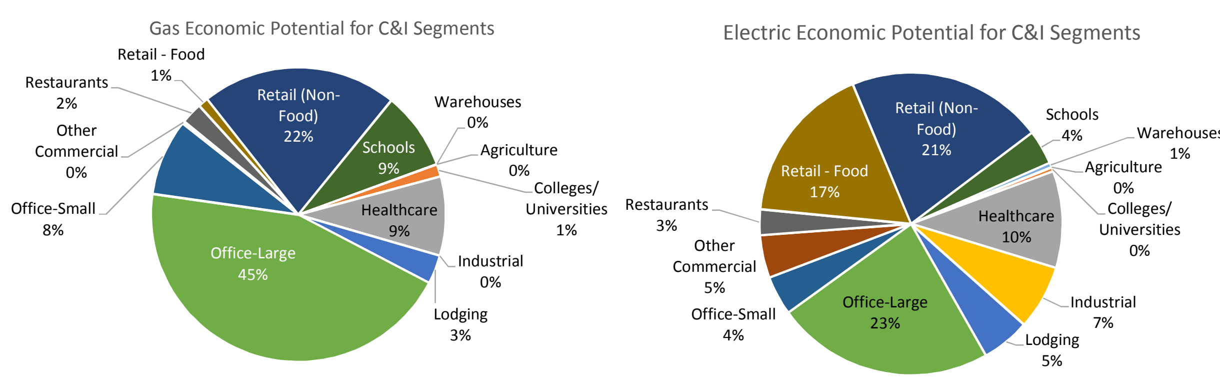
**Figure 4-3. Economic Potential by Residential Customer Segment in 2025 (Electric and Gas)**




*Source: Navigant analysis, 2015*

The C&I electric and gas economic potentials shown in Figure 4-1 and Figure 4-2, respectively, are broken out for each of the 13 C&I customer segments in Figure 4-4. The three customer segments providing the most economic potential are offices, retail, and healthcare segments. These customer segments also account for the greatest forecast gas sales in the commercial sector by 2025, which is consistent with their comparably large contribution to savings potential. Table 4-7 provides the magnitude of the C&I electric economic potential for each customer segment for 2016-2025. Table 4-8 provides comparable information for gas economic potential.

**Figure 4-4. Economic Potential by C&I Customer Segment in 2025 (Electric and Gas)**




*Source: Navigant analysis, 2015*

Table 4-5. Electric Economic Potential by Residential Customer Segment (GWh/year)

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Single Family** | 2,971 | 3,003 | 3,031 | 3,053 | 2,584 | 2,591 | 2,618 | 2,642 | 2,707 | 2,707 |
| **Multi-Family** | 177 | 179 | 183 | 185 | 152 | 153 | 155 | 157 | 162 | 162 |
| **Manufactured Home** | 148 | 153 | 156 | 160 | 121 | 122 | 127 | 128 | 135 | 136 |
| **Totals** | 3,297 | 3,335 | 3,370 | 3,398 | 2,857 | 2,867 | 2,900 | 2,927 | 3,003 | 3,006 |

*Source: Navigant analysis, 2015*

Table 4-6. Gas Economic Potential by Residential Customer Segment (Million Therms/year)

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Single Family** | 64.2 | 64.0 | 63.9 | 63.7 | 63.6 | 63.4 | 63.3 | 63.4 | 63.4 | 63.3 |
| **Multi-Family** | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.04 | 1.04 |
| **Manufactured Home** | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| **Totals** | 65.4 | 65.2 | 65.0 | 64.9 | 64.7 | 64.6 | 64.4 | 64.5 | 64.6 | 64.4 |

*Source: Navigant analysis, 2015*

**Table 4-7. Electric Economic Potential by C&I Customer Segment (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| Colleges/Universities | 3 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 7 | 7 |
| Healthcare | 72 | 91 | 117 | 123 | 116 | 128 | 135 | 144 | 158 | 164 |
| Lodging | 63 | 65 | 67 | 74 | 73 | 75 | 76 | 79 | 81 | 82 |
| Office-Large | 155 | 248 | 270 | 288 | 293 | 306 | 323 | 343 | 358 | 370 |
| Office-Small | 35 | 49 | 58 | 61 | 56 | 58 | 61 | 65 | 66 | 66 |
| Restaurants | 36 | 41 | 43 | 44 | 40 | 41 | 41 | 42 | 43 | 44 |
| Retail (Non-Food) | 268 | 283 | 293 | 299 | 286 | 299 | 309 | 319 | 328 | 333 |
| Retail - Food | 175 | 183 | 187 | 192 | 196 | 200 | 260 | 264 | 269 | 273 |
| Schools | 31 | 44 | 47 | 48 | 50 | 54 | 55 | 57 | 58 | 59 |
| Warehouses | 9 | 9 | 9 | 10 | 7 | 7 | 7 | 8 | 8 | 8 |
| Other Commercial | 55 | 57 | 70 | 71 | 60 | 62 | 62 | 70 | 71 | 73 |
| Industrial (net of opt-out) | 98 | 100 | 100 | 106 | 111 | 111 | 111 | 110 | 110 | 110 |
| Agriculture | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Totals | 1,000 | 1,175 | 1,268 | 1,321 | 1,295 | 1,346 | 1,447 | 1,507 | 1,556 | 1,588 |

*Source: Navigant analysis, 2015*

**Table 4-8. Gas Economic Potential by C&I Customer Segment (Million Therms/year)**

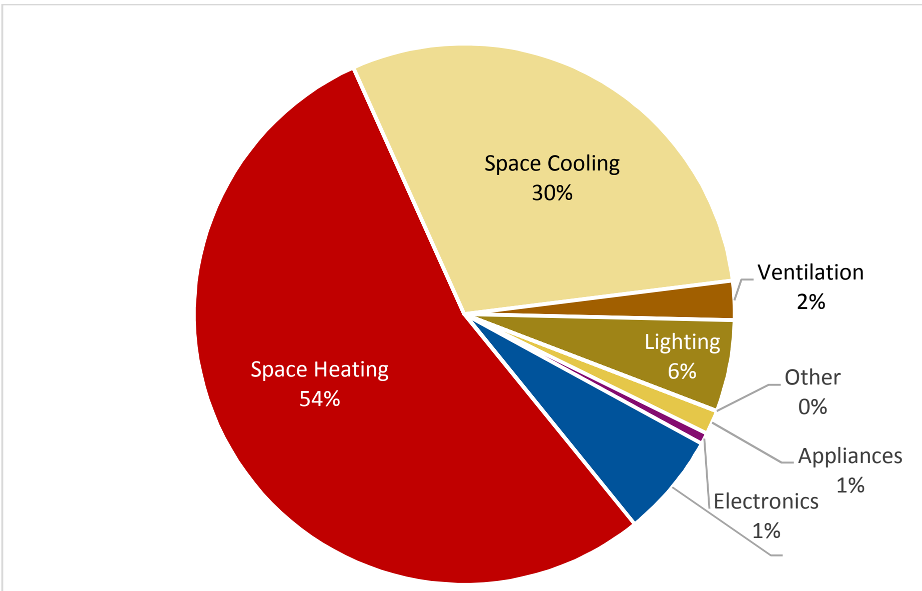
| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Colleges/Universities** | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| **Healthcare** | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 |
| **Lodging** | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| **Office-Large** | 8.8 | 8.9 | 9.0 | 9.1 | 9.2 | 9.4 | 9.5 | 9.7 | 9.8 | 9.9 |
| **Office-Small** | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.9 |
| **Restaurants** | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| **Retail (Non-Food)** | 4.4 | 4.4 | 4.5 | 4.5 | 4.6 | 4.6 | 4.6 | 4.7 | 4.7 | 4.8 |
| **Retail - Food** | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| **Schools** | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 |
| **Warehouses** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Other Commercial** | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| **Industrial (net of opt-out)** | - | - | - | - | - | - | - | - | - | - |
| **Agriculture** | - | - | - | - | - | - | - | - | - | - |
| **Totals** | 20.2 | 20.4 | 20.5 | 20.7 | 21.0 | 21.2 | 21.4 | 21.7 | 21.9 | 22.2 |

*Source: Navigant analysis, 2015*

### 4.2.3 Results by End Use

Economic potential for electric is broken out by residential end use in Figure 4-5 and Table 4-9. The comparable information is provided for residential gas in Figure 4-6 and Table 4-10. More than half of the potential for residential electric economic potential was found to be related to space heating and almost one-third more is related to space cooling opportunities. For natural gas, over 90% of the potential is associated with space heat, with the balance related to water heating.

**Figure 4-5. Electric Economic Potential by Residential End Use in 2025**



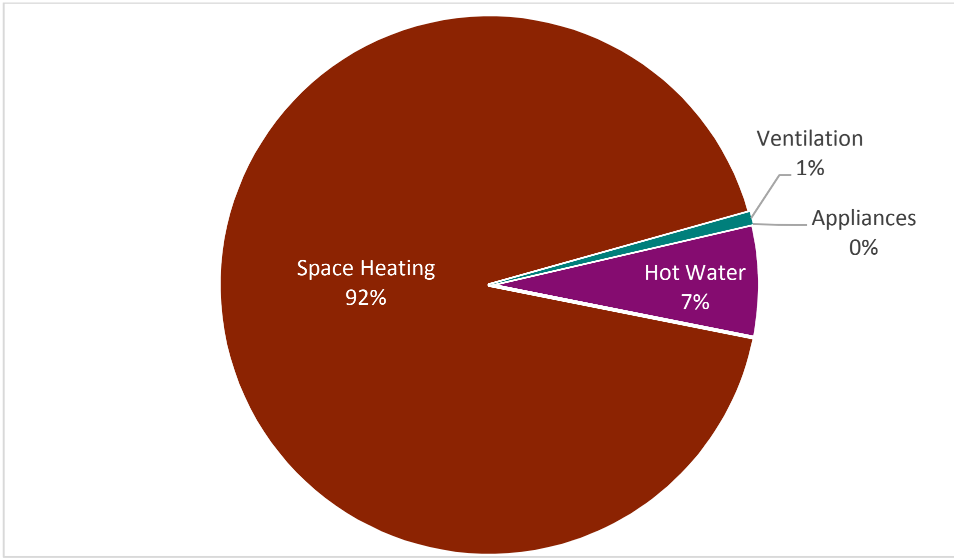

*Source: Navigant analysis, 2015*

**Table 4-9. Electric Economic Potential by Residential End Use (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Appliances** | 14 | 9 | 9 | 19 | 19 | 19 | 42 | 42 | 43 | 43 |
| **Electronics** | 13 | 13 | 12 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| **Hot Water** | 166 | 169 | 171 | 173 | 177 | 179 | 181 | 183 | 185 | 186 |
| **Space Heating** | 1,701 | 1,692 | 1,684 | 1,675 | 1,667 | 1,658 | 1,650 | 1,643 | 1,635 | 1,627 |
| **Space Cooling** | 785 | 827 | 844 | 854 | 860 | 867 | 873 | 880 | 887 | 894 |
| **Ventilation** | 37 | 37 | 36 | 36 | 36 | 36 | 47 | 71 | 71 | 71 |
| **Lighting** | 582 | 590 | 613 | 621 | 78 | 88 | 88 | 88 | 163 | 164 |
| **Other** | - | - | - | - | - | - | - | - | - | - |
| **Total** | 3,297 | 3,335 | 3,370 | 3,398 | 2,857 | 2,867 | 2,900 | 2,927 | 3,003 | 3,006 |

*Source: Navigant analysis, 2015*

**Figure 4-6. Gas Economic Potential by Residential End Use in 2025**




*Source: Navigant analysis, 2015*

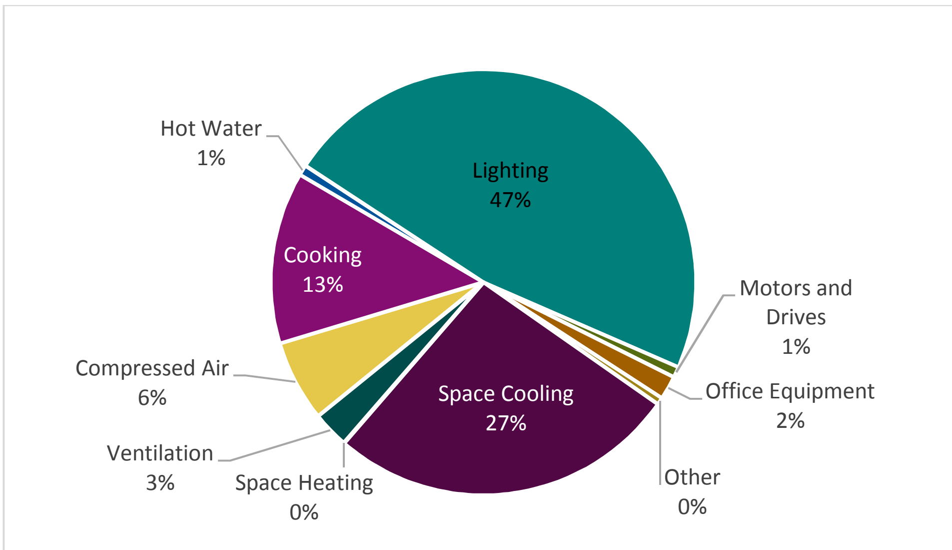
**Table 4-10. Gas Economic Potential by Residential End Use (Million Therms/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Appliances** | - | - | - | - | - | - | - | - | - | - |
| **Hot Water** | 3.8 | 3.9 | 3.9 | 4.0 | 4.0 | 4.1 | 4.2 | 4.2 | 4.3 | 4.3 |
| **Space Heating** | 61.1 | 60.8 | 60.6 | 60.4 | 60.2 | 60.0 | 59.8 | 59.8 | 59.8 | 59.6 |
| **Ventilation** | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| **Total** | 35.5 | 35.5 | 35.7 | 35.8 | 36.0 | 35.9 | 36.1 | 36.0 | 36.3 | 36.2 |

*Source: Navigant analysis, 2015*

Figure 4-7 and Table 4-11 present the electric economic potential summarized by C&I end use category. Comparable information for gas is provided in Figure 4-8 and Table 4-12. Lighting provides the greatest area of potential for electric efficiency followed by space cooling and cooking/food preparation related measures.

**Figure 4-7. Electric Economic Potential by C&I End Use in 2025**



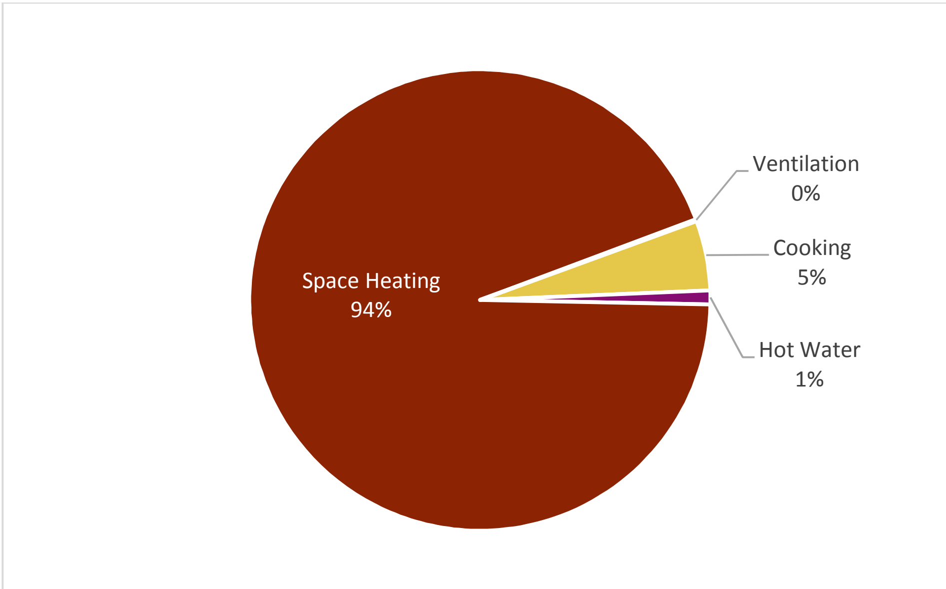

*Source: Navigant analysis, 2015*

**Table 4-11. Electric Economic Potential by C&I End Use (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Compressed Air** | 90 | 92 | 92 | 97 | 100 | 100 | 100 | 99 | 99 | 98 |
| **Cooking** | 142 | 151 | 151 | 151 | 151 | 151 | 208 | 208 | 208 | 208 |
| **Hot Water** | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 |
| **Lighting** | 605 | 726 | 750 | 759 | 685 | 696 | 713 | 728 | 745 | 751 |
| **Motors and Drives** | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 |
| **Office Equipment** | 4 | 4 | 6 | 7 | 7 | 7 | 7 | 23 | 29 | 29 |
| **Other** | 3 | 3 | 6 | 6 | 6 | 6 | 7 | 8 | 8 | 9 |
| **Space Cooling** | 93 | 134 | 198 | 235 | 279 | 318 | 345 | 371 | 397 | 423 |
| **Space Heating** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Ventilation** | 40 | 41 | 41 | 42 | 42 | 42 | 43 | 43 | 43 | 44 |
| **Total** | 1,000 | 1,175 | 1,268 | 1,321 | 1,295 | 1,346 | 1,448 | 1,507 | 1,556 | 1,588 |

*Source: Navigant analysis, 2015*

**Figure 4-8. Gas Economic Potential by C&I End Use in 2025**




*Source: Navigant analysis, 2015*

**Table 4-12. Gas Economic Potential by C&I End Use (Million Therms/year)**

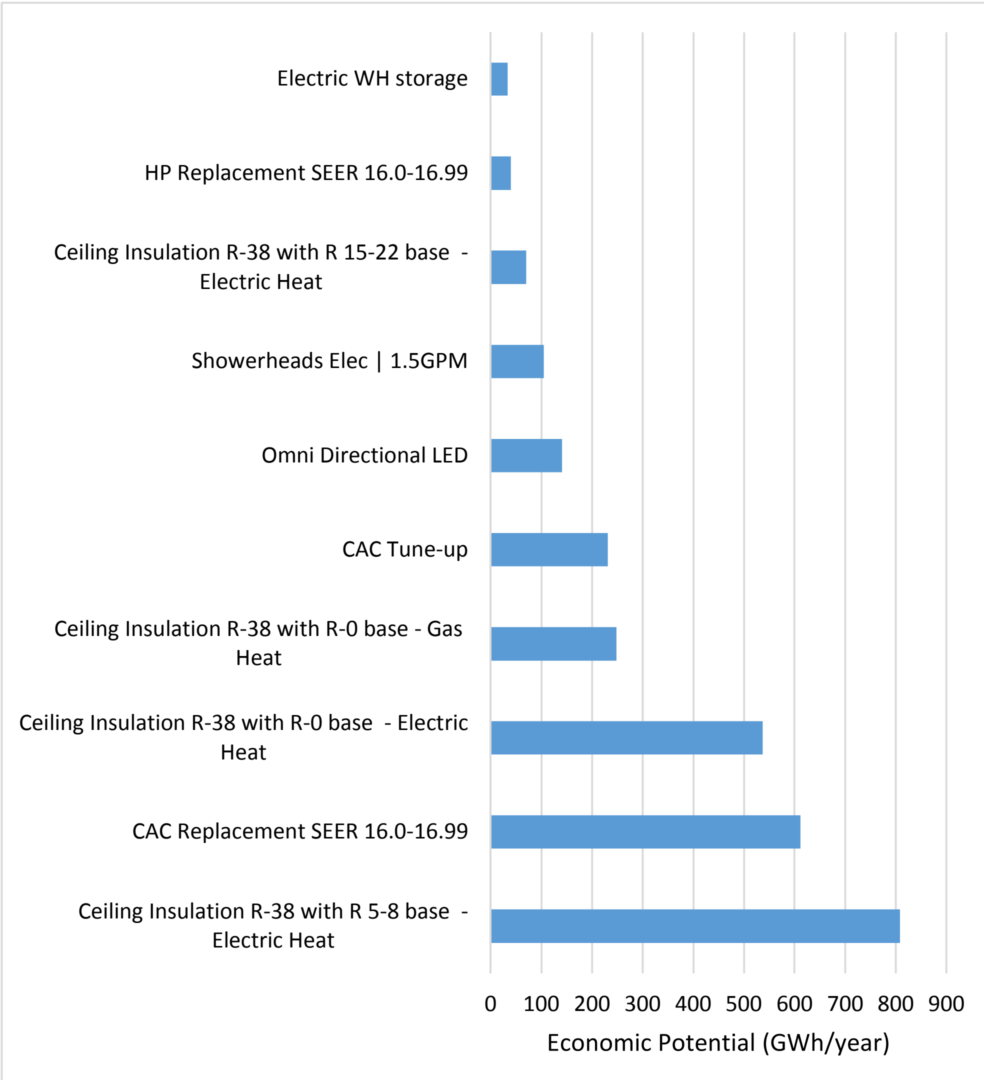
| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| Cooking | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 | 1.1 | 1.1 | 1.1 |
| Hot Water | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Space Heating | 19.0 | 19.2 | 19.3 | 19.5 | 19.7 | 19.9 | 20.1 | 20.4 | 20.6 | 20.8 |
| Ventilation | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 20.2 | 20.4 | 20.5 | 20.7 | 21.0 | 21.2 | 21.4 | 21.7 | 21.9 | 22.2 |

*Source: Navigant analysis, 2015*

### 4.2.4 Results by Measure

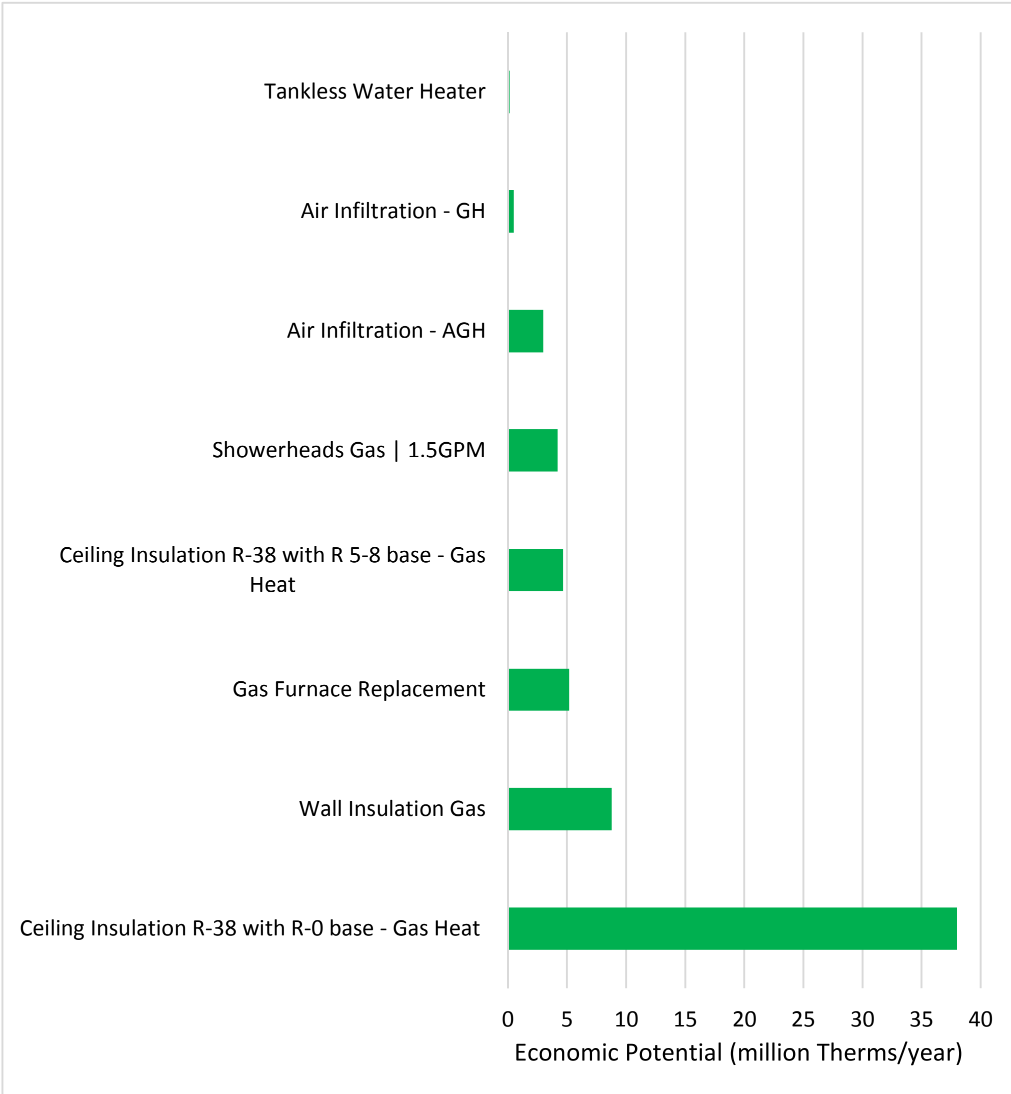
Figure 4-9 shows the top ranking electric residential measures along with their economic potential in 2025. The measures with the highest economic potential in the residential sector relate to space conditioning, including ceiling insulation, and CAC or heat pump replacements and tune-ups. Significant opportunities also exist for LED lighting and efficient showerheads. Figure 4-10 shows the comparable information for gas residential measures. The largest opportunities were found to lie in home weatherization measures, such as improved insulation and reductions in air infiltration, along with furnace replacements and more efficient showerheads.

**Figure 4-9. Top Residential Measures for Electric Economic Potential (GWh/year)**




*Source: Navigant analysis, 2015*

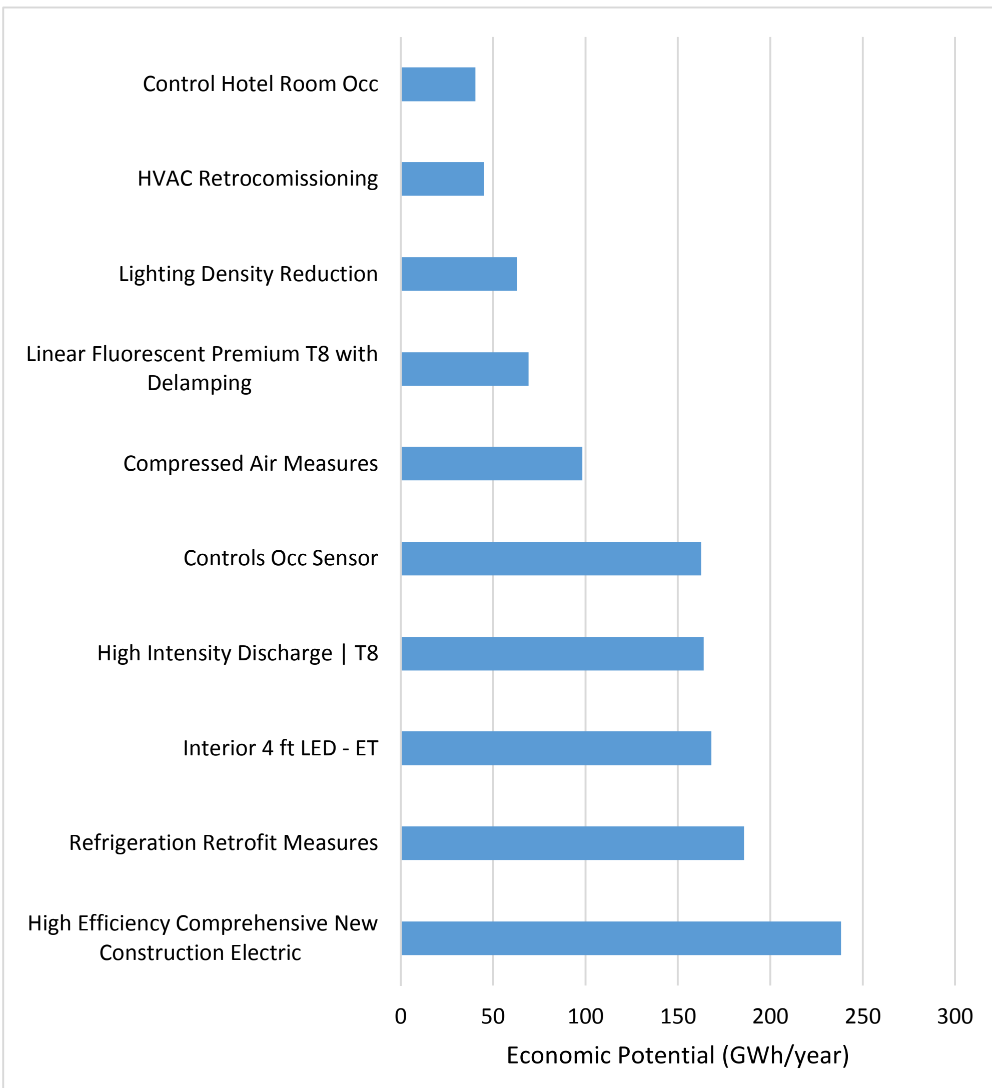
**Figure 4-10. Top Residential Measures for Gas Economic Potential (Million Therms/year)**




*Source: Navigant analysis, 2015*

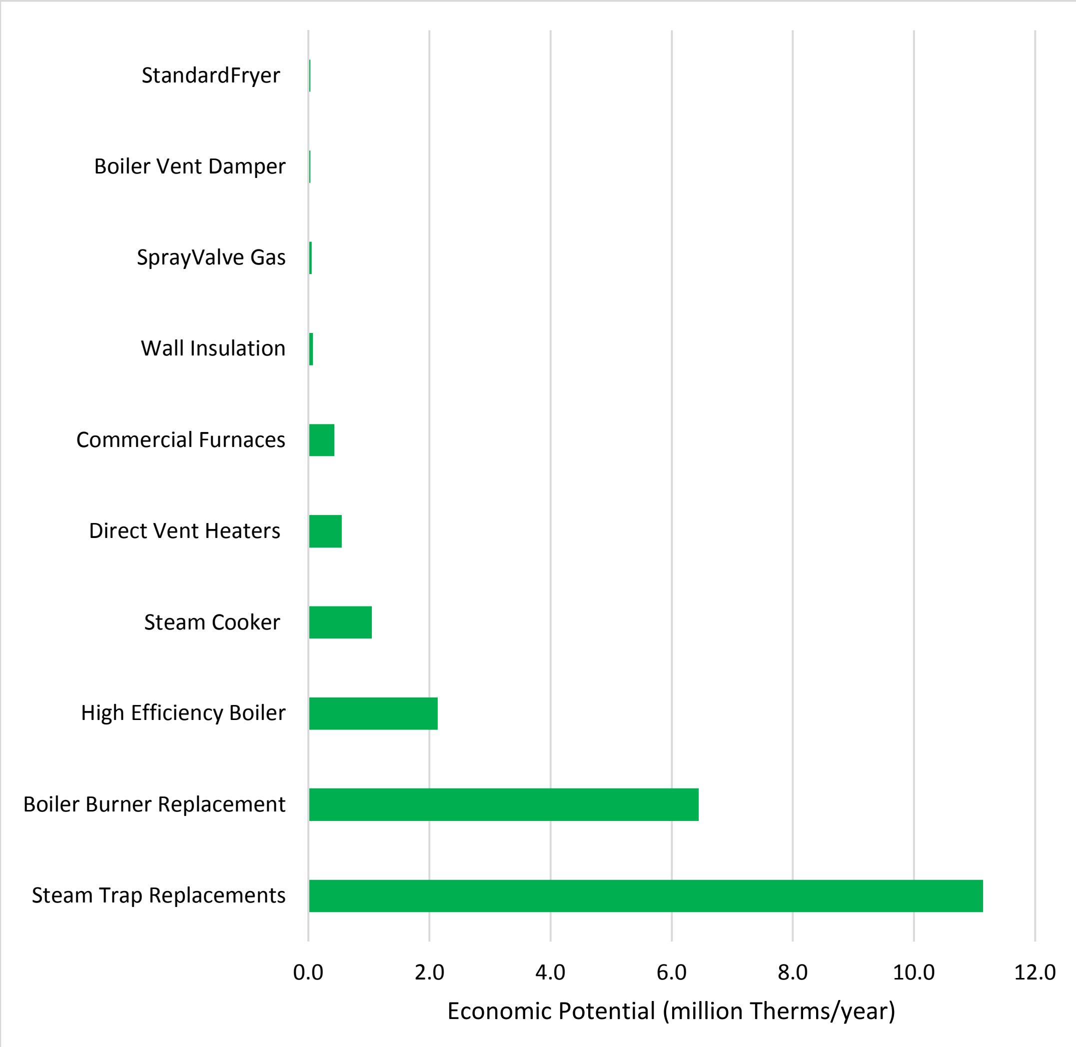
Figure 4-11 shows the top electric C&I measures ranked in order of their economic potential in 2025. The largest potential for C&I electric was found in improving the efficiency of new construction, followed by refrigeration and lighting measures, controls and compressed air measures. It should be noted that the potential for savings from lighting measures is significantly reduced starting in 2016 when the baseline for fluorescent lighting changes from T12 lamps to the more efficient T8 lamp. Figure 4-12 shows the comparable information for gas C&I measures. The top opportunities for C&I gas savings were found to be related to boiler systems (steam trap maintenance, burner replacements, high efficiency boilers) as well as furnace and direct vent heaters, and cooking measures.

**Figure 4-11. Top C&I Measures for Electric Economic Potential (GWh/year)**




*Source: Navigant analysis, 2015*

**Figure 4-12. Top C&I Measures for Gas Economic Potential (Million Therms/year)**




*Source: Navigant analysis, 2015*

# 5 Achievable Potential Forecast

This section contains details of the achievable potential analysis conducted by Navigant. Section 5.1 describes the approach to estimating achievable potential, including discussion of the various incentive approaches that were tested, the different budget scenarios, and finally the model calibration steps. Next, Section 5.2 provides achievable gas and electric savings estimates by sector, customer segment, end use, and measures for the mid-budget scenario. Section 5.3 follows with details of the estimated savings and associated budgets for the two other budget scenarios: high-budget and low-budget. Section 5.4 indicates the associated budgets under each the three scenarios. Finally, Section 5.5 offers the results of carbon sensitivity analyses conducted on the achievable potential estimates.

## *5.1 Approach to Estimating Achievable Potential*

This section provides a high-level summary of the approach to calculating achievable potential, which is fundamentally more complex than calculation of technical or economic potential. The adoption of EE measures can be broken down into calculation of the "equilibrium" market share and calculation of the dynamic approach to equilibrium market share.

### 5.1.1 Calculation of "Equilibrium" Market Share

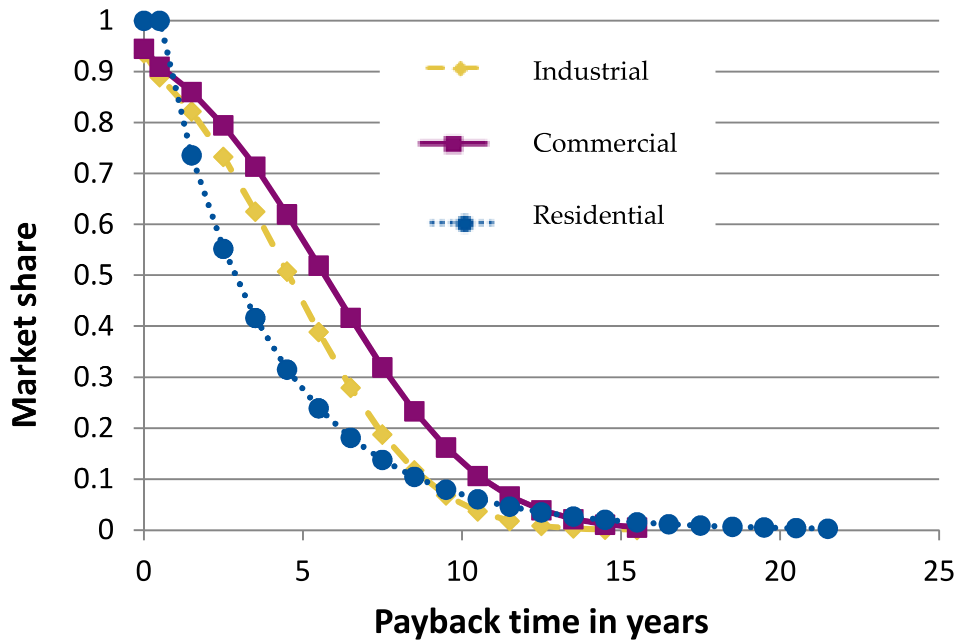
The equilibrium market share can be thought of as the percentage of individuals choosing to purchase a technology provided those individuals are fully aware of the technology and its relative merits (e.g., the energy- and cost-saving features of the technology). For EE measures, a key differentiating factor between the base technology and the efficient technology is the energy and cost savings associated with the efficient technology. Of course, that additional efficiency often comes at a premium in initial cost. In efficiency potential studies, equilibrium market share is thus often calculated as a function of the payback time of the efficient technology relative to the inefficient technology. While such approaches certainly have limitations, they are nonetheless directionally reasonable and simple enough to permit estimation of market share for the dozens or even hundreds of technologies that are often considered in potential studies.

In this Potential Study, Navigant used equilibrium "payback acceptance" curves that were developed using primary research conducted by Navigant in the US Midwest in 2012[28], supplemented where possible by the primary data that was collected for this project. To develop these curves, Navigant relied on surveys of 400 residential, 400 commercial, and 150 industrial customers. These surveys presented decision makers with numerous "choices" between technologies with low up-front costs, but high annual energy costs, and measures with higher up-front costs but lower annual energy costs. Statistical analysis was conducted by Navigant to develop the set of curves shown in Figure 5-1, which were used in this Potential Study. Navigant compared the results of primary data collection process carried out for Arkansas with the data used to estimate these curves to ensure that the curves used in the model were consistent with decision-making processes reported by Arkansas customers. Navigant compared the

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

results of primary data collection process carried out for Arkansas[29] with the data used to estimate these curves to ensure that the curves used in the model were consistent with decision-making processes reported by Arkansas customers. Based on this review Navigant did not modify the curves used in the model in estimating the potential for Arkansas.

**Figure 5-1. Payback Acceptance Curves**




*Source: Navigant*

Since the payback time of a technology can change over time, as technology costs and/or energy costs change over time, the "equilibrium" market share can also change over time. The equilibrium market share is therefore recalculated for every year of the forecast to ensure the dynamics of technology adoption take this effect into consideration. As such, "equilibrium" market share is a bit of an oversimplification and a misnomer, as it can itself change over time and is therefore never truly in equilibrium, but it is used nonetheless to facilitate understanding of the approach.

### 5.1.2 Calculation of the Approach to Equilibrium Market Share

Two approaches are used for calculating the approach to equilibrium market share, one for new technologies or those being modelled as RET measures, and one for technologies simulated as ROB, or

[29] Both the residential and C&I customer surveys included questions structured to determine the level of payback acceptance for an investment in EE. In the residential survey customers were asked how much they would be willing to pay for a light bulb which would save them $1 per year in energy costs. The C&I survey asked a series of questions about the level of payback required for an investment in EE and how that compared to other types of investments.

NEW measures.[30] A high-level overview of each approach is also provided below.

#### *5.1.2.1 Retrofit Technology Adoption Approach*

RET technologies employ an enhanced version of the classic Bass diffusion model[31,32] to simulate the S-shaped approach to equilibrium that is observed again and again for technology adoption. Figure 5-2 provides a stock/flow diagram illustrating the causal influences underlying the Bass model. In this model, market potential adopters "flow" to adopters by two primary mechanisms – adoption from external influences, such as marketing and advertising, and adoption from internal influences, or "word-of-mouth." The "fraction willing to adopt" was estimated using the payback acceptance curves illustrated in Figure 5-1.

The marketing effectiveness and word-of-mouth parameters for this diffusion model were estimated drawing upon case studies where these parameters were estimated for dozens of technologies[33]. Recognition of the positive, or self-reinforcing, feedback generated by the "word-of-mouth" mechanism is evidenced by increasing discussion of the concepts such as social marketing as well as the term "viral," which has been popularized and strengthened most recently by social networking sites such as Facebook and YouTube. However, the underlying positive feedback associated with this mechanism has been ever present and a part of the Bass diffusion model of product adoption since its inception in 1969.

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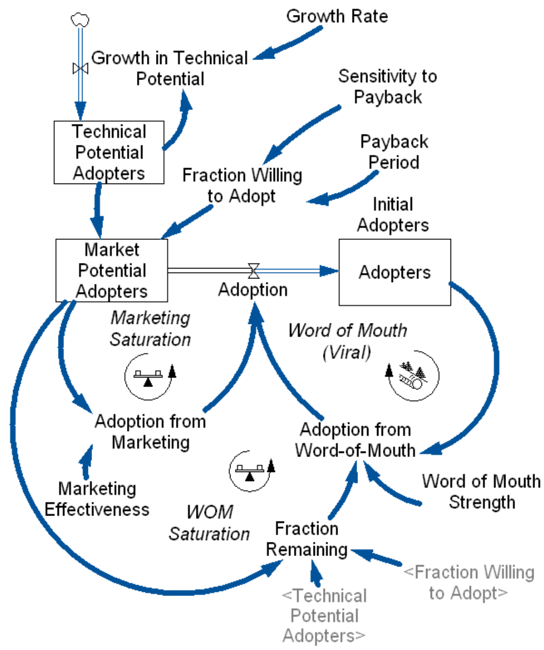
[30] Each of these approaches can be better understood by visiting Navigant's technology diffusion simulator, available at: [http://forio.com/simulate/navigantsimulations/technology-diffusion-simulation](http://forio.com/simulate/navigantsimulations/technology-diffusion-simulation).

[31] Bass, Frank (1969). "A new product growth model for consumer durables". Management Science 15 (5): p215–227.

[32] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill. 2000. p. 332.

[33] See Mahajan, V., Muller, E., and Wind, Y. (2000). New Product Diffusion Models. Springer. Chapter 12 for estimation of the Bass diffusion parameters for dozens of technologies. This model uses a value of 0.10 for the word-of-mouth strength in the base case scenario. The Marketing Effectiveness parameter for the base case scenario varied between 0.019 and 0.048, depending on the sector (values were determined as part of the calibration process). These values compare reasonably with the "most likely" value of 0.021 (75th percentile value is 0.055) per Mahajan 2000.

**Figure 5-2. Stock/Flow Diagram of Diffusion Model for New Products and Retrofits**



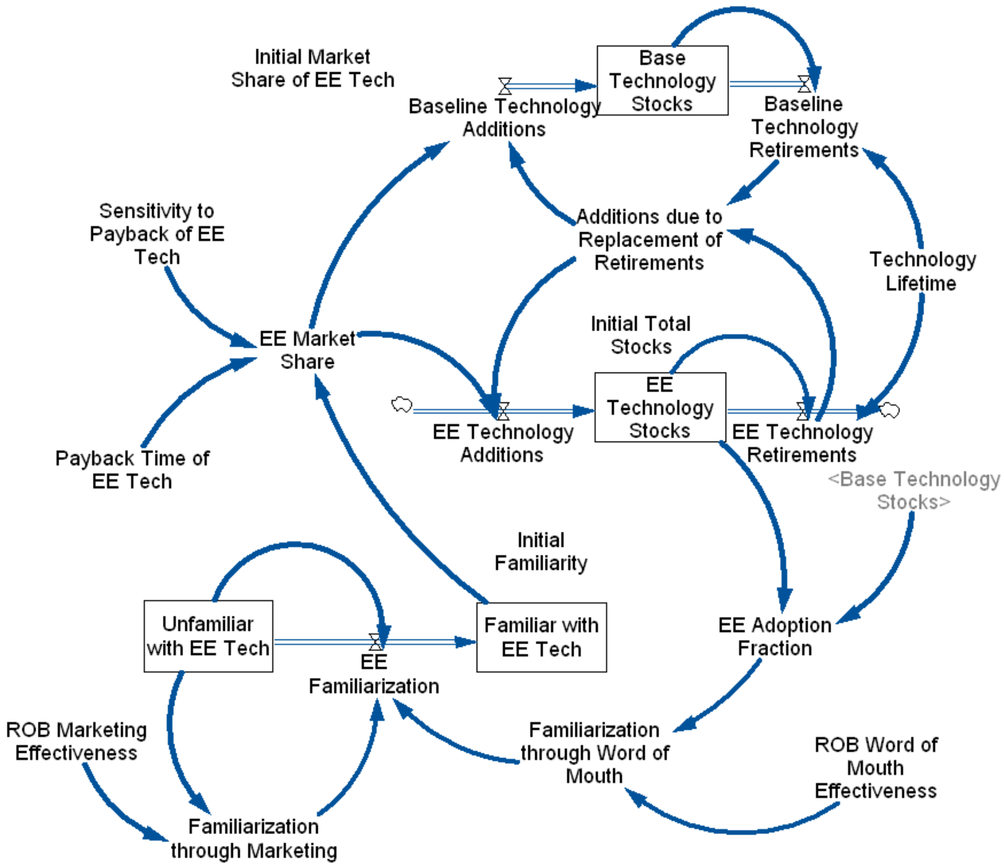

*Source: Navigant Consulting, Inc.*

The model illustrated above generates the commonly seen S-shaped growth of product adoption and is a simplified representation of that employed in DSMSim™.

### *5.1.2.2 Replace-on-Burnout Technology Adoption Approach*

The dynamics of adoption for ROB technologies is somewhat more complicated than for NEW/RET technologies since it requires simulating the turnover of long-lived technology stocks. The DSMSim™ model tracks the stock of all technologies, both base and efficient, and explicitly calculates technology retirements and additions consistent with the lifetime of the technologies. Such an approach ensures that technology "churn" is considered in the estimation of market potential, since only a fraction of the total stock of technologies are replaced each year, which affects how quickly technologies can be replaced. A model that endogenously generates growth in the familiarity of a technology, analogous to the Bass approach described above, is overlaid on the stock tracking model to capture the dynamics associated with the diffusion of technology familiarity. A simplified version of the model employed in DSMSim™ is illustrated graphically in Figure 5-3.

**Figure 5-3. Stock/Flow Diagram of Diffusion Model for ROB Measures**




*Source: Navigant Consulting, Inc.*

### 5.1.3 Determining the Incentive Approach

One of the most important drivers for estimating achievable potential is the approach that is taken for modeling incentives. During various discussions with the PWC over the course of this project, Navigant presented a number of methodologies for addressing achievable potential. The initial proposal put forth by Navigant was to analyze various incentive approaches based on industry practice to estimate achievable potential and then ultimately select one approach that would serve as the reference case for what would essentially comprise the "mid-level" funding scenario of achievable potential. From there, Navigant would then conduct scenarios to see what the potential would be under the high- and low-funding scenarios.

Drawing from Arkansas Commission policy requirements governing EE efforts by the IOUs, all EE measures must be cost-effective and overall design must meet requirement for "comprehensiveness". The Commission Comprehensiveness Checklist[34] outlines these requirements. Three specific items pertain to this Potential Study:

- Item 3) "Whether the programs and/or portfolio, reasonably address all major end-uses of electricity or natural gas, or electricity and natural gas, as appropriate;"
- Item 4) "Whether the programs and/or portfolio, to the maximum extent reasonable, comprehensively address the needs of customers at one time, in order to avoid cream-skimming and lost opportunities;" and
- Item 6) "Whether the programs and/or portfolio enables the delivery of all achievable, cost-effective energy efficiency within a reasonable period of time and maximizes net benefits to customers and to the utility system."

Concerns were expressed by some PWC participants that selecting one approach over another could lead to the possibility that all feasible and cost-effective achievable savings might not be fully considered or that the process might result in a savings potential that does not comport with these policies. As such, Navigant considered a variety of incentive approaches for the analysis. Based on our experience, three possible incentive approaches for achievable potential were considered:

- Approach #1: Least Cost based on Levelized Cost – This approach is similar to a least cost dispatch of supply where the incentive amounts are set to accept all available efficiency measures up to a certain levelized cost criteria that is tied to avoided cost. The approach is described in detail in Welch, Richerson-Smith (2012). This approach first reduces the incentive levels (from a starting point of 100 percent) for those measures that are most expensive on a levelized cost basis. Measures that exceed this levelized cost will have incentives lower than 100 percent in proportion to their levelized cost. It is entirely possible that some measures would be so cost-effective from a levelized cost perspective that rebates that go to as high as 100 percent of incremental cost could be included.
- Approach #2: Percentage of Incremental Cost – This is where the rebate levels are set as a fixed percentage of the incremental cost. Under this approach, the level of savings would be achieved by paying some level (say at 50 or 70 percent) of incremental costs. It would be possible to set

[34] Arkansas PSC Docket No. 08-144-U.

the rebates at different levels, depending on the sector or end-uses that are modeled. For example, there may be policy reasons why it would make sense to set rebate levels at higher amounts for end-uses that would target markets that are in the "highly inefficient" category.

» Approach #3: Payback Buy-down – This approach optimizes the payback of specific measures and uses rebate amounts to in effect buy down the incremental cost of the EE measure to an acceptable level.

Based on Navigant's past EE potential modeling experiences, there are pros and cons to each approach. Navigant discussed each approach with the PWC. It was determined that Approach #1 would not likely align with the Commission's "comprehensiveness" requirements. The two other approaches were tested and the outputs were reviewed with the PWC.

The results of the test for the two remaining approaches (percent of incremental cost vs. payback buy down) revealed that there were no significant differences between the results of the two different approaches. Essentially the estimate of achievable potential based on a payback buy down approach or providing incentives as a percentage of incremental cost yielded a very similar distribution of potential across end uses and customer segments. The payback buy down approach yielded slightly more comprehensive results in that less of the potential was derived from lighting and more from other measures.

As requested by the PWC, Navigant took the further step of reviewing the net present value (NPV) of the incentives paid under the two methods. Navigant's conclusion was that the payback method yielded slightly higher net benefits, particularly with the residential sector. Navigant concluded that the Payback method most closely matched the policy requirements for comprehensiveness and maximum net benefits. As such, Navigant proceeded to estimate the remaining budget cases and sensitivity analyses using the Payback Buy down approach.

### 5.1.4 Modeling the three Budget Scenarios

The RFP for this Potential Study indicated that Achievable Potential would be represented for three funding scenarios: high, mid and low. The mid funding scenario was deemed to represent a business as usual case, whereby the IOUs would continue implementing their EE programs at comparable funding levels and for the most part continue to realize the energy savings that they have experienced from the past.[35] The high funding scenario reflects increases in customer incentives that will lead to greater numbers of participants for the EE programs, increased program administration budgets to reflect greater levels of marketing, and ultimate increases in customer awareness. The low funding scenario reflects decreases in customer incentives that will lead to fewer numbers of participants of the EE

[35] Note that the results of the mid funding scenario ultimately did not achieve the intended outcome for C&I-Electric. The resultant budgets derived through the DSMSim™ model in 2016 were significantly below the historical budgets in 2014 for this sector. For the other sector-fuel segments (Res-Electric, Res-Gas, and C&I-Gas), comparable budget levels were observed through the model outputs in 2016 relative to the historical budgets from 2014. The factors that led to this outcome are explained in the sector-specific results below.

programs, decreased program administration budgets, and resulting decreases in customer awareness.[36]

The specific parameter adjustments for each scenario are indicated below:

- High funding scenario:
  - Incentive fraction: Set to the highest allowable level (90 percent) for all measures.
  - Fixed administration budgets: Increased 25 percent to reflect stepped up marketing and other programmatic activities due to higher volume.
  - Marketing factors: Increased approximately 38 percent relative to the comparable value for the mid-funding scenario.
- Low Funding Scenario:
  - Incentive fraction: Set to 25 percent below the weighted average incentive fraction derived from the mid funding scenario.
  - Fixed administration budgets: Decreased 25 percent to reflect budget cuts for marketing and other programmatic activities due to lower volume of participants.
  - Marketing factors: Decreased approximately 25 percent relative to the comparable value for the mid-funding scenario.

### 5.1.5 Model Calibration

Any model simulating *future* product adoption faces challenges with "calibration," as there is no future world against which one can compare simulated with actual results. Engineering models, on the other hand, can often be calibrated to a higher degree of accuracy since simulated performance can be compared directly with performance of actual hardware. Unfortunately, DSM potential models do not have this luxury, and therefore must rely on other techniques to provide both the developer and the recipient of model results with a level of comfort that simulated results are reasonable. For this Potential Study, Navigant took a number of steps to ensure that forecast model results were reasonable, including:

» Comparing 2016 forecast values, by program, against historic achieved savings for the past several years, considering drivers of differences likely caused by changes in the measures.

» Calculating 2016 forecast spending per savings ($/therm or $/kWh saved -- both first year and lifetime savings) costs for each program and comparing against results for the past several years.

» Calculating 2016 forecast portfolio-level savings as a percentage of gas sales and comparing them with results observed in other jurisdictions.

Navigant adjusted model parameters including assumed incentive levels and technology diffusion coefficients to obtain close agreement across a wide variety of metrics compared for the "base case" scenario. This process ensures that forecast potential is grounded against real-world results considering the many factors that come into play in determining likely adoption of EE measures, including both economic and non-economic factors.

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[36] To capture the increased customer awareness in the DSMSim™ model, adjustments are made to the *Marketing Factors*. These adjustments are based on product diffusion literature. See Mahajan, V., Muller, E., and Wind, Y. (2000). New Product Diffusion Models. Springer. Chapter 12.

## 5.2 *Mid-Level Achievable Potential Savings Results*

This sub-section provides DSMSim™ results pertaining to electric and gas achievable potential at different levels of aggregation. Results are shown by sector, customer segment, end use and by highest-impact measures.

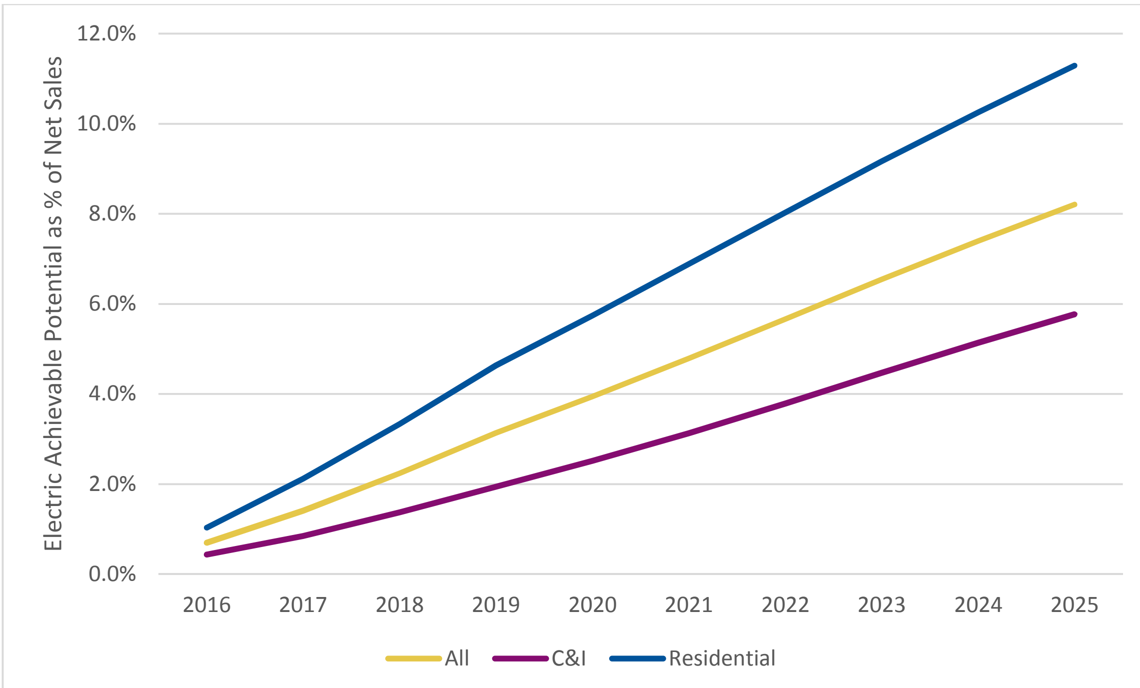
### 5.2.1 Overall Achievable Potential by Sector

As shown in Figure 5-4 and Table 5-1, achievable potential, which accounts for the rate of EE acquisition, grows to 8.2 percent of forecast net[37] electric sales in 2025, or 0.8 percent per year on average over the 10-year study horizon, under the "mid-level" achievable potential scenario. Figure 5-6 and Table 5-3 provide the comparable information for gas, with savings growing to 7.2 percent of forecast gas sales in 2025, or 0.7 percent per year on average over the 10-year study horizon. Note that Table 5-1 includes the "mid-level" achievable potential as a percentage of forecast gross electric sales in 2025. Figure 5-5 and Table 5-2 provides the comparable estimates for gas achievable potential.

Values shown below for achievable potential are termed "cumulative achievable" potential, in that they represent the accumulation of each year's annual achievable (e.g., an annual achievable potential of 0.8 percent per year, for ten years, would result in a cumulative achievable potential of 8 percent of forecast sales). Economic potential, as defined in this study, can be thought of as a bucket of potential from which programs can draw over time. Achievable potential represents the draining of that bucket, the rate of which is governed by a number of factors, including the lifetime of measures (for ROB technologies), market effectiveness, incentive levels, and customer willingness to adopt, among others. If the cumulative achievable potential ultimately reaches the economic potential, it would signify that all economic potential in the "bucket"' had been drawn down, or harvested. We also see that achievable electric potential reaches 8.2 percent of forecast sales by 2025, meaning that roughly 49 percent of economic potential (which is 17 percent of sales in 2025) has been harvested by the end of the Potential Study period. For gas, achievable potential reaches 7.2 percent of forecast sales by 2025, meaning that roughly 55 percent of economic potential (which is 15 percent of sales in 2025) has been harvested by the end of the Potential Study period.

[37] Net represents sales net of self-direct customers. Gross represents total sales inclusive of all customers, including self-directs.

**Figure 5-4. Total Electric Cumulative Potential as a Percentage of Forecast Electric Sales Net of Self-Directs**



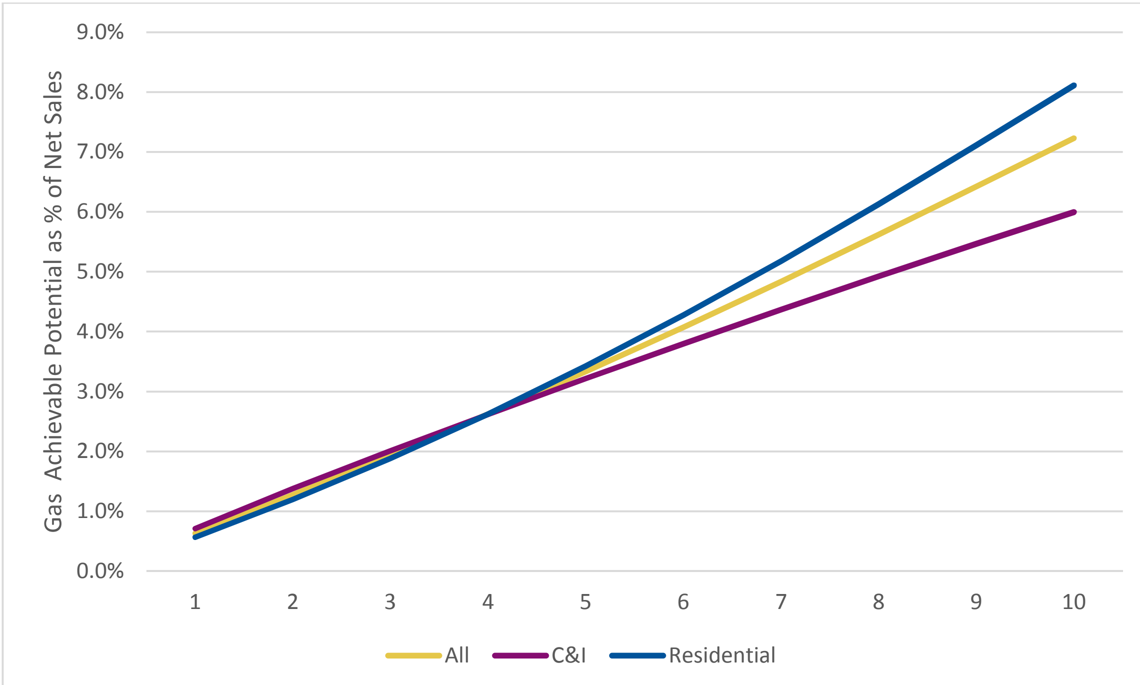

*Source: Navigant analysis, 2015*

**Table 5-1. Total Electric Cumulative Potential as a Percentage of Electric Sales**

| Year | Percent of Net Sales* | | | Percent of Gross Sales** | | |
|---|---|---|---|---|---|---|
| | Residential | C&I | Total | Residential | C&I | Total |
| **2016** | 1.0% | 0.4% | 0.7% | 1.0% | 0.4% | 0.6% |
| **2017** | 2.1% | 0.9% | 1.4% | 2.1% | 0.8% | 1.3% |
| **2018** | 3.3% | 1.4% | 2.2% | 3.3% | 1.2% | 2.1% |
| **2019** | 4.6% | 1.9% | 3.1% | 4.6% | 1.8% | 3.0% |
| **2020** | 5.7% | 2.5% | 3.9% | 5.7% | 2.3% | 3.7% |
| **2021** | 6.9% | 3.1% | 4.8% | 6.9% | 2.8% | 4.5% |
| **2022** | 8.0% | 3.8% | 5.7% | 8.0% | 3.4% | 5.3% |
| **2023** | 9.2% | 4.5% | 6.5% | 9.2% | 4.0% | 6.2% |
| **2024** | 10.3% | 5.1% | 7.4% | 10.3% | 4.6% | 7.0% |
| **2025** | 11.3% | 5.8% | 8.2% | 11.3% | 5.2% | 7.7% |

* Net sales excludes sales to self-direct customers.
** Gross sales includes sales to self-direct customers.
*Source: Navigant analysis, 2015*

**Figure 5-5. Total Gas Cumulative Potential as a Percentage of Forecast Gas Sales Net of Self-Directs**




*Source: Navigant analysis, 2015*

**Table 5-2. Total Gas Cumulative Potential as a Percentage of Gas Sales**

| Year | Percent of Net Sales* | | | Percent of Gross Sales** | | |
|---|---|---|---|---|---|---|
| | Residential | C&I | Total | Residential | C&I | Total |
| **2016** | 0.6% | 0.7% | 0.6% | 0.6% | 0.4% | 0.4% |
| **2017** | 1.2% | 1.4% | 1.3% | 1.2% | 0.9% | 1.0% |
| **2018** | 1.9% | 2.0% | 1.9% | 1.9% | 1.2% | 1.5% |
| **2019** | 2.6% | 2.6% | 2.6% | 2.6% | 1.6% | 2.1% |
| **2020** | 3.4% | 3.2% | 3.3% | 3.4% | 2.0% | 2.7% |
| **2021** | 4.3% | 3.8% | 4.1% | 4.3% | 2.4% | 3.2% |
| **2022** | 5.2% | 4.4% | 4.8% | 5.2% | 2.7% | 3.9% |
| **2023** | 6.1% | 4.9% | 5.6% | 6.1% | 3.1% | 4.5% |
| **2024** | 7.1% | 5.5% | 6.4% | 7.1% | 3.4% | 5.2% |
| **2025** | 8.1% | 6.0% | 7.2% | 8.1% | 3.8% | 5.8% |

* Net sales excludes sales to self-direct customers.

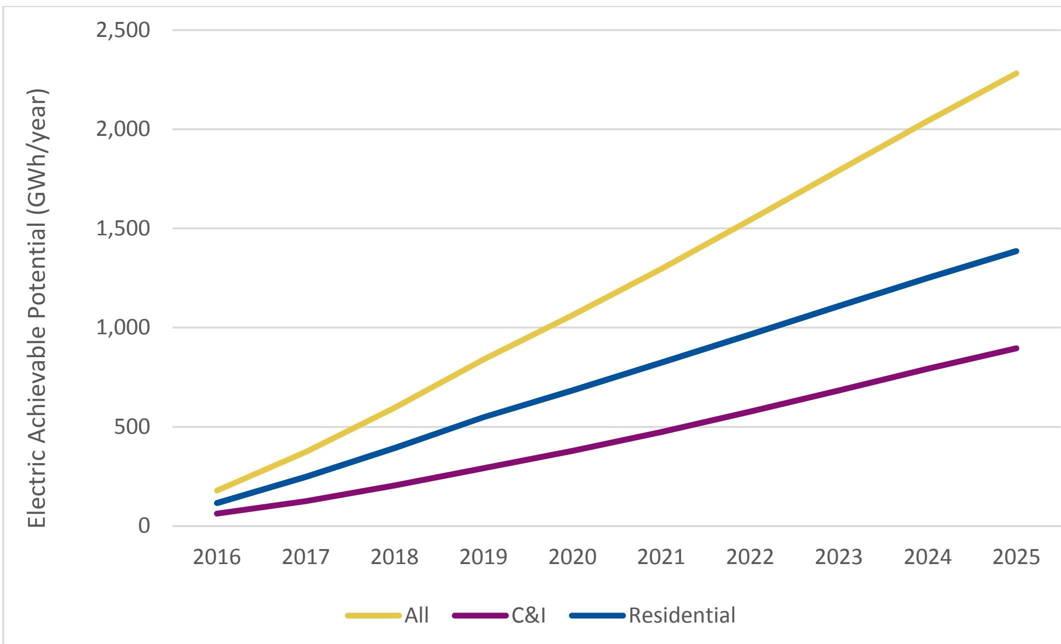
** Gross sales includes sales to all customers, including self-directs.

*Source: Navigant analysis, 2015*

Figure 5-6 and Table 5-3 shows the magnitude of electric achievable potential by sector. Figure 5-7 and Table 5-4 provides the comparable information for the gas achievable potential. The allocation of achievable potential among sectors is comparable with the allocation of forecasted sales among sectors. As previously noted, all savings reported in this Potential Study are gross, rather than net, meaning that the effect of possible free ridership is not included in the reported savings.

For electricity, the potential was found to be greatest in the residential sector (as a % of sales). The potential in the C&I sector has been diminished by changes to lighting standards, which have reduced the potential for program driven savings. For natural gas, the potential is more balanced between sectors.

**Figure 5-6. Electric Achievable Potential by Sector (GWh/year)**



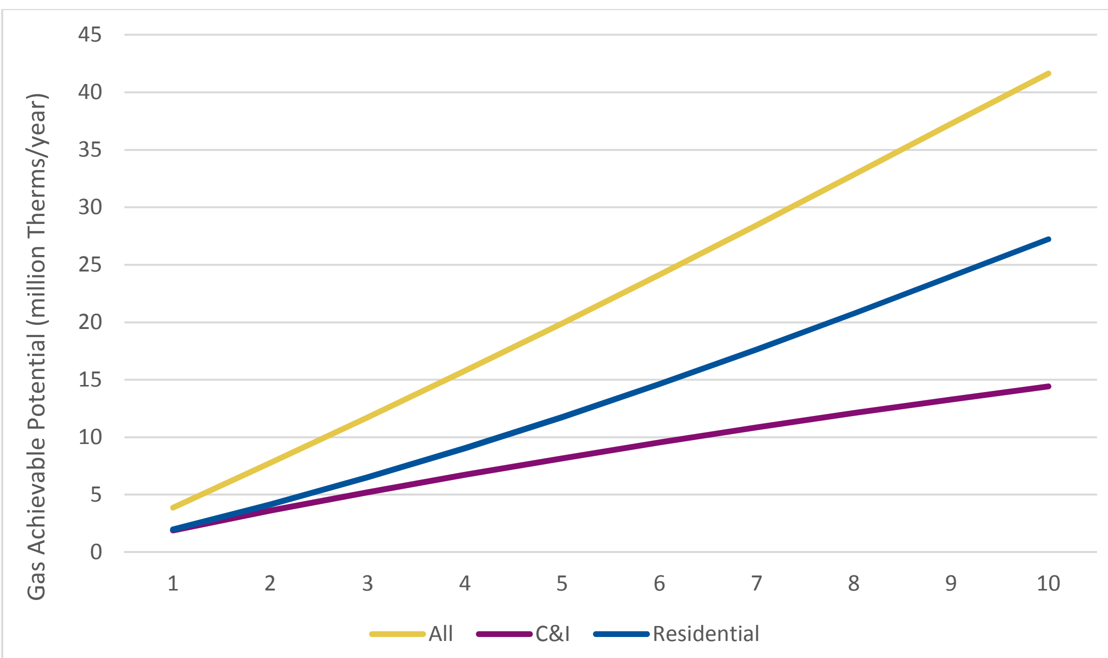

*Source: Navigant analysis, 2015*

**Table 5-3. Electric Achievable Potential by Sector (GWh/year)**

| Year | Residential | C&I | Total |
|---|---|---|---|
| **2016** | 116 | 62 | 178 |
| **2017** | 248 | 125 | 373 |
| **2018** | 392 | 204 | 597 |
| **2019** | 548 | 291 | 839 |
| **2020** | 683 | 379 | 1,062 |
| **2021** | 823 | 473 | 1,296 |
| **2022** | 965 | 576 | 1,542 |
| **2023** | 1,109 | 684 | 1,792 |
| **2024** | 1,250 | 792 | 2,042 |
| **2025** | 1,386 | 896 | 2,282 |

*Source: Navigant analysis, 2015*

**Figure 5-7. Gas Achievable Potential by Sector (Million Therms/year)**




*Source: Navigant analysis, 2015*

**Table 5-4. Gas Achievable Potential by Sector (Million Therms/year)**

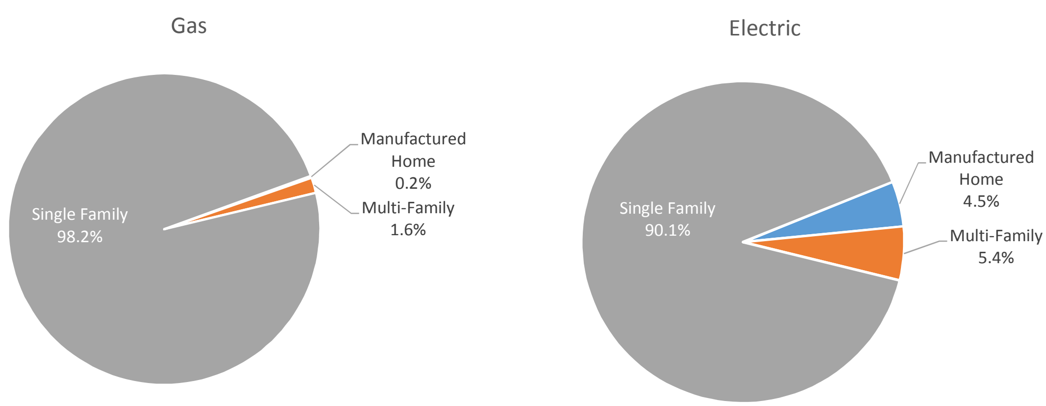
| Year | Residential | C&I | Total |
|---|---|---|---|
| **2016** | 2.0 | 1.9 | 3.9 |
| **2017** | 4.2 | 3.6 | 7.8 |
| **2018** | 6.5 | 5.2 | 11.7 |
| **2019** | 9.0 | 6.7 | 15.8 |
| **2020** | 11.7 | 8.2 | 19.9 |
| **2021** | 14.6 | 9.5 | 24.1 |
| **2022** | 17.6 | 10.8 | 28.5 |
| **2023** | 20.8 | 12.1 | 32.9 |
| **2024** | 24.0 | 13.3 | 37.3 |
| **2025** | 27.2 | 14.4 | 41.7 |

*Source: Navigant analysis, 2015*

### 5.2.2 Results by Customer Segment

The residential electric and gas achievable potentials shown in Figure 5-6 and Figure 5-7, respectively, are broken out for each of the three residential customer segments in Figure 5-8. Table 5-5 provides the magnitude of the residential electric achievable potential savings for each customer segment for 2016-2025. Table 5-6 provides comparable information for gas achievable potential.

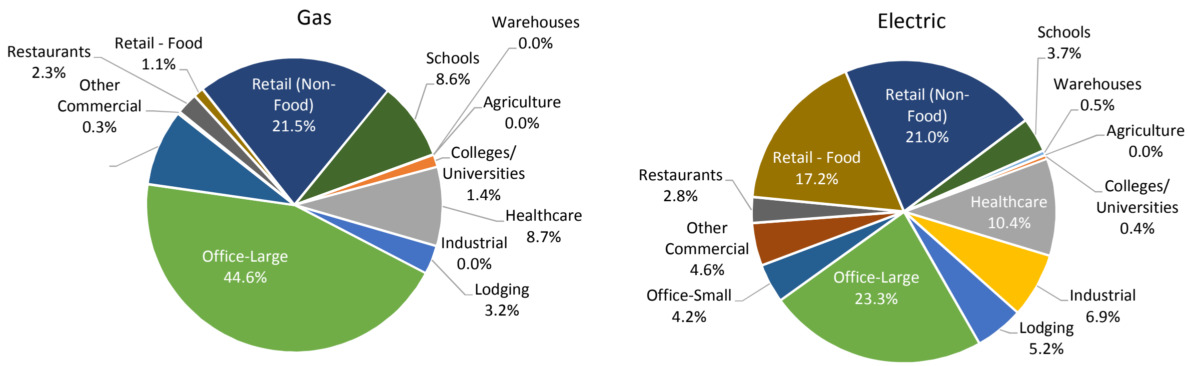
**Figure 5-8. Achievable Potential by Residential Customer Segment in 2025 (Electric and Gas)**




*Source: Navigant analysis, 2015*

The C&I electric and gas achievable potentials shown in Figure 5-6 and Figure 5-7, respectively, are broken out for each of the 13 C&I customer segments in Figure 5-9. Table 5-7 provides the magnitude of the C&I electric achievable potential savings for each customer segment for 2016-2025. Table 5-8 provides comparable information for gas achievable potential.

**Figure 5-9. Achievable Potential by C&I Customer Segment in 2025 (Electric and Gas)**




*Source: Navigant analysis, 2015*

**Table 5-5. Electric Achievable Potential by Residential Customer Segment (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Single Family** | 105 | 225 | 356 | 498 | 622 | 750 | 882 | 1,014 | 1,144 | 1,270 |
| **Multi-Family** | 6 | 13 | 21 | 29 | 35 | 42 | 49 | 56 | 63 | 70 |
| **Manufactured Home** | 5 | 10 | 16 | 22 | 26 | 30 | 34 | 38 | 43 | 47 |
| **Totals** | 116 | 248 | 392 | 548 | 683 | 823 | 965 | 1,109 | 1,250 | 1,386 |

*Source: Navigant analysis, 2015*

**Table 5-6. Gas Achievable Potential by Residential Customer Segment (Million Therms/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Single Family** | 1.9 | 4.1 | 6.4 | 8.9 | 11.5 | 14.3 | 17.3 | 20.4 | 23.6 | 26.8 |
| **Multi-Family** | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 |
| **Manufactured Home** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Totals** | 2.0 | 4.2 | 6.5 | 9.0 | 11.7 | 14.6 | 17.6 | 20.8 | 24.0 | 27.2 |

*Source: Navigant analysis, 2015*

**Table 5-7. Electric Achievable Potential by C&I Customer Segment (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Colleges/Universities** | 0.3 | 0.6 | 1.0 | 1.4 | 1.9 | 2.4 | 3.0 | 3.6 | 4.2 | 4.6 |
| **Healthcare** | 8.1 | 16.1 | 25.7 | 35.8 | 45.6 | 56.0 | 66.8 | 78.2 | 90.1 | 101.8 |
| **Lodging** | 4.8 | 8.6 | 12.8 | 17.5 | 22.5 | 27.6 | 32.9 | 38.4 | 43.8 | 49.0 |
| **Office-Large** | 8.1 | 18.2 | 35.6 | 54.8 | 74.8 | 96.1 | 119.9 | 144.9 | 170.2 | 194.6 |
| **Office-Small** | 2.2 | 4.2 | 6.9 | 9.9 | 12.8 | 16.0 | 19.7 | 23.7 | 27.6 | 31.5 |
| **Restaurants** | 3.6 | 6.2 | 9.1 | 12.0 | 14.4 | 16.8 | 19.1 | 21.5 | 23.7 | 25.9 |
| **Retail (Non-Food)** | 13.5 | 29.3 | 47.0 | 66.3 | 86.1 | 107.4 | 129.9 | 153.0 | 176.3 | 198.6 |
| **Retail - Food** | 10.0 | 20.7 | 32.6 | 45.6 | 59.4 | 74.0 | 92.4 | 111.3 | 130.4 | 149.1 |
| **Schools** | 1.9 | 4.3 | 7.1 | 10.2 | 13.7 | 17.6 | 21.7 | 25.9 | 29.9 | 33.1 |
| **Warehouses** | 0.5 | 0.9 | 1.4 | 1.9 | 2.3 | 2.8 | 3.3 | 3.7 | 4.3 | 4.8 |
| **Other Commercial** | 5.4 | 8.3 | 12.6 | 17.1 | 21.2 | 25.6 | 30.1 | 35.1 | 40.2 | 45.1 |
| **Industrial (net of opt-out)** | 3.7 | 7.9 | 12.6 | 18.0 | 24.0 | 30.5 | 37.3 | 44.2 | 51.1 | 57.9 |
| **Agriculture** | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 |
| **Totals** | 61.9 | 125.3 | 204.3 | 290.6 | 378.8 | 472.8 | 576.2 | 683.5 | 791.8 | 896.2 |

*Source: Navigant analysis, 2015*

**Table 5-8. Gas Achievable Potential by C&I Customer Segment (Million Therms/year)**

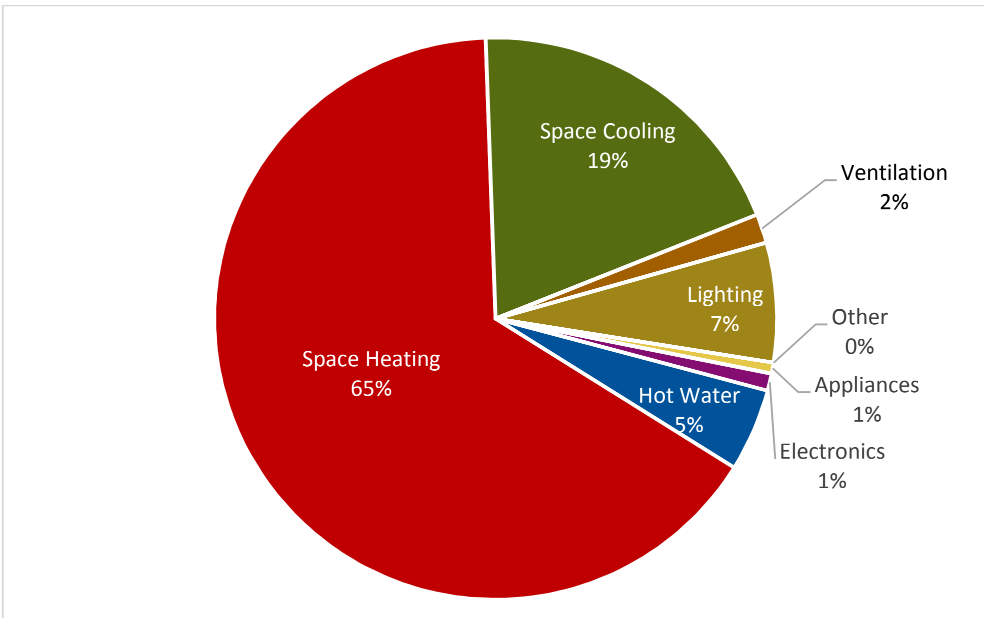
| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Colleges/Universities** | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 |
| **Healthcare** | 0.2 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 |
| **Lodging** | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 |
| **Office-Large** | 0.9 | 1.7 | 2.5 | 3.2 | 3.9 | 4.5 | 5.1 | 5.6 | 6.1 | 6.6 |
| **Office-Small** | 0.1 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 |
| **Restaurants** | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 |
| **Retail (Non-Food)** | 0.4 | 0.8 | 1.2 | 1.6 | 1.9 | 2.2 | 2.5 | 2.8 | 3.0 | 3.3 |
| **Retail - Food** | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| **Schools** | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| **Warehouses** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Other Commercial** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Industrial (net of opt-out)** | - | - | - | - | - | - | - | - | - | - |
| **Agriculture** | - | - | - | - | - | - | - | - | - | - |
| **Totals** | 1.9 | 3.6 | 5.2 | 6.7 | 8.2 | 9.5 | 10.8 | 12.1 | 13.3 | 14.4 |

*Source: Navigant analysis, 2015*

### 5.2.3 Results by End Use

Achievable potential for electric is broken out by residential end use in Figure 5-10 and Table 5-9. The same information is provided for residential gas in Figure 5-11 and Table 5-10. Almost two-thirds of the residential electric potential and over 90 percent of the gas potential comes from space heating. For the electric potential almost 20% comes from space cooling and 7% from lighting. On the gas side, water heating represents almost all of the balance.

**Figure 5-10. Electric Achievable Potential by Residential End Use in 2025**



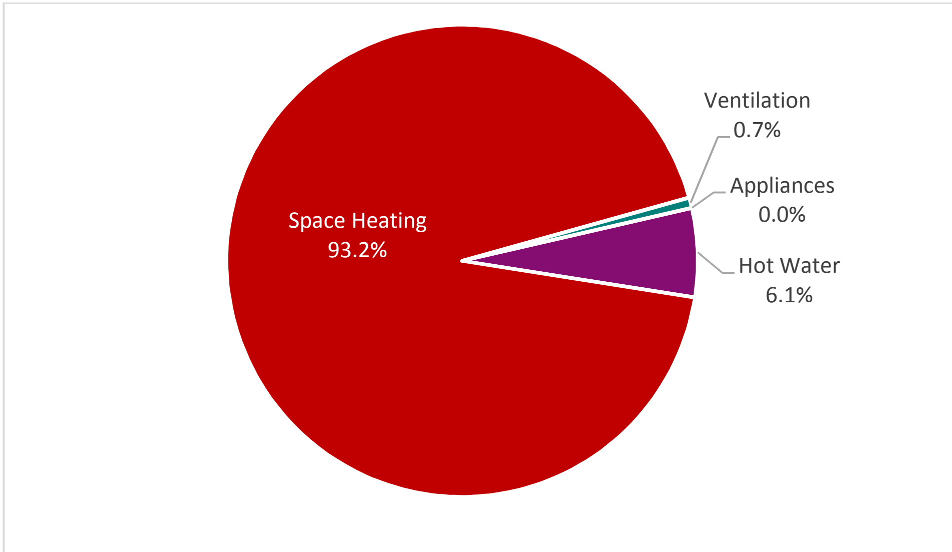

*Source: Navigant analysis, 2015*

**Table 5-9. Electric Achievable Potential by Residential End Use (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Appliances** | 0.5 | 0.7 | 1.0 | 1.6 | 2.4 | 3.1 | 4.5 | 6.0 | 7.5 | 8.9 |
| **Electronics** | 1.7 | 3.2 | 4.6 | 6.5 | 8.2 | 9.6 | 10.9 | 12.0 | 12.9 | 13.7 |
| **Hot Water** | 6.8 | 13.7 | 20.7 | 27.7 | 34.6 | 41.4 | 47.9 | 54.2 | 60.2 | 66.1 |
| **Space Heating** | 69.1 | 145.8 | 229.4 | 319.3 | 414.3 | 512.9 | 613.7 | 714.7 | 813.6 | 908.3 |
| **Space Cooling** | 19.5 | 43.9 | 70.9 | 98.6 | 127.0 | 155.7 | 184.8 | 213.7 | 242.5 | 270.7 |
| **Ventilation** | 1.4 | 2.9 | 4.5 | 6.3 | 8.1 | 10.0 | 12.4 | 15.9 | 19.5 | 23.2 |
| **Lighting** | 17.2 | 37.4 | 61.4 | 88.1 | 88.8 | 90.0 | 91.2 | 92.5 | 93.8 | 95.1 |
| **Other** | - | - | - | - | - | - | - | - | - | - |
| **Total** | 116.2 | 247.7 | 392.4 | 548.0 | 683.4 | 822.8 | 965.3 | 1,109.0 | 1,249.9 | 1,386.0 |

*Source: Navigant analysis, 2015*

**Figure 5-11. Gas Achievable Potential by Residential End Use in 2025**




*Source: Navigant analysis, 2015*

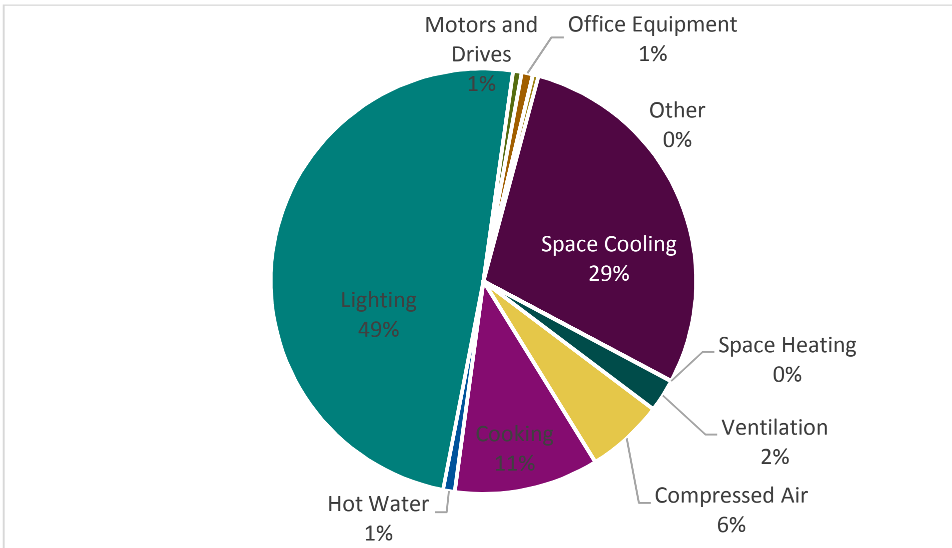
**Table 5-10. Gas Achievable Potential by Residential End Use (Million Therms/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Appliances** | - | - | - | - | - | - | - | - | - | - |
| **Hot Water** | 0.2 | 0.4 | 0.5 | 0.7 | 0.9 | 1.0 | 1.2 | 1.3 | 1.5 | 1.7 |
| **Space Heating** | 1.8 | 3.8 | 5.9 | 8.3 | 10.8 | 13.5 | 16.3 | 19.3 | 22.3 | 25.4 |
| **Ventilation** | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 |
| **Total** | 2.0 | 4.2 | 6.5 | 9.0 | 11.7 | 14.6 | 17.6 | 20.8 | 24.0 | 27.2 |

*Source: Navigant analysis, 2015*

Figure 5-12 and Table 5-11 present the electric achievable potential summarized by C&I end use category. Comparable information for gas is provided in Figure 5-13 and Table 5-12. Almost half of the electric potential comes from lighting measures, and almost 30% from space cooling, with just over 10% from cooking measures. On the gas side, 95% of the potential is associated with space heating with most of the balance from cooking measures.

**Figure 5-12. Electric Achievable Potential by C&I End Use in 2025**



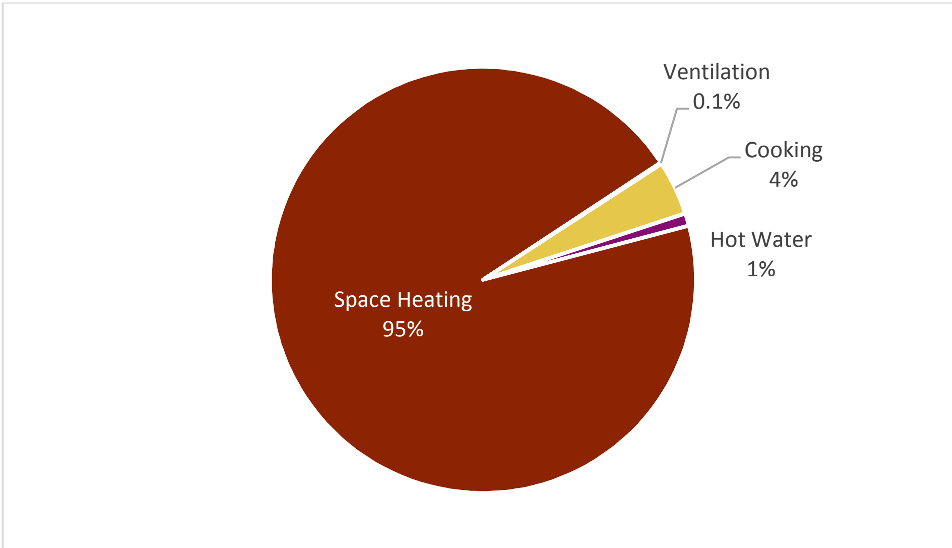

*Source: Navigant analysis, 2015*

**Table 5-11. Electric Achievable Potential by C&I End Use (GWh/year)**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| Compressed Air | 3.3 | 7.1 | 11.4 | 16.3 | 21.8 | 27.7 | 34.0 | 40.3 | 46.7 | 53.0 |
| Cooking | 6.0 | 13.3 | 21.2 | 29.5 | 38.2 | 47.3 | 59.9 | 72.8 | 85.7 | 98.4 |
| Hot Water | 0.9 | 1.8 | 2.6 | 3.5 | 4.3 | 5.0 | 5.8 | 6.5 | 7.2 | 7.9 |
| Lighting | 33.6 | 66.0 | 104.6 | 147.8 | 190.1 | 236.3 | 287.0 | 339.5 | 392.1 | 440.9 |
| Motors and Drives | 0.6 | 1.2 | 1.8 | 2.4 | 3.0 | 3.6 | 4.2 | 4.8 | 5.4 | 5.9 |
| Office Equipment | 0.3 | 0.6 | 1.0 | 1.5 | 1.9 | 2.3 | 2.7 | 4.1 | 5.9 | 7.6 |
| Other | 0.2 | 0.4 | 0.8 | 1.3 | 1.8 | 2.2 | 2.5 | 3.0 | 3.4 | 3.8 |
| Space Cooling | 14.9 | 30.8 | 54.4 | 79.7 | 106.7 | 135.1 | 164.5 | 194.5 | 225.2 | 256.2 |
| Space Heating | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 |
| Ventilation | 2.0 | 4.1 | 6.3 | 8.5 | 10.8 | 13.1 | 15.4 | 17.7 | 20.0 | 22.2 |
| Total | 61.9 | 125.3 | 204.3 | 290.6 | 378.8 | 472.9 | 576.3 | 683.6 | 791.9 | 896.2 |

*Source: Navigant analysis, 2015*

**Figure 5-13. Gas Achievable Potential by C&I End Use in 2025**




*Source: Navigant analysis, 2015*

**Table 5-12. Gas Achievable Potential by C&I End Use (Million Therms/year)**

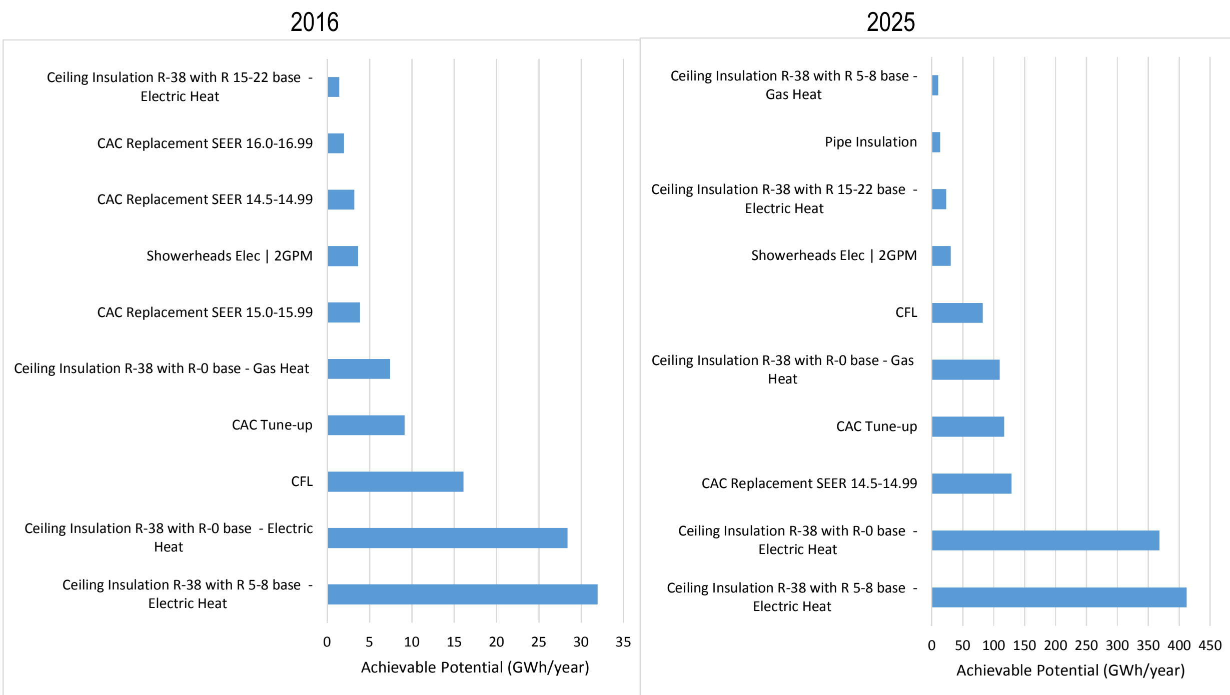
| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cooking** | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 |
| **Hot Water** | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| **Space Heating** | 1.8 | 3.4 | 5.0 | 6.4 | 7.8 | 9.1 | 10.3 | 11.5 | 12.6 | 13.7 |
| **Ventilation** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | 1.9 | 3.6 | 5.2 | 6.7 | 8.2 | 9.5 | 10.8 | 12.1 | 13.3 | 14.4 |

*Source: Navigant analysis, 2015*

### 5.2.4 Results by Measure

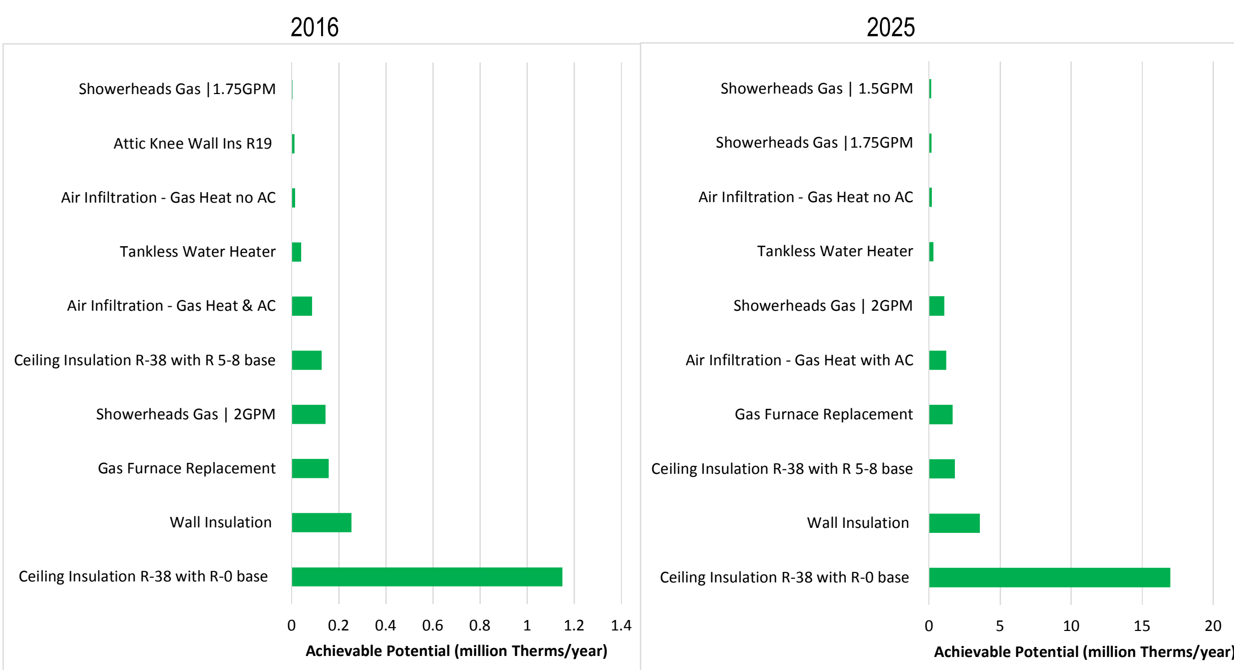
Figure 5-14 shows the top ranking electric residential measures along with their achievable potential in 2025. As was the case with the economic potential, the top achievable electric measures for the residential sector relate to space heating (ceiling insulation), cooling (CAC replacement and tune-ups) and efficient showerheads. Some of this potential is contributed by insulation measures implemented in gas heated homes which help reduce air conditioning electricity use. As the figures for 2025 illustrate the savings from each of the top measures accumulate over time, and in some instances the importance of measures changes over the period. For example, the relative ranking of CFLs decreases over the period. Figure 5-15 shows the comparable information for gas residential measures. The greatest areas of residential gas achievable potential were found to be in home weatherization (Ceiling and wall insulation and reducing air infiltration, followed by furnace replacements and efficient showerheads. Unlike the electric potential the relative ranking of measures does not change significantly over time.

**Figure 5-14. Top Residential Measures for Electric Achievable Potential (GWh/year)**




*Source: Navigant analysis, 2015*

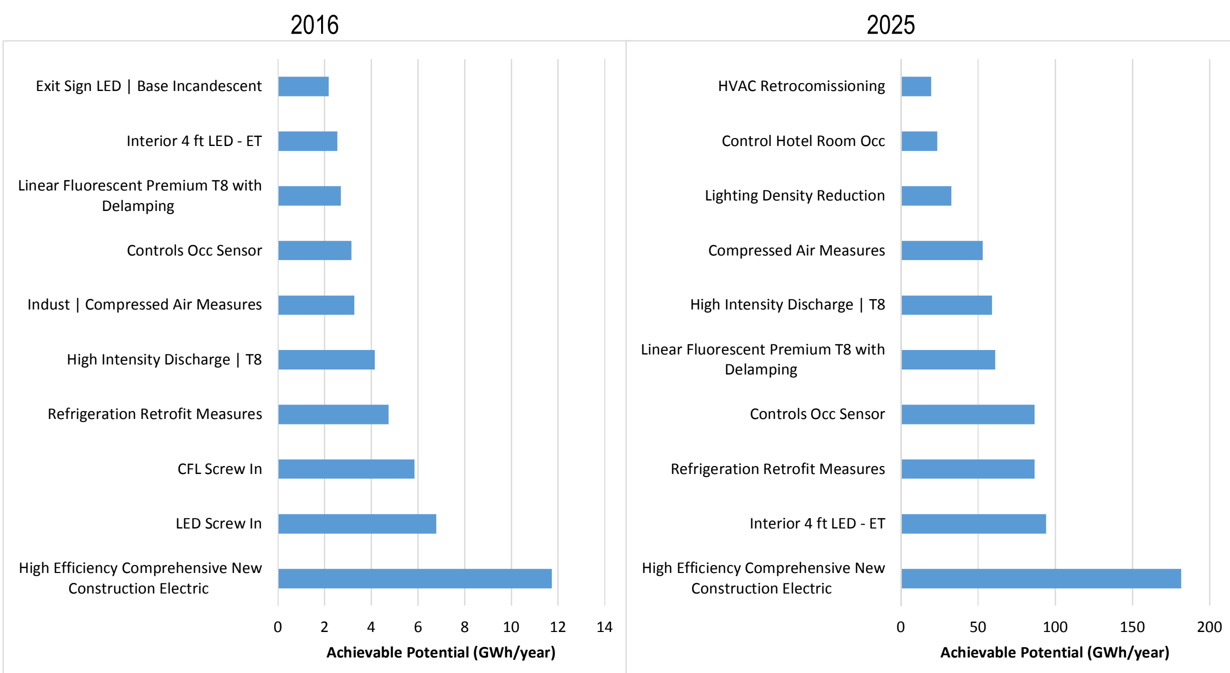
**Figure 5-15. Top Residential Measures for Gas Achievable Potential (Million Therms/year)**




*Source: Navigant analysis, 2015*

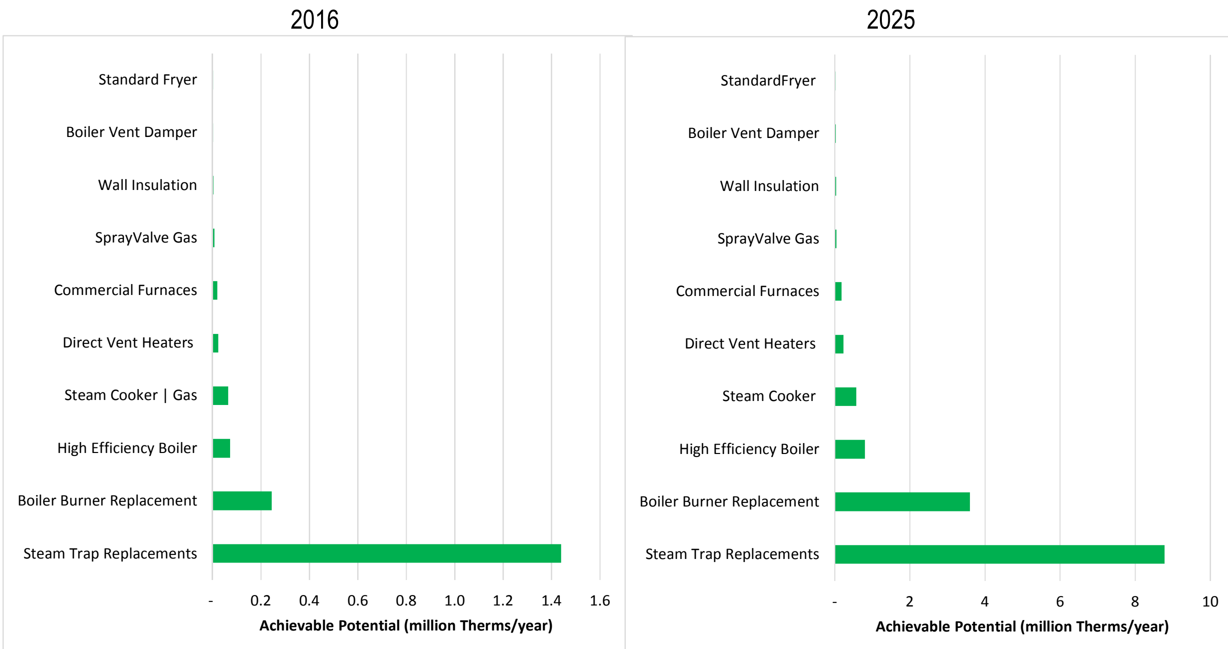
Figure 5-16 shows the top electric C&I measures ranked in order of their achievable potential in 2025. The top measures for achievable C&I gas potential are predominantly related to boiler systems (steam trap maintenance, burner replacements and high efficiency boilers), followed by cooking and heating equipment measures. The relative importance of the gas C&I measures do not change significantly over the modelled period. Figure 5-17 shows the comparable information for gas C&I measures. The top measures for achievable C&I gas potential are predominantly related to boiler systems (steam trap maintenance, burner replacements and high efficiency boilers), followed by cooking and heating equipment measures. The relative importance of the gas C&I measures do not change significantly over the modelled period.

**Figure 5-16. Top C&I Measures for Electric Achievable Potential (GWh/year)**




*Source: Navigant analysis, 2015*

**Figure 5-17. Top C&I Measures for Gas Achievable Potential (Million Therms/year)**




*Source: Navigant analysis, 2015*

## 5.3 *Achievable Potential by IOU*

Table 5-13 summarizes the electric incremental achievable potential under the medium funding scenario by year over the Potential Study time horizon. As can be seen from the table, the bulk of the achievable potential is expected to come from Entergy. This is an expected outcome since Entergy sells more than three-quarters of the total IOU electricity in the state.

Table 5-14 summarizes the gas incremental achievable potential under the medium funding scenario by year over the Potential Study time horizon. As can be seen from the table, the bulk of the achievable potential is expected to come from CenterPoint. This is an expected outcome since CenterPoint sells more than half of the total IOU gas in the state.

**Table 5-13. Electric Incremental Achievable Potential by IOU, Mid-Budget Scenario (GWh)**

| Year | Entergy | SWEPCO | OG&E | Empire | Electric Savings by Gas Utilities* | Total |
|---|---|---|---|---|---|---|
| **2016** | 126.4 | 25.9 | 16.7 | 0.7 | 8.4 | 178.1 |
| **2017** | 140.9 | 26.6 | 17.3 | 0.7 | 9.4 | 195.0 |
| **2018** | 163.7 | 29.9 | 19.0 | 0.8 | 10.4 | 223.7 |
| **2019** | 177.3 | 31.9 | 20.4 | 0.9 | 11.3 | 241.8 |
| **2020** | 161.6 | 29.7 | 19.0 | 1.0 | 12.2 | 223.6 |
| **2021** | 168.4 | 30.8 | 20.2 | 1.0 | 13.0 | 233.5 |
| **2022** | 178.4 | 31.8 | 20.9 | 1.1 | 13.8 | 245.9 |
| **2023** | 180.4 | 33.4 | 21.5 | 1.1 | 14.6 | 250.9 |
| **2024** | 178.5 | 33.2 | 21.6 | 1.1 | 15.0 | 249.3 |
| **2025** | 171.9 | 31.6 | 20.7 | 1.0 | 15.1 | 240.4 |

** These are the savings attributable to gas EE measures that result in electrical savings.*
*Source: Navigant analysis, 2015*

**Table 5-14. Gas Incremental Achievable Potential by IOU, Mid-Budget Scenario (Million Therms)**

| Year | CenterPoint | SourceGas | AOG | Gas Savings by Electric Utilities* | Total |
|---|---|---|---|---|---|
| **2016** | 2.4 | 1.3 | 0.1 | 0.0 | 3.9 |
| **2017** | 2.4 | 1.3 | 0.2 | 0.0 | 3.9 |
| **2018** | 2.4 | 1.4 | 0.2 | 0.0 | 4.0 |
| **2019** | 2.4 | 1.4 | 0.2 | 0.0 | 4.0 |
| **2020** | 2.5 | 1.5 | 0.2 | 0.0 | 4.1 |
| **2021** | 2.5 | 1.5 | 0.2 | 0.0 | 4.2 |
| **2022** | 2.5 | 1.5 | 0.2 | 0.0 | 4.3 |
| **2023** | 2.6 | 1.6 | 0.3 | 0.0 | 4.4 |
| **2024** | 2.6 | 1.6 | 0.3 | 0.0 | 4.4 |
| **2025** | 2.6 | 1.6 | 0.3 | 0.0 | 4.4 |

** Note that the gas savings attributable to electric EE measures were minimal.*
*Source: Navigant analysis, 2015*

Table 5-15 summarizes the IOU-specific electric incremental achievable potential as a percent of sales net of self-direct customers for the Potential Study time horizon. Table 5-16 provides the comparable information for the gas utilities.

**Table 5-15. Electric Incremental Achievable Potential by IOU as a Percent of Sales*, Mid Funding Scenario**

| Year | Entergy | SWEPCO | OG&E | Empire | Total |
|---|---|---|---|---|---|
| **2016** | 0.62% | 0.95% | 0.73% | 0.70% | 0.70% |
| **2017** | 0.66% | 0.97% | 0.75% | 0.77% | 0.71% |
| **2018** | 0.76% | 1.09% | 0.82% | 0.84% | 0.83% |
| **2019** | 0.82% | 1.16% | 0.87% | 0.95% | 0.89% |
| **2020** | 0.75% | 1.07% | 0.80% | 0.99% | 0.81% |
| **2021** | 0.77% | 1.10% | 0.84% | 1.01% | 0.84% |
| **2022** | 0.81% | 1.13% | 0.87% | 1.02% | 0.88% |
| **2023** | 0.82% | 1.18% | 0.88% | 1.04% | 0.88% |
| **2024** | 0.80% | 1.17% | 0.87% | 1.00% | 0.85% |
| **2025** | 0.77% | 1.11% | 0.83% | 0.92% | 0.82% |

** Sales represented as net sales, which excludes sales to self-direct customers.*
*Source: Navigant analysis, 2015*

**Table 5-16. Gas Incremental Achievable Potential by IOU as a Percent of Sales*, Mid Funding Scenario**

| Year | CenterPoint | SourceGas | AOG | Total |
|---|---|---|---|---|
| **2016** | 0.71% | 0.56% | 0.34% | 0.63% |
| **2017** | 0.72% | 0.58% | 0.39% | 0.65% |
| **2018** | 0.73% | 0.59% | 0.43% | 0.66% |
| **2019** | 0.74% | 0.61% | 0.48% | 0.69% |
| **2020** | 0.76% | 0.63% | 0.53% | 0.71% |
| **2021** | 0.78% | 0.64% | 0.58% | 0.74% |
| **2022** | 0.80% | 0.66% | 0.63% | 0.76% |
| **2023** | 0.82% | 0.67% | 0.69% | 0.79% |
| **2024** | 0.83% | 0.67% | 0.73% | 0.80% |
| **2025** | 0.83% | 0.67% | 0.75% | 0.81% |

** Sales represented as net sales, which excludes sales to self-direct customers.*
*Source: Navigant analysis, 2015*

## 5.4 *Achievable Potential Funding*

Navigant developed estimates of EE program funding needed to support the various levels of achievable potential to be obtained during the study period. Table 5-17 presents the estimated funding levels for incentives, program administration and total for electric and gas under the mid-funding scenario. These estimates were simulated through the DSMSim™ model. The incentive budgets were simulated based on the measures that make up the achievable potential estimates. Incentive values grow over time due changes in the mix of EE measures and cost inflation. The administration budgets are based on historical expenditures for administration reported by the utilities. Administration values grow over time due to cost inflation.

**Table 5-17. Estimated EE Program Funding, Mid Funding Scenario**

| Year | Electric | | | Gas | | | Total Funding |
|---|---|---|---|---|---|---|---|
| | Incentive | Administration | Total | Incentive | Administration | Total | |
| **2016** | $26.8 | $28.8 | $55.6 | $4.4 | $5.5 | $10.0 | $65.6 |
| **2017** | $32.8 | $29.4 | $62.2 | $4.7 | $5.6 | $10.3 | $72.5 |
| **2018** | $41.1 | $30.0 | $71.1 | $5.0 | $5.7 | $10.8 | $81.9 |
| **2019** | $44.5 | $30.6 | $75.0 | $5.4 | $5.9 | $11.3 | $86.3 |
| **2020** | $46.8 | $31.2 | $78.0 | $5.8 | $6.0 | $11.8 | $89.8 |
| **2021** | $49.4 | $31.8 | $81.3 | $6.1 | $6.1 | $12.2 | $93.5 |
| **2022** | $56.2 | $32.5 | $88.7 | $6.4 | $6.2 | $12.6 | $101.3 |
| **2023** | $59.3 | $33.1 | $92.4 | $6.7 | $6.3 | $13.1 | $105.5 |
| **2024** | $60.9 | $33.8 | $94.7 | $6.9 | $6.5 | $13.4 | $108.1 |
| **2025** | $62.1 | $34.5 | $96.5 | $7.1 | $6.6 | $13.7 | $110.3 |

*Source: Navigant analysis, 2015*

As can be seen from the table, the total simulated funding that corresponds with the mid-funding achievable potential scenario is $65.6 in 2016, growing to over $110 million by 2025. Nearly 85 percent of the funding is attributable to electric EE program efforts.

## 5.5 *High- and Low-Budget Achievable Potential Scenarios*

This section provides Navigant's estimate of the budget levels required to achieve the base case savings forecast. We first describe our approach to budget estimation. Then, we provide estimates of the budgets over time at the sector and portfolio levels. We conclude with a discussion of the cost effectiveness of achievable savings, over time, at the sector and portfolio levels.

Table 5-18 shows the electric achievable potential, the percent reduction, and the annual budget in 2016 and 2025 for the three alternative scenarios analyzed in this study: High Funding, Mid Funding and Low Funding. Table 5-19 shows the comparable information for the gas achievable potential funding scenarios.

**Table 5-18. Electric Achievable Potential and Budget by Scenario**

| Year | Incremental Achievable Savings (GWh) | Percent of Electric Sales Net of Self-Directs | Percent of Gross Electric Sales | Electric Annual Budget (Million $) |
|---|---|---|---|---|
| **High Funding Scenario** | | | | |
| **2016** | 225 | 0.88% | 0.81% | $82.7 |
| **2017** | 253 | 0.93% | 0.90% | $94.3 |
| **2018** | 290 | 1.07% | 1.01% | $107.3 |
| **2019** | 313 | 1.16% | 1.09% | $113.7 |
| **2025** | 265 | 0.89% | 0.84% | $130.0 |
| **Mid Funding Scenario** | | | | |
| **2016** | 178 | 0.70% | 0.66% | $55.6 |
| **2017** | 195 | 0.71% | 0.67% | $62.2 |
| **2018** | 224 | 0.83% | 0.78% | $71.1 |
| **2019** | 242 | 0.89% | 0.84% | $75.0 |
| **2025** | 240 | 0.82% | 0.77% | $96.5 |
| **Low Funding Scenario** | | | | |
| **2016** | 128 | 0.50% | 0.46% | $33.6 |
| **2017** | 136 | 0.50% | 0.48% | $36.3 |
| **2018** | 157 | 0.58% | 0.55% | $40.2 |
| **2019** | 172 | 0.64% | 0.60% | $42.4 |
| **2025** | 203 | 0.69% | 0.65% | $54.5 |

*Source: Navigant analysis, 2015*

As Table 5-18 shows, under the High Funding scenario, electric achievable potential is estimated to be 225 GWh in 2016, rising to 265 GWh in 2025. This represents a 26 percent increase in the 2016 electric savings relative to the estimated achievable potential of 178 GWh under the Mid Funding scenario. Under the Low Funding scenario, electric achievable potential is estimated to be 128 GWh in 2016, rising to 268 GWh in 2025. This represents a nearly 30 percent decrease in the 2016 savings relative to the estimated achievable potential of 178 GWh under the Mid Funding scenario. The table also reports on the percent savings relative to electric sales, and indicates the corresponding changes in those values for both the High and Low Funding scenarios. The corresponding electric budget for the High Funding scenario would be $82.7 million, which represents a 26 percent increase relative to the $65.6 million budget under the Mid Funding scenario. For the Low Funding scenario, the electric budget would be $33.6 million, which represents a nearly 50 percent decrease relative to the $65.6 million budget under the Mid Funding scenario.

**Table 5-19. Gas Achievable Potential and Budget by Scenario**

| Year | Incremental Achievable Savings (Million Therms) | Percent of Gas Sales Net of Self-Directs | Percent of Gross Gas Sales | Gas Annual Budget (Million $) |
|---|---|---|---|---|
| **High Funding Scenario** | | | | |
| **2016** | 5.53 | 0.90% | 0.52% | $18.7 |
| **2017** | 5.77 | 0.96% | 0.94% | $20.1 |
| **2018** | 6.02 | 1.00% | 0.80% | $21.6 |
| **2019** | 6.23 | 1.05% | 0.84% | $22.9 |
| **2025** | 5.08 | 0.95% | 0.78% | $23.7 |
| **Mid Funding Scenario** | | | | |
| **2016** | 3.87 | 0.63% | 0.37% | $10.0 |
| **2017** | 3.90 | 0.65% | 0.51% | $10.3 |
| **2018** | 3.96 | 0.66% | 0.52% | $10.8 |
| **2019** | 4.04 | 0.69% | 0.54% | $11.3 |
| **2025** | 4.38 | 0.81% | 0.65% | $13.7 |
| **Low Funding Scenario** | | | | |
| **2016** | 3.30 | 0.54% | 0.31% | $6.9 |
| **2017** | 3.31 | 0.55% | 0.54% | $7.3 |
| **2018** | 3.36 | 0.56% | 0.45% | $7.7 |
| **2019** | 3.45 | 0.58% | 0.47% | $8.1 |
| **2025** | 4.00 | 0.74% | 0.60% | $10.7 |

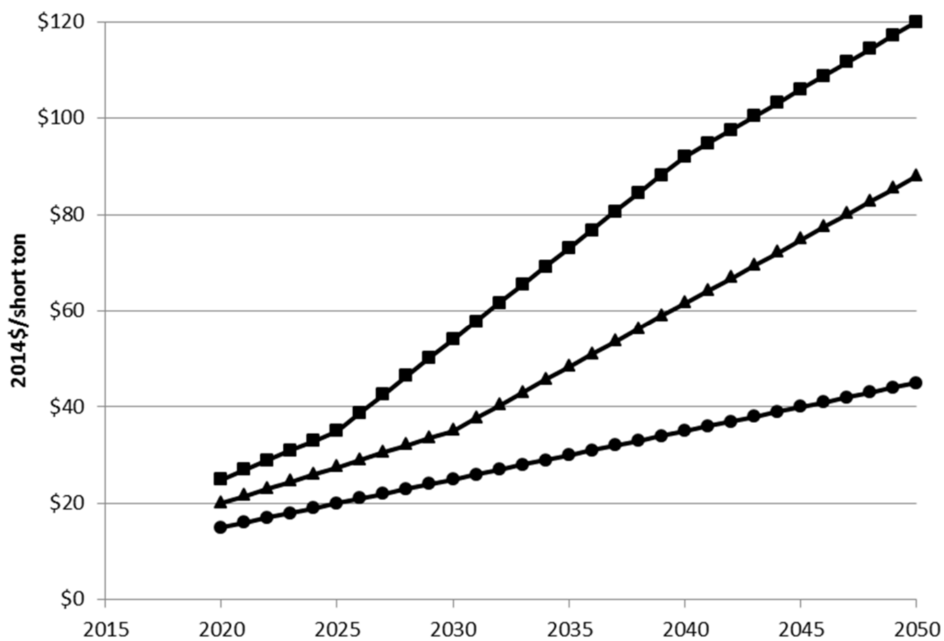
*Source: Navigant analysis, 2015*

As Table 5-19 shows, under the High Funding scenario, gas achievable potential is estimated to be 5.5 Million Therms in 2016, and 5.1 Million Therms in 2025. This represents a 31 percent increase in the 2016 savings relative to the estimated gas achievable potential of 3.9 Million Therms under the Mid Funding scenario. Under the Low Funding scenario, achievable potential is estimated to be 3.3 Million Therms in 2016, rising to 4 Million Therms in 2025. This represents a 15 percent decrease in the 2016 gas savings relative to the estimated achievable potential of 3.9 Million Therms under the Mid Funding scenario. The table also reports on the percent savings relative to gas sales, and indicates the corresponding changes in those values for both the High and Low Funding scenarios. The corresponding budget for the High Funding scenario would be $18.7 million, which represents a significant increase in funding relative to the $10 million gas budget under the Mid Funding scenario. For the Low Funding scenario, the gas budget would be $6.9 million, which represents a 31 percent decrease relative to the $65.6 million budget under the Mid Funding scenario.

### 5.6 *Carbon Price Sensitivity Analysis*

To assess the impact of avoided carbon ($CO_2$) costs on the achievable potential, Navigant also calculated achievable potential using the Societal Cost Test (SCT). In this analysis, the SCT only differed from the TRC in its inclusion of $CO_2$ externality costs. The PSC specified as part of the scope for this project that the carbon cost to be used in the analysis should be based on the Synapse Energy Economics forecast of avoided carbon costs.[38] Navigant used the carbon price from the Mid Funding projection in the *2015 Carbon Dioxide Price Forecast* published by Synapse Energy Economics, Inc. to project the additional avoided carbon cost for the analysis. Figure 5-18 summarizes the $CO_2$ price trajectories from the Synapse report for three alternative carbon price scenarios – High, Medium and Low.

**Figure 5-18. Synapse 2015 $CO_2$ Price Trajectories**




*Source: Synapse Energy Economics, Inc., 2015, 2015 Carbon Dioxide Price Forecast.*

The projected value of avoided $CO_2$ costs were added to other avoided costs in the SCT calculation, providing an increase in the monetary benefits of gas- and electricity-saving measures. The inclusion of these additional avoided costs pushed a number of additional EE measures into the "economic" classification, resulting in approximately 10% more measures passing the economic screen . Thus, for some scenarios and points in time, including avoided $CO_2$ costs in the analysis led to an increase in economic potential and a corresponding increase in achievable potential.

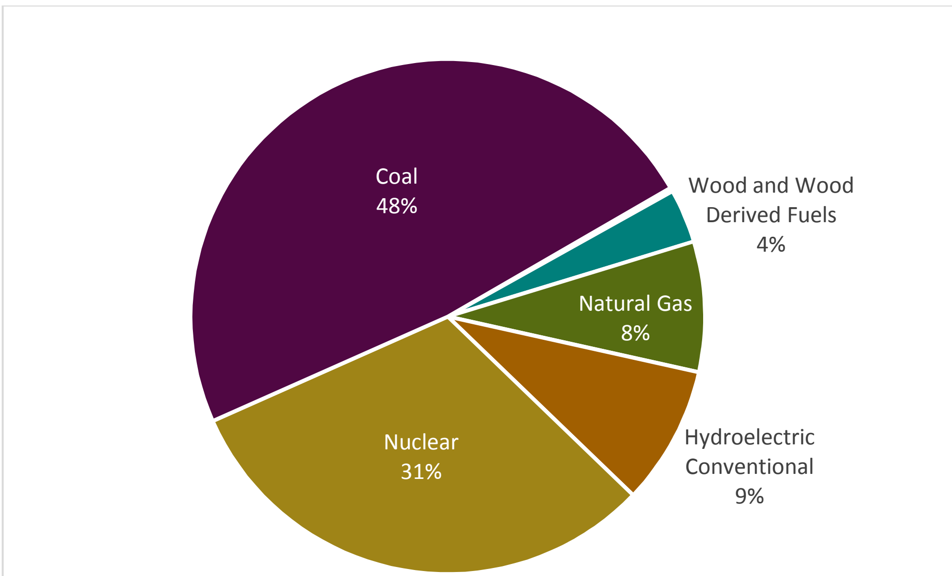
[38]Specified in section 5.1.12 of the PARTIES WORKING COLLABORATIVELY REQUEST FOR PROPOSAL for the ARKANSAS ENERGY EFFICIENCY POTENTIAL STUDY, PROPOSAL NO.: 2014-101, MARCH 10, 2014, issued by the Arkansas Public Service Commission.

To determine the avoided $CO_2$ costs for each measure, Navigant used the $CO_2$ intensities of energy listed below.

» Natural gas[39]: 117.0 pounds of $CO_2$ per million Btu (equivalent to 11.7 pounds of $CO_2$ per Therm.
» Electricity[40]: 2.15 pounds of $CO_2$ equivalent per kWh.

The emission factor for electricity assumes that most of the generation that would be displaced would be supplied by coal-fired generation based on the generation mix for Arkansas shown in Figure 5-19 below. To the extent that marginal generation is supplied by natural gas-fired generation the avoided carbon cost would be reduced.

**Figure 5-19. Arkansas Generation Mix**




*Source: US Energy Information Administration, Electricity , Detailed State Data, Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923),* *http://www.eia.gov/electricity/data/state/* *accessed May 2015.*

The following equation was used in the calculation of annual avoided $CO_2$ costs for each measure. The present value of these avoided costs over the life of each measure was added to the avoided costs in the SCT calculation.

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[39] Source: Energy Information Administration, *How much carbon dioxide is produced when different fuels are burned*, http://www.eia.gov/tools/faqs/faq.cfm?id=73&t=11 .

[40] Source: Energy Information Administration, *How much carbon dioxide is produced per kilowatt-hour when generating electricity with fossil fuels?*, *http://www.eia.gov/tools/faqs/faq.cfm?id=74&t=11*, accessed May 2015. Value used is for sub-bituminous coal. A review of the US EPA's National Electric Energy Data System (NEEDS database) indicates that the 6 coal units in Arkansas all burn sub-bituminous coal.

Avoided $CO_2$ Cost = $CO_2$ Price X (Gas Savings X Gas $CO_2$ Intensity + Electricity Savings X Electricity $CO_2$ Intensity)

where:

*$CO_2$ Price* is the cost of $CO_2$ emissions in $/ton
*Gas Savings* is the gas saved by a given measure in Therms/year
*Gas $CO_2$ Intensity* is the $CO_2$ intensity of gas in short tons $CO_2$/Therm
*Electricity Savings* is the electricity saved by a given measure in kWh/year
*Electricity $CO_2$ Intensity* is the $CO_2$ intensity of electricity in short tons $CO_2$/kWh

Table 5-20 shows the electric achievable potential, the percent reduction, and the annual budget in 2016 and 2025 for the carbon scenario, along with comparable figures for the medium funding scenario. Table 5-21 shows the comparable information for the gas carbon scenario analysis.

**Table 5-20. Electric Achievable Potential for Carbon Scenario**

| Year | Incremental Achievable Savings (GWh) | Percent of Electric Sales Net of Self-Directs | Percent of Gross Electric Sales | Electric Annual Budget (Million $) |
|---|---|---|---|---|
| **Carbon Scenario** | | | | |
| **2016** | 216 | 0.85% | 0.78% | $74.1 |
| **2017** | 227 | 0.83% | 0.81% | $76.8 |
| **2018** | 248 | 0.92% | 0.86% | $81.2 |
| **2019** | 267 | 0.99% | 0.93% | $85.8 |
| **2025** | 268 | 0.91% | 0.86% | $108.4 |
| **Mid Funding Scenario** | | | | |
| **2016** | 178 | 0.70% | 0.66% | $55.6 |
| **2017** | 195 | 0.71% | 0.67% | $62.2 |
| **2018** | 224 | 0.83% | 0.78% | $71.1 |
| **2019** | 242 | 0.89% | 0.84% | $75.0 |
| **2025** | 240 | 0.82% | 0.77% | $96.5 |

*Source: Navigant analysis, 2015*

Table 5-20 shows that electric achievable potential under the carbon scenario is estimated to be 216 GWh in 2016, rising to 268 GWh in 2025. This represents a 21 percent increase in electric savings relative to the Mid Funding scenario for 2016. The corresponding budget under the carbon scenario would be $74.1 million.

**Table 5-21. Gas Achievable Potential for Carbon Scenario**

| Year | Incremental Achievable Savings (Million Therms) | Percent of Gas Sales Net of Self-Directs | Percent of Gross Gas Sales | Gas Annual Budget (Million $) |
|---|---|---|---|---|
| **Carbon Scenario** | | | | |
| **2016** | 4.15 | 0.68% | 0.39% | $11.6 |
| **2017** | 4.20 | 0.70% | 0.69% | $12.0 |
| **2018** | 4.28 | 0.71% | 0.57% | $12.6 |
| **2019** | 4.39 | 0.74% | 0.59% | $13.3 |
| **2025** | 4.79 | 0.88% | 0.72% | $16.1 |
| **Mid Funding Scenario** | | | | |
| **2016** | 3.87 | 0.63% | 0.37% | $10.0 |
| **2017** | 3.90 | 0.65% | 0.51% | $10.3 |
| **2018** | 3.96 | 0.66% | 0.52% | $10.8 |
| **2019** | 4.04 | 0.69% | 0.54% | $11.3 |
| **2025** | 4.38 | 0.81% | 0.65% | $13.7 |

*Source: Navigant analysis, 2015*

Table 5-21 shows that gas achievable potential under the carbon scenario is estimated to be 4.15 Million Therms in 2016, rising to 4.79 Million Therms in 2025. This represents a 6 percent increase in gas savings relative to the Mid Funding scenario for 2016. The corresponding budget under the carbon scenario would be $11.6 million.

## 5.7 *Benchmarking the Results*

As part of this study, Navigant benchmarked levels of achievable electric gas relative to two main sources. First, Arkansas-specific EE program budgets and savings impacts reported to the Arkansas Commission were reviewed and assessed for consistency between historical budgets and savings and projected budgets and savings for this study. Second, a review and comparative analysis was conducted based on other EE potential studies conducted in the region.

### 5.7.1 Review of Arkansas Historical EE Accomplishments

Table 5-22 provides a comparison between the 2014 historical accomplishments and the 2016 forecasted Mid Funding achievable potential energy savings and incentive expenditures. Historical accomplishment data were derived from data provided to Navigant from the Arkansas Commission.[41]

[41] Based on reports compiled by the PSC from the IOU annual EE cost recovery (EECR) Rider that they file annually to the PSC to recover all cost associated with EE.

**Table 5-22. Comparing Achievable Potential Forecast Results to Historical Accomplishments**

| | Electric Achievable Forecast Percent of Historic | Gas Achievable Forecast Percent of Historic |
|---|---|---|
| **Incentive Expenditure** | | |
| **Residential** | 72% | 82% |
| **C&I** | 54% | 96% |
| **Total** | 62% | 85% |
| **Energy Savings** | | |
| **Residential** | 117% | 87% |
| **C&I** | 41% | 86% |
| **Total** | 71% | 87% |

*Source: Navigant analysis, 2015*

Several observations can be made based on the comparison:

- For residential electric, it appears that the projected energy savings in 2016 could exceed the historic accomplishments by 17 percent. Incentives paid for those savings can be done for 72 percent of the historic value. This seemingly counter-intuitive result might be explained based on a number of factors. First, there are still opportunities for relatively in-expensive EE measures such as CFLs to be deployed before federal standards make those measures the baseline in 2020. Second, measures with the largest savings potential for residential electric are ceiling insulation, which can be done fairly inexpensively.
- For C&I electric, the projected energy savings and incentive expenditures in 2016 are significantly lower than the 2014 savings and incentive expenditures. This finding is not surprising given that there was a major shift in the code baseline for fluorescent lighting, with the baseline going from T12 to T8. This has the effect of erasing a significant chunk of the savings and expenditures for C&I programs in 2014. A second factor might relate to lower electric avoided costs, which mean that fewer measures are able to pass through the economic screen than in the past thus leading to lower achievable potential that what has been seen in the recent past.
- For gas savings and incentive expenditures, the projected energy savings in 2016 are 15 percent and 13 percent below the historic values, respectively. It appears that both the residential and C&I sectors generally follow this trend. One possible cause of the lower amount of savings and incentive expenditures overall for the gas may also have to do with lower avoided costs relative to the recent past.

### 5.7.2 Review of Other EE Potential Studies

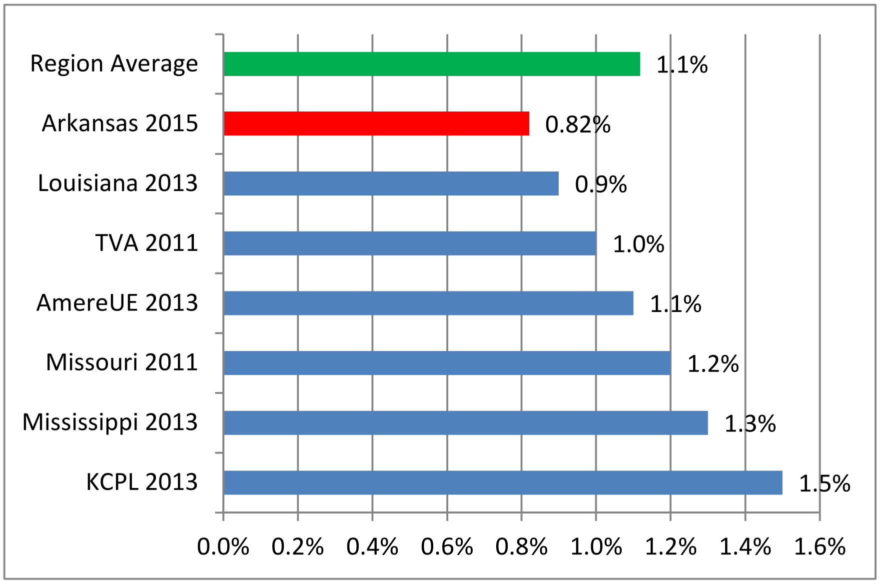
For the purpose of comparison, Navigant utilized data from a recent ACEEE publication and limited comparison points to other studies conducted in states that neighbor Arkansas.[42] This was done in order to obtain to the extent possible an "apples to apples" comparison. Benchmark assessments are often instructive in that they can highlight whether the results of the Potential Study might be considered in the realm of what other studies in the region revealed. Also, the benchmarking can rapidly highlight whether the results of the Potential Study are an outlier relative to the other studies assessed. Note however that each study will have different driving assumptions – different sets of avoided costs, different forecasts, etc. – all suggesting that the benchmark can't be a true "apples to apples" comparison. As such, results should be taken as indicative rather than definitive.

Figure 5-20 provides a comparison of the electric annual average percentage reduction from this study (savings relative to net sales) compared to six other studies from the region conducted over the past four years. As can be seen, the Arkansas 2015 study (this study) appears to show achievable savings on the lower side relative to the other studies at 0.82 percent (average yearly reduction over the 10 year time horizon). For additional context, a regional average percent savings was calculated. The regional average of the six studies, plus this one, indicate a 1.1 percent average annual reduction, which is 19 percent higher than what was found in this study. While it is difficult to know precisely why the figures from this study are significantly lower than the average for the region, there a few driving factors that might explain the differences:

- All of the other studies were completed at least 2 years ago. At that time, avoided costs were higher which means that more measures likely passed the economic screens in those studies and thus the achievable potential was higher.
- The effects of federal equipment standards were not playing as significant a role for the other studies, given that those standards would not have gone into effect for several years. In this study, codes and standards were influencing the achievable results from the beginning of the 10-year forecast horizon, which had the effect of reducing the savings.

[42]ACEEE. "Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies." August 2014. Data in the figures below were derived from Table 2 of this study. Note that one of the studies indicated on Table 2 was an Arkansas statewide potential study conducted by ACEEE in 2011. The results of this study were not included since it was conducted prior to the deployment of EE programs in the state and thus the results were not deemed comparable to the current effort.

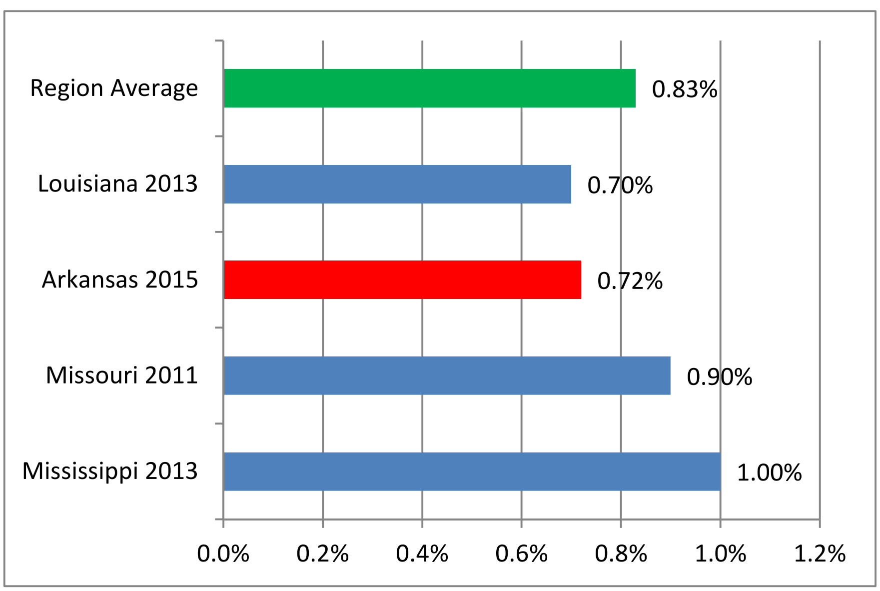
**Figure 5-20. Benchmarking of Electric Achievable Potential Savings**




*Source: Navigant analysis, 2015*

Figure 5-21 provides a comparison of the gas annual average percentage reduction from this study (savings relative to net sales) compared to three other studies from the region conducted over the past four years. As can be seen, the Arkansas 2015 study (this study) also appears to show achievable savings on the lower side relative to the other studies at 0.72 percent. For additional context, a regional average percent savings was calculated. The regional average of the three studies, plus this one, indicate a 0.83 percent average annual reduction, which is 13 percent higher than what was found in this study.

**Figure 5-21. Benchmarking of Gas Achievable Potential Savings**




*Source: Navigant analysis, 2015*

# 6 Demand Response Potential

This chapter presents the maximum and realistic achievable DR potential from DR technologies for the four electric IOUs. The section begins by explaining Navigant's approach to calculating realistic and maximum achievable potential including a description of the modeling tool, the methodology and key assumptions for calculating potential for several DR technology types. It then presents the realistic and maximum achievable potential by DR technology type, customer segment and utility. Appendix F contains more details of the impact and cost input assumptions that Navigant used in its analysis of DR potential.

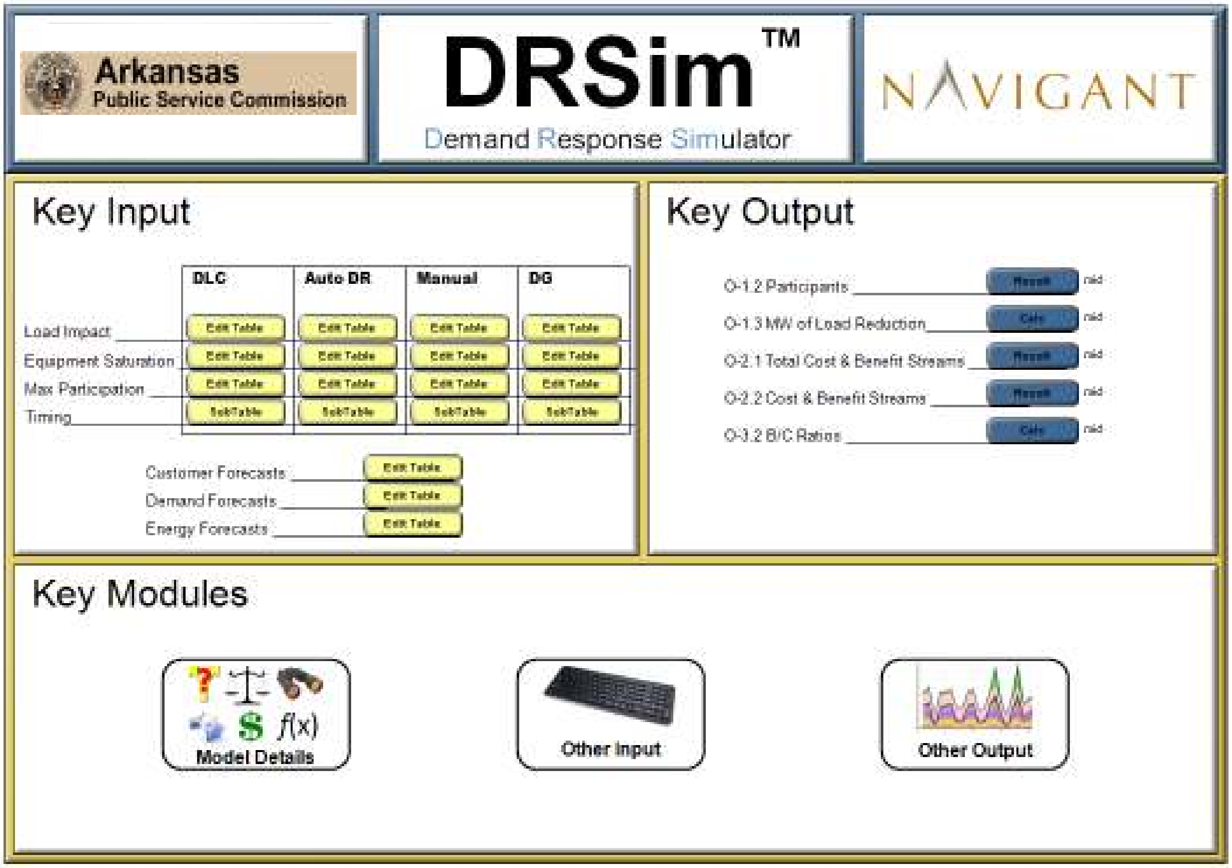
## 6.1 *Approach to Estimating Achievable Potential*

Navigant conducted the analysis for this Potential Study using its DRSim™ model. The model takes as input key variables including peak demand impacts for DR technologies, avoided cost estimates, technology enablement, administrative and annual operation cost estimates and the appropriate population of potential participants for each technology. Navigant used input data specific to the Arkansas electric utilities where it was readily available from the Potential Study data collection efforts. These data were supplemented with state-level work published by FERC in its *National Assessment of Demand Response Potential*, Navigant's in-house expertise assessing DR potential for other similar utilities, and a limited review of secondary resources. To capture a range of potential DR impacts, Navigant assumed realistic and maximum achievable potential DR scenarios as defined below:

- **Maximum Achievable DR Potential**: Maximum achievable potential is defined as the demand savings relative to a utility's baseline demand forecast, resulting from expected program participation and **ideal** implementation conditions. Maximum achievable potential establishes a maximum target for DR savings that a utility can expect to achieve through its DR programs and may involve incentive or deployment costs that represent a very high portion of total programs costs. Maximum achievable potential is considered the hypothetical upper-boundary of achievable DR savings potential, because it presumes conditions that are ideal and not typically observed.
- **Realistic Achievable DR Potential**: Realistic achievable potential is a subset of maximum achievable potential and is defined as the demand savings relative to a utility's baseline demand forecast, resulting from expected program participation and **realistic** implementation conditions. This scenario represents the approximate peak load reductions that the may be achieved through expansion of any current DR initiatives and implementation of new DR initiatives with "best practice" participation and incentive levels.

Figure 6-1 shows a screen shot of the graphical user interface of the DRSim™ modeling tool.

**Figure 6-1. DRSim Graphical User Interface**




### 6.1.1 Demand Response Technology Types

This Potential Study is focused on the potential demand reduction from various DR technologies rather than the programs designed to implement those technologies. Only technologies that are event driven and enabled by technology were considered in this Potential Study. While programs such as time-of-use and real time pricing can result in peak demand impacts, they require changes to rate cases and behavioral responses to realize an impact. They also require interval data collection and two-way communications between the utility and customer meter. In addition to advanced metering infrastructure (AMI), these programs require utility investment in a meter data management system (MDMS) and integration with the billing system. Because the scope of this analysis was limited, the modeling was limited to the most well established DR technologies. The four main technology categories that were modeled in this Potential Study include the following:

**<u>Direct Load Control</u>**

Direct load control (DLC) of a residential or small commercial customer's load with a device (e.g., a load control switch or programmable communicating thermostat) in exchange for an annual incentive payment. DLC technologies allow a utility to interrupt or cycle electrical equipment remotely during load peak times. DLC for central air conditioners is achieved through cycling units on-and-off or making thermostat adjustments throughout different times of the day. Similarly, DLC for electric water heaters is achieved by cycling the unit on and off during the peak period. The DLC technologies are mostly applicable to the residential customer segment but may also be deployed to small commercial customers as well. Because the scope of this analysis was limited, Navigant did not look at the potential for demand reduction from DLC in other end uses such as pool pumps, appliances, space heating etc., due to the relatively low expected impact. These end uses may provide additional opportunity for peak load reduction beyond what is presented in this report.

**Manual DR**

There are several different types of DR programs designed to achieve demand reduction without the need for additional investment in AMI or other equipment for participation. For medium to large C&I customers, interruptible/curtailable tariffs[43] and aggregator programs are some examples of programs designed to achieve demand reduction through Manual DR. Reductions are typically achieved by reducing lighting loads at the customer facility, reducing or shifting HVAC loads or shutting down equipment (process) during event periods which are called by the utility. Terms of the agreement between the utility and customer (i.e. incentive amount, pre-determined minimum load reduction, number of times the utility can call an event, etc.) are typically determined beforehand as part of the program design. This Potential Study considers the maximum and realistic achievable potential from Manual DR in the lighting, HVAC and process end use categories for the larger C&I customer segments. Programs to realize this potential are a function of program design which is not within the scope of this Potential Study.

**Auto DR**

Navigant Research uses the following definition of Auto DR:[44]

> *"A fully automated demand response system is an operation that is entirely managed via automation through information and network technology. This starts with the initiation of an external communications signal or notification from a utility, grid operator, or curtailment service provider. It flows all the way to a building energy management control system that automatically executes the signal based upon certain algorithms or predefined rules that have been programmed into this system. Ideally, there is little or no day-to-day oversight required from the facilities team."*

This Potential Study assumes that only customers with centrally managed lighting systems, centrally managed processes or energy management systems in their facility would provide potential demand reduction via Auto DR technologies.

**Distributed Generation**

Distributed Generation (DG) is generally for large customers with on-site generator sets; who have the ability to provide demand reduction, when a DR event is called by the utility, by switching the facility to onsite generation. In addition to the requirement that a customer has a generator set on site, in many cases additional emissions controls must be added to the existing generators to meet emissions requirements during periods of peak generation when the additional capacity will be called upon.

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[43] Id.

[44] Navigant Research, *Automated Demand Response - OpenADR, Commercial & Industrial ADR, Residential ADR, and DR Management Systems: Global Market Analysis and Forecasts.* 1Q 2014.

### 6.2 Market Characterization

This section discusses the analysis inputs to the DRSim™ model used to define the DR potential for each utility. For all of the "global inputs" to the model, the DRSim™ model leveraged the global input template to the DSMSim™ model used for the energy savings component of this Potential Study. The section of this report that covers market characterization for DR potential contains detail about how the customer forecasts, energy and demand forecast and avoided costs were determined and also contains the sources for these data.

For each of the technologies outlined above, only certain customer segments are applicable. Figure 6-1 shows a mapping of which technology is applicable to each customer segment. The global inputs to the model are broken out by the customer segments shown in the table.

**Table 6-1. Customer Segment Applicability for Each DR Technology**

| Program ↓ Sector → | Res SF | Res MF | Res Manuf | C&I Ag | C&I Col and Univ | C&I Health | C&I Ind | C&I Rest | C&I Lodge | C&I Office L | C&I Office S | C&I School | C&I Other Com | C&I Ret Food | C&I Ret N Food | C&I Warehouse |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC - Central AC | X | X | X | | | | | X | | | X | | | | | |
| DLC - Room AC | X | X | X | | | | | | | | | | | | | |
| DLC - PCT | X | X | X | | | | | X | | | X | | | | | |
| DLC - Water Heater | X | X | X | | | | | | | | | | | | | |
| DLC - Irrigation Pumping | | | | X | | | | | | | | | | | | |
| Auto DR Lighting | | | | | X | X | X | | X | X | | X | X | X | X | X |
| Auto DR EMS | | | | | X | X | X | | X | X | | X | X | X | X | X |
| Auto DR Process | | | | | X | X | X | | X | X | | X | X | X | X | X |
| DG Diesel Engine | | | | | X | X | X | | X | | | | | | | X |
| DG NG Engine | | | | | X | X | X | | X | | | | | | | X |
| DG Diesel Turbine | | | | | X | X | X | | X | | | | | | | X |
| DG NG Turbine | | | | | X | X | X | | X | | | | | | | X |
| Manual Lighting Control | | | | | X | X | X | | X | X | | X | X | X | X | X |
| Manual HVAC Control | | | | | X | X | X | | X | X | | X | X | X | X | X |
| Manual Process Control | | | | | X | X | X | | X | X | | X | X | X | X | X |

*Glossary: SF – Single Family, MF – Multi Family, Manuf – Manufactured, PCT - Programmable Communicating Thermostat, EMS – Energy Management System, NG – Natural Gas.*
*Source: Navigant analysis, 2015*

Within each customer segment, only the portion of customers with suitable load or certain enabling technologies are considered eligible to be potential participants in the DR technology. For example, only residential single family customers that have central air conditioning would be eligible for the DLC – Central A/C Program. A full list of these equipment saturation values for each customer segment is presented in Appendix F. Of the customers in each segment with suitable loads for the DR technologies, Navigant assumed participation rates for both the maximum and realistic achievable potential scenarios as inputs in the model. A full list of these participation values for each customer segment is presented in Appendix F.

## 6.3 Peak Demand Reduction Assumptions

The amount of potential peak demand reduction for each technology within each customer segment was inputted into the model on the basis of either kW/ft$^2$ of floor space or kW/participant. For most of the residential technologies (e.g. DLC – Central AC or DLC - Water Heater), the impacts were calculated on the basis of kW/participant whereas for the C&I technologies, the calculation basis was kW/ ft$^2$ of floor space. For the irrigation pump DLC technology, the impact was calculated based on number of acres of irrigated land. Navigant used a variety of sources for estimating these peak demand impacts; a full list of these impact assumptions for each customer segment and each DR technology are presented in Appendix F.

## 6.4 Energy Savings from Demand Response

Navigant conservatively assumed that there are no significant energy savings achieved from the utility's DR technologies in either scenario. There are some studies that claim modest energy savings from DR technologies but the typical industry assumption for dispatchable programs like DLC and manual/auto DR is that the energy reduced during the DR event is consumed at a later time (i.e. "Snapback Effect").

## 6.5 DR Technology Costs

The cost effectiveness analysis looked at the utility administrative costs, participant costs, equipment costs for enabling the demand response technologies and avoided costs. Navigant used the Total Resource Cost (TRC) test to evaluate the cost effectiveness of each technology area so incentive costs and bill impacts were not considered as they are transfer payments within the TRC framework. Equipment de-commissioning costs were also excluded from this analysis as they are typically not considered in a potential study. A detailed breakdown of the cost assumption for each DR technology is included in Appendix F. Table 6-2 and Table 6-3 show a breakdown of estimated total program costs for the realistic and maximum achievable scenarios.

**Table 6-2. Total Program Costs – Realistic Achievable Potential Scenario**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | $5,895,957 | $2,498,228 | $4,074,833 | $2,328,138 | $228,145 | $29,688 | $45,298 | $44,569 | $102,177 | $172,366 | $101,041 |
| 2017 | $3,658,776 | $2,559,029 | $3,789,723 | $2,089,356 | $197,663 | $24,641 | $36,337 | $34,624 | $199,982 | $332,056 | $191,351 |
| 2018 | $3,925,414 | $2,627,163 | $3,507,339 | $1,870,600 | $168,410 | $20,329 | $28,817 | $26,119 | $294,020 | $479,386 | $271,528 |
| 2019 | $4,195,519 | $2,679,637 | $3,248,948 | $1,667,723 | $144,261 | $16,533 | $22,517 | $19,248 | $383,901 | $615,394 | $342,331 |
| 2020 | $4,456,297 | $2,741,552 | $3,000,454 | $1,483,029 | $121,090 | $13,437 | $17,129 | $13,901 | $470,307 | $740,211 | $404,562 |
| 2021 | $4,708,883 | $2,792,511 | $2,756,908 | $1,310,132 | $102,380 | $10,663 | $12,843 | $9,642 | $553,021 | $854,608 | $458,493 |
| 2022 | $2,555,977 | $707,858 | $885,178 | $462,373 | $37,707 | $4,447 | $6,269 | $5,718 | $541,920 | $837,336 | $449,172 |
| 2023 | $2,478,656 | $690,701 | $865,273 | $452,310 | $36,902 | $4,323 | $6,113 | $5,459 | $530,955 | $820,406 | $440,171 |
| 2024 | $2,430,043 | $676,001 | $845,658 | $442,493 | $35,866 | $4,334 | $5,953 | $5,328 | $520,220 | $803,765 | $431,243 |
| 2025 | $2,383,525 | $660,595 | $830,898 | $434,162 | $35,150 | $4,159 | $5,804 | $5,168 | $509,664 | $787,551 | $422,567 |

**Table 6-3. Total Program Costs – Maximum Achievable Potential Scenario**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | $8,387,421 | $3,741,859 | $5,954,668 | $3,373,845 | $328,628 | $42,308 | $64,089 | $62,487 | $153,041 | $256,314 | $148,996 |
| 2017 | $6,470,856 | $3,844,234 | $5,249,663 | $2,816,956 | $256,866 | $31,185 | $44,644 | $41,123 | $300,000 | $489,337 | $277,077 |
| 2018 | $7,003,749 | $3,940,124 | $4,586,082 | $2,323,880 | $198,516 | $22,454 | $29,870 | $25,007 | $441,029 | $700,516 | $386,228 |
| 2019 | $7,537,517 | $4,024,846 | $3,988,136 | $1,889,124 | $148,409 | $15,512 | $18,407 | $13,658 | $576,075 | $890,183 | $477,557 |
| 2020 | $8,050,532 | $4,109,909 | $3,434,993 | $1,511,553 | $107,824 | $9,804 | $9,849 | $5,564 | $705,566 | $1,059,915 | $552,869 |
| 2021 | $8,539,642 | $4,186,410 | $2,927,320 | $1,188,093 | $73,159 | $5,684 | $4,726 | $4,019 | $829,529 | $1,210,559 | $613,414 |
| 2022 | $4,497,117 | $1,059,320 | $1,116,033 | $551,135 | $43,028 | $4,782 | $6,283 | $5,428 | $812,773 | $1,186,044 | $601,006 |
| 2023 | $4,357,215 | $1,036,336 | $1,091,386 | $538,944 | $40,979 | $4,567 | $6,156 | $5,169 | $796,347 | $1,162,104 | $588,827 |
| 2024 | $4,273,603 | $1,015,024 | $1,071,498 | $528,832 | $40,302 | $4,607 | $6,004 | $5,041 | $780,294 | $1,138,672 | $576,956 |
| 2025 | $4,190,646 | $992,970 | $1,047,111 | $516,589 | $39,195 | $4,440 | $5,910 | $4,959 | $764,552 | $1,115,818 | $565,319 |

### 6.6 Peak Load Reduction Potential

Navigant estimates up to 833 MW of peak load reduction within the four electric utility service territories by 2025 in the maximum achievable potential scenario, which represents approximately 13 percent of the total forecasted peak load for 2025. For the realistic achievable potential scenario, Navigant estimates up to 596 MW, or 9 percent of total forecasted peak load in 2025. Figure 6-2 shows the total peak load reduction potential for the electric utilities for both the maximum and realistic achievable potential scenarios. Table 6-4 presents estimates total peak reduction for both scenarios broken out by each utility in tabular format.

**Figure 6-2. Total Peak Load Reduction Potential by Scenario for the Electric Utilities**

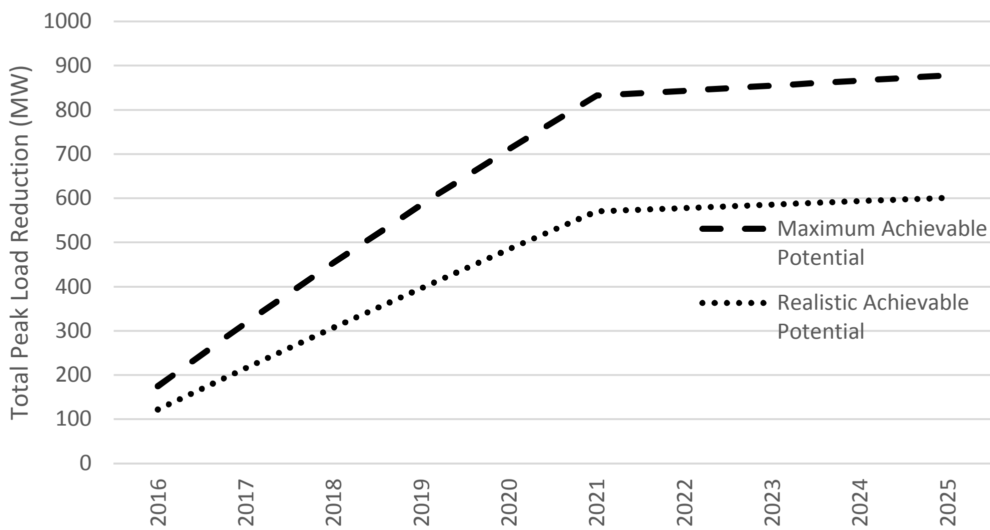


**Table 6-4. Total Peak Load Reduction by Utility and Scenario**

| | Entergy | | Empire | | OG&E | | SWEPCO | |
|---|---|---|---|---|---|---|---|---|
| | Realistic Scenario | Maximum Scenario | Realistic Scenario | Maximum Scenario | Realistic Scenario | Maximum Scenario | Realistic Scenario | Maximum Scenario |
| 2016 | 96 | 138 | 1 | 1 | 10 | 14 | 16 | 22 |
| 2017 | 170 | 251 | 1 | 2 | 17 | 25 | 27 | 40 |
| 2018 | 243 | 359 | 1 | 2 | 24 | 36 | 39 | 57 |
| 2019 | 314 | 464 | 2 | 3 | 31 | 46 | 49 | 73 |
| 2020 | 384 | 564 | 2 | 3 | 38 | 56 | 60 | 88 |
| 2021 | 453 | 662 | 3 | 4 | 45 | 65 | 70 | 102 |
| 2022 | 460 | 671 | 3 | 4 | 45 | 66 | 70 | 102 |
| 2023 | 467 | 681 | 3 | 4 | 46 | 67 | 70 | 103 |
| 2024 | 474 | 691 | 3 | 4 | 47 | 68 | 71 | 103 |
| 2025 | 480 | 701 | 3 | 4 | 47 | 69 | 71 | 103 |

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The preceding figures show a significant difference between maximum and realistic achievable potentials. Figure 6-3 shows the maximum achievable potential estimates by technology type while Figure 6-4 shows realistic achievable potential by technology type.

**Figure 6-3. Maximum Achievable Peak Demand Reduction by Technology Type**

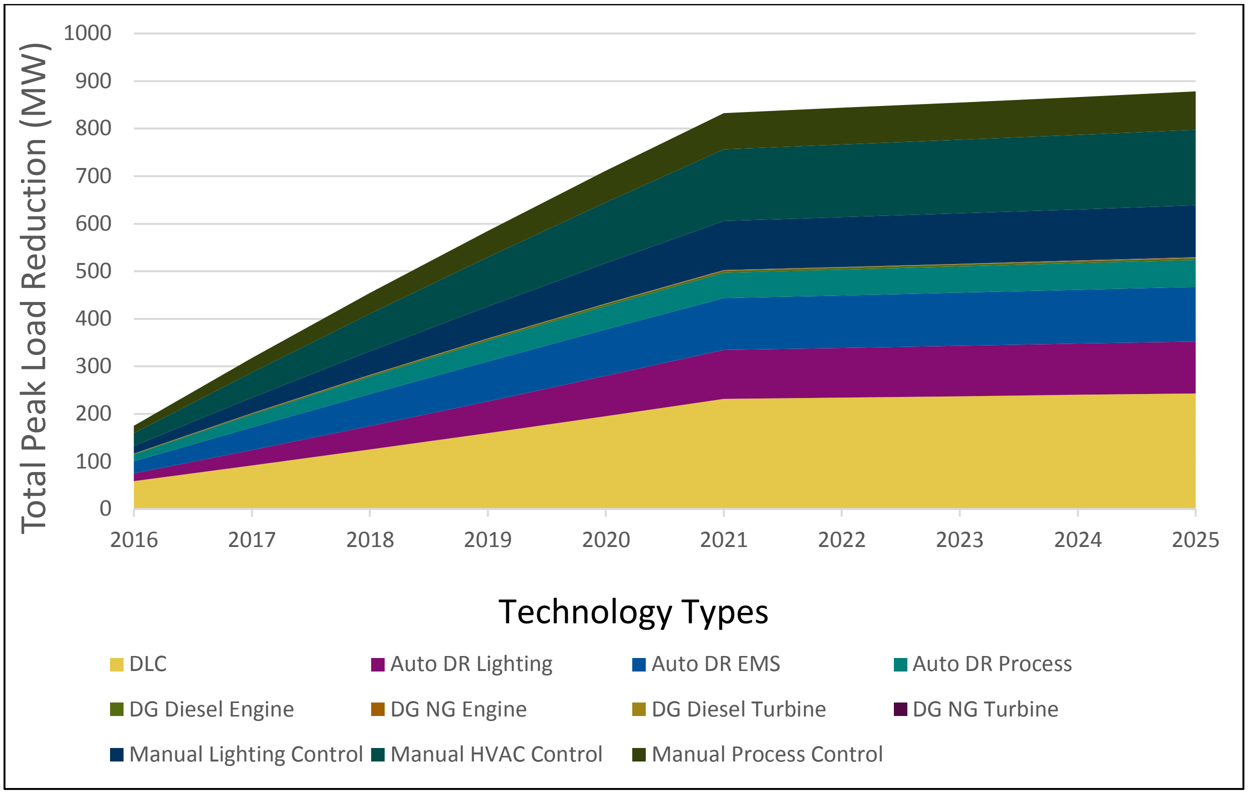


**Figure 6-4. Realistic Achievable Peak Demand Reduction by Technology Type**

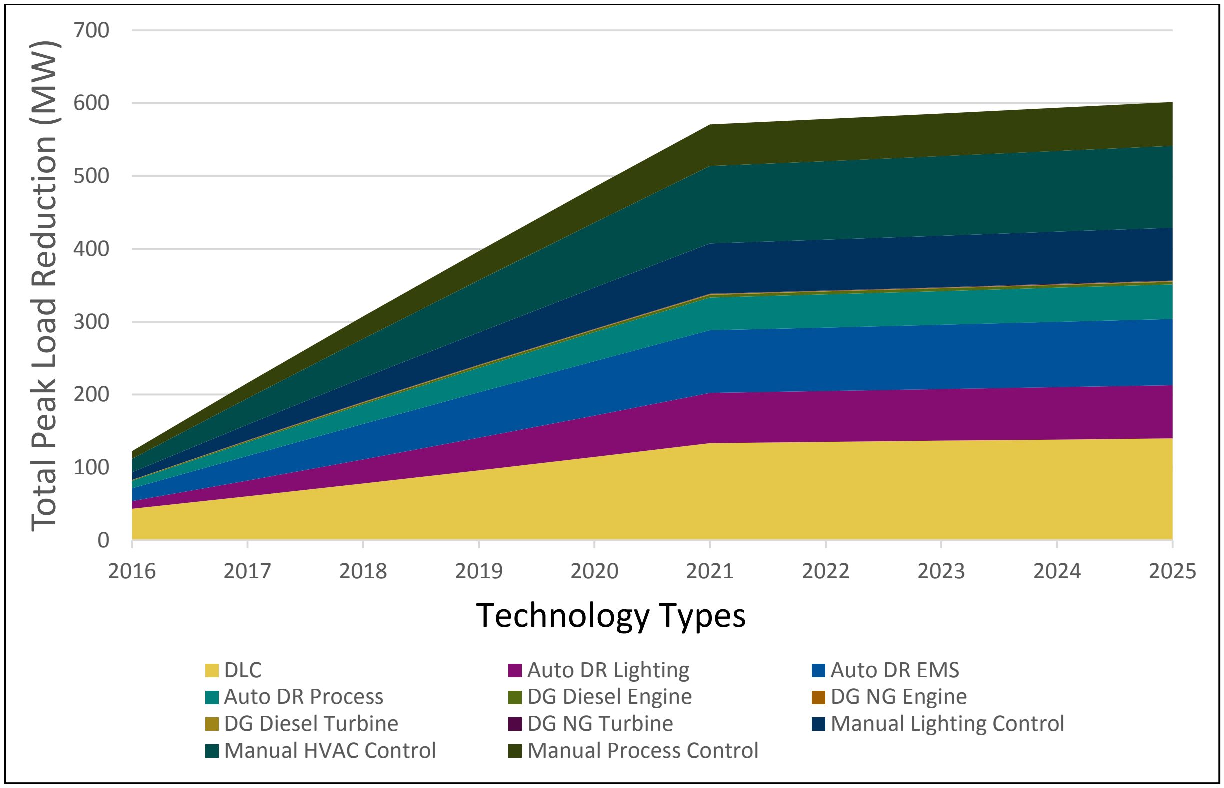



Table 6-5 shows the breakout of maximum achievable peak demand reduction by technology type. Table 6-6 shows the breakout of realistic achievable peak demand reduction by technology type. A further breakout of the potential by technology type for each electric utility as well as a breakout of the DLC potential by sub-program type is presented in Appendix F.

**Table 6-5. Maximum Achievable Peak Demand Reduction by Technology Type**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 59 | 16 | 26 | 14 | 1.2 | 0.2 | 0.2 | 0.2 | 16 | 27 | 16 |
| 2017 | 91 | 33 | 48 | 26 | 2.2 | 0.3 | 0.4 | 0.4 | 33 | 53 | 30 |
| 2018 | 125 | 50 | 67 | 36 | 2.9 | 0.4 | 0.5 | 0.5 | 50 | 79 | 43 |
| 2019 | 160 | 67 | 84 | 44 | 3.4 | 0.4 | 0.6 | 0.5 | 67 | 103 | 56 |
| 2020 | 195 | 85 | 98 | 50 | 3.8 | 0.4 | 0.6 | 0.5 | 85 | 127 | 66 |
| 2021 | 231 | 103 | 109 | 54 | 4.0 | 0.4 | 0.6 | 0.5 | 103 | 151 | 76 |
| 2022 | 234 | 105 | 110 | 54 | 4.0 | 0.5 | 0.6 | 0.5 | 105 | 153 | 77 |
| 2023 | 237 | 106 | 112 | 55 | 4.1 | 0.5 | 0.6 | 0.5 | 106 | 155 | 78 |
| 2024 | 240 | 107 | 113 | 56 | 4.1 | 0.5 | 0.6 | 0.5 | 107 | 157 | 79 |
| 2025 | 243 | 109 | 115 | 57 | 4.2 | 0.5 | 0.6 | 0.5 | 109 | 159 | 81 |

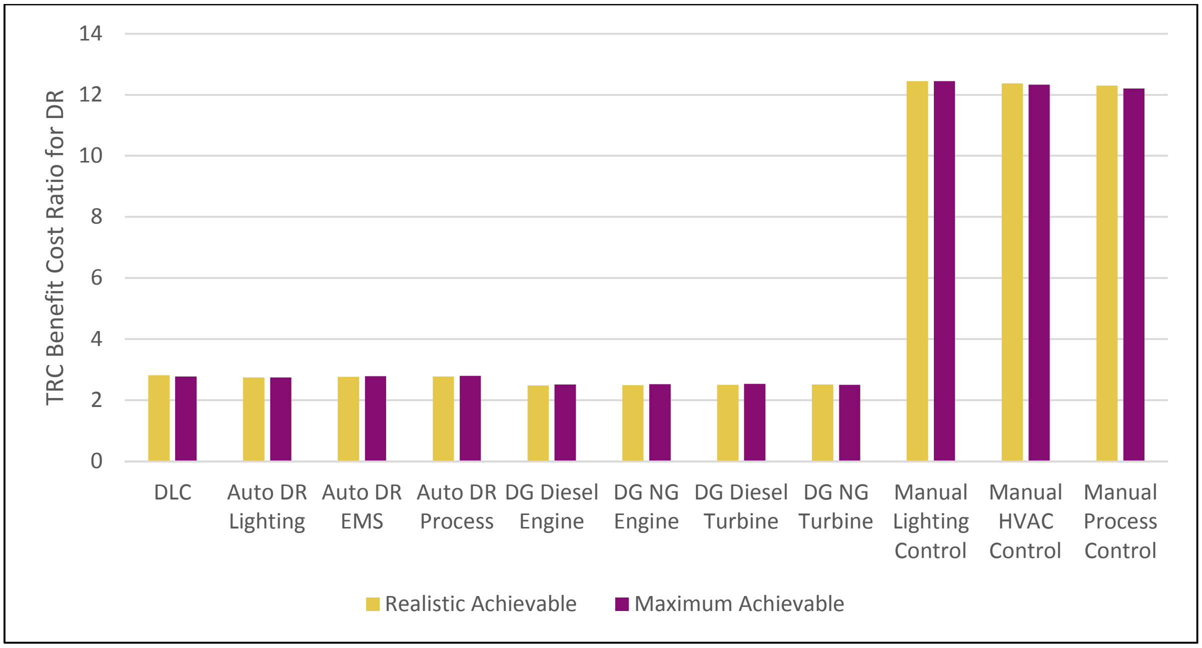
**Table 6-6. Realistic Achievable Peak Demand Reduction by Technology Type**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 43 | 11 | 17 | 10 | 0.9 | 0.1 | 0.2 | 0.2 | 11 | 18 | 11 |
| 2017 | 60 | 22 | 34 | 19 | 1.6 | 0.2 | 0.3 | 0.3 | 22 | 36 | 21 |
| 2018 | 78 | 33 | 49 | 27 | 2.2 | 0.3 | 0.4 | 0.4 | 33 | 54 | 31 |
| 2019 | 96 | 45 | 62 | 34 | 2.7 | 0.3 | 0.5 | 0.5 | 45 | 72 | 40 |
| 2020 | 115 | 57 | 75 | 40 | 3.2 | 0.4 | 0.5 | 0.5 | 57 | 89 | 49 |
| 2021 | 133 | 69 | 86 | 45 | 3.5 | 0.4 | 0.6 | 0.5 | 69 | 106 | 57 |
| 2022 | 135 | 70 | 87 | 46 | 3.6 | 0.4 | 0.6 | 0.5 | 70 | 108 | 58 |
| 2023 | 137 | 71 | 88 | 46 | 3.6 | 0.4 | 0.6 | 0.5 | 71 | 109 | 59 |
| 2024 | 138 | 72 | 90 | 47 | 3.7 | 0.4 | 0.6 | 0.5 | 72 | 111 | 59 |
| 2025 | 140 | 73 | 91 | 48 | 3.7 | 0.4 | 0.6 | 0.6 | 73 | 112 | 60 |

## *6.7 Cost Effectiveness*

This analysis finds all of the technology types to be cost effective using the TRC test. The lack of incentive costs, which are generally a large portion of DR program implementation costs and are considered a transfer payment within the TRC framework, partially explains why all of the programs are cost effective by the TRC test. Figure 6-5 shows the results of the benefit cost test screening for the DR technologies. The figure shows that the ratio for manual technologies is very high which is attributable to the lack of equipment costs necessary to enable the technology. The cost for enabling DLC, Auto DR and DG technologies are higher which drives the benefit-cost ratio down. In general, the only costs associated with Manual DR technologies are program administrative costs so the benefit-cost ratio is very favorable.

**Figure 6-5. TRC Benefit-Cost Test Results**



# Appendix A Overview of DSMSim and DRSim Models

On April 7, 2015, Navigant conducted a webinar for the PWC in which it provided an overview of the DSMSim™ and DRSim™ models. This appendix provides the materials that were used by the Navigant team during the webinar.

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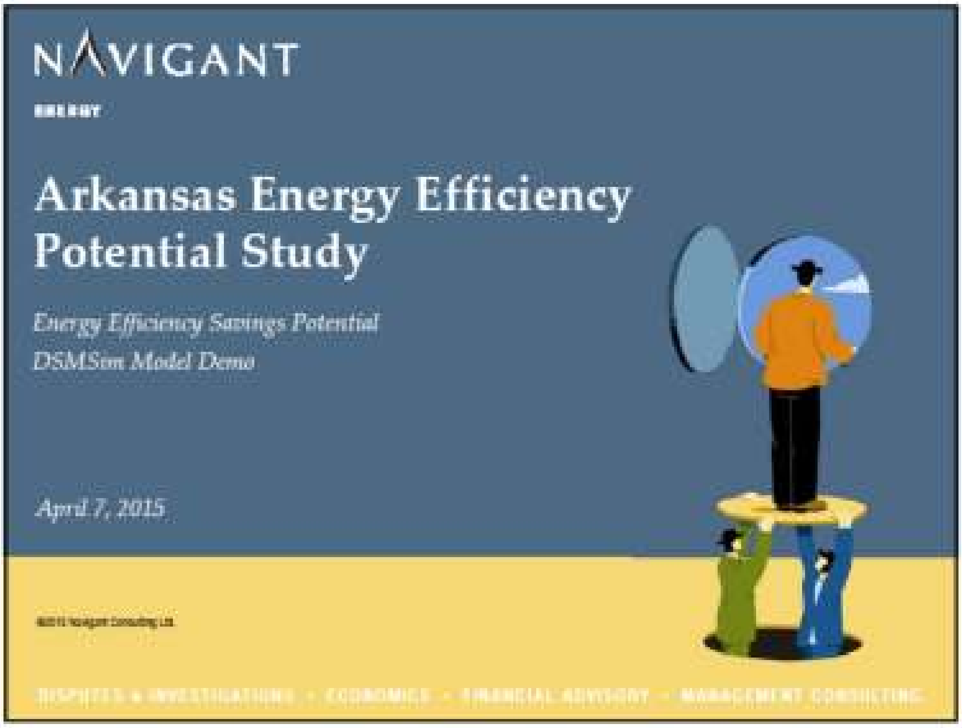
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Arkansas Energy Efficiency Potential Study
Energy Efficiency Savings Potential
DSMSim Model Demo
April 7, 2015
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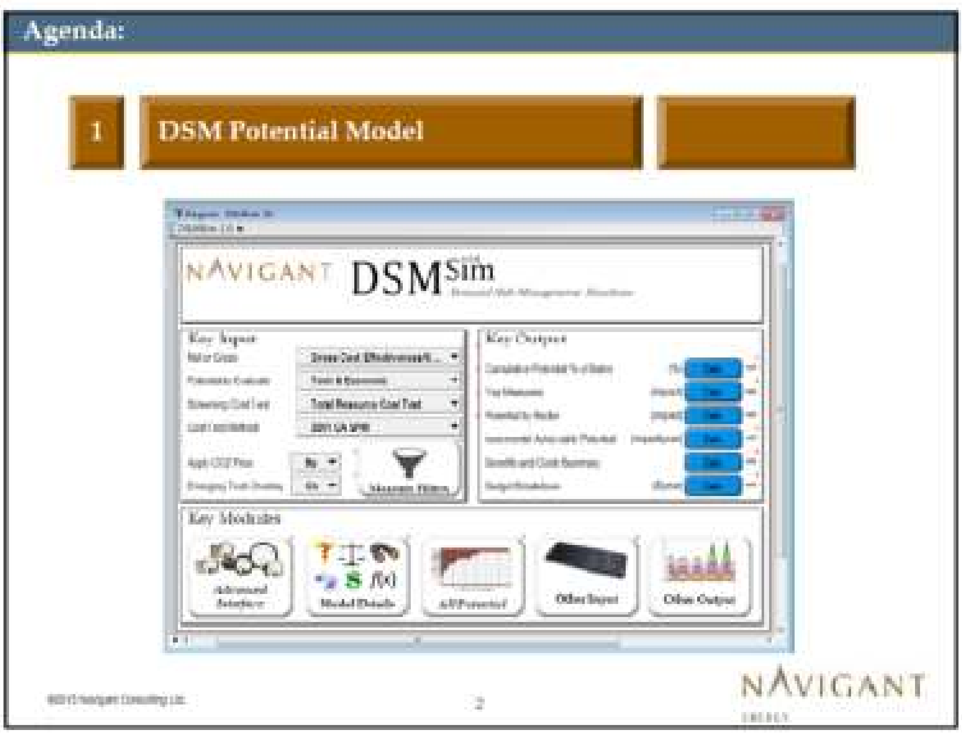
Agenda:
1
DSM Potential Model
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DSMSim
Key Input
Key Output
Key Modules
Model Details
Other Input
Other Output
2
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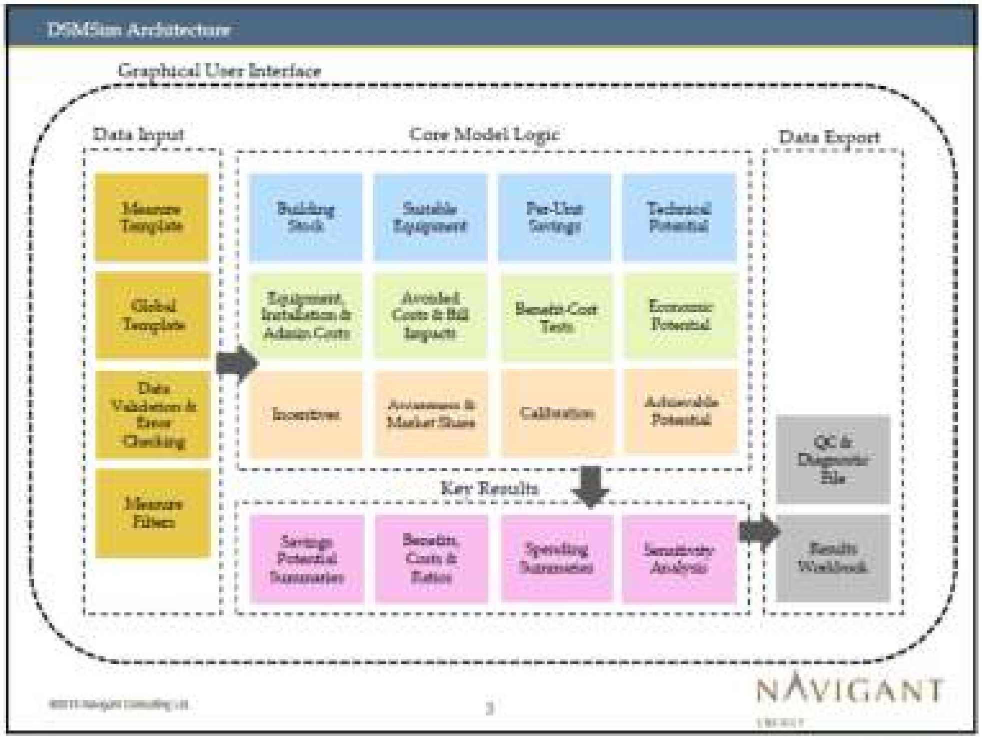
DSMSim Architecture
Graphical User Interface
Data Input
Core Model Logic
Data Export
Measure Template
Global Template
Data Validation & Error Checking
Measure Filters
Building Stock
Suitable Equipment
Per-Unit Savings
Technical Potential
Equipment, Installation & Admin Costs
Avoided Costs & Bill Impacts
Benefit-Cost Tests
Economic Potential
Incentives
Awareness & Market Share
Calibration
Achievable Potential
Key Results
Savings Potential Summaries
Benefits, Costs & Ratios
Spending Summaries
Sensitivity Analysis
QC & Diagnostic File
Results Workbook
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Input Data
Input templates provide easy access to key input assumptions
Measure Template
• Includes all measure-related input data
• 50+ measure characteristics
• Incremental participant costs, consumption & demand, measure density, initial saturation, scaling basis, variable admin & load shape type
• Time-changing cost & consumption multipliers
• Data sources, descriptions & citations
Global Template
• Includes system and service territory-specific data
• Retail rates & avoided costs
• Building stock forecasts
• Sales and load forecasts with end use allocations
• Load shape profiles
• Discount rates, inflation rates & line losses
• Program & portfolio admin costs
Both input templates are Excel workbooks
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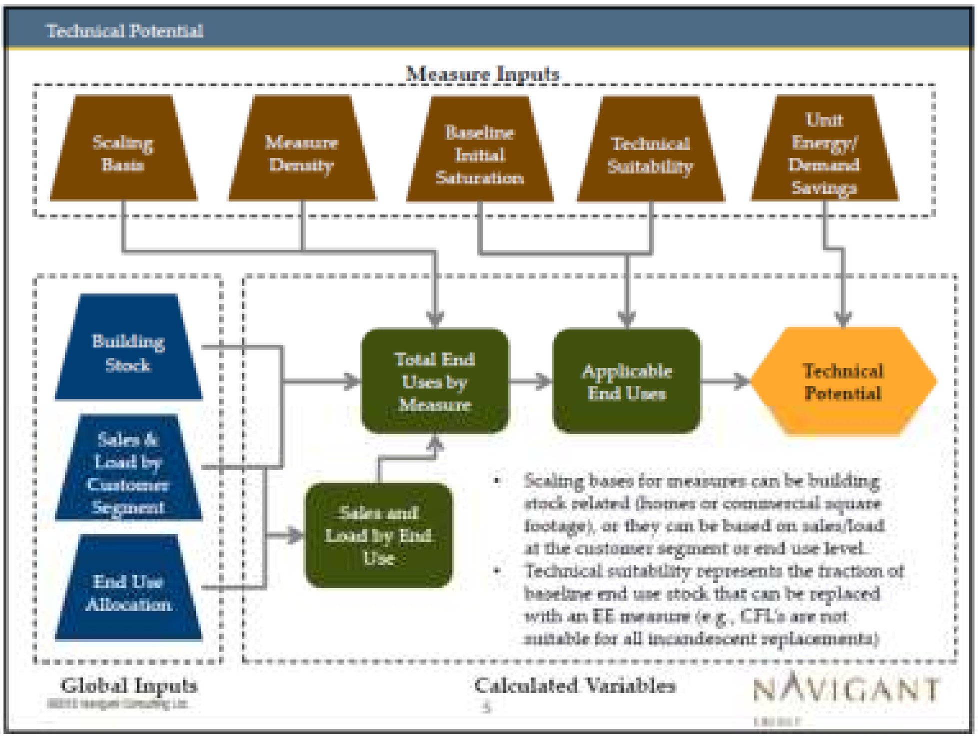


## Economic Potential

- Economic potential is the subset of technical potential that meets some TRC screening threshold.
- Screening thresholds can differ by measure, sector, end use, etc.
- TRC calculations follow standard practice and include:
  - Incremental participant costs
  - Avoided costs
  - Bill impacts
  - O&M costs/savings
  - Administrative costs
- Costs and benefits are calculated over the measure life or over a user-specified horizon
- Users can decide whether avoided costs from secondary savings will be included for a given utility (e.g., if Entergy incentivizes an insulation program, can it claim CenterPoint's avoided gas costs)

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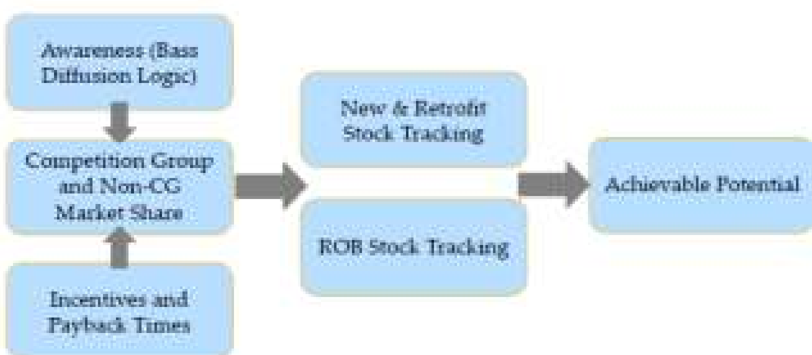
## Competition Groups

- Measures competing for the same end use savings are lumped into competition groups to prevent double-counting of savings potential (e.g., high efficiency water heaters and heat pump water heaters).
- Competing technologies share the same baseline assumptions and measure densities.
- Competition can only occur within a given customer segment, replacement type and service territory (service territories are differentiated by utility *and* climate zone).
- For technical and economic potential, only the measure with the greatest potential within the competition group is included in the reported totals.
  - For economic potential, no consideration for the most economic competing measure is made other than the requirement that it pass the TRC screening threshold.



## Achievable Potential

Achievable potential is calculated by modeling market mechanisms, participant interaction, measure attractiveness and stock turnover dynamics



## Incentive Methods

| Percentage of Incremental Costs [%] | Targeted Payback Period [years] | Targeted Participant Cost [level. $/kWh] | Max Utility Incentive [level. $/kWh] |
|---|---|---|---|
| Incentives calculated to be a specified percentage of the incremental costs | Incentives calculated to produce a specified payback period for the participant | Incentives calculated to produce a specified levelized cost for the participant | Incentives calculated as the minimum of the measure's levelized cost or the specified max incentive threshold |
| Equitable in relative terms | Equitable in absolute terms and promotes comprehensiveness | Equitable in absolute terms | Focus is minimizing acquisition costs and has the byproduct of maximizing lifetime savings (ie, persistence) |

All strategies can be differentiated by program, customer segment or end use, and all strategies apply a minimum incentive as a percentage of incremental costs

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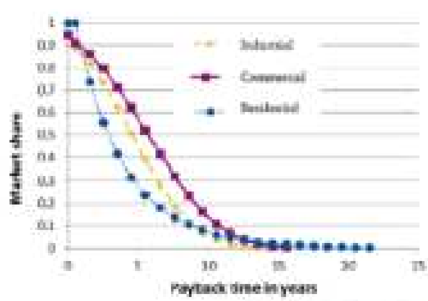
## Market Share

- Among competing efficient measures
  - Relies on a logit formulation for simulating discrete choice of competing EE measures.
  - PCT ratio is the main driver for participant's selection among EE measures.
  - Logit market share is used to determine a weighted simple payback for entire competition group.
- Among EE and baseline measures
  - Relies on payback acceptance curves empirically based on Navigant-led participant surveys.
  - Competition groups treated as single EE measure to determine total EE market share, which is then re-distributed to competing measures based on market share logit.
  - Payback adders (positive or negative) can be applied for calibration to observed acceptance levels.

$$CGMarketShare = \frac{e^{PCT_m \cdot sensParam}}{\sum_m e^{PCT_m \cdot sensParam}}$$

- $CGMarketShare$ = competition group market share
- $PCT$ = participant cost test ratio
- $sensParam$ = sensitivity to differences in PCT
- $m$ = competing measure

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## Nested Competition for Market Share

- Competition group measures compete for nested subsets of the suitable end use opportunities
- The size of each subset is a function of each measure's "effective technical suitability", which is the minimum of awareness or technical suitability
- The calculated market share for each subset is multiplied by the incremental area of the subset to determine a weighted average market share across all subsets

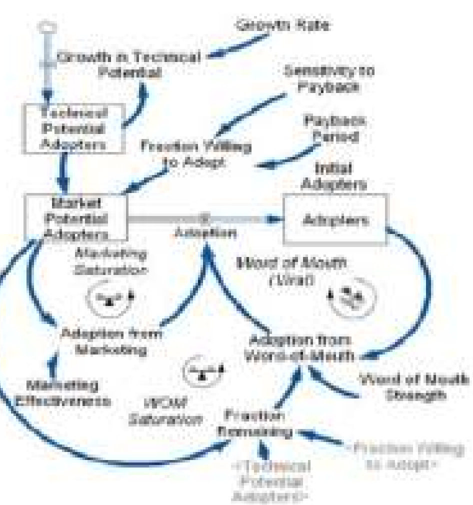
Nested Competition Among Lighting Measures


Area represents the fraction of end use opportunities (e.g., sockets) that are suitable for each competing EE measure and for the baseline measure (100% suitable)



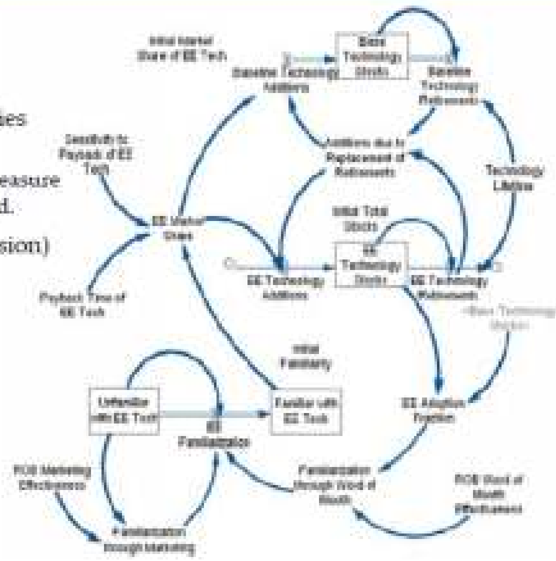
## Stock-and-Flow Diagram for New and Retrofit Measures

- New Construction
  - Upper bound on EE opportunities limited by growth in building stock.
  - Awareness (s-shaped bass diffusion) limits market adoption when low.
- Retrofit
  - Upper bound on EE opportunities limited by awareness (s-shaped bass diffusion).
  - Assume initial awareness is low to prevent retrofit of entire stock.



## Stock-and-Flow Diagram for ROB Measures

- Upper bound on EE opportunities limited by measure turnover.
  - Measure turnover dictated by measure lifetime exponentially distributed.
- Awareness (s-shaped bass diffusion) limits market share when low.

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## Calibration

- A typical calibration process includes calibrating the first several simulation years to historic levels or industry averages of savings potential and acquisition costs
- A secondary calibration shapes the calculated budget over time to reflect regulatory environments or spending targets
- Lastly, sensitivities provide insight into savings potential at different budget levels

| Calibrated Results | Calibration Levers |
|---|---|
| • Initial savings potential<br>• Initial total spending<br>• Total spending over time<br>• Initial acquisition costs<br>• By sector, end use, program or total | • Incentives (four approaches)<br>• Bass diffusion parameters<br>  • Marketing factors<br>  • Word-of-mouth factors<br>  • Initial awareness<br>• TRC screening threshold (eg. low income sector)<br>• Payback adders |

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# Arkansas Demand Response Potential Study

*Demand Response Potential – Model Walkthrough*

*April 7, 2015*



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## Demand Response Achievable Potential Estimation Methodology

- Navigant's Demand Response Simulator (DRSim™) tool mirrors the approach from FERC's *National Assessment of Demand Response*
- Global input data matches the inputs from the EE potential estimation, which in turn was informed by primary data received from the IOUs and the data collection efforts. These inputs include the following:
  - Customer, energy sales and peak demand forecasts (excluding opt out customers)
  - Avoided costs
  - Equipment saturations
- DR specific inputs were developed from a variety of other secondary sources including:
  - Technology specific peak demand reduction
  - Participation forecasts and attrition*

*Note: Participation forecasts will represent two levels of achievable potential: Realistic and Maximum (as denoted on p.22 of the project work plan.*

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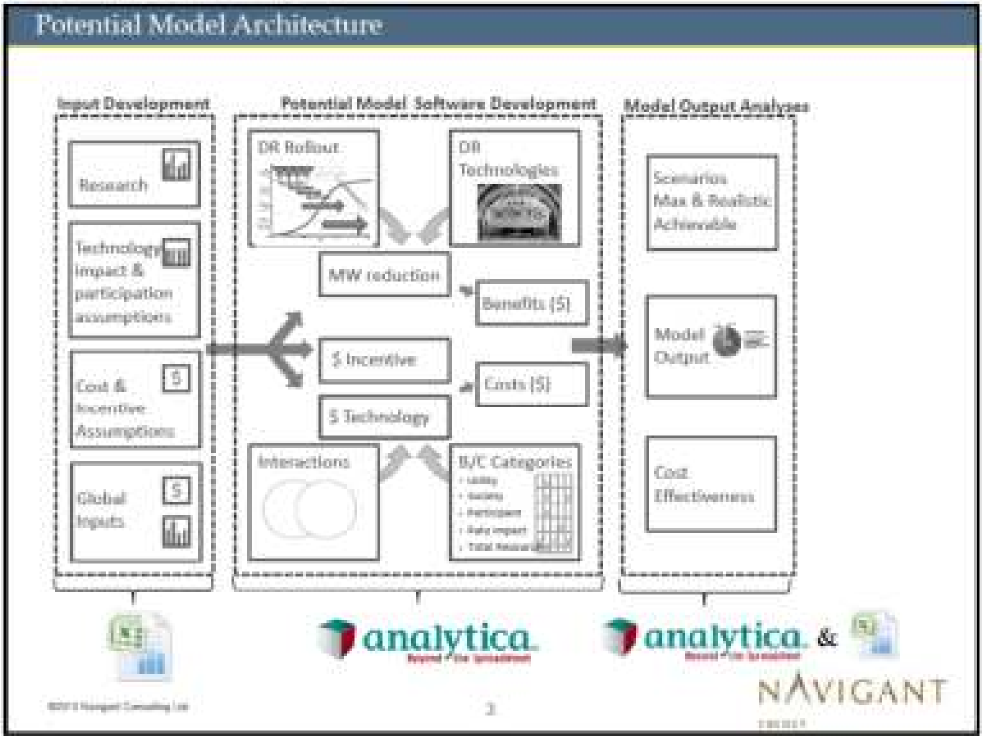


## Technology Inputs

- Example Input Assumptions for Residential Water Heater Direct Load Control Technology

| | Value Field | Unit basis | Res SF | Res MF | Res Manuf |
|---|---|---|---|---|---|
| Direct Load Control - Water Heater | RF Reduction | % | 1% | 1% | 1% |
| | DLC WH Impact | kW/participant | 0.58 | 0.58 | 0.58 |
| | Equipment Saturation | % | 55% | 52% | 75% |
| | Max Participation (Realistic Achievable) | % | 25% | 25% | 25% |
| | Max Participation (Max Achievable) | % | 35% | 35% | 35% |
| | Initial Participation | % | 0% | 0% | 0% |
| | Start Year | Year | 2015 | 2015 | 2015 |
| | End Year | Year | 2025 | 2025 | 2025 |
| | Number of Year to Reach Max Participation | Year | 5 | 5 | 5 |
| | Year Attrition Begins | Year | 2016 | 2016 | 2016 |

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## Cost Inputs

- Example Cost Assumptions for Residential Water Heater Direct Load Control Technology
  - Technology cost for residential WH DLC switch = $60 (cost of one-way switch)
  - Installation cost for residential WH DLC switch = $80/switch
  - Administration cost for residential WH DLC = $20/kW-yr
  - Incentive cost for residential WH DLC = $40/yr/participant

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## B/C Tests

- Benefits and costs for the TRC test are defined below.

| Cost/Benefit Category | TRC Test |
|---|---|
| Administrative | COST |
| Equipment | COST |
| Installation | COST |
| Incentives | TRANSFER |
| Avoided Costs of Supplying Electricity | BENEFIT |

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# Appendix B Residential Survey Results

A key objective of this Potential Study was to perform primary data collection for residential customers that are served by the IOUs across Arkansas. The survey data are useful for characterizing various elements of the EE measures assessed for the various levels of potential. Therefore, a survey of residential customers was designed and conducted to supplement the existing data. This appendix provides a summary of the results from the residential data collection effort described in Chapter 2.

The tables and figures that follow provide some high level results of the survey followed by the detailed survey results.

## *B.1 Space Heating*

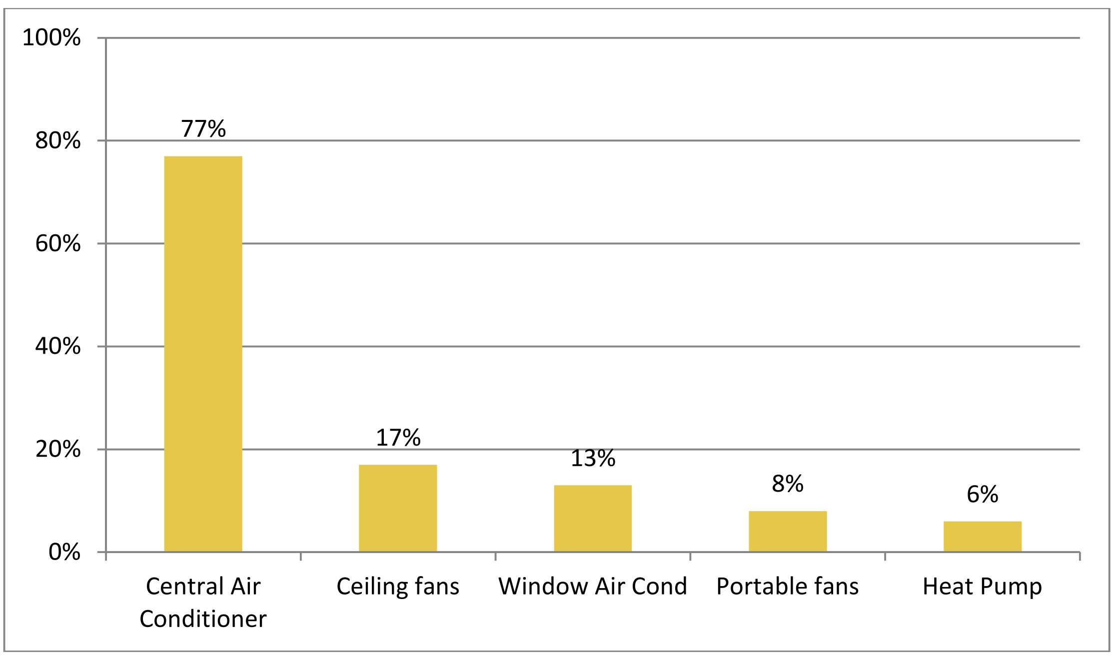
| | Single Family | Multi-Family | Manufactured Home |
|---|---|---|---|
| Electricity | 36.5% | 70.1% | 68.9% |
| Natural Gas | 59.6% | 27.3% | 17.8% |
| Propane | 2.1% | .0%H | 11.1% |
| Oil Or Kerosene | .1% | .0% | .0% |
| Wood Or Corn Pellets | 1.0% | 1.3% | 2.2% |
| Solar | .1% | .0% | .0% |
| Other Specify | .4% | .0% | .0% |
| No Heating System | .2% | 1.3% | .0% |

| | Single family | Multi-family | Manufactured home |
|---|---|---|---|
| Forced Air Furnace | 62.8% | 60.0% | 55.3% |
| Electric Baseboard Or Individual Room Heaters | 5.4% | 9.2% | 18.4% |
| Heat Pump | 18.6% | 7.7% | 10.5% |
| Boiler Steam Or Hot Water System | 1.9% | 7.7% | 2.6% |
| Electric Thermal Storage | 1.9% | 3.1% | .0% |
| Stove Or Fireplace | 4.7% | 1.5% | 5.3% |
| Other | 4.7% | 10.8% | 7.9% |

## B.2 Cooling

| | Single family | Multi-family | Manufactured home |
|---|---|---|---|
| Central AC | 77.2% | 78.1% | 60.9% |
| Window or room or wall mounted air conditioners | 12.9% | 3.1% | 28.3% |
| Heat Pump | 6.4% | 1.0% | 6.5% |
| Other Specify | 3.5% | 17.7% | 4.3% |

| | Single family | Multi-family | Manufactured home |
|---|---|---|---|
| Electric AC with Gas Heat | 53.7% | 22.2% | 15.8% |
| Gas Heat only | 2.1% | 4.8% | 0.8% |
| Electric AC with Electric Resistance Heat | 32.8% | 57.0% | 61.4% |
| Heat Pump | 1.2% | 0.1% | 0.7% |

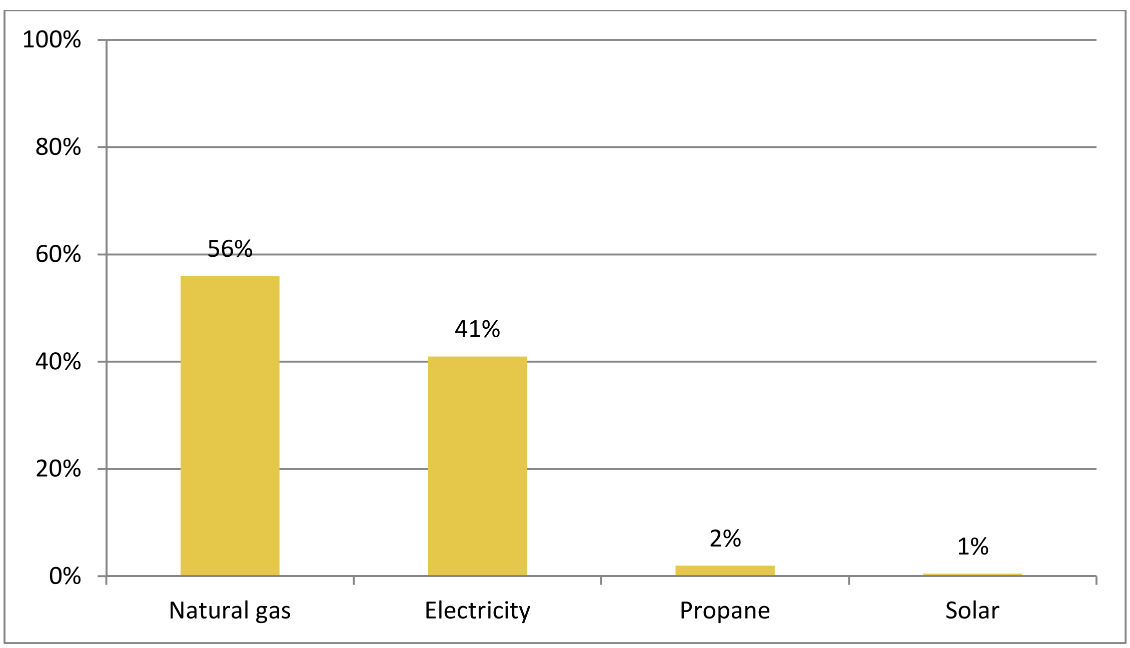



| | Estimated square foot that is heated | Estimated square foot that is air conditioned |
|---|---|---|
| Mean | 1543.39 | 1552.21 |
| N | 1055 | 1051 |
| Std. Deviation | 696.253 | 691.552 |

## B.3 *Water heating*

| | Single family | Multi-family | Manufactured home |
|---|---|---|---|
| Electricity | 37.5% | 60.9% | 86.4% |
| Natural gas | 60.3% | 37.7% | 9.1% |
| Propane | 2.0% | 0.0% | 2.3% |
| Solar | 0.2% | 1.4% | 0.0% |
| Other | 0.0% | 0.0% | 2.3% |
| | | | |

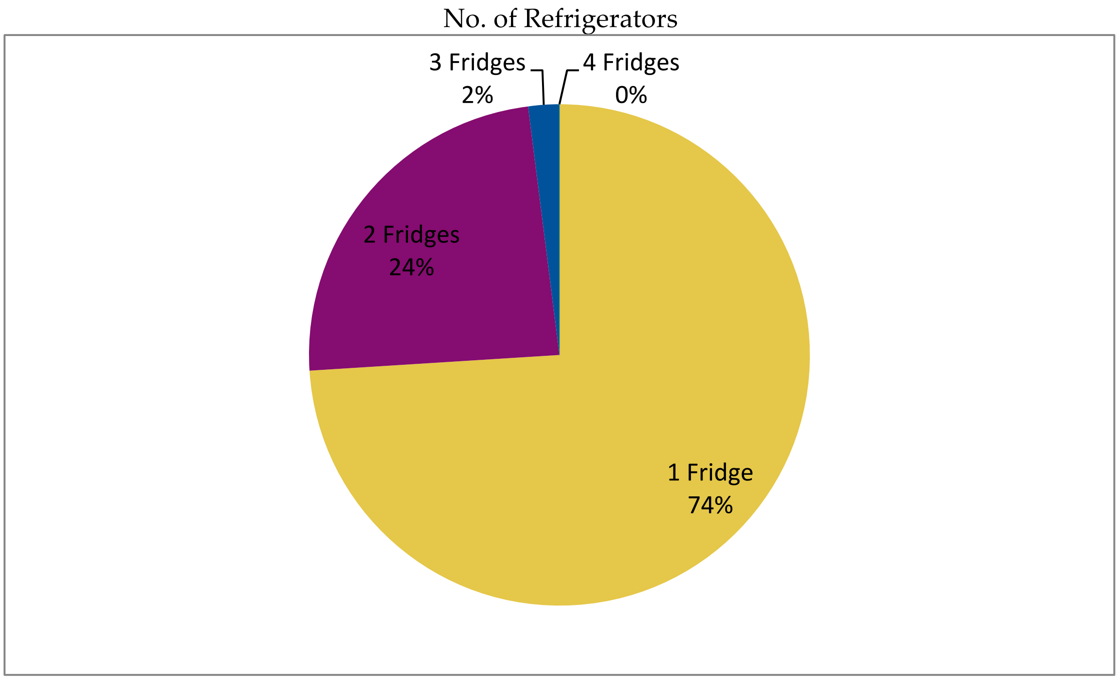
| | Single family | Multi-family | Manufactured home |
|---|---|---|---|
| Storage tank the most common type of water heater | 93.4% | 89.7% | 92.7% |
| Instant or tankless water heaters | 3.4% | 2.9% | 2.4% |
| Heat pump water heater | 2.9% | 7.4% | 2.4% |
| Other | 0.2% | 0.0% | 2.4% |



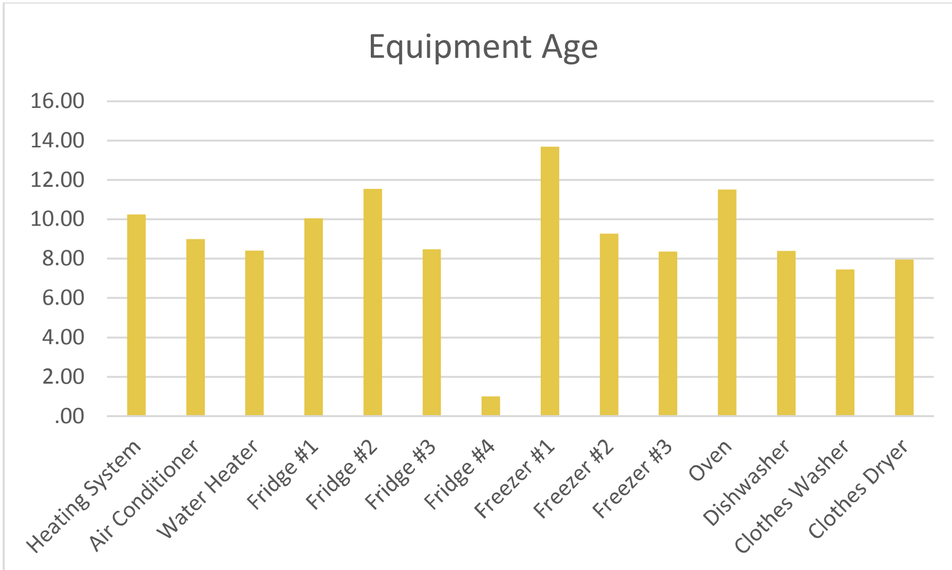
## *B.4 Mapping of Service Providers*

| Electric: Which of the following utilities provide you with electric service? | | Gas: Which of the following utilities provide you with gas services? | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | None of those listed | Center Point | AOG | Source Gas | Other | |
| None of those listed | Count | 0 | 17 | 23 | 0 | 0 | 40 |
| | % | .0% | 3.9% | 20.4% | .0% | .0% | 3.6% |
| Entergy | Count | 200 | 228 | 4 | 25 | 5 | 462 |
| | % | 58.7% | 51.8% | 3.5% | 12.5% | 15.6% | 41.0% |
| SWEPCO | Count | 84 | 31 | 23 | 87 | 8 | 233 |
| | % | | 7.0% | 20.4% | 43.5% | 25.0% | 20.7% |
| Empire | Count | | 1 | 4 | 4 | 0 | 16 |
| | % | | 0.2% | 3.5% | 2.0% | .0% | 1.4% |
| OG&E | Count | | 3 | 48 | 7 | 19 | 127 |
| | % | | .7% | 42.5% | 3.5% | 59.4% | 11.3% |
| Other | Count | | 160 | 11 | 77 | 0 | 248 |
| | % | | 36.4% | 9.7% | 38.5% | .0% | 22.0% |
| Total | Count | | 440 | 113 | 200 | 32 | 1126 |
| | % | | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

### B.5 End Use Characteristics

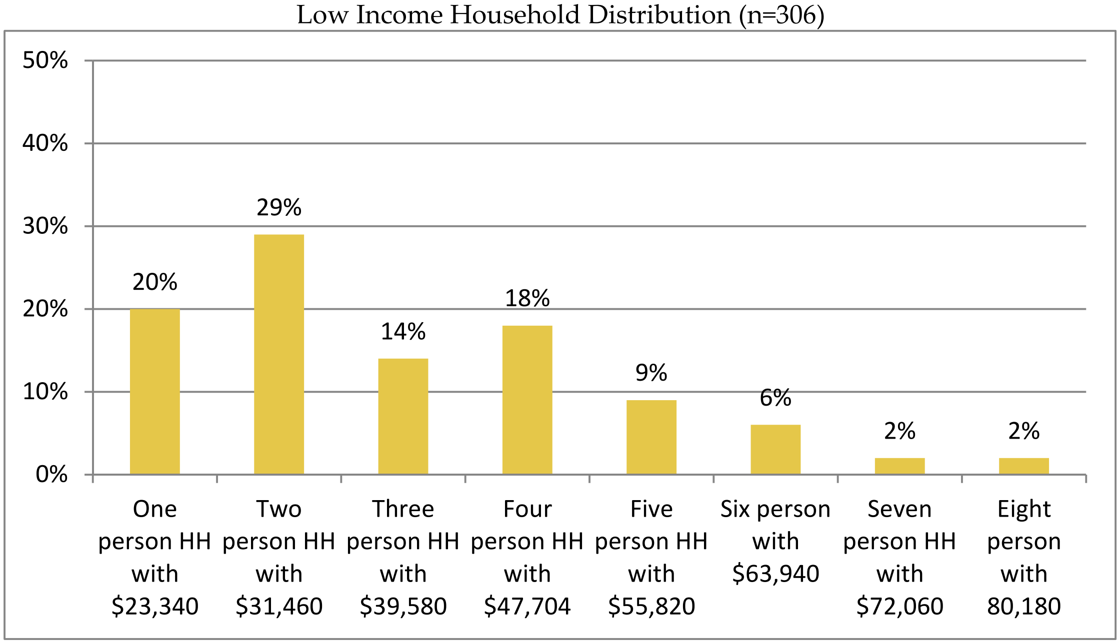



| | Mean | N | Std. Deviation |
|---|---|---|---|
| Age of heating system | 10.2 | 1035 | 8.618 |
| Age of air conditioner | 9.0 | 1034 | 7.119 |
| Age of Water heater | 8.4 | 1038 | 6.513 |
| Number of showers | 1.8 | 1038 | .822 |
| Number of refrigerators | 1.3 | 1125 | .521 |
| Age of first frig | 10.0 | 1023 | 64.789 |
| Age of second frig | 11.5 | 265 | 9.085 |
| Age of third frig | 8.5 | 27 | 7.501 |
| Age of fourth frig | 1.0 | 2 | .000 |
| Number of freezers | 1.2 | 550 | .466 |
| Age of first freezer | 13.7 | 490 | 90.352 |
| Age of second freezer | 9.3 | 82 | 7.858 |
| Age of third freezer | 8.4 | 11 | 7.061 |
| Age of oven | 11.5 | 1102 | 60.533 |
| Age of dishwasher | 8.4 | 886 | 7.366 |
| Age of clothes washer | 7.4 | 926 | 7.086 |
| Age of dryer | 7.9 | 993 | 6.757 |




## B.6 *Low Income Households*

Low Income Household Distribution (n=306)




## B.7 *Detailed Survey Results*

The data tabulations for the residential survey are provided as a separate Excel file, which is accompanied with this Final Report. The file name is: Appendix B-Residential Survey Results_6-1-15.xlsx

# Appendix C Commercial and Industrial Survey Results

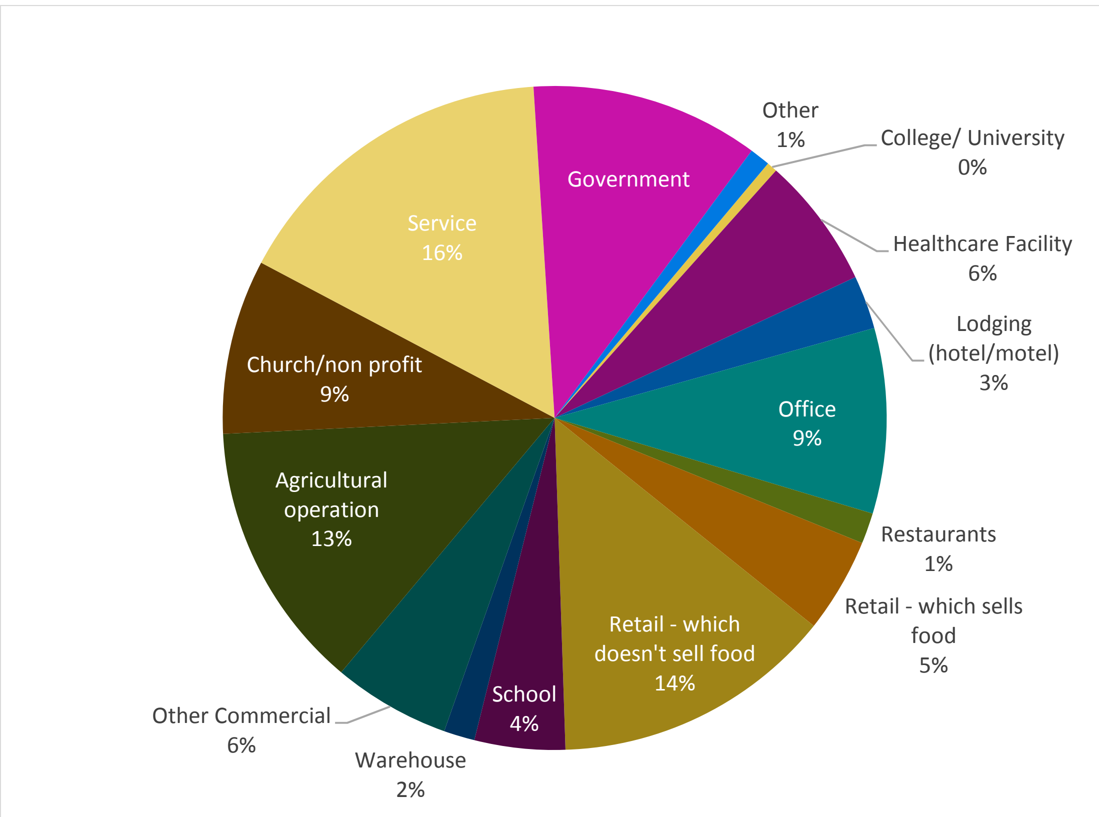
A key objective of this study was to perform primary data collection for C&I customers that are served by the IOUs across Arkansas. The survey data are useful for characterizing various elements of the EE measures assessed for the various levels of potential. Therefore, a survey of C&I customers was designed and conducted to supplement the existing data. This appendix provides a summary of the results from the C&I data collection effort described in Chapter 2.

The tables and figures that follow provide some high level results of the survey followed by the detailed survey results.

## *C.1 Summary of Results*

The C&I telephone survey collected information from 500 Arkansas customers selected from a sample provided the utilities. As Figure C-6 below shows, a variety of business types agreed to participate in the telephone survey.

**Figure C-6. Business Types Responding to Survey**



To provide context and help direct the questions asked in the survey, customers were asked to identify key types of equipment that drove energy use in their facilities. As expected, virtually all commercial customers identified space heating and cooling as significant end uses (Table C-7). Other end uses perceived to be significant drivers of energy use included lighting, office equipment, refrigeration-related equipment and food preparation and cooking equipment.

### Table C-7. Commercial End Uses

| Commercial End Uses Reported as Significant | Percent Reporting End Use |
|---|---|
| Office Equipment | 56.5% |
| Food preparation and cooking | 18.3% |
| Refrigeration, freezers or vending machines | 29.5% |
| Laundry | 11.9% |
| Shower facilities | 11.6% |
| Swimming pool | 3.9% |
| Loading/Shipping doors | 6.9% |
| Air Conditioning | 99.4% |
| Space Heating | 98.9% |
| Lighting | 98.8% |
| Motors and pumps | 10.0% |
| Miscellaneous | 96.2% |

The survey requested floor area for the facility where the respondent worked. Table C-8 shows the average floor area for each business type for the survey respondents. While educational facilities were clearly the largest facilities followed by healthcare facilities, the average facility size for most of the business types were less than 30,000 square feet.

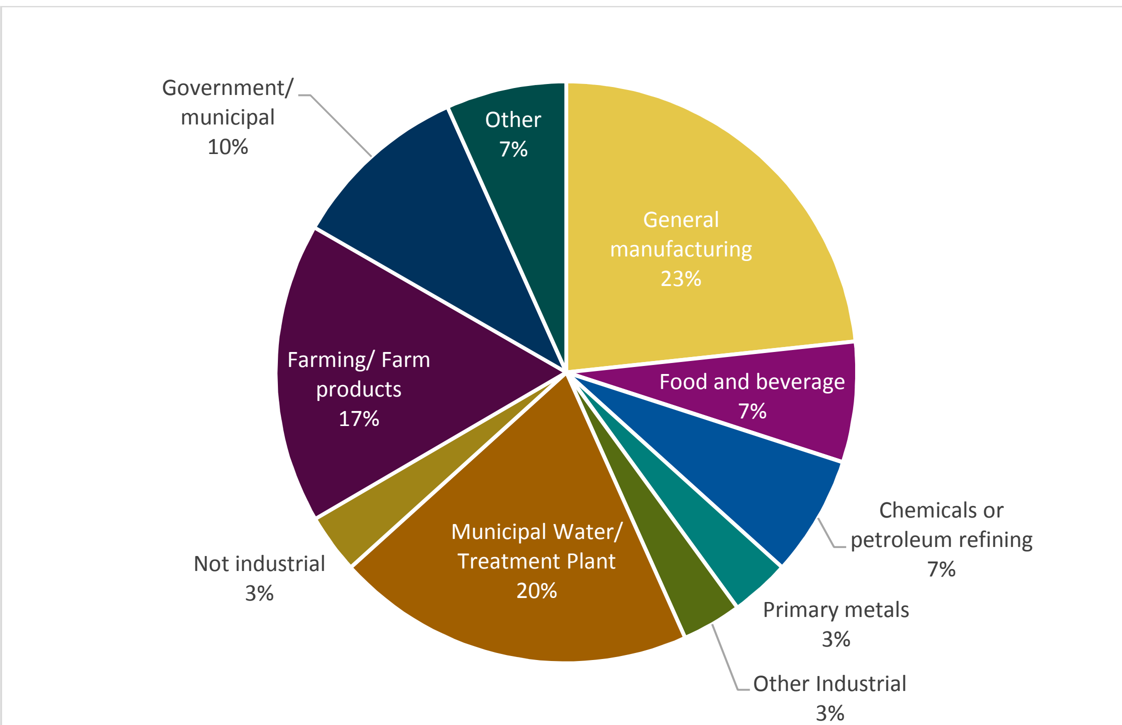
### Table C-8. Commercial Floor Area

| Type of Commercial Business | Mean Floor Area (sq.ft.) |
|---|---|
| College/University | 127,500 |
| Healthcare Facility | 46,771 |
| Lodging (hotel/motel) | 20,000 |
| Office | 30,833 |
| Restaurants | 6,250 |
| Retail - which sells food | 9,118 |
| Retail - which doesn't sell food | 18,632 |

| Type of Commercial Business | Mean Floor Area (sq.ft.) |
|---|---|
| School | 128,088 |
| Warehouse | 9,583 |
| Commercial other than segments just listed | 19,545 |
| Agricultural operation | 31,467 |
| Church/non profit | 12,222 |
| Service | 10,647 |
| Government | 28,056 |
| Other | 40,000 |
| Total | 27,702 |

Figure C-7 shows the types of industries participating in the survey. One-quarter of respondents were involved in general manufacturing or assembly, while 20 percent of respondents represented municipal water treatment facilities. Overall, municipal and government related facilities represented almost one-third of the responses.

**Figure C-7. Industrial Respondents**




Industrial customers were also asked to identify whether certain end uses were used in their facility. As Table C-9 shows, compressed air systems were reported to be in use at over half the industrial facilities. Motors and drives were the most commonly reported a significant end use (56 percent). About one-third of the industrial respondents indicated that process heat is a significant end use; but only 8 percent of all respondents indicated that a boiler is used to deliver this process heat.

### Table C-9. Industrial End Uses

| Industrial End Uses Reported as Significant | Percent Reporting End Use |
|---|---|
| Compressed Air | 52.8% |
| Plastic extrusion equipment | 0.0% |
| Motors and drives (apart from HVAC) | 55.6% |
| Process heat (boiler) | 8.3% |
| Process heat (other than boiler) | 25.0% |

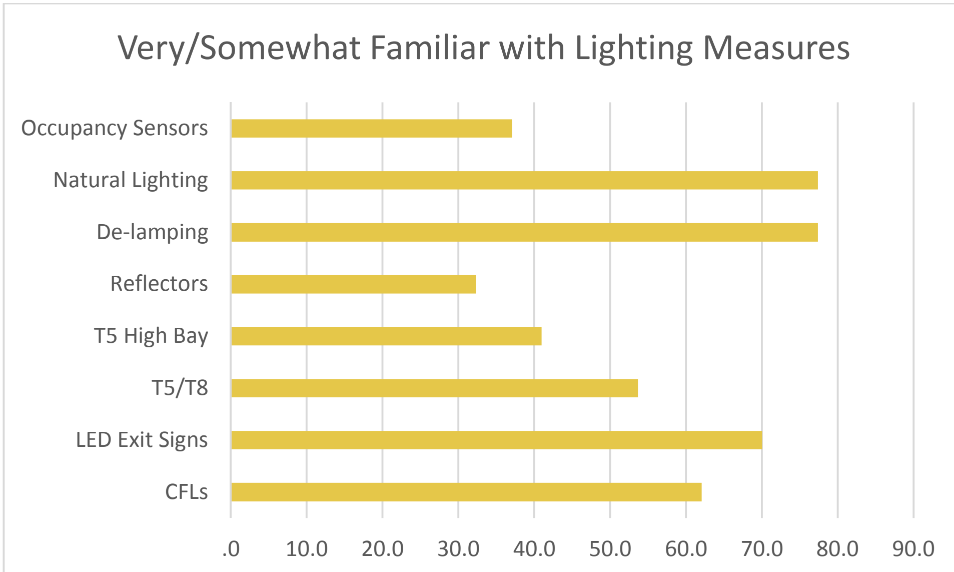
As expected, industrial facilities were, on average, much larger than other commercial facilities, as shown in the table below.

### Table C-10. Industrial Floor Area

| Type of Business | Mean Floor Area (sq.ft.) |
|---|---|
| General manufacturing and assembly (including metal fabrication, electronics, transportation, etc.) | 58,750 |
| Food and beverage | 250,000 |
| Chemicals or petroleum refining | 128,750 |
| Primary metals (smelting, refining, etc.) | 250,000 |
| Other Industrial | 5,000 |
| Municipal Water Plant/Treatment Plant | 14,167 |
| Not industrial | 12,500 |
| Farming/Farm products | 188,750 |
| Government/municipal | 87,500 |
| Other | 127,500 |
| Total | 92,037 |

While levels of awareness varied by end use and technology (see detailed results) overall the survey found a relatively high level of awareness of potential EE measures. Looking at lighting for example, more than 60 percent of respondents indicated they were very or somewhat familiar with compact fluorescent lamps (CFLs), LED exit signs, use of natural daylighting and de-lamping. Over 50 percent indicated the same level of awareness of T5/T8 fluorescent lighting options and 40 percent were aware of the use of T5 lamps for high bay lighting.

**Figure C-8. Lighting Measure Awareness**

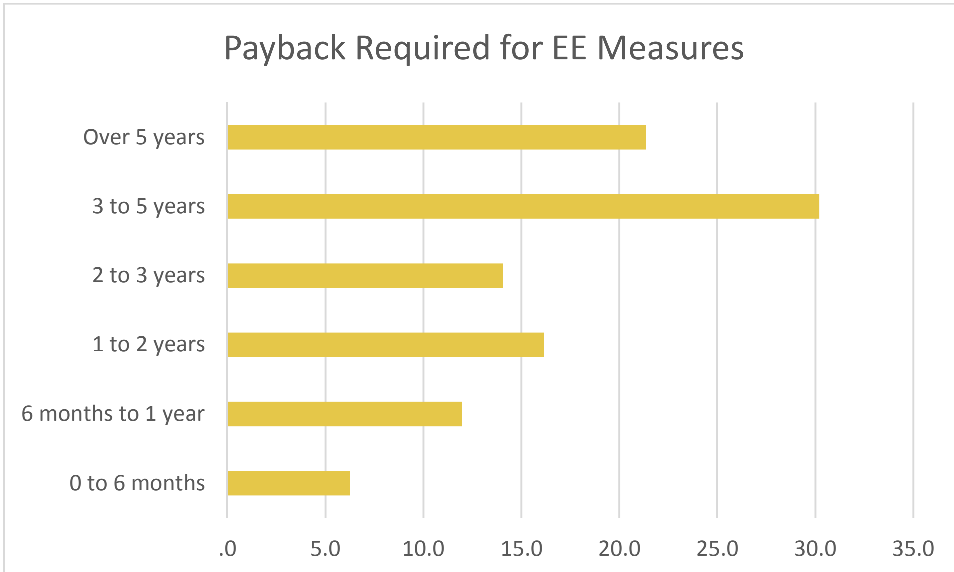



The survey also explored customer decision making and the barriers to implementing EE. Concerns over first cost and capital constraints far outweigh other issues in limiting adoption of EE measures. While a significant portion of respondents indicated familiarity with a number of efficiency measures, more than half of respondents indicated that the main barrier to implementing lighting and other efficiency measures related to concerns over first cost and capital constraints. First cost and capital constraints were noted as a barrier by 50 percent of customers with respect to motor efficiency measures and over 60 percent of customers responding with respect to refrigeration efficiency measures.

Overall, almost 70 percent of respondents indicate that they consider energy costs when considering a new project or equipment. Almost one-quarter indicated that they always purchase Energy Star equipment, however, very few reported a specific policy or standard with respect to EE and less than 3 percent report having a plan for EE.

Most of the respondents use a simple payback approach in evaluating EE investments. As shown in Figure C-9 the payback period required varied, however, 30 percent indicated a willingness to make investments that pay back in 3 to 5 years, while 30 percent require 1 to 3 years and about 20 percent require a payback of one year or less.

**Figure C-9. Payback Requirements**




Only about 30 percent of respondents indicated that EE investments face a different investment threshold compared to other types of investments. Of those indicating a different threshold, over half indicated that a higher level of return was required for energy investments.

## *C.2 Detailed Survey Results*

The data tabulations for the C&I survey are provided as a separate Excel file, which is accompanied with this Final Report. The file name is: Appendix C-C&I Survey Results_6-1-15.xlsx

# Appendix D Medium/Large Commercial and Industrial Interview Results

To supplement the broader C&I survey, Navigant conducted in-depth interviews of 44 medium/large C&I customers. The purpose of these interviews was to gain a more detailed understanding of the various barriers that these customers face when deciding whether to adopt EE measures, and explore what it will take to overcome those barriers. This information was used to help refine the estimates of customer acceptance as part of the achievable modeling effort.

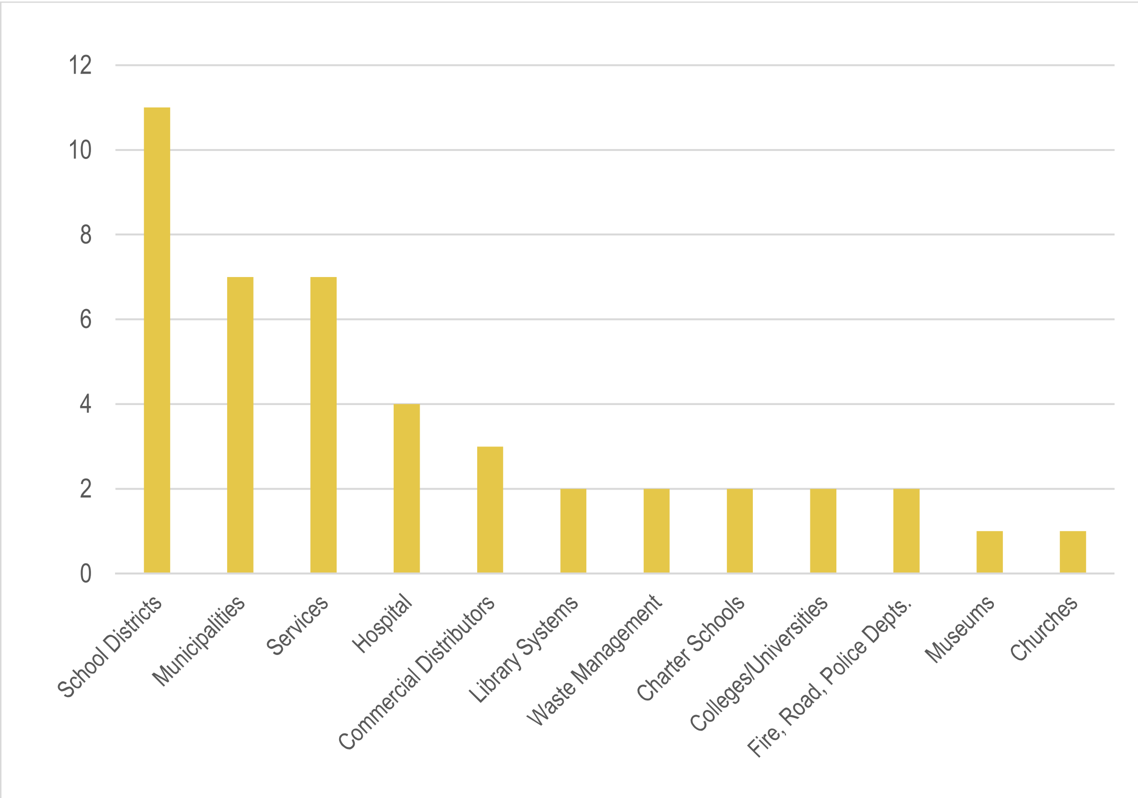
## *D.1 Summary of Results*

Listings of all commercial and industrial customers who had not opted out of EE programs were obtained from each utility. These lists were reviewed to eliminate duplicate customers or accounts. A sample for the medium/large customer interviews were selected from the top quartile in terms of annual energy consumption. Multiple attempts were made to contact each customer with a goal of obtaining 50 completed interviews. In total, approximately 200 medium/large C&I customers were contacted in order to obtain 47 completed interviews.

Since one of the key objectives of the interviews was to gain a deeper understanding of the motivations and barriers facing these customers, the discussions were necessarily more qualitative than the residential or C&I phone survey. The information obtained from the interviews is discussed by topic area below.

Figure D-10 below shows how respondents were distributed by type of organization or business. As the figure illustrates, almost 40 percent of respondents represented schools and municipalities. While these customers represent a significant share of the sample, they were disproportionately represented. This may reflect a greater willingness of these customers to share their experience with energy management or may reflect a stronger relationship between these customers and the utilities.

**Figure D-10. Large/Medium C&I Respondents by Business Type**




The interviews found a higher level of awareness of EE and utility programs among municipalities and schools compared to smaller commercial entities which exhibited lower awareness. There also appeared to be a trend that awareness and/or participation in EE programs and upgrades increased with organization size.

Most respondents indicated that EE helps the bottom line, but often the dollar amounts didn't justify any change or business interruption necessary to pursue efficient projects. This was especially true of operations that run 24/7 and would need to shut down equipment or areas to make changes. Very few of the respondents knew what percentage energy costs represented as a share of total expenses.

Interviewers encountered a certain amount of polarity among the respondents. Some were excited about EE and actively evaluated options, whereas others were more vaguely aware of efficiency and did not give it priority. The latter group was more reluctant to participate in the interviews.
A number of respondents compared their decisions about EE at work to their decisions about evaluating efficient products at home. In general those who were engaged in improving efficiency at home were more likely to affect improvements at the workplace; indicating some potential for motivating business EE decisions through effective residential efficiency program.

The interview questioned customers regarding their awareness of EE measures, barriers to implementing EE investments and their decision making processes. In terms of barriers to action:

- » Most customers agreed that the biggest barrier to increasing the uptake of EE measures was the capital cost. A municipality suggested that even a 90/10 split of costs with the utility or the state would be a significant driver to pursue EE projects, and noted that their previous capital allocated to EE projects came from municipal bonds.
- » While most customers are aware of the available lighting technologies (e.g., CFLs, LEDs, T5/T8, occupancy sensors, etc.), most perceive costs, particularly with regards to LEDs, as the main hurdle to pursing them. Once pursued, customers were content with the savings.
- » Another important consideration mentioned related to competing priorities and investments which were a more immediate need to the customer (e.g., a public-works project for a municipality, or equipment needed for a school). Additionally, some respondents indicated that while EE helps the bottom line, often the savings did not justify a change or business interruption necessary to pursue efficient projects. This was especially true of operations that run 24/7 and felt they would need to shut down equipment or areas to make changes.
- » With regards to HVAC systems, most customers raised similar issues as with lighting technologies. Additionally, several customers noted related to dealing with older infrastructure and rented facilities were also hurdles to pursuing more efficient HVAC options.

The interviews explored customer awareness and participation in existing utility programs:

- » Municipalities and school districts were generally found to have a higher awareness of utility programs, whereas awareness was lower among small commercial entities. In general, the larger the organization, the higher the level of awareness and/or participation in EE programs and upgrades.
- » A significant number of customers expressed their interest in participating in EE programs, however, as stated, some customers still felt “in the dark” with regards to existing programs, as well as available federal, state and/or municipal funding, tax credits, and potential energy and financial savings.
- » Customers that were more knowledgeable of EE tended to evaluated alternatives when considering investments, whereas less knowledgeable organizations did not place a priority on improving efficiency or considered alternatives.
- » Approximately half of all customers reported having participated in a utility-sponsored EE program.
    - › Some customers noted that they had opted-out of a program after evaluating the program’s effectiveness for their particular needs. In specific, two large customers noted that their particular program was set up such that large customers contributed more into the program than did smaller customers, effectively subsidizing the smaller customers. Both customer opted out of the utility program and created an internal program to achieve the desired energy savings

- › These customers also emphasized the 5-year rule, wherein customers are signed into a program for 5 years, as an unattractive feature of their programs; as well as made the suggestion to remove the any funding caps associated with the EE programs.
- › In contrast, another customer was very content with the structure of the lighting EE program in which it had participated in the past.

- » Several customer stated that they felt utilities should be more proactive in engaging with their customers in order to promote customer-participation in EE programs
- » One customer suggested that utilities should reach out to customers and educate them with respect to the potential savings (kWh and, particularly, $$) of particular EE actions. This customer, who had already implemented many EE alternatives and understood their financial value, suggested that while customers may not understand or be confused by kWh savings, they will understand financial savings.
- » A different customer (a small municipality) echoed this point. They reported that their streetlight retrofit program was saving them $20,000 annually, and that the administrative and governing branches of the city were very supportive of additional EE actions once they understood the financial savings available.
- » Several customers suggested that utilities should create EE programs which were tailored to their particular equipment. These included industrial motors, heat pumps, and CFL-to-LED lighting rebates.

Finally, the interviews explored how customers approach decision making around EE investments and how these processes align with decisions on other types of investments.

- » While most C&I customers state that they do not have explicit goals for reducing electricity and gas consumption, most noted that improving EE is an important objective.
- » Similarly, although most customers do not have policies that require a certain standard for new equipment, such as Energy Star equipment or LEED buildings, customer indicated that they do consider energy costs and consider energy efficient alternatives when making relevant EE investments.
- » Approximately half of all customers highlighted that, when considering the purchase of new equipment or a facility expansion, the costs of electricity and gas become part of the evaluation process. Despite this, most also noted that, in general, the main objective is to minimize the upfront costs of such investments, which is generally not characteristic of EE projects.
- » A small number of customers noted that EE actions that were originally planned, were not actually implemented as a result of competing priorities and budgetary constraints.

» Approximately one third of customers noted that, with regards to EE investments, they look for a particular payback period. While expectations for a payback period varied slightly, most respondents indicated a rule-of-thumb of about 2 to 5 years.

# Appendix E Measure Characterization Data

This appendix is provided as a separate Excel spreadsheet that contains all characterization data (e.g., consumption, costs and measure lifetimes) for every measure at the customer segment and replacement type level.

## *E.1 Measure Characterization Key Data Parameters*

The measure characterization consisted of estimating/defining key parameters across the various residential and C&I customer segments, all of which are input to the DSMSim™ model and used in the calculation of technical, economic, and achievable potential. These parameters are listed and defined as follows:

1. **Unique Measure Name:** Measure identification that includes a sector identifier and the unique measure identifier.
2. **Climate Zone:** Specifies whether the measure applies to one or more of the four climate zones in Arkansas. In many cases, this identifier is indicated as being applicable to all weather zones.
3. **Measure Description:** Qualitatively indicates the EE action that is being performed by this measure.
4. **Baseline Assumption**: Describes the baseline technology being characterized per the Arkansas TRM or Navigant's engineering assumptions.
5. **End-Use, Sector and Segment Mapping:** These parameters facilitate the mapping of each measure to the appropriate end uses, sectors, and customer segments.
6. ***Replacement Type****:* Characterizes the measure as a RET, ROB, and/or NEW application. The baseline definition and cost basis for each application is as follows:
    a. RET: The baseline is considered the existing equipment, and the measure cost is considered the full installed cost of the efficient equipment.
    b. ROB: The baseline is considered as described in the Arkansas TRM, and the measure cost is considered the incremental cost between the efficient and baseline equipment.
    c. NEW: The baseline is considered the least cost, code-compliant option, and the measure cost is considered the incremental cost between the efficient and code-compliant equipment.
7. **Scaling and Unit Basis**: The normalizing unit for energy, demand, cost, and density estimates.
8. **Measure Lifetime:** The lifetime in years for the base and EE technologies. The Base and EE lifetime only vary in instances where the two cases represent inherently different technologies, such as LED or CFL bulbs compared to a baseline incandescent.

9. **Measure Costs:** The following variables are used as inputs for the incremental measure costs.
   a. ***Base Costs***: The cost of the base equipment, including both material and labor costs.
   b. ***EE Costs:*** The cost of the EE equipment.
   c. ***Measure Cost Source:*** Source of data indicated.
10. **Annual Energy Consumption:** The annual energy consumption in kilowatt-hours (kWh) or Therms for each of the base and EE technologies.
    a. ***Base Consumption:*** The consumption of the baseline technology.
    b. ***Efficient Consumption:*** The consumption of the high efficiency technology.
    c. ***Savings Source:*** Lists the source of the savings estimates.

## *E.2 Measure Characteristics Data File*

The measure characterization data that served as the key input for the DSMSim potential model is provided as a separate Excel file, which is accompanied with this Final Report. The file name is: Appendix E-Measure Characteristics Data_6-1-15.xlsx

# Appendix F Demand Response Potential Assumptions and Detailed Results

This appendix contains the DRSim™ model inputs and sources used for the DR potential assessment along with more detailed results of the DR potential assessment.

## *F.1 Load Reduction, Participation and Timing Assumptions*

DLC – Central AC 50% Cycling

- Radio Frequency (RF) reduction is assumed to be 1%
- DLC Central AC Impact for 50% cycling was calculated from a weighted average load impact representative of all cycling programs[45]
    - The following assumptions were made:
        - 50% of participants are in 50% cycling program, representing the most common cycling program
        - 25% of participants are in 75% cycling program
        - 25% of participants are in 100% cycling program
    - The following calculations were made:
        - Load impact of 100% cycling program = x
        - Load impact of 75% cycling program = 0.75*x
        - Load impact of 50% cycling program = 0.5*x
        - 1.11=.5(.5*x)+.25(.75*x)+.25(x)
        - 1.11=.6875x
        - x=1.61
    - The calculation results yielded the following load impact:
        - Load impact of 100% cycling program = x = 1.61 kW/participant
        - Load impact of 75% cycling program = 0.75*x = 1.21 kW/participant
        - Load impact of 50% cycling program = 0.5*x = 0.81 kW/participant
- Equipment Saturations for all sectors were assumed to be the same as those of the 100% cycling program
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 20%
- Initial Participation assumed to be 2.51%[46]
- Simulation Start Year was set to 2015
- Simulation End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

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[45] 1.11 kW/participant. ESource, *DLC Program Benchmarks: How Do You Compare?*

[46] Based on email from Gabe Munoz of Entergy on 4/29/15 about existing enrollment in their programs.

DLC – Central AC 75% Cycling

- RF reduction is assumed to be 1%
- DLC Central AC Impact for 75% cycling was calculated from a weighted average load impact representative of all cycling programs[45]
    - The following assumptions were made:
        - 50% of participants are in 50% cycling program, representing the most common cycling program
        - 25% of participants are in 75% cycling program
        - 25% of participants are in 100% cycling program
    - The following calculations were made:
        - Load impact of 100% cycling program = x
        - Load impact of 75% cycling program = 0.75*x
        - Load impact of 50% cycling program = 0.5*x
        - 1.11=.5(.5*x)+.25(.75*x)+.25(x)
        - 1.11=.6875x
        - x=1.61
    - The calculation results yielded the following load impact:
        - Load impact of 75% cycling program = 0.75*x = 1.21 kW/participant
- Equipment Saturations for all sectors were assumed to be the same as those of the 100% cycling program
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 20%
- Initial Participation assumed to be 2.51%[46]
- Simulation Start Year was set to 2015
- Simulation End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

DLC – Central AC 100% Cycling

- RF reduction is assumed to be 1%
- DLC Central AC Impact for 50% cycling was calculated from a weighted average load impact representative of all cycling programs[45]
    - The following assumptions were made:
        - 50% of participants are in 50% cycling program, representing the most common cycling program
        - 25% of participants are in 75% cycling program
        - 25% of participants are in 100% cycling program
    - The following calculations were made:
        - Load impact of 100% cycling program = x
        - Load impact of 75% cycling program = 0.75*x
        - Load impact of 50% cycling program = 0.5*x

        - 1.11=.5(.5*x)+.25(.75*x)+.25(x)
        - 1.11=.6875x
        - x=1.61
    - The calculation results yielded the following load impact:
        - Load impact of 100% cycling program = x = 1.61 kW/participant
- Equipment Saturations for all sectors were assumed to be:
    - Residential Single-Family = 74% (number of Res SF homes with central AC out of all Res SF buildings with space cooling in AR/OK/LA)[47,48]
    - Residential Multi-Family = 74% (number of Res MF homes with central AC out of all Res SF buildings with space cooling in AR/OK/LA)[47,48]
    - Residential Manufactured = 49% (number of Res Manuf homes with central AC out of all Res Manuf homes with space cooling in AR/OK/LA)[47,48]
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 20%
- Initial Participation assumed to be 2.51%[46]
- Simulation Start Year was set to 2015
- Simulation End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

<u>DLC – Central AC C&I</u>

- RF reduction is assumed to be 1%
- DLC Central AC Impact for C&I participants was calculated to be 1.39 kW/participant:
    - Florida Power and Light's load impact for its 2013 Business Load Management (On Call) program was 1.00 kW/installation at the meter and 1.08 kW/installation at the generator[49]
    - Florida Power and Light's load impact for its 2013 Residential Load Management (On Call) program was 1.16 kW/installation at the meter and 1.25 kW/installation at the generator[49]
    - The load impact used for residential participants (1.61 kW/participant) was scaled down using FPL's load impact different between residential and commercial participants:
        - (1.61)*average((1/1.16),(1.08/1.25)) = 1.39 kW/participant
- Equipment Saturations for C&I sector = 24% (number of C&I buildings with central AC units out of all buildings with cooling in the South)[50]

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[47] Residential Energy Consumption Survey (RECS), 2009. Table HC10.4 Total Square Footage of South Homes, by Housing Characteristics

[48] Residential Energy Consumption Survey (RECS), 2009. Table HC7.10 Air Conditioning in Homes in South Regions, Divisions, and States

[49] Florida Power and Light DSM Annual Report 2013, pp. 5 and 15

[50] Commercial Building Energy Consumption Survey, 2012. Table B3. Census Region, Number of Buildings and Floorspace

- Max Participation (Realistic Achievable) was assumed to be 1%
- Max Participation (Max Achievable) was assumed to be 5%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

<u>DLC – Window AC</u>

- RF reduction is assumed to be 1%
- DLC Window AC load impact used = 0.27 kW/participant[51]
- Equipment Saturations for residential single-family (SF) and residential multi-family = 23% (number of Res SF homes with window AC out of all Res SF buildings with space cooling in AR/OK/LA)[47]
- Equipment Saturations for residential manufactured = 49% (number of Res Manuf homes with window AC out of all Res SF buildings with space cooling in AR/OK/LA)[47]
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 25%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

<u>DLC – Programmable Communicating Thermostats (PCT)</u>

- RF reduction is assumed to be 1%
- DLC PCT load impact used for residential = 1.00 kW/participant[52]
- DLC PCT load impact used for commercial and industrial = 1.40 kW/participant
- Equipment Saturation for residential = 0.42%, calculated as follows:
    - Expected penetration of communicating and smart thermo-stats within the non-communicating thermostat market in North America in 2015 is 1.68%[53]
    - This number is then multiplied by the % of residential customers in the South with programmable thermostats[48,54]
- Equipment Saturation for commercial and industrial = 1.06%, calculated as follows:

[51] Navigant, *Assessing Demand Response (DR) Program Potential for the Seventh Power Plan*
[52] Navigant, *Demand Response Study for Con Edison of New York*
[53] Navigant Research, *Communicating Thermostats, Smart Thermostats, and Associated Software and Services: Global Market Analysis and Forecasts*
[54] Residential Energy Consumption Survey (RECS), 2009. Table HC6.10 Space Heating in U.S. Homes in South Region, Divisions, and States

- Expected penetration of communicating and smart thermo-stats within the non-communicating thermostat market in North America in 2015 is 1.68%[53]
- This number is then multiplied by the number of buildings which reduce heating and cooling equipment usage when the building is not in full use, out of all buildings in the South[50]

- Max Participation (Realistic Achievable) was assumed to be 25%
- Max Participation (Max Achievable) was assumed to be 50%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

DLC – Water Heater

- RF reduction is assumed to be 1%
- DLC WH load impact for residential = 0.58 kW/participant[51]
- Equipment saturation for single family homes = 37.5%[55]
- Equipment saturation for multi-family homes = 60.9%[55]
- Equipment saturation for manufactured homes = 86.4%[55]
- Max Participation (Realistic Achievable) was assumed to be 20%
- Max Participation (Max Achievable) was assumed to be 30%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

DLC – Agricultural Irrigation Pumping

- RF reduction is assumed to be 1%
- Load impact for Irrigation Pumping DLC program = 0.0068 kW/irrigated acre
- Percentage of electricity consumption in the agricultural sector for irrigation = 88%
- Max Participation (Realistic Achievable) was assumed to be 50%
- Max Participation (Max Achievable) was assumed to be 60%
- Initial Participation assumed to be 3.4%[56]
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years

[55] Equipment saturation for electric water heaters was taken from the Navigant survey performed as part of the primary data collection effort for the EE potential study.
[56] Navigant Research "Demand Response Tracker 4Q13".

- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

Auto DR Lighting

- Load impacts for C&I (kW per thousand square foot)[52]:
  - C&I Col and Univ = 0.043
  - C&I Health = 0
  - C&I Ind = 0.229
  - C&I Lodge = 0.008
  - C&I Office L = 0.068
  - C&I School = 0.043
  - C&I Other Com = 0.229 (assumes load impact of C&I Ind)
  - C&I Ret Food = 0.568
  - C&I Ret N Food = 0.295
  - C&I Warehouse = 0.001
- Equipment Saturation = 3% (number of commercial buildings in South region with Demand Responsive lighting out of the total commercial buildings in South region)[50]
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 15%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

Auto DR Energy Management System (EMS)

- Load impacts for C&I (kW per thousand square foot)[52]:
  - C&I Col and Univ = 0.269
  - C&I Health = 0
  - C&I Ind = 0.147
  - C&I Lodge = 0.023
  - C&I Office L = 0.343
  - C&I School = 0.269
  - C&I Other Com = 0.147 (assumes load impact of C&I Ind)
  - C&I Ret Food = 0.364
  - C&I Ret N Food = 0.416
  - C&I Warehouse = 0.005
- Equipment Saturation = 13% (number of commercial buildings in South region with Building Automation Systems out of total commercial buildings in South region)[50]
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 15%
- Initial Participation assumed to be 0%

- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

Auto DR Process

- Load impacts for C&I (kW per thousand square foot)[52]:
  - C&I Ind = 0.399
  - C&I Warehouse = 0.037
- Equipment Saturation for C&I Industrial and C&I Warehouse = 9% (number of manufacturing facilities (US average) that have a full-time energy manager. It is assumed that a facility would require a full-time energy manager to participate in DR)[57]
- Equipment Saturation for all other sectors is 0%, assuming Auto DR Process only applies to the industrial sector
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 15%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

DG Diesel Engine

- Load impacts for C&I (kW per thousand square foot)[52]:
  - C&I Col and Univ = 0.003
  - C&I Health = 0.182
  - C&I Ind = 0.002
  - C&I Lodge = 0.068
  - C&I Warehouse = 0.002 (assumes load impact of C&I Ind)
- Equipment Saturation = 1.53%, calculated from:
  - [number of commercial buildings in South region with electricity generation] / [total commercial buildings in South region][50]
  - Multiplied, by [Fuel Oil expenditures for the South region] / [Cumulative Fuel Oil and Nat Gas expenditures for the South region][50]
  - This results in the assumption that the Southern Region consumes about 3 times more Nat Gas than Fuel Oil for backup electricity generation, thus the load impact of DG NG is three times greater than the load impact of DG Diesel
- Max Participation (Realistic Achievable) was assumed to be 10%

[57] Manufacturing Energy Consumption Survey (MECS), 2013. Table 8.4 Number of Establishments by Participation in Specific Energy-Management Activities

- Max Participation (Max Achievable) was assumed to be 15%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

DG Natural Gas Engine

- Load impacts for C&I (kW per thousand square foot)[52]:
    - C&I Col and Univ = 6.046E-05
    - C&I Health = 0.003
    - C&I Ind = 2.878E-05
    - C&I Lodge = 0.001
    - C&I Warehouse = 2.878E-05 (assumes load impact of C&I Ind)
- Equipment Saturation = 4.74%, calculated from:
    - [number of commercial buildings in South region with electricity generation] / [total commercial buildings in South region][50]
    - Multiplied, by [Fuel Oil expenditures for the South region] / [Cumulative Fuel Oil and Nat Gas expenditures for the South region][50]
    - This results in the assumption that the Southern Region consumes about 3 times more Nat Gas than Fuel Oil for backup electricity generation, thus the load impact of DG NG is three times greater than the load impact of DG Diesel
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 15%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

DG Diesel Turbine

- Load impacts for C&I (kW per thousand square foot)[52]:
    - Assumes same load impacts as DG NG Turbine measure:
        - C&I Col and Univ = 1.463E-04
        - C&I Health = 0.007
        - C&I Ind = 6.963E-05
        - C&I Lodge = 0.003
        - C&I Warehouse = 6.963E-05 (assumes load impact of C&I Ind)
- Equipment Saturation = 1.53%, calculated from:
    - [number of commercial buildings in South region with electricity generation] / [total commercial buildings in South region][50]

- Multiplied, by [Fuel Oil expenditures for the South region] / [Cumulative Fuel Oil and Nat Gas expenditures for the South region][50]
- This results in the assumption that the Southern Region consumes about 3 times more Nat Gas than Fuel Oil for backup electricity generation, thus the load impact of DG NG is three times greater than the load impact of DG Diesel

- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 15%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

<u>DG Natural Gas Turbine</u>

- Load impacts for C&I (kW per thousand square foot)[52]:
  - C&I Col and Univ = 1.463E-04
  - C&I Health = 0.007
  - C&I Ind = 6.963E-05
  - C&I Lodge = 0.003
  - C&I Warehouse = 6.963E-05 (assumes load impact of C&I Ind)
- Equipment Saturation = 4.74%, calculated from:
  - [number of commercial buildings in South region with electricity generation] / [total commercial buildings in South region][50]
  - Multiplied, by [Fuel Oil expenditures for the South region] / [Cumulative Fuel Oil and Nat Gas expenditures for the South region][50]
  - This results in the assumption that the Southern Region consumes about 3 times more Nat Gas than Fuel Oil for backup electricity generation, thus the load impact of DG NG is three times greater than the load impact of DG Diesel
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 15%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

<u>Manual Lighting Control</u>

- Load impacts for C&I (kW per thousand square foot)[52]:
  - C&I Col and Univ = 0.099
  - C&I Health = 0
  - C&I Ind = 0.090

  - C&I Lodge = 0.048
  - C&I Office L = 0.092
  - C&I School = 0.099
  - C&I Other Com = 0.090
  - C&I Ret Food = 0.365
  - C&I Ret N Food = 0.264
  - C&I Warehouse = 0.012
- Equipment Saturation = 95% (assumes higher saturation than AutoDR measures, almost 100%)
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 15%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

<u>Manual HVAC Control</u>

- Load impacts for C&I (kW per thousand square foot)[52]:
  - C&I Col and Univ = 0.199
  - C&I Health = 0
  - C&I Ind = 0.182
  - C&I Lodge = 0.097
  - C&I Office L = 0.154
  - C&I School = 0.199
  - C&I Other Com = 0.182 (assumes load impact of C&I Ind)
  - C&I Ret Food = 0.490
  - C&I Ret N Food = 0.585
  - C&I Warehouse = 0.024
- Equipment Saturation = 95% (assumes higher saturation than AutoDR measures, almost 100%)
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 15%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

<u>Manual Process Control</u>

- Load impacts for C&I (kW per thousand square foot)[52]:
  - C&I Ind = 0.133
  - C&I Warehouse = 0.024

  - All other C&I sectors = 0.133 (assumes the same load impact as C&I Ind)
- Equipment Saturation = 95% (assumes higher saturation than AutoDR measures, almost 100%)
- Max Participation (Realistic Achievable) was assumed to be 10%
- Max Participation (Max Achievable) was assumed to be 15%
- Initial Participation assumed to be 0%
- Start Year was set to 2015
- End Year was set to 2025
- Number of Year to Reach Max Participation was assumed to be 5 years
- Year Attrition Begins was set to 2016
- Attrition Rate was assumed to be 1%

## F.2 *Cost Assumptions*

The following cost assumptions were used in the DR potential study model.

Equipment Costs:

- Load switch for residential Central AC DLC technology enablement: $60/switch, 1.1 switch/participant[58]
- Load switch for residential Water Heater DLC technology enablement: $60/switch, 1 switch/participant – assumed to be the same as central AC switch
- Load switch for C&I Central AC DLC technology enablement: $100/switch, 1.8 switches per participant [59]
- Load switch for Irrigation pumping DLC technology enablement: $100/switch (based on C&I load switch cost assumption)
- Residential PCT = $400/kW * load impact(kW)[60]
- Commercial PCT = $286/kW * load impact(kW)[60]
- Auto DR + Lighting Control System = ($138.50/kW * load impact)[60]
- Auto DR + Energy Management System = ($138.50/kW * load impact)[60]
- Auto DR + Process = ($138.50/kW * load impact) – assumed to be the same as Auto DR from Lighting or EMS
- There are no equipment costs associated with manual DR.
- All DG technologies = ($175/kW * load impact). Cost of upgrading emissions controls of existing DG resources. Navigant experience based estimate.

Installation Costs:

- Residential DLC = ($80/kW * load impact) (Navigant experience-based estimate)
- Commercial DLC switches = ($60/kW * load impact) (assumes downward trend in installation cost from residential, based on a larger load offset)

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[58] Navigant Research, Demand Response for Residential Markets, RDR-12, 4Q 2012. Does not include labor costs associated with installation and integration.
[59] Navigant analysis conducted for Tucson Electric Power's mass market DLC program. Does not include costs associated with installation and integration.
[60] Navigant analysis conducted for BPA smart grid investment case, 2014.

- Irrigation pumping DLC switches = ($40/kW * load impact) (assumes downward trend in installation cost from commercial, based on a larger load offset)
- Installation Cost for Residential PCTs = ($114.90/kW * load impact)[60]
- Installation Cost for all Auto DR technologies = ($96/kW * load impact)[60]
- Installation Costs for all DG technologies assumed to be the same as Auto DR.
- There are no installation costs associated with manual DR.

Administrative Costs:

- Residential DR = $20/kW-yr (Navigant experience-based estimates)
- Commercial and Industrial DR = $10/kW-yr (assumes a 50% derate from residential estimate, based on scale economies due to larger customers)

## F.3 Demand Response Potential by Utility and Technology

This section presents the realistic and maximum achievable DR potential for each technology area for each of the four electric utilities.

**Table F-1. Realistic Achievable DR Potential for Entergy**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 34 | 8 | 14 | 8 | 0.7 | 0.1 | 0.1 | 0.1 | 8 | 14 | 8 |
| 2017 | 48 | 17 | 27 | 15 | 1.3 | 0.2 | 0.2 | 0.2 | 17 | 28 | 16 |
| 2018 | 62 | 26 | 38 | 21 | 1.7 | 0.2 | 0.3 | 0.3 | 26 | 43 | 24 |
| 2019 | 76 | 35 | 49 | 27 | 2.2 | 0.3 | 0.4 | 0.4 | 35 | 57 | 32 |
| 2020 | 91 | 45 | 59 | 32 | 2.5 | 0.3 | 0.4 | 0.4 | 45 | 71 | 39 |
| 2021 | 106 | 55 | 68 | 36 | 2.8 | 0.3 | 0.5 | 0.4 | 55 | 84 | 45 |
| 2022 | 108 | 55 | 69 | 36 | 2.8 | 0.3 | 0.5 | 0.4 | 55 | 86 | 46 |
| 2023 | 109 | 56 | 70 | 37 | 2.9 | 0.3 | 0.5 | 0.4 | 56 | 87 | 47 |
| 2024 | 111 | 57 | 71 | 37 | 2.9 | 0.3 | 0.5 | 0.4 | 57 | 88 | 47 |
| 2025 | 112 | 58 | 73 | 38 | 3.0 | 0.4 | 0.5 | 0.4 | 58 | 90 | 48 |

**Table F-2. Maximum Achievable DR Potential for Entergy**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 46 | 13 | 20 | 11 | 1.0 | 0.1 | 0.2 | 0.2 | 13 | 21 | 12 |
| 2017 | 72 | 26 | 38 | 21 | 1.7 | 0.2 | 0.3 | 0.3 | 26 | 42 | 24 |
| 2018 | 99 | 39 | 53 | 29 | 2.3 | 0.3 | 0.4 | 0.4 | 39 | 62 | 34 |
| 2019 | 127 | 53 | 66 | 35 | 2.7 | 0.3 | 0.5 | 0.4 | 53 | 82 | 44 |
| 2020 | 155 | 67 | 77 | 39 | 3.0 | 0.3 | 0.5 | 0.4 | 67 | 101 | 53 |
| 2021 | 184 | 82 | 86 | 43 | 3.1 | 0.4 | 0.5 | 0.4 | 82 | 120 | 61 |
| 2022 | 187 | 83 | 88 | 43 | 3.2 | 0.4 | 0.5 | 0.4 | 83 | 121 | 61 |
| 2023 | 189 | 84 | 89 | 44 | 3.2 | 0.4 | 0.5 | 0.4 | 84 | 123 | 62 |
| 2024 | 192 | 86 | 90 | 45 | 3.3 | 0.4 | 0.5 | 0.4 | 86 | 125 | 63 |
| 2025 | 195 | 87 | 92 | 45 | 3.3 | 0.4 | 0.5 | 0.4 | 87 | 127 | 64 |

**Table F-3. Realistic Achievable DR Potential for Empire District**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 0.223 | 0.053 | 0.087 | 0.047 | 0.004 | 0.001 | 0.001 | 0.001 | 0.053 | 0.089 | 0.050 |
| 2017 | 0.299 | 0.100 | 0.159 | 0.090 | 0.008 | 0.001 | 0.001 | 0.001 | 0.100 | 0.170 | 0.095 |
| 2018 | 0.380 | 0.155 | 0.223 | 0.126 | 0.011 | 0.001 | 0.002 | 0.002 | 0.155 | 0.252 | 0.141 |
| 2019 | 0.463 | 0.207 | 0.288 | 0.156 | 0.013 | 0.002 | 0.002 | 0.002 | 0.207 | 0.331 | 0.185 |
| 2020 | 0.545 | 0.260 | 0.348 | 0.183 | 0.015 | 0.002 | 0.003 | 0.002 | 0.260 | 0.406 | 0.223 |
| 2021 | 0.629 | 0.312 | 0.391 | 0.204 | 0.017 | 0.002 | 0.003 | 0.002 | 0.312 | 0.484 | 0.262 |
| 2022 | 0.632 | 0.317 | 0.391 | 0.207 | 0.017 | 0.002 | 0.003 | 0.002 | 0.317 | 0.486 | 0.263 |
| 2023 | 0.636 | 0.319 | 0.399 | 0.207 | 0.017 | 0.002 | 0.003 | 0.002 | 0.319 | 0.486 | 0.263 |
| 2024 | 0.641 | 0.319 | 0.401 | 0.209 | 0.017 | 0.002 | 0.003 | 0.002 | 0.319 | 0.491 | 0.263 |
| 2025 | 0.643 | 0.320 | 0.401 | 0.211 | 0.017 | 0.002 | 0.003 | 0.002 | 0.320 | 0.494 | 0.265 |

**Table F-4. Maximum Achievable DR Potential for Empire District**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 0.296 | 0.076 | 0.120 | 0.068 | 0.006 | 0.001 | 0.001 | 0.001 | 0.076 | 0.122 | 0.071 |
| 2017 | 0.448 | 0.154 | 0.223 | 0.123 | 0.009 | 0.001 | 0.002 | 0.002 | 0.154 | 0.252 | 0.141 |
| 2018 | 0.603 | 0.233 | 0.316 | 0.170 | 0.013 | 0.002 | 0.002 | 0.002 | 0.233 | 0.366 | 0.203 |
| 2019 | 0.761 | 0.309 | 0.391 | 0.202 | 0.015 | 0.002 | 0.003 | 0.002 | 0.309 | 0.475 | 0.258 |
| 2020 | 0.921 | 0.389 | 0.451 | 0.228 | 0.017 | 0.002 | 0.003 | 0.002 | 0.389 | 0.580 | 0.305 |
| 2021 | 1.083 | 0.471 | 0.496 | 0.246 | 0.019 | 0.002 | 0.003 | 0.002 | 0.471 | 0.683 | 0.347 |
| 2022 | 1.089 | 0.473 | 0.496 | 0.246 | 0.019 | 0.002 | 0.003 | 0.002 | 0.473 | 0.687 | 0.347 |
| 2023 | 1.095 | 0.477 | 0.504 | 0.246 | 0.019 | 0.002 | 0.003 | 0.002 | 0.477 | 0.693 | 0.349 |
| 2024 | 1.103 | 0.479 | 0.506 | 0.250 | 0.019 | 0.002 | 0.003 | 0.002 | 0.479 | 0.702 | 0.353 |
| 2025 | 1.110 | 0.479 | 0.506 | 0.251 | 0.019 | 0.002 | 0.003 | 0.002 | 0.479 | 0.702 | 0.353 |

**Table F-5. Realistic Achievable DR Potential for OG&E**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 4 | 1 | 1 | 1 | 0.1 | 0.0 | 0.0 | 0.0 | 1 | 1 | 1 |
| 2017 | 5 | 2 | 3 | 1 | 0.1 | 0.0 | 0.0 | 0.0 | 2 | 3 | 2 |
| 2018 | 6 | 3 | 4 | 2 | 0.2 | 0.0 | 0.0 | 0.0 | 3 | 4 | 2 |
| 2019 | 8 | 3 | 5 | 3 | 0.2 | 0.0 | 0.0 | 0.0 | 3 | 6 | 3 |
| 2020 | 9 | 4 | 6 | 3 | 0.2 | 0.0 | 0.0 | 0.0 | 4 | 7 | 4 |
| 2021 | 11 | 5 | 7 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 5 | 8 | 4 |
| 2022 | 11 | 5 | 7 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 5 | 8 | 5 |
| 2023 | 11 | 6 | 7 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 6 | 9 | 5 |
| 2024 | 11 | 6 | 7 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 6 | 9 | 5 |
| 2025 | 11 | 6 | 7 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 6 | 9 | 5 |

**Table F-6. Maximum Achievable DR Potential for OG&E**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 5 | 1 | 2 | 1 | 0.1 | 0.0 | 0.0 | 0.0 | 1 | 2 | 1 |
| 2017 | 7 | 3 | 4 | 2 | 0.2 | 0.0 | 0.0 | 0.0 | 3 | 4 | 2 |
| 2018 | 10 | 4 | 5 | 3 | 0.2 | 0.0 | 0.0 | 0.0 | 4 | 6 | 3 |
| 2019 | 13 | 5 | 7 | 3 | 0.3 | 0.0 | 0.0 | 0.0 | 5 | 8 | 4 |
| 2020 | 16 | 7 | 8 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 7 | 10 | 5 |
| 2021 | 18 | 8 | 8 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 8 | 12 | 6 |
| 2022 | 19 | 8 | 9 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 8 | 12 | 6 |
| 2023 | 19 | 8 | 9 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 8 | 12 | 6 |
| 2024 | 19 | 8 | 9 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 8 | 12 | 6 |
| 2025 | 19 | 9 | 9 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 9 | 12 | 6 |

**Table F-7. Realistic Achievable DR Potential for SWEPCO**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 5 | 1 | 2 | 1 | 0.1 | 0.0 | 0.0 | 0.0 | 1 | 2 | 1 |
| 2017 | 7 | 3 | 4 | 2 | 0.2 | 0.0 | 0.0 | 0.0 | 3 | 4 | 2 |
| 2018 | 10 | 4 | 5 | 3 | 0.2 | 0.0 | 0.0 | 0.0 | 4 | 6 | 3 |
| 2019 | 13 | 5 | 7 | 3 | 0.3 | 0.0 | 0.0 | 0.0 | 5 | 8 | 4 |
| 2020 | 16 | 7 | 8 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 7 | 10 | 5 |
| 2021 | 18 | 8 | 8 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 8 | 12 | 6 |
| 2022 | 19 | 8 | 9 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 8 | 12 | 6 |
| 2023 | 19 | 8 | 9 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 8 | 12 | 6 |
| 2024 | 19 | 8 | 9 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 8 | 12 | 6 |
| 2025 | 19 | 9 | 9 | 4 | 0.3 | 0.0 | 0.0 | 0.0 | 9 | 12 | 6 |

**Table F-8. Maximum Achievable DR Potential for SWEPCO**

| | DLC | Auto DR Lighting | Auto DR EMS | Auto DR Process | DG Diesel Engine | DG NG Engine | DG Diesel Turbine | DG NG Turbine | Manual Lighting Control | Manual HVAC Control | Manual Process Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 7 | 2 | 3 | 2 | 0.2 | 0.0 | 0.0 | 0.0 | 2 | 3 | 2 |
| 2017 | 11 | 4 | 6 | 3 | 0.3 | 0.0 | 0.1 | 0.0 | 4 | 7 | 4 |
| 2018 | 15 | 6 | 9 | 5 | 0.4 | 0.0 | 0.1 | 0.1 | 6 | 10 | 6 |
| 2019 | 19 | 8 | 11 | 6 | 0.4 | 0.1 | 0.1 | 0.1 | 8 | 13 | 7 |
| 2020 | 23 | 11 | 12 | 6 | 0.5 | 0.1 | 0.1 | 0.1 | 11 | 16 | 8 |
| 2021 | 28 | 13 | 13 | 7 | 0.5 | 0.1 | 0.1 | 0.1 | 13 | 19 | 9 |
| 2022 | 28 | 13 | 13 | 7 | 0.5 | 0.1 | 0.1 | 0.1 | 13 | 19 | 9 |
| 2023 | 28 | 13 | 14 | 7 | 0.5 | 0.1 | 0.1 | 0.1 | 13 | 19 | 9 |
| 2024 | 28 | 13 | 14 | 7 | 0.5 | 0.1 | 0.1 | 0.1 | 13 | 19 | 10 |
| 2025 | 28 | 13 | 14 | 7 | 0.5 | 0.1 | 0.1 | 0.1 | 13 | 19 | 10 |

## F.4 DR Potential for Direct Load Control Sub-technologies

This section presents the realistic and maximum achievable DR potential for each DLC sub-technology area.

**Table F-9. Realistic Achievable DLC Potential by Sub-technology Type**

| | Res Central AC DLC | Water Heater DLC | C&I Central AC DLC | Res PCT | C&I PCT | Ag Pumping DLC |
|---|---|---|---|---|---|---|
| 2016 | 25.2 | 7.6 | 0.000 | 0.2 | 0.001 | 10.4 |
| 2017 | 33.6 | 15.4 | 0.003 | 0.3 | 0.003 | 11.2 |
| 2018 | 42.3 | 23.4 | 0.003 | 0.5 | 0.006 | 12.0 |
| 2019 | 51.1 | 31.6 | 0.007 | 0.6 | 0.007 | 12.7 |
| 2020 | 60.2 | 40.0 | 0.007 | 0.8 | 0.011 | 13.5 |
| 2021 | 69.6 | 48.6 | 0.012 | 1.0 | 0.012 | 14.2 |
| 2022 | 70.6 | 49.3 | 0.012 | 1.0 | 0.012 | 14.2 |
| 2023 | 71.5 | 50.0 | 0.012 | 1.0 | 0.012 | 14.2 |
| 2024 | 72.5 | 50.7 | 0.012 | 1.0 | 0.012 | 14.2 |
| 2025 | 73.5 | 51.4 | 0.012 | 1.0 | 0.012 | 14.2 |

**Table F-10. Maximum Achievable DLC Potential by Sub-technology Type**

| | Res Central AC DLC | Water Heater DLC | C&I Central AC DLC | Res PCT | C&I PCT | Ag Pumping DLC |
|---|---|---|---|---|---|---|
| 2016 | 36.0 | 11.4 | 0.007 | 0.3 | 0.003 | 10.9 |
| 2017 | 55.6 | 23.0 | 0.019 | 0.6 | 0.007 | 12.1 |
| 2018 | 75.7 | 35.0 | 0.032 | 0.9 | 0.012 | 13.4 |
| 2019 | 96.3 | 47.3 | 0.047 | 1.3 | 0.017 | 14.6 |
| 2020 | 117.5 | 60.0 | 0.059 | 1.6 | 0.022 | 15.8 |
| 2021 | 139.2 | 73.0 | 0.072 | 1.9 | 0.029 | 17.1 |
| 2022 | 141.1 | 74.0 | 0.073 | 2.0 | 0.029 | 17.1 |
| 2023 | 143.0 | 75.0 | 0.073 | 2.0 | 0.030 | 17.1 |
| 2024 | 145.0 | 76.0 | 0.074 | 2.0 | 0.030 | 17.1 |
| 2025 | 147.0 | 77.0 | 0.076 | 2.1 | 0.030 | 17.1 |