FINAL REPORT

Austin Energy Potential Assessment 2025 to 2035

Austin Energy

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Date: July 10, 2025

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Glossary & acronyms

Achievable potential: The amount of savings that would occur in response to specific program funding and measure incentive levels. Savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention.

Applicability factor: The percentage of the building stock that has a particular type of equipment or for which an efficiency measure applies. For example, the applicability factor for a tankless electric water heater (compared to a base standard electric water heater) is the percentage of homes with electric water heaters. The applicability factor for high-efficiency clothes washers as an electric water heating measure is the percentage of homes with electric water heating that also have a clothes washer. For base measures, this is sometimes referred to as the equipment saturation.

C&I: Commercial and industrial

CBECS: U.S. Energy Information Administration Commercial Buildings Energy Consumption Survey

Coincidence factor: Utility coincidence factors are the ratio of actual demand at the utility peak to the average demand, as calculated from the load shape. These factors vary by market segment or building type, end-use, and time-of-use period.

Cumulative annual: Savings occurring in a particular year that are due to cumulative program activities over time. For example, if a program installs one high-efficiency widget in year 1 of the program, two in year 2, and five in year 3, the cumulative annual savings in year three would be the savings accruing on all eight surviving units in place in year 3, regardless of what year they were installed. Cumulative annual savings does account for equipment retirement. In the example above, widgets are assumed to have an effective useful life of more than three years. If the equipment in the above example were doohickeys, which only have a two-year effective useful life, the year 1 doohickey would have retired at the end of year 2, so only the units sold in years 2 and 3 would contribute to year 3 cumulative annual savings.

Demand-side management (DSM): An electric system must balance the supply of electricity with the demand for electricity. Demand-side management (DSM) programs focus on managing the demand side of this balance through energy efficiency and load management.

DOE: U.S. Department of Energy.

Economic potential: The technical potential of those energy conservation measures that are cost-effective when compared to supply-side alternatives.

Effective useful life (EUL): A measure of the typical lifetime of an efficiency measure. Technically, it is the age at which half of the units have failed and half survive. In DNV's ASSYST™ model, all measures are assumed to remain in place until the end of their effective useful lives and then retire.

EIA: US Energy Information Agency

End-use energy intensity (EUEI): Energy use per unit of building stock having a specific end-use. For example, the EUEI for commercial electric heating is the amount of electricity used for heating divided by the number of square feet of floor space that are electrically heated. EUEI differs from energy intensity in that it accounts for the equipment type's saturation. If the saturation of the equipment type is low, the EUEI will be much higher than the energy intensity.

EUI adjustment factor: Because equipment efficiencies can change over time independent of program activities, due to either naturally occurring technological changes or external intervention, such as appliance standards, the efficiency of new equipment may differ from the typical efficiency of the equipment stock. The EUI adjustment factor is the ratio of new standard efficiency equipment's energy use to the average energy use of units in the equipment stock.

Feasibility factor: The fraction of the applicable floor space, or households, that is technically feasible to convert to a DSM technology, from an engineering perspective.

Free rider: A program participant who would have invested in an energy efficiency measure even without the intervention of the program. Free riders add to program costs but do not contribute to net energy savings.

Free-rider energy savings: The subset of naturally occurring energy savings for which the utility pays incentives or provides other program benefits. These savings are included in gross program savings but not in net program savings.

GHG: Greenhouse gas emissions

Incremental cost: The additional cost required to purchase an efficiency measure compared to base equipment.

IRP: Integrated Resource Planning

kW: kilowatts, 1,000 watts. A measure of electric power or electricity demand.

kWh: kilowatt-hour. A measure of electrical energy.

Line losses: When electricity is transmitted over the transmission and distribution system, some of the electricity is dissipated as heat due to resistance in the transmission lines or inefficiencies in transformers in the distribution system. As a result, the amount of electricity delivered to consumers is less than the amount produced at the generator. These are referred to as line losses or transmission and distribution losses.

MW: Megawatt, one million watts. A measure of electric power or electricity demand.

MWh: Megawatt-hour, equal to 1,000 kWh. A measure of electrical energy.

NAICS: The North American Industry Classification System is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

Naturally occurring energy savings: The amount of savings estimated to occur as a result of normal market forces, that is, in the absence of any utility or governmental intervention.

REUS: Residential Energy Use Survey

RECS: EIA Residential Energy Consumption Survey

Replace on burnout (ROB): A measure that is installed when the previous equipment reaches the end of its useful life. ROB measures penetrate the market gradually as the existing stock of equipment turns over due to equipment age and eventual failure.

Retrofit: A measure that is installed to achieve energy savings independent of the condition of the existing equipment. This includes measures that affect the energy use of other equipment, such as insulation to reduce heating costs. It also includes replacing equipment with higher efficiency equipment before the end of existing equipment's useful life, for example replacing T12 fluorescent lighting in an office with higher efficiency T8s. Retrofits can be done at any time and therefore have the potential to penetrate the market more quickly than ROB measures.

Technical potential: The savings that would result from complete penetration of all analyzed measures in applications where they were deemed technically feasible, from an engineering perspective.

Technology saturation: A factor that relates the cost units used in the model for a measure to its savings units. For example, the cost of a chiller may be expressed in dollars per ton, though the savings are in kWh per square foot. The technology saturation then represents the number of tons of cooling per square foot.

Total resource cost test (TRC): A benefit-cost test that compares the value of avoided energy production and power plant construction to the costs of energy efficiency measures and the program activities necessary to deliver them. The values of both energy savings and peak-demand reductions are incorporated in the TRC test.

TRM: Texas Technical Reference Manual

UEC: Unit energy consumption

1 EXECUTIVE SUMMARY

Austin Energy retained DNV to conduct a demand-side management (DSM) market potential study based on existing and proposed customer programs. This study provides estimates of potential energy, demand, and carbon savings from the five program types in Austin Energy's service territory: Energy Efficiency, Green Building, electrification, Solar, and Demand Response. These estimates include technical, economic, and achievable program potential.

The DNV team provides deep capabilities in the full range of technology, market, economic, and regulatory analytics for DSM and DERs, along with extensive experience in shaping and supporting technology and policy-oriented stakeholder processes. With decades of experience providing these services, DNV has developed analytical methodologies and computer-based tools that estimate savings potential and customer adoption. DNV has a long history of supporting Austin Energy with potential assessments as referenced in the Resource & Generation Plan in 2012, 2015 and 2021.

Within this study DNV defines several types of potential, namely technical, economic, achievable program, and naturally occurring. The 2024 Austin Energy Efficiency Potential Assessment assessed the potential for electric demand (kW) savings and carbon savings (GHG) from company-sponsored demand side management (DSM) programs over 11 years starting in 2025 for Austin Energy's service territory.

Austin Energy asked DNV focus this report on the achievable results rather than technical or economic results, as achievable results represent the most actionable and realistic outputs of the three scenarios. As such, this report focuses on:

- Achievable potential for utility-run programs in the five program types in Austin Energy's service territory
- Annual cumulate achievable savings in megawatts (MW) and greenhouse gas (GHG) reductions
- Estimates of the annual costs associated with achieving those savings

For this study, DNV leveraged our fully vetted model, DSM Assyst™, an industry-recognized, spreadsheet-based model, that uses a bottom-up approach to estimate potential savings.[1] The tool builds up potential estimates from underlying assumptions about measure costs, savings, and applicability grounded in data provided by Austin Energy or from industry secondary sources. Our forecasts are based on historical program, customer, and forecasted consumption data provided by Austin Energy and regional and national secondary sources.

1.1 Key findings

At its core, this study represents a modeling exercise intended to support the development of future goals that can help drive program achievements based on DNV's estimates of achievable potential. Austin Energy can use these estimates to inform subsequent implementation plans and achievable targets for demand and carbon reductions.

1.1.1 Demand savings potential

Figure 1-1 and associated Table 1-1 below present the total demand savings identified in the study. These savings reflect cumulative annual savings potential over an 11-year period, which is the annual savings potential in 2035 of all installations from 2025 through 2035. Within this report, we start accumulating savings, both in MW and GHG in the year 2025 which means that our estimates exclude existing installed capacity.[2]

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[1] The DSM Assyst Suite of tools includes DER Assyst for solar, the DR Assyst, Decarb Assyst for electrification, and DSM Assyst for EE and GB. DER and Decarb Assyst are based on the same foundational methodologies as DSM Assyst.

[2] Demand response is an exception to this statement. In demand response section 5.6, we add back in the installed capacity to present MW totals that are familiar to reader. In the summary section, however, that installed capacity has been excluded to make an apples-to-apples comparison with other resources.

Figure 1-1. Cumulative achievable MW savings from 2025 – 2035 for all program types

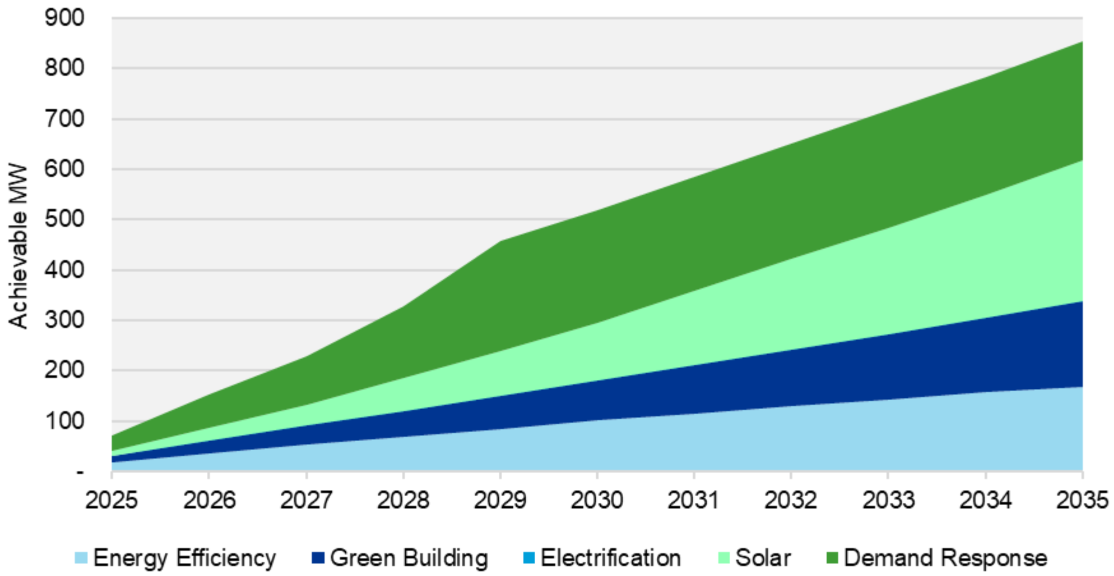

Table 1-1. Cumulative achievable MW savings from 2025 – 2035 for all program types

Sector	2025	2030	2035
Energy Efficiency	18.27	100.79	168.25
Green Building	13.90	84.36	178.98
Electrification	(0.51)	(5.48)	(10.15)
Solar	10.18	116.08	279.49
Demand Response	30.25	222.73	236.90
Total	**72.08**	**518.48**	**853.46**

Total demand potential of just over 850 MW in 2035 across all programs with DR and Solar having the largest shares of potential.

- This does NOT include about 120 MW of existing Solar capacity or 17 MW of existing Demand Response capacity.

The potential for **electrification of space and water heat** is

- Negative, representing load growth due to the addition of electric appliances
- Small in comparison to other programs because of limited cost-effectiveness given the low avoided cost of natural gas

Demand Response potential grows quickly between 2025 and 2030 as new and existing programs ramp to achievable participation rates over the first five years of the study.
Solar incentives have the largest contribution to overall potential, accounting for just under one-third of the total in 2035.
Energy Efficiency and **Green Building** both make meaningful contributions to the overall potential.

1.1.2 Carbon savings potential

Figure 1-2 and associated Table 1-2 below present the total carbon savings potential found by the study. These savings reflect cumulative annual savings of all installations from 2025 through 2035.

Figure 1-2. Cumulative achievable GHG savings from 2025 – 2035 for all program types

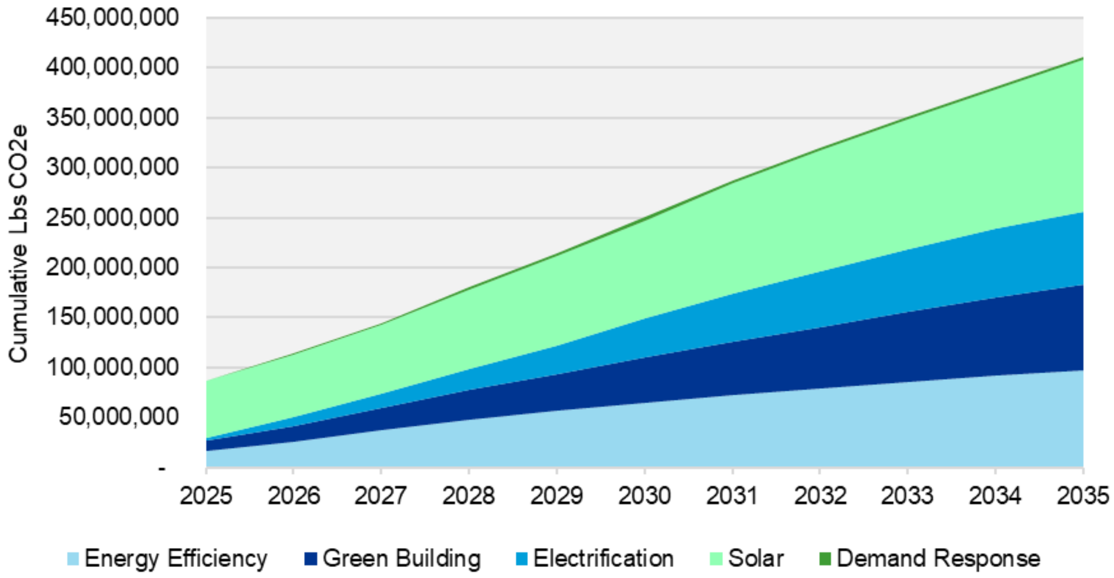

Table 1-2. Cumulative achievable GHG savings from 2025 – 2035 for all program types

Sector	2025	2030	2035
Energy Efficiency	16,650,336	64,677,589	96,676,024
Green Building	10,043,160	45,216,303	86,861,977
Electrification	3,497,303	39,099,913	72,981,442
Solar	56,841,318	98,391,432	151,157,023
Demand Response	436,009	2,894,637	3,047,215
Total	**87,468,126**	**250,279,874**	**410,723,681**

Total GHG potential is just over 400 M lbs. of CO_2e and is concentrated in EE, Green Building, and Solar, equivalent to approximately:

- 45,000 gasoline-powered vehicles driven for one year
- 430,000 barrels of oil consumed
- 3,000,000 tree seedlings grown for 10 years.

The potential for **GHG reduction among Demand Response programs is low** compared to other program types due to availability. While an EE or solar resource is available for 8,760 hours of the year, demand response resources are only available to contribute for 40 hours resulting in much lower GHG potential.

In 2035 **the annual carbon emissions factor** represents a 90% carbon free grid.
Note that 90% is a conservative estimate and AE remains committed to 100% carbon free in 2035. New advanced technologies (such as nuclear and geothermal) may be ready to help AE achieve the final 10% in the coming years.

1.1.3 Annual program spending

Figure 1-3 and associated Table 1-3 below present the total annual program savings for each program type in each year of the study from 2025 through 2035. Unlike the MW and GHG estimates, spending is not cumulative but represents the spending on that program type in a given year. Note that spending for Green Building is not included in the figures below because, unlike the other programs, Austin Energy does not offer incentives for Green Building.

Figure 1-3. Annual spending from 2025 – 2035 for all program types

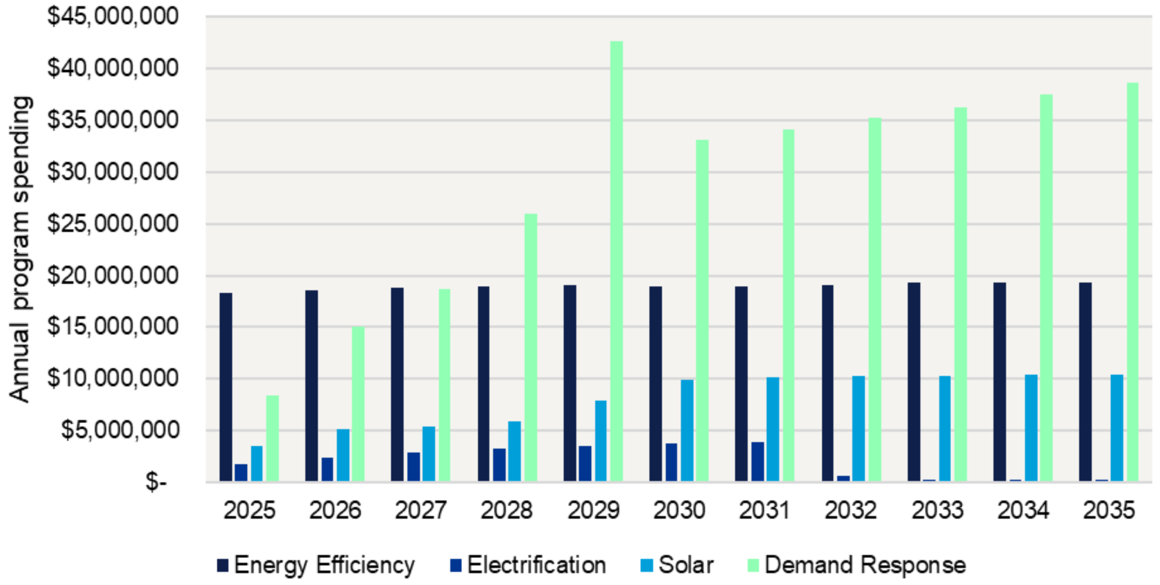

Table 1-3. Annual spending from 2025 – 2035 for all program types

Sector	2025	2030	2035
Energy Efficiency	$18,311,828	$18,877,331	$19,311,387
Electrification	$1,767,313	$3,763,955	$250,295
Solar	$3,568,247	$9,845,455	$10,402,291
Demand Response	$8,341,869	$33,052,388	$38,659,173
Total	**$31,989,257**	**$65,539,130**	**$68,623,145**

While the program costs include marketing and administration budgets, **the primary driver of total program spending is customer incentives.**

Total annual spending including program incentives grows from $32 million in 2025 to $68 million dollars in 2035.

- **Incentives are the primary driver of annual DR spend** as those incentives must be paid annually for most programs to retain participants.
- **Solar installation** spending also sees some **significant growth** over the study timeline as solar demand grows.
- Annual **spending for EE programs remains stable** over the time horizon.
- **Electrification spend falls sharply starting in 2032** as most of the cost-effective equipment replacements have already occurred.

2 INTRODUCTION

Austin Energy retained DNV to conduct a demand-side management (DSM) market potential study based on existing and proposed customer programs (Energy Efficiency, Green Building, Electrification, Solar, and Demand Response). This study provides estimates of potential energy and carbon savings from the five program types in Austin Energy's service territory, including technical, economic, and achievable program potential. DNV combines extensive expertise in technology, market trends, economics, and regulatory analytics for DSM and DERs with decades of experience in supporting stakeholders in shaping technology and policy-oriented processes. Over the years, DNV has developed analytical methodologies and computer-based tools that estimate savings potential and customer adoption.

DNV has an established partnership with Austin Energy, contributing to its Resource & Generation Plan in 2012, 2015, and 2021. In this latest collaboration, the 2024 Austin Energy Efficiency Potential Assessment evaluates the potential for electric demand (kW) savings and carbon savings from company-sponsored DSM programs. The study spans an 11-year period starting in 2025 and focuses on the following objectives:

- Achievable potential for utility-run programs in the following areas: Energy Efficiency, Green Building, electrification, Solar, and Demand Response
- Annual cumulate achievable savings in MW and GHG reductions
- Estimates of the annual costs associated with achieving those savings

2.1 Overview

The study analyses residential and non-residential commercial sectors within Austin Energy's service territory, focusing on the period from 2025 to 2035. It includes commercially available energy efficiency, electrification, solar, and demand response measures and program options. It also considers existing codes and standards effective within the next year. We excluded future codes and standards from the analysis to maintain a near-to-mid-term focus.

The study integrates data from several sources, including Austin Energy's historical and forecasted data, DNV's extensive energy efficiency database, and various third-party sources.

2.2 Study approach

DNV calculated this study's potential elements after identifying and developing baseline end-use and measure, program, or installation data, then developing estimates of future impacts under varying levels of program effort.

DNV performed a baseline characterization to identify the types and approximate sizes of the various market segments that are the most likely sources of DSM potential in Austin Energy's service territory. These characteristics served as inputs to a modeling process that incorporated Austin Energy's energy-cost parameters and specific measure, program, or installation characteristics (such as costs, savings, and existing penetration and existing capacity estimates) to provide more detailed potential estimates.

We leveraged our DSM Assyst™, a robust tool that ensures clear documentation, efficient data processing, and transparent estimation of energy efficiency potential. This model estimated technical, economic, and achievable program potential for the residential and non-residential sectors, with a focus on impacts through 2035.

2.3 Organization of the report

The remainder of the report is structured as follows:

- Section 3 reviews and summarizes the data collection and development process.

- Section 4 discusses the methodology and concepts used to develop the technical, economic, and achievable potential estimates.
- Section 5 provides achievable results developed for the study by DSM program type and sector, where applicable.

The report includes the following appendices:

- Appendix A, Detailed methodology and model description
- Appendix B, Key assumptions by program type

3 DATA COLLECTION AND DEVELOPMENT

This section describes how DNV developed data inputs for this potential study.

DNV heavily relied on the program and energy consumption data provided by Austin Energy staff and secondary data sources. We also used additional data sources to inform certain inputs of the potential study model that could not be ascertained through the data collection efforts. This section outlines those sources and their use in the modeling process.

3.1 Measure data

In addition to Austin Energy's current program data, several secondary data sources provided insight on measure-level energy usage and savings potential, measure costs and lifetimes, and the current penetration of various efficiency measures and end uses applicable for demand response programs. DNV reviewed various data sources for this information-seeking data, where available, specific to Austin Energy's service territory or geographic location. The sources listed below provided information for these inputs:

- **Energy Efficiency:** Develop a list of energy efficiency measure opportunities to include in scope based on the measure list developed for the 2020 study with adjustments to reflect current program designs and codes and standards.
- **Green Building:** Include current and planned Green Building measures.
- **Electrification:** Include residential space and water heating measures.[3]
- **Solar:** A list of solar options aligned with Austin Energy's current programs was developed in consultation with the Austin Energy Team.
- **Demand Response**: A list of program options and controllable technologies was developed in consultation with the Austin Energy Team.
- **Secondary information**:
  - ENERGY STAR Calculators
  - U.S. Energy Information Administration (EIA) Commercial Buildings Energy Consumption Survey (CBECS)
  - EIA Residential Energy Consumption Survey (RECS)
  - Texas Technical Reference Manual (TRM)
  - Austin Energy program tracking data and program reports
  - Professional judgment of DNV engineers with experience in Austin Energy's service territory
  - Northwest Power and Conservation Council 2021 Power Plan technical resources for demand response in the state of Utah
  - DNV's internal DER cost database, developed from data sources including NREL Annual Technology Baseline (ATB), LBL's Tracking the Sun Database, and actual project cost reviews

3.2 Economic data

We used economic inputs from Austin Energy's service territory to provide a more accurate picture of the monetary cost and benefits associated with energy efficiency. Austin Energy provided data to support the following model requirements:

- Customer discount rate
- Inflation rate
- Utility discount rate
- Avoided cost and retail rate forecasts

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[3] Carbon savings from the ChargePoint program is included in the GHG results.

- Line-loss estimates

3.3 Building data

DNV developed building and customer characteristics, including total square footage or the total number of households, average available rooftop space, and technically viable customers by customer segment, energy consumption and intensity by end-use, market shares of key electric consuming equipment, and market shares of energy efficiency technologies and practices. The following sources were used to develop this information:

- Austin Energy billing data to identify consumption of residential and commercial customers
- Austin Energy system load data
- U.S. Energy Information Administration (EIA) Commercial Buildings Energy Consumption Survey (CBECS)
- EIA Residential Energy Consumption Survey (RECS)
- Other secondary studies for specific end-uses

3.4 Program budgets

As part of the potential modeling process, past and projected program budgets were used as a starting point for the achievable potential analysis, which estimates the market penetration of measures as a function of marketing, incentive levels, and other factors.[4] Austin Energy provided past and planned program budgets and savings that we used to help calibrate the achievable modeling efforts. Specifically, marketing and administrative dollars were two inputs into the model that were derived from the indicator tables DNV compiled for Austin Energy.

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[4] The methodology of calculation measure penetration is described in more detail in Section 4 and Appendix A

4 METHODOLOGY

This section provides a brief overview of the concepts and methods DNV used to conduct this study.

4.1 Characterizing the DSM resources

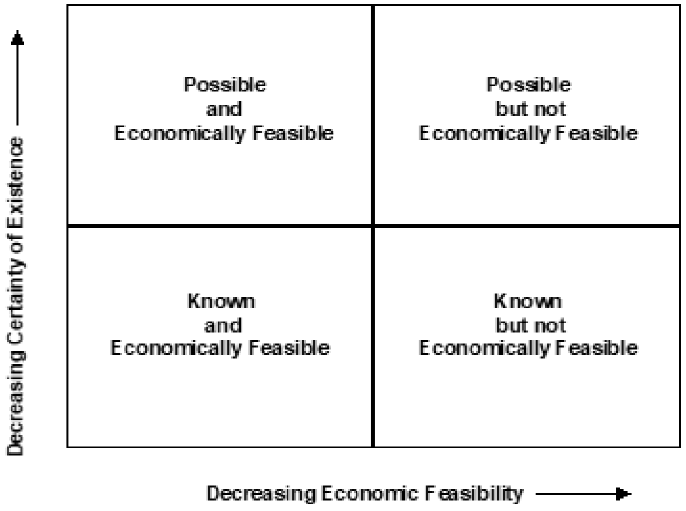
Demand-side management resources (including energy efficiency, but also demand response, behind the meter storage, and electrification) have long been characterized as an alternative to energy supply options, such as conventional power plants that produce electricity from fossil or nuclear fuels. In the early 1980s, researchers developed and popularized the use of a conservation supply-curve paradigm to characterize the potential costs and benefits of energy conservation and efficiency. Under this framework, technologies or practices that reduced energy use through efficiency were characterized as making the energy saved available to meet other demands and could therefore be thought of as a resource and plotted on an energy supply curve. The energy efficiency resource paradigm argued simply that the more energy efficiency produced, fewer new plants would be needed to meet end-users' power demands.

4.2 Defining potential

DSM potential studies became popular throughout the utility industry from the late 1980s through the mid-1990s. This period coincided with the advent of what was called least-cost or integrated resource planning (IRP). DSM potential studies became one of the primary means of characterizing the resource availability and value of energy efficiency within the overall resource planning process.

There are several ways in which the energy efficiency resource can be estimated and characterized. Definitions of DSM potential are similar to definitions of potential developed for finite fossil fuel resources like coal, oil, or natural gas. For example, fossil fuel resources are typically characterized along two primary dimensions: the degree of geological certainty with which resources may be found, and the likelihood that extraction of the resource will be economical. This relationship is conceptualized in Figure 4-1 to the right.

Figure 4-1. Conceptual framework for estimates of fossil fuel resources

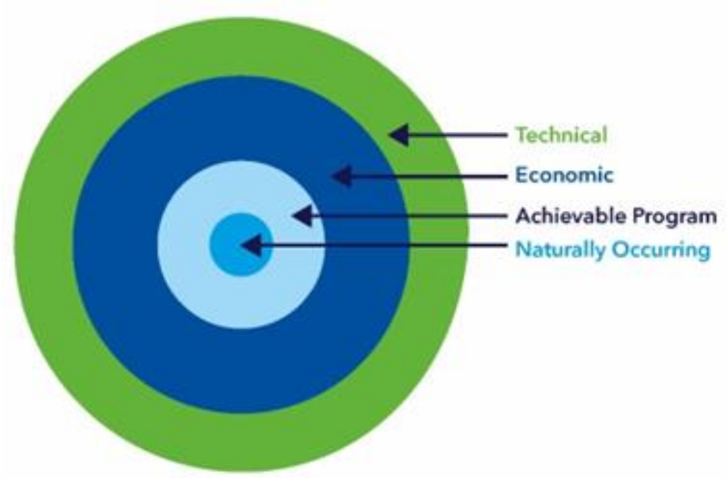


Somewhat analogously, this DSM potential study defines several different *types* of DSM *potential*, namely technical, economic, achievable program, and naturally occurring. These types of potential are conceptualized in Figure 4-2 and described below.

- **Technical potential** is defined in this study as the complete penetration of all measures analyzed in applications where they were deemed technically feasible from an engineering perspective.
- **Economic potential** refers to the technical potential of those energy conservation measures that are cost-effective when compared to supply-side alternatives.

- **Achievable program potential** refers to the amount of savings that would occur in response to various measure incentive levels. Savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention.
- **Naturally occurring potential** refers to the amount of savings estimated to occur as a result of normal market forces; that is, in the absence of any utility or governmental intervention.
- **Market potential**, which was provided in this study, includes both achievable potential and naturally occurring potential. Note that for demand response, naturally occurring potential is zero.

Figure 4-2. Conceptual relationship among energy efficiency potential definitions



One metric of savings potential that we use throughout this report is "cumulative annual savings." These savings occur in a year due to both current program activities and past program activities that are still generating energy savings.

Cumulative annual savings that account for equipment retirement is a performance metric that takes into account the effective useful life (EUL) of various equipment.[5] Within this report, we start accumulating savings, both in MW and GHG in the year 2025 which means that our estimates exclude existing installed capacity.[6]

4.3 Summary of analytical steps used to calculate potential

The crux of this study involves carrying out several basic analytical steps to produce estimates of the DSM potentials introduced above. The basic analytical steps for this study are shown in relation to one another in Figure 4-3. The bulk of the analytical process for this study was carried out in a model developed by DNV for conducting DSM potential studies. Details on the steps employed and analyses conducted are described in Appendix A. The model used DSM ASSYST™, a Microsoft® Excel-based model that integrates technology-specific engineering and customer behavior data with utility market saturation data, load shapes, rate projections, and marginal costs into an easily updated data management system. [7]

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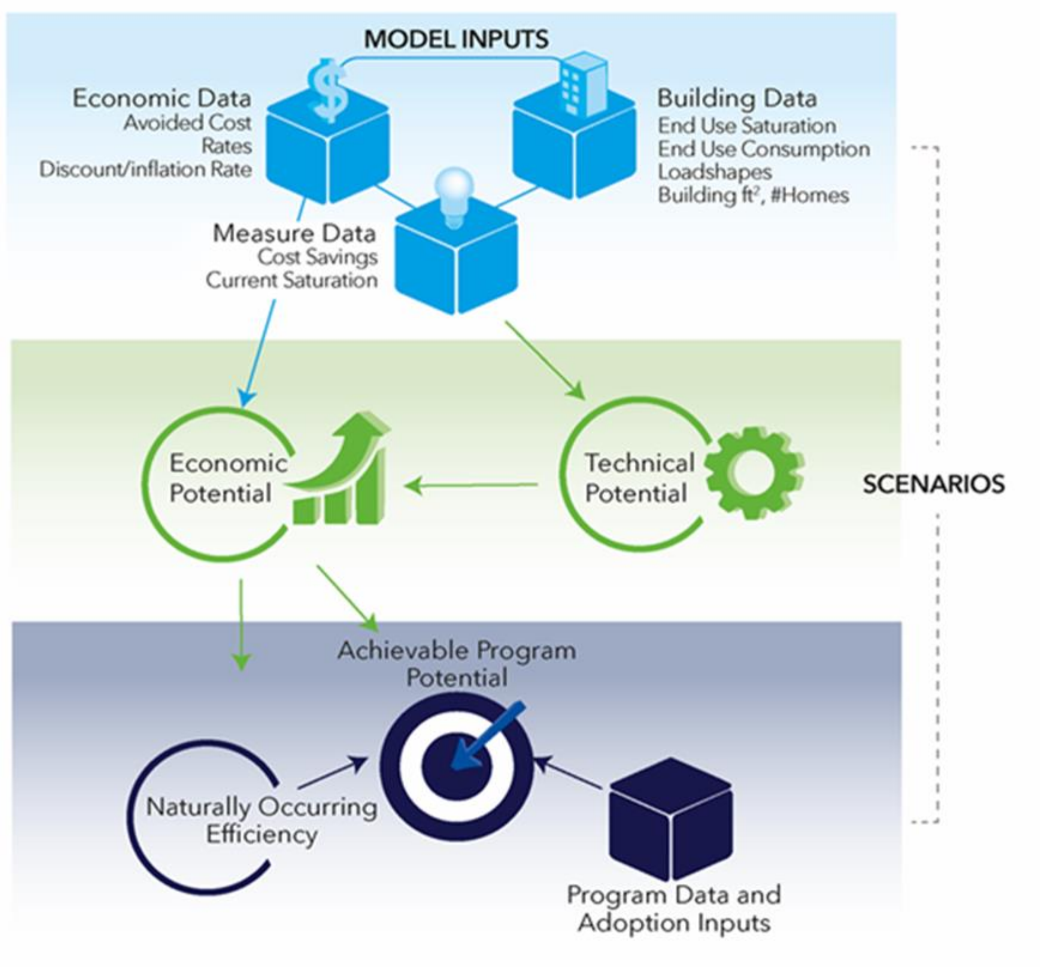
[5] In this analysis we have assumed an average useful life of the portfolio of measures to be 10 years, so in this case, the sum of the incremental savings does equal the cumulative savings.

[6] Demand response is an exception to this statement. In the demand response section, we add back in the installed capacity to present MW totals that are familiar to readers. In the summary section, however, that installed capacity has been excluded to make an apples-to-apples comparison with other resources.

[7] The DSM Assyst Suite of tools includes DER Assyst for solar, the DR Assyst, Decarb Assyst for electrification, and DSM Assyst for EE and GB. DER and Decarb Assyst are based on the same foundational methodologies as DSM Assyst.

Figure 4-3. Conceptual overview of study process



The key steps implemented in this study are:

1. **Develop initial input data**
    a. Measure data:
        i. **Energy Efficiency:** Develop a list of energy efficiency measure opportunities to include in scope based on the measure list developed for the 2020 study with adjustments to reflect current program designs and codes and standards.
        ii. **Solar and storage:** A list of solar and storage options aligned with Austin Energy's current programs was developed in consultation with the Austin Energy Team.
        iii. **Demand Response:** A list of program options and controllable technologies was developed in consultation with the Austin Energy Team.
    b. Gather and develop technical data (costs and savings) on measures and opportunities. Data on measures were gathered from a variety of sources including:
        i. ENERGY STAR Calculators
        ii. U.S. Energy Information Administration (EIA) Commercial Buildings Energy Consumption Survey (CBECS)

        iii. EIA Residential Energy Consumption Survey (RECS)
        iv. Texas Technical Reference Manual (TRM)
        v. Austin Energy program tracking data and program reports
        vi. Professional judgment of DNV engineers with experience in Austin Energy's service territory
        vii. Northwest Power and Conservation Council 2021 Power Plan technical resources for demand response in the state of Utah
        viii. DNV's internal DER cost database, developed from data sources including NREL Annual Technology Baseline (ATB), LBL's Tracking the Sun Database, and actual project cost reviews

    c. Gather, analyze, and develop information on building characteristics, including total square footage or the total number of households, average available rooftop space and technically viable customers by customer segment, energy consumption and intensity by end-use, market shares of key electric consuming equipment, and market shares of energy efficiency technologies and practices.

        i. U.S. Energy Information Administration (EIA) Commercial Buildings Energy Consumption Survey (CBECS)
        ii. EIA Residential Energy Consumption Survey (RECS)
        iii. Billing data to identify consumption of residential and commercial customers
        iv. System load data
        v. Other secondary studies for specific end-uses

    d. Collect data on economic parameters: avoided costs, electricity rates, discount rates, and inflation rate as provided by Austin Energy.

2. Estimate technical potential

    a. Match and integrate data on energy-saving measures and opportunities with data on existing building characteristics to produce estimates of technical potential.

3. Estimate economic potential

    a. Match and integrate measure and building data with economic assumptions to produce indicators of costs from different viewpoints (e.g., societal and consumer).
    b. Estimate total economic potential.

4. Estimate achievable program and naturally occurring potentials

    a. Screen initial measures for inclusion in the program analysis. This screening may take into account factors such as cost-effectiveness, potential market size, non-energy benefits, market barriers, and potentially adverse effects associated with a measure. For this study, measures were screened using the total-resource-cost test.
    b. Gather and develop estimates of program costs (e.g., for incentives, administration, and marketing) and historic program savings.
    c. Develop estimates of customer adoption of DSM measures, programs, or installations as a function of the economic attractiveness of the measures, barriers to their adoption, and the effects of program intervention. This process utilized Austin's past program performance metrics to calibrate the model's adoption curves.
    d. Estimate achievable program and naturally occurring potentials and associated program costs.

4.4 Calculating GHG savings

Within this report, we have included estimates of both demand and carbon savings. The carbon savings were estimated using the following process:

- Austin Energy provided Austin-specific GHG factors for 2019 through 2023 for both an average hour and a 4 CP (4 coincident peak) hour. The GHG factors were calculated to reflect the differences in generation mix between ERCOT and Austin Energy.
- DNV developed a simple trend model to forecast both the average and peak GHG factors over the study horizon. This model accounts for increased greening of the grid but does not force the carbon emissions to zero at a specific point in time. In 2035 the final factors represent a grid that is on average 90% carbon-free, and at peak 73% carbon-free acknowledging that there will likely still need to be some supplementation at peak time with natural gas.
- DNV assumed 40 peak hours per year, which aligns with their recent event calling strategy of approximately 20 2-hour events.
- DNV then applied the GHG factors to the total MWh and MW saved for each program assuming 8720 average hours and 40 peak hours.
- All carbon savings are presented throughout the report as lbs of CO2e avoided.

5 ACHIEVABLE POTENTIAL RESULTS

In this section, we present the achievable potential results, including estimates of demand savings, carbon savings, and annual program costs. We first present our system-level results and findings and then the detailed results for each program type, including Energy Efficiency, Green Building, electrification, Solar, and Demand Response.

5.1 System level results

Figure 5-1 and Table 5-1 associated below present the total demand savings identified in the study. These savings reflect cumulative annual savings potential over an 11-year period, which is the annual savings potential in 2035 of all installations from 2025 through 2035. Within this report, we start accumulating savings, both in MW and GHG in the year 2025 which means that our estimates exclude existing installed capacity.[8]

Figure 5-1. Cumulative achievable MW savings from 2025 – 2035 for all program types

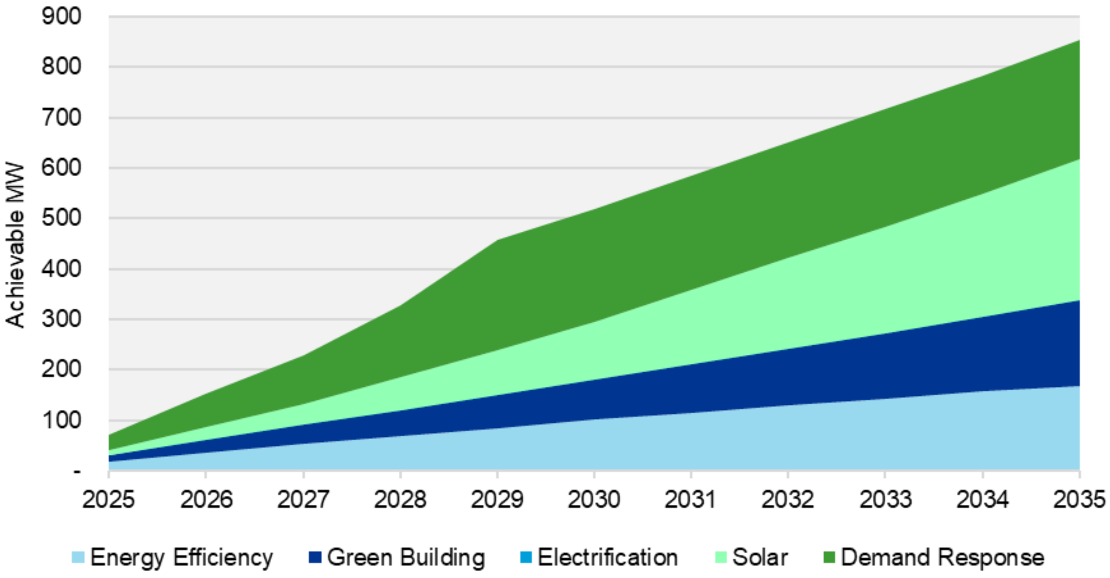


Table 5-1. Cumulative achievable MW savings from 2025 – 2035 for all program types

Sector	2025	2030	2035
Energy Efficiency	18.27	100.79	168.25
Green Building	13.90	84.36	178.98
Electrification	(0.51)	(5.48)	(10.15)
Solar	10.18	116.08	279.49
Demand Response	30.25	222.73	236.90
Total	**72.08**	**518.48**	**853.46**

Key observations include:

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[8] Demand response is an exception to this statement. In demand response section 5.6, we add back in the installed capacity to present MW totals that are familiar to readers. In the summary section, however, that installed capacity has been excluded to make an apples-to-apples comparison with other resources.

- Total demand potential of just over 850 MW in 2035 across all programs with DR and Solar having the largest shares of potential. This does not include about 120 MW of existing Solar capacity or 17 MW of existing Demand Response capacity.
- The potential for electrification of space and water heat is negative, representing load growth due to the addition of electric appliances. It is also small in comparison to other programs because of limited cost-effectiveness given the low avoided cost of natural gas.
- Demand Response potential grows quickly between 2025 and 2030 as new and existing programs ramp to achievable participation rates over the first five years of the study.
- Solar incentives have the largest contribution to overall potential, accounting for just under one-third of the total in 2035.
- Energy Efficiency and Green Building both make meaningful contributions to the overall potential.

5.1.1 Carbon savings potential

Figure 5-1 and associated Table 5-2 below present the total carbon savings potential found by the study. These savings reflect cumulative annual savings of all installations from 2025 through 2035.

Figure 5-2. Cumulative achievable GHG savings from 2025 – 2035 for all program types

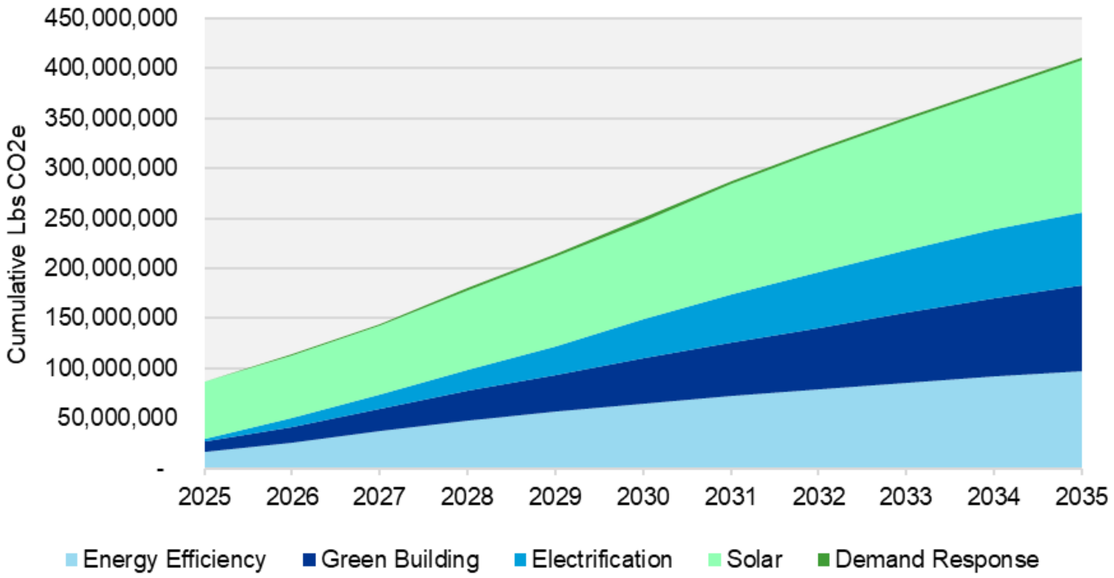

Table 5-2. Cumulative achievable GHG savings from 2025 – 2035 for all program types

Sector	2025	2030	2035
Energy Efficiency	16,650,336	64,677,589	96,676,024
Green Building	10,043,160	45,216,303	86,861,977
Electrification	3,497,303	39,099,913	72,981,442
Solar	56,841,318	98,391,432	151,157,023
Demand Response	436,009	2,894,637	3,047,215
Total	**87,468,126**	**250,279,874**	**410,723,681**

Key observations include:

- Total GHG potential is just over 400 M lbs. of CO2e and is concentrated in EE, Green Building, and Solar, equivalent to approximately:
  - 45,000 gasoline-powered vehicles driven for one year
  - 430,000 barrels of oil consumed
  - 3,000,000 tree seedlings grown for 10 years.
- The potential for GHG reduction among Demand Response programs is low compared to other program types due to availability. While an EE or solar resource is available for 8,760 hours of the year, Demand Response resources are only available to contribute for 40 hours resulting in much lower GHG potential.
- In 2035 the annual carbon emissions factor represents a 90% carbon free grid, while the 4CP factor represents a 73% carbon free grid.

5.1.2 Annual program spending

Figure 5-3 and associated Table 5-3 below present the total annual program savings for each program type in each year of the study from 2025 through 2035. Unlike the MW and GHG estimates, spending is not cumulative but represents the spending on that program type in a given year. Note that spending for Green Building is not included in the figures below because, unlike the other programs, Austin Energy does not offer incentives for Green Building.

Figure 5-3. Annual spending from 2025 – 2035 for all program types

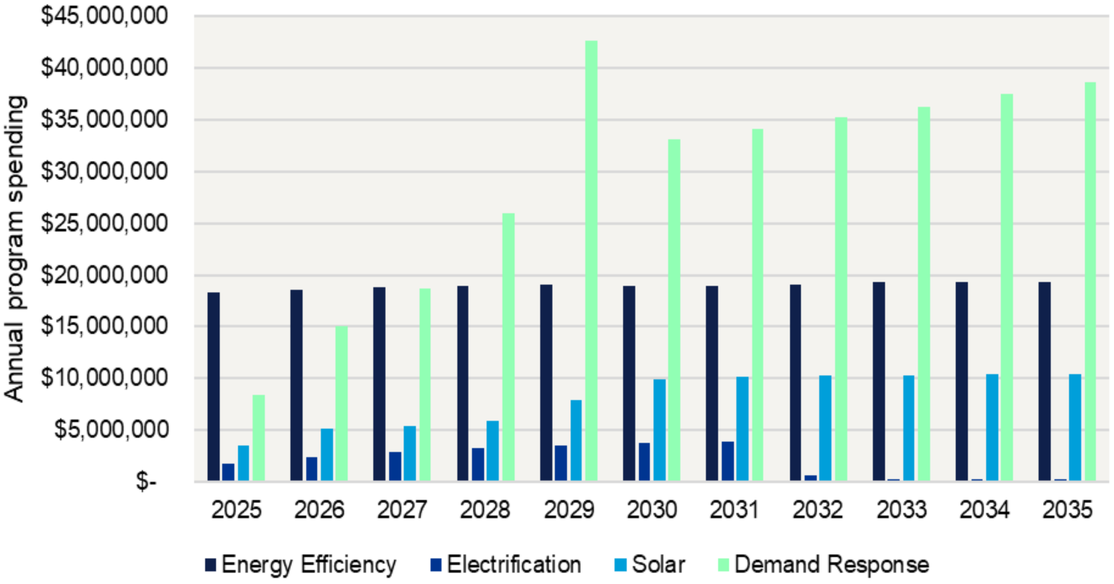

Table 5-3. Annual spending from 2025 – 2035 for all program types

Sector	2025	2030	2035
Energy Efficiency	$18,311,828	$18,877,331	$19,311,387
Electrification	$1,767,313	$3,763,955	$250,295
Solar	$3,568,247	$9,845,455	$10,402,291
Demand Response	$8,341,869	$33,052,388	$38,659,173
Total	**$31,989,257**	**$65,539,130**	**$68,623,145**

Key observations include:

- While the program costs include marketing and administration budgets, the primary driver of total program spending is customer incentives.
- Total annual spending including program incentives grows from $32 million in 2025 to $68 million dollars in 2035.
- Incentives are the primary driver of annual DR spend as those incentives must be paid annually for most programs to retain participants.
- Solar installation spending also sees some significant growth over the study timeline as solar demand grows.
- Annual spending for EE programs remains stable over the time horizon.
- Electrification spend falls sharply starting in 2032 as most of the cost-effective equipment replacements have already occurred.

5.2 Energy Efficiency

The energy efficiency analysis was based on Austin Energy's current mix of programs and measures. Each program is described briefly below.

- **Strategic Energy Partnerships between Utilities and Retailers** provides savings to Austin Energy customers on selected energy efficiency products, including ENERGY STAR products at participating Austin-area stores.
- The **Appliance Efficiency Program** provides individual rebates for installing energy-efficient equipment, including HVAC, variable-speed pool pumps, heat pump water heaters, window ACs, and smart thermostats in single family residential properties.
- **Weatherization Assistance Program** is a whole home program for low to moderate-income customers that includes free improvements including attic insulation, duct system improvements, weather stripping and sealing, solar screens, LED lighting, HVAC tune-ups, reflective roof coating for mobile homes, smart thermostats, air testing, and carbon monoxide and smoke detectors. The program provides participants with energy savings, bill savings, and improved comfort, air quality, and health and safety.
- **Home Energy Savings** is a whole home residential rebate program offering energy efficiency improvements. It includes measures such as HVAC replacements and tune-ups, duct system improvements, weatherstripping and sealing, attic insulation, solar shading, smart thermostats, and air testing. The program is available to Austin Energy customers in single-family residences that are at least 10 years old and require a participating contractor. The program includes both a rebate option and a financing option to maximize participation.
- The **Multifamily** and **Multifamily Income Qualified** programs provide energy efficiency rebates for residential multifamily housing properties in Austin Energy's service area. Rebates are paid to the property owner to help offset the cost of installing energy-efficient upgrades in tenant units and interior common areas. Measures include insulation, HVAC rebates and tune-ups, duct sealing, plenum remediation, lighting, solar screens, window replacement, and Power Partner[9] thermostats.
- The **Commercial Rebate** program includes a wide variety of offerings for large and small businesses, including lighting retrofits and new construction, HVAC rebates, building envelop measures, rebates on appliances, equipment, and motors, and custom rebates.

In total, the achievable demand reduction for Austin Energy's current portfolio of energy efficiency programs reaches 168 MW in 2035 with an associated GHG savings of 96 million Lbs of CO_2e. In the subsections that follow, we

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[9] Properties receive rebates for the installation of an approved Wi-Fi-enabled smart thermostat (Ecobee3 lite; Nest E; or Honeywell T5+/T6 Pro). Tenants are eligible to receive an additional rebate if they choose to enrol in Smart Energy Saving Events.

present the demand and carbon savings results and the annual program costs for the energy efficiency portfolio by sector including residential, multifamily, and commercial and industrial.

5.2.1 Demand savings

As shown in Figure 5-4 and Table 5-4, the commercial sector is by far the largest contributor to EE program potential at 46% of the total in 2035. Residential customers contribute approximately 32% of the savings in 2035, while multifamily contributes 21%.

Figure 5-4. Energy Efficiency: Cumulative achievable MW by sector

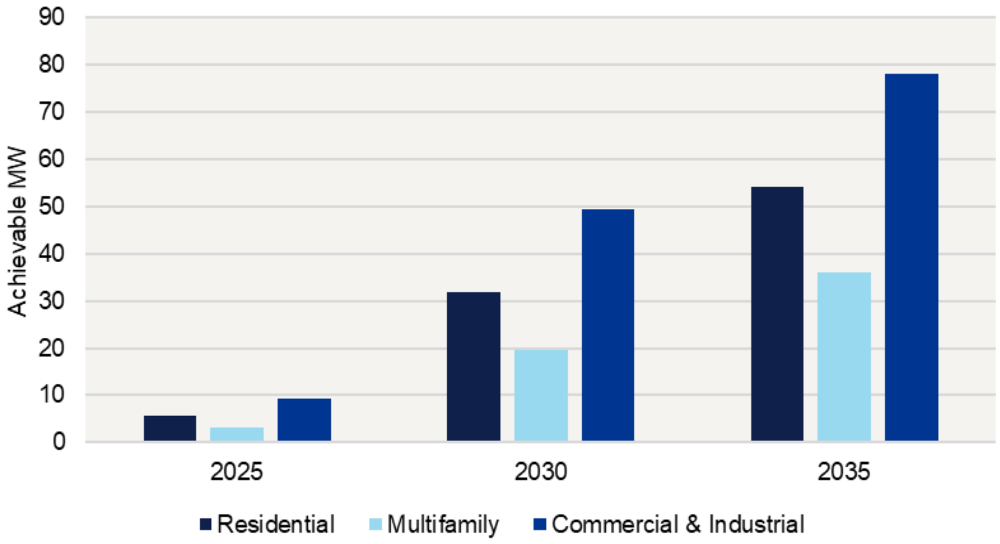


Table 5-4. Energy Efficiency: Cumulative achievable MW by sector

Sector	2025	2030	2035
Residential	5.77	31.79	54.10
Multifamily	3.20	19.55	36.11
Commercial	9.29	49.45	78.04
Total	**18.27**	**100.79**	**168.25**

5.2.2 Carbon savings

As seen in Figure 5-5 and Table 5-5 the commercial sector accounts for 58% of the total achievable GHG savings in 2035, while residential and multifamily account for 11% and 9% respectively. We see this shift in proportions as we move from demand to GHG because the GHG calculation takes into account total energy and demand saved each year. Therefore, sectors with higher energy savings but proportionally lower demand savings will have higher GHG potential. See the discussion of GHG savings in section 4 for more information on how these estimates are calculated.

Figure 5-5. Energy Efficiency: Cumulative achievable GHG by sector

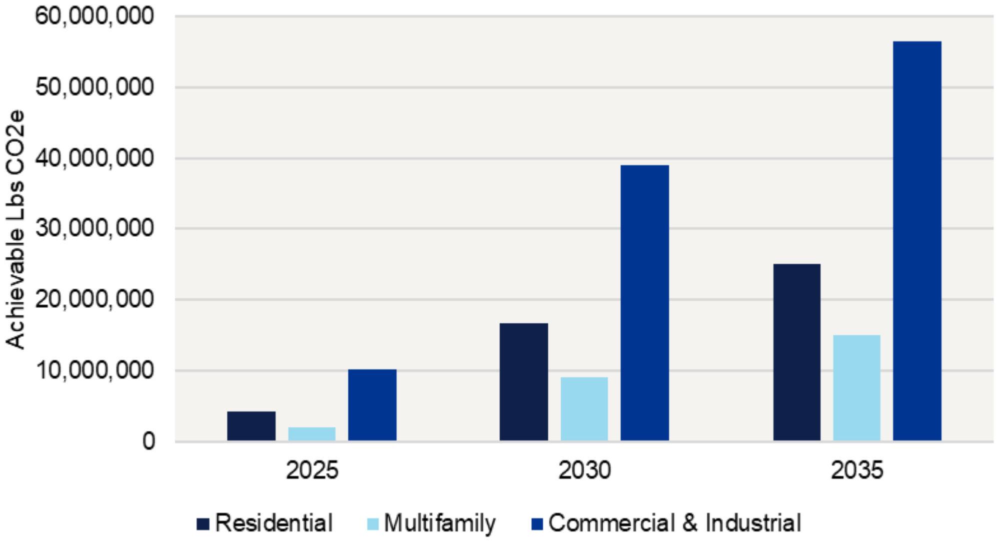


Table 5-5. Energy Efficiency: Cumulative achievable GHG by sector

Sector	2025	2030	2035
Residential	4,304,593	16,715,193	25,158,895
Multifamily	2,053,053	9,016,059	15,038,397
Commercial	10,292,690	38,946,338	56,478,732
Total	**16,650,336**	**64,677,589**	**96,676,024**

5.2.3 Program costs

Total program spending, shown in Figure 5-6 and Table 5-6, including incentives, marketing, and administration budgets across the energy efficiency portfolio is approximately 19 million dollars in 2035. This equates to an average $/kW of $1,739 in 2035 up from $1,003 in 2025 as potential shifts away from low-cost measures like lighting and toward higher-cost measures like HVAC retrofits.

The commercial sector is responsible for approximately 24% of the total cost in 2025, while residential and multifamily account for 57% and 19% respectively. Also note that while commercial accounts for only 24% of the spending, it accounts for 46% of the total MW in 2035, making it the most cost-effective of the three sectors.

Figure 5-6. Energy Efficiency: Annual program spending by sector

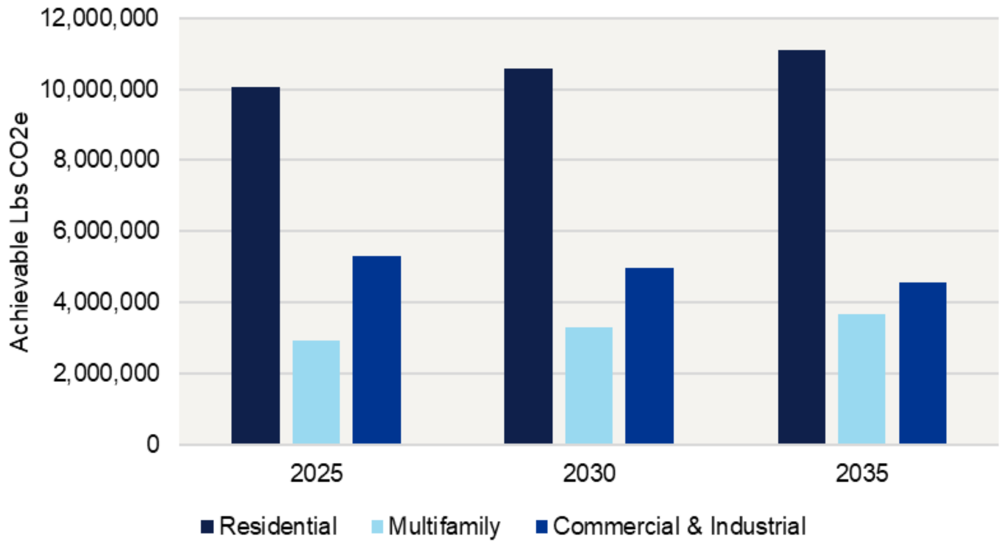


Table 5-6. Energy Efficiency: Annual program spending by sector

Sector	2025	2030	2035
Residential	$10,059,764	$10,582,789	$11,089,477
Multifamily	$2,943,116	$3,311,294	$3,678,232
Commercial & Industrial	$5,308,949	$4,983,248	$4,543,677
Total annual spend	**$18,311,828**	**$18,877,331**	**$19,311,387**
Annual (incremental) MW	18.27	15.27	11.10
Average $/kW over time	***$1,003***	***$1,236***	***$1,739***

5.2.4 Recommendations

These results represent a reduction in LED-related savings, with no additional screw-based LEDs being available in the programs before the study period and a cessation of program savings from linear LEDs starting in 2029. Lighting has a larger impact on commercial peak demand savings as commercial lighting is more coincident with summer peak whereas lighting impacts program-attributable GHG savings in both the residential and commercial sectors.

Relatively low avoided costs limit the available potential. Low avoided costs create a challenging environment for DSM programs and measures to demonstrate cost-effectiveness in terms of the TRC. Low avoided costs also lead to low customer retail rates, which means less cost-effectiveness in terms of the participant test and a less compelling value proposition for customer adoption. Further, measures that provide high MW savings may not provide commensurate energy savings, which drives customer savings, particularly in the residential sector, further limiting available potential despite the measure’s ability to impact peak demand savings.

Among residential measures targeting existing buildings, the largest share of savings come from measures that reduce cooling use in homes. This is unsurprising given the reduction in available lighting savings and the contribution of cooling to peak demand. Measures impacting cooling usage in commercial facilities also comprises a large portion of demand saving potential in the commercial sector, though linear LEDs provide a moderate amount of savings in through 2028. As all program administrators work to transition away from lighting programs, HVAC programs will continue to grow in importance and prevalence.

5.3 Green Building

Austin Energy Green Building developed the first rating system in the U.S. for evaluating the sustainability of buildings, creating a model for many other cities as well as the U.S. Green Building Council's LEED certification system. Since 1991, Green Building has provided ratings and programs, education and outreach, and advocacy and planning. The Green Building analysis was based on Austin Energy's current mix of programs and measures including:

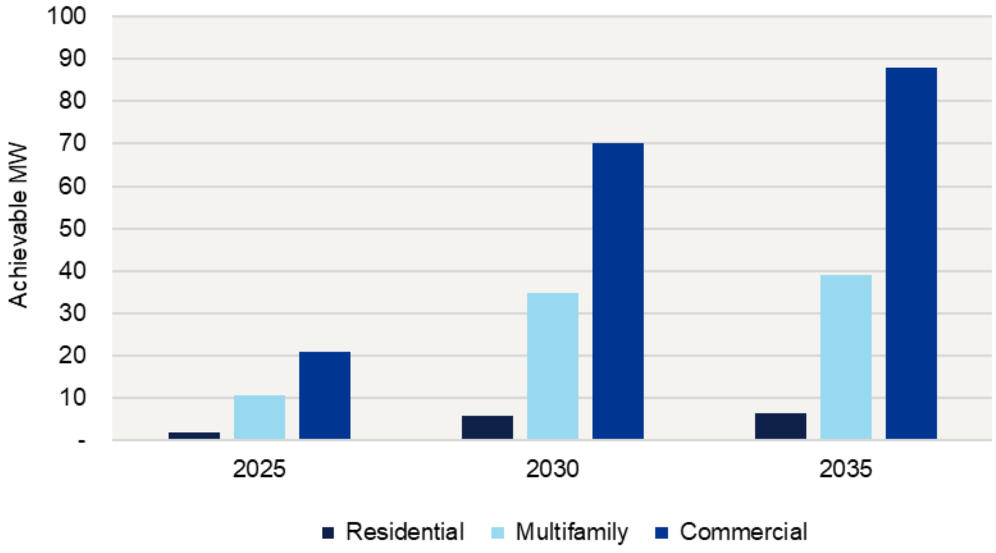
- Residential Ratings - single-family homes, duplexes, and town homes
- Residential Energy Code – new building permits applied to single-family homes, duplexes, and town homes
- Multifamily Ratings - multifamily and mixed used developments up to seven stories tall
- Multifamily Energy Code – new building permits applied to multifamily developments up to seven stories tall
- Commercial Ratings - commercial buildings and multifamily and mixed-use developments over seven stories tall
- Commercial Energy Code – new building permits applied to commercial buildings, and multifamily and mixed-use developments over seven stories tall

In total, the achievable demand reduction for Austin Energy's current green building programs reaches 179 MW in 2035 with an associated GHG savings of 86 million Lbs of CO_2e. In the subsections that follow, we present the demand and carbon savings results by sector including, residential, multifamily, and commercial and industrial.[10]

5.3.1 Demand savings

As shown in Figure 5-7 and Table 5-7, the commercial sector is the largest contributor to green building potential at 48% of the total in 2035 while multifamily and residential contribute 39% and 11% respectively.

Figure 5-7. Green Building: Cumulative achievable MW by sector



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[10] We do not include a section on program costs for Green Building because the program does not include incentives paid to Austin Energy customers.

Table 5-7. Green Building Cumulative achievable MW by sector

Sector	2025	2030	2035
Residential	1.83	10.59	20.93
Multifamily	5.75	34.81	70.19
Commercial	6.31	38.96	87.86
Total	**13.90**	**84.36**	**178.98**

5.3.2 Carbon savings

As seen in Figure 5-8 and Table 5-8, the commercial sector takes on even more GHG potential at 58% of the total in 2035 while multifamily and residential contribute 33% and 8% respectively. We see this shift in proportions as we move from demand to GHG because the GHG calculation considers total energy and demand saved each year.

Figure 5-8. Green Building: Cumulative achievable GHG by sector

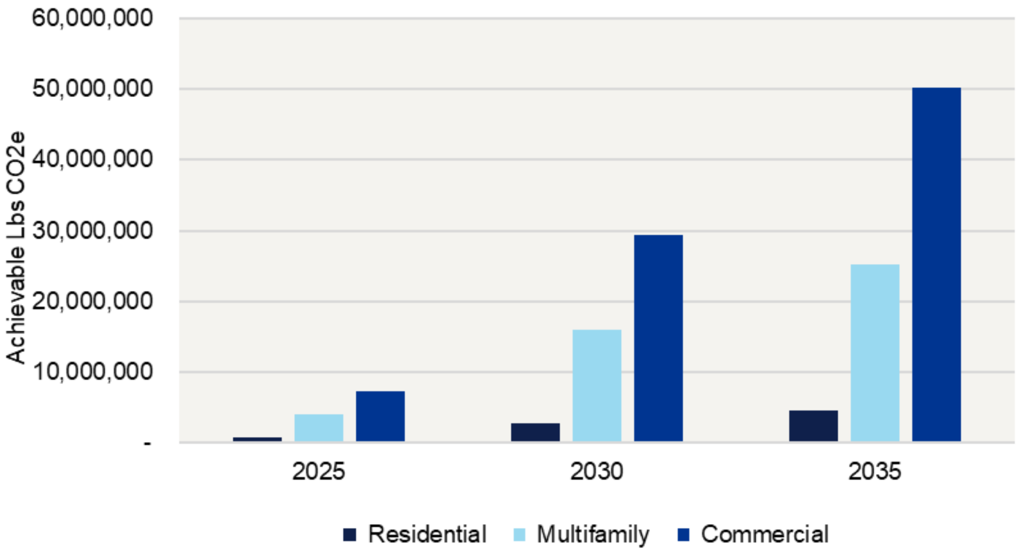


Table 5-8. Green Building: Cumulative achievable GHG by sector

Sector	2025	2030	2035
Residential	786,288	4,036,603	7,207,431
Multifamily	2,806,249	15,936,645	29,364,303
Commercial	4,544,503	25,179,892	50,227,081
Total	**8,137,040**	**45,153,140**	**86,798,815**

5.3.3 Recommendations

Savings from Green Building is lower than what have previously been estimated prior to the Covid-19 pandemic. As a result of changing market conditions fewer new construction opportunities have transpired in the commercial sector. The commercial sector still represents the largest source of potential MW and GHG savings through Green Building despite the changing market conditions.

In addition, in a change from the previous study, only savings from incremental codes were included in the estimates.

5.4 Electrification

The analysis of electrification potential considered the transition of residential natural gas space and water heating technologies to electric space and water heating technologies. The primary driver of potential for electrification is the saturation of natural gas technologies that can be electrified. Natural gas saturations were estimated from City of Austin's Energy Conservation Audit and Disclosure Ordinance, City of Austin Code Chapter 6-7 Energy Conservation data which is collected from residential single-family homes during audits that take place when homes are sold within the Austin Energy service area and within the Austin city limits. The data estimates that approximately 70% of residential homes are gas heated and 74% have gas water heating. The subsections that follow present the demand savings, carbon savings, and program costs for residential space and water heating.

Note that we also included a subsection that presents the estimated GHG from Austin Energy's public charging stations. This information was provided directly to DNV from the Austin Energy program team.

5.4.1 Demand savings

Figure 5-9 and Table 5-9, present the change in demand. Note that for electrification that change is negative, representing an increase in usage during the peak hour as equipment moves from natural gas to electric. The vast majority of the change in demand comes from space heating with a small amount from water heating. Increases during summer peak result from adding cooling where it did not previously exist or adding central AC (via the HP) where it was previously room AC. In addition, the overall change in demand is small, primarily because with the low avoided cost of natural gas ($3/MMBtu) most of the measures are not cost-effective.

Figure 5-9. Electrification: Cumulative achievable MW by end use

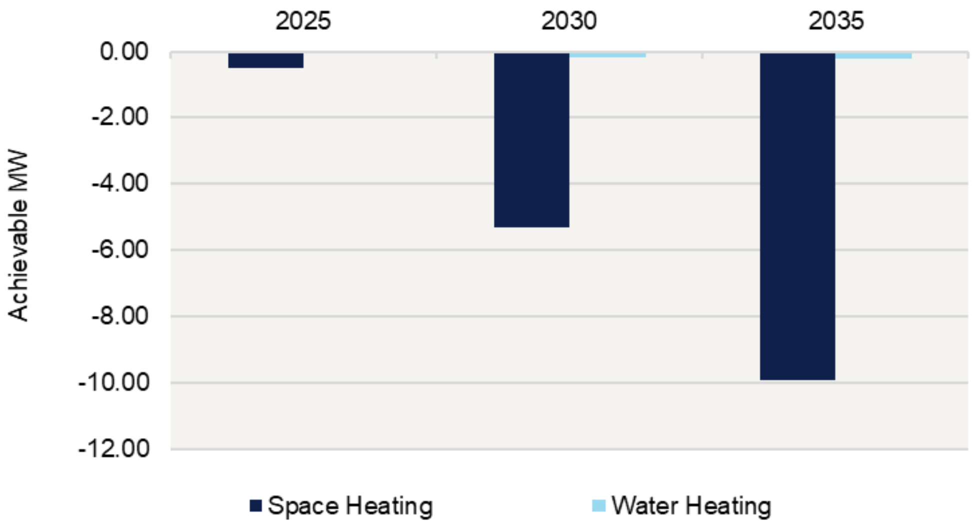


Table 5-9. Electrification: Cumulative achievable MW by end use

Sector	2025	2030	2035
Space heating	-0.50	-5.29	-9.92
Water heating	-0.01	-0.18	-0.23
Total	**-0.51**	**-5.48**	**-10.15**

5.4.2 Carbon savings

Figure 5-10 and Table 5-10 present the change in carbon emissions which follows the same pattern as the change in demand with space heat being responsible for the vast majority of the savings. Here, the change is positive and quite substantial in comparison to other programs despite the small demand savings because the avoided GHG considers the elimination of natural gas consumption for that end use.

Figure 5-10. Electrification: Cumulative achievable GHG by end use

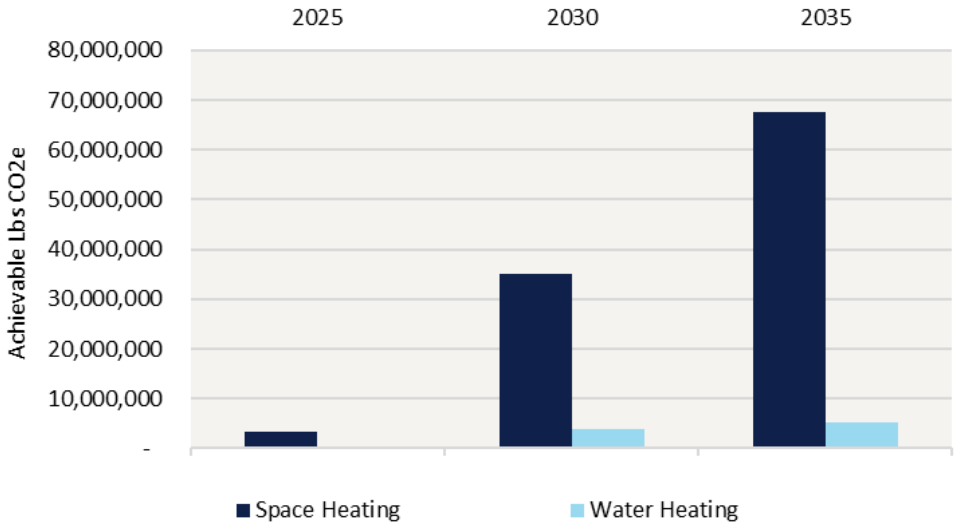


Table 5-10. Electrification: Cumulative achievable GHG by end use

Sector	2025	2030	2035
Space heating	3,259,248	35,162,017	67,741,379
Water heating	238,054	3,937,897	5,240,063
Total	**3,497,303**	**39,099,913**	**72,981,442**

5.4.3 Program costs

Figure 5-11 and Table 5-11 present the annual program costs which grow quickly through 2030 and then fall sharply in 2035 as most of the cost-effective equipment replacements have already occurred.

Figure 5-11. Electrification: Annual program costs by end use

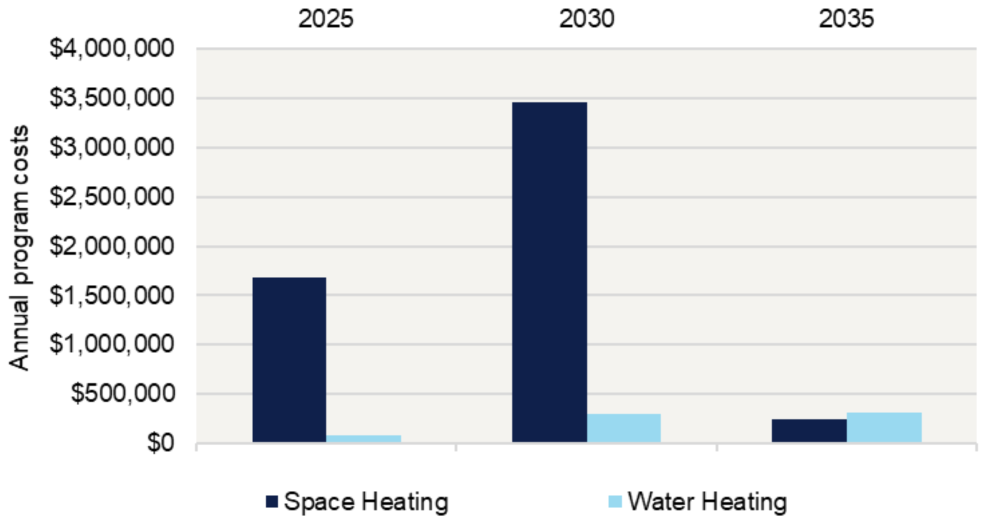


Table 5-11. Electrification: Annual program costs by end use

End use	2025	2030	2035
Space heating	$1,677,489	$3,462,935	$250,295
Water heating	$89,824	$301,020	$314,618
Total	**$1,767,313**	**$3,763,955**	**$564,913**
Annual MW	-0.51	-1.23	-0.74
$/kW	***-$3,453.01***	***-$3,053.20***	***-$760.85***

5.4.4 Recommendations

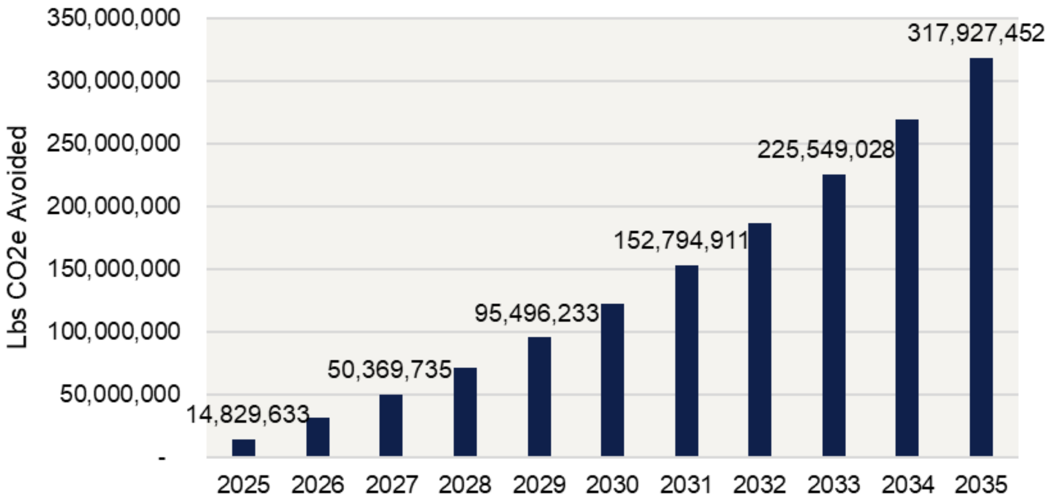
Currently, the electrification of space and water heating has limited potential due to very low avoided costs for natural gas. As such, these measures will struggle to gain traction, especially in existing homes where retrofits are needed. However, the electrification of new construction through Green Building or another efficient home program would be more feasible, particularly if avoided carbon savings are included as benefits during the financial analysis. Targeting electrification promotions to reach customers who complete weatherization retrofits through existing efficiency programs can also ensure customers who have well-equipped facilities and thus a better benefit-cost for electrification receive the appropriate marketing. Similarly, targeting marketing and outreach efforts on customers with delivered fuel service will also improve program cost-effectiveness and the likelihood of customer adoption as the economics of electrification are more advantageous for these customers.

Electrification of space and water heating would also increase load during winter months, specifically at the time of the winter peak. However, these same loads would also be good candidates for winter peaking demand response and so have some capability to offset their own load impacts.

5.4.5 Electric Vehicle Public Charging carbon savings

In Figure 5-12 below, we present the estimated GHG savings from Austin Energy's public charging program. The savings are assumed to grow steadily over the time period at 1% per year starting at just over 14 million pounds avoided and ramping up to more than 300 million pounds avoided.

Figure 5-12. Electrification: Annual program costs by end use



5.5 Solar installations

The analysis of solar installations was based on technology types (configurations) and included standalone solar PV, solar PV + battery storage, and the standard offer community solar program. Solar for all rebates and participants were included as part of the standalone solar PV group. We have summarized the results in this section to include:

- Solar only
- Solar plus battery
- Standard offer

It is important to note that the solar plus battery installation type includes savings from solar PV only and excludes any demand or GHG savings from the batteries. Batteries and their associated savings were considered within the demand response analysis.

In total, the achievable demand reduction for Austin Energy's solar installations will reach 279 MW in 2035, with an associated GHG savings of 151 million Lbs of CO2e. In the subsections that follow, we present the demand and carbon savings results and the annual program costs by installation type, including solar only, solar plus battery, and standard offer.

5.5.1 Demand savings

As shown in Figure 5-13 and Table 5-12, solar only is by far the largest contributor to solar program potential at 66% of the total in 2035. This represents a reduction from 71% of installations in 2025 as more customers choose a solar plus battery installation over the next 10 years. Solar plus battery accounts for about 22% of the total potential in

2035 while standard offer accounts for 11%. While these numbers represent all customer types, the percentage of residential customers that are projected to install solar plus battery systems is greater than 22% and continues to increase over time.

Figure 5-13. Solar: Cumulative achievable MW by installation type

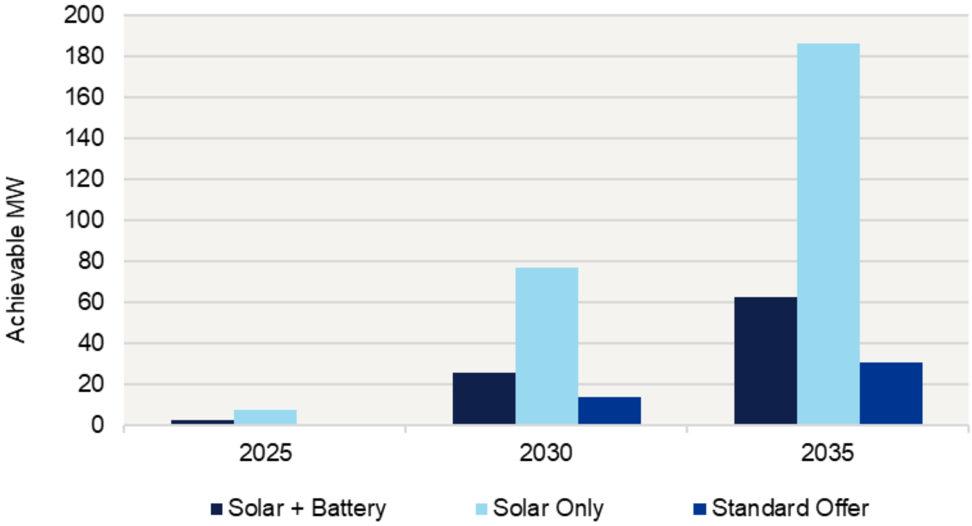


Table 5-12. Solar: Cumulative achievable MW by installation type

Installation type	2025	2030	2035
Solar + battery	2.24	25.40	62.51
Solar only	7.19	77.03	186.33
Standard offer	0.75	13.65	30.65
Total	**10.18**	**116.08**	**279.49**

5.5.2 Carbon savings

As seen in Figure 5-14 and Table 5-13, again, solar only is the largest overall contributor with 73% of the total GHG in 2035 while solar plus battery and standard offer contribute 15% and 10% respectively.

Figure 5-14. Solar: Cumulative achievable GHG by installation type

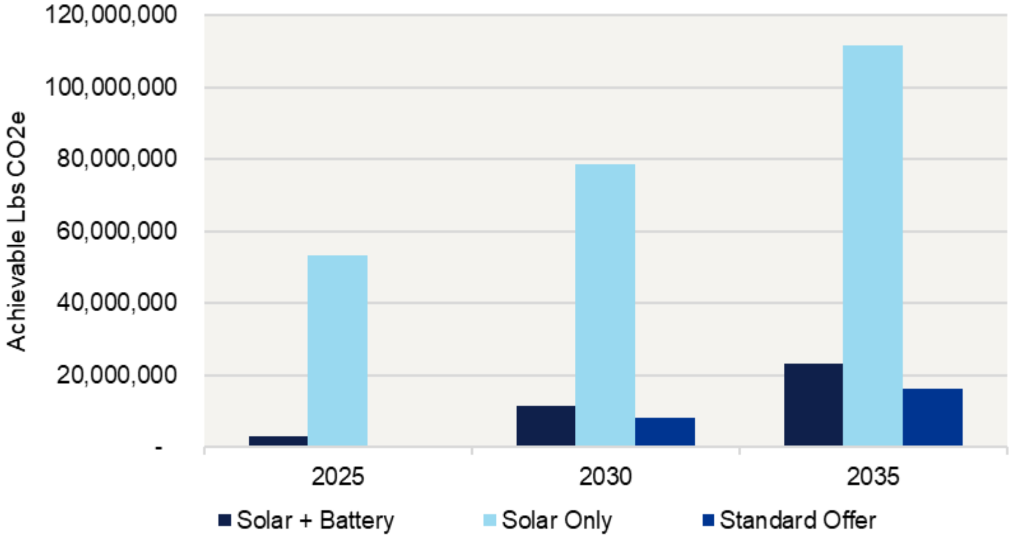


Table 5-13. Solar: Cumulative achievable GHG by installation type

Installation type	2025	2030	2035
Solar + battery	2,934,979	11,597,757	23,113,445
Solar only	53,399,521	78,598,265	111,635,757
Standard offer	506,819	8,195,410	16,407,821
Total	**56,841,318**	**98,391,432**	**151,157,023**

5.5.3 Program costs

As shown in Figure 5-15 and Table 5-14, solar only and standard offer are the costliest installation types. Solar only represents 79% of the cost and 66% of MW while the solar + battery represents 20% of the cost and 22% of MW. The costs for the standard offer program are zero in our analysis because rather than one-time rebates (like solar only or solar + battery) standard offer incentives are paid in the form of a tariff and are recouped by Austin Energy using a revenue neutral rate design. Therefore, they are not true costs from a programmatic perspective.[11]

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[11] While there are budgets for program administration and marketing, they are small relative to the incentive costs and are shared across the whole solar portfolio rather than broken across offerings. As such they were not included in the analysis.

Figure 5-15. Solar: Annual program spending by installation type

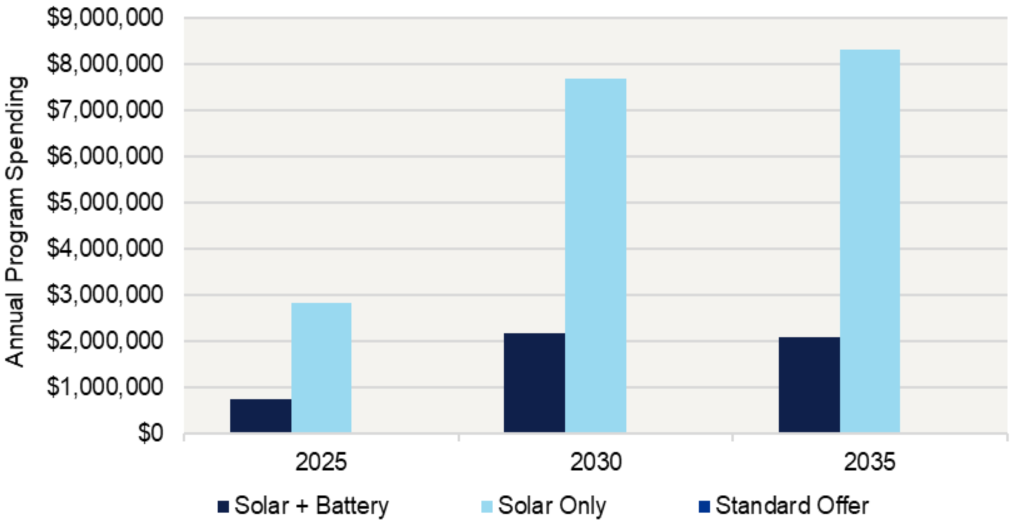

Table 5-14. Solar: Annual program spending by installation type

Installation type	2025	2030	2035
Solar + Battery	$745,284	$2,156,761	$2,095,236
Solar Only	$2,822,963	$7,688,694	$8,307,055
Standard Offer	$0	$0	$0
Total	**$3,568,247**	**$9,845,455**	**$10,402,291**
Annual MW	10.18	27.41	36.66
$/kW	***$351***	***$359***	***$284***

5.5.4 Recommendations

Overall, forecasted solar adoption follows historical patterns, but increases most significantly in the near term (2025-2030). Battery storage is expected to increase as an addition to solar installations, even without incentives driving adoption. Future battery storage incentives could work to promote the adoption of battery systems that could participate in demand response programs, while also pushing more customers to adopt solar PV which could assist in demand reduction for Austin Energy.

Technical constraints such as available hosting capacity on select circuits could limit achievable potential over time. Therefore, increasing hosting capacity on circuits in advance of identified constraints and aligned with load growth upgrades will likely be required to achieve full demand reduction potential from all solar programs. Further, the continued adoption of solar plus battery systems could potentially assist in alleviating future hosting capacity constraints as long as adequate visibility and battery dispatch measures align with local grid operations.

5.6 Demand Response

The analysis of Demand Response was based on both current and new programs. For current programs, the study relied on historical performance to establish impacts and program costs. For new programs, the study leveraged secondary data to develop the impacts and costs. For both new and current programs, the potential was forecasted using achievable participation rates that represent the upper end of actual observed participation rates for mature programs in the industry. The programs included in the study are described briefly below.

- Direct load control of various eligible equipment at the customers' premises including:
  - Smart thermostats (residential and small or medium commercial)
  - Battery (residential)
  - Electric vehicles (residential)
  - Pool pumps (residential)
  - Water heaters (residential)
- Behavioral demand response leveraging requests for voluntary load reduction during events.
- The commercial demand response program is consistent with Austin Energy's existing program and includes both manual and automated response.

Of the programs included, only residential and commercial smart thermostats, residential batteries, and the commercial demand response programs were found to be cost effective. Therefore, only those three program types were carried into the achievable potential results included below.[12]

Demand response capacity for residential and commercial programs included in the study was estimated for the summer peaking season only. We assumed that each season would include 20 2-hour events for a total of 40 summer DR hours. When estimating impacts for existing programs, we aligned the forecasted impacts with the current average 4CP impacts.[13]

In total, the achievable demand reduction for Austin Energy's demand response programs reaches 254 MW in 2035 with an associated GHG savings of just over 3 million Lbs of CO_2e. In the subsections that follow, we present the demand and carbon savings results and the annual program costs by sector.

Note that throughout this section, Austin Energy's existing capacity has been included in the cumulative totals. This results in approximately 17 additional MW being captured below, which was intentionally excluded from the system level results in favor of an apples-to-apples comparison with other program types.

5.6.1 Demand savings

As shown in Figure 5-16 and Table 5-15, residential and commercial contribute relatively evenly to the total demand response potential. Residential contributes 53% of the total potential in 2035 while commercial contributes 47%.

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[12] The three DLC programs did not pass the cost effectiveness screening due to a combination of low coincident impacts (0.06 – 0.34 kW), combined with high equipment or incentive costs required for sustained participation. For the behavioral demand response program, the impacts were simply too small to overcome the costs when looking at this type of program on a stand-alone basis, i.e. without an accompanying home energy report (HER) program.

[13] 4CP – Four Coincident Peak – the average coincident peak demand reading over the four month period of June to September. It is in this four month window when the Electricity Reliability Council of Texas (ERCOT) reaches its highest peaks. Austin Energy runs its DR season based on 4CP. It is how transmission costs are allocated.

Figure 5-16. Demand Response: Cumulative achievable MW by sector

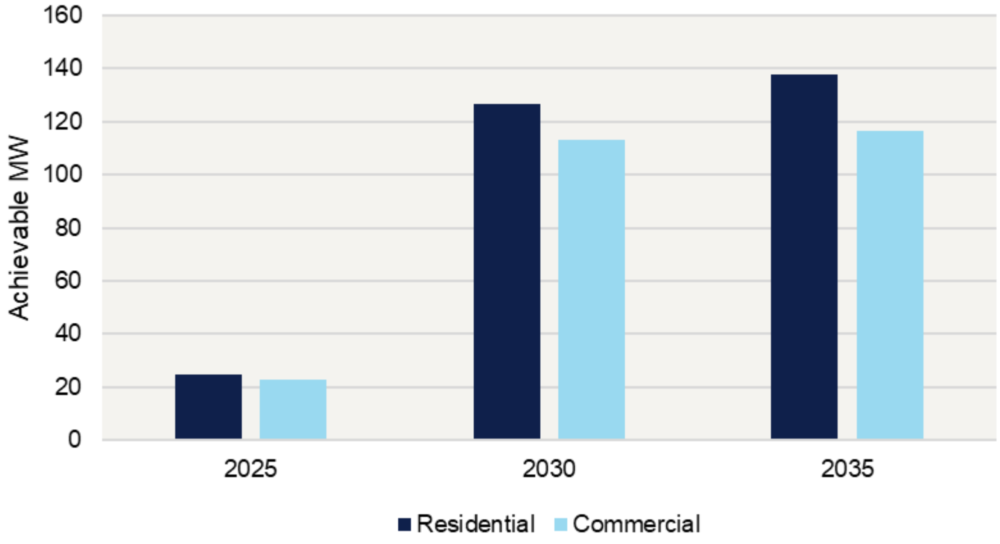


Table 5-15. Demand Response: Cumulative achievable MW by sector

Installation type	2025	2030	2035
Residential	24.59	126.78	137.65
Commercial	22.85	113.13	116.43
Total	**47.44**	**239.92**	**254.08**

5.6.2 Carbon savings

As seen in Figure 5-17 and Table 5-16, again, residential and commercial programs contributed similarly to total GHG potential. The potential for GHG reduction among demand response programs is quite low compared with other program types due to the availability of the program. Demand response resources are only available during events, so for this study we assumed a total of 20 2-hour events each season. While an energy efficiency or solar resource is contributing to a GHG goal in all 8,760 hours of the year, demand response resources are only available to contribute during 40 hours resulting in much lower GHG potential.

Figure 5-17. Demand Response: Cumulative achievable GHG by sector

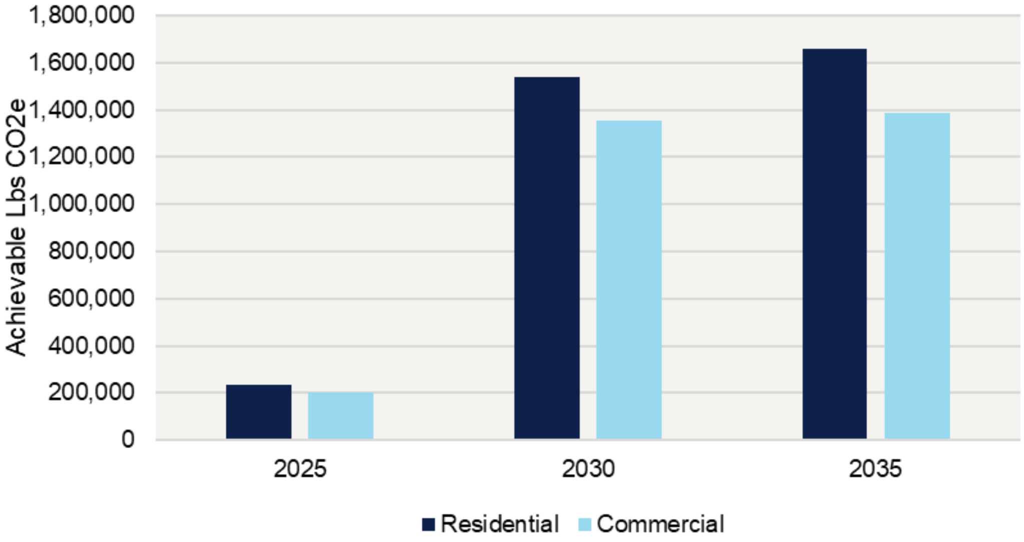


Table 5-16. Demand Response: Cumulative achievable GHG by sector

Installation type	2025	2030	2035
Residential	235,961	1,541,044	1,658,117
Commercial	200,047	1,353,592	1,389,098
Total	**436,009**	**2,894,637**	**3,047,215**

5.6.3 Program costs

As shown in Figure 5-18 and Table 5-17, commercial programs make up a larger portion of the annual program spending relative to residential. This is a result of two primary drivers, 1) commercial customers need higher incentives to participate in a program, and 2) the commercial demand response program assumes a shift from manual to automated participation which is a more costly form of load reduction. In total, the commercial sector accounts for 58% of the costs and 47% of the MW in 2035. It is also important to note that while for other program types, the costs are being compared to incremental capacity, for demand response we compare the costs to total installed capacity since all installed and maintained MW are available for curtailment during the year.

Figure 5-18. Demand Response: Annual program spending by sector

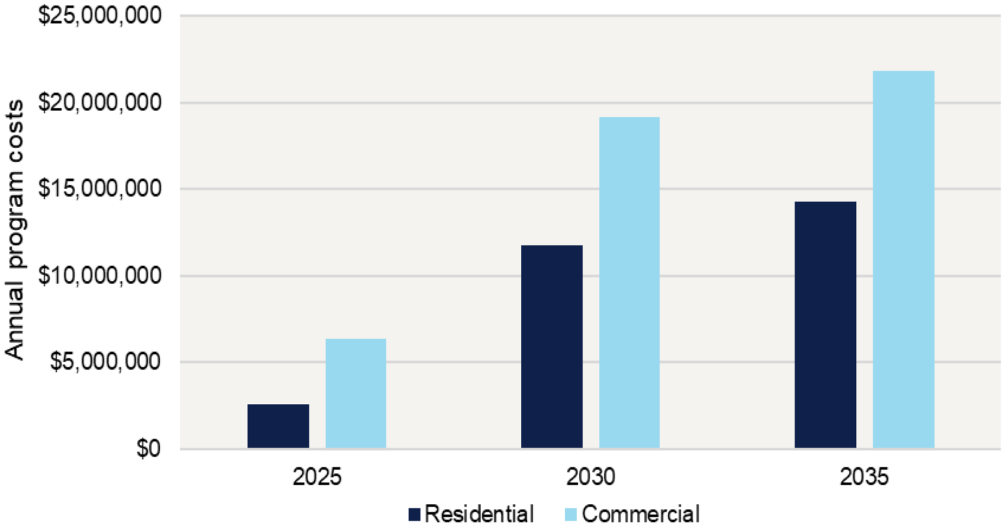


Table 5-17. Demand Response: Annual program spending by sector

Sector	2025	2030	2035
Residential	$2,605,797	$11,794,424	$14,303,468
Commercial	$6,374,757	$19,192,852	$21,841,568
Total	**$8,980,554**	**$30,987,277**	**$36,145,036**
Annual MW	47.44	239.92	254.08
$/kW	***$189.31***	***$129.16***	***$142.26***

5.6.4 Considerations for winter demand response

While winter peaking demand response potential estimation was not part of the scope of this study, DNV did develop several considerations for winter demand response program design and planning. The considerations are separated into the following groups: winter peaking loads, weather-neutral loads, and summer peaking loads.

Winter peaking loads:

- **Space heating** tends to be coincident with morning peaks and both electric forced air furnaces and heat pumps have savings potential although impacts from heat pumps tend to be low, less than 0.5 kW per customer. Heating loads also tend to be less responsive than cooling loads and those running winter demand response note anecdotally that people seem less likely to participate in and respond to winter demand response than summer demand response.
- **Water heating** also tends to be coincident with morning peaks, and like space heating, both traditional electric water heaters and heat pump water heaters have the potential to respond. However, heat pump water heaters have a lower impact, on the order of 0.3 kW per customer or less depending on the type. Unlike electric heating, participation rates for water heating programs tend to be high as the control of water heating is generally not noticed by participants. Water heating programs can also add extra benefits for the utility in terms of ancillary services by leveraging load, frequent events, and short-duration events. In particular, the CTA 2045 water heater is sold grid-ready.

Weather-neutral loads:

- **Electric vehicles** are not likely to be coincident with winter (or summer) peaks; however, these non-weather sensitive impacts are still good targets for year-round programs.
- **Storage**, like electric vehicles, is not weather-sensitive and is a good target for year-round programs. One unique benefit of storage programs is their ability to add extra benefits for the utility in terms of ancillary services by leveraging load increases and load decreases, frequent events, and short-duration events.
- **Pool pump** impacts are not weather sensitive which makes them for year-round programs or permanent load shifts. It should be noted that pump run times are often reduced during the winter and may not be on peak.
- **Commercial demand response** can leverage commercial loads that are not weather-sensitive and will reduce demand year-round. Impacts and participation do tend to be lower in winter months, as evidence from California's year-round capacity bidding program suggests at least a 50% reduction in participating load during winter months.
- **Behavioral demand response** can leverage residential loads that are not weather-sensitive and should be able to provide some load reduction year-round. However, there are few winter-targeted behavioral DR programs to reference so the effect on impacts is uncertain. For estimation purposes, we would recommend at least a 50% reduction in assumed impacts.

Summer peaking loads:

- Space cooling loads are not available and generate zero impacts during the shoulder and winter months.

5.6.5 Recommendations

In terms of load reduction, smart thermostats in residential homes continue to deliver the largest controllable, cost-effective load reduction. The technology is well-proven throughout the industry as a reliable and widely accepted demand response approach. EVs and batteries will grow over time to become a new source of load reduction; however, the penetration of both EVs and batteries is still low compared with electric AC so even in the out years of the study, smart thermostats carry the bulk of the load reduction in the residential sector. Another important consideration around EVs is that, unlike air conditioning, they are not necessarily coincident with the system's summer peak.

Commercial demand response is, from a programmatic perspective, not specific to end uses or building types, and the bidding style program that Austin Energy runs is a best practice within the industry. These types of programs allow for flexibility in response, which is critical to commercial customers while providing reliable reduction and access to controlling and enabling technologies.

Heat pump HVAC and water heating are emerging demand response resources. However, barriers to electrification (particularly in terms of cost-effectiveness) and lower impacts mean that they will deliver smaller impacts than traditional AC load control.

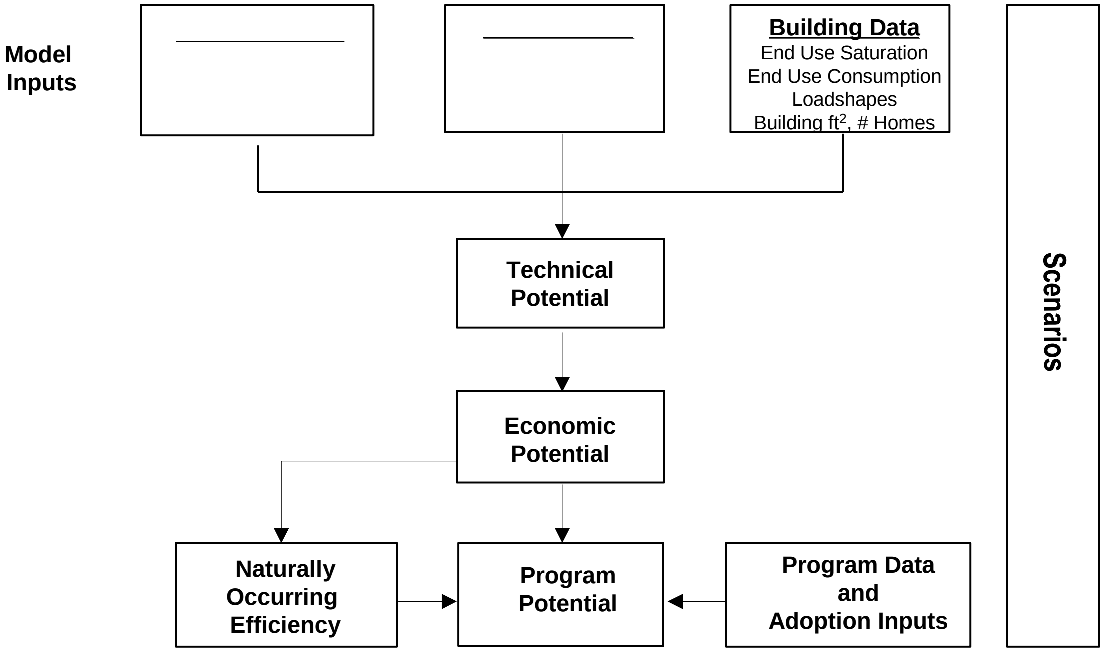
APPENDIX A: DETAILED METHODOLOGY AND MODEL DESCRIPTION

In this appendix we present and discuss our basic methodology for conducting market potential studies. We also present an overview of DSM ASSYST^{TM}, our model used to develop market potential estimates. Information presented here has been extracted from several recent energy efficiency potential reports.

A.1 Overview of DSM Forecasting Method

The crux of any DSM forecasting process involves carrying out a number of systematic analytical steps that are necessary to produce accurate estimates of energy efficiency (EE) effects on system load. A simplified overview of these basic analytical steps is shown in Figure A-1.

Figure A-19. Simplified Conceptual Overview of Modeling Process



Developing a DSM forecast is viewed by DNV as a five-step process. The steps include:

Step 1: Develop Initial Input Data

- Develop list of EE measure opportunities to include in scope
- Gather and develop technical data (costs and savings) on efficient measure opportunities
- Gather, analyze, and develop information on building characteristics, including total square footage and households, electricity consumption and intensity by end use, end-use consumption load patterns by time of day and year (i.e., load shapes), market shares of key electric consuming equipment, and market shares of EE technologies and practices.

Step 2: Estimate Technical Potential and Develop Supply Curves

- Match and integrate data on efficient measures to data on existing building characteristics to produce estimates of technical potential and EE supply curves.

Step 3: Estimate Economic Potential

- Gather economic input data such as current and forecasted retail electric prices and current and forecasted costs of electricity generation, along with estimates of other potential benefits of reducing supply, such as the value of reducing environmental impacts associated with electricity production
- Match and integrate measure and building data with economic assumptions to produce indicators of costs from different viewpoints (e.g., utility, societal, and consumer)
- Estimate total economic potential using supply curve approach

Step 4: Estimate Achievable Program and Naturally Occurring Potentials

- Gather and develop estimates of program costs (e.g., for administration and marketing) and historic program savings
- Develop estimates of customer adoption of EE measures as a function of the economic attractiveness of the measures, barriers to their adoption, and the effects of program intervention
- Estimate achievable program and naturally occurring potentials; calibrate achievable and naturally occurring potential to recent program and market data
- Develop alternative economic estimates associated with alternative future scenarios

Step 5: Scenario Analyses and Resource Planning Inputs

- Recalculate potentials under alternate economic scenarios and deliver data in format required for resource planning.

Provided below is additional discussion of DNV's modeling approaches for technical, economic, and achievable DSM forecasts.

A.1.1 Estimate Technical Potential and Develop Energy-Efficiency Supply Curves

Technical potential refers to the amount of energy savings or peak demand reduction that would occur with the *complete* penetration of all measures analyzed in applications where they were deemed *technically* feasible from an *engineering* perspective. Total technical potential is developed from estimates of the technical potential of individual measures as they are applied to discrete market segments (commercial building types, residential dwelling types, etc.).

A.1.1.1 Core Equation

The core equation used to calculate the energy technical potential for each individual efficiency measure, by market segment, is shown below (using a commercial example):[14]

$$\text{Technical Potential of Efficient Measure} = \text{Total Square Feet} \times \text{Base Case Equipment EUI} \times \text{Applicability Factor} \times \text{Not Complete Factor} \times \text{Feasibility Factor} \times \text{Savings Factor}$$

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[14] Note that stock turnover is not accounted for in our estimates of technical and economic potential, stock turnover *is accounted for* in our estimates of achievable potential. Our definition of technical potential assumes instantaneous replacement of standard-efficiency with high-efficiency measures.

where:

Square feet is the total floor space for all buildings in the market segment. For the residential analysis, the **number of dwelling units** is substituted for square feet.

Base-case equipment EUI is the energy used per square foot by each base-case technology in each market segment. This is the consumption of the energy-using equipment that the efficient technology replaces or affects. For example, if the efficient measure were a CFL, the base EUI would be the annual kWh per square foot of an equivalent incandescent lamp. For the residential analysis, unit energy consumption (UECs), energy used per dwelling, are substituted for EUIs.

Applicability factor is the fraction of the floor space (or dwelling units) that is applicable for the efficient technology in a given market segment; for the example above, the percentage of floor space lit by incandescent bulbs.

Not complete factor is the fraction of applicable floor space (or dwelling units) that has not yet been converted to the efficient measure; that is, (1 minus the fraction of floor space that already has the EE measure installed).

Feasibility factor is the fraction of the applicable floor space (or dwelling units) that is technically feasible for conversion to the efficient technology from an *engineering* perspective.

Savings factor is the percent reduction in energy consumption resulting from application of the efficient technology.

Technical potential for peak demand reduction is calculated analogously.

An example of the core equation is shown in Equation A-1 for the case of a prototypical 4-lamp 4-foot standard T-8 lighting fixture, which is replaced by a 4-lamp 4-foot premium T-8 fixture in the office segment of a large utility service territory.

Equation A-1. Example of Technical Potential Calculation—Replace 4-Lamp 4-Foot Standard T-8s with 4-Lamp 4-Foot Premium T-8s in the Office Segment of a Utility Service Territory
(Note: Data are illustrative only)

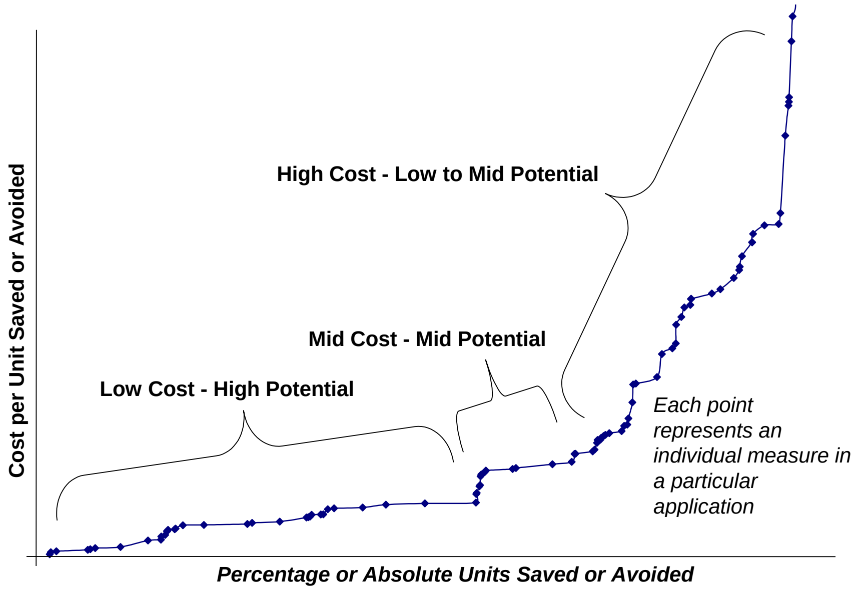
Technical Potential of Efficient Measure	=	Total square feet	×	Base Case Equipment UEC	×	Applicability Factor	×	Not Complete Factor	×	Feasibility Factor	×	Savings Factor
57 million kWh		195 million		5.74		0.34		0.95		1.00		0.16

Technical EE potential is calculated in two steps. In the first step, all measures are treated independently; that is, the savings of each measure are not marginalized or otherwise adjusted for overlap between competing or synergistic measures. By treating measures independently, their relative economics are analyzed without making assumptions about the order or combinations in which they might be implemented in customer buildings. However, the total technical potential across measures cannot be estimated by summing the individual measure potentials directly. The cumulative savings cannot be estimated by adding the savings from the individual savings estimates because some savings would be double counted. For example, the savings from a measure that reduces heat gain into a building, such as window film, are partially dependent on other measures that affect the efficiency of the system being used to cool the building, such as a high-efficiency chiller; the more efficient the chiller, the less energy saved from the application of the window film.

A.1.1.2 Use of Supply Curves

In the second step, cumulative technical potential is estimated using an EE supply curve approach.[15] This method eliminates the double-counting problem. In Figure A-2, we present a generic example of a supply curve. As shown in the figure, a supply curve typically consists of two axes—one that captures the cost per unit of saving a resource or mitigating an impact (e.g., $/kWh saved or $/ton of carbon avoided) and the other that shows the amount of savings or mitigation that could be achieved at each level of cost. The curve is typically built up across individual measures that are applied to specific base-case practices or technologies by market segment. Savings or mitigation measures are sorted on a least-cost basis, and total savings or impacts mitigated are calculated incrementally with respect to measures that precede them. Supply curves typically, but not always, end up reflecting diminishing returns, i.e., as costs increase rapidly and savings decrease significantly at the end of the curve.

Figure A-20. Generic Illustration of EE Supply Curve



As noted above, the cost dimension of most EE supply curves is usually represented in dollars per unit of energy savings. Costs are usually annualized (often referred to as "levelized") in supply curves. For example, EE supply curves usually present levelized costs per kWh or kW saved by multiplying the initial investment in an efficient technology or program by the "capital recovery rate" (CRR):

$$\mathrm{CRR} = \frac{d}{1-(1+d)^{-n}}$$

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[15] This section describes conservation supply curves as they have been defined and implemented in numerous studies. Readers should note that Stoft 1995 describes several technical errors in the definition and implementation of conservation supply curves in the original and subsequent conservation supply curve studies. Stoft concludes that conservation supply curves are not "true" supply curves in the standard economic sense but can still be useful (albeit with his recommended improvements) for their intended purpose (demonstration of cost-effective conservation opportunities).

where d is the real discount rate and n is the number of years over which the investment is written off (i.e., amortized).

Thus,

Levelized Cost per kWh Saved = Initial Cost x CRR/Annual Energy Savings

Levelized Cost per kW Saved = Initial Cost x CRR/Peak Demand Savings

The levelized cost per kWh and kW saved are useful because they allow simple comparison of the characteristics of EE with the characteristics of energy supply technologies. However, the levelized cost per kW saved is a biased indicator of cost-effectiveness because all of the efficiency measure costs are arbitrarily allocated to peak savings.

Returning to the issue of EE supply curves, Table A-1 shows a simplified numeric example of a supply curve calculation for several EE measures applied to commercial lighting for a hypothetical population of buildings. What is important to note is that in an EE supply curve, the measures are sorted by relative cost—from least to most expensive. In addition, the energy consumption of the system being affected by the efficiency measures goes down as each measure is applied. As a result, the savings attributable to each subsequent measure decrease if the measures are interactive. For example, the occupancy sensor measure shown in Table A-1 would save more at less cost per unit saved if it were applied to the base-case consumption before the T8 lamp and electronic ballast combination. Because the T8 electronic ballast combination is more cost-effective, however, it is applied first, reducing the energy savings potential for the occupancy sensor. Thus, in a typical EE supply curve, the base-case end-use consumption is reduced with each unit of EE that is acquired. Notice in Table A-1 that the total end-use GWh consumption is recalculated after each measure is implemented, thus reducing the base energy available to be saved by the next measure.

Table A-1 shows an example that would represent measures for one base-case technology in one market segment. These calculations are performed for all of the base-case technologies, market segments, and measure combinations in the scope of a study. The results are then ordered by levelized cost and the individual measure savings are summed to produce the EE potential for the entire sector.

In the next subsection, we discuss how economic potential is estimated as a subset of the technical potential.

Table A-18. Sample Technical Potential Supply Curve Calculation for Commercial Lighting (Note: Data are illustrative only)

Measure	Total End Use Consumption of Population (GWh)	Applicable, Not Complete and Feasible (1000s of ft^2)	Average kWh/ft^2 of population	Savings %	GWh Savings	Levelized Cost ($/kWh saved)
Base Case: T12 lamps with Magnetic Ballast	425	100,000	4.3	N/A	N/A	N/A
1. T8 w. Elec. Ballast	425	100,000	4.3	21%	89	$0.04
2. Occupancy Sensors	336	40,000	3.4	10%	13	$0.11
3. Perimeter Dimming	322	10,000	3.2	45%	14	$0.25

With all measures	309		3.1	27%	116	

A.1.2 Estimation of Economic Potential

Economic potential is typically used to refer to the technical potential of those energy conservation measures that are cost effective when compared to either supply-side alternatives or the price of energy. Economic potential takes into account the fact that many EE measures cost more to purchase initially than do their standard-efficiency counterparts. The incremental costs of each efficiency measure are compared to the savings delivered by the measure to produce estimates of energy savings per unit of additional cost. These estimates of EE resource costs can then be compared to estimates of other resources such as building and operating new power plants.

A.1.2.1 Cost Effectiveness Tests

To estimate economic potential, it is necessary to develop a method by which it can be determined that a measure or program is economic. There is a large body of literature that debates the merits of different approaches to calculating whether a public purpose investment in EE is cost effective (Chamberlin and Herman 1993, RER 2000, Ruff 1988, Stoft 1995, and Sutherland 2000). We usually utilize the total resource cost (TRC) test to assess cost effectiveness. The TRC is a form of societal benefit-cost test. Other tests that have been used in analyses of program cost-effectiveness by EE analysts include the utility cost, ratepayer impact measure (RIM), and participant tests. These tests are discussed in detail the California Standard Practice Manual (CASPM).

Before discussing the TRC test and how it is often used in our DSM forecasts, we present below a brief introduction to the basic tests as described in the CASPM:[16]

- Total Resource Cost Test—The TRC test measures the net costs of a demand-side management program as a resource option based on the total costs of the program, including both the participants' and the utility's costs. The test is applicable to conservation, load management, and fuel substitution programs. For fuel substitution programs, the test measures the net effect of the impacts from the fuel not chosen versus the impacts from the fuel that is chosen as a result of the program. TRC test results for fuel substitution programs should be viewed as a measure of the economic efficiency implications of the total energy supply system (gas and electric). A variant on the TRC test is the societal test. The societal test differs from the TRC test in that it includes the effects of externalities (e.g. environmental, national security), excludes tax credit benefits, and uses a different (societal) discount rate.
- Participant Test—The participant test is the measure of the quantifiable benefits and costs to the customer due to participation in a program. Since many customers do not base their decision to participate in a program entirely on quantifiable variables, this test cannot be a complete measure of the benefits and costs of a program to a customer.
- Utility (Program Administrator) Test—The program administrator cost test measures the net costs of a demand-side management program as a resource option based on the costs incurred by the program administrator (including incentive costs) and excluding any net costs incurred by the participant. The benefits are similar to the TRC benefits. Costs are defined more narrowly.

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[16] These definitions are direct excerpts from the California Standard Practice Manual, October 2001.

- Ratepayer Impact Measure Test—The ratepayer impact measure (RIM) test measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by the program. Rates will go down if the change in revenues from the program is greater than the change in utility costs. Conversely, rates or bills will go up if revenues collected after program implementation are less than the total costs incurred by the utility in implementing the program. This test indicates the direction and magnitude of the expected change in customer bills or rate levels.

The key benefits and costs of the various cost-effectiveness tests are summarized in Table A-2.

Table A-19. Summary of Benefits and Costs of California Standard Practice Manual Tests

Test	Benefits	Costs
TRC Test	Generation, transmission and distribution savings Participants avoided equipment costs (fuel switching only)	Generation costs Program costs paid by the administrator Net participant measure costs
Participant Test	Bill reductions Incentives Participants avoided equipment costs (fuel switching only)	Bill increases Participant measure costs
Utility (Program Administrator) Test	Generation, transmission and distribution savings	Generation costs Program costs paid by the administrator Incentives
Ratepayer Impact Measure Test	Generation, transmission and distribution savings Revenue gain	Generation costs Revenue loss Program costs paid by the administrator Incentives

Generation, transmission and distribution savings (hereafter, energy benefits) are defined as the economic value of the energy and demand savings stimulated by the interventions being assessed. These benefits are typically measured as induced changes in energy consumption, valued using some mix of avoided costs. Electricity benefits are valued using three types of avoided electricity costs: avoided distribution costs, avoided transmission costs, and avoided electricity generation costs.

Participant costs are comprised primarily of incremental measure costs. Incremental measure costs are essentially the costs of obtaining EE. In the case of an add-on device (say, an adjustable-speed drive or ceiling insulation), the incremental cost is simply the installed cost of the measure itself. In the case of equipment that is available in various levels of efficiency (e.g., a central air conditioner), the incremental cost is the excess of the cost of the high-efficiency unit over the cost of the base (reference) unit.

Administrative costs encompass the real resource costs of program administration, including the costs of administrative personnel, program promotions, overhead, measurement and evaluation, and shareholder incentives. In this context, administrative costs are not defined to include the costs of various incentives (e.g., customer rebates and salesperson incentives) that may be offered to encourage certain types of behavior. The exclusion of these incentive costs reflects the fact that they are essentially transfer payments. That is, from a societal perspective they involve offsetting costs (to the program administrator) and benefits (to the recipient).

A.1.2.2 Use of the Total Resource Cost to Estimate Economic Potential

We often use the TRC test in two ways in our model. First, we develop an estimate of economic potential by calculating the TRC of individual measures and applying the methodology described below. Second, we develop estimates of whether different program scenarios are cost effective.

Economic potential can be defined either inclusively or exclusively of the costs of programs that are designed to increase the adoption rate of EE measures. In many of our projects, we define economic potential to exclude program costs. We do so primarily because program costs are dependent on a number of factors that vary significantly as a function of program delivery strategy. There is no single estimate of program costs that would accurately represent such costs across the wide range of program types and funding levels possible. Once an assumption is made about program costs, one must also link those assumptions to expectations about market response to the types of interventions assumed. Because of this, we believe it is more appropriate to factor program costs into our analysis of program potential. Thus, our definition of economic potential is that portion of the technical potential that passes our economic screening test (described below) exclusive of program costs. Economic potential, like technical potential, is a theoretical quantity that will exceed the amount of potential we estimate to be achievable through current or more aggressive program activities.

As implied in Table A-2 and defined in the CASPM 2001, the TRC focuses on resource savings and counts benefits as utility-avoided supply costs and costs as participant costs and utility program costs. It ignores any impact on rates. It also treats financial incentives and rebates as transfer payments; i.e., the TRC is not affected by incentives. The somewhat simplified benefit and cost formulas for the TRC are presented in Equations A-2 and A-3 below.

Equation A-2

$$\text{Benefits} = \sum_{t=1}^{N} \frac{\text{Avoided Costs of Supply}_{p,t}}{(1+d)^{t-1}}$$

Equation A-3

$$\text{Costs} = \sum_{t=1}^{N} \frac{\text{Program Cost}_t + \text{Participant Cost}_t}{(1+d)^{t-1}}$$

Where:

d = the discount rate
p = the costing period
t = time (in years)
n = 20 years

A nominal discount rate is typically used in the analysis, as inflation is taken into account separately.

The avoided costs of supply are calculated by multiplying measure energy savings and peak demand impacts by per-unit avoided costs by costing period. Energy savings are allocated to costing periods and peak impacts estimated using load shape factors.

As noted previously, in the measure-level TRC calculation used to estimate economic potential, program costs are excluded from Equation A-3. Using the supply curve methodology discussed previously, measures are ordered by

TRC (highest to lowest) and then the economic potential is calculated by summing the energy savings for all of the technologies for which the marginal TRC test is greater than 1.0. In the example in Table A-3, the economic potential would include the savings for measures 1 and 2, but exclude saving for measure 3 because the TRC is less than 1.0 for measure 3. The supply curve methodology, when combined with estimates of the TRC for individual measures, produces estimates of the economic potential of efficiency improvements. By definition and intent, this estimate of economic potential is a theoretical quantity that will exceed the amount of potential we estimate to be achievable through program activities in the final steps of our analyses.

Table A-20. Sample Use of Supply Curve Framework to Estimate Economic Potential

(Note: Data are illustrative only)

Measure	**Total End Use Consumption of Population (GWh)**	**Applicable, Not Complete and Feasible Sq.Feet (000s)**	**Average kWh/ft^2 of population**	**Savings %**	**GWh Savings**	**Total Resource Cost Test**	**Savings Included in Economic Potential?**
Base Case: T12 lamps with Magnetic Ballast	425	100,000	4.3	N/A	N/A	N/A	N/A
1. T8 w. Elec. Ballast	425	100,000	4.3	21%	89	2.5	Yes
2. Occupancy Sensors	336	40,000	3.4	10%	13	1.3	Yes
3. Perimeter Dimming	322	10,000	3.2	45%	14	0.8	No
Technical Potential with all measures				27%	116		
Economic Potential with measures for which TRC Ratio > 1.0				24%	102		

A.1.3 Estimation of Program and Naturally occurring Potentials

In this section we present the method we employ to estimate the fraction of the market that adopts each EE measure in the presence and absence of EE programs. We define:

- Program potential as the amount of savings that would occur in response to one or more specific market interventions
- Naturally occurring potential as the amount of savings estimated to occur as a result of normal market forces, that is, in the absence of any utility or governmental intervention.

Our estimates of program potential are typically the most important results of the modeling process. Estimating technical and economic potentials are necessary steps in the process from which important information can be obtained; however, the end goal of the process is better understanding how much of the remaining potential can be captured in programs, whether it would be cost-effective to increase program spending, and how program costs may be expected to change in response to measure adoption over time.

A.1.3.1 Adoption Method Overview

We use a method of estimating adoption of EE measures that applies equally to be our program and naturally occurring analyses. Whether as a result of natural market forces or aided by a program intervention, the rate at which measures are adopted is modeled in our method as a function of the following factors:

- The availability of the adoption opportunity as a function of capital equipment turnover rates and changes in building stock over time
- Customer awareness of the efficiency measure
- The cost-effectiveness of the efficiency measure
- Market barriers associated with the efficiency measure

The method we employ is executed in the measure penetration module of DNV's DSM ASSYST™ model.

In many of our projects, only measures that pass the measure-level TRC test are put into the penetration module for estimation of customer adoption.

A.1.3.2 Availability

A crucial part of the model is a stock accounting algorithm that handles capital turnover and stock decay over a period of up to 20 years. In the first step of our achievable potential method, we calculate the number of customers for whom each measure will apply. The input to this calculation is the total floor space available for the measure from the technical potential analysis, i.e., the total floor space multiplied by the applicability, not complete, and feasibility factors described previously. We call this the eligible stock. The stock algorithm keeps track of the amount of floor space available for each efficiency measure in each year based on the total eligible stock and whether the application is new construction, retrofit, or replace-on-burnout.[17]

Retrofit measures are available for implementation by the entire eligible stock. The eligible stock is reduced over time as a function of adoptions[18] and building decay.[19] Replace-on-burnout measures are available only on an annual basis, approximated as equal to the inverse of the service life.[20] The annual portion of the eligible market that does not accept the replace-on-burnout measure does not have an opportunity again until the end of the service life.

New construction applications are available for implementation in the first year. Those customers that do not accept the measure are given subsequent opportunities corresponding to whether the measure is a replacement or retrofit-type measure.

A.1.3.3 Awareness

In our modeling framework, customers cannot adopt an efficient measure merely because there is stock available for conversion. Before they can make the adoption choice, they must be aware and informed about the efficiency measure. Thus, in the second stage of the process, the model calculates the portion of the available market that is informed. An initial user-specified parameter sets the initial level of awareness for all measures. Incremental awareness occurs in the model as a function of the amount of money spent on awareness/information building and how costly it is to reach each customer.

The model also controls for information retention. An information decay parameter in the model is used to control for the percentage of customers that will retain program information from one year to the next. Information retention is

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[17] Replace-on-burnout measures are defined as the efficiency opportunities that are available only when the base equipment turns over at the end of its service life. For example, a high-efficiency chiller measure is usually only considered at the end of the life of an existing chiller. By contrast, retrofit measures are defined to be constantly available, for example, application of a window film to existing glazing.

[18] That is, each square foot that adopts the retrofit measure is removed from the eligible stock for retrofit in the subsequent year, and remains out of the eligible stock until the end of the measure's useful life.

[19] Buildings do not last forever. An input to the model is the rate of decay of the existing floor space. Floor space typically decays at a very slow rate.

[20] For example, a base-case technology with a service life of 15 years is only available for replacement to a high-efficiency alternative each year at the rate of 1/15 times the total eligible stock. For example, the fraction of the market that does not adopt the high-efficiency measure in year *t* will not be available to adopt the efficient alternative again until year *t* + 15.

based on the characteristics of the target audience and the temporal effectiveness of the marketing techniques employed.

A.1.3.4 Adoption

The portion of the total market this is available and informed can now face the choice of whether or not to adopt a particular measure. Only those customers for whom a measure is available for implementation (stage 1) and, of those customers, only those who have been informed about the program/measure (stage 2), are in a position to make the implementation decision.

In the third stage of our penetration process, the model calculates the fraction of the market that adopts each efficiency measure as a function of the participant test. The participant test is a benefit-cost ratio that is generally calculated as follows:

Equation A-4

$$\text{Benefits} = \sum_{t=1}^{N} \frac{\text{Customer Bill Savings (\$)}_t}{(1+d)^{t-1}}$$

Equation A-5

$$\text{Costs} = \sum_{t=1}^{N} \frac{\text{Participant Costs (\$)}_t}{(1+d)^{t-1}}$$

Where:

d = the discount rate
t = time (in years)
N = measure lifetime

The bill reductions are calculated by multiplying measure energy savings and customer peak demand impacts by retail energy and demand rates.

The model uses measure implementation curves to estimate the percentage of the informed market that will accept each measure based on the participant's benefit-cost ratio. The model provides enough flexibility so that each measure in each market segment can have a separate implementation rate curve. The functional form used for the implementation curves is:

$$y = \frac{a}{\left(1+e^{-\ln\frac{x}{4}}\right) \times \left(1+e^{-c\ln(bx)}\right)}$$

where:

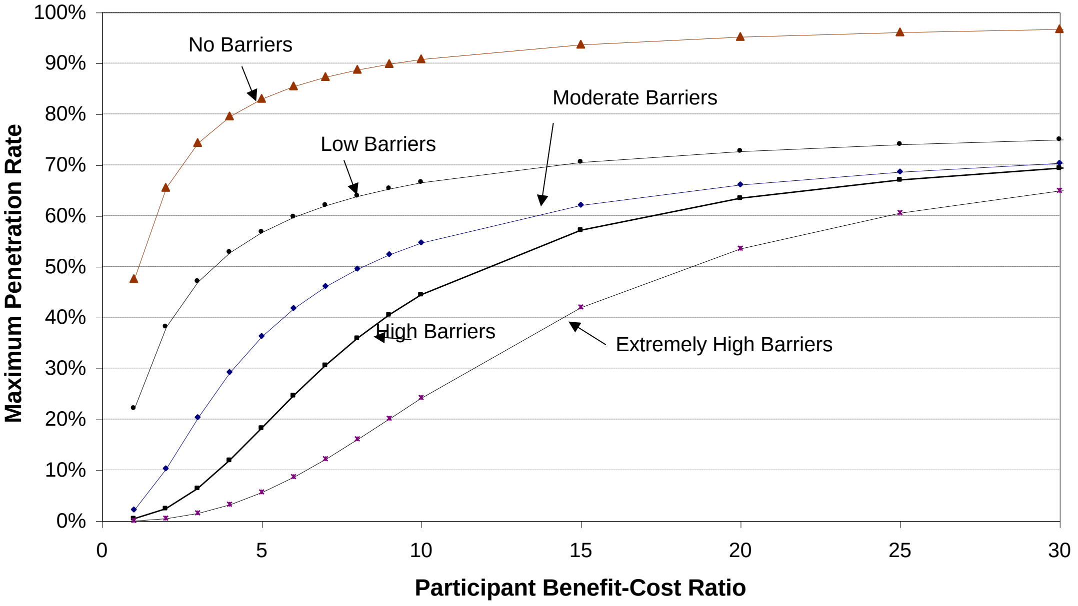
y = the fraction of the market that installs a measure in a given year from the pool of informed applicable customers;
x = the customer's benefit-cost ratio for the measure;
a = the maximum annual acceptance rate for the technology;
b = the inflection point of the curve. It is generally 1 over the benefit-cost ratio that will give a value of 1/2 the

maximum value; and

c = the parameter that determines the general shape (slope) of the curve.

The primary curves utilized in our model are shown in Figure A-3. These curves produce base year program results that are calibrated to actual measure implementation results associated with major IOU commercial efficiency programs over the past several years. Different curves are used to reflect different levels of market barriers for different efficiency measures. A list of market barriers is shown in Table A-4. It is the existence of these barriers that necessitates program interventions to increase the adoption of EE measures.

Figure A-21. Primary Measure Implementation Curves Used in Adoption Model



Note that for the moderate, high barrier, and extremely high curves, the participant benefit-cost ratios have to be very high before significant adoption occurs. This is because the participant benefit-cost ratios are based on a 15-percent discount rate. This discount rate reflects likely adoption if there were no market barriers or market failures, as reflected in the no-barriers curve in the figure. Experience has shown, however, that actual adoption behavior correlates with implicit discount rates several times those that would be expected in a perfect market.[21]

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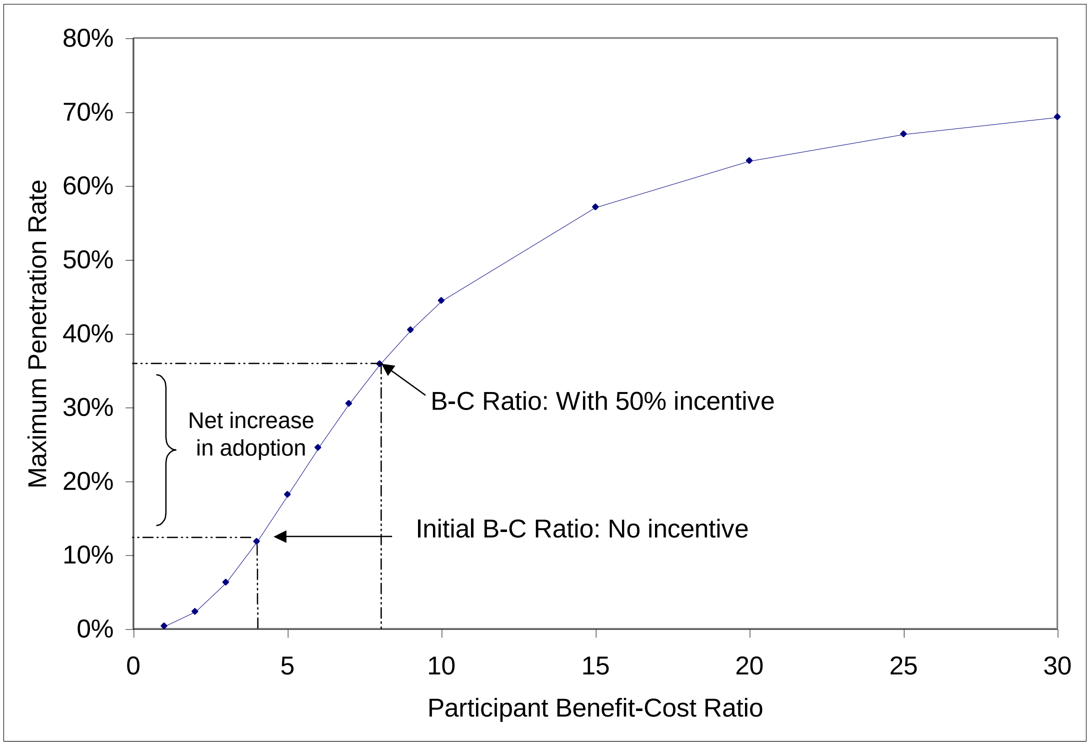
[21] For some, it is easier to consider adoption as a function of simple payback. However, the relationship between payback and the participant benefit-cost ratio varies depending on measure life and discount rate. For a long-lived measure of 15 years with a 15-percent discount rate, the equivalent payback at which half of the market would adopt a measure is roughly 6 months, based on the high barrier curve in Figure 2-3. At a 1-year payback, one-quarter of the market would adopt the measure. Adoption reaches near its maximum at a 3-month payback. The curves reflect the real-world observation that implicit discount rates can average up to 100 percent.

Table A-21. Summary Description of Market Barriers from Eto, Prahl, Schlegel 1997

Barrier	Description
Information or Search Costs	The costs of identifying energy-efficient products or services or of learning about energy-efficient practices, including the value of time spent finding out about or locating a product or service or hiring someone else to do so.
Performance Uncertainties	The difficulties consumers face in evaluating claims about future benefits. Closely related to high search costs, in that acquiring the information needed to evaluate claims regarding future performance is rarely costless.
Asymmetric Information and Opportunism	The tendency of sellers of energy-efficient products or services to have more and better information about their offerings than do consumers, which, combined with potential incentives to mislead, can lead to sub-optimal purchasing behavior.
Hassle or Transaction Costs	The indirect costs of acquiring EE, including the time, materials and labor involved in obtaining or contracting for an energy-efficient product or service. (Distinct from search costs in that it refers to what happens once a product has been located.)
Hidden Costs	Unexpected costs associated with reliance on or operation of energy-efficient products or services - for example, extra operating and maintenance costs.
Access to Financing	The difficulties associated with the lending industry’s historic inability to account for the unique features of loans for energy savings products (i.e., that future reductions in utility bills increase the borrower’s ability to repay a loan) in underwriting procedures.
Bounded Rationality	The behavior of an individual during the decision-making process that either seems or actually is inconsistent with the individual’s goals.
Organization Practices or Customs	Organizational behavior or systems of practice that discourage or inhibit cost-effective EE decisions, for example, procurement rules that make it difficult to act on EE decisions based on economic merit.
Misplaced or Split incentives	Cases in which the incentives of an agent charged with purchasing EE are not aligned with those of the persons who would benefit from the purchase.
Product or Service Unavailability	The failure of manufacturers, distributors or vendors to make a product or service available in a given area or market. May result from collusion, bounded rationality, or supply constraints.
Externalities	Costs that are associated with transactions, but which are not reflected in the price paid in the transaction.
Non-externality Pricing	Factors other than externalities that move prices away from marginal cost. An example arises when utility commodity prices are set using ratemaking practices based on average (rather than marginal) costs.
Inseparability of Product Features	The difficulties consumers sometimes face in acquiring desirable EE features in products without also acquiring (and paying for) additional undesired features that increase the total cost of the product beyond what the consumer is willing to pay.
Irreversibility	The difficulty of reversing a purchase decision in light of new information that may become available, which may deter the initial purchase, for example, if energy prices decline, one cannot resell insulation that has been blown into a wall.

The model estimates adoption under both naturally occurring and program intervention situations. There are only two differences between the naturally occurring and program analyses. First, in any program intervention case in which measure incentives are provided, the participant benefit-cost ratios are adjusted based on the incentives. Thus, if an incentive that pays 50 percent of the incremental measure cost is applied in the program analysis, the participant benefit-cost ratio for that measure will double (since the costs have been halved). The effect on the amount of adoption estimated will depend on where the pre- and post-incentive benefit-cost ratios fall on the curve. This effect is illustrated in Figure A-4.

Figure A-22. Illustration of Effect of Incentives on Adoption Level as Characterized in Implementation Curves



In many of our projects achievable potential EE forecasts are developed for several scenarios, ranging from base levels of program intervention, through moderate levels, up to an aggressive EE acquisition scenario. Uncertainty in rates and avoided costs are often characterized in alternate scenarios. The final results produced are annual streams of achievable program impacts (energy and demand by time-of-use period) and all societal and participant costs (program costs plus end-user costs).

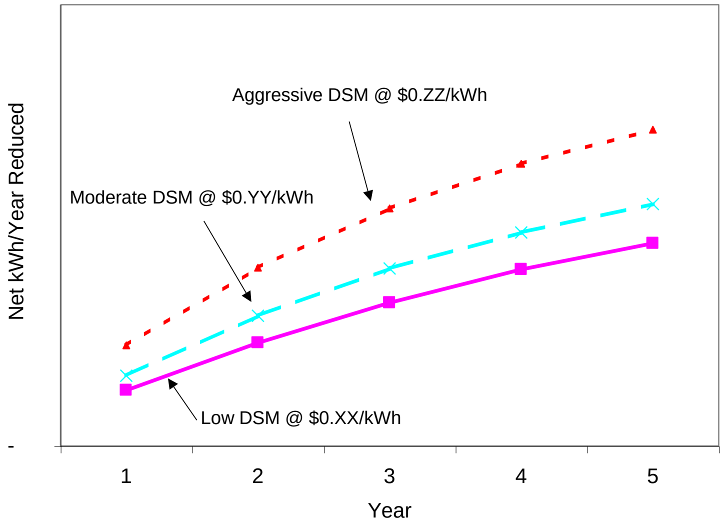
A.1.4 Scenario Analyses

Achievable potential forecasts can be developed for multiple scenarios. For example, program savings can be modeled under low levels of program intervention, through moderate levels, up to an aggressive DSM acquisition scenario. Uncertainty in rates and avoided costs can be characterized in alternate scenarios as well. The final results produced will be annual streams of achievable DSM program impacts (energy and demand by time-of-use period) and all societal and participant costs. An example of the types of outputs that have been produced for similar studies in the past is shown in Table A-5 and Figure A-5.

Table A-22. Example Format of DSM ASSYST Achievable Potential Outputs

DSM ASSYST Program Output	2006	2007	2008	etc.
Annual Energy Savings (kWh)				
Summer Period Energy Savings (kWh)				
Non Summer Period Energy Savings (kWh)				
Net Annual Energy Savings (kWh)				
Summer Period Net Energy Savings (kWh)				
Non Summer Period Net Energy Savings (kWh)				
Peak Demand Savings (kW)				
Net Peak Demand Savings (kW)				
Annual Program Costs				
Supplemental Customer Costs				

Figure A-23. Example of DSM Scenario Outputs



A.2 DSM ASSYST™ Model Description

DSM ASSYST™ (Demand-Side Management Technology Assessment System) is a tool developed to assess the technical, economic and market potential of DSM technologies in the residential, commercial and industrial sectors. Based on user-specified information about base technologies, conservation technologies, load shapes, utility avoided costs, utility service rates, and economic parameters, DSM ASSYST yields numeric data for a variety of criteria. The user can then evaluate and compare technologies. DSM ASSYST allows the user to analyze each DSM technology in multiple combinations of building types, market segments, end uses, and vintages both individually and compared to other DSM technology options.

Table A-23. Example of Industrial Efficiency Levels Developed for a Recent California Potential Study

DSM ASSYST ADDITIVE SUPPLY ANALYSIS			Year	2011			
		Vintage: Existing			Levelized	Levelized	Total
		Sector: Industrial Scenario: Base			Cost per	Cost per	Resource
End	Measure		GWH	MW	KWh Saved	KW Saved	Cost Test
Use	Number	Measure	Savings	Savings	$/kWH	$/kW	TRC
Motors	101	Replace 1-5 HP Motor	248.7	34.1	$0.10	$698	0.8
Motors	102	Add 1-5 HP VSD	447.1	61.3	$0.14	$1,019	0.6
Motors	103	Motor Practices Level 1	607.0	83.2	$0.06	$440	1.3
Motors	104	Motor Practices Level 2	539.1	73.9	$0.24	$1,764	0.3
Motors	121	Replace 21-50 HP Motor	78.1	10.7	$0.09	$661	0.9
Motors	122	Add 21-50 HP VSD	319.0	43.7	$0.04	$278	2.1
Motors	123	Motor Practices Level 1	404.3	55.4	$0.03	$211	2.7
Motors	124	Motor Practices Level 2	361.9	49.6	$0.12	$840	0.7
Motors	151	Replace 201-500 HP Motor	143.5	19.7	$0.03	$201	2.8
Motors	152	Add 201-500 HP VSD	516.6	70.8	$0.01	$106	5.4
Motors	153	Motor Practices Level 1	598.6	82.0	$0.02	$152	3.7
Motors	154	Motor Practices Level 2	554.9	76.0	$0.08	$586	1.0
Compressed Air	202	CAS Level 1	433.9	59.5	$0.02	$168	3.4
Compressed Air	203	CAS Level 2	453.6	62.2	$0.05	$362	1.6
Compressed Air	204	CAS Level 3	325.5	44.6	$0.13	$936	0.6
Other Process	301	Process Level 1	1,031.8	141.4	$0.03	$190	3.0
Other Process	302	Process Level 2	1,219.7	167.1	$0.05	$345	1.7
Other Process	303	Process Level 3	767.3	105.1	$0.25	$1,831	0.3

The current version of DSM ASSYST uses a combination of Microsoft Excel spreadsheets and Visual Basic (VB) programming software. All input and output data are stored in spreadsheets. The VB modules read input data from various spreadsheets, perform the various analyses, and store output results into spreadsheets.

There are three major VB analysis modules: Basic, Supply, and Penetration. Figure A-6 provides an overview of the model process and key inputs. Each module is briefly described below.

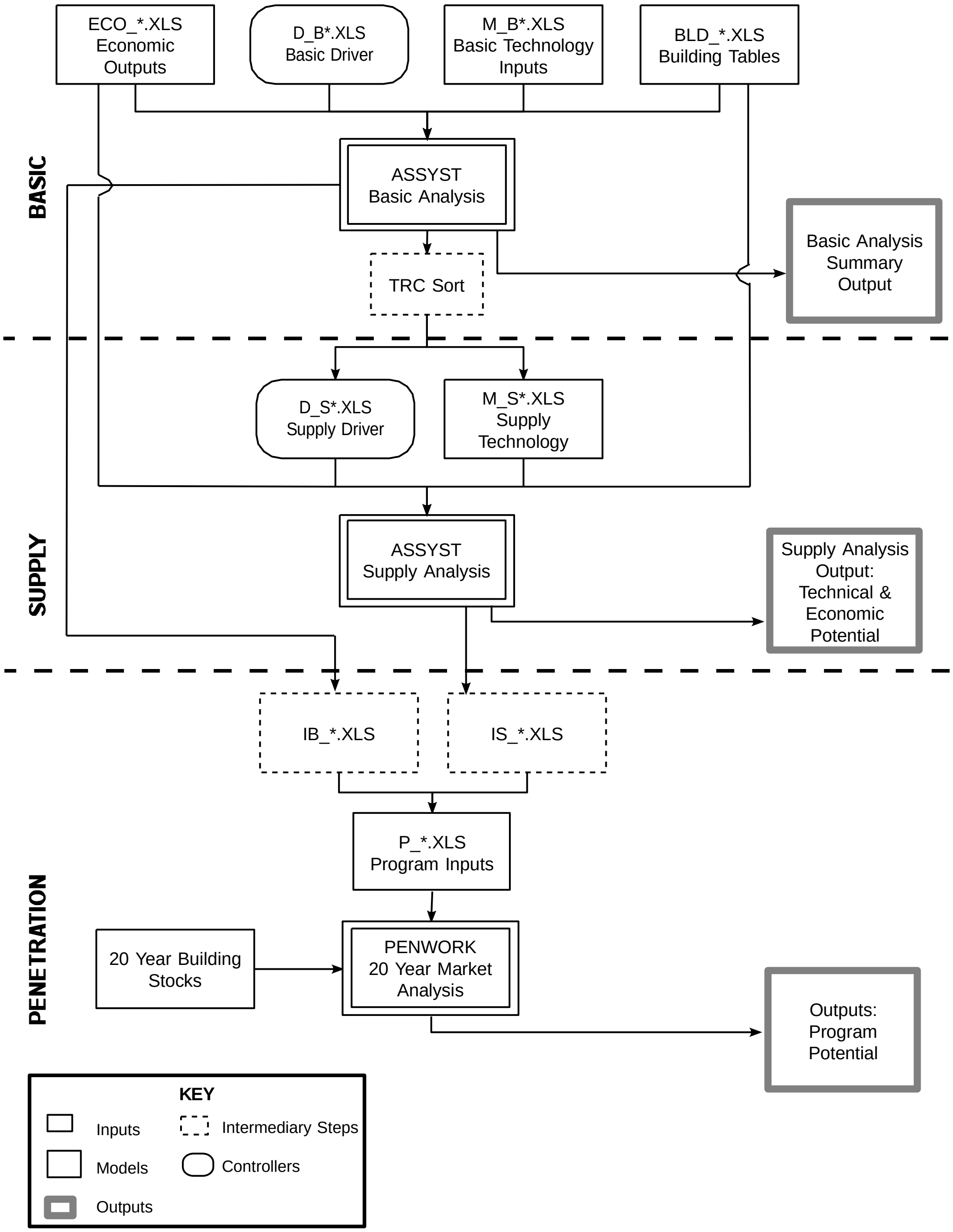
A.2.1 Basic Module

In the Basic module, each technology is assessed individually by comparing it to a base case. Comparisons are made at a high degree of segmentation. The segmentation may include, but is not limited to sector, building type, end use, vintage and geographic area.

The Basic module reads four types of information, contained within four spreadsheet files. These files include:

- Economic: containing utility rates paid by customers, discount rates, avoided costs, and other utility-specific economic parameters
- Building: containing square footage or number of households and load shape data
- Measure: containing technology based inputs for the Basic Analysis
- Driver: containing information that drives the analysis process.

Figure A-24. DSM ASSYST Analytic Flow



The output files produced by the Basic module include a Summary Basic Output file that contains an assessment of how much energy and demand each technology will save relative to the base case within each segment. In addition, the summary contains cost data, savings fractions, before and after EUIs or UECs, service life, the levelized costs of implementing the technology, and results of economic tests including the TRC test, participant test, and customer payback.

This module also produces a second file that contains all the measures that were assessed in the Basic Analysis sorted in the highest to lowest TRC order within each market segment and end use. This file serves as an input file for the Supply module.

A.2.2 Supply Module

In the Supply Module each technology, within each market segment, is stacked, or implemented, such that all energy savings are realized from preceding technologies prior to the implementation of all subsequent technologies. The stacking order generally follows the TRC sort order, highest to lowest, resulting from the Basic module.

The Supply module requires two input files: a Driver file and a modified output file from the Basic module. As in the Basic module, the Driver file contains instructions for the analysis process. The output file from the basic analysis must be modified in Excel to address overlapping measures, such as different SEER levels or measures that are direct substitutes for each other.

Output from the Supply module contains the technical and economic potential plus energy and demand supply curves. The Supply module produces measure-level information that can be incorporated into the input file for the Penetration module.

A.2.3 Penetration Module

The Penetration (or Program Potential) module of ASSYST is designed to calculate the costs and net energy and demand savings from DSM programs under a variety of marketing scenarios. This module estimates the net impact and cost of a program over time by forecasting the naturally occurring penetration of each measure as well as the penetration of each measure given the program activities (i.e., incentives and awareness building).

Using a stock accounting algorithm over a period of 20 years, this module first calculates the number of customers for whom the measure will apply. Second, the model calculates the number of informed customers based on the amount of money spent on advertising. Third, the model calculates the number of customers who will implement the technology based on their benefit/cost ratio. Finally, the model compares the number of customers that implement the technology due to the program with those who would take the technology anyway (naturally occurring). Per-unit energy and demand savings are applied to the net number of customers (total minus naturally occurring) over the 20-year period. After completing the analysis, the results are automatically summed across measures to provide program-level costs and savings for 20 years, and formatted for input into Integrated Resource Planning models.

A program input file is used to define a program and provide the building stock forecast. The program characterization variables include:

- Incentive Levels
- Incentive Budget Constraints
- Yearly Incentive Adjuster
- Technology Acceptance Curve Parameters
- Administration Budgets
- Advertising Budgets
- Awareness Decay Rate
- Advertising Effective Ratio.

APPENDIX B: KEY ASSUMPTIONS BY PROGRAM TYPE

B.1 Energy Efficiency

The energy efficiency analysis was based largely on the analysis performed for Austin Energy in 2020 with the removal of measures at the program level to align with current offerings. Below we include a description of key measures driving the savings for each program and key measures that were removed from the analysis.

Commercial Rebate and Small Business BAU

2023 Savings in the DNV analysis are driven by - Vent hood VFD (restaurants)- .961 MW, Variable Speed Drives (College) - .75 MW, Ceiling insultation (all buildings)- 3.6 MW, EMS- Chillers (all buildings)- 2.2 MW

2034 Savings in the DNV analysis are driven by - Vent hood VFD (restaurants)- .26 MW, Variable Speed Drives (College) - .13 MW, Ceiling insultation (all buildings)- 2.6 MW, EMS- Chillers (all buildings)- .91 MW

2023 results from AE's Com SB MF FY22-23 measure flat file 061424 shows 9.58 MW in savings (filtering out residential and new construction) shows significant savings from lighting (3.82 MW and 1.11 MW from small business) and minimal savings from VFDs (0.05)

Due to low number of linear LEDs removed in 2029 on, DNV did not make a manual adjustment to admin or marketing budgets to account for removed measure as we felt the budget would be allocated to other efforts. Incentives for these lamps were removed starting in 2029.

Strategic Partnership between Utilities and Retailers BAU

The SPUR FY2023 YearEnd Report 6.14.24 shows .13 MW in savings from LEDs in 2023, .107 from air cleaners, 1.35 MW from power strips, and ~.5 from self-weatherization. DNV's analysis in 2020 did not include screw-based LEDs after 2021 and did not include air cleaners or power strips as they were not deemed to be cost-effective. DNV's analysis in 2020 estimated .38 MW from self-weatherization compared to ~.5 in actual results for 2023.

In DNV's analysis, all screw-based LEDs are removed from the program starting in 2022 (done in 2020 forecast).

in DNV's analysis, all linear-based LEDs are removed from the program starting in 2029

Due to the number of linear LEDs removed in 2029 on, DNV made a manual adjustment to admin or marketing budgets to account for removed linear LEDs- adjustment was based on average of change in MWh and MW in each year after LEDs are removed.

Appliance Efficiency Program BAU

Compared to program measures listed on website and/or 2023 program handbook, DNV's analysis does not include solar screens.

DNV analysis include central AC, air-source heat pumps, ductless mini splits, ground source heat pumps, room air conditioners, heat pump water heaters, smart thermostats, and variable speed pool pumps

Largest savers in DNV's analysis are Central AC (0.8 MW in 2023 and 2034) and smart thermostats for central AC with 1.3 MW in 2023 and 0.7 in 2034

Smart thermostats in AE's participation data for 2023 account for up to 0.21 MW, significantly less than the 2023 forecast under this program.

ACs account for at least 1.3 MW of savings in 2023 (from AE's participation data) which is higher than DNV's forecast of 0.8)

Since program does not include LEDs, no other changes to budgets or incentives were made compared to 2020 forecast.

Weatherization Assistance Program BAU

In 2020 analysis program was named the low income program. Renamed to align with current AE program

Compared to program measures listed on website, DNV analysis includes an advanced room air conditioner (<0.001 MW per year) and does not include reflective roof coating for mobile homes or smart thermostats.

In DNV's analysis, all screw-based LEDs are removed from the program starting in 2022.

in DNV's analysis, all linear-based LEDs are removed from the program starting in 2029

The vast majority of savings in DNV's analysis come from solar screens (0.48 MW in 2023 to 0.3 in 2034 . AC maintenance is second largest saver (0.05 MW in 2023 and 0.03 in 2034).

It is not possible to determine the savings from solar screens and AC maintenance alone in the participation data provided by AE to compare against the forecast values.

Due to low number of linear LEDs removed in 2029 on, DNV did not make a manual adjustment to admin or marketing budgets to account for removed measure as we felt the budget would be allocated to other efforts. Incentives for these lamps were removed starting in 2029.

Multifamily Rebate BAU

Screw-based LEDs had been removed starting in 2022 in the 2020 forecast. Smart screw-based LEDs were removed starting in 2024 and linear LEDs were removed starting in 2029.

The incentive budget was revised to remove incentives associated with the LEDs removed. Admin and marketing was updated based on share of savings remaining after LEDs were removed.

Largest savers in DNV's analysis are duct repair (1.432 .685 MW in 2023, 1 in 2034) and solar screens (.12 MW in 2023, 0.195 MW in 2034)

Multifamily Weatherization Assistance BAU

LEDs in this program were already removed from the analysis starting in 2022 in DNV's 2020 forecast so no changes to LED savings or budgets were made

Largest savers in DNV's analysis are solar screens (.4 MW in 2023, .26 in 2034), R19-r38 ceiling insulation (.19 MW in 2023, .18 in 2034), R11-R38 ceiling insulation (.18 MW in 2023, .17 MW in 2034) and R0-R38 ceiling insulation (.15 MW in 2023, .14MW in 2034)

Home Energy Savings

2023 Savings in the DNV analysis are driven by - R19-R49 ceiling insulation (.353 MW), Duct Repair (.335 MW), and Air sealing (.233)

2034 Savings in the DNV analysis are driven by - R19-R49 ceiling insulation (.392 MW), Duct Repair (.393 MW), and Air sealing (.259)

Large savers in the DNV analysis are retrofit measures, meaning there are not lost opportunities when the base measure fails and needs to be replaced, allowing for consistent growth in savings

Large saving measures are included in AE's measure glossary (assuming comprehensive is comprehensive air sealing, otherwise air sealing not included) and handbook but it is not possible to tell how they performed in AE's participation data as they are often packaged with other measures

Program does not include LEDs so no changes to forecast or budgets made

B.2 Green Building

Savings estimates for Green Building were developed by Austin Energy Staff using the results of the 2020 DNV study and current program data. DNV's notes on the analysis are below.

DNV reviewed and agrees with Austin Energy's approach to developing savings estimates.

DNV's understanding of Austin Energy's approach: the actual MW for the energy code in 2025 is derived from permits issued in 2024. The MW values for ratings in 2025 are derived from the projects currently in progress and projected to be reported in 2025. For years beyond 2025, estimated MW values are projected by applying the DNV factors from the 2020 study to all programs. The energy code values in 2026, 2027, and 2028 were also adjusted to account for the reduction in deemed savings attributed to the 2025 City of Austin Energy Code adoption.

DNV confirmed that the correct values from the 2020 DNV analysis are being used. The report only provides values through 2034 so we observed AE used the 2034 value for the 2035 update.

B.3 Electrification

Key assumptions for the electrification analysis are described below.

Measures

Measure service life, energy savings, technology saturation develop from TX TRM and DNV research

Measure costs based on recent research by DNV adjusted for Austin Energy

Measure costs including equipment and labor

Distribution of Household Income https://data.austintexas.gov/stories/s/EOA-B-2-Distribution-of-household-income/i3a3-vjnc/

Customer count based https://austinenergy.com/about/company-profile July 2024

HVAC and Water Heating end use

Rates

Utility discount rate 4%

Customer discount rate 7%

General Inflation 2.5%

Utility line loss rate 4.71%

Utility gas leakage rate 2%

Electric rates--Energy Information Administration (EIA) 2022 escalated by EIA Annual Energy Outlook (AEO) 2023 Macroeconomic Indicators: Price Indices: GDP Chain-type Price Index table 20

Natural gas rates--EIA Texas Price of Natural Gas Delivered to Residential Consumers escalated by EIA Annual Energy Outlook (AEO) 2023 Macroeconomic Indicators: Price Indices: GDP Chain-type Price Index table 20

Building types:

Building stock develop from Table HC9.1 Household demographics of U.S. homes, by housing unit type, 2020 and Distribution of Household Income https://data.austintexas.gov/stories/s/EOA-B-2-Distribution-of-household-income/i3a3-vjnc/

Residential Energy Consumption Survey (RECS) used to develop eligible households

Avoided Costs

Avoided cost of energy: PUCT 2024 Avoided cost of energy for ERCOT ($/MWh) escalated by EIA Annual Energy Outlook (AEO) 2023 Macroeconomic Indicators: Price Indices: GDP Chain-type Price Index table 20

Avoided capacity costs provided by Austin Energy escalated by EIA Annual Energy Outlook (AEO) 2023 Macroeconomic Indicators: Price Indices: GDP Chain-type Price Index table 20

Avoided cost of natural gas (energy): Henry Hub Natural Gas Futures Jul 2024.

Avoided GHG costs: Based on EPA Social Cost of Carbon August 2016 Update: https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html

Budget

Electrification budget set to 1/10th 2023 total budget ($1.4M)

Heat Pump Water Heater incentive $800 https://savings.austinenergy.com/residential/offerings/appliances-and-equipment/hp-water-heater

Heat Pump incentive max of $750 https://savings.austinenergy.com/residential/offerings/cooling-and-heating/ac

Incentive costs for Business-as usual include IRA incentives included from 2025-2031

Year-over-Year budget growth rate of 0%

B.4 Solar installations

Key assumptions for the solar analysis are described below.

General

Technology types (configurations) include standalone solar PV, solar PV + battery storage, and battery storage retrofitted onto existing solar PV

Customer segments include: residential, commercial small, commercial medium, commercial large, industrial (aligned with relevant AE rate classes and customer data provided)

(3) scenarios are provided: achievable assumes current levels of rebates and incentives, while the 75% and 100% scenarios assume rebate and incentive increases aligned with each scenario

All cost data is presented in $2024 (either total $ or $/kW)

General rates used: utility discount rate = 4%, customer discount rate = 7%, general inflation rate = 2%

Average System Sizes

Based on historical AE installation data (aligned w/customer segments and rate class using billing data)

Solar PV Average System Sizes	kW-DC	kW-AC
Residential Solar	8.2	6.8
Commercial Small Solar	41.7	34.1
Commercial Medium Solar	130.2	106.7
Commercial Large Solar	454.3	372.4
Industrial Solar	651.7	534.2
Residential Solar+Storage	10.4	8.5
Commercial Small Solar+Storage	45.0	36.9
Commercial Medium Solar+Storage	135.0	110.7
Commercial Large Solar+Storage	460.0	377.0
Industrial Solar+Storage	670.0	549.2

Technology Metrics

Technical potential for each customer segment and technology type (configuration) developed from DNV internal project data and NREL Solar PV Technical Potential study

Technology metrics and generation shapes based on state-specific DNV DER cost & performance data developed for EIA, internal DNV system performance modeling (SolarFarmer & BattRE), and NREL System Advisor Model (SAM)

Assumes 20-year lifetime for all systems (O&M cost data incorporates equipment replacement costs over system lifetime)

Assumes year-one and annual equipment degradation of 1.4% and 0.5% respectively

Technology Costs

Year-one capital and O&M costs based on state-specific DNV DER cost & performance data developed for EIA, and reported historical AE installation data

Capital and O&M costs escalated for future years using NREL ATB 2023 (aligned w/technology types)

O&M cost data incorporates equipment replacement costs over system lifetime (e.g., inverters)

Customer Data

Segment and rate class load shapes provided by AE used in 8760 billing analysis, and rate class load growth provided by AE incorporated in economic and adoption analysis

Customer count forecasts provided by AE and incorporated in economic and adoption analysis

Rates and Fees Data

Current rate class tariff data used based on city of Austin utility rates and fees schedule (both energy and demand)

Value of Solar (VoS) rates and forecast provided by AE

Residential CBI incentives, commercial PBI incentives, and commercial CBI incentives applied throughout the forecast timeframe (excluding all double-counting as applicable)

Commercial PBI rate forecast aligned with electric rate forecast

Commercial adoption assumes historical percentage of PBI and CBI incentives applied to future adoption

Commercial adoption assumes historical percentage of for-profit and non-profit commercial installations applied to future adoption

Investment Tax Credit (ITC) percentages applied to system capital cost throughout the forecast timeframe

B.5 Demand Response

Key assumptions for the demand response analysis are described below.

General

Customer segments include: residential, commercial small and medium, commercial large, industrial (aligned with relevant AE rate classes and customer data provided)

Ramp rate for new programs is 5 years starting in 2025

One time program start-up costs for new programs in $150,000

All impacts, costs, and rebates leverage actual program data where applicable

General rates used: utility discount rate = 4%, customer discount rate = 7%, general inflation rate = 2%

Impacts, costs, and rebates for new programs were pulled from the Northwest Power and Conservation Council's 2021 power plan demand response detailed assumptions for the state of Utah unless otherwise noted. Impacts were translated into a percentage per customer then applied to the relevant Austin Energy loads.

Customer Data

Segment and rate class load shapes provided by AE used in 8760 billing analysis, and rate class load growth provided by AE incorporated in economic and adoption analysis

Customer count forecasts provided by AE and incorporated in economic and adoption analysis

Impacts

Smart thermostats: 1.0 kW per customer for residential, 5.3kW per customer for small/medium C&I – existing program impacts

Batteries 3.87 kW per customer for residential NREL assumption of, 5kW capacity battery x 86% round-trip efficiency /w 10% emergency retention.

EV Managed Charging 0.34 kW per customer for residential – NWPCC 2021 Power plan

Pool pumps 0.06 kW per customer for residential LBNL 2017 (Tablge G-52; avg. 4 hr shed;base case) (70% equipment peak shed)

Water heaters 0.28 kW per customer – blend of electric resistance and heat pump water heaters operated via switch or grid interactive. Total range 0.10-0.50 kW

Behavioral DR 0.02 kW per customer, existing program impacts

C&I Manual and Auto DR 13.11 kW per customer – existing program impact

Achievable participation rates – % of eligible population

Smart thermostats 18% residential 10% small/medium C&I

Batteries 60%

EV managed charging 20%

Pool pumps and water heaters 25%

Behavioral DR 30%

C&I Manual and Auto DR 15%

Costs

Include one-time technology costs, annual incentives, per participant marketing, and ongoing administration costs

Benefits

Include the avoided cost of capacity using Austin Energy’s postage stamp rate

About DNV