Intermountain Gas Company

2023 Conservation Potential Assessment

2025 – 2030

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Exhibit No. 4

2023 Conservation Potential Assessment

Final Report

Prepared for:

Intermountain Gas Company

Submitted by:

Guidehouse Inc.
1375 Walnut St, Suite 100
Boulder, CO 80302
303.728.2500

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Introduction and Background

Intermountain Gas Company (IGC) retained Guidehouse to conduct a Conservation Potential Assessment (CPA) with the primary objective of developing an estimate of the potential for gas energy efficiency for IGC's southern Idaho service territory over a 20-year time horizon from 2024 to 2044.

Through this Study, Guidehouse leveraged IGC data and secondary research and data sources to characterize customer and measure data to inform the modeling inputs for energy efficiency potential. Guidehouse modeled the technical, economic, and achievable potential for energy efficiency using its proprietary DSMSim model.

For energy efficiency, Guidehouse calculated net achievable gas energy efficiency potential for four scenarios, listed below. Further detail and discussion regarding the 2023 CPA scenarios can be found in Section 5.1.3 sand Appendix E.

- Business as Usual: The reflection of IGC's historical data and secondary data collected on the market for energy efficient technologies in IGC's service territory.
- Unconstrained Historic Budget: This scenario is consistent with Business as Usual but with the removal of modeled portfolio budget constraints reflecting the limited overall historic period with actual in-market EE programs.
- Medium Adoption: Reflects the Unconstrained Historic Adoption model with the addition of model parameter assumptions designed to model higher overall customer awareness of energy efficiency and an increase in the willingness of customers to adopt efficient technologies.
- High Incentive, High Adoption scenario: Builds on the Medium Adoption scenario, with increases in measure incentives and further heightened market adoption-related assumptions.

Throughout this Study, Guidehouse sought regular input and feedback from IGC, who provided important market knowledge and industry expertise critical to producing a robust final set of outcomes. Table A summarizes the various elements of the project scope.

Table A. Summary of Project Scope

Element	Dimensions
Forms of Energy	Natural Gas
Type of Potential	Technical, Economic, Achievable
Scenarios (4)	Business as Usual, Unconstrained Historic Budget, Medium Adoption, High Incentive/High Adoption
Sectors	Residential, Commercial
Climate	Two Weather Zones DOE CZ 5 and CZ6
Time Horizon	2024-2044 (20 years)

Source: Guidehouse analysis 2023

Report Organization

The report is organized as follows:

- Section 1 provides an overview of **Market & Baseline Characterization** developed and used in the Study. This section provides the breakdown of customers by sector and segment.
- Section 2 discusses the **Energy Efficiency Measure Characterization**, including key parameters.
- Section 3 presents the **Energy Efficiency Technical Potential Forecast** for energy efficiency measures, including a summary of results by sector and end use.
- Section 4 provides the **Energy Efficiency Economic Potential Results** for energy efficiency measures, including a summary of results by sector and end use.
- Section 5 presents the **Energy Efficiency Achievable Potential Results by Scenario** for energy efficiency measures, including a summary of results by sector, end use, customer segment, and measure, as well as cost-effectiveness test results.

The report also includes the following five appendices and two attachments:

- Appendix A. Market Characterization
- Appendix B. Measure Characterization
- Appendix C. Energy Efficiency Technical Potential
- Appendix D. Energy Efficiency Economic Potential
- Appendix E. Energy Efficiency Achievable Potential
- Attachment A – Results Figures and Tables
- Attachment B – Measures Inputs and Database

1. Market & Baseline Characterization

This section outlines Guidehouse's approach and summarizes the outcomes of the baseline and market characterization tasks conducted for the Intermountain Gas Company's (IGC) 2023 Conservation Potential Assessment (CPA).

1.1 Global Inputs

Baseline and market characterization refers to the collection and analyzing of information pertaining to the size and characteristics of the customer population within IGC's service territory. Market characterization forms the basis for scaling up energy efficiency potential from an individual measure level to an aggregate utility-wide level. This information is also referred to as the *Global Inputs.* Guidehouse developed the following global inputs for the 2023 CPA:

- Building Stock
- Gas Sales
- Avoided Costs
- Retail Rates
- Inflation Rate
- Discount Rate
- Building Stock Demolition Rate

Guidehouse developed these market characterization inputs in parallel with measure characterization (see Section 2), as both are key inputs to the calculation of technical and economic potential.

1.2 Study Indices

A key aspect of any potential assessment is defining the study breadth and scope, level of segmentation, and parameters for variation within the inputs, modeling, and results, which Guidehouse collectively refers to as the *Study Indices*. Guidehouse developed the study indices to meet the needs of the CPA in consultation with IGC staff.

For the development of global inputs, the study indices dictate the level of granularity at which the global inputs can or should be developed. The remainder of this section summarizes the key study indices that are relevant to the development of global inputs.

Service Territory and Climate Zone
In line with the 2019 CPA, Guidehouse considered two climate zones within the IGC service territory:

- Zone 5
- Zone 6

These climate zones are derived from the U.S. Department of Energy (DOE) using climate zone designations from the International Energy Conservation Code (IECC).[1]

Guidehouse developed the *Building Stock* and *Gas Sales* global inputs with this climate zone differentiation. This will allow savings for measures that have different impacts by climate zone to be appropriately scaled to the correct proportion of buildings and gas sales within the two climate zones. For measures that are not weather sensitive, impacts will be scaled to the entire service territory. As such, the global inputs contain three combinations of service territory and climate zone:

- All
- IGC | Zone 5
- IGC | Zone 6

Sector
The scope of the 2023 CPA covers two sectors:

- Residential
- Commercial

Guidehouse differentiated the *Building Stock*, *Gas Sales,* and *Retail Rate* global inputs by these two sectors.

Customer Segment
Within each sector, the customer segment index provides building type granularity, which are used for the *Building Stock* and *Gas Sales* global inputs. The 2023 CPA contains the following customer segments (11 in total):

- Commercial (9): Education, Food Service, Healthcare, Light/Converted, Lodging, Manufacturing/Industrial, Office, Other, Retail
- Residential (2): Single Family, Multi-Family

At the request of IGC staff, Guidehouse added the Light/Converted customer segment within the Commercial sector to represent zoned commercial customers that exist in buildings that were originally residential homes.

1.3 Data Request and Sources

To perform the baseline and market characterization, Guidehouse requested several data items from IGC in a formal data request. Table A-1 in Appendix A contains a detailed summary of each data source and its components. The items Guidehouse requested from IGC are listed below:

- Customer Stock Data
- Gas Sales Data

[1] For more information on DOE Climate Regions, see the following link: https://www.energy.gov/sites/prod/files/2015/10/f27/ba_climate_region_guide_7.3.pdf

- Retail Rate Data
- Avoided Cost Data
- IGC Discount Rate(s)
- IGC Inflation Rate(s)

Guidehouse developed the data request with an expectation that not all data could be provided at the desired level of detail. To supplement the data that IGC provided, Guidehouse used the following secondary sources:

- **National Renewable Energy Laboratory (NREL) ComStock**:[2] ComStock is a U.S. DOE model of the U.S. commercial building stock, developed and maintained by NREL. ComStock provides access to a vast ecosystem of reliable and granular data for commercial buildings across the country.
- **NREL ResStock**:[3] ResStock is a similar DOE analysis tool for residential premises across the country.
- Market Characterization Memo from the 2019 IGC CPA

In Appendix A, Table A-2 through Table A-9 show market characterization results for all global inputs and study indices.

[2] Available at: https://comstock.nrel.gov/.
[3] Available at: https://resstock.nrel.gov/.

2. Measure Characterization

This section outlines Guidehouse's approach to the measure characterization task conducted for the IGC 2023 CPA. Guidehouse characterized energy efficiency measures applicable to IGC's residential and commercial sectors. The team prioritized measures for inclusion based on their likelihood to have high savings in IGC's territories and their current market availability and cost-effectiveness. IGC's leadership team reviewed the list in detail and provided feedback that was incorporated to finalize the measure list for this Study.

2.1 Energy Efficiency Measure List

The first step in the measure characterization process was to create a vetted measure list defining each of the individual measures to be included and characterized in the CPA. To focus the efforts of the Study on the measures most likely to contribute achievable potential, Guidehouse and IGC developed a measure list based on IGC's experience managing portfolios and Guidehouse's experience estimating potential, while considering Idaho-specific characteristics.

Table 2-1 summarizes the final number of measures that were characterized in the CPA by sector and end use. In total, Guidehouse characterized 31 measures for the residential sector and 55 measures for the commercial sector. The full residential (Table B-1) and commercial (Table B-2) measure lists can be found in Appendix B.

Table 2-1. Measure List Summary

Sector	End Use	Unique Measure Count	Measure ID Count*	Example Measures†
Residential	Appliance	4	6	Clothes Washer, Clothes Dryer, Pool Heater
	Behavioral	1	1	Home Energy Report
	Envelope	6	12	Air Sealing, Attic/Roof Insulation, Windows
	Hot Water	6	10	Storage Water Heater, Tankless Water Heater, Faucet Aerator
	HVAC	14	17	Furnace, Boiler, Tune-Up, Duct Insulation, Thermostat
	Total	**31**	**46**	
Commercial	Appliance	4	7	Clothes Washer and Dryer, Ozone Laundry
	Behavioral	1	1	Building Operator Certification
	Envelope	5	9	Dock Door Sealing, Wall Insulation, Windows
	Hot Water	10	15	Storage Water Heater, Tankless Water Heater, Indirect Water Heater, Pre-Rinse Spray Valve
	HVAC	23	30	Furnace, Boiler, Energy Management System
	Kitchen	8	8	Fryer, Oven, Steamer

	Process	4	4	Process Boiler, Grain Dryer
	Total	**55**	**74**	

* The Measure ID Count exceeds the Unique Measure Count to the extent that certain measures have multiple IDs to differentiate RET Only and NEW Only replacement types in the model. For example, the Windows measure counts as one unique measure, but has two measure IDs for both RET and NEW replacement types.

† Measures listed here are provided for example. This is not a full list. The full measure list can be found in Appendix B.

Source: Guidehouse

To develop the final measure list, Guidehouse utilized the following sources and considerations:

- Existing energy efficiency measures offered by IGC in its programs
- Measures that are not currently offered by IGC, but which were analyzed in the previous iteration of the CPA in 2019
- Input from IGC staff on additional measures of interest
- Other measures commonly offered in other jurisdictions or commonly included in potential studies

2.1.1 Measure Replacement Types

In the measure list, each measure is assigned one of several replacement types. Depending on the measure replacement type, the same measure may be treated differently when calculating cost-effectiveness, calculating energy savings relative to the baseline, and modeling consumer decisions and market adoption. See Table B-3 in Appendix B for complete definitions. The types of measure replacement types are outlined below:

- New Construction (NEW)
- Replace on Burnout (ROB) – also known as Normal Replacement (NR)
- Retrofit (RET) – add-on equipment or accelerated replacement

The Guidehouse potential model allows individual measures to have one of the following replacement type values in the measure characterization:

- **ROB and NEW**: indicating a measure that is applicable both in a normal replacement scenario and a new construction scenario
- **RET Only**: a measure that is applicable to a retrofit situation (could be either add-on equipment or accelerated replacement)
- **NEW Only**: a measure that is applicable to new construction

Several measures that Guidehouse characterized for the IGC CPA were identified as applicable to both a RET scenario and a NEW scenario. Given the allowable values listed above, these measures were characterized twice using measure codes that differentiate between the RET case and the NEW case.

2.1.2 Competition Groups

Most measures in the measure list represent a standalone single efficient technology, relative to a defined baseline technology, which a customer could adopt. However, a handful of measures are not standalone but are related to another measure within a **competition group**. A competition group consists of two or more efficiency levels of the same technology relative to a common baseline. Competition groups are named as such because technologies within them compete for installations; only one of the measures within the group can be installed at a time because they represent the same fundamental equipment or consumption.

The final measure list includes the following competition groups and efficiency levels:

- **Commercial Furnaces**: 95% thermal efficiency furnace, gas heat pump
- **Commercial Thermostats**: programmable thermostat, Wi-Fi thermostat
- **Commercial Water Heaters**: efficient storage water heater, tankless water heater
- **Commercial Indirect Water Heaters**: mid-efficiency, high-efficiency
- **Residential Furnaces**: 95 AFUE, 98 AFUE, gas heat pump
- **Residential Thermostats**: programmable thermostat, Wi-Fi thermostat
- **Residential Water Heaters**: efficient storage water heater, tankless water heater

2.2 Energy Efficiency Measure Characterization Parameters

After specification of the measure list, the measure characterization process includes specifying various characterization parameters for each technology necessary to calculate potential. Some parameters are defined in the measure list, while others are determined during the characterization process from various data sources. Table B-4 in Appendix B summarizes the key measure characterization parameters that the Guidehouse team defined for each characterized measure. All measure parameters are listed below:

- Measure Description
- Measure Replacement Type
- Measure Applicability
- Unit Basis
- Energy Consumption and Savings
- Costs
- Measure Density and Saturation
- Measure Lifetime
- Net-to-Gross Ratio (NTGR)

As described in Appendix B, Guidehouse used default NTGR assumptions of 1.0 for all measures given limited data available to inform specific NTGR assumptions that would be applicable to IGC Service Territory.

2.3 Energy Efficiency Measure Characterization Approaches and Sources

To characterize the key Unit Basis, Energy Consumption and Savings, and Cost inputs for each measure, Guidehouse utilized a range of Technical Reference Manuals (TRM) from other state jurisdictions.[4] In general, TRMs across all jurisdictions are maintained by regulatory bodies and organizations comprised of stakeholders and expert advisors who provide collaborative peer review of measure assumptions on a recurring basis. Guidehouse determined which TRMs would be most relevant to use for the IGC CPA based on the following criteria:

- **Climate Zones**. Guidehouse prioritized TRMs from states with similar IECC climate zones as Idaho for weather-sensitive measures. The Michigan, Iowa, Illinois, and New York TRMs were prioritized by this criterion.
- **Codes and Standards**. Guidehouse prioritized the use of TRMs from states like Michigan, Iowa, Illinois, and Minnesota that – like Idaho – do not set appliance standards that go beyond Federal code requirements. Conversely, Guidehouse was careful to avoid using the California, Massachusetts, and New York TRMs for measures where these states have adopted state-level appliance standards that go beyond Federal code requirements, resulting in differing baseline efficiency levels compared to Idaho.[5]
- **Data Format**. Given the timeline and budget constraints for measure characterization, Guidehouse prioritized TRMs which contain deemed values (pre-calculated values using validated common measure input parameters for various measure characteristics), rather than those which contain only engineering algorithms and equations. The Michigan and California TRMs were prioritized by this criterion.

  An advantage to using TRMs with deemed values is the ability to incorporate values for technical measure parameters and variables that have been vetted and approved by the regulatory bodies and experts who maintain such TRMs. This ultimately creates less reliance on Guidehouse's own assumptions for key measure parameters, and instead leverages measure parameter values whose embedded assumptions can be found in publicly available sources and proceedings, which helps to increase transparency.

In Appendix B, Table B-5 lists the key TRMs data sources that were used to develop measure energy and cost inputs and their frequency of use. Where a TRM was used to characterize weather-sensitive measures, Table B-5 also shows which climate regions in each TRM were used for the IGC CPA Climate Zones (Zone 5 and Zone 6). Appendix B also provides citations for each of the TRMs used, which can be referenced to find the TRMs themselves as well as details about specific measure assumptions and supporting documentation such as workpapers, engineering studies, and materials from technical stakeholder working groups.

In addition to TRMs, Guidehouse utilized findings from existing IGC evaluation, measurement, and verification (EM&V) studies to inform measure assumptions where available. It is a best practice in potential studies to account for realized program results and EM&V findings in the characterization of measure savings. Most notably, Guidehouse aligned residential furnace

[4] Guidehouse and IGC staff also reviewed resources available from the Northwest Power and Conservation Council Regional Technical Forum (RTF) but decided to prioritize the use of TRMs from other states because of limited gas measures and because IGC is not a member of the RTF.

[5] The American Council for an Energy Efficient Economy (ACEEE) maintains a database of state-level appliance standards which go beyond Federal standards, available at: https://database.aceee.org/state/appliance-standards-summary

measure therm savings with the findings from the 2020 Furnace Impact Evaluation billing analysis provided by IGC.

2.4 Density and Saturation Inputs

Guidehouse developed density and saturation inputs defined as:

- **Density** represents the average prevalence of a particular measure among the building stock, or the number of measure units per building. Density for a measure has units of measure Unit Basis[6] divided by sector Scaling Basis.[7] The potential model uses density information to determine the number of applicable measure units within the total IGC service territory to scale up per unit measure impacts to an aggregate service-territory level.

  Within a competition group, the density is the same for all measures in the group and represents the total measure prevalence regardless of efficiency level. Measures within a competition group share the same density under the assumption that lower efficiency technologies are replaced on an equivalent unit basis with higher efficiency technologies.

- **Saturation** represents the percentage of a specific measure that is efficient or not. Saturation is divided up into baseline saturation and efficient saturation. The baseline saturation is the percentage of a measure's total population that is the base model, whereas the efficient saturation is the percentage of a measure's total population that is the efficient model.

Guidehouse referenced a variety of secondary sources which contain data about the prevalence of measures in the building stock or the distribution of technology efficiency levels.

Where applicable, Guidehouse also referenced the density and saturation assumptions that were documented in the 2019 IGC CPA Market Characterization Memorandum. See Table B-6 in Appendix B for a complete list of sources used to find density and saturation inputs.

[6] Unit Basis: the units in which a measure is characterized (e.g., per sq. ft, per kBTU/h, per appliance)

[7] Scaling Basis: the units from the global inputs used to characterize the population (e.g., households for residential, 1000 sq. ft. floor area for commercial).

3. Energy Efficiency Technical Potential

This Study defines technical potential as the total energy savings available, assuming that all installed measures being considered can immediately be replaced with the most efficient measure or technology—wherever technically feasible—regardless of the cost, market acceptance, or whether existing equipment has failed and must be replaced.

3.1 Approach to Estimating Technical Potential

Guidehouse used its DSMSim model to estimate the technical potential for demand-side resources in IGC's service territory. DSMSim is a bottom-up technology diffusion and stock tracking model implemented using a systems dynamics framework.[8]

Guidehouse calculates the technical potential of each measure relative to a baseline which is defined, where relevant, by current codes and standards. Any known planned changes to codes and standards may be used to adjust measure baselines in future forecast years. The calculation of technical potential in this Study differs depending on the assumed measure replacement type. Technical potential is calculated on a per-measure basis and includes estimates of savings per unit, measure density (e.g., quantity of measures per building), and total building stock in the service territory. The Study accounts for three replacement types, where potential from retrofit and ROB measures are calculated differently from potential for new measures. The formulas used to calculate technical potential by replacement type are shown in Appendix C.1.

3.1.1 Competition Groups

Guidehouse's modeling approach recognizes that some efficient technologies will compete in the calculation of potential for a given stock unit. The Study defines competition as an efficient measure competing for the same installation as another efficient measure for a specific end use. For instance, a consumer has the choice to install an efficient storage water heater, a tankless water heater, or a heat pump water heater, but not all three. These efficient technologies compete for the same installation. A detailed explanation of the calculation of potential for measures in a competition group can be found in Appendix C.2

3.2 Technical Potential Results

This section provides the technical savings potential calculated through DSMSim by sector. The Attachment B: Measure Inputs provides the associated data.

Figure 3-1 shows the total cumulative technical potential split by sector for natural gas energy. The allocation of technical potential among sectors is generally comparable with the allocation of forecast sales among sectors, with the residential sector contributing the greatest gas energy technical potential.

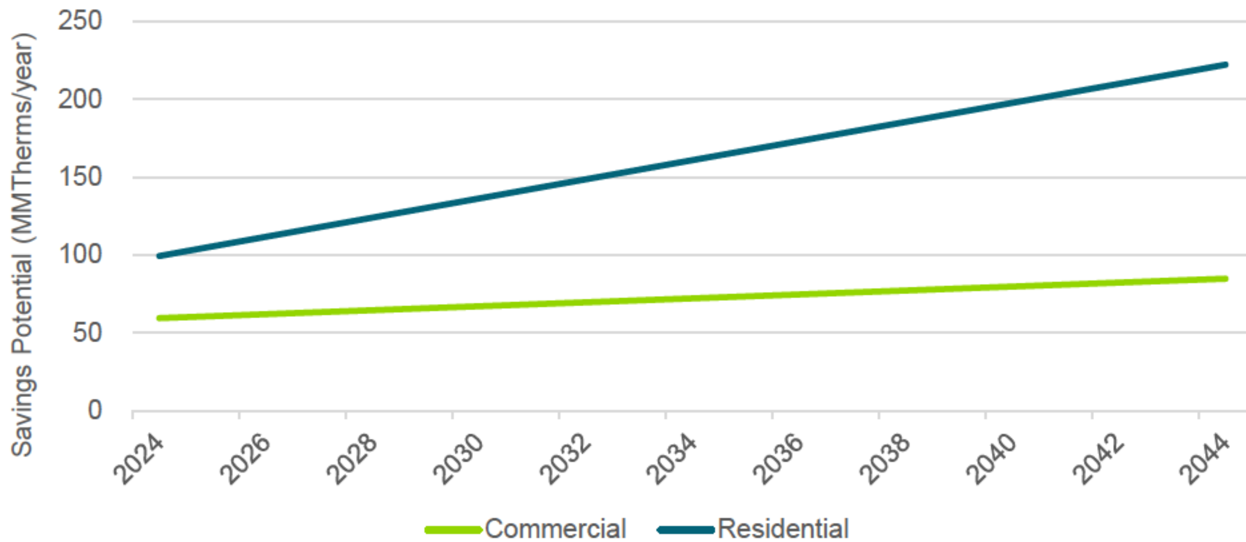
Technical potential grows over time due to new stock additions to the territory. This model uses a frozen *in-situ* efficiency baseline, meaning the baseline characteristics do not change over the forecast independent of the efficient measure adoption. The increase in potential in the

[8] Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill. 2000 for detail on System Dynamics modelling.

commercial and residential sectors from 2024-2044 corresponds with an increase in projected sales during that time period.

This highest natural gas technical potential exists within the residential sector, as well as the greatest growth in technical potential over time.

Figure 3-1. Gas Energy (MMTherms/year) Technical Savings Potential by Sector

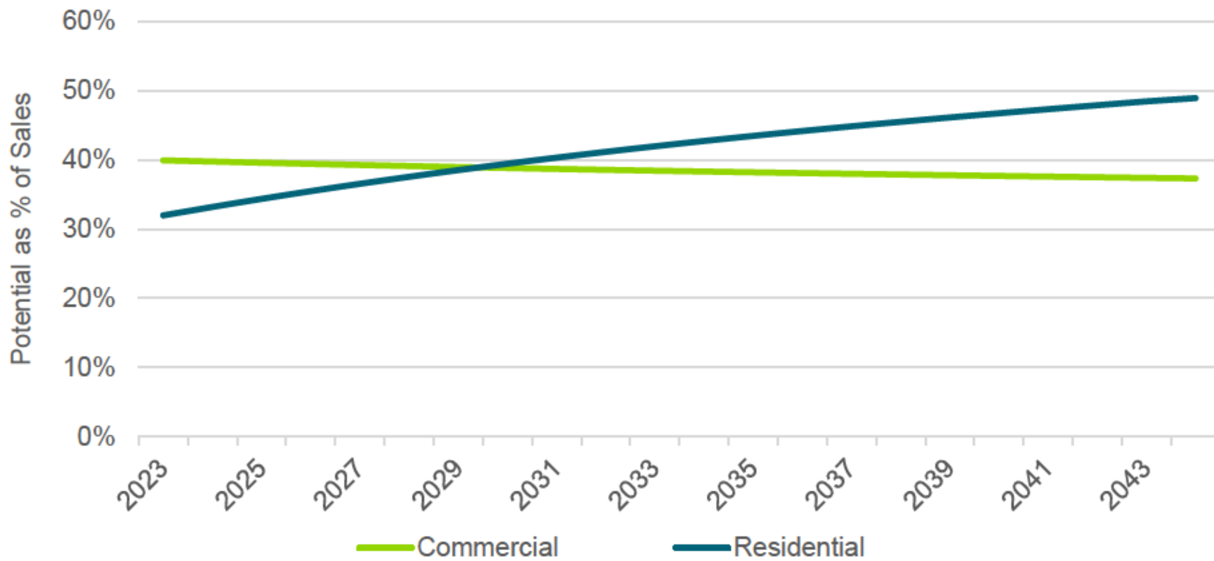


Source: Guidehouse analysis 2023

Figure 3-2 shows the natural gas energy savings potential for all sectors as a percentage of that sector's total forecast sales. The percentages reflect a weighted average savings among measures applicable to existing building stock and new building stock constructed during the study period. The growth in residential shows that technical savings potential slightly outpaces sales projections. And the decline in commercial shows that technical savings potential is outpaced by sales projections.

The 2023 CPA model shows the residential sector has the greatest technical potential for natural gas energy savings for the study period overall. This is primarily driven by the three measures with the highest technical potential (Furnace, Tankless Water Heater, and Furnace Tune-up, representing 41% of the total potential across all characterized measures) all being applicable to the residential sector.

Figure 3-2. Natural Gas Demand Technical Savings Potential by Sector as a Percent of Sector Sales (%)



Source: Guidehouse analysis 2023

Appendix C provides detailed results by segment and shows the top 40 measures contributing to technical potential.

4. Energy Efficiency Economic Potential

This section describes the economic savings potential available in IGC's service territory. Economic potential are savings that are considered cost-effective under the Utility Cost Test (UCT), which is detailed further in this section. The results below detail Guidehouse's approach for calculating economic potential as well as the detailed results for this portion of our analysis.

4.1 Approach to Estimating Economic Potential

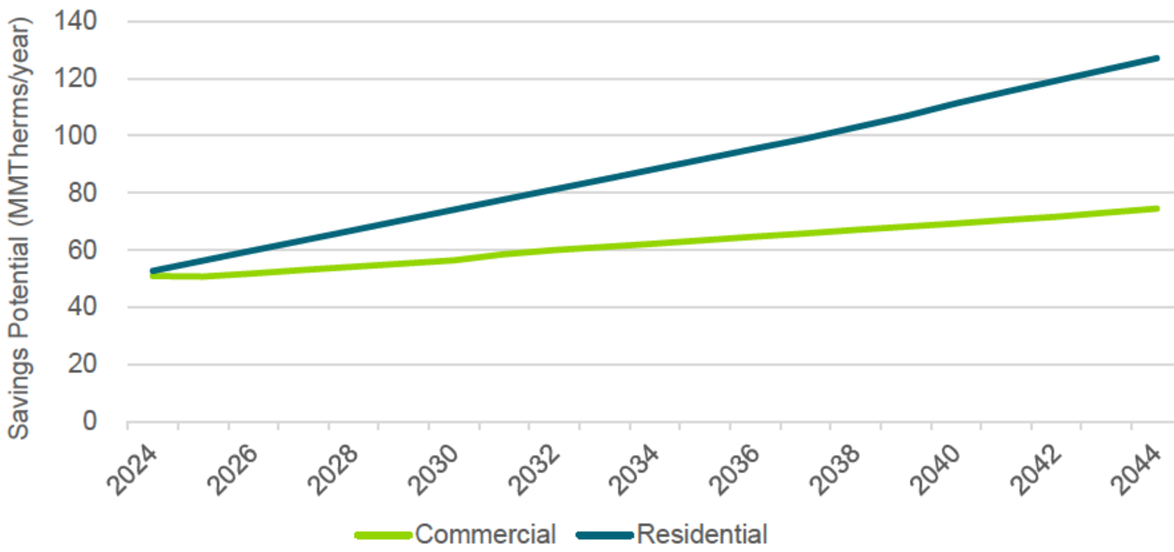
Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but including only those measures that have passed the benefit-cost test chosen for measure screening. In this Study Guidehouse used the UCT per IGC's guidance.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

The UCT is a cost-benefit metric that measures net benefits of energy efficiency from the viewpoint of the utility (or program administrator), by comparing the costs of administering a program to the cost of supply-side options for comparable energy consumption. A detailed explanation of algorithms and the approach for calculating the UCT ratio is provided in Appendix D.1.

4.2 Economic Potential Results

This section provides the economic potential calculated through DSMSim by sector. Figure 4-1 shows gas energy economic potential across all sectors. On average, 65% of technically viable natural gas energy savings potential passes the economic screening process across the study period. Technically viable savings for all of these analyses refers specifically to the energy efficiency technical potential identified in Section 3.

Figure 4-1. Natural Gas (MMTherms/year) Economic Potential Savings by Sector

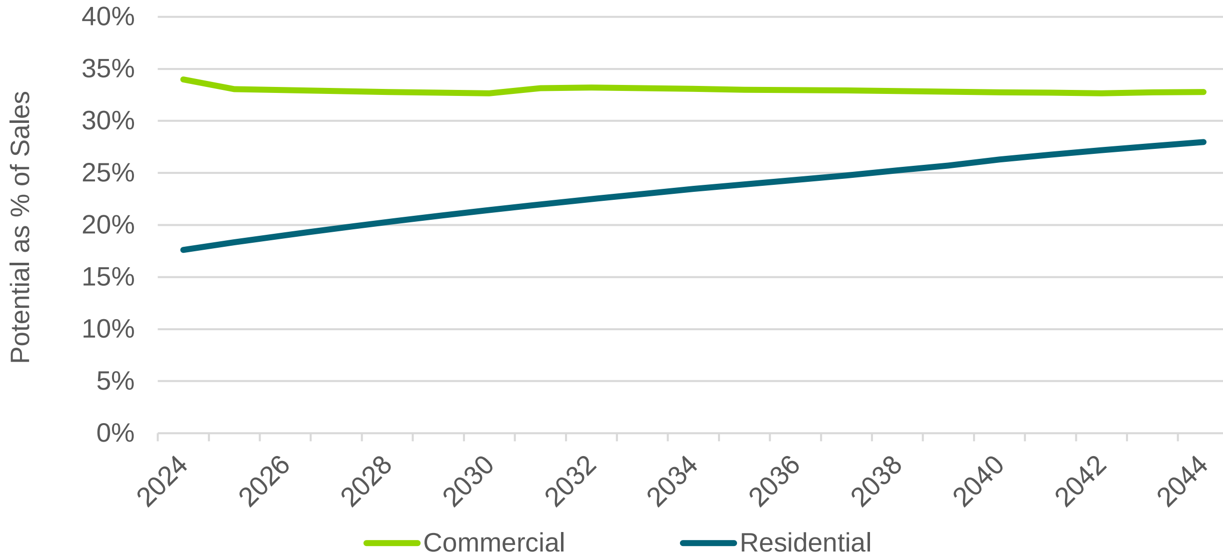


Source: Guidehouse analysis 2023

Increases in select years of the economic potential occur whenever one or more measures cross the cost-effectiveness threshold in one or more customer segments. Marginally economic measures having a UCT ratio slightly less than 1.0 at the beginning of the study period can become economically feasible as avoided costs increase. Conversely some avoided costs do not increase as fast as the inflation of measure costs, which may cause some measures to fall out of cost-effectiveness. An example of this would be an HVAC measure, Res Furnace 95 in Zone 5, which falls out of cost effectiveness from 2025-2035 due to lower avoided costs in these years compared to measure costs.

Figure 4-2 shows the economic natural gas energy savings potential as a percentage of sales. The most noteworthy trend in economic potential as a percent of sales is that, like technical potential as a percent of sales, it is relatively flat over time for the Commercial sector. For the Residential sector, the economic potential as a percent of sales is less than the Commercial sector (unlike in technical potential) because several high potential measures are not cost effective including Tankless Water Heater and Furnace Tune-up over the study period.

Figure 4-2. Natural Gas Economic Potential by Sector as a Percentage of Sector Consumption (%)



Source: Guidehouse analysis 2023

Appendix D.2 provides detailed results by segment and shows the top 40 measures contributing to economic potential. All the measure-level data inputs are provided as an attachment to this report (Attachment A – Results Figures and Tables).

5. Energy Efficiency Achievable Potential

As discussed in this report's introduction, the overall objective of the 2023 CPA is to provide IGC a well-defined estimate of the total achievable potential gas savings impact that can be realized through energy efficiency programs within its service territory. In addition to supporting EE portfolio budget and goal setting processes, this Study seeks to inform IGC's broader resource planning process and provide a forward-looking view on how demand-side programs may impact infrastructure planning and natural gas acquisition strategies over the next several decades.

To best serve these objectives, Guidehouse refined the estimate of total modeled cost-effective EE potential detailed in Section 4 to account for broader market influences that impact the adoption of these measures and technologies in the real world. In addition, several iterations of model inputs and parameters were applied to determine how the future achievable EE potential may vary depending on variables both within IGC's influence and external to it. These iterations collectively provide several potential scenarios for the future net potential impact of EE programs serving residential and commercial customers.

The following sections describe in greater detail Guidehouse's approach to calculating achievable potential as well as the results of the 2023 CPA.

5.1 Approach to Estimating Achievable Potential

5.1.1 Energy Efficiency Measure Adoption

The adoption of energy efficiency measures can be broken down into calculation of the equilibrium market share and calculation of the dynamic approach to reaching that equilibrium market share. The equilibrium market share can be thought of as the percentage of individuals choosing to purchase a technology provided those individuals are fully aware of the technology and its relative merits (e.g., the energy- and cost-saving features of the technology). In this 2023 CPA, Guidehouse used equilibrium payback acceptance curves that were developed using a meta-analysis which involved averaging payback acceptance curves from other potential studies based on Guidehouse's experience. For the research referenced to inform this Study, customer decision makers were surveyed and asked about the quantity of various end uses within their home or business to inform density and saturation estimates, and whether they would be likely to make investments in energy efficiency upgrades based on a variety of project costs and expected annual energy savings. Appendix E.1.1 provides a more detailed explanation with examples of these concepts. Initial efficient saturation (which is informed by the customer survey reference above) has a large impact on net achievable potential.

Energy efficient technologies can either be adopted as a retrofit, replace-on-burnout, or new construction measures. Guidehouse models the dynamics of how customers become aware of an efficient measure and eventually choose to adopt it or not, and how the building stock changes over time. Based on discussions with IGC, Guidehouse modeled incentives as representing a portion of the EE measure's incremental cost, defined as the net difference in the cost between baseline and efficiency measures. Additional detail regarding incentive value calculation is in Section 5.1.3 below. This methodology is described in greater detail within Appendix E.

5.1.2 Calibration

For all models that simulate future product adoption, there is no future world against which one can compare simulated with actual results. As a results, the model has to be calibrated using historic data. For this CPA Study, Guidehouse took a number of steps to ensure that forecast model results were reasonable by comparing historic program performance and incentive spending with the modeled forecast. Guidehouse adjusted model parameters and technology diffusion coefficients to obtain close agreement across a wide variety of metrics as the foundation for the CPA Study. This process ensures that forecast net potential is grounded against real-world results considering the many factors that come into play in determining the likely adoption of energy efficient measures, including both economic and non-economic factors. In the absence of robust historical data, the model was calibrated to the historic accomplishments for IGC for 2019-2021. Calibration targets were estimated using the actual incentive spend, and therm savings were estimated using unit energy saving values from the 2021 EE Annual Report and the number of annual installations. Historic accomplishments were assigned to sector and end use combinations using the closest available measure in the Study. For the Whole Home measure, the historical data was allocated based on unit energy savings from the closest available measures in the study. The model was calibrated on a sector and end use level. For measures where there was no historical data, the model was calibrated so that these measures would have very little achievable potential in 2019-2021 compared to the other measures with historical data. Appendix E.1.5 provides modeled versus historic savings for both the residential and commercial sectors and more details on how the model was calibrated.

5.1.3 Scenarios

While the calibration process detailed above seeks to align the model as closely as possible with historic actual program achievements, there is always uncertainty regarding future market influences and decisions made by IGC as it designs and implements EE programs. To account for multiple future possible sets of conditions, different model scenarios were considered representing varying approaches to calculating net achievable energy efficiency potential for the CPA study period. The specific elements of these scenarios were developed collaboratively and reflect variations in future EE budgets, IGC customer attitudes and awareness regarding energy efficiency, and different approaches to defining incentive amounts for EE measures.

Multiple model input variations, or “levers”, were considered for the 2023 CPA. IGC shared that along with the overall population of Idaho, their customer base is growing due to population migration from other states. This may reflect a future where customers in aggregate may have a greater propensity to adopt EE technologies. In addition, IGC opted to test different variations of modeled EE incentive amounts, representing different percentages of incremental measure costs.

Guidehouse modeled achievable potential for four scenarios, defined as Business as Usual, Unconstrained Historical Budget, Medium Incentive, and High Incentive, High Adoption. Together, these scenario levers provide a broader view of possible future outcomes for their EE portfolio and system.

These scenarios are defined as follows:

- **Business as Usual:** This scenario is aligned and calibrated closely with IGC’s historic program activity using IGC’s available program accomplishments on a sector and end use basis. Incentive levels are defined as 50% of measure incremental cost, with the exception of Residential Furnace which was set at 40% of incremental cost to ensure the largest potential measure was cost effective throughout the study period. While this scenario represents no intentionally defined changes to the model, it does reflect an assumption that future program budgets will be closely correlated with IGC's historic EE program spending.

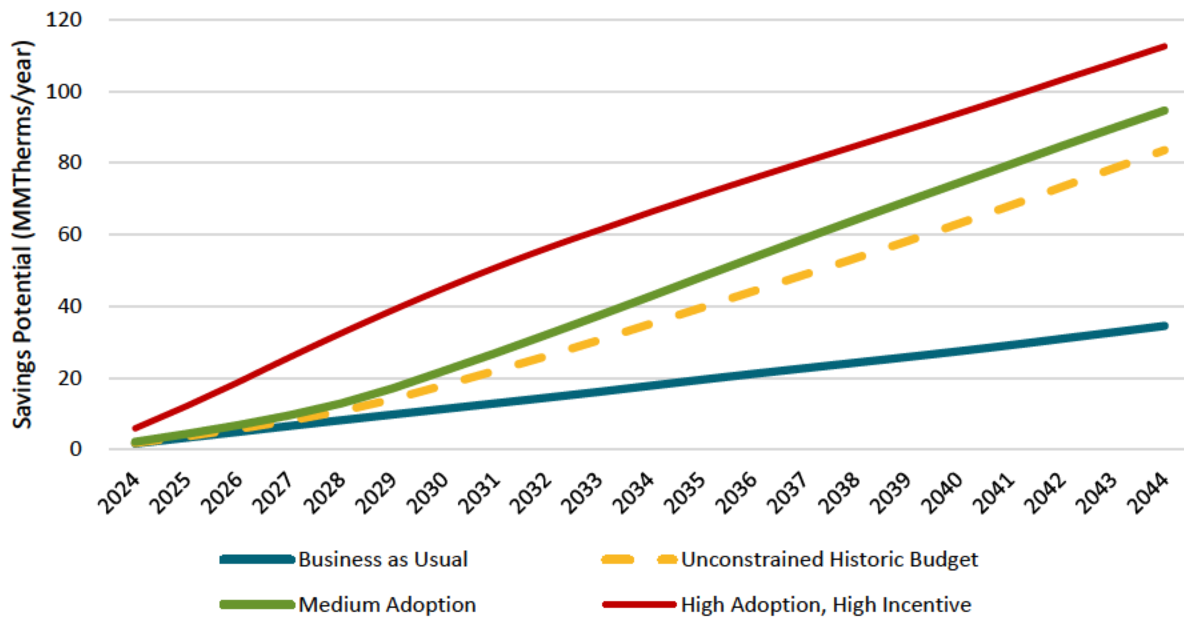
- **Unconstrained Historical Budget:** This scenario reflects a ramp up of customer adoption of natural gas energy efficiency over a 10 year period from the start of the EE program (through 2029), driven by increased IGC program activity without constraining program spending to historic levels. Incentive levels are consistent with Business as Usual Scenario.
- **Medium Adoption:** This scenario increases the adoption parameters compared to the unconstrained historical budget scenario, and increases model parameter values relating to customer awareness and willingness to adopt energy efficient technologies. Incentive levels are consistent with Business as Usual Scenario.
- **High Incentive, High Adoption:** this scenario reflects the savings possible by increasing the incentives from 50% of measure incremental cost to 65% of incremental cost, and further increasing the customer awareness and willingness to adopt energy efficiency measures to the highest values based on Guidehouse's experience and rules of thumb. Residential Furnace was kept at 40% of incremental cost to ensure it remained cost effective.

5.2 Achievable Potential Results

Figure 5-1 presents the overall net natural gas achievable potential by sector for the Business as Usual, Unconstrained Historical Budget, Medium Adoption, and High Incentive, High Adoption scenarios. Figures 5-2, 5-3, 5-4, and 5-5 show the natural gas energy savings by sector for the Business as Usual, Unconstrained Historical Budget, Medium Adoption, and High Incentive, High Adoption scenarios respectively.

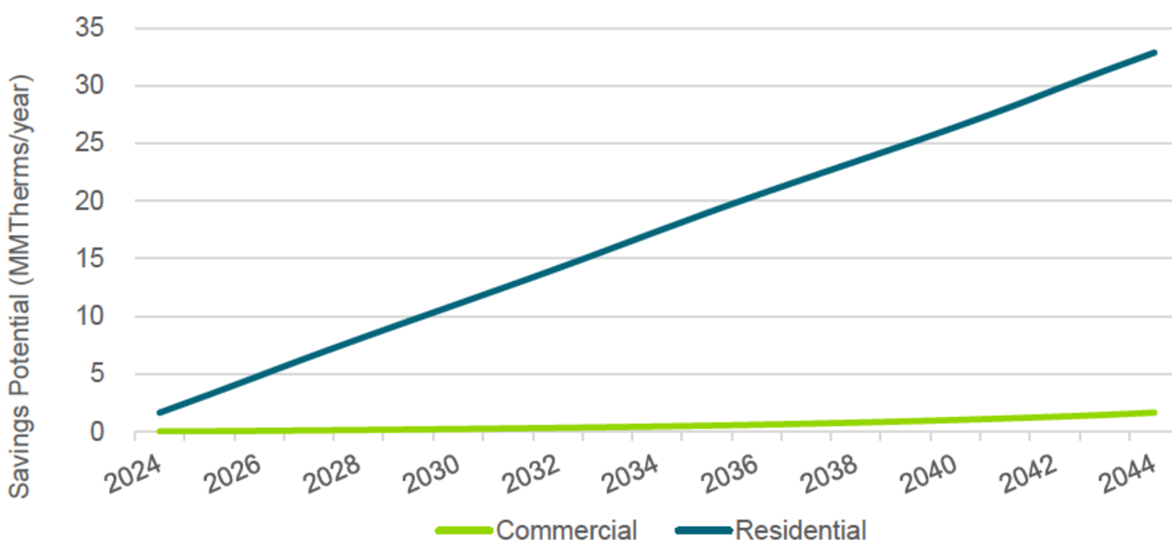
In the Business as Usual scenario, Guidehouse calibrated the residential and commercial sectors to historical accomplishments from 2019-2021 and from 2021, respectively, in alignment with the years IGC's programs were active through the 2019-2021 calibration period. In the Unconstrained Historical Budget scenario, the commercial potential is significantly higher than in the Business as Usual scenario due to the assumption that there will be a significant increase in customer awareness and adoption of measures over 10 years (by 2029). The residential sector increases due to significantly greater potential from the Hot Water end use due to the assumption of increased customer awareness and adoption of measures over 10 years (by 2029).

Figure 5-1. Total Natural Gas Energy (MMTherms/year) Cumulative Net Achievable Potential by Scenario



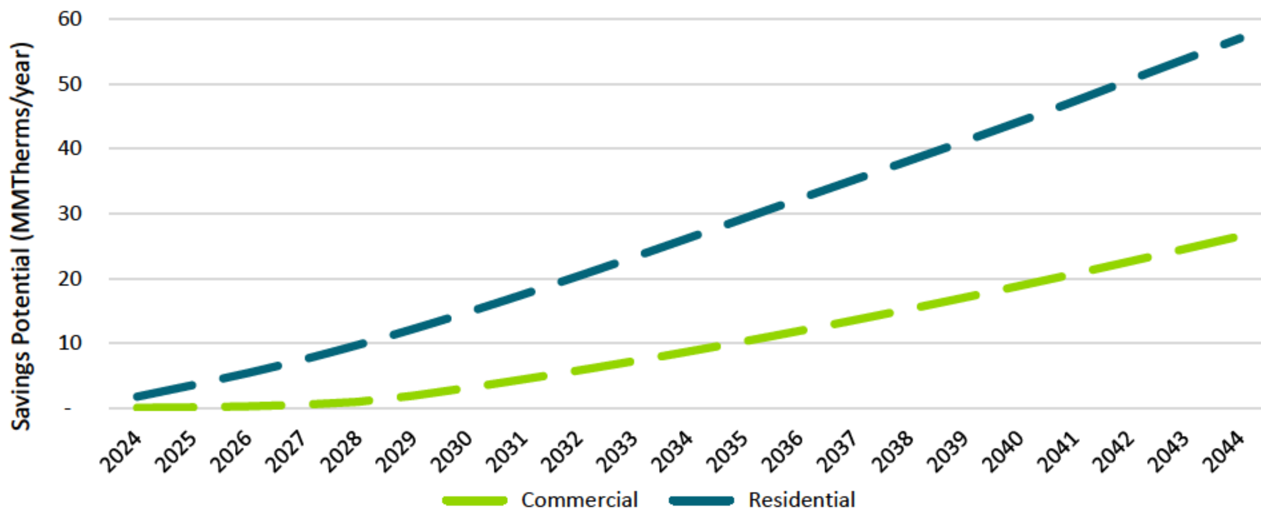
Source: Guidehouse analysis 2023

Figure 5-1. Natural Gas Energy (MMTherms/year) Cumulative Net Achievable Potential by Sector (Business as Usual)



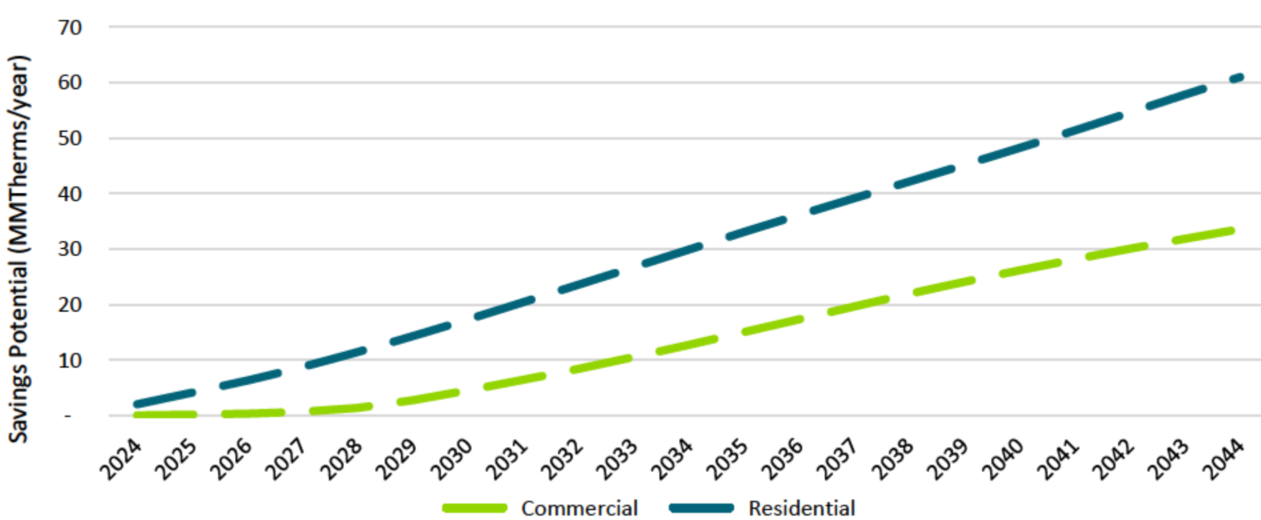
Source: Guidehouse analysis 2023

Figure 5-2. Natural Gas Energy (MMTherms/year) Cumulative Net Achievable Potential by Sector (Unconstrained Budget)



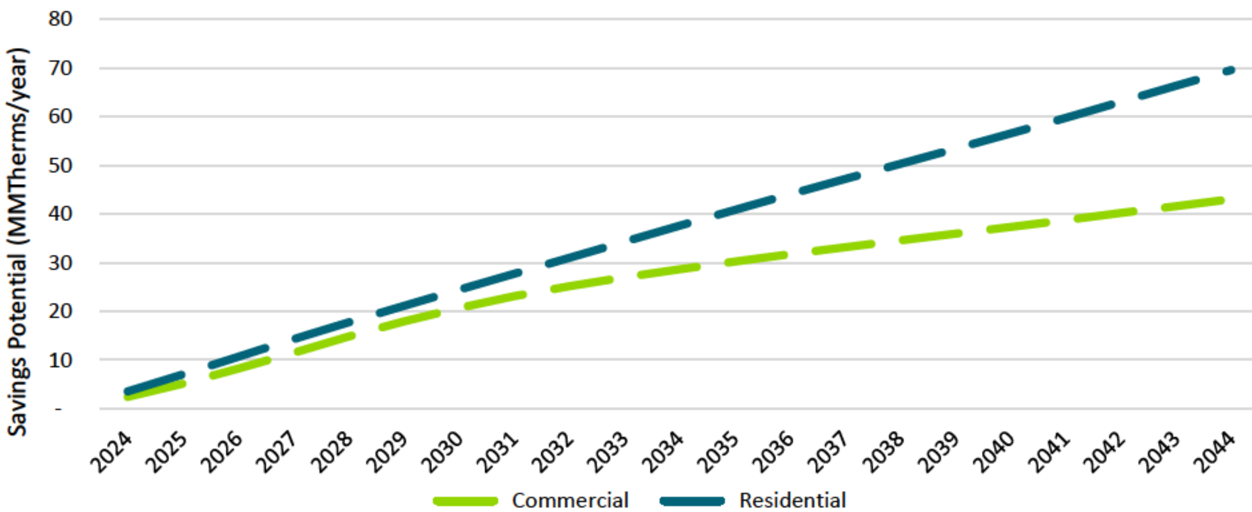
Source: Guidehouse analysis 2023

Figure 5-3. Natural Gas Energy (MMTherms/year) Cumulative Net Achievable Potential by Sector (Medium Adoption)



Source: Guidehouse analysis 2023

Figure 5-4. Natural Gas Energy (MMTherms/year) Cumulative Net Achievable Potential by Sector (High Incentive, High Adoption)



Source: Guidehouse analysis 2023

The High Incentive, High Adoption scenario potential yields significantly more achievable than the Business as Usual scenario, and it comes with a higher cost, as shown in Table 5-1. Overall, High Incentive, High Adoption scenario potential is 226% higher on a cumulative MMTherm basis, but the overall budget ranges between 92% and 163% higher annually versus the Business as Usual scenario depending on the year. The Medium Adoption scenario savings are 174% higher than the Business as Usual scenario, and the modeled budget increases as savings grows overall over the forecast period, generally about 23% - 97% higher than the Business as Usual Scenario annually. Table 5-2 provides two measure-level examples of savings and incentive costs for each scenario to highlight these differences. Both measures detailed are in the top 10 measures for each scenario in terms of overall savings potential.

Table 5-1. Gas Cumulative Net Achievable Potential and Budgets for All Scenarios

	Cumulative Gas Savings (MMTherms)	Gas Percent of Sales	Portfolio Annual Budget ($000s)
Business as Usual			
2024	1.68	0%	10,313
2029	9.77	2%	9,103
2034	17.82	3%	9,582
2039	25.80	4%	8,710
2044	34.52	5%	9,767
Unconstrained Historical Budget			
2024	1.83	0%	10,740
2029	14.07	3%	13,653

2034	34.99	6%	16,560
2039	58.17	9%	16,211
2044	83.57	12%	18,126
Medium Adoption			
2024	2.17	0%	12,639
2029	17.11	3%	15,963
2034	42.70	8%	18,259
2039	69.31	11%	16,960
2044	94.63	14%	17,692
High Adoption, High Incentive			
2024	5.93	1%	12,639
2029	38.96	8%	15,963
2034	66.17	12%	18,259
2039	89.25	14%	16,960
2044	112.55	17%	17,692

Source: Guidehouse analysis 2023

Table 5-2. Key Measure-Level Examples of Gas Savings and Incentives by Scenario (Cumulative Net in 2044)

Measure	Scenario	Cumulative Savings Potential (MMTherm)	Cumulative Incentives (Thousands $)
Com | Boiler, Large (> 300 kBtuh)	Business as Usual	0.03	143
	Unconstrained Historic Budget	1.56	6,916
	Medium Adoption	1.66	7,340
	High Incentive, High Adoption	2.68	15,522
Res | Furnace 98 AFUE (Res)	Business as Usual	26.39	136,894
	Unconstrained Historic Budget	26.39	136,894
	Medium Adoption	26.78	138,920
	High Incentive, High Adoption	26.66	138,300

Appendix E.3 provides results for the Unconstrained Historical Budget, Medium Adoption and High Incentive, High Adoption scenarios, the assumptions Guidehouse made in developing this scenario, and how it compares to the Business as Usual scenario.

To supplement this report, Guidehouse has included a detailed output file in Attachment A - Results Figures and Tables. This file shows the detailed results for all scenarios.

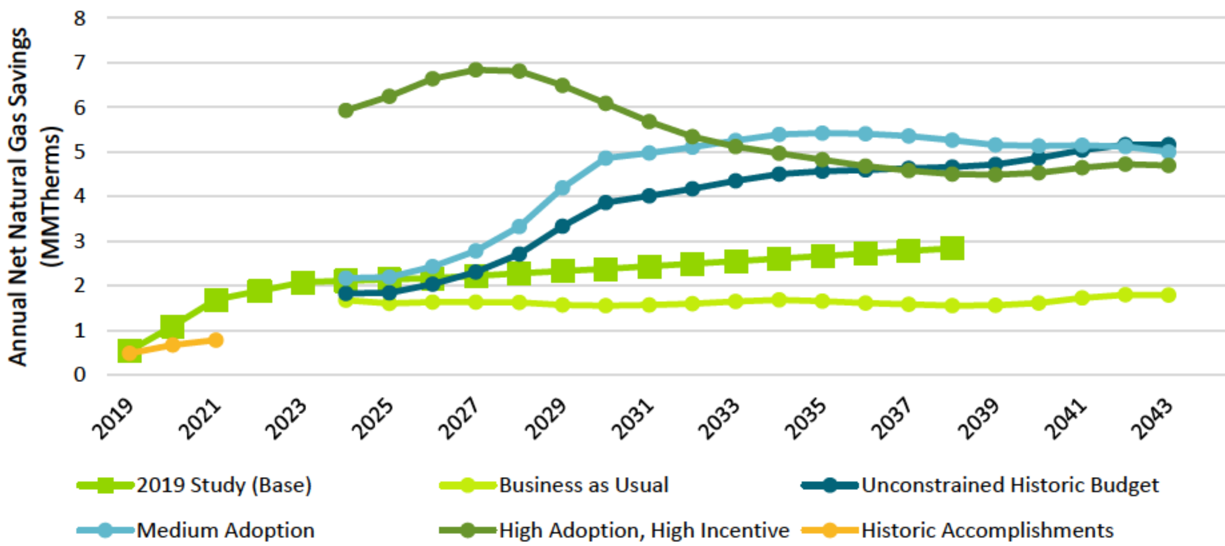
5.3 Comparison of Historical Achievements to Current and Past Potential Study Achievable Potential Results

Guidehouse presents these achievable potential results as a follow up to a previous CPA completed by Dunsky in 2019. The previous Study was conducted prior to the design and implementation of a significant part of IGC's energy efficiency program portfolio, and as a result reflected very little available historical data regarding program impacts. The 2023 CPA was calibrated using 3 years of historical accomplishments, and the Business as Usual case demonstrates what is achievable if the forecast is constrained to the historical budget. Since IGC's program is still in the relatively nascent phase, the Unconstrained Historical Budget scenario models what would happen if the program is ramped up over the course of 10 years with 2029 as the final year for the ramp up[9]. There is some continuity between the previous CPA and this Study. The previous Low scenario in the long run has similar incremental achievable potential to the Business as Usual scenario in this Study. And the Unconstrained Historical Budget and Medium Adoption scenario are comparable in achievable potential to the Base and Max scenarios in the previous Study, respectively. Figure 5-6 details the IGC's historic claimed

[9] The 2023 CPA model includes "pre-study" period beginning in 2019.

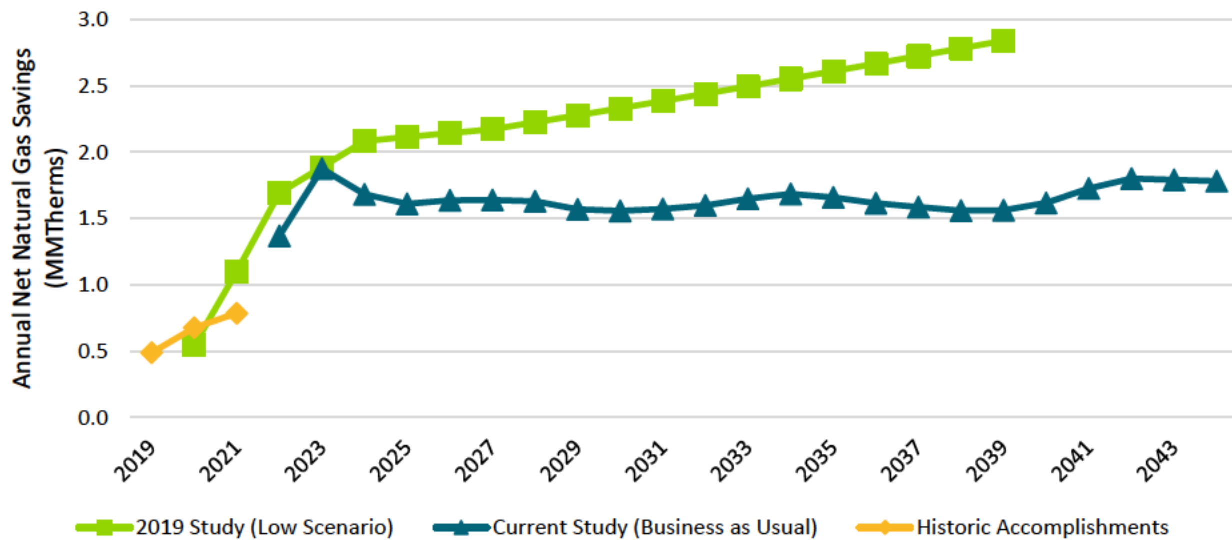
portfolio accomplishments, the 2019 CPA Base Scenario achievable potential, and the four 2023 CPA Scenarios. All values represent incremental (first year) MMTherm savings.

Figure 5-6. Natural Gas Historic Accomplishments Compared to Past and Current Study All Achievable Potential Scenario Results (Annual Net Gas Savings MMTherms)



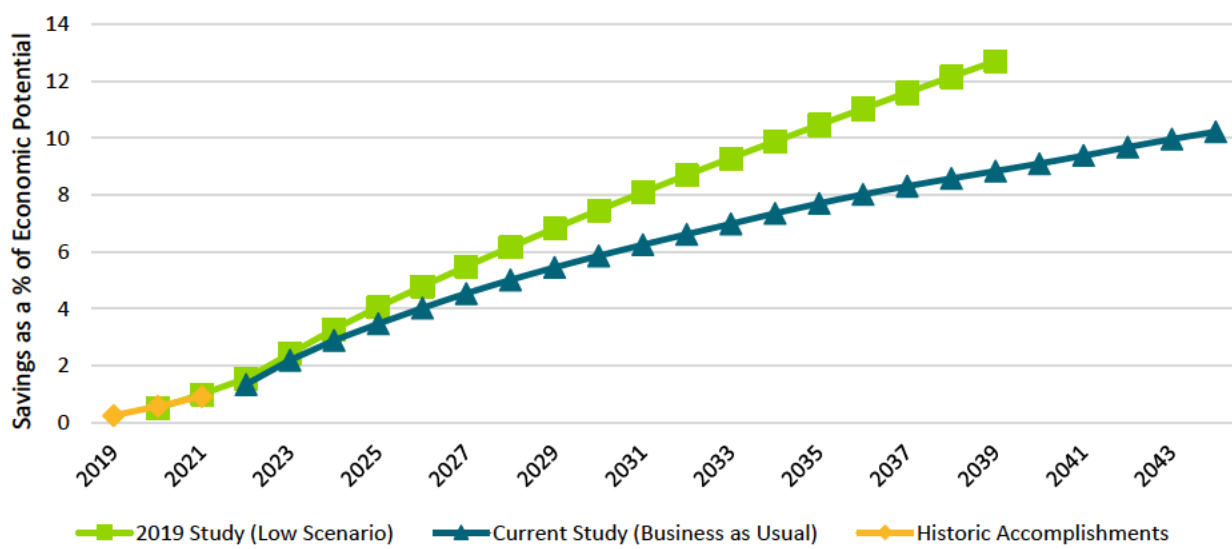
The figures below illustrate how programs have performed historically compared to the current and previous forecasts. Figure 5-7 provides a focused comparison of IGC's historical accomplishments to specific comparable scenarios from the past and current potential studies (2019 CPA Low scenario and 2023 CPA Business as Usual scenario) on an annual, incremental basis for gas savings. These results show the effect and importance of calibration and incorporating new data and market learnings into the studies over time. Figure 5-8 offers a cumulative view of historical accomplishments and Study results as a percent of economic potential from the current Study. This figure illustrated how much of the available cost-effective energy efficiency potential IGC's programs have already accomplished, and how much is remaining as the market nears saturation. In these figures, past and current CPA results are added cumulatively to any historical accomplishments before the start year of that study.

Figure 5-5. Natural Gas Historic Accomplishments Compared to Past and Current Study Achievable Potential Low Scenario Results (Annual Net Gas Savings MMTherms)



Source: Guidehouse analysis 2023

Figure 5-6. Cumulative Net Historic and Forecast Natural Gas Savings by Study as a Percent of Economic Potential



Source: Guidehouse analysis 2023

Appendix A. Market Characterization

This appendix provides a more detailed explanation of the market characterization task.

A.1 Data Request and Sources

Table A-1. Data Request and Sources

Item	Desired Scope/Granularity	Data Received
Customer Stock Data	- Historic (2019-2022) and forecast (thru 2044) - Residential: households by segment - Commercial: square footage by segment	Years: 2019-2044
Gas Sales Data	- Historic (2019-2022) and forecast (thru 2044) - By sector and segment	Number of accounts at sector level
Retail Rate Data	- Historic (2019-2022) and forecast (thru 2074) - By sector and load shape period	Years: 2019-2044
Avoided Cost Data	- Historic (2019-2022) and forecast (thru 2074) - By load shape period	Sales at sector level
IGC Discount Rate(s)	Over study period (2019-2044)	Years: 2019-2023
IGC Inflation Rate(s)	Over study period (2019-2044)	Retail rates at sector level

Source: Guidehouse

A.2 Global Inputs Data

Table A-2. Commercial Gas Sales - Zone 5 (Therms)

Year	Food Service	Healthcare	Lodging	Office	Light/ Converted	Education	Retail	M&I
2019	18,499,878	1,875,118	5,509,368	5,218,140	996,814	10,796,428	50,473,544	3,286,290
2020	17,557,332	1,779,583	5,228,672	4,952,282	946,027	10,246,363	47,901,978	3,118,857
2021	17,705,932	1,794,645	5,272,927	4,994,197	954,034	10,333,086	48,307,408	3,145,254
2022	20,564,228	2,084,357	6,124,143	5,800,418	1,108,045	12,001,172	56,105,746	3,652,998
2023	20,308,012	2,058,388	6,047,841	5,728,149	1,094,240	11,851,646	55,406,709	3,607,484
2024	20,858,769	2,114,212	6,211,859	5,883,497	1,123,916	12,173,064	56,909,349	3,705,320
2025	21,388,225	2,167,876	6,369,534	6,032,837	1,152,444	12,482,052	58,353,871	3,799,371
2026	21,927,698	2,222,557	6,530,192	6,185,003	1,181,512	12,796,885	59,825,726	3,895,202
2027	22,467,589	2,277,279	6,690,975	6,337,287	1,210,602	13,111,963	61,298,719	3,991,108
2028	23,018,872	2,333,156	6,855,150	6,492,783	1,240,307	13,433,689	62,802,795	4,089,037
2029	23,547,097	2,386,696	7,012,458	6,641,776	1,268,769	13,741,958	64,243,960	4,182,870
2030	24,086,891	2,441,409	7,173,212	6,794,033	1,297,854	14,056,979	65,716,691	4,278,758
2031	24,626,766	2,496,130	7,333,990	6,946,312	1,326,944	14,372,047	67,189,641	4,374,661
2032	25,179,220	2,552,126	7,498,514	7,102,139	1,356,711	14,694,456	68,696,910	4,472,798
2033	25,706,480	2,605,568	7,655,535	7,250,859	1,385,121	15,002,162	70,135,442	4,566,459
2034	26,246,366	2,660,290	7,816,316	7,403,142	1,414,211	15,317,237	71,608,424	4,662,364
2035	26,786,257	2,715,012	7,977,098	7,555,425	1,443,302	15,632,314	73,081,417	4,758,269
2036	27,339,847	2,771,123	8,141,961	7,711,573	1,473,130	15,955,386	74,591,788	4,856,608
2037	27,865,989	2,824,452	8,298,649	7,859,978	1,501,480	16,262,440	76,027,271	4,950,071
2038	28,405,856	2,879,172	8,459,424	8,012,255	1,530,569	16,577,503	77,500,199	5,045,972
2039	28,945,740	2,933,894	8,620,205	8,164,537	1,559,659	16,892,577	78,973,174	5,141,877
2040	29,500,478	2,990,122	8,785,409	8,321,008	1,589,550	17,216,318	80,486,674	5,240,419
2041	30,025,620	3,043,349	8,941,799	8,469,131	1,617,845	17,522,789	81,919,430	5,333,705
2042	30,565,628	3,098,084	9,102,617	8,621,448	1,646,942	17,837,935	83,392,743	5,429,631
2043	31,105,715	3,152,826	9,263,457	8,773,787	1,676,043	18,153,126	84,866,271	5,525,571
2044	31,661,789	3,209,189	9,429,059	8,930,635	1,706,006	18,477,648	86,383,418	5,624,351

Source: Guidehouse

Table A-3. Commercial Gas Sales - Zone 6 (Therms)

Year	Food Service	Healthcare	Lodging	Office	Light, Converted	Education	Retail	M&I
2019	5,694,295	776,823	2,897,731	1,683,248	372,624	4,454,991	19,612,077	639,524
2020	5,404,178	737,245	2,750,095	1,597,488	353,639	4,228,015	18,612,866	606,941
2021	5,449,917	743,485	2,773,372	1,611,009	356,632	4,263,799	18,770,400	612,078
2022	6,329,706	863,507	3,221,081	1,871,077	414,204	4,952,111	21,800,534	710,887
2023	6,250,842	852,748	3,180,949	1,847,764	409,043	4,890,411	21,528,915	702,030
2024	6,420,366	875,875	3,267,217	1,897,876	420,137	5,023,040	22,112,783	721,069
2025	6,583,333	898,107	3,350,148	1,946,050	430,801	5,150,539	22,674,069	739,372
2026	6,749,384	920,760	3,434,649	1,995,135	441,667	5,280,451	23,245,975	758,021
2027	6,915,563	943,430	3,519,214	2,044,258	452,541	5,410,463	23,818,324	776,684
2028	7,085,249	966,579	3,605,565	2,094,417	463,645	5,543,219	24,402,750	795,742
2029	7,247,838	988,760	3,688,303	2,142,479	474,285	5,670,421	24,962,731	814,002
2030	7,413,988	1,011,426	3,772,854	2,191,593	485,157	5,800,410	25,534,978	832,662
2031	7,580,162	1,034,096	3,857,417	2,240,715	496,032	5,930,419	26,107,309	851,325
2032	7,750,208	1,057,294	3,943,951	2,290,981	507,159	6,063,456	26,692,976	870,423
2033	7,912,500	1,079,434	4,026,539	2,338,955	517,779	6,190,426	27,251,934	888,650
2034	8,078,678	1,102,104	4,111,104	2,388,077	528,653	6,320,438	27,824,278	907,313
2035	8,244,857	1,124,774	4,195,670	2,437,200	539,528	6,450,450	28,396,627	925,977
2036	8,415,253	1,148,020	4,282,381	2,487,570	550,678	6,583,761	28,983,499	945,114
2037	8,577,201	1,170,113	4,364,794	2,535,442	561,276	6,710,462	29,541,272	963,302
2038	8,743,373	1,192,782	4,449,356	2,584,563	572,150	6,840,469	30,113,596	981,965
2039	8,909,550	1,215,453	4,533,921	2,633,685	583,024	6,970,479	30,685,937	1,000,628
2040	9,080,299	1,238,746	4,620,812	2,684,159	594,198	7,104,066	31,274,025	1,019,805
2041	9,241,939	1,260,797	4,703,068	2,731,940	604,775	7,230,527	31,830,739	1,037,959
2042	9,408,154	1,283,473	4,787,652	2,781,074	615,652	7,360,567	32,403,211	1,056,626
2043	9,574,394	1,306,151	4,872,249	2,830,215	626,530	7,490,627	32,975,768	1,075,297
2044	9,745,554	1,329,501	4,959,349	2,880,810	637,731	7,624,536	33,565,272	1,094,520

Source: Guidehouse

Table A-4. Residential Gas Sales - Zone 5 and Zone 6 (Therms)

	Zone 5		Zone 6	
Year	Single family	Multi-family	Single family	Multi-family
2019	166,278,673	22,996,993	62,157,476	8,596,623
2020	165,192,113	22,846,718	61,751,304	8,540,448
2021	164,335,181	22,728,201	61,430,969	8,496,144
2022	193,108,925	26,707,723	72,187,029	9,983,750
2023	186,422,036	25,782,900	69,687,369	9,638,037
2024	191,477,835	26,482,137	71,577,303	9,899,422
2025	196,338,093	27,154,329	73,394,141	10,150,698
2026	201,290,311	27,839,241	75,245,355	10,406,728
2027	206,246,360	28,524,682	77,098,001	10,662,956
2028	211,306,991	29,224,587	78,989,741	10,924,591
2029	216,155,953	29,895,217	80,802,356	11,175,283
2030	221,111,118	30,580,536	82,654,671	11,431,466
2031	226,067,023	31,265,957	84,507,263	11,687,686
2032	231,138,397	31,967,348	86,403,019	11,949,877
2033	235,978,498	32,636,753	88,212,322	12,200,111
2034	240,934,510	33,322,189	90,064,954	12,456,337
2035	245,890,558	34,007,630	91,917,600	12,712,565
2036	250,972,369	34,710,464	93,817,257	12,975,295
2037	255,802,213	35,378,451	95,622,726	13,224,999
2038	260,758,043	36,063,861	97,475,290	13,481,215
2039	265,714,031	36,749,294	99,327,913	13,737,440
2040	270,806,369	37,453,584	101,231,506	14,000,715
2041	275,627,037	38,120,302	103,033,544	14,249,944
2042	280,584,163	38,805,892	104,886,593	14,506,228
2043	285,542,012	39,491,582	106,739,911	14,762,549
2044	290,646,620	40,197,569	108,648,091	15,026,458

Source: Guidehouse analysis 2023

Table A-5. Commercial Stock - Zone 5 (1,000 sq. ft. floor area)

Year	Food Service	Healthcare	Lodging	Office	Light, Converted	Education	Retail	M&I
2019	11,304	13,121	36,107	55,566	2,933	49,151	96,059	93,187
2020	11,493	13,340	36,712	56,497	2,982	49,975	97,669	94,748
2021	11,658	13,531	37,237	57,305	3,025	50,689	99,066	96,103
2022	11,822	13,722	37,762	58,113	3,067	51,404	100,462	97,458
2023	11,981	13,906	38,269	58,893	3,109	52,094	101,810	98,766
2024	12,139	14,090	38,775	59,672	3,150	52,783	103,158	100,073
2025	12,291	14,267	39,261	60,420	3,189	53,444	104,450	101,326
2026	12,446	14,447	39,756	61,182	3,229	54,118	105,767	102,604
2027	12,602	14,627	40,253	61,947	3,270	54,795	107,089	103,887
2028	12,756	14,806	40,746	62,705	3,310	55,466	108,401	105,159
2029	12,911	14,986	41,239	63,464	3,350	56,137	109,713	106,432
2030	13,066	15,166	41,734	64,226	3,390	56,811	111,030	107,710
2031	13,220	15,345	42,228	64,986	3,430	57,483	112,344	108,984
2032	13,375	15,524	42,721	65,745	3,470	58,155	113,657	110,258
2033	13,529	15,704	43,215	66,505	3,510	58,827	114,970	111,532
2034	13,684	15,883	43,709	67,265	3,550	59,499	116,284	112,806
2035	13,838	16,062	44,202	68,024	3,591	60,171	117,596	114,079
2036	13,993	16,242	44,696	68,784	3,631	60,843	118,909	115,353
2037	14,147	16,421	45,189	69,543	3,671	61,514	120,221	116,626
2038	14,302	16,600	45,682	70,301	3,711	62,185	121,533	117,898
2039	14,456	16,779	46,175	71,060	3,751	62,856	122,844	119,170
2040	14,610	16,958	46,668	71,819	3,791	63,527	124,155	120,443
2041	14,765	17,137	47,160	72,577	3,831	64,198	125,466	121,714
2042	14,919	17,316	47,653	73,335	3,871	64,869	126,777	122,986
2043	15,073	17,495	48,146	74,094	3,911	65,540	128,088	124,258
2044	15,227	17,675	48,639	74,852	3,951	66,210	129,399	125,530

Source: Guidehouse

Table A-6. Commercial Stock - Zone 6 (1,000 sq. ft. floor area)

Year	Food Service	Healthcare	Lodging	Office	Light, Converted	Education	Retail	M&I
2019	4,226	4,905	13,497	20,771	1,096	18,373	35,908	34,835
2020	4,296	4,987	13,723	21,120	1,115	18,681	36,510	35,418
2021	4,358	5,058	13,920	21,422	1,131	18,948	37,032	35,925
2022	4,419	5,130	14,116	21,724	1,147	19,216	37,554	36,431
2023	4,479	5,198	14,305	22,015	1,162	19,473	38,058	36,920
2024	4,538	5,267	14,495	22,306	1,177	19,731	38,562	37,409
2025	4,595	5,333	14,676	22,586	1,192	19,978	39,045	37,877
2026	4,653	5,400	14,861	22,871	1,207	20,230	39,537	38,355
2027	4,711	5,468	15,047	23,157	1,222	20,483	40,032	38,834
2028	4,769	5,535	15,231	23,440	1,237	20,734	40,522	39,310
2029	4,826	5,602	15,416	23,724	1,252	20,985	41,012	39,786
2030	4,884	5,669	15,601	24,009	1,267	21,237	41,505	40,264
2031	4,942	5,736	15,785	24,293	1,282	21,488	41,996	40,740
2032	5,000	5,803	15,970	24,577	1,297	21,739	42,487	41,216
2033	5,058	5,870	16,154	24,861	1,312	21,991	42,978	41,692
2034	5,115	5,937	16,339	25,145	1,327	22,242	43,469	42,169
2035	5,173	6,004	16,523	25,429	1,342	22,493	43,959	42,645
2036	5,231	6,071	16,708	25,712	1,357	22,744	44,450	43,121
2037	5,288	6,138	16,892	25,996	1,372	22,995	44,940	43,596
2038	5,346	6,205	17,077	26,280	1,387	23,246	45,431	44,072
2039	5,404	6,272	17,261	26,563	1,402	23,497	45,921	44,548
2040	5,462	6,339	17,445	26,847	1,417	23,747	46,411	45,023
2041	5,519	6,406	17,629	27,130	1,432	23,998	46,901	45,499
2042	5,577	6,473	17,814	27,414	1,447	24,249	47,391	45,974
2043	5,635	6,540	17,998	27,697	1,462	24,500	47,881	46,449
2044	5,692	6,607	18,182	27,981	1,477	24,750	48,371	46,925

Source: Guidehouse

Table A-7. Residential Stock - Zone 5 and Zone 6 (Households)

	Zone 5		Zone 6	
Year	**Single family**	**Multi-family**	**Single family**	**Multi-family**
2019	218,507	30,220	81,681	11,297
2020	225,534	31,192	84,308	11,660
2021	232,388	32,140	86,870	12,014
2022	239,256	33,090	89,437	12,370
2023	246,159	34,045	92,018	12,726
2024	252,912	34,979	94,543	13,076
2025	259,657	35,912	97,064	13,424
2026	266,409	36,845	99,588	13,773
2027	273,155	37,778	102,109	14,122
2028	279,905	38,712	104,633	14,471
2029	286,653	39,645	107,155	14,820
2030	293,404	40,579	109,679	15,169
2031	300,153	41,512	112,202	15,518
2032	306,904	42,446	114,725	15,867
2033	313,655	43,380	117,249	16,216
2034	320,406	44,313	119,772	16,565
2035	327,157	45,247	122,296	16,914
2036	333,908	46,181	124,820	17,263
2037	340,658	47,114	127,343	17,612
2038	347,409	48,048	129,867	17,961
2039	354,160	48,982	132,391	18,310
2040	360,912	49,916	134,914	18,659
2041	367,665	50,849	137,439	19,008
2042	374,418	51,783	139,963	19,357
2043	381,172	52,718	142,488	19,707
2044	387,927	53,652	145,013	20,056

Source: Guidehouse

Table A-8. Residential and Commercial Retail Rates ($)

	Commercial			Residential		
Year	HVAC	Hot Water	Other	HVAC	Hot Water	Other
2019	0.4674	0.4674	0.4674	0.5182	0.5182	0.5182
2020	0.4896	0.4896	0.4896	0.5403	0.5403	0.5403
2021	0.5579	0.5579	0.5579	0.5967	0.5967	0.5967
2022	0.7083	0.7083	0.7083	0.7339	0.7339	0.7339
2023	0.8442	0.8442	0.8442	0.8698	0.8698	0.8698
2024	0.6812	0.6700	0.6700	0.7163	0.7042	0.7042
2025	0.6677	0.6509	0.6509	0.7075	0.6893	0.6893
2026	0.6541	0.6318	0.6318	0.6987	0.6744	0.6744
2027	0.6406	0.6127	0.6127	0.6899	0.6596	0.6596
2028	0.6270	0.5935	0.5935	0.6811	0.6447	0.6447
2029	0.6066	0.5833	0.5833	0.6589	0.6336	0.6336
2030	0.6081	0.5872	0.5872	0.6605	0.6378	0.6378
2031	0.6083	0.5959	0.5959	0.6607	0.6472	0.6472
2032	0.6140	0.6044	0.6044	0.6669	0.6565	0.6565
2033	0.6254	0.6157	0.6157	0.6793	0.6687	0.6687
2034	0.6316	0.6181	0.6181	0.6860	0.6713	0.6713
2035	0.6287	0.6162	0.6162	0.6829	0.6693	0.6693
2036	0.6249	0.6139	0.6139	0.6788	0.6668	0.6668
2037	0.6224	0.6107	0.6107	0.6760	0.6633	0.6633
2038	0.6203	0.6102	0.6102	0.6738	0.6628	0.6628
2039	0.6240	0.6157	0.6157	0.6778	0.6688	0.6688
2040	0.6397	0.6325	0.6325	0.6949	0.6870	0.6870
2041	0.6651	0.6533	0.6533	0.7224	0.7096	0.7096
2042	0.6772	0.6619	0.6619	0.7355	0.7190	0.7190
2043	0.6736	0.6601	0.6601	0.7317	0.7170	0.7170
2044	0.6765	0.6605	0.6605	0.7348	0.7175	0.7175

Source: Guidehouse

Table A-9. Avoided Costs ($)

Year	HVAC	Hot Water	Other
2019	0.4149	0.4149	0.4149
2020	0.4587	0.4587	0.4587
2021	0.5025	0.5025	0.5025
2022	0.8698	0.8798	0.8798
2023	1.6844	1.0899	1.0899
2024	0.8904	0.7213	0.7213
2025	0.7510	0.6460	0.6460
2026	0.6938	0.6176	0.6176
2027	0.6295	0.5812	0.5812
2028	0.5759	0.5451	0.5451
2029	0.5572	0.5357	0.5357
2030	0.5585	0.5393	0.5393
2031	0.5587	0.5473	0.5473
2032	0.5639	0.5551	0.5551
2033	0.5744	0.5655	0.5655
2034	0.5801	0.5677	0.5677
2035	0.5775	0.5659	0.5659
2036	0.5740	0.5638	0.5638
2037	0.5716	0.5609	0.5609
2038	0.5697	0.5604	0.5604
2039	0.5731	0.5655	0.5655
2040	0.5875	0.5809	0.5809
2041	0.6109	0.6000	0.6000
2042	0.6219	0.6079	0.6079
2043	0.6187	0.6063	0.6063
2044	0.6213	0.6067	0.6067

Source: Guidehouse

Appendix B. Measure Characterization

This appendix provides additional details regarding the energy efficiency measure characterized as part of the 2023 CPA.

B.1 Residential Measure List

Table B-1. Residential End Uses and Measures

End Use	Common Measure	Baseline Measure	Efficient Measure Name	Replacement Type
Appliance	Clothes Washer (Res)	Standard Clothes Washer	ENERGY STAR Clothes Washer	ROB and NEW
	Clothes Dryer (Res)	Standard Clothes Dryer	ENERGY STAR Clothes Dryer	ROB and NEW
	Pool Heater (Res)	Standard Pool Heater 82% Eff.	ENERGY STAR Pool Heater	NEW Only
	Pool Heater (Res)	Standard Pool Heater 82% Eff.	ENERGY STAR Pool Heater	RET Only
	Pool Cover (Res)	No Pool Cover	Pool with Cover	NEW Only
	Pool Cover (Res)	No Pool Cover	Pool with Cover	RET Only
Behavioral	Home Energy Report	No Home Energy Report	Home Energy Report	RET Only
Envelope	Windows (Res)	Standard Windows	ENERGY STAR Windows	NEW Only
	Windows (Res)	Standard Windows	ENERGY STAR Windows	RET Only
	ENERGY STAR Doors	Standard Doors	ENERGY STAR Doors	NEW Only
	ENERGY STAR Doors	Standard Doors	ENERGY STAR Doors	RET Only
	Air Sealing (Res)	No Air Sealing	Air Sealing Energy Kit Distribution	NEW Only
	Air Sealing (Res)	No Air Sealing	Air Sealing Energy Kit Distribution	RET Only
	Attic/Roof Insulation (Res)	R-11 Attic/Roof Insulation	R-30 Attic/Roof Insulation	NEW Only
	Attic/Roof Insulation (Res)	R-11 Attic/Roof Insulation	R-30 Attic/Roof Insulation	RET Only
	Basement Insulation	R-5 Basement Insulation	R-20 Basement Insulation	NEW Only
	Basement Insulation	R-5 Basement Insulation	R-20 Basement Insulation	RET Only
	Wall Insulation (Res)	R-5 Wall Insulation	R-15 Wall Insulation	NEW Only
	Wall Insulation (Res)	R-5 Wall Insulation	R-15 Wall Insulation	RET Only
HVAC	Furnace 95 AFUE (Res)	Standard Res Central Furnace (80 AFUE)	Efficient Res Central Furnace (95 AFUE)	ROB and NEW
	Furnace 98 AFUE (Res)	Standard Res Central Furnace (80 AFUE)	Efficient Res Central Furnace (98 AFUE)	ROB and NEW
	Gas Heat Pump (Space Heating) (Res)	Standard Res Central Furnace (80 AFUE)	Res Central Gas Absorption Heat Pump	ROB and NEW

End Use	Common Measure	Baseline Measure	Efficient Measure Name	Replacement Type
	Furnace Tune-Up (Res)	No Furnace Tune-Up	Furnace Tune-Up	RET Only
	Boiler (Res)	Standard Res Boiler 84 AFUE	High-efficiency Res Boiler 95 AFUE	ROB and NEW
	Boiler Reset Control (Res)	No Reset Control	Reset Control	RET Only
	Boiler Tune-Up (Res)	No Boiler Tune-Up	Boiler Tune-Up	RET Only
	Combination Boiler, Space and Water Heat (Res)	Standard Gas Boiler and Water Heater	Combo Boiler 95 AFUE	ROB and NEW
	Duct Insulation (Res)	No Duct Insulation	Duct Insulation R-6	NEW Only
	Duct Insulation (Res)	No Duct Insulation	Duct Insulation R-6	RET Only
	Duct Sealing (Res)	Leaky Ducts (20% leakage rate)	Sealed Ducts (6% leakage rate)	RET Only
	Fireplace	Standard Fireplace (64% Eff.)	Efficient Fireplace (70% Eff.)	ROB and NEW
	Heat Recovery Ventilator (HRV)	No Heat Recovery	ENERGY STAR HRV	NEW Only
	Programmable Thermostat (Res)	Manual Thermostat	Programmable Thermostat	NEW Only
	Programmable Thermostat (Res)	Manual Thermostat	Programmable Thermostat	RET Only
	Wi-Fi Thermostat (Res)	Manual Thermostat	Wi-Fi Thermostat	NEW Only
	Wi-Fi Thermostat (Res)	Manual Thermostat	Wi-Fi Thermostat	RET Only
Hot Water	High-Efficiency Storage Water Heater (Res)	Standard Res Storage Water Heater	Efficient Res Storage Water Heater 0.68 UEF	ROB and NEW
	Tankless Water Heater (Res)	Standard Res Storage Water Heater	Tankless Res Water Heater 0.87 UEF	ROB and NEW
	Faucet Aerator (Res)	No Faucet Aerator	Low-flow Faucet Aerator 1.5 gpm	NEW Only
	Faucet Aerator (Res)	No Faucet Aerator	Low-flow Faucet Aerator 1.5 gpm	RET Only
	Low-flow Showerhead (Res)	2.5gpm Showerhead	1.5gpm Showerhead	NEW Only
	Low-flow Showerhead (Res)	2.5gpm Showerhead	1.5gpm Showerhead	RET Only
	Hot Water Pipe Insulation (Res)	Non-insulated Hot Water Pipe	Insulated Hot Water Pipe R4	NEW Only
	Hot Water Pipe Insulation (Res)	Non-insulated Hot Water Pipe	Insulated Hot Water Pipe R4	RET Only
	Thermostatic Restrictor Shower Valve (Res)	No Thermostatic Valve	Thermostatic Valve	NEW Only
	Thermostatic Restrictor Shower Valve (Res)	No Thermostatic Valve	Thermostatic Valve	RET Only

Source: Guidehouse

B.2 Commercial Measure List

Table B-2. Commercial End Uses and Measures

End Use	Common Measure	Baseline Measure	Efficient Measure	Replacement Type
Appliance	Ozone Laundry	Standard Commercial Process Washer	Ozone Laundry System Retrofit	NEW Only
	Ozone Laundry	Standard Commercial Process Washer	Ozone Laundry System Retrofit	RET Only
	Clothes Washer and Dryer (Com)	Standard Clothes Washer and Dryer, Gas Water Heat	ENERGY STAR Clothes Washer and Dryer	ROB and NEW
	Pool Heater (Com)	Standard Pool Heater 78% Eff.	ENERGY STAR Pool Heater 84%+ Eff.	NEW Only
	Pool Heater (Com)	Standard Pool Heater 78% Eff.	ENERGY STAR Pool Heater 84%+ Eff.	RET Only
	Pool Cover (Com)	No Pool Cover	Pool with Cover	NEW Only
	Pool Cover (Com)	No Pool Cover	Pool with Cover	RET Only
Behavioral	Building Operator Certification	No BOC Training	BOC Training	RET Only
Envelope	Windows (Com)	Standard Windows	ENERGY STAR Windows	NEW Only
	Windows (Com)	Standard Windows	ENERGY STAR Windows	RET Only
	Air Sealing (Com)	No Air Sealing	Air Sealing Energy Kit Distribution	NEW Only
	Air Sealing (Com)	No Air Sealing	Air Sealing Energy Kit Distribution	RET Only
	Dock Door Sealing	Dock Door without Sealing	Dock Door with Sealing	RET Only
	Attic/Roof Insulation (Com)	R-11 Attic/Roof Insulation	R-30 Attic/Roof Insulation	NEW Only
	Attic/Roof Insulation (Com)	R-11 Attic/Roof Insulation	R-30 Attic/Roof Insulation	RET Only
	Wall Insulation (Com)	R-5 Wall Insulation	R-15 Wall Insulation	NEW Only
	Wall Insulation (Com)	Uninsulated wall	Code level wall insulation	RET Only
HVAC	Furnace (Com)	Standard Com Furnace 81 Et	Efficient Com Furnace 95 Et	ROB and NEW
	Gas Heat Pump (Space Heating) (Com)	Standard Com Furnace	Com Gas Absorption Heat Pump	ROB and NEW
	Boiler, Small (< 300 kBtuh)	Standard Small Boiler 84 AFUE	High-efficiency Small Boiler 90 AFUE	ROB and NEW
	Boiler, Large (> 300 kBtuh)	Standard Large Boiler 80 Et	High-efficiency Large Boiler 90 Et	ROB and NEW
	Boiler Stack Economizer	No Economizer	Economizer	NEW Only
	Boiler Stack Economizer	No Economizer	Economizer	RET Only
	Combo Condensing Boiler/Water Heater (Com)	Standard Gas Boiler and Water Heater	Combo Boiler 95 AFUE	ROB and NEW
	Boiler Reset Control (Com)	No Reset Control	Reset Control	RET Only

End Use	Common Measure	Baseline Measure	Efficient Measure	Replacement Type
	Boiler Shut Off Damper, Space Heating	No Damper	Damper	RET Only
	Condensing Make Up Air Unit (MAU)	Standard MAU	Condensing MAU with VFD	NEW Only
	Condensing Make Up Air Unit (MAU)	Standard MAU	Condensing MAU with VFD	RET Only
	Energy Management System (EMS)	No EMS	EMS	RET Only
	Energy Recovery Ventilator (ERV)	No ERV	ERV	NEW Only
	Energy Recovery Ventilator (ERV)	No ERV	ERV	RET Only
	Demand Control Ventilation (DCV)	No DCV	DCV	NEW Only
	Demand Control Ventilation (DCV)	No DCV	DCV	RET Only
	Steam Trap	Leaky Steam Trap	Steam Trap Repair	RET Only
	Furnace Shut Off Damper, Space Heating	No Damper	Damper	RET Only
	Infrared Heater	Standard Heater	Infrared Heater	ROB and NEW
	Programmable Thermostat (Com)	Manual Thermostat	Programmable Thermostat	NEW Only
	Programmable Thermostat (Com)	Manual Thermostat	Programmable Thermostat	RET Only
	Wi-Fi Thermostat (Com)	Manual Thermostat	Wi-Fi Thermostat	NEW Only
	Wi-Fi Thermostat (Com)	Manual Thermostat	Wi-Fi Thermostat	RET Only
	Overhead Door Air Curtain	No Curtain	Air Curtain	NEW Only
	Overhead Door Air Curtain	No Curtain	Air Curtain	RET Only
	Duct Insulation (Com)	No Duct Insulation	Duct Insulation R-6	RET Only
	Duct Sealing (Com)	Leaky Ducts (20% leakage rate)	Sealed Ducts (8% leakage rate)	RET Only
	Boiler Tune-Up (Com)	No Boiler Tune-Up	Boiler Tune-Up	RET Only
	Furnace Tune-Up (Com)	No Furnace Tune-Up	Furnace Tune-Up	RET Only
	HTHV Heater	Gas Unit Heater (80% Eff.)	HTHV Heater (92% Eff.)	ROB and NEW
Kitchen	Infrared Broiler	Standard Broiler	High-efficiency Broiler	ROB and NEW
	Dishwasher	Standard Dishwasher	ENERGY STAR Dishwasher	ROB and NEW
	Fryer	Standard Fryer	ENERGY STAR Fryer	ROB and NEW
	Steamer	Standard Steamer	ENERGY STAR Steamer	ROB and NEW

End Use	Common Measure	Baseline Measure	Efficient Measure	Replacement Type
	Oven - Combination	Standard Combination Oven	ENERGY STAR Combination Oven	ROB and NEW
	Oven - Rack	Standard Rack Oven	ENERGY STAR Rack Oven	ROB and NEW
	Oven - Convection	Standard Convection Oven	ENERGY STAR Convection Oven	ROB and NEW
	Griddle	Standard Efficiency Griddle	ENERGY STAR Griddle	ROB and NEW
Process	Process Boiler - Steam	Standard Efficiency Steam Boiler 80%	High-efficiency Steam Boiler 82%	ROB and NEW
	Process Boiler - Water	Standard Efficiency Hot Water Boiler 80%	High-efficiency Hot Water Boiler 82%	ROB and NEW
	Process Boiler Tune-Up	No Service	Process Boiler Tune-Up	RET Only
	Process Grain Dryer	Standard Grain Dryer	High-efficiency Grain Dryer	ROB and NEW
Hot Water	High-Efficiency Storage Water Heater (Com)	Standard Com Storage Water Heater	Efficient Com Storage Water Heater 0.68 UEF	ROB and NEW
	Tankless Water Heater (Com)	Standard Com Storage Water Heater	Tankless Com Water Heater 0.87 UEF	ROB and NEW
	Mid-Efficiency Indirect Water Heater	Gas Water Heater and Boiler	Indirect Water Heater, Boiler 84-89% Eff	ROB and NEW
	High-Efficiency Indirect Water Heater	Gas Water Heater and Boiler	Indirect Water Heater, Boiler 90%+ Eff	ROB and NEW
	Faucet Aerator (Com)	No Faucet Aerator	Low-flow Faucet Aerator 1.5gpm	NEW Only
	Faucet Aerator (Com)	No Faucet Aerator	Low-flow Faucet Aerator 1.5gpm	RET Only
	Low-flow Showerhead (Com)	2.5gpm Showerhead	1.5gpm Showerhead	NEW Only
	Low-flow Showerhead (Com)	2.5gpm Showerhead	1.5gpm Showerhead	RET Only
	Pre-Rinse Spray Valve	1.16gpm Spray Valve	1.12gpm Spray Valve	ROB and NEW
	Hot Water Pipe Insulation (Com)	Non-insulated Hot Water Pipe	Insulated Hot Water Pipe R4	NEW Only
	Hot Water Pipe Insulation (Com)	Non-insulated Hot Water Pipe	Insulated Hot Water Pipe R4	RET Only
	Recirculation Pump with Demand Controls	Uncontrolled pump	Recirculating pump	NEW Only
	Recirculation Pump with Demand Controls	Uncontrolled pump	Recirculating pump	RET Only
	Thermostatic Restrictor Shower Valve (Com)	No Thermostatic Valve	Thermostatic Valve	NEW Only
	Thermostatic Restrictor Shower Valve (Com)	No Thermostatic Valve	Thermostatic Valve	RET Only

Source: Guidehouse

B.3 Measure Replacement Types and Definitions

Table B-3. Measure Replacement Types and Definitions

New or Existing	Measure Replacement Type	Definition
New Construction	**New Construction (NEW)**	Equipment installed in a newly constructed building. In this situation, energy savings calculations are always relative to code.
Existing Construction	**Normal replacement (NR) (i.e., replace on burnout [ROB])**	New equipment needs to be installed to replace equipment that has reached the end of its useful life, has failed, or is no longer functional. Upon failure, normal replacement equipment is generally not repaired by the customer and is instead replaced with a new piece of equipment. Appliance standards are applicable to some types of normal replacement equipment and apply to all new purchases.
	Retrofit (RET) – add-on equipment	New equipment installed onto an existing system, either as an additional, integrated component or to replace a component of the existing system. In either case, the primary purpose of the add-on measure is to improve the overall efficiency of the system. These measures cannot operate on their own as standalone equipment and are not required to operate the existing equipment or building. Codes or standards may be applicable to some types of add-on measures by setting minimum efficiency levels of newly installed equipment, but the codes or standards do not require the measure to be installed.
	Retrofit (RET) – accelerated replacement	Equipment that will be replaced before it fails. These measures are installed to replace previously existing equipment that has either not failed or is past the end of its Effective Useful Life (EUL)but is not compromising use of the building (such as insulation and water fixtures). Many of these installations are subject to building code, but upgrades are not always required by code until a major building renovation (and even then, some may not be required).

B.4 Key Measure Characterization Parameters

Table B-4. Key Measure Characterization Parameters

Parameter Name	Definition
Measure Description	Definitions of the measure, including both baseline and efficient levels, and including characteristics such as capacity or efficiency where relevant. This is included in the Measure List.
Measure Replacement Type	Each measure is defined as retrofit/early retirement, ROB, or new construction. This input is included in the Measure List.
Measure Applicability	Each measure will have a defined applicability. Sector and End Use applicability is defined in the Measure List, while Building Type and Climate Zone applicability was determined during the individual characterization of each measure.
Unit Basis	The measure unit basis must be clearly specified and remain consistent across all energy, cost, and density inputs.
Energy Consumption and Savings	For each measure, the relative annual gas energy consumption between the baseline and efficient levels is defined (in therms), yielding unit energy savings.
Costs	Incremental measure costs per unit are defined, including both material and labor/installation costs.
Measure Density and Saturation	Density and saturation represent the prevalence of the measure in the building stock. Density values are defined as unit basis per household for residential and unit basis per 1,000 sq. ft. for commercial. Saturations are defined as the % penetration of the existing technology.
Measure Lifetime	The effective useful life for each measure is used to calculate lifetime energy savings.
Net-to-Gross Ratio (NTGR)	Measures are assigned a Net-to-Gross (NTG) Ratio to account for any free riders and/or spillover that may result from participating in a program. Based on discussion with IGC staff, Guidehouse used default NTGR assumptions of 1.0 for all measures given limited data available to inform specific NTGR assumptions applicable to IGC Service Territory.

Source: Guidehouse

B.5 Measure Data Sources

Table B-5. Measure Data Sources

Source	Data Format	Usage Count	Notes
2023 Michigan Energy Measures Database ("MI MEMD")[10]	Deemed values (pre-calculated with validated parameters	65	Climate Zone map for weather-sensitive measures: -Zone 5: DE (Detroit City Airport) -Zone 6: AL (Alpena)
2023 Iowa TRM ("Iowa TRM")[11]	Engineering algorithms and equations	10	Climate Zone map for weather-sensitive measures: -Zone 5: Iowa Zone 5 -Zone 6: Iowa Zone 6
2023 California TRM ("CA eTRM")[12]	Deemed values (pre-calculated with validated parameters	8	Used only for non-weather-sensitive measures given climate differences
2023 Illinois TRM ("IL TRM")[13]	Engineering algorithms and equations	3	Climate Zone map for weather-sensitive measures: -Zone 5: Illinois Zone 2 -Zone 6: Illinois Zone 1
2023 New York TRM ("NY TRM")[14]	Engineering algorithms and equations	1	Climate Zone map for weather-sensitive measures: -Zone 5: Albany/Buffalo (Zone 5A) -Zone 6: Massena (Zone 6A)
2023 Minnesota TRM ("MN TRM")[15]	Engineering algorithms and equations	1	None
2023 Massachusetts TRM ("MA eTRM")[16]	Deemed values (pre-calculated with validated parameters	1	None

* The Usage Count column shows the number of measures for which the source was used to characterize the measure's inputs.

Source: Guidehouse

[10] MI MEMD available at https://www.michigan.gov/mpsc/regulatory/ewr/michigan-energy-measures-database.

[11] Iowa TRM available at https://iub.iowa.gov/regulated-industries/energy-efficiency-programs.

[12] CA eTRM, maintained by the California Technical Forum, available at http://www.caltf.org/etrm-overview.

[13] IL TRM available at https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency.

[14] NY TRM available at https://dps.ny.gov/technical-resource-manual-trm.

[15] MN TRM available at https://mn.gov/commerce/energy/industry-government/cip/technical-reference-manual/.

[16] MA eTRM available at https://www.masssavedata.com/Public/TechnicalReferenceLibrary.

B.6 Density and Saturation Data Sources

Table B-6. Density and Saturation Data Sources

Source	Link
Northwest Energy Efficiency Alliance – Residential Building Stock Assessment	https://neea.org/data/residential-building-stock-assessment
Northwest Energy Efficiency Alliance – Commercial Building Stock Assessment	https://neea.org/data/commercial-building-stock-assessments
2019 California Residential Appliance Saturation Study	https://www.energy.ca.gov/publications/2021/2019-california-residential-appliance-saturation-study-rass
California Lighting and Appliance Saturation Survey	https://webtools.dnvgl.com/projects62/Default.aspx?tabid=190
California Commercial Saturation Survey	https://www.calmac.org/publications/California_Commercial_Saturation_Study_Report_Finalv2.pdf
Characterizing the Energy Efficiency Potential of Gas-Fired Commercial Food Service Equipment	https://www.caetrm.com/media/reference-documents/CEC-500-2014-095.pdf
ENERGY STAR® Shipment Data 2021	https://www.energystar.gov/sites/default/files/asset/document/2021%20Unit%20Shipment%20Data%20Summary%20Report_0.pdf
ENERGY STAR® Windows, Doors, and Skylights Version 7.0 Criteria Analysis Report	https://www.energystar.gov/sites/default/files/asset/document/ES_Residential_WDS_Draft%201_Criteria%20Analysis%20Report.pdf

Appendix C. Energy Efficiency Technical Potential

This appendix details the energy efficiency technical potential task. The Attachment B: Measure Inputs and Database provides the associated data.

C.1 Approach to Technical Potential and Replacement Types

Guidehouse's modeling approach considers an energy efficient measure to be any change made to a building, piece of equipment, process, or behavior that could save energy. The savings can be defined in numerous ways, depending on which method is most appropriate for a given measure. Measures like residential water heaters are best characterized as some fixed amount of savings per water heater; savings for measures like large boilers in commercial buildings are typically characterized as savings per 1,000 sq/ft of floor space. The DSMSim model can appropriately handle savings characterizations for both methods. The following sections include the formulas used to calculate technical potential by replacement type.

C.1.1 New Construction Measures

The cost of implementing new construction (NEW) measures is incremental to the cost of a baseline (and less efficient) measure. However, new construction technical potential is driven by equipment installations in new building stock rather than by equipment in existing building stock.[17] New building stock is added to keep up with forecast growth in total building stock and to replace existing stock that is demolished each year. Demolished (sometimes called replacement) stock is calculated as a percentage of existing stock in each year, and this Study uses a demolition rate of 0.5% per year for all building stock. New building stock (the sum of growth in building stock and replacement of demolished stock) determines the incremental annual addition to technical potential, which is then added to totals from previous years to calculate the total potential in any given year. The team used the following equations to calculate technical potential for new construction measures.

Equation C-1. Annual Incremental NEW Technical Potential (AITP)

$AITP_{YEAR}$ = New $Buildings_{YEAR}$ (e.g., buildings/year[18]) X Measure Density (e.g., widgets/building) X $Savings_{YEAR}$ (e.g., kWh/widget) X Technical Suitability (dimensionless)

Equation C-2. Total NEW Technical Potential (TTP)

$$\text{TTP} = \sum_{YEAR=2024}^{YEAR=2044} AITP_{YEAR}$$

$$\mathbf{TTP} = \sum_{Year=2024}^{2044} \boldsymbol{AITP_{Year}}$$

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

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

C.1.2 Retrofit and ROB Measures

Retrofit (RET) measures, commonly referred to as advancement or early-retirement measures, are replacements of existing equipment before the equipment fails. RET measures can also be efficient processes that are not currently in place and not required for operational purposes. For RET measures, we calculated a deferred replacement credit, which accounts for the value of deferring the replacement of baseline equipment by some number of years (lifetime of equipment minus remaining useful life of existing equipment). The deferred replacement credit is subtracted from the incremental costs of RET measures. In contrast, replace-on-burnout (ROB) measures, sometimes referred to as lost-opportunity measures, are replacements of existing equipment that have failed and must be replaced, or they are existing processes that must be renewed. Because the failure of the existing measure requires a capital investment by the customer, the cost of implementing ROB measures is always incremental to the cost of a baseline (and less efficient) measure.

Retrofit and ROB measures have a different meaning for technical potential compared with new construction measures. In any given year, we use the entire building stock for the calculation of technical potential.[19] This method does not limit the calculated technical potential to any pre-assumed rate of adoption of retrofit measures and assumes that all ROB equipment is instantly eligible for replacement. Existing building stock is reduced each year by the quantity of demolished building stock in that year and does not include new building stock that is added throughout the simulation. For RET and ROB measures, annual potential is equal to total potential, offering an instantaneous view of technical potential. The team used Equation C-3 to calculate technical potential for RET and ROB measures.

Equation C-3. Annual/Total RET/ROB Technical Savings Potential

Total Technical Potential = Existing Building Stock$_{YEAR}$ (e.g., buildings[20]) X Measure Density (e.g., widgets/building) X Savings$_{YEAR}$ (e.g., kWh/widget) X Technical Suitability (dimensionless)

C.2 Competition Groups

General characteristics of competing technologies used to define competition groups in this Study include the following:

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

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

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

To address the overlapping nature of measures within a competition group, Guidehouse's analysis only selects one measure per competition group to include in the summation of technical potential across measures (e.g., at the end use, customer segment, sector, service territory, or total level). The measure with the largest energy savings potential in a given competition group is used for calculating total technical potential of that competition group, regardless of the customer economics or cost-effectiveness of that measure. This approach confirms the aggregated technical potential does not double-count savings. However, the model still calculates the technical potential for each individual measure outside of the summations. Although measure savings are not double counted, this approach does not consider savings interaction between measures. For example, if a high-efficiency air conditioner is installed in a house with poor insulation or a leaky envelope, the potential savings for retrofitting those components after the new air conditioner is installed will be less than if they were installed first. These interactive effects are addressed when calculating achievable potential.

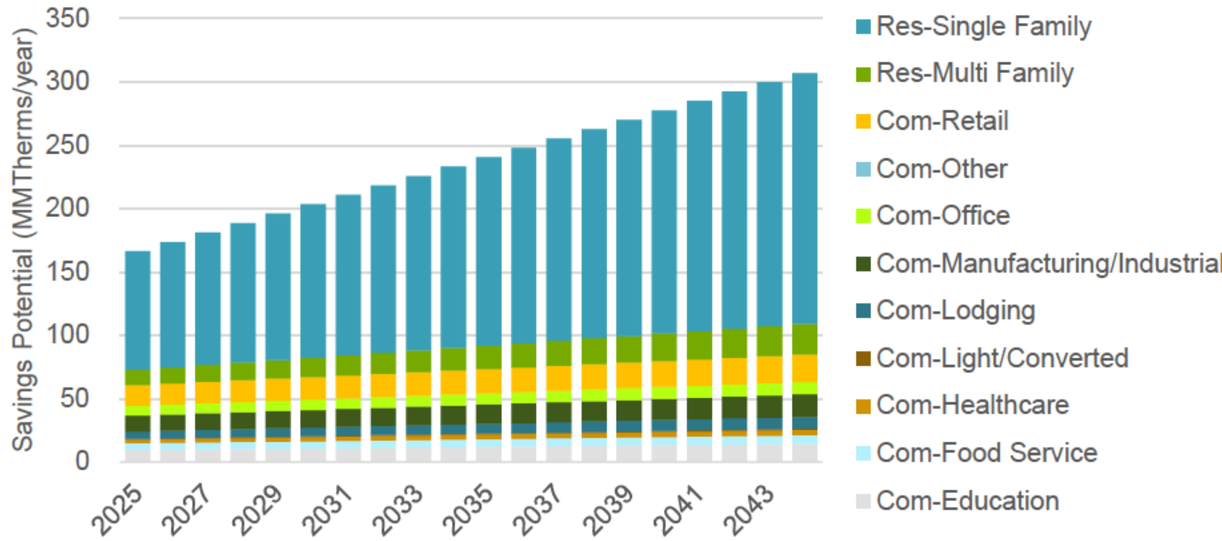
In practice, some measures have within-end use interactive effects that are not accounted for in technical potential, leading to the technical and economic potential to be higher than practicable. These interactive effects occur when the installation of one measure would reduce the savings for other measures after installation, despite the measures not competing directly. The whole is less than the sum of its parts. An example of this is with HVAC and insulation measures. When installed in a home without upgraded insulation, an efficient furnace would save more energy per year relative to a home with upgraded insulation. The same is true for the savings of an insulation measure in a home with a baseline furnace versus a home with an efficient furnace. Because the order of installation matters when assigning the discount factor to the applied savings, it does not make sense to evaluate these interactive effects when the stock can turnover instantly, as is the case for technical and economic potential. The sum of technical or economic potential over measures that interact will be overstated.

C.3 Technical Potential Results

C.3.1 Results by Customer Segment

The natural gas energy technical potentials shown in Figure C-1 are broken out for each of the customer segments. Attachment B provides the associated data. These figures show that technical potential is slightly larger for the residential sector compared to the commercial sector. The largest customer segment was for single family residential due to the large building stock of single family homes in IGC's territory.

Figure C-1. Natural Gas Technical Potential by Customer Segment (MMTherms/year)



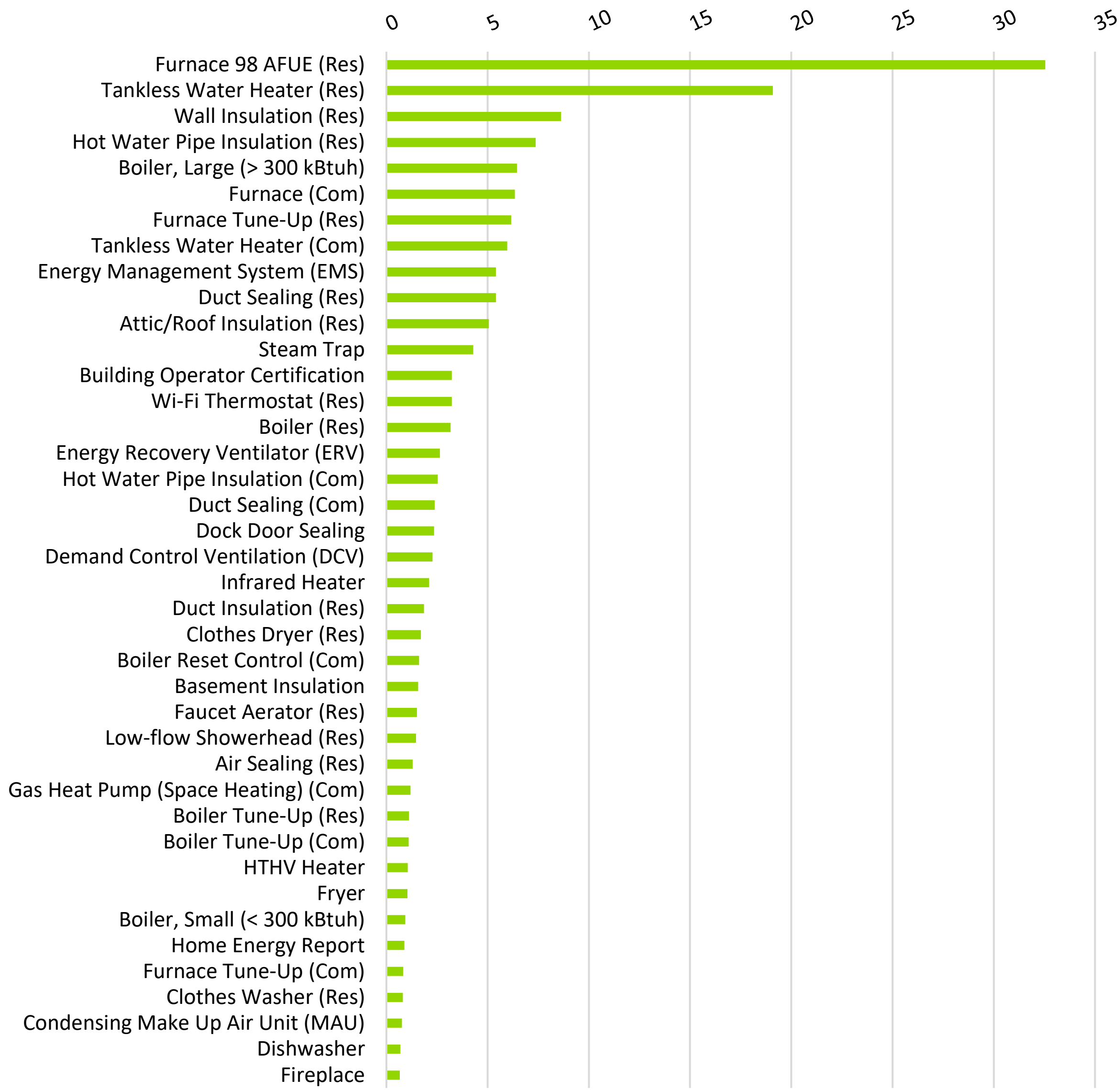
Source: Guidehouse analysis 2023

C.3.2 Results by Measure

The measure-level savings potential shown in Figure C-2 are after adjustments are made due to competition groups for natural gas. Attachment B provides the associated data. This is consistent with the aggregate results shown above. However, for the achievable potential scenarios, measures gain market share relative to their economic characteristics rather than their savings potential alone; measures will be included in the achievable potential forecast that are not shown in the technical and economic potential.

Figure C-2 shows the top 40 natural gas measures, which is topped with predominately residential HVAC and water heating measures.

Figure C-2. Top 40 Measures - Natural Gas Technical Potential in 2024 (MMTherms/year)



Source: Guidehouse analysis 2023

Appendix D. Energy Efficiency Economic Potential

This appendix details the economic potential task.

D.1 Economic Potential UCT

The model used Equation D-1 to calculate the UCT benefit-cost ratio.

Equation D-1. Benefit-Cost Ratio for UCT

$$\text{UCT} = \frac{PV(Avoided\ Costs)}{PV(Incentives + Admin\ Costs)}$$

Where:

- *PV( )* is the present value calculation that discounts cost streams over time.
- *Avoided Costs* are the monetary benefits resulting from natural gas savings (e.g., avoided costs of infrastructure investments and avoided commodity costs due to natural gas energy conserved by efficient measures).
- *Admin Costs* are the administrative costs incurred by the utility or program administrator.
- *Incentives* are measure-level incentives that are provided to the customer for adopting the measures.

Guidehouse calculated UCT ratios for each measure based on the present value of benefits and costs (as defined above) over each measure's life. Guidehouse included administration costs at the measure level estimated from IGC's historic administrative costs and allocated it to each measure using the historical average of cost per therm savings. These administrative spending levels are held constant over time and across all scenarios and used 2023 dollars to be comparable to the incremental costs which used 2023 dollars as well.

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

D.2 Economic Potential Results

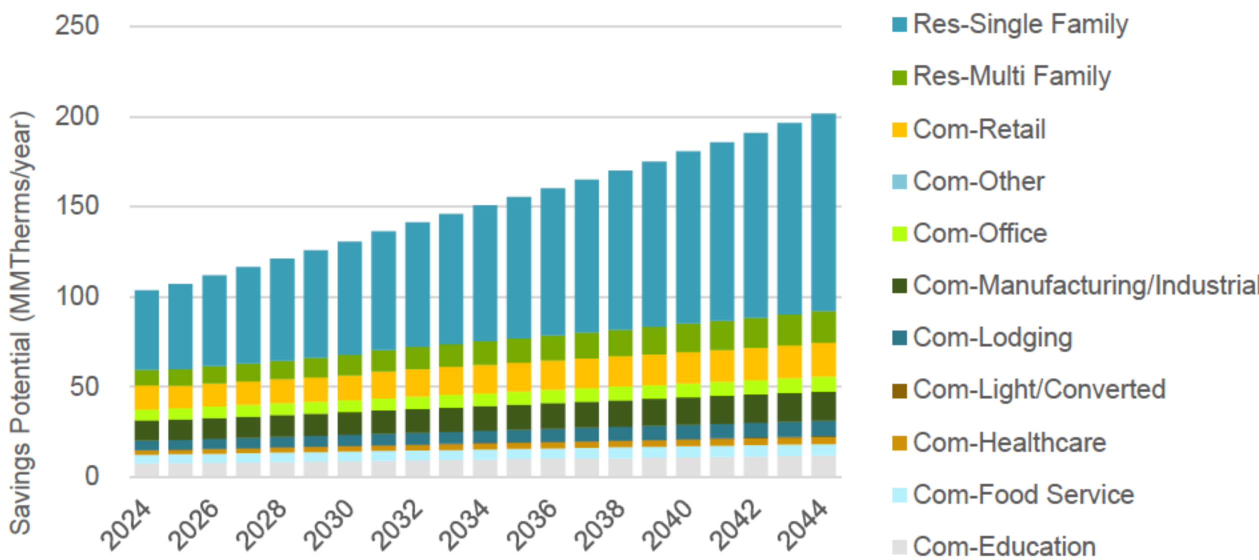
D.2.1 Results by Customer Segment

Figure D-1 depicts the economic natural gas energy savings potential for all customer segments. Attachment B provides the corresponding measure input data. Economic potential steadily increases at the same rate as technical potential. Residential measures that pass the

UCT largely remain economic throughout the forecast. The mix of economic potential from the Commercial sector does not change appreciably relative to the technical potential.

Figure D-1 shows the economic natural gas potential by segment, which again is dominated by residential and single family homes because so much of IGC's territory serves residential compared to commercial.

Figure D-1. Natural Gas Economic Potential by Customer Segment (MMTherms/year)

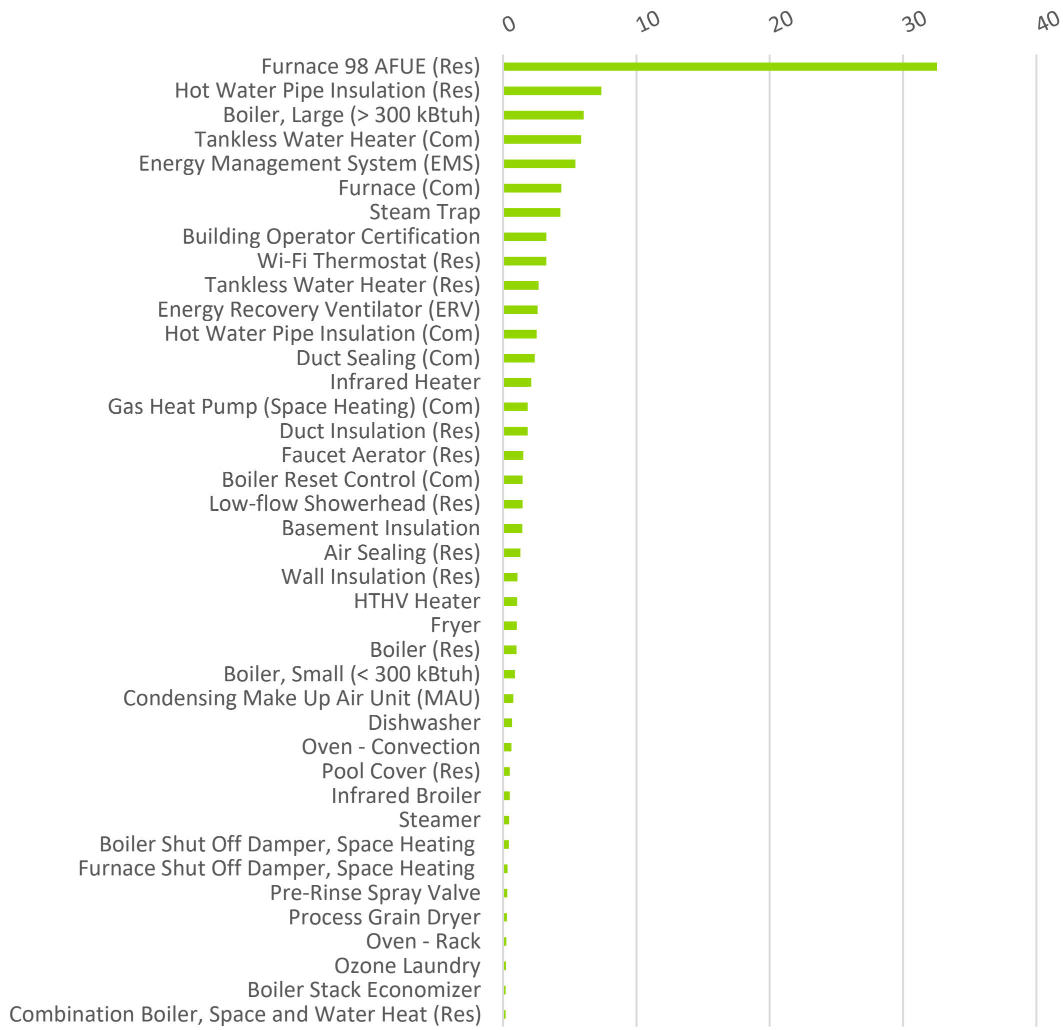


Source: Guidehouse analysis 2023

D.2.2 Results by Measure

Figure D-2 provides the top 40 natural gas measures, which are predominately residential measures. As discussed before, this is because the residential natural gas load makes up most of the applicable natural gas load for energy efficiency measures. Guidehouse's secondary research showed relatively low efficient saturation of gas furnaces, which results in high remaining savings potential for gas furnaces.

Figure D-2. Top 40 Measures - Natural Gas Economic Potential in 2024 (MMTherms/year)



Source: Guidehouse analysis 2023

Appendix E. Energy Efficiency Achievable Potential

This appendix describes Guidehouse's approach to calculating achievable energy efficiency potential and presents the results for IGC's service territory.

E.1 Approach to Estimating Achievable Potential

This section provides a high level summary of the approach to calculating net achievable potential. The adoption of energy efficiency measures can be broken down into calculation of the equilibrium market share and calculation of the dynamic approach to equilibrium market share. This section also provides an overview of the sensitivity analysis and model calibration process.

E.1.1 Calculation of Equilibrium Market Share

The equilibrium market share can be thought of as the percentage of individuals that would choose to purchase a technology provided those individuals are fully aware of the technology and its relative merits (e.g., the energy- and cost-saving features of the technology). In this context – fully aware means ready and capable of making an informed purchase decision. For energy efficiency measures, a key differentiating factor between the base technology and the efficient technology is the energy and cost savings associated with the efficient technology. Of course, that additional efficiency often comes at a premium in initial cost, meaning that it can take some time for the higher efficiency to pay off. Equilibrium market share is calculated as a function of the payback time of the efficient technology relative to the inefficient technology. This approach allows Guidehouse to estimate the market share for the dozens or even hundreds of technologies that are often considered in potential studies.

In the 2023 CPA, Guidehouse used equilibrium payback acceptance curves that were developed from a meta-analysis of secondary sources from a few other potential studies. Guidehouse typically employs surveys of residential and commercial customers to define the payback acceptance curves at sector level. In the surveys, customer decision makers were asked about the quantity of various end uses within their home or business to inform density and saturation estimates, and then were asked whether they would be likely to make investments in energy efficiency upgrades based on a variety of project costs and expected annual energy savings. This willingness to pay question battery is typical of discrete choice experiments and designed to elicit the customer's inherent response to different economic returns. Guidehouse conducted statistical analysis on these responses to develop a set of payback acceptance curves for each customer sector combination which were used in other potential studies. Using an average of each sector's payback curves, Guidehouse developed a payback acceptance curve for each sector.

Figure E-1 shows an example of a payback acceptance curve for residential measures. In this example, at a payback period of 0 (i.e., the cost of the efficient technology after incentives is equivalent to the cost of the baseline technology), approximately 95% of customers would choose to install the efficient technology. This indicates that there are additional considerations or barriers beyond just cost that impact whether or not a particular customer is willing to install the efficient technology.

Figure E-1. Payback Acceptance Curve for Residential Sector

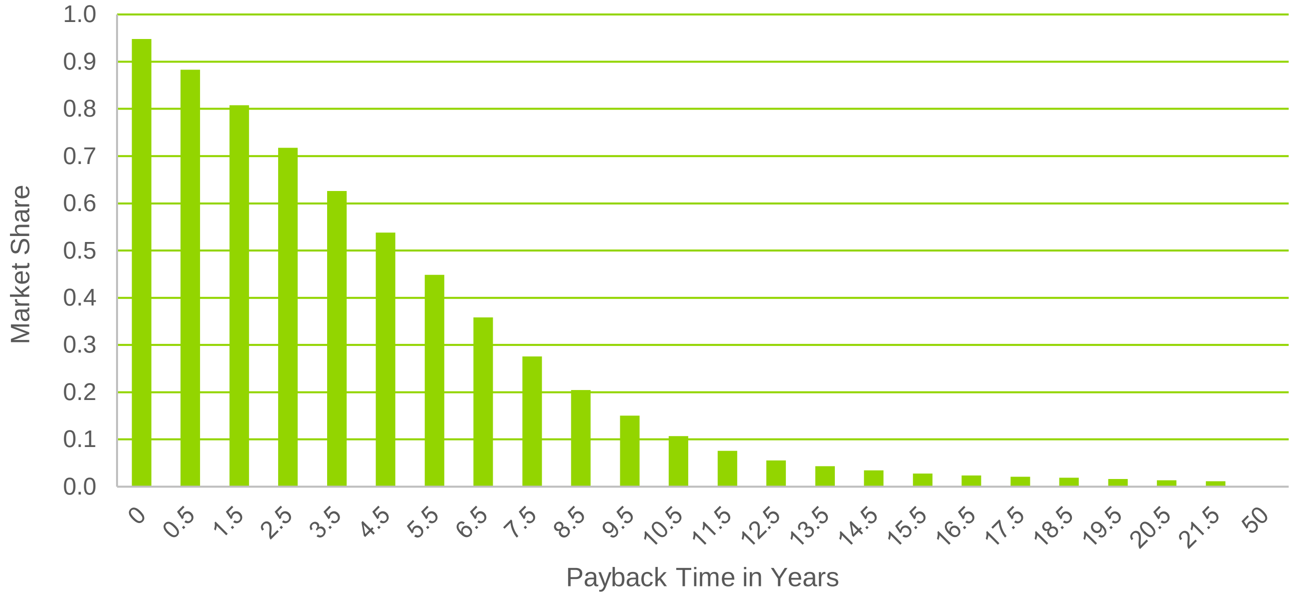
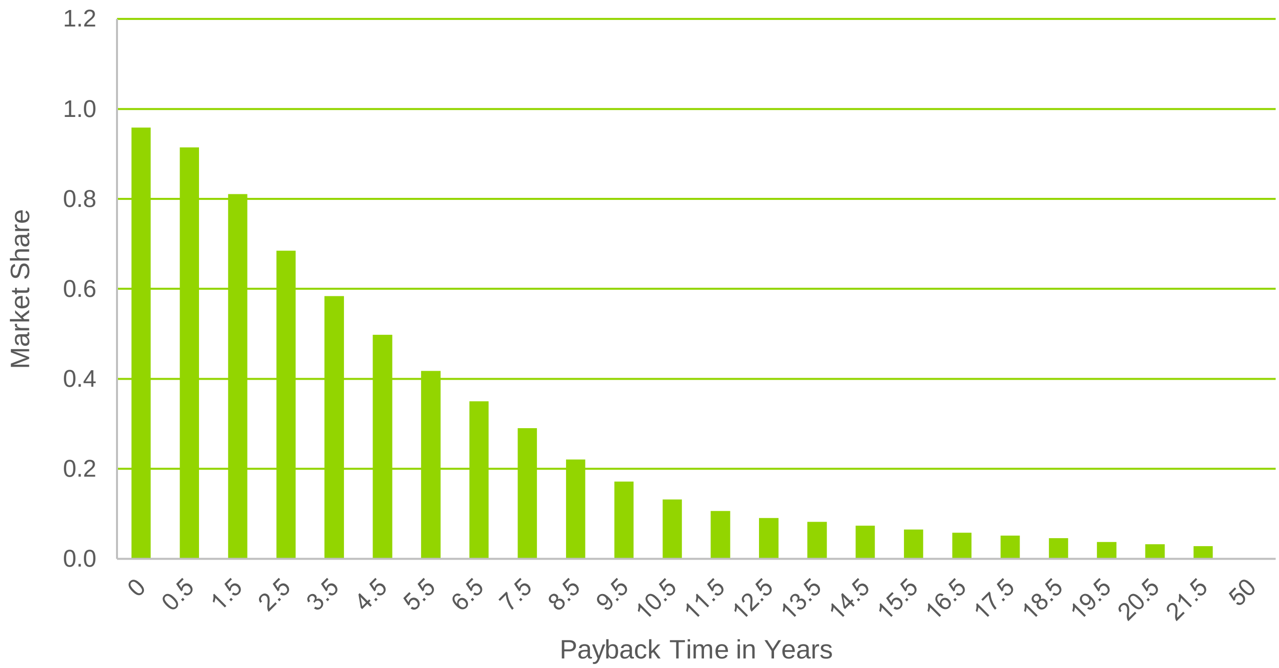


Figure E-2. Payback Acceptance Curve for Commercial Sector



Source: Guidehouse analysis 2023

Since the payback time of a technology can change over time, as technology costs or energy costs change over time, the equilibrium market share can also change over time. The equilibrium market share is recalculated for every year of the forecast to ensure the dynamics of technology adoption take this effect into consideration. As such, equilibrium market share is a bit of an oversimplification since the whole system is dynamic. Thus, the equilibrium refers to the long run market share at each time step in the model.

E.1.2 Retrofit and New Construction Technology Adoption Approach

Retrofit technologies employ an enhanced version of the classic Bass diffusion model[21,22] to simulate the S-shaped approach to equilibrium that is observed again and again for technology adoption. Figure E-3 and E-4 provide a stock/flow diagram illustrating the causal influences underlying the Bass model. In this model, market potential adopters flow to adopters by two primary mechanisms – adoption from external influences, such as marketing and advertising, and adoption from internal influences, or word-of-mouth. The fraction willing to adopt was estimated using the payback acceptance curves Figure E-1 and Figure E-2 illustrate.

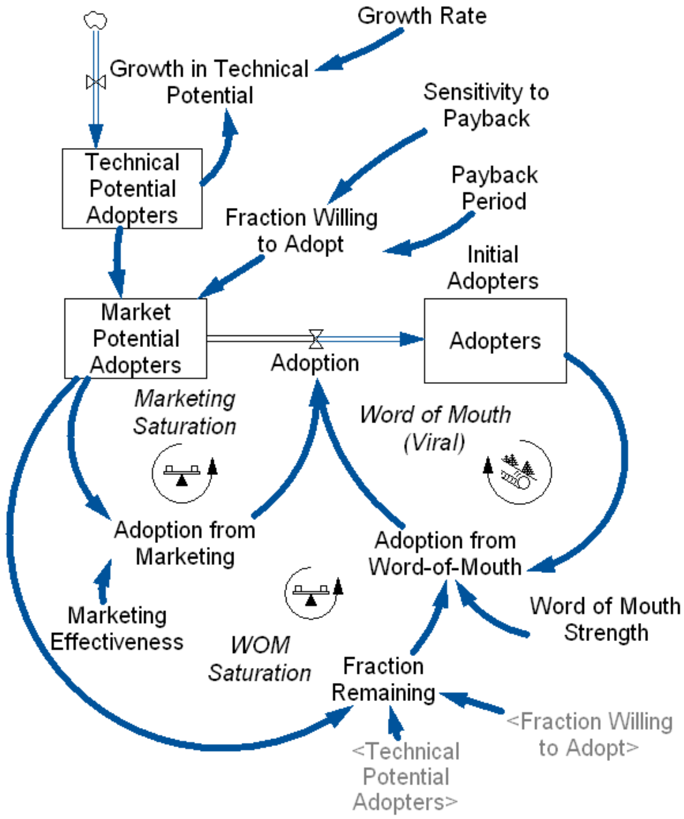
The marketing effectiveness and word-of-mouth parameters for this diffusion model were estimated drawing upon case studies where these parameters were estimated for dozens of technologies.[23] Recognition of the positive, or self-reinforcing, feedback generated by the word-of-mouth mechanism is evidenced by increasing discussion of the concepts such as social marketing as well as the term viral, which has been popularized and strengthened most recently by social networking sites such as Twitter, Facebook, and YouTube. However, the underlying positive feedback associated with this mechanism has been ever present and a part of the Bass diffusion model of product adoption since its inception in 1969.

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

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

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

Figure E-3. Stock/Flow Diagram of Diffusion Model for Retrofits

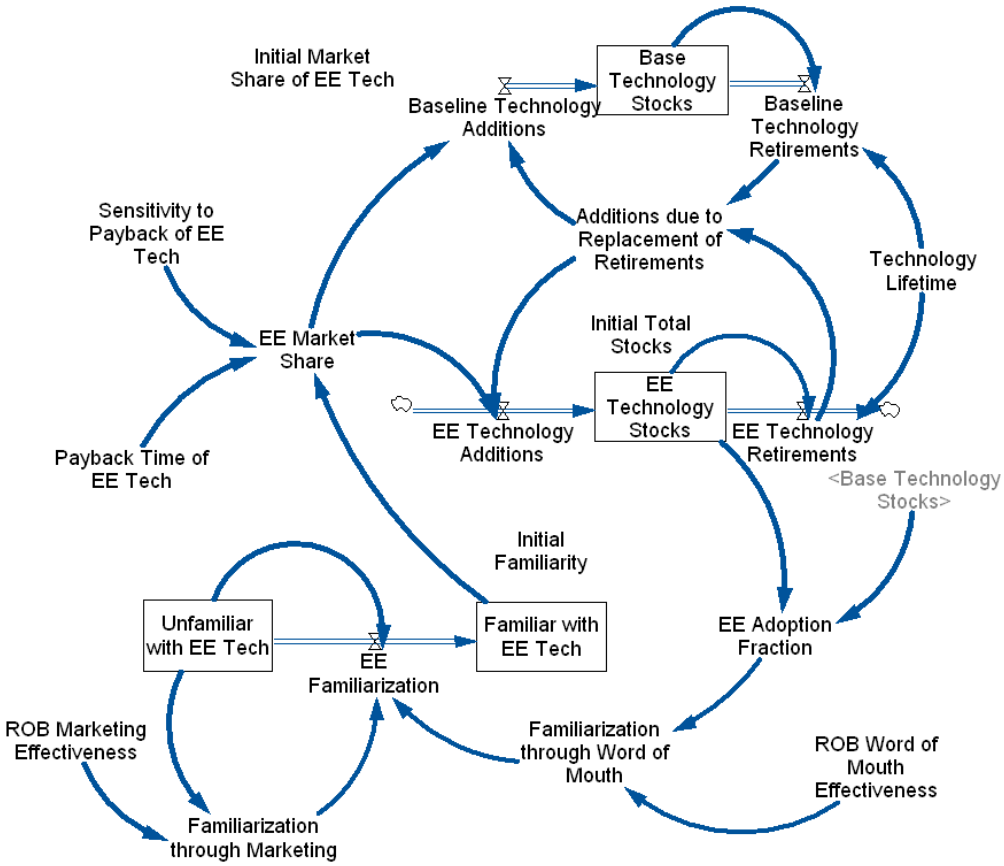


Source: Guidehouse

E.1.3 Replace-on-Burnout (ROB) Technology Adoption Approach

The dynamics of adoption for ROB technologies is somewhat more complicated than for NEW/RET technologies since it requires simulating the turnover of long-lived technology stocks. The DSMSim model tracks the stock of all technologies, both base and efficient, and explicitly calculates technology retirements and additions consistent with the lifetime of the technologies. Such an approach ensures that technology churn is considered in the estimation of market potential, since only a fraction of the total stock of technologies are replaced each year, which affects how quickly technologies can be replaced. A model that endogenously generates growth in the familiarity of a technology, analogous to the Bass approach described above, is overlaid on the stock tracking model to capture the dynamics associated with the diffusion of technology familiarity. Figure E-4 illustrates a simplified version of the model employed in DSMSim.

Figure E-4.Stock/Flow Diagram of Diffusion Model for ROB Measures



Source: Guidehouse

E.1.4 Approach to Applying Customer Incentives

One of the most important drivers for estimating net achievable potential is the approach for modeling incentives. Through various discussions with the IGC over the course of this project, Guidehouse chose the percentage of incremental cost approach for applying incentives in the model. This is where the rebate levels are set as a fixed percentage of the incremental cost of installing the efficient measure. Under this approach, the level of savings would be achieved by paying some level (50% or 65%, depending on Scenario) of incremental costs. It is possible to set the rebates at different levels, depending on the sector or end uses that are modeled. For example, there may be policy reasons why it would make sense to set rebate levels at higher amounts for end uses that would target markets that are in the highly inefficient category.

For the 2023 CPA, IGC provided Guidehouse with historic project and incentive costs where they were available through program tracking data. Guidehouse used 50% incremental costs for the business as usual scenario, with the exception of both residential furnaces (Furnace 95 AFUE and Furnace 98 AFUE) which was set at 40% of incremental costs for all scenarios to ensure that the largest potential measure was cost effective throughout the study period. The behavioral measures had their adoption specified exogenously in the model as the adoption model uses a planned rollout rather than payback based approach. Planned rollout is used instead of the payback based approach for behavioral measures because there are no incentives for the behavioral measures.

E.1.5 Model Calibration

Any model simulating future product adoption faces challenges with calibration, as there is no future world against which one can compare simulated with actual results. For this potential Study, Guidehouse took a number of steps to ensure that forecast model results were reasonable, including:

- A comparison of 2019-2021 historic program savings values by sector and end use against Guidehouse's modeled program net savings potential. The residential sector had historical data for 2019-2021, while the commercial sector only had historical data for 2021.
- Due to natural year-over-year variations in program achievement, rather than calibrating to a point estimate (i.e., tuning the model's 2020 potential to IGC's achieved 2020 savings), Guidehouse looked at the savings trend over the past 3 years of program achievement and calibrated the model to match the overall historical data.

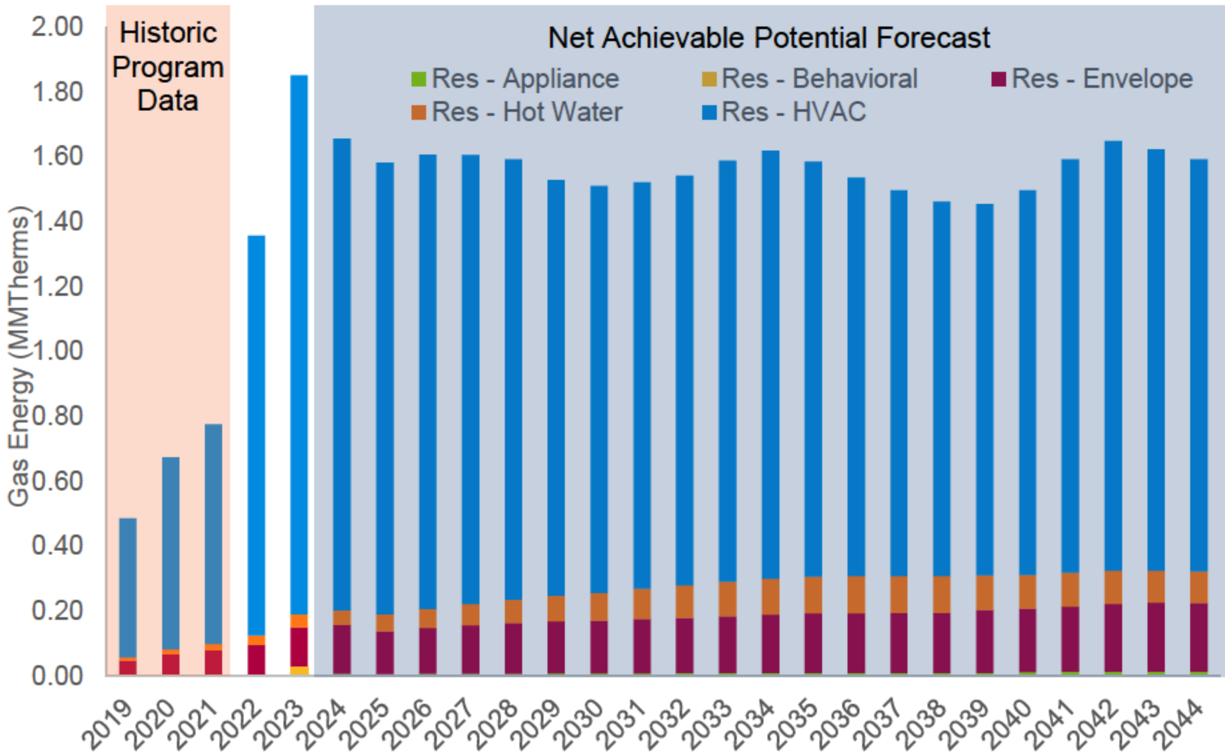
Guidehouse adjusted model parameters, including assumed technology diffusion coefficients, to obtain close agreement across a wide variety of metrics compared for the Business as Usual scenario. This process ensures that forecast net potential is grounded against real-world results considering the many factors that come into play in determining the likely adoption of energy efficiency measures, including both economic and non-economic factors. The model was calibrated to the historic program savings by sector and end use. For sector and end uses where there was no historic program savings, similar calibration coefficients were applied as for the other measures, so that the resulting potential was only a small proportion of the Business as Usual scenario potential in 2019-2021.

Since the IGC program in 2019-2021 was still in its nascent phase, the level of adoption was too high at the modeled payback levels to align with historic program savings. To address this, a payback adder was added to most measures. A positive payback adder slows down the adoption rate, while a negative payback adder speeds up the adoption rate. The payback adders were calibrated for all measures to get energy savings closest to the historical data trend for 2019-2021. For sector and end uses with measures with historical data, the measures that historically had programs were calibrated to have more potential than measures without historical data, using the payback adder.

Figure E-5 and Figure E-6 show the historic gas program savings from 2019-2021 by end use for the residential sector and commercial sectors, respectively, combined with the modeled net achievable potential from 2024-2044. Historic savings for the residential sector have increased year over year. Historic natural gas savings for the commercial sector have less data available due to the program being introduced in 2021.

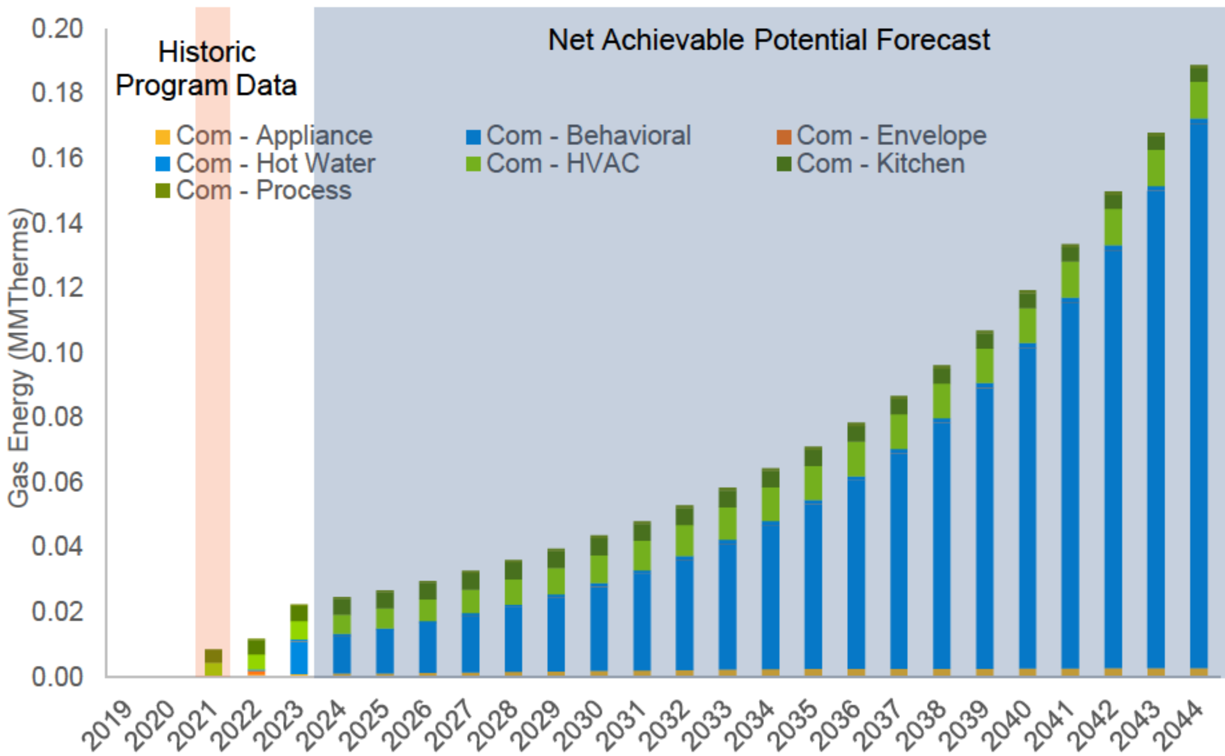
The calibrated results are lower than what could be achieved in the market due to the historical values being a pilot and still in a ramp up phase. In other scenarios, the historic budget constraints were reduced over a period of 10 years, and better show what is achievable by the current market. This was modeled by phasing out the payback adder linearly over 10 years starting 2019. For the high incentive, high adoption scenario, the payback adder was phased out over 4 years with a concave shape which means that most of the payback adder is removed in the last few years. This ensures the calibration period of 2019-2021 is as close as possible to the historical data, while also increasing the forecasted potential.

Figure E-5. Natural Gas (MMTherms) Historic and Modeled Achievable Savings for Residential Sector



Source: Guidehouse analysis 2023

Figure E-6. Natural Gas (MMTherms) Historic and Modeled Achievable Savings for Commercial Sector



Source: Guidehouse analysis 2023

E.2 Achievable Potential Savings – Business as Usual Scenario

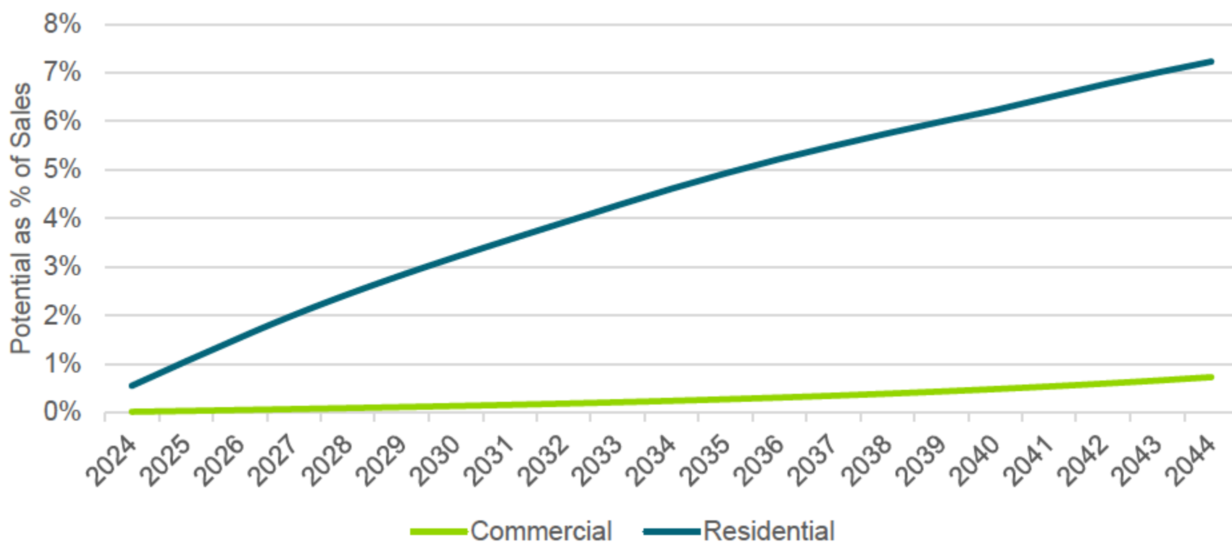
This section provides results pertaining to the Business as Usual scenario for natural gas net achievable potential at different levels of aggregation. Results are shown by sector, customer segment, end use, and by highest-impact measures. The Business as Usual Scenario represents where IGC would continue implementing their energy efficiency programs at comparable funding levels and for the most part continue to realize the energy savings that they have experienced from the past.

E.2.1 Results by Sector

Figure E-7 and Table E-1 show the natural gas percent of sales data is growing from 0.4% to 5.1% in 2044, or an average of 0.24% per year over the study horizon.

Values shown below for net achievable potential are termed cumulative achievable potential, in that they represent the accumulation of each year's annual incremental net achievable potential. As an example, an annual net achievable potential of 1.05% per year, for 10 years, would result in a cumulative net achievable potential of 10.5% of forecast sales. Economic potential, as defined in this Study can be thought of as a theoretical upper limit on potential if 100% of customers were willing to adopt the efficient measure regardless of payback and they chose to install the highest saving measure within a competition group (this is discussed in more detail in the Technical and Economic Potential chapters). The long run market potential considers customers' willingness to pay for an efficient measure and can be thought of as a bucket of potential from which programs can draw over time. Net achievable potential represents the draining of that bucket, the rate of which is governed by a number of factors, including the lifetime of measures (for ROB technologies), market effectiveness, incentive levels, and customer willingness to adopt, among others. If the cumulative net achievable potential ultimately reaches the economic potential, it will signify that all long run market potential in the bucket had been drawn down or harvested. Achievable gas savings potential reaches 5.1% of forecast sales by 2044, meaning that roughly 17% of economic potential has been harvested by the end of the potential study period (which represents 29.6% of sales in 2044).

Figure E-7.Total Natural Gas Cumulative Net Achievable Potential as a Percentage of Forecast Natural Gas Sales



Source: Guidehouse analysis 2023

Table E-1. Total Natural Gas Cumulative Net Achievable Potential as a Percentage of Natural Gas Sales

Gas Energy Achievable Potential by Sector as a Percent of Total Sales (%)			
	All	**Commercial**	**Residential**
2019	0.0%	0.0%	0.0%
2020	0.0%	0.0%	0.0%
2021	0.0%	0.0%	0.0%
2022	0.0%	0.0%	0.0%
2023	0.0%	0.0%	0.0%
2024	0.4%	0.0%	0.6%
2025	0.7%	0.0%	1.1%
2026	1.0%	0.1%	1.5%
2027	1.4%	0.1%	2.0%

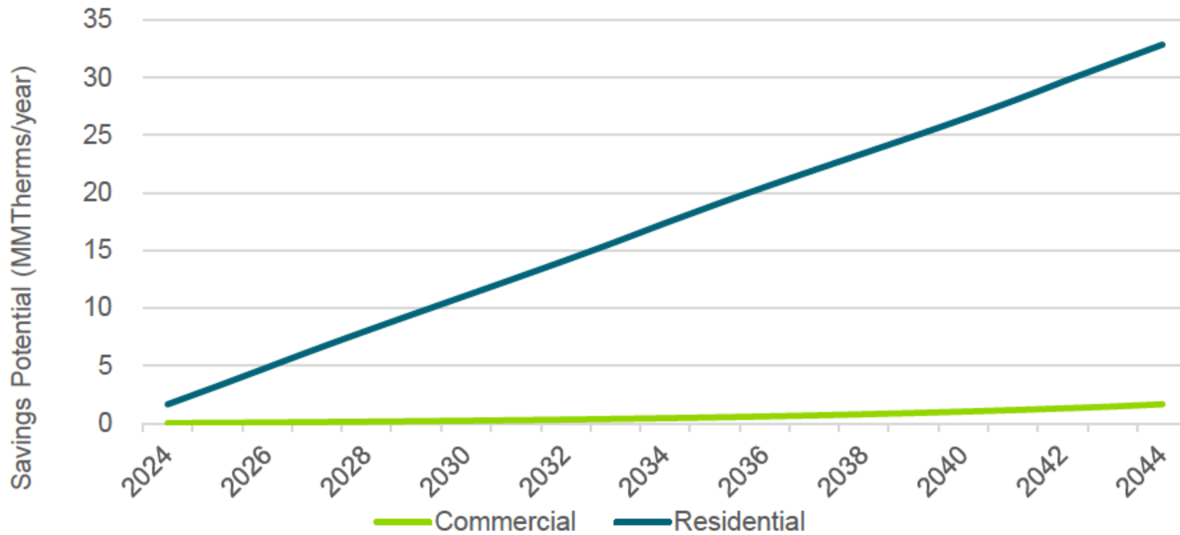
2028	1.7%	0.1%	2.4%
2029	1.9%	0.1%	2.8%
2030	2.2%	0.1%	3.2%
2031	2.4%	0.2%	3.6%
2032	2.7%	0.2%	3.9%
2033	2.9%	0.2%	4.3%
2034	3.2%	0.2%	4.6%
2035	3.4%	0.3%	4.9%
2036	3.6%	0.3%	5.2%
2037	3.8%	0.3%	5.5%
2038	4.0%	0.4%	5.8%
2039	4.1%	0.4%	6.0%
2040	4.3%	0.5%	6.2%
2041	4.5%	0.5%	6.5%
2042	4.7%	0.6%	6.8%
2043	4.9%	0.7%	7.0%
2044	5.1%	0.7%	7.2%

Source: Guidehouse analysis 2023

Figure E-8 and Table E-2 provide the total natural gas net achievable savings by sector (MMTherms/year). All savings reported in this potential study are net, meaning that the effect of possible free ridership is accounted for in the reported savings.

The residential sector makes up the largest portion of applicable sales. The residential sector makes up the most net natural gas potential as well as having the highest percentage of sales. Gas furnaces in the residential sector show the largest amount of savings potential.

Figure E-8. Cumulative Natural Gas Net Achievable Potential by Sector (MMTherms/year)



Source: Guidehouse analysis

Table E-2. Cumulative Natural Gas Net Achievable Potential by Sector (MMTherms/year)

	Commercial	Residential
2019	0.0%	0.0%
2020	0.0%	0.0%
2021	0.0%	0.0%
2022	0.0%	0.0%
2023	0.0%	0.0%
2024	0.0%	0.6%
2025	0.0%	1.1%
2026	0.1%	1.5%
2027	0.1%	2.0%
2028	0.1%	2.4%
2029	0.1%	2.8%
2030	0.1%	3.2%
2031	0.2%	3.6%
2032	0.2%	3.9%
2033	0.2%	4.3%
2034	0.2%	4.6%
2035	0.3%	4.9%
2036	0.3%	5.2%
2037	0.3%	5.5%
2038	0.4%	5.8%

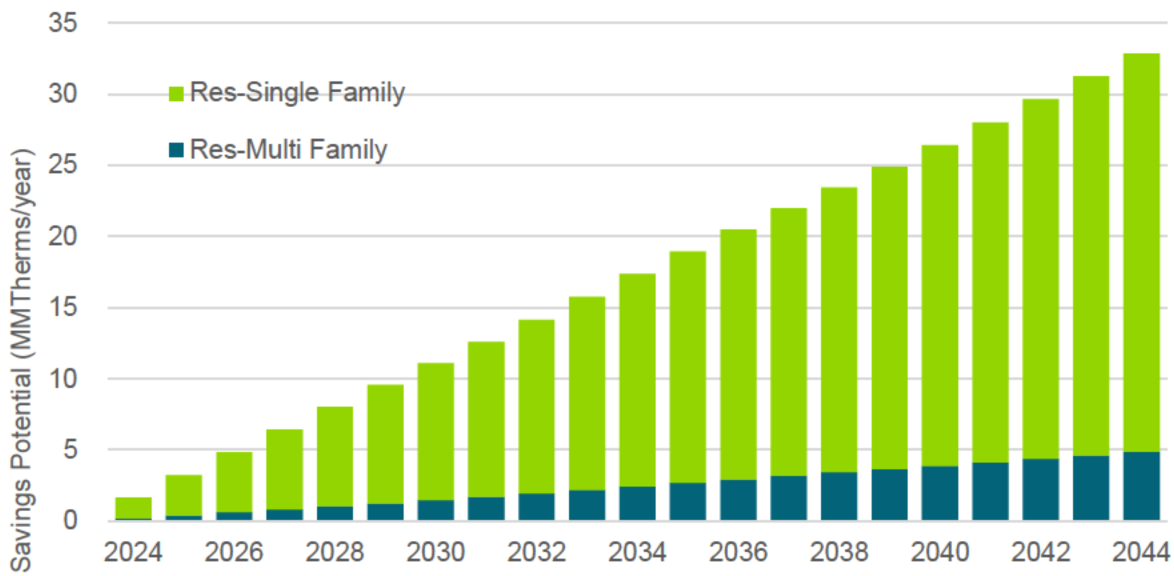
2039	0.4%	6.0%
2040	0.5%	6.2%
2041	0.5%	6.5%
2042	0.6%	6.8%
2043	0.7%	7.0%
2044	0.7%	7.2%

Source: Guidehouse analysis

E.2.2 Results by Customer Segment

Figure E-9 shows the cumulative net natural gas achievable savings potential by segment in the residential sector.

Figure E-9. Cumulative Net Natural Gas Achievable Potential by Residential Customer Segment (MMTherms/year)

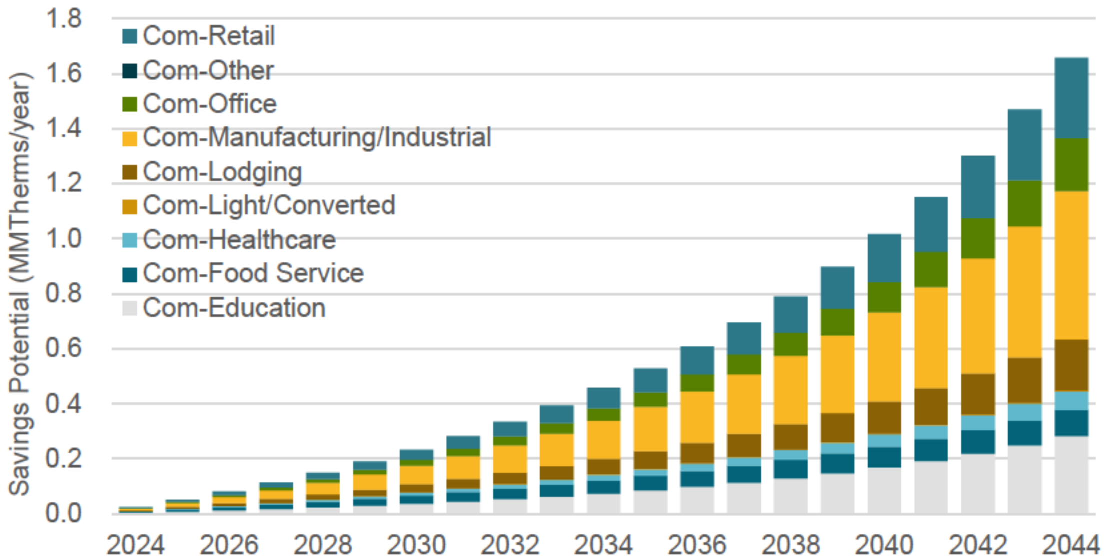


Source: Guidehouse analysis 2023

Residential single family dominates the potential as well as the stock forecast. Most of the potential is in the HVAC and Envelope use, with furnaces and air sealing high on the top measures list, detailed in later sections.

Figure E-10 shows the net natural gas potential for all of the commercial customer segments from 2024-2044.

Figure E-10. Cumulative Net Natural Gas Achievable Potential by Commercial Customer Segment (MMTherms/year)



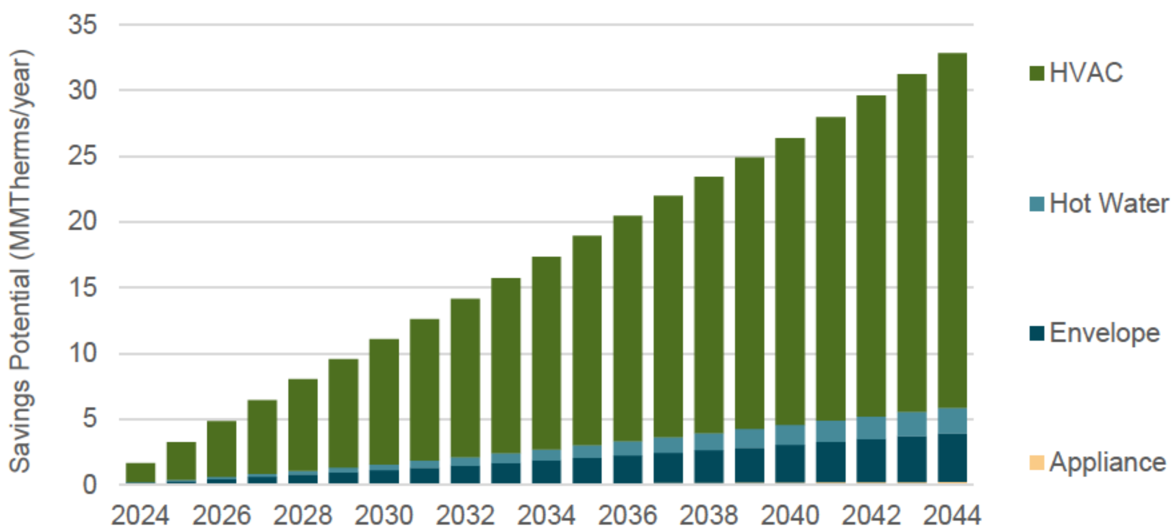
Source: Guidehouse analysis 2023

The natural gas savings are dominated by the Manufacturing/Industrial sector, which again makes up most of the load in the Commercial sector.

E.2.3 Results by End Use

Figure E-11 shows the residential sector by end use for 2024-2044.

Figure E-11. Cumulative Net Natural Gas Achievable Potential by Residential Sector End Use (MMTherms/year)

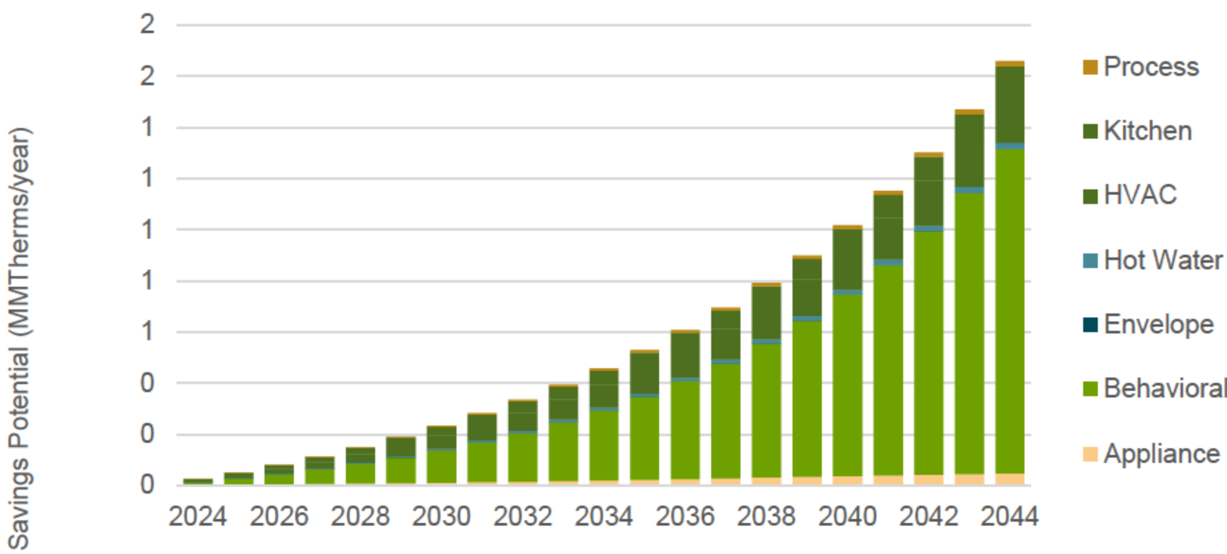


Source: Guidehouse analysis 2023

Natural gas savings are largely the Envelope and HVAC end uses. The largest gain in HVAC end use is from the growth in adoption for Furnace 98 AFUE. The largest gain in Envelope end use is from the growth in adoption for air sealing measures.

Figure E-12 shows the net potential savings by end use in the Commercial sector from 2024-2044.

Figure E-12. Cumulative Net Natural Gas Achievable Potential by Commercial Sector End Use (MMTherms/year)



Source: Guidehouse analysis 2023

Natural gas savings are largely the HVAC and Behavioral end uses. The largest gain in HVAC end use is from the growth in adoption for Boiler, Large measures.

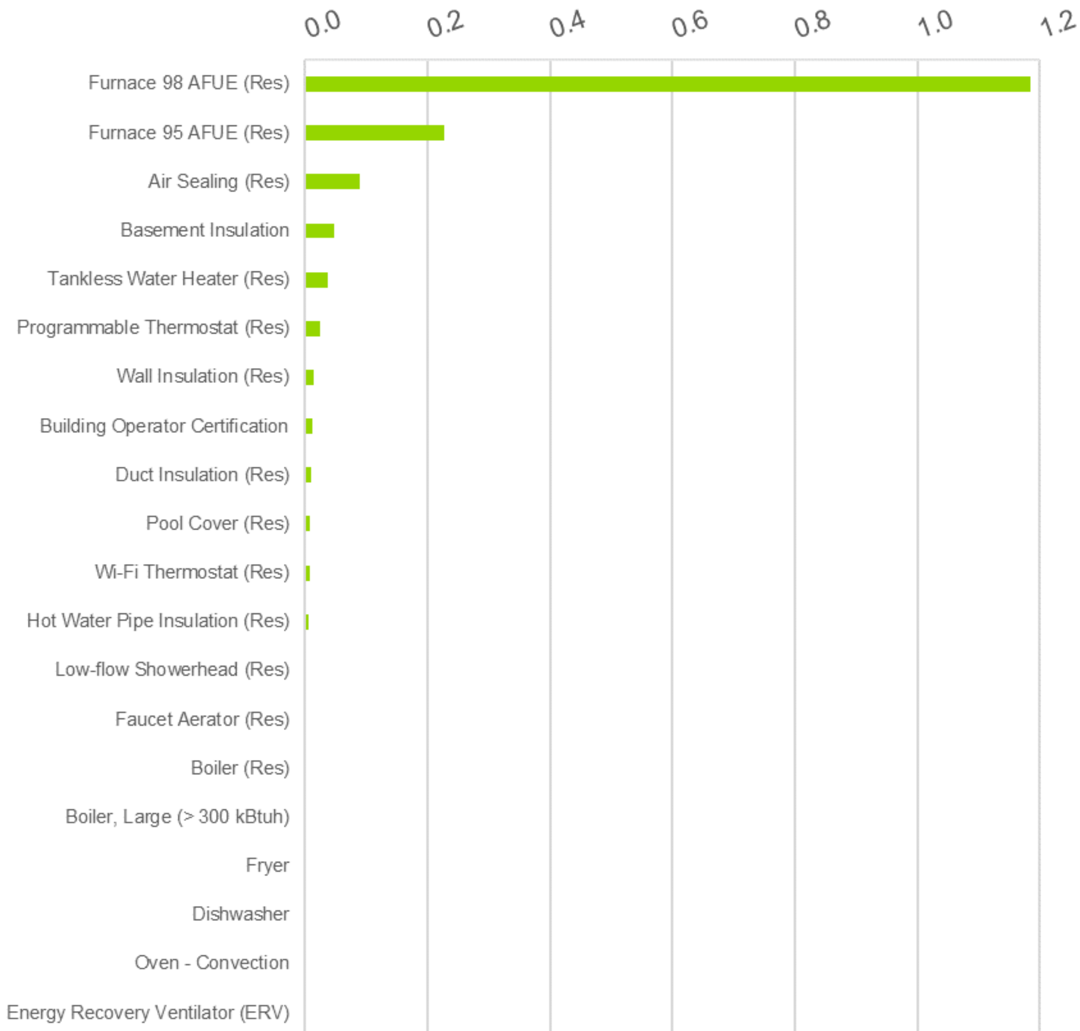
E.2.4 Results by Measure

Figure E-13 shows the top 20 ranking natural gas savings measures along with their cumulative net achievable gas energy potential in 2024. The top achievable measures are Building Operator Certification and Boiler, Large measures.

In the commercial sector, the growth in savings is split evenly between the different end uses, except for behavioral which experiences relatively larger growth due to its adoption being specified exogenously in the model.

When interpreting these measures and comparing to their technical and economic potential, it is important to remember that some measures, it is important to remember that adoption is not just based solely on economics. Some measures are low in achievable potential compared to economic potential due to there being high barriers of entry to adopting a technology, the customer does not know about the technology, or due to the model calibration with limited historical data.

Figure E-13. Top 20 Energy Efficiency Measures for Natural Net Achievable Potential by 2024 (MMTherms/year)



Source: Guidehouse analysis 2023

E.2.5 Budget Estimates

Guidehouse developed estimates of energy efficiency program funding needed to support the various levels of net achievable potential to be obtained during the study period. Table E-3 presents the estimated funding levels for incentives, program administration and portfolio administration under the Business as Usual scenario. These estimates were calculated in the DSMSim model and reflect calibrated incentive levels based on the percent of incremental cost approach described in this earlier in this report. The incentive budgets reflect the amount of spending that would result from the level of adoption for each measure that make up the net achievable potential estimates. Incentive values vary over time due to changes in the mix of measures. The administration budgets are based on historical expenditures for administration reported by IGC and applied on a measure level based on unit energy savings for each measure.

The table below is the total portfolio budget for natural gas programs. As the table shows, the total simulated funding that corresponds with the Business as Usual scenario net achievable potential is just over $10.3 million in 2024, decreasing slightly but keeping to a similar level year to year depending on the level of adoption. The share of incentives compared to the total budget remains steady over time.

Table E-3. Estimated Program Funding, Business as Usual Scenario (Thousands $)

	Incentives	Administration	Annual Total
2024	8,196	2,117	10,313
2025	7,598	2,026	9,624
2026	7,651	2,060	9,711
2027	7,604	2,064	9,668
2028	7,496	2,051	9,547
2029	7,128	1,975	9,103
2030	7,007	1,958	8,965
2031	7,028	1,977	9,005
2032	7,112	2,010	9,122
2033	7,325	2,075	9,399
2034	7,462	2,121	9,582
2035	7,314	2,087	9,401
2036	7,084	2,034	9,117
2037	6,882	1,995	8,877
2038	6,708	1,963	8,671
2039	6,743	1,967	8,710
2040	6,982	2,035	9,017
2041	7,485	2,174	9,658
2042	7,789	2,266	10,055
2043	7,666	2,255	9,921
2044	7,524	2,243	9,767

E.3 Achievable Potential Savings – Scenario Results

Guidehouse conducted three additional scenario analysis in addition to the Business as Usual case scenario results described above. The four scenarios are described in detail below:

- **Business as Usual:** This scenario is aligned and calibrated closely with IGC's historic program activity using IGC's program data, where available, with calibration to IGC's historic program accomplishments on a sector and end use basis. Incentive levels are defined as

50% of measure incremental cost, with the exception of Residential Furnace which was set at 40% of incremental cost to ensure the largest potential measure was cost effective throughout the study period. While this scenario represents no intentionally defined changes to the model, it does reflect an assumption that future program budgets will be closely aligned with IGC's historic EE program spending.

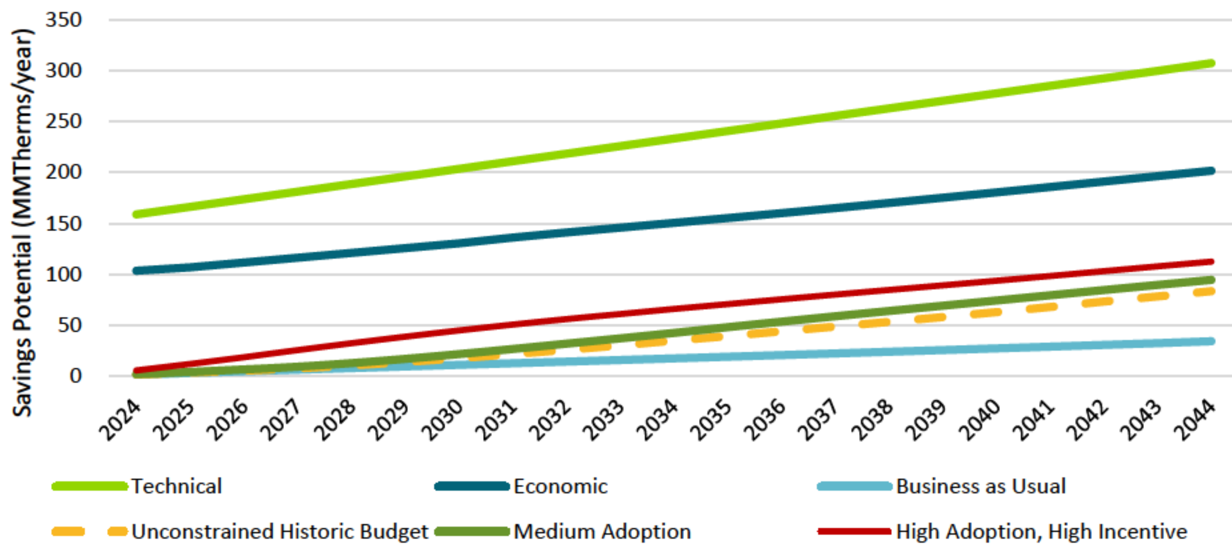
- **Unconstrained Historical Budget:** This scenario reflects a ramp up of customer adoption of natural gas energy efficiency over a 10 year period from the start of the EE program (through 2029), driven by increased IGC program activity without constraining program spending to historic levels. Incentive levels are consistent with Business as Usual Scenario.
- **Medium Adoption:** This scenario increases the adoption parameters compared to the unconstrained historical budget scenario, and increases model parameter values relating to customer awareness and willingness to adopt energy efficient technologies. Incentive levels are consistent with Business as Usual Scenario.
- **High Incentive, High Adoption:** this scenario reflects the savings possible by increasing the incentives from 50% of measure incremental cost to 65% of incremental cost, and further increasing the customer awareness and willingness to adopt energy efficiency measures to the highest values based on Guidehouse's experience and rules of thumb. Residential Furnace was kept at 40% of incremental cost to ensure it remained cost effective.

E.3.1 Natural Gas Energy Scenario Analyses Results

Figure E-14 and Figure E-15 compare the natural gas net savings results from the four different scenarios to the Business as Usual case technical and economic potential.

In Figure E-15, the slight variation in incremental savings over the study period for the Business as Usual and Unconstrained Historical Budget scenario is driven primarily by the HVAC end use and the variation in retail rates which was informed by the avoided costs. For the Medium Adoption Scenario, achievable potential decreases after 2035 due to the Commercial Energy Management System (EMS) measure's rapid adoption, leading to this technology becoming saturated in the market prior to the end of the study cycle. This results in the Commercial HVAC end use potential to trend down significantly, as this measure representing as much as 10% of overall portfolio savings. For the High Incentive, High Adoption scenario, the overall first year achievable potential decreases after 2027, due primarily to two measures with significant impact (Commercial Steam Trap and EMS) becoming saturated.

Figure E-14. Cumulative Net Natural Gas Energy Achievable Savings by Scenario



Source: Guidehouse analysis 2023

Figure E-15. Incremental Net Natural Gas Energy Achievable Savings by Scenario

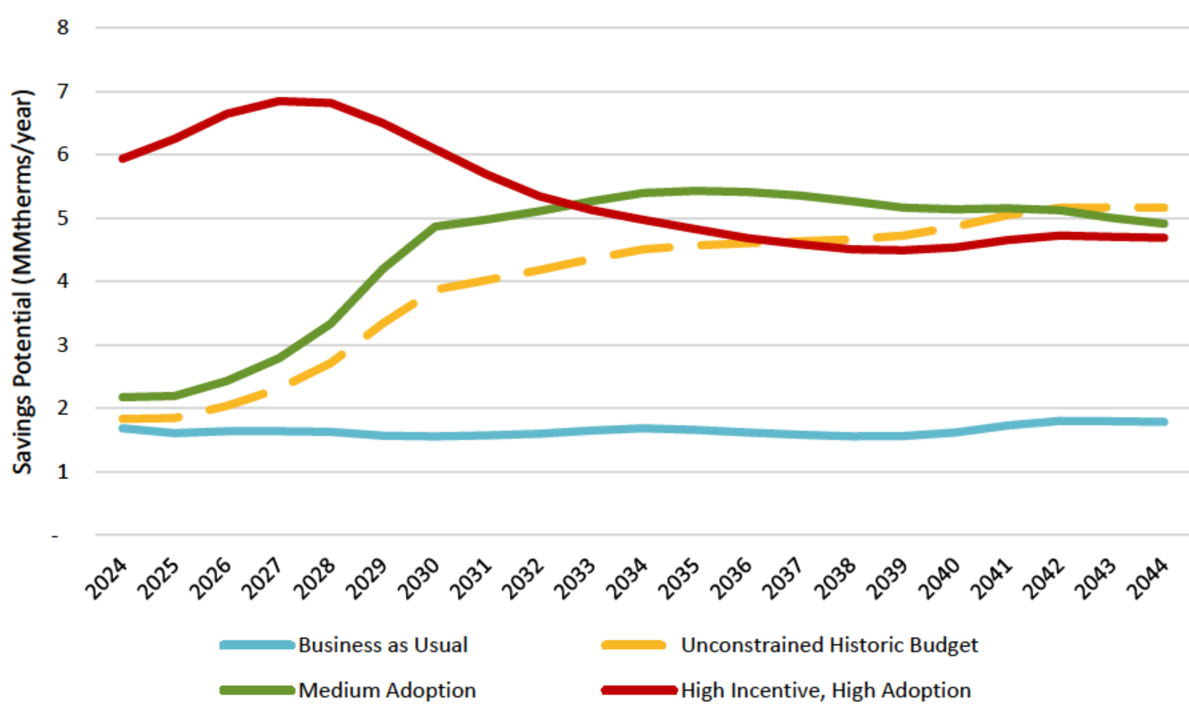
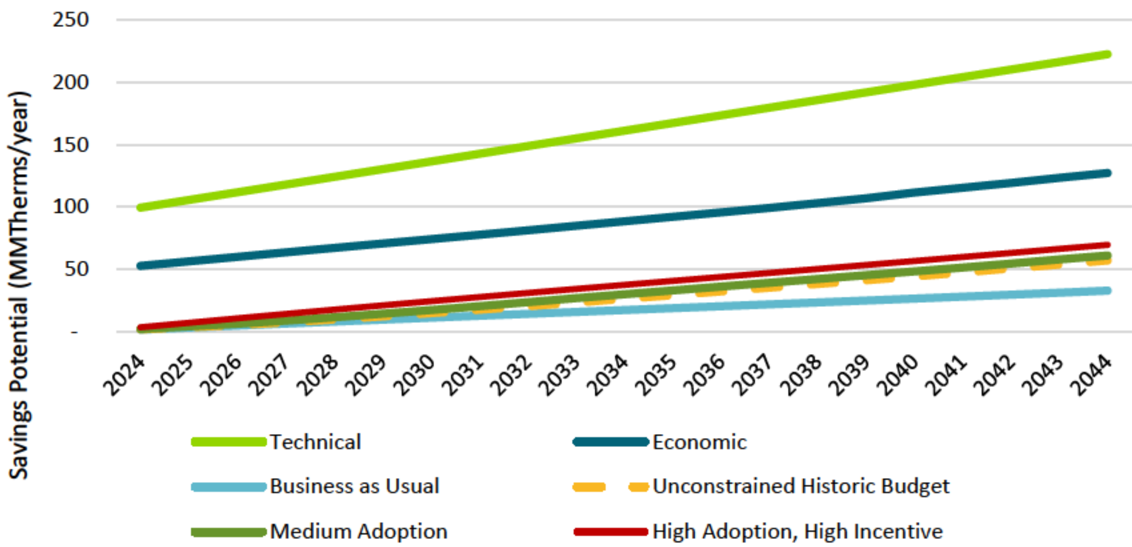


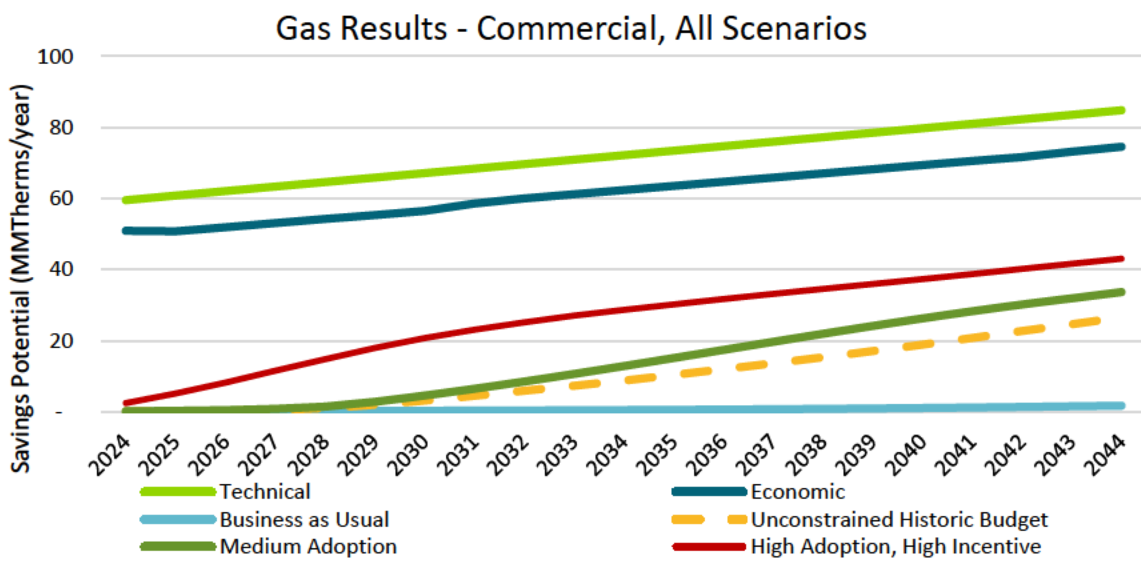
Figure E-16 and Figure E-17 show the net natural gas energy potential for the residential sector and commercial sectors, respectively. As the incentive percent of incremental cost, the maximum long run market share decreases for measures. For residential, the HVAC end use drives the decreases in potential. For commercial, the economic potential decreases for all end uses and is primarily driven by HVAC and envelope end uses.

Figure E-16. Residential Natural Cumulative Gas Energy Results by Scenario (MMTherms/year)



Source: Guidehouse analysis 2023

Figure E-17. Commercial Natural Gas Cumulative Energy Results by Scenario (MMTherms/year)



Source: Guidehouse analysis 2023

E.3.2 Budget Comparison – All Scenarios

Table E-4 summarizes results from the Unconstrained Historic Budget, Medium Adoption and High Incentive, High Adoption scenarios relative to the Business as Usual scenario. Compared to the Business as Usual scenario, the total spending over the study period is 1.6 times higher for the Unconstrained historical budget scenario, times 1.7 higher for the High Adoption scenario, and 2.2 times higher for the High Incentive, High Adoption scenario. Compared to the

Business as Usual scenario, the growth in savings over the study period is 2.4 times higher for the Unconstrained historical budget scenario, 2.7 times higher for the High Adoption scenario, and 3.3 times higher for the High Incentive, High Adoption scenario.

Table E-4. Total Portfolio Spending By Scenario (Thousands $)

	Business as Usual	Unconstrained Historic Budget	Medium Adoption	High Incentive, High Adoption
2024	10,313	10,740	12,639	25,459
2025	9,624	10,221	11,952	24,979
2026	9,711	10,701	12,406	25,403
2027	9,668	11,298	13,023	25,390
2028	9,547	12,207	14,075	24,897
2029	9,103	13,653	15,963	23,597
2030	8,965	14,788	17,215	22,489
2031	9,005	15,136	17,326	21,575
2032	9,122	15,550	17,541	20,756
2033	9,399	16,123	17,955	20,301
2034	9,582	16,560	18,259	19,888
2035	9,401	16,546	18,107	19,352
2036	9,117	16,374	17,790	18,681
2037	8,877	16,215	17,454	18,181
2038	8,671	16,084	17,098	17,765
2039	8,710	16,211	16,960	17,715
2040	9,017	16,848	17,316	18,011
2041	9,658	17,749	17,949	18,819
2042	10,055	18,302	18,259	19,267
2043	9,921	18,190	17,923	19,068
2044	9,767	18,126	17,692	18,946

The Portfolio UCT was calculated for each year of the study period. The avoided costs were calculated based on the measures that were adopted in each achievable scenario. The program costs were also calculated based on the number of installations. Since only measures that are cost-effective are in the achievable potential, this results in the UCT ranging from 1.19 to 2.09.

Table E-5. Benefit-Cost Ratios By Scenario

	Scenario 1: Business as Usual	Scenario 2: Unconstrained Historic Budget	Scenario 3: Medium Adoption	Scenario 4: High Incentive, High Adoption
2024	1.24	1.28	1.29	1.62
2025	1.21	1.28	1.30	1.65

2026	1.19	1.31	1.34	1.68
2027	1.19	1.36	1.41	1.70
2028	1.19	1.45	1.52	1.71
2029	1.20	1.57	1.67	1.72
2030	1.22	1.67	1.78	1.72
2031	1.23	1.71	1.82	1.70
2032	1.25	1.74	1.86	1.68
2033	1.26	1.76	1.88	1.67
2034	1.28	1.79	1.91	1.67
2035	1.29	1.82	1.95	1.68
2036	1.30	1.87	1.99	1.70
2037	1.33	1.91	2.03	1.72
2038	1.35	1.96	2.06	1.75
2039	1.36	1.99	2.07	1.77
2040	1.38	2.00	2.05	1.79
2041	1.39	2.01	2.03	1.79
2042	1.41	2.02	2.02	1.80
2043	1.43	2.06	2.04	1.83
2044	1.46	2.09	2.05	1.85

ATTACHMENT A

ATTACHMENT B