GDS Associates, Inc.
ENGINEERS & CONSULTANTS

DTE ENERGY

Natural Gas Efficiency Potential Study

Prepared for:

DTE Energy

Final Report

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1 Executive Summary

Background

DTE Energy staff and GDS Associates, Inc. (GDS) worked together to complete this 2016 study of natural gas energy efficiency potential for the DTE Energy service area. This energy efficiency potential study provides a roadmap for policy makers and identifies the energy efficiency measures having the greatest potential energy savings and the measures that are the most cost-effective. In addition to technical and economic potential estimates, the development of achievable potential estimates for a range of feasible energy efficiency measures is useful for program planning and modification purposes. Unlike achievable potential estimates, technical and economic potential estimates do not include customer acceptance considerations for energy efficiency measures, which are often among the most important factors when estimating the likely customer response to new programs. For this study, GDS produced the following estimates of energy efficiency potential:

- Technical Potential
- Economic Potential
- Achievable Potential
  - Achievable Potential Scenario #1: Based on Utility Cost Test (UCT) cost-effectiveness screening, incentives for program participants set at 50% of incremental measure costs and no budget constraints
  - Achievable Potential Scenario #2: Based on UCT cost-effectiveness screening, incentives for program participants set at 50% of incremental measure costs and energy efficiency program annual budgets constrained to 2% of projected annual DTE Energy natural gas revenues

Definitions of the types of energy efficiency potential are provided below.

Technical Potential is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures. It is often estimated as a "snapshot" in time assuming immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.

Economic Potential refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources. Both technical and economic potential are theoretical numbers that often assume immediate implementation of efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them.

Achievable Potential is the amount of energy use that efficiency can realistically be expected to displace assuming different market penetration scenarios for cost effective energy efficiency measures. An aggressive scenario, for example, could, provide program participants with payments for the entire incremental cost of more energy efficient equipment. This is often referred to as "maximum achievable potential." Achievable potential takes into account real-world barriers to convincing end-users to adopt cost effective energy efficiency measures, the non-measure costs of delivering programs (for administration, marketing, data and reporting tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.[1] Achievable potential is a subset of economic potential.

This potential study evaluates two achievable potential scenarios:

1) **Scenario #1 |** For the first scenario, achievable potential represents the amount of energy use that efficiency can realistically be expected to displace assuming incentives equal to 50% of the incremental measure cost and no cap on total annual energy efficiency program expenditures. Cost-effectiveness of measures was determined with the UCT.
2) **Scenario #2 |** The second scenario is a subset of Achievable Scenario #1 (based on UCT cost-effectiveness screening). While scenario #1 assumed no cap on total annual energy efficiency program expenditures, Achievable Scenario #2 assumed a spending cap of approximately 2% of projected annual DTE Energy natural gas revenues. According to Michigan Public Act 295 of 2008, natural gas and electric utilities are not permitted (without specific approval from the Commission) to spend more than 2.0% of annual retail revenues for programs implemented to comply with Michigan's energy optimization performance standard.

The purpose of this energy efficiency potential study is to provide a foundation for the continuation of utility-administered natural gas energy efficiency programs in the DTE Energy service area and to determine the remaining opportunities for cost-effective natural gas energy efficiency savings for the DTE Energy service area. This detailed report presents results of the technical, economic, and achievable potential for natural gas energy efficiency measures in the DTE Energy service area for two time periods:

- The ten-year period from January 1, 2016 through December 31, 2025
- The twenty-year period from January 1, 2016 through December 31, 2035

All results were developed using customized residential, commercial and industrial sector-level potential assessment analytic models and DTE Energy-specific cost-effectiveness criteria including the most recent DTE Energy specific avoided cost projections for natural gas. To help inform these energy efficiency potential models, up-to-date energy efficiency measure data were primarily obtained from the following recent studies and reports:

1) October 2015 Michigan Energy Measures Database (MEMD)
2) Energy efficiency baseline studies conducted by DTE Energy
3) 2009 U.S. Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS)
4) 2007 American Housing Survey (AHS)
5) 2003 EIA Commercial Building Energy Consumption Survey (CBECS)[2]

The above data sources provided valuable information regarding the current saturation, costs, savings and useful lives of natural gas energy efficiency measures considered in this study.

The results of this study provide detailed information on energy efficiency measures that are the most cost-effective and have the greatest potential natural gas savings for the DTE Energy service area. The data used for this report were the best available at the time this analysis was developed. As building and appliance codes and energy efficiency standards change, and as energy prices fluctuate, additional opportunities for energy efficiency may occur while current practices may become outdated.

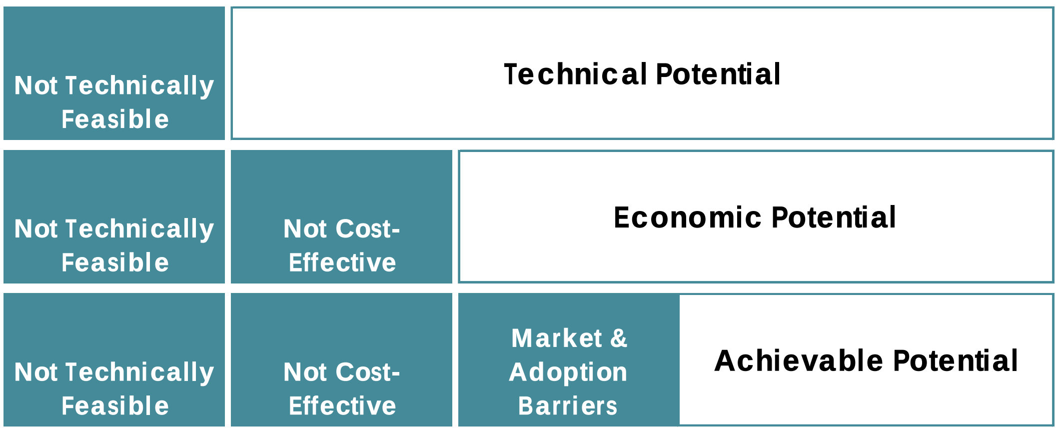
Study Scope

[1] These definitions are from the November 2007 NAPEE "Guide for Conducting Energy Efficiency Potential Studies"
[2] This is the latest publicly available CBECS data released by the Energy Information Administration (EIA).

The study examines the potential to reduce natural gas consumption through the implementation of energy efficiency technologies and practices in residential, commercial, and industrial facilities in the DTE Energy service area. This study assesses natural gas energy efficiency potential in the DTE Energy service area over twenty years, from 2016 through 2035.

The main objective of this study was to evaluate the natural gas energy efficiency technical, economic and achievable potential savings for the DTE Energy service area, based upon cost-effectiveness screening with the UCT benefit/cost test. As noted above, the scope of this study distinguishes among three types of energy efficiency potential; (1) technical, (2) economic, and (3) achievable potential. The definitions used in this study for energy efficiency potential estimates were obtained directly from a 2007 National Action Plan for Energy Efficiency (NAPEE) report.[3] Figure 1-1 below provides a graphical representation of the relationship of the various definitions of energy efficiency potential.

Figure 1-1: Types of Energy Efficiency Potential[4]



Limitations to the scope of study: As with any assessment of energy efficiency potential, this study necessarily builds on a large number of assumptions and data sources, including the following:

- Energy efficiency measure lives, measure savings and measure costs
- The discount rate for determining the net present value (NPV) of future savings
- Projected penetration rates for energy efficiency measures
- Projections of DTE Energy specific natural gas avoided costs
- Future changes to current energy efficiency codes and standards for buildings and equipment

While the GDS Team has sought to use the best and most current available data, there are many assumptions where there may be reasonable alternative assumptions that would yield somewhat different results. Furthermore, while the lists of energy efficiency measures examined in this study represent the most commercially available measures, these measure lists are not exhaustive.

With respect to non-energy benefits of energy efficiency programs, GDS did not place a value on reductions in power plant emissions of CO_2 or other emissions.

Finally, there was no attempt to place a dollar value on some difficult to quantify benefits arising from installation of some measures, such as increased comfort or increased safety, which may in turn support

[3] National Action Plan for Energy Efficiency, "Guide for Conducting Energy Efficiency Potential Studies", November 2007.
[4] Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. US EPA. Figure 2-1.

some personal choices to implement particular measures that may otherwise not be cost-effective or only marginally so.

Summary of Results

This study examined several hundred natural gas energy efficiency measures in the residential, commercial and industrial sectors combined.

The data in Figure 1-2 below shows that cost-effective natural gas energy efficiency resources can play a significantly expanded role in DTE Energy's energy resource mix over the next ten and twenty years. For the DTE Energy service area overall, the achievable potential for natural gas savings based on the UCT cost-effectiveness test screening is 13.6% of forecast MMBtu sales for 2025, and 19.6% of forecast MMBtu sales in 2035.

Figure 1-2: Natural Gas Energy Efficiency Potential Savings Summary

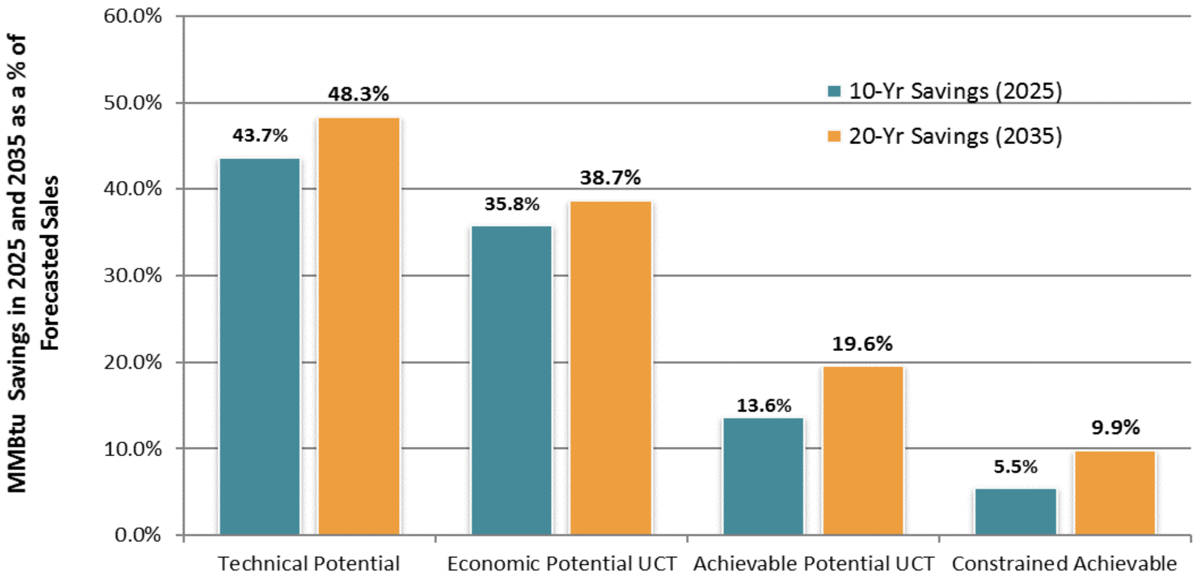


Table 1-1 and Table 1-2 present additional detail, providing the energy efficiency savings potential for all scenarios over a period of and 10 and 20 years, respectively.

Table 1-1: Summary of Technical, Economic and Achievable Natural Gas Energy Savings for 2025

End Use	Technical Potential	Economic Potential (UCT)	Achievable Potential (UCT)	Constrained Achievable (UCT)
Natural Gas Savings as % of Sales Forecast				
Savings % - Residential	43.6%	35.1%	12.7%	4.6%
Savings % - Commercial	43.9%	38.7%	16.5%	8.1%
Savings % - Industrial	41.7%	20.7%	17.2%	8.5%
Savings % - Total	43.7%	35.8%	13.6%	5.5%
Savings MMBtu - Residential	49,972,671	40,188,718	14,511,239	5,312,355
Savings MMBtu - Commercial	16,180,324	14,261,672	6,078,410	2,983,129
Savings MMBtu - Industrial	529,264	262,883	218,040	108,003

End Use	Technical Potential	Economic Potential (UCT)	Achievable Potential (UCT)	Constrained Achievable (UCT)
Savings MMBtu - Total	66,682,259	54,713,273	20,807,688	8,403,487

Table 1-2: Summary of Technical, Economic and Achievable Natural Gas Energy Savings for 2035

End Use	Technical Potential	Economic Potential (UCT)	Achievable Potential (UCT)	Constrained Achievable (UCT)
Natural Gas Savings as % of Sales Forecast				
Savings % - Residential	49.7%	38.7%	18.7%	9.1%
Savings % - Commercial	44.5%	39.3%	22.1%	12.1%
Savings % - Industrial	41.7%	20.7%	19.8%	11.5%
Savings % - Total	48.3%	38.7%	19.6%	9.9%
Savings MMBtu - Residential	59,125,302	46,074,300	22,307,589	10,844,287
Savings MMBtu - Commercial	17,294,774	15,259,641	8,566,066	4,706,903
Savings MMBtu - Industrial	529,264	262,883	251,267	145,393
Savings MMBtu - Total	76,949,340	61,596,824	31,124,921	15,696,583

The ten-year and twenty-year budgets and acquisition costs for the achievable potential scenarios for natural gas energy efficiency savings are shown in Table 1-3.

GDS is providing the information on the projected acquisition per first year unit of energy saved in order to provide program planners and decision-makers with the expected cost to utilities to acquire the natural gas savings for the two achievable potential scenarios examined in this report. It is important for program planners and other decision-makers to have a good understanding of the cost to utilities to acquire these levels of natural gas energy efficiency savings.

Table 1-3: Achievable Potential Scenarios; Budgets and Acquisition Costs Per Unit of Energy Saved – Natural Gas Savings (Budgets Are Not in Present Value Dollars)

All Sectors Combined	10 - Year EE Budget	20-Year EE Budget	Acquisition Cost Per First Year MMBtu Saved - 10 years	Acquisition Cost Per First Year MMBtu Saved - 20 years
Achievable UCT – No budget constraint	$641,588,995	$1,323,528,053	$25.84	$26.18
Constrained UCT	$246,995,206	$627,506,534	$24.86	$25.74

Table 1-4 and Table 1-5 present the annual utility budgets, in total and by sector, required to achieve the natural gas energy efficiency savings levels in each of the two achievable potential scenarios. These tables also present annual information on the percent of annual utility revenues needed each year to fund acquiring the energy efficiency savings levels for each achievable potential scenario.

Table 1-4: Annual Natural Gas Energy Efficiency Program Budgets Associated with the Achievable UCT Scenario (in millions)

	Residential	Commercial	Industrial	Total Budgets	% of Annual Revenue
2016	$37.7	$8.4	$0.4	$46.4	4.7%
2017	$41.1	$8.4	$0.4	$49.9	5.0%
2018	$45.2	$8.5	$0.4	$54.1	5.2%
2019	$48.9	$8.6	$0.4	$57.8	5.2%
2020	$52.6	$8.6	$0.4	$61.6	5.1%
2021	$56.4	$8.7	$0.4	$65.5	5.1%
2022	$60.2	$8.8	$0.4	$69.4	5.2%
2023	$64.1	$10.4	$0.4	$74.9	5.4%
2024	$68.0	$10.5	$0.5	$78.9	5.4%
2025	$71.9	$10.6	$0.5	$83.0	5.4%
2026	$59.2	$7.8	$0.2	$67.2	4.2%
2027	$59.2	$7.8	$0.2	$67.2	4.0%
2028	$58.1	$8.3	$0.2	$66.6	3.9%
2029	$58.9	$8.6	$0.2	$67.7	3.8%
2030	$57.9	$10.3	$0.2	$68.4	3.7%
2031	$59.1	$16.1	$0.4	$75.6	3.8%
2032	$58.0	$16.3	$0.4	$74.7	3.6%
2033	$57.7	$14.8	$0.4	$72.9	3.3%
2034	$57.5	$15.0	$0.5	$72.9	3.1%
2035	$56.7	$15.1	$0.5	$72.2	2.9%

Table 1-5: Annual Natural Gas Energy Efficiency Program Budgets Associated with the Constrained UCT Scenario (in millions)

	Residential	Commercial	Industrial	Total Budgets	% of Annual Revenue
2016	$15.8	$3.6	$0.2	$19.6	2.0%
2017	$16.3	$3.7	$0.2	$20.1	2.0%
2018	$16.9	$3.8	$0.2	$20.9	2.0%
2019	$18.1	$4.0	$0.2	$22.4	2.0%
2020	$19.5	$4.4	$0.2	$24.1	2.0%
2021	$20.7	$4.6	$0.2	$25.5	2.0%
2022	$21.7	$4.8	$0.2	$26.7	2.0%
2023	$22.7	$5.0	$0.2	$27.9	2.0%
2024	$23.7	$5.2	$0.3	$29.2	2.0%
2025	$24.9	$5.5	$0.3	$30.6	2.0%
2026	$26.2	$5.7	$0.3	$32.2	2.0%
2027	$27.2	$5.9	$0.3	$33.4	2.0%
2028	$28.1	$6.1	$0.3	$34.5	2.0%
2029	$29.2	$6.3	$0.3	$35.8	2.0%
2030	$30.4	$6.6	$0.3	$37.3	2.0%
2031	$32.1	$7.0	$0.3	$39.4	2.0%
2032	$33.9	$7.3	$0.4	$41.6	2.0%
2033	$35.9	$7.8	$0.4	$44.0	2.0%

	Residential	Commercial	Industrial	Total Budgets	% of Annual Revenue
2034	$37.9	$8.2	$0.4	$46.5	2.0%
2035	$40.1	$8.7	$0.4	$49.2	2.0%

Energy Efficiency Potential Savings Detail By Sector

Note that Sections 5, 6 and 7 of this report include additional detail about the natural gas energy efficiency savings potential in the DTE Energy service area by 2035.

Cost-Effectiveness Findings

This study examines the two achievable potential scenarios presented in this study. This potential study concludes that significant cost-effective natural gas energy efficiency potential remains in the DTE Energy service area. Table 1-6 and Table 1-7 show the preliminary present value benefits, costs and benefit-cost ratios for these two scenarios.

Table 1-6: UCT Benefit-Cost Ratios for Achievable Potential Scenarios For 2016 to 2025 Time Period

Achievable Potential Scenarios	NPV $ Benefits	NPV $ Costs	UCT Benefit/Cost Ratio	UCT Net Benefits
Achievable UCT – Scenario #1	$553,747,610	$423,567,579	1.31	$130,180,031
Constrained UCT – Scenario #2	$222,436,585	$164,510,156	1.35	$57,926,429

Table 1-7: UCT Benefit-Cost Ratios for Achievable Potential Scenarios For 2016 to 2035 Time Period

Achievable Potential Scenarios	NPV $ Benefits	NPV $ Costs	UCT Benefit/Cost Ratio	UCT Net Benefits
Achievable UCT – Scenario #1	$852,050,531	$622,160,694	1.37	$229,889,837
Constrained UCT – Scenario #2	$389,670,965	$272,605,086	1.43	$117,065,879

In addition, GDS did calculate UCT benefit/cost ratios for each individual energy efficiency measure considered in this study. Only measures that had a UCT benefit/cost ratio greater than or equal to 1.0 were retained in the economic and achievable potential savings estimates. It is important to note that energy efficiency measures for low income households do not necessarily need to be cost-effective in the DTE Energy service area. However, for consistency in this report, GDS has excluded all non-cost effective measures from estimates of economic and achievable potential energy efficiency savings.

Report Organization

The remainder of this report is organized as follows:

Section 2: Glossary of Terms defines key terminology used in the report.

Section 3: Characterization of Natural Gas Consumption provides an overview of the Energy natural gas service area and a brief discussion of the historical and forecasted natural gas energy sales by sector.

Section 4: Potential Study Methodology details the approach used to develop the estimates of technical, economic and achievable potential savings for natural gas energy efficiency savings.

Section 5: Residential Natural Gas Energy Efficiency Potential Estimates provides a breakdown of the residential sector technical, economic, and achievable natural gas energy efficiency savings.

Section 6: Commercial Natural Gas Energy Efficiency Potential Estimates provides a breakdown of the commercial sector technical, economic, and achievable natural gas energy efficiency savings.

Section 7: Industrial Natural Gas Energy Efficiency Potential Estimates provides a breakdown of the industrial sector technical, economic, and achievable natural gas energy efficiency savings.

2 GLOSSARY OF TERMS

The following list defines many of the key energy efficiency terms used throughout this energy efficiency potential study.

Achievable Potential: The November 2007 NAPEE "Guide for Conducting Energy Efficiency Potential Studies" defines achievable potential as the amount of energy use that energy efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (*e.g*., providing end-users with payments for the entire incremental cost of more efficient equipment). This is often referred to as maximum achievable potential. Achievable potential takes into account real-world barriers to convincing end-users to adopt efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time. For purposes of this study, two achievable potential scenarios were included: the first is an achievable potential scenario which assumes incentives are set to 50% of the incremental or full measure cost; the second assumed a spending cap of approximately 2% of utility revenues.

Administrative Costs: Costs incurred by the utility that do not include incentives paid to the customer (i.e.: program administrative costs, program marketing costs, data tracking and reporting, program evaluation, etc.). These costs may also be referred to as 'non-incentive' costs.

Applicability Factor: The fraction of the applicable housing units or businesses that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install CFLs in all light sockets in a home because the CFLs may not fit in every socket in a home).

Acquisition Costs: The cost of energy savings associated with energy efficiency programs, generally expressed in costs per first year MMBtu saved ($/MMBtu) in this report.

Avoided Costs: There are two main categories of avoided costs: energy-related and capacity-related. Energy-related avoided costs refer to market prices of energy, fuel costs, natural gas commodity prices, and other variable costs. Capacity related avoided costs refer to infrastructure investments such as power plants, transmission and distribution lines, and natural gas transmission and distribution pipelines and gas storage facilities.

Base Case Equipment End-Use Intensity: The energy used per customer per year by each base-case technology in each market segment. This is the consumption of the energy using equipment that the efficient technology replaces or affects.

Base Case Factor: The fraction of the market that is applicable for the efficient technology in a given market segment. For example, for residential domestic water heating, this would be the fraction of all residential customers that have a gas water heater in their household.

Coincidence Factor: The fraction of connected load expected to be "on" and using electricity coincident with the electric system peak period.

Cost-Effectiveness: A measure of the relevant economic effects resulting from the implementation of an energy efficiency measure or program. If the benefits are greater than the costs, the measure is said to be cost-effective.

Cumulative Annual: Refers to the overall annual savings occurring in a given year from both new participants and annual savings continuing to result from past participation with energy efficiency measures that are still in place. Cumulative annual does not always equal the sum of all prior year incremental values as some energy efficiency measures have relatively short useful lives and, as a result, their energy savings drop off over time.

Commercial Sector: Comprised of non-manufacturing premises typically used to sell a product or provide a service, where electricity and natural gas are consumed primarily for lighting, space cooling and heating, office equipment, refrigeration and other end uses. Commercial business types are described in Section 5 – Methodology.

Economic Potential: The November 2007 NAPEE "Guide for Conducting Energy Efficiency Potential Studies" refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources as economic potential. Economic potential ignores market barriers to ensuring actual implementation of efficiency and only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration, evaluation) that would be necessary to capture them.

End-Use: A category of equipment or service that consumes energy (*e.g.*, lighting, refrigeration, heating, process heat, cooling).

Energy Efficiency: Using less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way. Sometimes "conservation" is used as a synonym, but that term is usually taken to mean using less of a resource even if this results in a lower service level (*e.g.*, setting a thermostat lower or reducing lighting levels).

Free Rider: Participants in an energy efficiency program who would have adopted an energy efficiency technology or improvement in the absence of a program or financial incentive.

Incentive Costs: A rebate or some form of payment used to encourage electric and natural gas consumers to implement a given demand-side management (DSM) technology.

Incremental: Savings or costs in a given year associated only with new installations of energy efficiency measures happening in that specific year.

Industrial Sector: Comprised of manufacturing premises typically used for producing and processing goods, where electricity and natural gas is consumed primarily for operating motors, process cooling and heating, and space heating, ventilation, and air conditioning (HVAC). Industrial business types are described in section 5 – Methodology.

Measure: Any action taken to increase energy efficiency, whether through changes in equipment, changes to a building shell, implementation of control strategies, or changes in consumer behavior. In some cases, bundles of technologies or practices may be modeled as single measures.

MMBtu: A measure of power, used in this report to refer to consumption and savings associated with natural gas consuming equipment. One British thermal unit (symbol Btu or sometimes BTU) is a traditional unit of energy equal to about 1055 joules. MMBtu is defined as one million BTUs.

MW: A unit of electrical output, equal to one million watts or one thousand kilowatts. It is typically used to refer to the output of a power plant.

MWh: One thousand kilowatt-hours, or one million watt-hours. One MWh is equal to the use of 1,000,000 watts of power in one hour.

Participant Cost: The cost to the participant to participate in an energy efficiency program.

Portfolio: Either a collection of similar programs addressing the same market, technology, or mechanisms; or the set of all programs conducted by one energy efficiency organization or utility.

Program: A mechanism for encouraging energy efficiency that may be funded by a variety of sources and pursued by a wide range of approaches (typically includes multiple energy efficiency measures).

Remaining Factor: The fraction of applicable units that have not yet been converted to the electric or natural gas energy efficiency measure; that is, one minus the fraction of units that already have the energy efficiency measure installed.

Replace-on-burnout: An energy efficiency measure is not implemented until the existing technology it is replacing fails or burns out. An example would be an energy efficient water heater being purchased after the failure of the existing water heater at the end of its useful life.

Retrofit: Refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher-efficiency units, or the installation of additional controls, equipment, or materials in existing facilities for purposes of reducing energy consumption (e.g., increased insulation, low flow devices, lighting occupancy controls, economizer ventilation systems).

Savings Factor: The percentage reduction in electricity or natural gas consumption resulting from application of the efficient technology. The savings factor is used in the formulas to calculate energy efficiency potential.

Technical Potential: The theoretical maximum amount of energy use that could be displaced by energy efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the energy efficiency measures.

Utility Cost Test: The UCT measures the net benefits of the energy efficiency program for a region or service area as a whole from the utility's perspective. Costs included in the UCT are the utility's costs to design, implement and evaluate a program. The benefits included are the avoided utility costs of energy and capacity.

3 Characterization of Natural Gas Consumption in DTE Energy's Service Territory

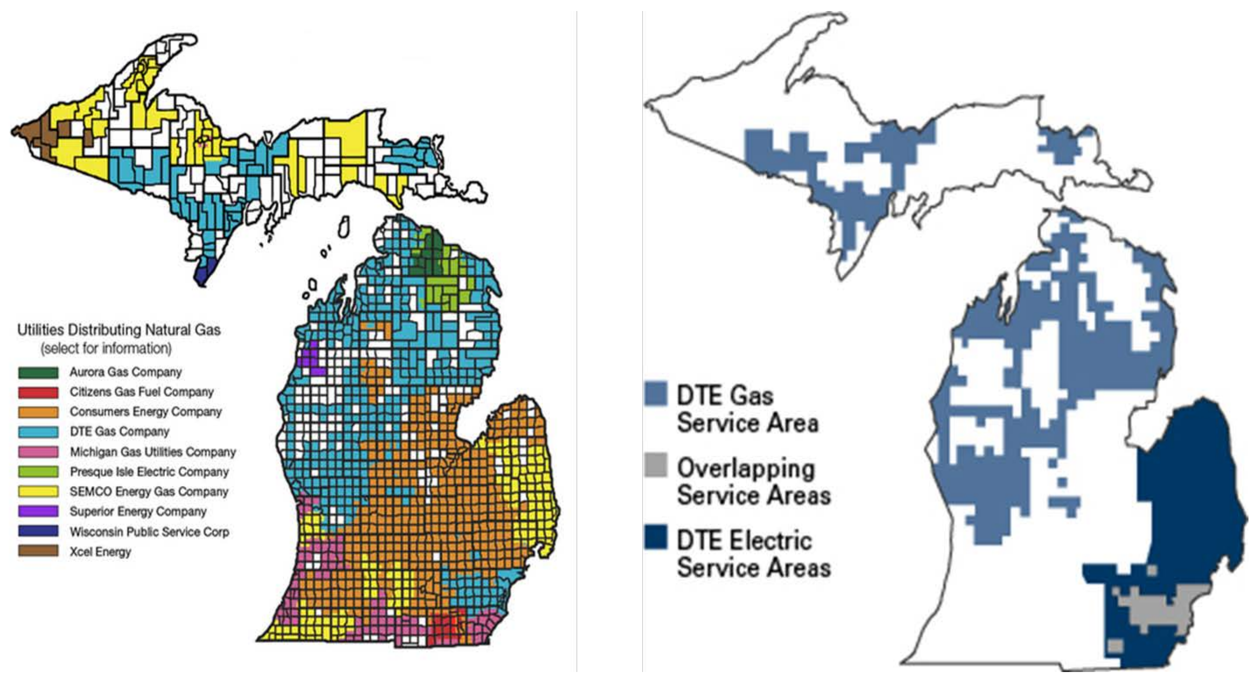
This section provides up-to-date forecast information on natural gas consumption, consumption by market segment and by energy end use, and natural gas customers in DTE Energy's natural gas service territory. Developing this information is a fundamental part of any energy efficiency potential study. It is necessary to understand how energy is consumed in a utility service area or region before one can assess the energy efficiency savings potential that remains to be tapped.

3.1 Michigan Natural Gas Utilities

There are multiple utilities that provide natural gas to Michigan customers. According to data from the Michigan Public Service Commission, Michigan has 10 natural gas utilities. The two largest electric utilities are DTE Energy Company (DTE) and Consumers Energy. These two utilities provide approximately 84% of natural gas delivery in the State.

Figure 3-1 shows the DTE natural gas service area in Michigan. On the left, the DTE natural gas service area is shown relative to other natural gas utilities in Michigan. On the right, the DTE natural gas service area is shown relative to the DTE Energy Company.

Figure 3-1: Michigan Natural Gas Utility Service Territories



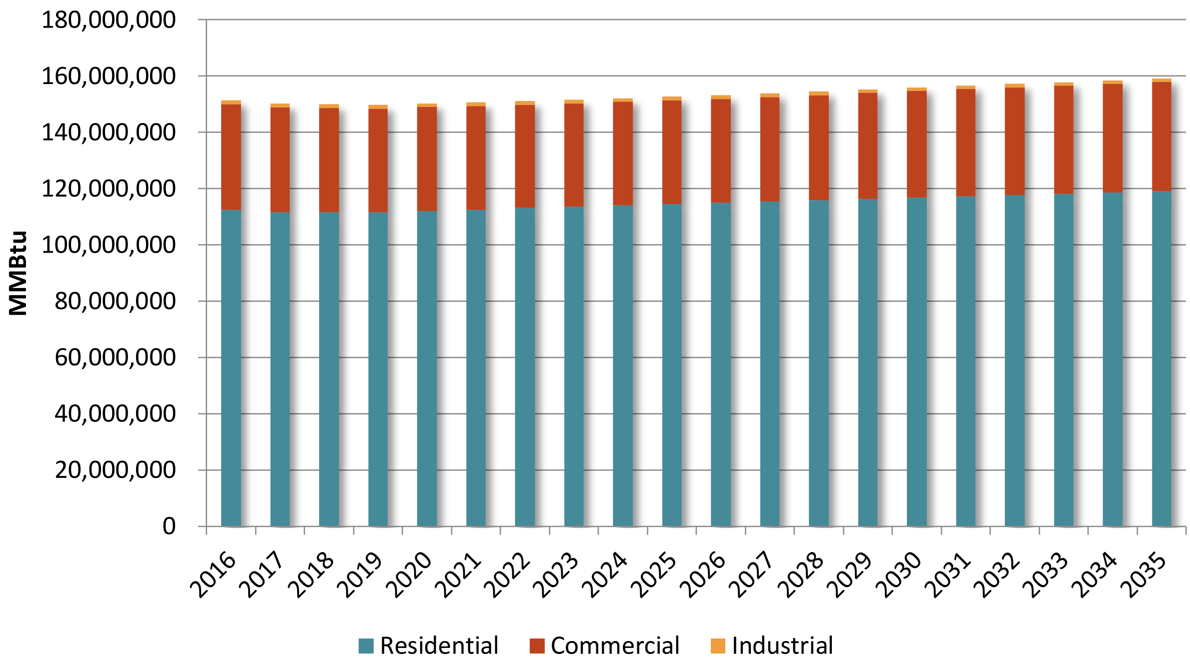
3.2 Residential, Commercial and Industrial Sector Baseline Segmentation Findings

This section provides detailed information on the breakdown of DTE residential, commercial and industrial sector natural gas sales in the DTE Energy service territory by market segment and end use.

3.2.1 Natural Gas Sales Forecast by Sector for the DTE Energy Service Area

Figure 3-2 and Table 3-1 show historical and forecast natural gas sales by sector (in MMBtu) for the DTE service area for the period 2016 to 2035. GDS coordinated with DTE Energy to develop forecast sales that exclude the impacts of future DSM programs. Preparation of a forecast of natural gas sales that excludes such impacts is important in order to ensure that the methodology used in this study to estimate potential savings is based on levels of natural gas sales before the implementation of future energy efficiency programs.

Figure 3-2: DTE Energy Forecast of Annual Natural Gas Sales (MMBtu)[5]



The DTE Energy forecast of annual natural gas sales shown in Figure 3-2 above highlights that the Company expects future MMBtu sales to remain at 2016 levels for the next two decades. The residential sector is forecast to have the largest share of annual MMBtu sales, followed by the commercial and industrial sectors.

Table 3-1: DTE Energy Projected Natural Gas MMBtu Sales by Sector for 2016 to 2035

Year	Residential Sales (MMBtu)	Commercial Sales (MMBtu)	Industrial Sales (MMBtu)	Total Sales (MMBtu)
2016	112,438,984	37,672,410	1,312,202	151,423,596
2017	111,678,756	37,263,299	1,299,123	150,241,178
2018	111,628,742	37,112,546	1,287,652	150,028,940
2019	111,572,950	36,962,003	1,276,349	149,811,302
2020	112,088,348	37,008,405	1,266,447	150,363,200
2021	112,596,991	36,779,551	1,265,378	150,641,920
2022	113,098,931	36,706,769	1,265,883	151,071,584
2023	113,594,218	36,719,268	1,266,568	151,580,054
2024	114,082,902	36,786,632	1,267,834	152,137,368

[5] Excludes the transportation sector

Year	Residential Sales (MMBtu)	Commercial Sales (MMBtu)	Industrial Sales (MMBtu)	Total Sales (MMBtu)
2025	114,565,033	36,875,488	1,268,064	152,708,586
2026	115,040,661	36,916,689	1,267,295	153,224,644
2027	115,509,833	37,055,317	1,268,146	153,833,297
2028	115,972,600	37,314,733	1,269,034	154,556,367
2029	116,429,010	37,618,018	1,269,690	155,316,718
2030	116,879,110	37,892,852	1,269,607	156,041,569
2031	117,322,950	38,081,243	1,270,096	156,674,289
2032	117,760,575	38,233,251	1,270,406	157,264,232
2033	118,192,034	38,392,367	1,270,052	157,854,453
2034	118,617,373	38,593,276	1,269,848	158,480,497
2035	119,036,639	38,846,755	1,269,572	159,152,967

3.2.2 Natural Gas Consumption by Market Segment

Figure 3-3 shows the estimated breakdown of 2014 commercial sector annual natural gas consumption by building type for the DTE Energy commercial sector. The Office market sector (22%) contributed the largest share of commercial natural gas consumption in 2014, followed by the Other (23%) category and Education buildings (15%). Figure 3-4 shows a similar estimate of sales by industrial market segment for the industrial sector. In the industrial sector breakdown, Automobile Manufacturing (45% of 2014 annual industrial natural gas sales) is the largest sector, followed by Primary Metals (24%) and Rubber and Plastics (7%).

Table 3-2 and Table 3-3 provide additional detail regarding the 2014 MMBtu market segment breakdown of DTE's commercial and industrial natural gas sales.

Figure 3-3: DTE Energy 2014 Commercial Natural Gas Consumption by Market Segment

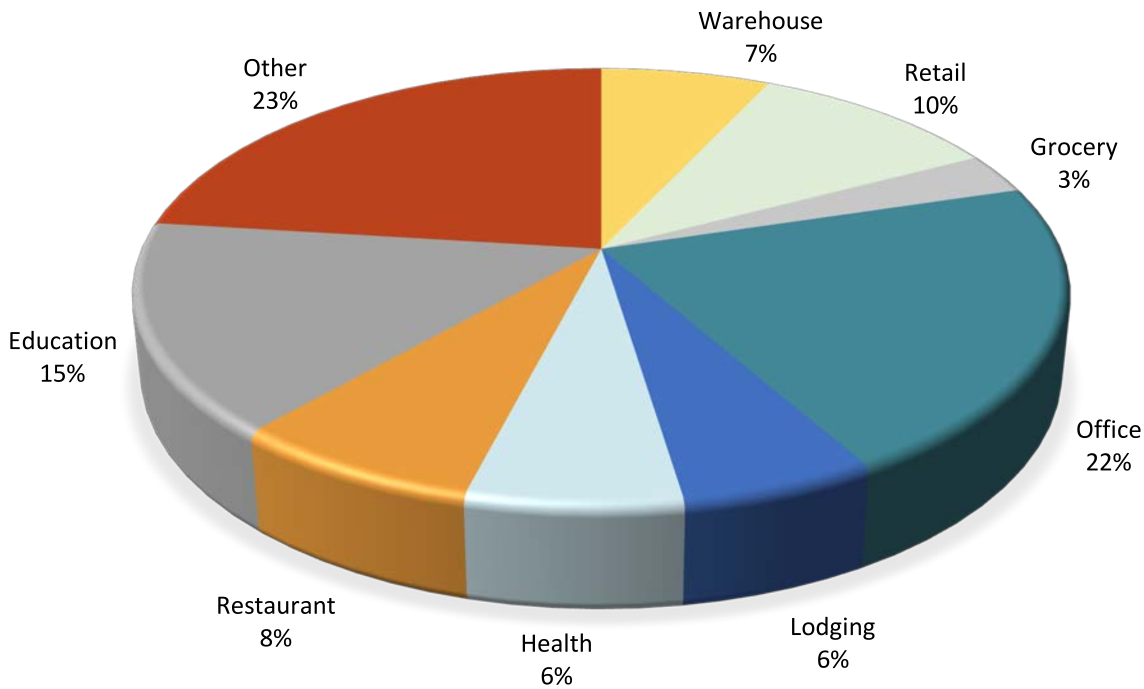


Figure 3-4: DTE Energy 2014 Industrial Natural Gas Consumption by Market Segment

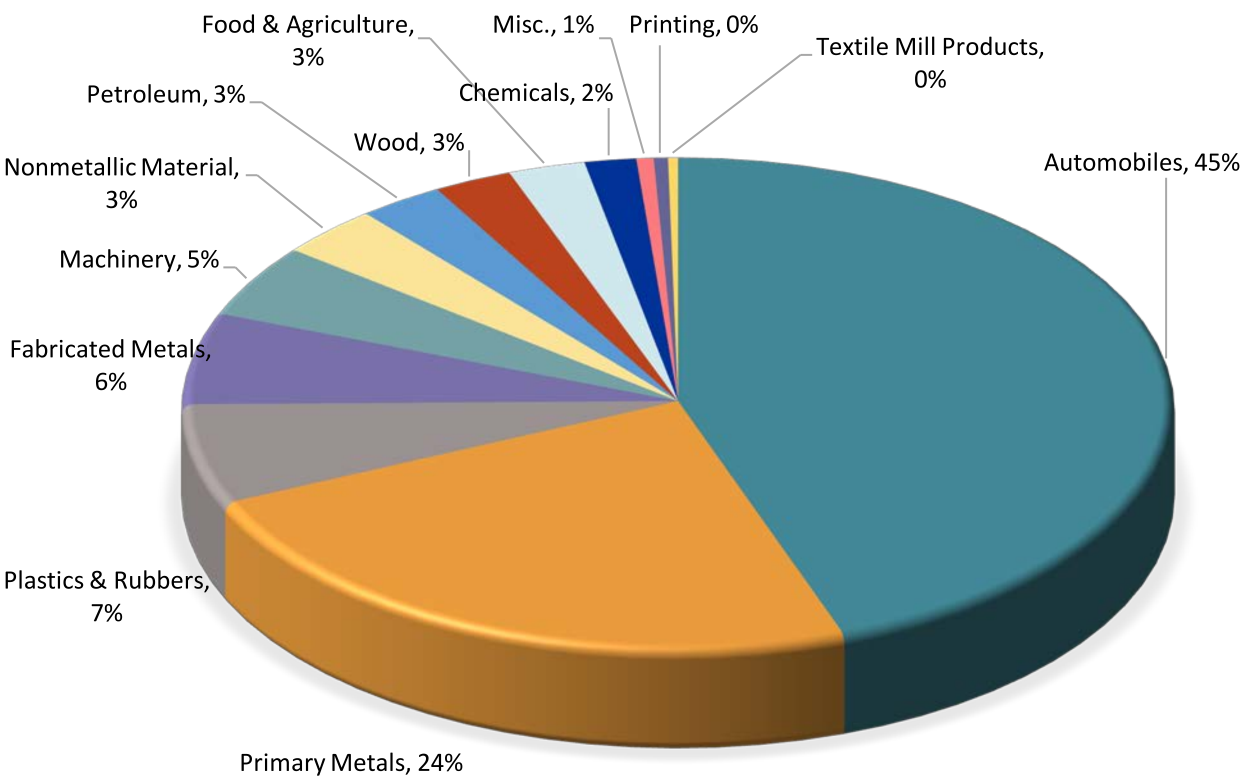


Table 3-2: 2014 DTE Energy Commercial Sector Natural Gas Consumption by Market Segment

Market Segment	2014 DTE Commercial Sector Natural Gas Consumption (MMBtu)	Percent of Total Commercial Sector Sales
Warehouse	2,699,647	7%
Retail	4,005,545	10%
Grocery	1,165,403	3%
Office	8,348,472	22%
Lodging	2,247,629	6%
Health	2,491,705	6%
Restaurant	2,904,473	7%
Education	6,008,318	15%
Other	8,934,754	23%
Total	38,805,946	100%

Table 3-3: 2014 DTE Energy Industrial Natural Gas Consumption by Market Segment

Market Segment	2014 Industrial Natural Gas Consumption (MMBtu)	Natural Gas Share
Automobiles	639,616	45%
Primary Metals	339,684	24%
Plastics & Rubber	93,998	7%
Fabricated Metal	86,392	6%
Machinery	68,884	5%
Nonmetallic Mineral	48,075	3%
Petroleum	40,326	3%
Wood	37,312	3%
Food & Agriculture	36,595	3%
Chemicals	24,540	2%
Misc.	8,180	1%
Printing	6,745	0%
Textile Mill Products	4,736	0%
Total	1,435,081	100%

3.2.3 Natural Gas Consumption by End-Use

Table 3-4 shows the breakdown of DTE 2014 natural gas energy consumption by commercial market segment by end use. Table 3-5 and Table 3-6 show the same end-use energy breakdown for the industrial sector by market segment. Space Heating is the largest end use for the commercial sector (80% of commercial sector natural gas consumption), followed by water heating at (14%). As for the industrial sector, Process Heat represents the largest end use, followed by facility HVAC and CHP/Other.

Table 3-4: Breakdown of DTE Commercial Natural Gas Sales by Market Segment and End-Use

	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other	Total
Space Heating	96%	84%	78%	93%	33%	63%	34%	83%	90%	80%
Water Heating	4%	9%	6%	6%	63%	35%	30%	16%	5%	14%
Cooking	0%	7%	15%	1%	5%	3%	36%	1%	6%	6%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 3-5: Industrial Natural Gas Consumption by End Use (Table 1 of 2)

	Automobiles	Primary Metals	Plastics & Rubber	Fabricated Metal	Machinery	Nonmetallic Mineral	Petroleum
Process Heat	43%	82%	36%	65%	43%	90%	66%
Facility HVAC	43%	11%	40%	27%	52%	7%	12%
CHP and Other[6]	14%	8%	24%	7%	4%	3%	22%
Total Industrial	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 3-6: Industrial Natural Gas Consumption by End Use (Table 2 of 2)

	Wood	Food & Agriculture	Chemicals	Misc.	Printing	Textile Mill Products
Process Heat	65%	36%	43%	27%	48%	38%
Facility HVAC	18%	34%	18%	53%	39%	38%
CHP and Other	18%	29%	39%	20%	13%	25%
Total Industrial	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

[6] CHP and other minor non-process/non-HVAC end uses are shown as a percentage of total natural gas sales, but there is no energy efficiency potential associated with this end-use group

4 Potential Study Methodology

This section describes the overall methodology GDS utilized to develop the natural gas energy efficiency potential study for DTE Energy. The main objective of this energy efficiency potential study is to quantify the technical, economic and achievable potential for natural gas energy efficiency savings in the DTE natural gas service area. This report provides estimates of the potential MMBtu natural gas savings for each level (technical, economic and achievable potential) of energy efficiency potential.

This document describes the general steps and methods that were used at each stage of the analytical process necessary to produce the various estimates of energy efficiency potential. GDS did not examine delivery approaches for energy efficiency programs as this task was not included in the scope of work for this study.

4.1 Overview of Approach

GDS used a bottom-up approach to estimate energy efficiency potential in the residential sector. Bottom-up approaches begin with characterizing the eligible equipment stock, estimating savings and screening for cost-effectiveness first at the measure level, then summing savings at the end-use and service area levels. In the commercial and industrial sectors, the GDS team utilized the bottom-up modeling approach to first estimate measure-level savings and costs as well as cost-effectiveness, and then applied cost-effective measure savings to all applicable shares of the natural gas load. Further details of the market research and modeling techniques utilized in this assessment are provided in the following sections.

4.2 Forecast Disaggregation for the Commercial and Industrial sectors

For the commercial sector, the baseline natural gas energy forecasts for the DTE service area were disaggregated by combining sales breakdowns by business type provided by DTE Energy with regional energy use estimates by business type available from the EIA[7] The forecasts were then further disaggregated by end use based on end use consumption estimates for the East North Central Region (Michigan, Wisconsin, Ohio, Indiana, Illinois). The disaggregated forecast provided the foundation for the development of energy efficiency potential estimates for the commercial sector. The commercial sector, as defined in this analysis, is comprised of the following business segments:

- Warehouse
- Retail
- Grocery
- Office
- Lodging
- Healthcare
- Restaurant
- Institutional, including education
- Other

For the industrial sector, the baseline natural gas forecast was disaggregated by industry type and then by end use. The industry type breakdowns are based on DTE electric sales by market segment data, since DTE was not able to provide such a breakdown for natural gas sales. Further disaggregation by end use is based on data from the EIA's 2010 Manufacturing Energy Consumption Survey. The disaggregated forecast data provides the foundation for the development of energy efficiency potential estimates for the industrial sector.

[7] 2003 EIA Commercial Building Energy Consumption Survey (CBECS), East North Central and Midwest Regions.

Commercial and industrial baseline energy consumption data was advanced to 2016 and future years based upon the observed historical trend in DTE Energy's nonresidential consumption and the forecast of natural sales for DTE's commercial and industrial sectors.

End use natural gas energy consumption estimates were calculated for the following end use categories for specific manufacturing segments:

- **Direct Uses - Process**
  - Process heating (e.g., kilns, furnaces, ovens, strip heaters)
- **Direct Uses – Non-Process**
  - Facility heating, ventilation and air conditioning
- **CHP and Other**[8]

It was not necessary to develop a disaggregated residential sales forecast because a bottom-up approach was used for the residential sector.

4.3 Measure List Analysis

4.3.1 Measure List Development

Energy efficiency measures considered in the study include measures in the 2015 MEMD, as well as other energy efficiency measures based on GDS' knowledge and current databases of natural gas end-use technologies and energy efficiency measures in other jurisdictions. The study includes measures and practices that are currently commercially available as well as emerging technologies. Emerging technology research was focused on measures that are either commercially available but currently not widely accepted, or are not currently available but expected to be commercialized over the analysis timeframe.[9]

In total, GDS analyzed 156 measure types. Many measures required multiple permutations for different applications, such as different building types, efficiency levels, and replacement decision types. GDS developed a total of 1,729 measure permutations for this study, and tested all measures for cost-effectiveness using the UCT. The parameters for cost-effectiveness under the UCT are discussed in detail later in this section of the report. Approximately 75% of the measures had a measure UCT benefit-cost ratio of 1.0 or higher.[10]

Table 4-1: Number of Measures Evaluated

	# of Measures	Total # of Measure Permutations	# with UCT ≥ 1
By Sector			
Residential	19	256	122
Commercial	77	693	486
Industrial	60	780	686
Total	***156***	***1,729***	***1,294***

8 No energy efficiency potential was associated with CHP and other small non-process/non-HVAC end uses

9 For example, an ENERGY STAR criteria was recently established for clothes dryers. High efficiency clothes dryers were included as an emerging technology (these measures are also in the MEMD), even though the commercialization of high efficiency clothes dryers has not become widespread.

10 The residential included some low income-specific measures with a UCT ratio less than 1.0 in the economic and achievable potential analysis. Low income-specific measures with a UCT ratio of 0.50 or greater were retained in the residential analysis of economic and achievable potential. This approach recognizes that low-income measures and programs may not always be cost-effective, but are offered by utilities to generate savings and address equity concerns.

A complete listing of the energy efficiency measures included in this study is provided in the Appendices of this report.

4.3.2 Measure Characterization

A significant amount of data is needed to estimate the MMBtu savings potential for individual energy efficiency measures or programs across the residential and non-residential sectors in the DTE Energy service area. GDS used DTE Energy or Michigan-specific data wherever it was available and reflective of recent updates. Considerable effort was expended to identify, review, and document all available data sources.[11] This review has allowed the development of reasonable and supportable assumptions regarding: measure lives; measure costs (incremental or full costs as appropriate); measure natural gas savings; and saturations for each energy efficiency measure included in the final list of measures examined in this study. This study addresses natural gas efficiency potential, but electric savings have been analyzed to the extent that some measures yield both electric and natural gas savings. Only the natural gas portion of the costs and savings of these measures are addressed in this assessment of natural gas energy efficiency potential.[12]

Costs and savings for new construction and replace on burnout measures are calculated as the incremental difference between the code minimum equipment and the energy efficiency measure. This approach is utilized because the consumer must select an efficiency level that is at least the code minimum equipment when purchasing new equipment. The incremental cost is calculated as the difference between the cost of high efficiency and standard efficiency (code compliant) equipment. However, for retrofit or direct install measures, the measure cost was considered to be the "full" cost of the measure, as the baseline scenario assumes the consumer would not make energy efficiency improvements in the absence of a program. In general, the savings for retrofit measures are calculated as the difference between the energy use of the removed equipment and the energy use of the new high efficiency equipment (until the removed equipment would have reached the end of its useful life).

Savings | Estimates of annual measure savings as a percentage of base equipment usage were developed from a variety of sources, including:

- 2016 MEMD
- Secondary sources such as the American Council for an Energy-Efficient Economy (ACEEE), Department of Energy, EIA, ENERGY STAR® savings calculators, Air Conditioning Contractors of America, and other technical potential studies and Technical Reference Manuals (TRMs)
- Program evaluations conducted by DTE Energy

Measure Costs | Measure costs represent either incremental or full costs, and typically also include the incremental cost of measure installation. For purposes of this study, nominal measure costs were held constant over time.

When available, GDS obtained measure cost estimates from the MEMD. For measures not in the database, GDS referenced the following data sources:

- Secondary sources such as ACEEE, ENERGY STAR, and other technical potential studies and TRMs
- Retail store pricing (such as web sites of Home Depot and Lowe's) and industry experts
- DTE program evaluation reports

[11] The appendices and supporting databases to this report provide the data sources used by GDS to obtain up-to-date data on energy efficiency measure costs, savings, useful lives and saturations.
[12] Electric savings were analyzed as part of the electric energy efficiency potential study completed for DTE Energy.

Measure Life | Represents the number of years that energy-using equipment is expected to operate. Useful life estimates have been obtained from the following data sources:

- MEMD
- Manufacturer data
- Savings calculators and life-cycle cost analyses
- Secondary sources such as ACEEE, ENERGY STAR, and other technical potential studies
- The California Database for Energy Efficient Resources (DEER) database
- Evaluation reports
- GDS and other consultant research or technical reports

Baseline and Efficient Technology Saturations | In order to assess the amount of natural gas energy efficiency savings still available, estimates of the current saturation of baseline equipment and energy efficiency measures, or for the non-residential sector the amount of energy use that is associated with a specific end use (such as HVAC) and percent of that energy use that is associated with energy efficient equipment are necessary. Up-to-date measure saturation data were primarily obtained from the following recent studies:

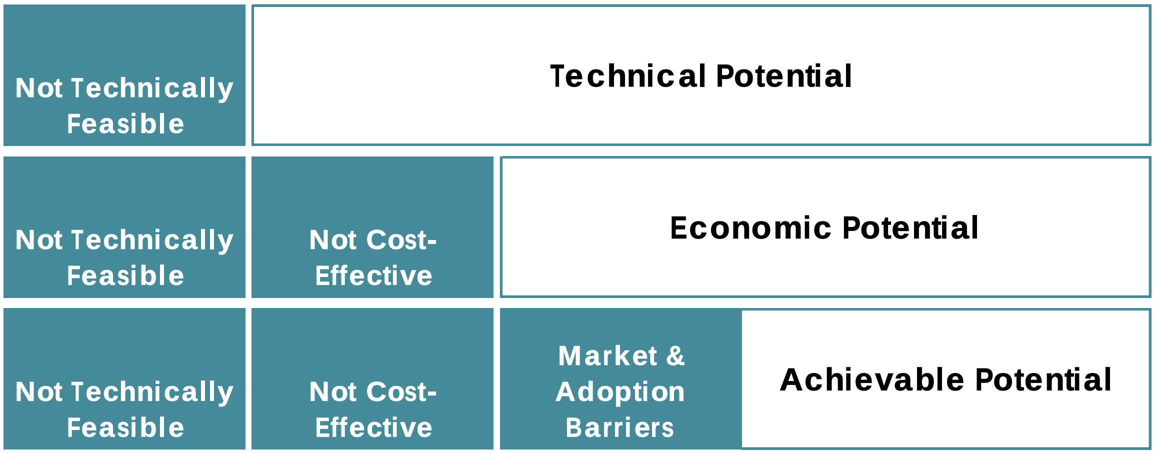
- 2013 DTE Energy Commercial Baseline Study
- 2011 Michigan Residential Baseline Study conducted by the MPSC
- Energy efficiency baseline studies conducted by DTE Energy
- 2011 Michigan Commercial Baseline Study conducted by the MPSC
- 2009 EIA Residential Energy Consumption Survey (RECS)
- 2007 American Housing Survey (AHS)
- 2010 EIA Manufacturing Energy Consumption Survey
- 2003 EIA Commercial Building Energy Consumption Survey (CBECS)

Further detail regarding the development of measure assumptions for energy efficiency in the residential and non-residential sectors are provided in this report in later sections. Additionally, as noted above, the appendices of the report provide a comprehensive listing of all energy efficiency measure assumptions and data sources.

4.4 Potential Savings Overview

Potential studies often distinguish between several types of energy efficiency potential: technical, economic, and achievable. However, because there are often important definitional issues between studies, it is important to understand the definition and scope of each potential estimate as it applies to this analysis. The first two types of potential, technical and economic, provide a theoretical upper bound for energy savings from energy efficiency measures. Still, even the best designed portfolio of programs is unlikely to capture 100% of the technical or economic potential. Therefore, achievable potential attempts to estimate what may realistically be achieved, when it can be captured, and how much it would cost to do so. Figure 4-1 below illustrates the three most common types of energy efficiency potential.

Figure 4-1: Types of Energy Efficiency Potential[13]



4.5 Technical Potential

Technical potential is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end users to adopt the efficiency measures. Technical potential is only constrained by factors such as technical feasibility and applicability of measures. Under technical potential, GDS assumed that 100% of new construction and burnout measures are adopted as those opportunities become available (e.g., as new buildings are constructed they immediately adopt efficiency measures), while retrofit opportunities are replaced incrementally (10% per year) until 100% of homes (residential) and stock (commercial and industrial) are converted to the efficient measures over a period of 10 years. [14]

In instances where technical reasons do not permit the installation of the efficient equipment in all eligible households or nonresidential facilities an applicability factor is used to limit the potential. The alternative technologies are then utilized to meet the remaining market potential. The applicability factor was also used to delineate between two (or more) competing technologies for the same end use. In the technical potential estimate, priority was given to measures that produced the most savings.[15]

In developing the overall potential natural gas savings, the analysis also accounts for the interactive effects of measures designed to impact the same end-use. For instance, if a home or business were to install energy efficient heating and cooling equipment, the overall space heating and cooling consumption in that home would decrease. As a result, the remaining potential for energy savings derived from duct sealing or other building shell equipment would be reduced.

4.5.1 Core Equation for the Residential Sector

The core equation used in the residential sector energy efficiency technical potential analysis for each individual efficiency measure is shown below.

Equation 4-1: Core Equation for Residential Sector Technical Potential

[13] Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. US EPA. Figure 2-1.
[14] Low-income direct install measures were assumed to occur at a rate of 5% annually over the entire 20-year study timeframe.
[15] For estimates of economic and achievable potential, priority was generally assigned to measures that were found to be most cost-effective, according to the UCT Test.

Technical Potential of Efficient Measure = Total Number of Households × Base Case Equipment End Use Intensity × Saturation Share × Applicability Factor × Savings Factor

Where:

- **Total Number of Households** = the number of households in the market segment (e.g. the number of households living in detached single-family buildings)
- **Base Case Equipment End-use Intensity** = the natural gas used per customer per year by each base-case technology in each market segment. In other words, the base case equipment end-use intensity is the consumption of the natural gas-using equipment that the efficient technology replaces or affects.
- **Saturation Share** = this variable has two parts: the first is the fraction of the end-use natural gas energy that is applicable for the efficient technology in a given market segment. For example, for residential water heating, the saturation share would be the fraction of all residential natural gas customers that have natural gas water heating in their household; the second is the share of market for a given end-use (i.e. Natural gas water heating) that is applicable for the efficient technology that has not yet been converted to an efficient technology.
- **Applicability Factor** = the fraction of the applicable units that is technically feasible for conversion to the most efficient available technology from an engineering perspective (e.g., it may not be possible to install CFLs in all light sockets in a home because the CFLs may not fit in every socket).[16]
- **Savings Factor** = the percentage reduction in natural gas consumption resulting from the application of the efficient technology.

4.5.2 Core Equation for the Commercial Sector

The core equation utilized in the commercial sector technical potential analysis for each individual efficiency measure is shown below.

Equation 4-2: Core Equation for Commercial Sector Technical Potential

Technical Potential of Efficient Measure = Total End Use Sales by Industry Type × Base Case Factor × Remaining Factor × Convertible Factor × Savings Factor

Where:

- **Total end-use sales by commercial sector and by building type** = the forecasted natural gas sales level for a given end use (e.g., space heating) in a commercial or industrial industry type (e.g., office buildings or fabricated metals).
- **Base Case factor** = the fraction of end-use energy applicable for the efficient technology in a given commercial sector type. For example, for space heating, this would be the fraction of all space heating MMBtu in a given building or industry type that is associated with gas furnaces.
- **Remaining factor** = the fraction of applicable MMBtu sales associated with equipment not yet converted to the natural gas energy efficiency measure; that is, one minus the fraction of the industry type with energy efficiency measures already installed.

[16] In instances where there are two (or more) competing technologies for the same end use, an applicability factor aids in determining the proportion of the available population assigned to each measure. In estimating the technical potential, measures with the most savings are given priority for installation. For all other types of potential, measures with the greatest UCT ratio are assigned installation priority.

- **Convertible factor** = the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install a heat recovery water heater at all sites.)
- **Savings factor** = the fraction of natural gas consumption reduced by application of the efficient technology.

4.5.3 Core Equation for the Industrial Sector

Estimating energy efficiency potential for the industrial sector can be more challenging than it is for the residential and commercial sectors because of the significant differences in the way energy is used across manufacturing industries (or market segments). For example, the auto industry uses energy differently than a plastics manufacturer uses energy. Further, even within a particular industrial segment, energy use is influenced by the particular processes utilized, past investments in energy efficiency, the age of the facility, and the corporate operating philosophy.

Recognizing the variability of energy use across industry types and the significance of process energy use in the industrial sector, GDS employed a top-down approach that constructed an energy profile based on local economic data, national energy consumption surveys and any available Michigan studies related to industrial energy consumption.

The core equation for estimating technical potential in the industrial sector analysis for each measure is provided below:

Equation 4-3: Core Equation for Industrial Sector Technical Potential

Technical Potential of Efficient Measure = Total End Use Sales by Industry Type × Base Case Factor × Remaining Factor × Convertible Factor × Savings Factor

Where:

- **Total end-use sales by industry type** = the forecasted natural gas sales level for a given end use (e.g., space heating) by industrial industry type (e.g., fabricated metals, automobile manufacturing, paper and allied products, etc.).
- **Base Case factor** = the fraction of end-use energy applicable for the efficient technology in a given industry type. For example, with process boilers, this would be the fraction of all process MMBtu in a given industry type that is associated with process boilers.
- **Remaining factor** = the fraction of applicable sales associated with equipment not yet converted to the natural gas energy-efficiency measure; that is, one minus the fraction of the industry type with energy-efficiency measures already installed.
- **Convertible factor** = the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install stack economizers on all boilers.)
- **Savings factor** = the fraction of energy consumption reduced by application of the efficient technology.

4.6 Economic Potential

Economic potential refers to the subset of the technical potential that is economically cost-effective (based on screening with the UCT Test) as compared to conventional supply-side energy resources. GDS has calculated the benefit/cost ratios for this study according to the cost-effectiveness test definitions provided in the November 2008 NAPEE guide titled "Understanding Cost Effectiveness of Energy Efficiency Programs". Both technical and economic potential are theoretical numbers that assume immediate implementation of energy efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of energy efficiency. Finally, they typically only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration, program evaluation, etc.) that would be necessary to capture them.

Furthermore, all measures that were not found to be cost-effective based on the results of the measure-level cost-effectiveness screening were excluded from the economic and achievable potential. Then allocation factors were re-adjusted and applied to the remaining measures that were cost effective

4.6.1 Utility Cost Test

The UCT examines the costs and benefits of an energy efficiency program from the perspective of the entity implementing the program (utility, government agency, nonprofit, or other third party). GDS set incentives at 50% of measure costs when calculating the UCT. When conducting screening at the measure level, GDS only included utility costs relating to the equipment cost. For program or portfolio screening, GDS included all costs incurred by the utility. Overhead costs include the utility's administration, marketing, research and development, evaluation, and measurement and verification costs. Incentive costs are payments made to the utility's customers to offset purchase or installations costs. The benefits from the utility perspective are the savings derived from not delivering the energy to customers

4.6.2 Financial Incentives for Program Participants

There are several reasons why an incentive level of 50% of measure costs (and not 100% of measure costs) was assumed for the three achievable potential scenarios examined for this study:

1) First, an incentive level of 50% of measure costs assumed in this study for the two achievable potential scenarios is a reasonable target based on the current financial incentive levels for program participants used by DTE Energy for their existing energy efficiency programs.

2) Second, GDS has reviewed other energy efficiency potential studies conducted in the US. The incentive levels used in several studies reviewed by GDS as well as actual experience with incentive levels in other states confirm that an incentive level assumption of 50% or below is commonly used.[17] GDS also notes that the majority of energy efficiency programs offered by the New York State Energy Research and Development Authority offer no incentives to consumers. The results of recent literature searches conducted by GDS indicates that many utilities and public benefits program administrators set incentives in the range of 20% to 50% of measure increment cost.[18] GDS is not aware of utilities of public benefits program administrators that set incentives to participants at 100% of incremental cost in practice.

3) Third, and most important, the highly recognized 2004 National Energy Efficiency Best Practices Study concluded that use of an incentive level of 100% of measure costs is not recommended as a program strategy.[19] This national best practices study concluded that it is very important to limit incentives to participants so that they do not exceed a pre-determined portion of average or customer-specific incremental cost estimates. The report states that this step is critical to avoid grossly overpaying for energy savings. This best practices report also notes that if incentives are set too high, free-ridership problems will increase significantly. Free riders dilute the market impact of program dollars.

[17] GDS October 25, 2013 survey of financial incentives used in energy efficiency programs implemented by Consumers Energy, DTE Energy, Ameren-Illinois, Efficiency Maine, Wisconsin Focus on Energy, and Xcel Energy (Minnesota).
[18] Id.
[19] See "National Energy Efficiency Best Practices Study, Volume NR5, Non-Residential Large Comprehensive Incentive Programs Best Practices Report", prepared by Quantum Consulting for Pacific Gas and Electric Company, December 2004, page NR5-51.

4) Fourth, financial incentives are only one of many important programmatic marketing tools. Program designs and program logic models also need to make use of other education, training and marketing tools to maximize consumer awareness and understanding of energy efficient products. A program manager can ramp up or down expenditures for the mix of marketing tools to maximize program participation and savings. The February 2010 NAPEE Report titled "Customer Incentives for Energy Efficiency Through Program Offerings" states on page 1 that "Incentives can be used in conjunction with other program strategies to achieve market transformation, whereby there is a lasting change in the availability and demand for energy-efficient goods and services." On page 11 of this report it is stated that "Well-designed incentives address the key market barriers in the target market. Financial incentives are designed to be just high enough to gain the desired level of program participation. In some cases, financial incentives can be bundled with financing, information, or technical services to reach program participation and energy savings goals at lower total program cost than using financial incentives alone."

4.7 Achievable Potential

Achievable potential was determined as the amount of energy that can realistically be saved assuming an aggressive program marketing strategy and with three scenarios. Achievable potential takes into account barriers that hinder consumer adoption of energy efficiency measures such as financial, political and regulatory barriers, and the capability of programs and administrators to ramp up activity over time. This potential study evaluates three achievable potential scenarios:

1) **Scenario #1**: For the first scenario, achievable potential represents the amount of energy use that efficiency can realistically be expected to displace assuming incentives equal to 50% of the incremental measure cost and no spending cap. Cost-effectiveness of measures was determined with the UCT. The long-term market penetration for Scenario #1 was estimated based on the utilities paying incentives equal to 50% of measure costs. Year-by-year estimates of achievable potential for the period 2016 to 2035 were estimated by applying market penetration curves to this long-term penetration rate estimate. In general, these curves were developed based on willingness to pay data collected through survey research. Although this simplifies what an adoption curve would look like in practice, it succeeds in providing a concise method for estimating achievable savings potential over a specified period of time.

2) **Scenario #2**: The second scenario is a subset of Achievable Scenario #1 (based on UCT screening). While scenario #1 assumed no spending cap on efficiency measures, Achievable Scenario #2 assumed a spending cap of approximately 2% of utility annual natural gas revenues. Revenues are apportioned across each customer sector to prevent cross-subsidization of energy efficiency savings. GDS has not attempted to define specific program plans. Instead the market adoption assumptions from Achievable Scenario #1 have been scaled down to fit within the spending parameters.

While many different incentive scenarios could be modeled, the number of achievable potential scenarios that could be developed was limited to two scenarios due to the available budget for this potential study[20].

For new construction, energy efficiency measures can be implemented when each new home or building is constructed, thus the rate of availability will be a direct function of the rate of new construction. For existing buildings, energy efficiency potential in the existing stock of buildings will be captured over time through two principal processes:

[20] Neither of the two scenarios are considered a "maximum" achievable scenario, assuming 100% incentives. The achievable potential scenarios included in the report assume 50% incentives, approximating the level of incentives currently offered by DTE.

1) As equipment replacements are made normally in the market when a piece of equipment is at the end of its effective useful life (referred to as “replace-on-burnout” or “turnover” vintage).
2) At any time in the life of the equipment or building (referred to as “retrofit” or “early replacement” vintage).

For the replace-on-burnout measures, the opportunity to replace existing equipment with high efficiency equipment is when equipment fails beyond repair or if the consumer is in the process of building or remodeling. Using this approach, only equipment that needs to be replaced in a given year will be eligible to be upgraded to energy efficient equipment.

For the retrofit measures, savings can theoretically be captured at any time; however, in practice, it takes many years to retrofit an entire stock of buildings, even with the most aggressive of energy efficiency programs.

4.7.1 Market penetration methodology

GDS assessed achievable potential on a measure-by-measure basis. In addition to accounting for the natural replacement cycle of equipment in the achievable potential scenario, GDS estimated end-use specific maximum adoption rates that reflect the presence of possible market barriers and associated difficulties in achieving the 100% market adoption assumed in the technical and economic scenarios. The methodology utilized to forecast participation within each customer sector is described below.

4.7.1.1 Residential

As noted earlier in the report, there are approximately 256 residential measure permutations included in this study. Due to the wide variety of measures across multiple end-uses, GDS employed varied, measures and end-use-specific maximum adoption rates versus a singular universal market adoption curve. These long-term market adoption estimates were based on publicly available DSM research including market adoption rate surveys and other utility program benchmarking.[21] GDS relied on one additional source for this study compared to the 2013 study.[22] This added reference point strengthened the market adoption estimates while also affirming that the estimates used in the 2013 study were reasonable. GDS acknowledges that reliance on additional studies and alternate methods could produce different estimates of achievable potential.

For the majority of residential measures, the analysis assumes that increased incentives and reduced participant costs will also reduce the simple payback period of energy efficiency measures. As incentives increase and payback periods decline, maximum market adoption rates will increase. Table 4-2 below provides the maximum market adoption rates used for the residential sector.

Table 4-2: Market Adoption Rates End Use – Residential Sector

End Use	Initial Year Adoption Rate	Ultimate Adoption Rate
Appliances	21%	55%
Water Heating	21%	49%
HVAC Shell	21%	38%
HVAC Equipment	21%	49%
Cross-Cutting	21%	49%

[21] Massachusetts Multifamily Market Characterization and Potential Study Volume I. May 2012. Cadmus Group. & Appliance Recycling Program Process Evaluation and Market Characterization. Volume I. CALMAC Study ID# SCE0337.01. September 2012. Cadmus.
[22] 2014 Pennsylvania Statewide Act 129 Residential Baseline Study - April 2014. Submitted by GDS Associates Inc. in partnership with Nexant Inc., Research Into Action, and Apex Analytics.

End Use	Initial Year Adoption Rate	Ultimate Adoption Rate
Low Income	80%	80%

Once the long-term market adoption rate was determined, GDS estimated the time interval required to reach the ultimate maximum adoption rate. For this study GDS assumed that each measure would reach the ultimate adoption rate after 10 years. The low-income sector is assumed to have an initial year adoption rate of 80% which is equal to the ultimate adoption rate. The high starting point recognizes that participation should be expected to be high with 100% incentives being offered for low-income measures. The overall penetration of low-income measures is constrained to the extent that it is assumed that it will take 20 years to reach all of the customers in this sector.

One caveat to this approach is that the ultimate long-term adoption rate is generally a simple function of incentive levels and payback. There are many other possible elements that may influence a customer's willingness to purchase an energy efficiency measure. For example, increased marketing and education programs can have a critical impact on the success of energy efficiency programs. Additionally, other perceived measure benefits, such as increased comfort or safety as well as reduced maintenance costs could also factor into a customer's decision to purchase and install energy efficiency measures. Although these additional elements are not explicitly accounted for under this incentive/payback analysis, the estimated adoption rates and penetration curves provide a concise method for estimating achievable savings potential over a specified period of time.

4.7.1.2 Non-Residential

The non-residential approach for estimating market adoption rates is very similar to the residential sector approach. GDS employed varied, measures-specific maximum adoption rates versus a singular universal market adoption curve. These long-term market adoption estimates were based on the following survey results reported in the 2010 DTE Electric and Natural Gas Potential Study.[23] That study reported the adoption factors by end-use and incentive level shown in Table 4-3 below.

Table 4-3: Adoption Factors by Equipment and Incentive Level

Equipment Type	50%	75%	100%
AC / HVAC	62%	68%	74%
Energy Management System	59%	67%	74%
Food Service	63%	69%	75%
Water Heating	68%	74%	80%
Overall	64%	69%	75%

GDS used the data shown above to estimate long term market penetration for commercial and industrial (process) measures based on the assumed incentive level stated as a percent of incremental cost.

GDS assumed two different paths to achieving long term market penetration, one for full cost measures such as insulation and another for incremental cost measures such as energy efficient fluorescent lighting. The participation for the maximum achievable cost effective savings was allocated equally at 5% per year across the full twenty years for replace on burnout/new construction incremental cost

[23] Assessment of Nonresidential Electric and Natural Gas Energy Efficiency Potential (2010–2029), Prepared for DTE Energy by The Cadmus Group, Inc.

measures. The retrofit measures, in keeping with the rate of participant achievement of the previous study, were allocated at 10% per year for the first ten years of the study.

As with the residential approach, the non-residential market penetration methodology uses the relationship between incentives and program participation as a concise quantitative method for estimating achievable savings potential over a specified period of time. While there are many other elements that may influence a business customer's willingness to install an energy efficiency measure, such as access to capital, corporate policy or reduced maintenance costs, these factors are difficult to quantify and fit into a forecasting approach.

5 Residential Natural Gas Energy Efficiency Potential Estimates

This section provides natural gas energy efficiency potential estimates for the residential sector in DTE Energy's service area. Estimates of technical, economic and achievable potential are provided.

According to 2014 historical sales data for DTE, the residential sector accounts for approximately 93% of total natural gas customers and 74% of total natural gas sales. From 2004 – 2014, residential sector natural gas sales and totals customers have been generally stable. This analysis assumes residential MMBtu sales will continue to be stable across the 2016 – 2035 timeframe, with a slight increase in MMBtu sales. The residential potential calculations are based upon these approximate consumption values and sales forecast figures over the time horizon covered by the study. The potential is calculated for the entire residential sector and includes breakdowns of the potential associated with each end use.

5.1 Residential Energy Efficiency Measures Examined

For the residential sector, there were 256 total natural gas savings measures included in the potential energy savings analysis[24]. Table 5-1 provides a brief description of the types of measures included for each end use in the residential model. The list of measures was developed based on a review of the MEMD and measures found in other residential potential studies and TRMs from the Midwest. Measure data includes incremental costs, natural gas savings, and measure life.

Table 5-1: Measures and Programs Included in the Natural Gas Residential Sector Analysis

End Use Type	End Use Description	Measures Included
HVAC Envelope	Building envelope upgrades	• Air/duct sealing • Duct insulation • Duct Sealing • Improved insulation • Efficient windows
HVAC Equipment	Heating/cooling/ventilation equipment	• Dual fuel heat pumps • Efficient boilers • Efficient furnaces with ECMs • Boiler controls • Furnace Tune-Ups • Programmable thermostats
Water Heating	Domestic hot water	• Instant Gas Water Heater • Low flow showerhead/faucet aerator • Gravity film heat exchangers • Pipe wrap • Restriction valves (ShowerStart / TubSpout)
Appliances	High-efficiency appliances / retirement of inefficient appliances	• ENERGY STAR clothes washers • ENERGY STAR dishwashers • ENERGY STAR dryers
Behavioral	Consumer response to feedback from utility and smartphone applications	• Home energy reports • Mobile applications

[24] This total represents the number of unique natural gas energy efficiency measures and all permutations of these unique measures. For example, there are 16 permutations of the ENERGY STAR Clothes Washer measure to account for the various housing types, water heating type and presence and fuel type of dryers.

5.2 Residential Sector Results

This section presents estimates for natural gas technical, economic, and achievable potential for the residential sector. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative annual energy savings (MMBtu), percentage of savings by end use, and savings as a percentage of forecast sales. Data is provided on a 10-year and 20-year time horizon.

There are a variety of factors which contribute to uncertainty surrounding the savings estimates produced by this energy efficiency potential study. These factors can include the following:

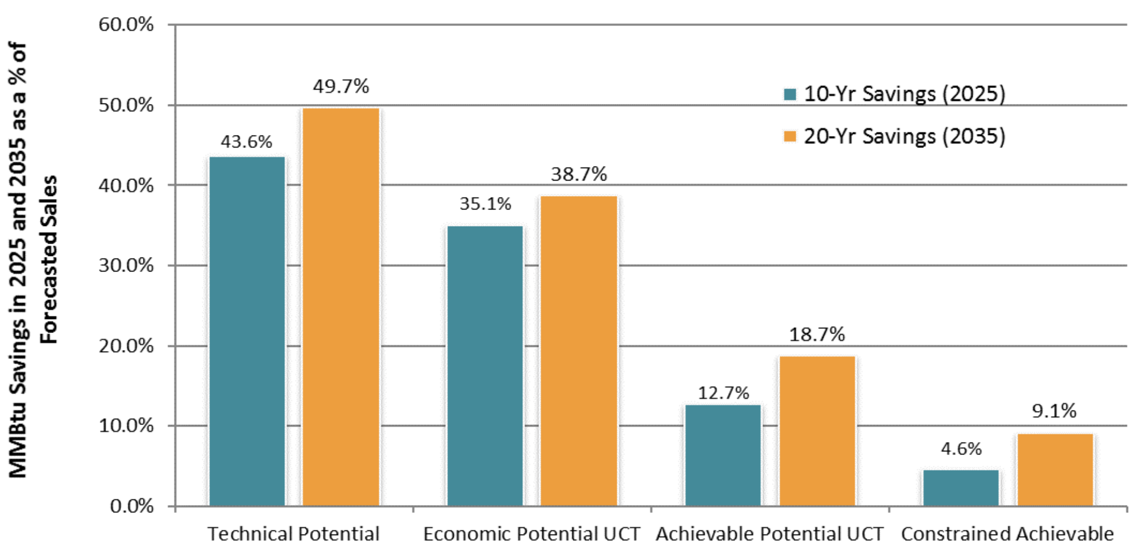
- Uncertainty in economic and fuel price forecasts used as inputs to the natural gas sales forecasts
- Changes to codes and standards in the future which cannot be anticipated at the present time, and
- Uncertainty regarding the future adoption of energy efficiency technologies which have minimal market share at the present time, such as behavioral measures

GDS also assimilated baseline study data into the estimates of weather sensitive measure savings where possible to adjust values acquired from the MEMD. These adjustments apply to measures such as insulation, for which savings are provided on a square footage basis in the MEMD.

5.2.1 Summary of Findings

Figure 5-1 illustrates the estimated savings potential for each of the scenarios included in this study.

Figure 5-1: Summary of Residential Natural Gas Energy Efficiency Potential as a % of 2025 and 2035 Sales Forecasts



The potential estimates are expressed as cumulative 10-year and 20-year savings, as percentages of the respective 2025 and 2035 sector sales. The technical potential is 43.6% in 2025 and 49.7% in 2035. The 10-year and 20-year economic potential is 35.1% and 38.7% based on the UCT screen, assuming an incentive level equal to 50% of the measure cost. The relatively small drop from technical potential to economic potential indicates that most measures are cost-effective, particularly when screening based on the UCT.

The 10-year and 20-year achievable potential savings are: 12.7% and 18.7% for the Achievable UCT scenario and 4.6% and 9.1% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Constrained

Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on DSM approximately equal to 2% of future annual residential revenue from natural gas retail sales.

5.2.2 Technical Potential

Technical potential represents the quantification of savings that can be realized if all technologically available energy-efficiency measures are immediately adopted in all feasible instances, regardless of cost. Table 5-2 shows that it is technically feasible to save nearly 50 million MMBtu in the residential sector between 2016 and 2025, as well as approximately 59 MMBtu during the 20 year period from 2016 to 2035 statewide, representing 43.6% of 10-year residential sales, and 49.7% of 20-year residential sales. HVAC Shell and HVAC Equipment measures are the greatest contributors to the technical potential.

Table 5-2: Residential Sector Technical Potential Energy Savings by End Use

End Use	2025 Energy (MMBtu)	% of 2025 Savings	2035 Energy (MMBtu)	% of 2035 Savings
Appliances	492,463	1.0%	608,565	1.0%
Water Heating	6,684,576	13.4%	9,060,897	15.3%
HVAC Shell	29,344,819	58.7%	30,795,561	52.1%
HVAC Equipment	12,902,258	25.8%	18,128,847	30.7%
Cross-Cutting	548,555	1.1%	531,432	0.9%
Total	***49,972,671***	***100.0%***	***59,125,302***	***100.0%***
% of Annual Sales Forecast	***43.6%***		***49.7%***	

5.2.3 Economic Potential

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective. The UCT was used for this study because it is mandated in Michigan to be the primary cost-effectiveness test used when considering energy efficiency programs. Forty eight percent of all measures that were included in the natural gas potential analysis passed the UCT.

Table 5-3 indicates that the economic potential based on the UCT screen is more than 40 million MMBtu during the 10 year period from 2016 to 2025, and the economic potential more than 46 million MMBtu during the 20 year period from 2016 to 2035. This represents 35.1% and 38.7% of residential sales across the respective 10-year and 20-year timeframes. Similar to the technical potential scenario, HVAC Shell and HVAC Equipment measures are the greatest contributors to the potential.

Table 5-3: Residential Sector Economic Potential (UCT) Energy Savings by End Use

End Use	2025 Energy (MMBtu)	% of 2025 Savings	2035 Energy (MMBtu)	% of 2035 Savings
Appliances	382,764	1.0%	448,198	1.0%
Water Heating	4,444,846	11.1%	5,195,051	11.3%
HVAC Shell	22,893,786	57.0%	22,769,790	49.4%
HVAC Equipment	11,835,675	29.5%	17,014,062	36.9%
Cross-Cutting	631,646	1.6%	647,198	1.4%
Total	***40,188,718***	***100.0%***	***46,074,300***	***100.0%***
% of Annual Sales Forecast	***35.1%***		***38.7%***	

5.2.4 Achievable Potential

Achievable potential is a refinement of economic potential that takes into account the estimated market adoption of energy efficiency measures based on the incentive level and measure payback, the natural replacement cycle of equipment, and the capabilities of programs and administrators to ramp up program activity over time. Achievable potential also takes into account the non-measure costs of delivering programs (for administration, marketing, monitoring and evaluation, etc.). For purposes of this analysis, non-incentive costs, or administrative costs, were assumed to be equivalent to $9.16 per first-year MMBtu[25], which is based on a review of administrative costs projected by other natural gas utilities in the US.

This study estimated achievable potential for two scenarios. The Achievable UCT Scenario determines the achievable potential of all measures that passed the UCT economic screening assuming incentives equal to 50% of the measure cost.[26] The second scenario, Constrained UCT, assumes a spending cap equal to 2% of utility natural gas revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

5.2.4.1 Achievable UCT Scenario

Table 5-4 shows the estimated savings for the Achievable UCT scenario over 10 and 20 year time horizons. As noted above, the scenario assumes an incentive level approximately equal to 50% of the incremental measure cost and include an estimate 10-year market adoption rates based on incentive levels and equipment replacement cycles. The 10-year and 20-year Achievable UCT potential savings estimates are approximately 14.5 million MMBtu and 22.3 million MMBtu, respectively. This equates to 12.7% and 18.7% of sector sales in 2025 and 2035.

Table 5-4: Residential Achievable UCT Potential Natural Gas Savings by End Use

End Use	2025 Energy (MMBtu)	% of 2025 Savings	2035 Energy (MMBtu)	% of 2035 Savings
Appliances	142,808	1.0%	246,509	1.1%
Water Heating	1,777,957	12.3%	2,791,408	12.5%
HVAC Shell	7,617,965	52.5%	10,299,232	46.2%
HVAC Equipment	4,549,448	31.4%	8,543,326	38.3%
Cross-Cutting	423,061	2.9%	427,114	1.9%
Total	14,511,239	100.0%	22,307,589	100.0%
% of Annual Sales Forecast	12.7%		18.7%	

5.2.4.2 Constrained UCT Scenario

Although the Achievable UCT assumes incentives are set and capped at 50% of the incremental measure cost, and that measures are typically replaced at the end of their useful life, the Achievable UCT scenario also assumes no DSM spending cap to reach all potential participants. In the constrained UCT scenario, the analysis assumes a spending cap roughly equal to 2% of DTE Energy's residential sector natural gas annual revenues. To model the impact of a spending cap the market penetration of all cost effective measures was reduced by the ratio of capped spending to uncapped spending that would be required to achieve the Achievable UCT scenario savings potential.

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[25] $22.09 per first-year MMBtu for low-income measures.

[26] Traditional low income measures associated with Michigan's Weatherization Assistance Program were evaluated using 100% incentives across all three achievable potential scenarios. All other measures were evaluated at the 50% incentive level.

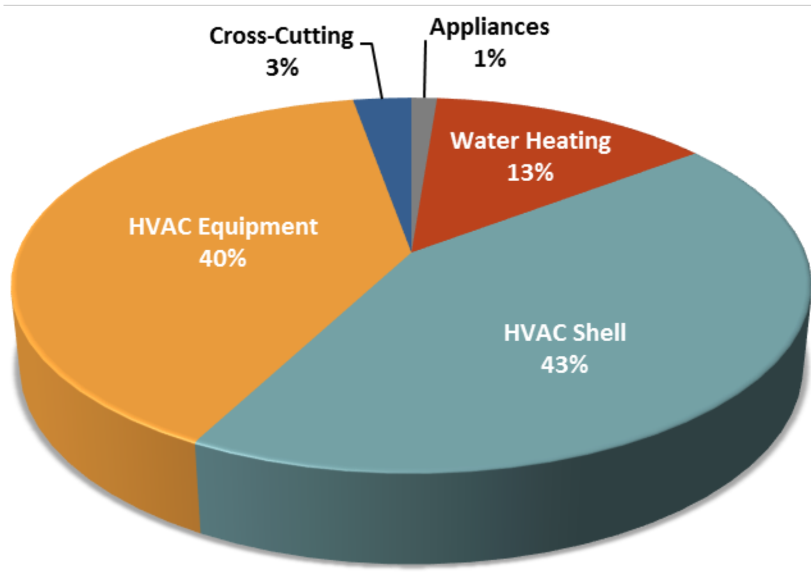
Table 5-5 shows the estimated savings for the Constrained UCT scenario over 10 and 20 year time horizon. The 10-year and 20-year Achievable UCT potential savings estimates are approximately 5.3 million MMBtu and 10.8 million MMBtu. This equates to 4.6% and 9.1% of sector sales in 2025 and 2035.

Table 5-5: Residential Constrained Achievable Savings Potential Energy Savings by End Use

End Use	2025 Energy (MMBtu)	% of 2025 Savings	2035 Energy (MMBtu)	% of 2035 Savings
Appliances	52,105	1.0%	132,806	1.2%
Water Heating	651,678	12.3%	1,460,038	13.5%
HVAC Shell	2,794,201	52.6%	4,666,573	43.0%
HVAC Equipment	1,667,810	31.4%	4,282,823	39.5%
Cross-Cutting	146,561	2.8%	302,046	2.8%
Total	***5,312,355***	***100.0%***	***10,844,287***	***100.0%***
% of Annual Sales Forecast	***4.6%***		***9.1%***	

Figure 5-2 shows the percentage of natural gas savings by each end use for the Constrained UCT scenario by 2035. The HVAC Shell end use shows the largest potential for savings with 43% of total natural gas savings, followed closely by the HVAC equipment end-use at 40%.

Figure 5-2: Residential Sector 2035 Constrained UCT Natural Gas Potential Savings, by End Use



5.2.4.3 Annual Achievable Potential

Table 5-6 and Table 5-7 show cumulative annual energy savings (MMBtu) for both achievable potential scenarios for each year across the 10-year time horizon for the study, broken out by end use. The year by year associated incentive and administrative costs to achieve these savings are shown in Section 5.3.

Table 5-6: Cumulative Annual Residential Natural Gas Savings in the Achievable UCT Potential Scenario, by End Use for DTE Energy

End Use	Appliances	Water Heating	HVAC Shell	HVAC Equipment	Cross-Cutting	Total	% of Annual Forecast Sales
2016	7,353	115,117	523,753	316,997	283,004	1,246,224	1.1%
2017	16,129	242,418	1,101,709	651,025	299,868	2,311,149	2.1%
2018	26,659	386,894	1,736,297	1,024,137	317,060	3,491,048	3.1%
2019	38,707	544,961	2,424,313	1,429,926	333,818	4,771,725	4.3%
2020	52,272	716,619	3,164,851	1,868,393	350,170	6,152,306	5.5%
2021	67,352	901,824	3,956,905	2,339,461	366,008	7,631,549	6.8%
2022	83,947	1,100,569	4,799,413	2,843,114	381,272	9,208,314	8.1%
2023	102,054	1,312,844	5,691,242	3,379,340	395,907	10,881,387	9.6%
2024	121,675	1,538,643	6,631,187	3,948,122	409,855	12,649,482	11.1%
2025	142,808	1,777,957	7,617,965	4,549,448	423,061	14,511,239	12.7%
2026	162,934	1,936,760	8,197,420	5,099,608	421,396	15,818,119	13.8%
2027	178,100	2,081,608	8,718,362	5,640,924	420,040	17,039,035	14.8%
2028	191,743	2,216,772	9,181,491	6,173,398	418,963	18,182,368	15.7%
2029	204,133	2,338,670	9,495,823	6,697,028	418,573	19,154,227	16.5%
2030	215,001	2,447,302	9,753,090	7,211,815	418,486	20,045,693	17.2%
2031	224,347	2,542,654	9,968,705	7,535,738	419,425	20,690,870	17.6%
2032	232,170	2,624,735	10,130,929	7,827,840	420,767	21,236,441	18.0%
2033	238,471	2,693,549	10,239,600	8,096,763	422,478	21,690,861	18.4%
2034	243,251	2,749,105	10,295,595	8,335,257	424,592	22,047,800	18.6%
2035	246,509	2,791,408	10,299,232	8,543,326	427,114	22,307,589	18.7%

Table 5-7: Cumulative Annual Residential Natural Gas Savings in the Constrained UCT Potential Scenario, by End Use for DTE Energy

End Use	Appliances	Water Heating	HVAC Shell	HVAC Equipment	Cross-Cutting	Total	% of Annual Forecast Sales
2016	3,089	48,350	219,982	133,142	118,865	523,429	0.5%
2017	6,564	98,768	448,853	265,049	118,762	937,995	0.8%
2018	10,509	152,895	686,507	404,426	118,784	1,373,121	1.2%
2019	14,983	211,592	941,887	555,042	123,962	1,847,467	1.7%
2020	20,020	275,325	1,216,713	717,835	130,011	2,359,903	2.1%
2021	25,555	343,313	1,507,301	890,646	134,360	2,901,176	2.6%
2022	31,526	414,818	1,810,142	1,071,629	137,176	3,465,292	3.1%
2023	37,939	490,000	2,125,607	1,261,357	140,219	4,055,122	3.6%
2024	44,784	568,773	2,452,981	1,459,589	142,982	4,669,108	4.1%
2025	52,105	651,678	2,794,201	1,667,810	146,561	5,312,355	4.6%
2026	61,045	723,963	3,052,923	1,916,470	186,584	5,940,986	5.2%
2027	68,349	796,612	3,296,717	2,169,136	192,986	6,523,800	5.6%
2028	75,781	873,957	3,528,634	2,434,134	202,622	7,115,128	6.1%
2029	83,241	949,440	3,710,175	2,702,696	207,578	7,653,131	6.6%
2030	90,835	1,026,653	3,886,452	2,985,657	219,661	8,209,259	7.0%
2031	98,302	1,103,507	4,056,514	3,204,893	227,862	8,691,078	7.4%
2032	106,246	1,186,007	4,222,232	3,444,633	246,222	9,205,340	7.8%
2033	114,603	1,272,658	4,377,853	3,707,853	262,807	9,735,775	8.2%
2034	123,369	1,363,344	4,525,559	3,985,045	279,788	10,277,105	8.7%
2035	132,806	1,460,038	4,666,573	4,282,823	302,046	10,844,287	9.1%

5.2.5 Residential Summary by Measure Group

Table 5-8 provides an end-use breakdown of the residential natural gas savings potential estimates for technical and economic potential, and each of the achievable potential scenarios. Table 5-8 indicates how the savings potential decreases systematically from the technical potential scenario to the Constrained UCT potential scenario as additional limiting factors such as cost-effectiveness requirements and anticipated market adoption at given funding levels are introduced.

Table 5-8: Breakdown of Residential Cumulative Annual Natural Gas Savings Potential for Technical, Economic and Achievable Potential, by End Use for DTE Energy

Measure	Technical Potential (MMBtu)	Economic UCT (MMBtu)	Achievable UCT (MMBtu)	Constrained UCT (MMBtu)
Appliances				
ENERGY STAR clothes washers	376,477	376,477	207,062	111,006
ENERGY STAR dishwashers	71,721	71,721	39,447	21,800
ENERGY STAR dryers	160,367	0	0	0
Water Heating[27]				
Efficient water heater	0	0	0	0
Instant gas water heater	4,778,787	0	0	0
Solar water heater	0	0	0	0
Low flow showerhead/faucet aerator	2,030,229	2,780,065	1,498,544	828,464
Gravity film heat exchangers	828,950	0	0	0
Pipe wrap	917,258	1,255,922	713,331	311,321
Flow restriction valves (ShowerStart/TubSpout)	505,674	1,159,065	579,533	320,253
HVAC Envelope				
Air Sealing	7,124,854	6,921,634	3,568,753	1,809,578
Duct insulation/sealing	2,770,330	857,370	359,186	155,541
Improved Insulation	12,368,741	3,907,074	1,660,561	803,643
Efficient windows	8,531,635	11,083,712	4,710,731	1,897,810
Window film	0	0	0	0
Cool Roofs	0	0	0	0
HVAC Equipment				
Efficient boiler	1,827,801	2,080,289	1,071,169	510,476
Boiler tune-up	0	0	0	0
Boiler controls	246,863	246,036	123,018	58,037
Furnace tune-up	700,305	0	0	0
Dual fuel heat pumps	175,262	175,262	83,742	41,676
Programmable thermostats	2,531,854	2,289,884	1,144,942	632,386
Efficient furnaces	11,724,769	11,377,514	6,078,200	3,010,367
Cross-Cutting/Behavioral				
Home Energy Reports	531,432	647,198	427,114	302,046

[27] Based on the assumptions in the Michigan Energy Measures Database (MEMD) and DTE Energy's latest forecast of avoided costs of electricity and other fuels, high efficiency natural gas water heaters did not screen as cost-effective in the residential sector. Setting incentives at 50% of measure incremental cost did play a role in that, but the larger impact was probably the new measure incremental costs and natural gas savings assumptions. Commercial high efficiency natural gas water heaters were largely cost-effective.

Measure	Technical Potential (MMBtu)	Economic UCT (MMBtu)	Achievable UCT (MMBtu)	Constrained UCT (MMBtu)
Mobile applications	921,993	845,077	42,254	29,881
Total				
Total	59,125,302	46,074,300	22,307,589	10,844,287
Percent of Annual Sector Sales Forecast	49.7%	38.7%	18.7%	9.1%

5.3 Residential Benefit-Cost and Program Budget Estimates

Table 5-9 and Table 5-10 below provide the NPV benefits and costs associated with the three achievable potential scenarios for the residential sector at the 10-year and 20-year periods. Table 5-9 and Table 5-10 compares the NPV benefits and costs associated with the Achievable UCT and Constrained UCT Scenarios. Both scenarios compared the benefits and costs based on the UCT. However, the constrained scenario's 2% of revenue spending cap on DSM results in reduced program participation and overall NPV benefits.

Table 5-9: 10-Year Benefit-Cost Ratios for Achievable UCT vs. Constrained UCT Scenarios – Residential Sector Only

10-year	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
Achievable UCT	$385,751,313	$358,757,214	1.08	$26,994,100
Constrained UCT	$141,473,431	$133,401,617	1.06	$8,071,814

Table 5-10: 20-Year Benefit-Cost Ratios for Achievable UCT vs. Constrained UCT Scenarios– Residential Sector Only

20-year	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
Achievable UCT	$589,506,496	$524,627,427	1.12	$64,879,069
Constrained UCT	$252,007,495	$221,470,493	1.14	$30,537,002

Year by year budgets for all three scenarios, broken out by incentive and administrative costs are depicted in Table 5-11 through Table 5-12. Table 5-13 shows the revenue requirements for each scenario as a percentage of forecasted sector sales.

Table 5-11: Annual Program Budgets Associated with the Achievable UCT Scenario (in millions)

Achievable UCT	Incentives	Admin.	Total Costs
2016	$22.8	$14.90	$37.7
2017	$24.8	$16.30	$41.1
2018	$27.2	$17.90	$45.2
2019	$29.4	$19.50	$48.9
2020	$31.5	$21.10	$52.6
2021	$33.7	$22.70	$56.4
2022	$35.8	$24.40	$60.2
2023	$37.9	$26.10	$64.1
2024	$40.1	$27.90	$68.0
2025	$42.2	$29.70	$71.9
2026	$33.5	$25.80	$59.2
2027	$33.1	$26.10	$59.2
2028	$32.0	$26.10	$58.1

Achievable UCT	Incentives	Admin.	Total Costs
2029	$31.7	$27.20	$58.9
2030	$30.7	$27.20	$57.9
2031	$31.2	$27.90	$59.1
2032	$30.1	$27.90	$58.0
2033	$29.5	$28.20	$57.7
2034	$29.1	$28.40	$57.5
2035	$28.1	$28.50	$56.7

Table 5-12: Annual Program Budgets Associated with the Constrained UCT Scenario (in millions)

Constrained UCT	Incentives	Admin.	Total Costs
2016	$9.6	$6.30	$15.8
2017	$9.8	$6.50	$16.3
2018	$10.2	$6.70	$16.9
2019	$10.9	$7.20	$18.1
2020	$11.7	$7.80	$19.5
2021	$12.4	$8.30	$20.7
2022	$12.9	$8.80	$21.7
2023	$13.4	$9.30	$22.7
2024	$14.0	$9.70	$23.7
2025	$14.6	$10.30	$24.9
2026	$14.8	$11.40	$26.2
2027	$15.2	$12.00	$27.2
2028	$15.5	$12.60	$28.1
2029	$15.7	$13.50	$29.2
2030	$16.1	$14.30	$30.4
2031	$16.9	$15.10	$32.1
2032	$17.6	$16.30	$33.9
2033	$18.4	$17.50	$35.9
2034	$19.1	$18.70	$37.9
2035	$19.9	$20.20	$40.1

Table 5-13: Annual Achievable Scenario Budgets as a % of Annual Sector Revenue

	Achievable UCT	Constrained UCT
2016	4.8%	2.0%
2017	5.0%	2.0%
2018	5.3%	2.0%
2019	5.4%	2.0%
2020	5.4%	2.0%
2021	5.4%	2.0%
2022	5.6%	2.0%
2023	5.6%	2.0%
2024	5.7%	2.0%
2025	5.8%	2.0%
2026	4.5%	2.0%

	Achievable UCT	Constrained UCT
2027	4.4%	2.0%
2028	4.1%	2.0%
2029	4.0%	2.0%
2030	3.8%	2.0%
2031	3.7%	2.0%
2032	3.4%	2.0%
2033	3.2%	2.0%
2034	3.0%	2.0%
2035	2.8%	2.0%

6 Commercial Natural Gas Energy Efficiency Potential Estimates

This section provides natural gas energy efficiency potential estimates for the commercial sector for DTE Energy. Estimates of technical, economic and achievable natural gas energy efficiency potential are provided.

According to 2014 historical sales data[28], the commercial sector accounts for approximately 25% of retail natural gas sales in the DTE Energy service area, but only 7% of the total retail customers. The average commercial natural gas customer in the DTE Energy service area consumes approximately 515 MMBtu annually. Commercial MMBtu sales over the period 2007 to 2014 have increased by a total of 7% while natural gas revenues have declined 33%. For this study, commercial natural gas sales are estimated to remain relatively stable throughout the 20 year study period of 2016 – 2035.[29]

6.1 Commercial Energy Efficiency Measures Examined

For the commercial sector, there were 77 unique energy efficiency measures included in the natural gas energy savings potential analysis. Table 6-1 provides a brief description of the types of measures included for each end use in the commercial sector. The list of measures was developed based on a review of the latest MEMD, measures found in other TRMs and measures included in other commercial energy efficiency potential studies. For each measure, the analysis considered incremental costs, energy savings, and measure useful lives.

Table 6-1: Types of Natural Gas Energy Efficiency Measures Included in the Commercial Sector Analysis

End Use Type	End Use Description	Measures Included
Building Envelope	Space Heating	• Building Envelope Improvements • Integrated Building Design
Cooking	Cooking Equipment Improvements	• Efficient Oven/Broiler • Efficient Fryer • Efficient Steamer
HVAC Controls	Space Heating	• Programmable Thermostats • EMS Installation/Optimization • HVAC Occupancy Sensors • Retrocommissioning & Commissioning
Space Heating	Heating System Improvements	• Efficient Heating Equipment • Improved Duct Sealing • Heating System Controls & Tune-up • Destratification Fans • Boiler Upgrades • Steam Trap Repair • Ventilation Controls
Water Heating	Water Heating Improvements	• Efficient Water Heating Equipment • Efficient HW Appliances • Low Flow Equipment • Pipe and Tank Insulation • Water Heater Tune-ups • Heat Recovery Systems • Efficient Pool Heater & Pool Cover • Solar Water Heating System

[28] DTE provided historical sales from 2014
[29] GDS forecast based on MMBTu sales forecasts provided by DTE Energy

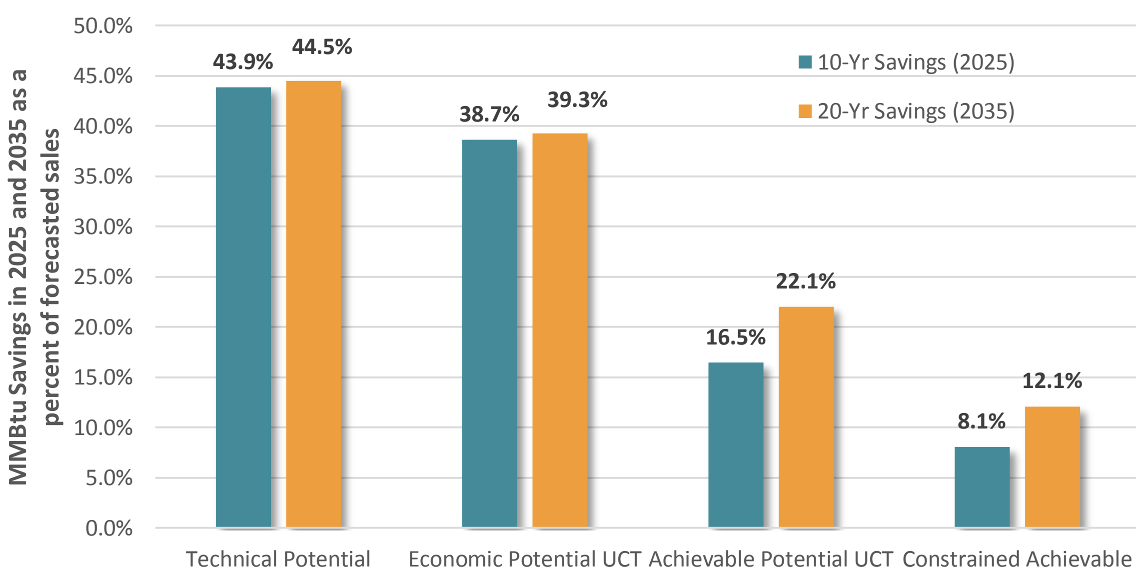
6.2 Commercial Sector Results

This section presents estimates for natural gas technical, economic, and achievable savings potential for the commercial sector. Each of the tables in the technical, economic and achievable sections presents the respective potential for efficiency savings expressed as cumulative annual savings (MMBtu) and percentage of commercial sector forecast annual MMBtu sales. Data is provided for 10 and 20-year horizons for DTE Energy.

6.2.1 Summary of Findings

Figure 6-1 illustrates the estimated natural gas efficiency savings potential in the DTE Energy service area for each of the scenarios included in this study.

Figure 6-1: Summary of Commercial Natural Gas Energy Efficiency Potential as a % of Sales Forecasts



The potential savings estimates are expressed as cumulative annual 10-year and 20-Year savings, as percentages of the respective 2025 and 2035 commercial sector natural gas sales forecasts. The technical savings potential for the commercial sector is 43.9% in 2025 and 44.5% in 2035. The 10-year and 20-year economic potential is 38.7% and 39.3% (respectively) based on the UCT screen, assuming an incentive level set equal to 50% of the measure cost.

The 10-year and 20-year achievable potential savings are 16.5% and 22.1% for the Achievable UCT scenario; and 8.1% and 12.1% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Constrained Achievable scenario is a subset of the Achievable UCT scenario, assuming a spending cap on non-residential DSM expenditures approximately equal to 2% of future annual commercial revenue.

6.2.2 Technical Potential

Technical potential represents the quantification of savings that can be realized if energy-efficiency measures passing the qualitative screening are applied in all feasible instances, regardless of cost. Table 6-2 shows that it is technically feasible to save approximately 16,180,324 MMBtu annually in the commercial sector by 2025, and approximately 17,294,774 MMBtu annually by 2035 across DTE Energy, representing 43.9% of the commercial sales forecast in 2025, and 44.5% of the commercial sales forecast in 2035. Space Heating and HVAC Controls energy efficiency measures make up a majority of the savings potential.

Table 6-2: Commercial Sector Technical Potential Natural Gas Energy Savings by End Use

End Use	2025 Energy Savings (MMBtu)	% of 2025 Total	2035 Energy Savings (MMBtu)	% of 2035 Total
Building Envelope	2,382,788	15%	2,611,382	15%
Cooking	664,004	4%	707,928	4%
HVAC Controls	5,450,682	34%	5,803,802	34%
Space Heating	5,818,128	36%	6,188,063	36%
Water Heating	1,864,723	12%	1,983,599	11%
Total	**16,180,324**	**100%**	**17,294,774**	**100%**
% of Annual Sales Forecast	***43.9%***		***44.5%***	

6.2.3 Economic Potential

Economic potential is a subset of technical potential and only includes measures that are cost-effective. This analysis of cost-effectiveness screen is based on the UCT. The utility incentive was assumed to be equal to 50% of the measure incremental cost. 70% of all measures that were included in the natural gas potential analysis for the commercial sector passed the UCT.

Table 6-3 indicates that it is technically feasible to save approximately 14,261,672 MMBtu annually in the commercial sector by 2025, and approximately 15,259,641 MMBtu annually by 2035 across DTE Energy, representing 38.7% of the commercial sales forecast in 2025, and 39.3% of the commercial sales forecast in 2035. Space Heating and HVAC Controls energy efficiency measures make up a majority of the savings potential.

Table 6-3: Commercial Sector Economic Potential (UCT) Natural Gas Energy Savings by End Use

End Use	2025 Energy Savings (MMBtu)	% of 2025 Total	2035 Energy Savings (MMBtu)	% of 2035 Total
Building Envelope	1,942,417	14%	2,147,470	14%
Cooking	571,192	4%	608,977	4%
HVAC Controls	5,091,619	36%	5,421,657	36%
Space Heating	5,399,891	38%	5,743,434	38%
Water Heating	1,256,553	9%	1,338,102	9%
Total	**14,261,672**	**100%**	**15,259,641**	**100%**
% of Annual Sales Forecast	***38.7%***		***39.3%***	

6.2.4 Achievable Potential

Achievable potential is an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles. This study estimated achievable potential for two scenarios. The Achievable UCT Scenario determines the achievable potential of all measures that passed the UCT economic screening assuming incentives equal to 50% of the measure cost. Unlike the economic potential, the commercial achievable potential takes into account the estimated market adoption of energy efficiency measures based on the incentive level and the natural replacement cycle of equipment.

The second scenario, Constrained UCT, assumes a spending cap equal to 2% of annual utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

6.2.4.1 Achievable UCT Scenario

Table 6-4 shows the estimated cumulative annual savings for the Achievable UCT scenario over 10 and 20 year time horizons. As noted above, this scenario assumes an incentive level approximately equal to 50% of the incremental measure cost and includes estimated 20-year market adoption rates based on incentive levels and equipment replacement cycles.

Table 6-4: Commercial Achievable UCT Potential Natural Gas Energy Savings by End Use

End Use	2025 Energy Savings (MMBtu)	% of 2025 Total	2035 Energy Savings (MMBtu)	% of 2035 Total
Building Envelope	147,753	2%	220,924	3%
Cooking	214,875	4%	429,751	5%
HVAC Controls	3,382,053	56%	3,826,044	45%
Space Heating	1,660,586	27%	3,195,326	37%
Water Heating	673,142	11%	894,021	10%
Total	**6,078,410**	**100%**	**8,566,066**	**100%**
% of Annual Sales Forecast	***16.5%***		***22.1%***	

6.2.4.2 Constrained UCT Scenario

Although the Achievable UCT scenario assumes incentives are set at 50% of the incremental measure cost, and that measures are typically replaced at the end of their useful life, the Achievable UCT scenario also assumes no annual DSM spending cap to reach all potential participants. In the Constrained UCT scenario, the analysis assumes a utility spending cap approximately equal to 2% of annual DTE Energy's commercial sector natural gas revenues. To model the impact of a spending cap the market penetration of all cost effective measures was reduced by the ratio of capped spending to uncapped spending that would be required to achieve the Achievable UCT scenario savings potential. Table 6-5 shows the estimated savings for the Constrained UCT scenario over 10 and 20 year time horizons. The 10-year and 20-year Constrained UCT potential cumulative annual savings estimates are 2,983,129 MMBtu and 4,709,903 MMBtu, respectively. This equates to 8.1% and 12.1% of sector sales in 2025 and 2035.

Table 6-5: Commercial Constrained Achievable Natural Gas Energy Efficiency Savings by End Use

End Use	2025 Energy Savings (MMBtu)	% of 2025 Total	2035 Energy Savings (MMBtu)	% of 2035 Total
Building Envelope	72,439	2%	114,551	2%
Cooking	104,692	4%	251,682	5%
HVAC Controls	1,671,899	56%	2,048,149	44%
Space Heating	807,087	27%	1,780,275	38%
Water Heating	327,011	11%	512,246	11%
Total	**2,983,129**	**100%**	**4,706,903**	**100%**
% of Annual Sales Forecast	***8.1%***		***12.1%***	

Figure 6-2 shows the estimated 20-year cumulative annual energy efficiency savings potential broken out by end use across the entire commercial sector for the Constrained UCT achievable potential scenario. HVAC

Controls and Space Heating end use show the largest potential for energy efficiency savings in this scenario, accounting for 44% and 38% respectively of total savings.

Figure 6-2: Commercial Sector 2035 Constrained UCT Potential Savings by End Use

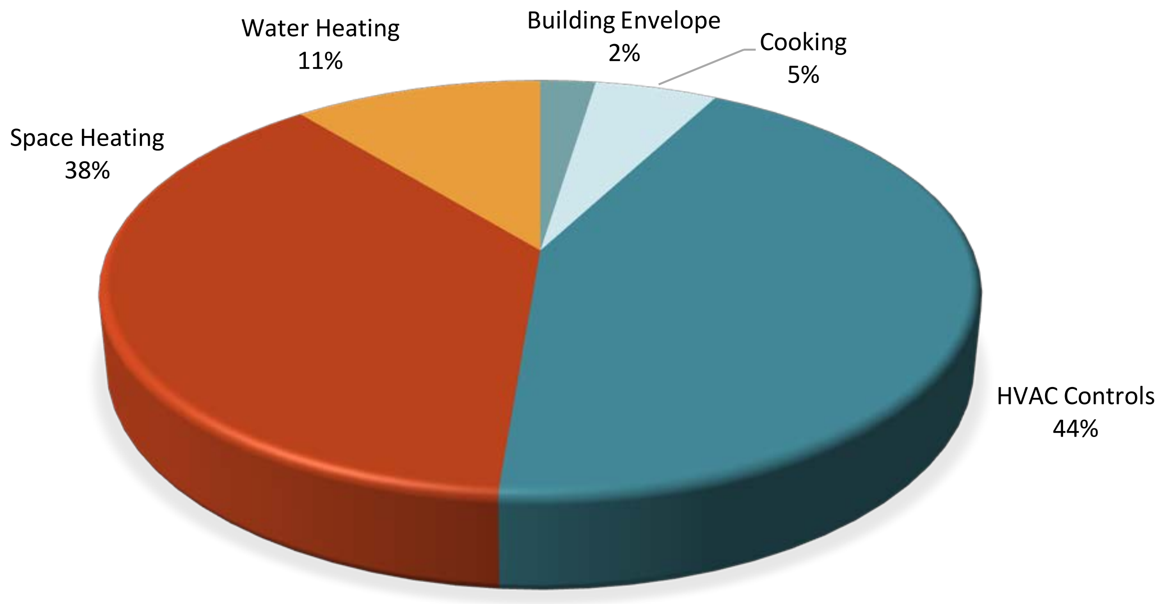
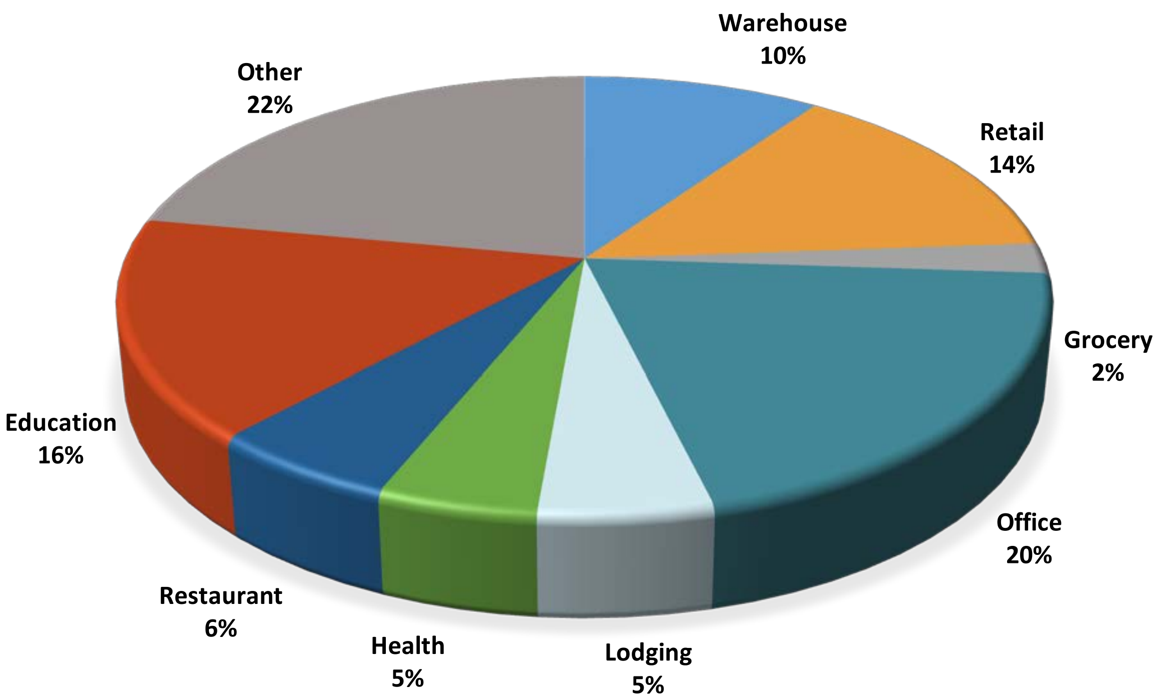


Figure 6-3 shows the breakdown of estimated savings in 2035 by building type for the Constrained UCT achievable potential scenario. Approximately 22% of the potential savings are found in Other buildings type, followed by 20% in Office building types and 16% in Educational buildings.

Figure 6-3: Commercial Constrained UCT Savings in 2035 by Building Type



6.2.4.3 Annual Achievable Potential

Table 6-6 and Table 6-7 show cumulative annual natural gas savings for the Achievable UCT and Constrained Achievable scenarios for each year across the 20-year horizon for the study, broken out by end use.

Table 6-6: Cumulative Annual Commercial Sector Natural Gas Savings in the Unconstrained Achievable UCT Potential Scenario by End Use (MMBTU)

	Building Envelope	Cooking	HVAC Controls	Space Heating	Water Heating	Total	% of Annual Sales Forecast
2016	14,775	21,488	338,205	166,059	67,314	607,841	1.6%
2017	29,551	42,975	676,411	332,117	134,628	1,215,682	3.1%
2018	44,326	64,463	1,014,616	498,176	201,943	1,823,523	4.7%
2019	59,101	85,950	1,352,821	664,234	269,257	2,431,364	6.3%
2020	73,877	107,438	1,691,027	830,293	336,571	3,039,205	7.8%
2021	88,652	128,925	2,029,232	996,352	403,885	3,647,046	9.4%
2022	103,427	150,413	2,367,437	1,162,410	471,199	4,254,887	11.0%
2023	118,203	171,900	2,705,642	1,328,469	538,514	4,862,728	12.5%
2024	132,978	193,388	3,043,848	1,494,527	605,828	5,470,569	14.1%
2025	147,753	214,875	3,382,053	1,660,586	673,142	6,078,410	15.6%
2026	155,070	236,363	3,426,452	1,814,060	695,230	6,327,175	16.3%
2027	162,387	257,850	3,470,851	1,967,534	717,318	6,575,941	16.9%
2028	169,705	279,338	3,515,250	2,121,008	739,406	6,824,706	17.6%
2029	177,022	300,825	3,559,649	2,274,482	761,493	7,073,472	18.2%
2030	184,339	322,313	3,604,049	2,427,956	783,581	7,322,238	18.8%
2031	191,656	343,801	3,648,448	2,581,430	805,669	7,571,003	19.5%
2032	198,973	365,288	3,692,847	2,734,904	827,757	7,819,769	20.1%
2033	206,290	386,776	3,737,246	2,888,378	849,845	8,068,534	20.8%
2034	213,607	408,263	3,781,645	3,041,852	871,933	8,317,300	21.4%
2035	220,924	429,751	3,826,044	3,195,326	894,021	8,566,066	22.1%

Table 6-7: Cumulative Annual Commercial Sector Natural Gas Savings in Constrained Achievable UCT Potential Scenario by End Use (MMBtu)

	Building Envelope	Cooking	HVAC Controls	Space Heating	Water Heating	Total	% of Annual Sales Forecast
2016	6,423	9,341	147,025	72,189	29,263	264,241	0.7%
2017	12,864	18,708	294,460	144,580	58,607	529,219	1.4%
2018	19,400	28,212	444,053	218,030	88,381	798,076	2.1%
2019	26,380	38,364	603,840	296,485	120,184	1,085,254	2.8%
2020	33,859	49,240	775,021	380,535	154,255	1,392,910	3.6%
2021	41,872	60,568	953,321	468,133	189,748	1,713,641	4.4%
2022	50,181	72,270	1,137,503	558,628	226,412	2,044,994	5.3%

	Building Envelope	Cooking	HVAC Controls	Space Heating	Water Heating	Total	% of Annual Sales Forecast
2023	57,401	82,710	1,308,119	638,708	258,866	2,345,804	6.0%
2024	64,788	93,474	1,485,526	721,219	292,264	2,657,271	6.8%
2025	72,439	104,692	1,671,899	807,087	327,011	2,983,129	7.7%
2026	78,856	120,998	1,747,006	921,078	352,642	3,220,580	8.3%
2027	85,415	137,679	1,820,550	1,037,919	379,223	3,460,787	8.9%
2028	91,985	159,655	1,885,832	1,151,015	404,344	3,692,831	9.5%
2029	98,508	181,651	1,948,692	1,264,329	431,699	3,924,879	10.1%
2030	103,743	199,682	2,026,133	1,362,265	451,814	4,143,637	10.7%
2031	104,691	207,961	2,024,549	1,427,702	458,261	4,223,164	10.9%
2032	105,769	216,321	2,026,233	1,498,112	465,345	4,311,781	11.1%
2033	108,118	226,866	2,030,642	1,589,514	480,226	4,435,366	11.4%
2034	110,783	238,013	2,035,335	1,683,005	495,825	4,562,961	11.7%
2035	114,551	251,682	2,048,149	1,780,275	512,246	4,706,903	12.1%

6.2.5 Commercial Summary by Measure Group

Table 6-8 below provides an end-use breakdown of the commercial natural gas savings potential estimates for technical and economic potential, and each of the two achievable potential scenarios. Table 6-8 indicates how the savings potential decreases systematically from the technical potential scenario to the Constrained UCT potential scenario as additional limiting factors such as cost-effectiveness requirements and anticipated market adoption at given funding levels are introduced.

Table 6-8: Commercial Sector Cumulative Natural Gas Savings Potential by End-Use and Measure by 2035

Measure	Technical Potential (MMBtu)	Economic UCT (MMBtu)	Achievable UCT (MMBtu)	Constrained UCT (MMBtu)
Building Envelope				
Energy Efficient Windows	597,530	597,530	28,773	15,806
Ceiling Insulation	1,194,602	1,194,602	71,904	34,929
Wall Insulation	44,968	44,968	2,679	1,301
Roof Insulation	246,796	0	0	0
Integrated Building Design	127,254	127,254	63,495	34,881
Building Operator Certification	64,625	64,625	48,368	24,498
Duct Insulation	118,490	118,490	5,706	3,134
Window Improvements	217,115	0	0	0
Cooking				
High Efficiency Gas Griddle	32,970	0	0	0
High Efficiency Gas Combination Oven	31,176	0	0	0
High Efficiency Gas Convection Oven	51,742	51,742	39,048	22,993
High Efficiency Gas Conveyer Oven	28,548	28,548	19,181	11,294
High Efficiency Gas Rack Oven	44,215	44,215	33,368	19,648
Power Burner Range	45,341	45,341	34,217	18,775
High Efficiency Fryer	64,629	64,629	35,596	20,960
High Efficiency Gas Steamer	304,452	304,452	229,760	135,292
Large Vat Fryer	70,049	70,049	38,581	22,718
Flexible Batch Broiler	34,806	0	0	0
HVAC Controls				

Measure	Technical Potential (MMBtu)	Economic UCT (MMBtu)	Achievable UCT (MMBtu)	Constrained UCT (MMBtu)
EMS install	1,999,826	1,999,826	1,341,290	683,883
EMS Optimization	4,177	4,177	106	52
HVAC Occupancy Sensors	1,236,332	1,236,332	859,640	482,603
Retrocommissioning	2,090,952	2,090,952	1,564,961	848,511
Commissioning	42,361	42,361	31,705	17,190
Programmable Thermostats	382,145	0	0	0
EMS Pump Scheduling Controls	13,353	13,353	5,982	3,358
Web enabled EMS	34,656	34,656	22,359	12,552
Space Heating				
Improved Duct Sealing - Heating	861,328	861,328	51,844	29,137
Gas Furnace 92 AFUE	1,253,811	1,253,811	843,960	473,800
Gas Furnace 95 AFUE	933,069	933,069	654,511	367,443
Gas Unit Heater - Condensing (AFUE =93%)	46,629	46,629	32,708	18,198
Infrared Heater	143,219	143,219	8,620	4,840
Boiler Tune-Up	39,299	0	0	0
Boiler Reset Controls	74,871	74,871	4,507	2,530
Boiler O2 Trim Controls	2,826	2,826	2,115	1,188
Repair/Replace malfunctioning steam traps	188,751	188,751	11,361	5,754
Destratification Fans (HVLS)	970,867	970,867	695,739	390,588
Exhaust Hood Makeup Air	384,127	384,127	256,559	140,942
Demand Controlled Ventilation	488,625	488,625	361,492	202,942
CKV Hood with Demand Control	59,143	59,143	39,502	21,700
Engineered CKV hood	42,917	42,917	28,664	16,092
Guest Room Energy Management, Gas Heating	56,727	56,727	35,999	20,466
Boiler Efficiency Improvement 80% to 88%	63,447	0	0	0
Condensing Boiler 90%	110,552	0	0	0
Boiler turndown control	57,119	57,119	41,900	23,523
Boiler Economizer	15,172	0	0	0
Sensible ERV (Flat plate HX)	41,425	0	0	0
Total ERV (Enthalpy Wheel)	0	0	0	0
Boiler sequencing	10,716	0	0	0
Furnace Tune-Up	155,621	0	0	0
Linkageless and O2 Trim Controls	8,397	0	0	0
VAV System Conversion	179,405	179,405	125,846	61,133
Water Heating				
Small High Efficiency Gas Water Heater	49,620	49,620	2,027	1,168
Large High Efficiency Gas Water Heater	260,654	260,654	203,153	117,083
Instant Gas Water Heater	41,804	41,804	32,582	17,899
Indirect Gas Water Heater	7,963	0	0	0
Domestic Water Heater Tune-up	111,973	0	0	0
Low Flow Showerhead	121,695	121,695	60,721	37,218
Low Flow Faucet Aerator	360,310	360,310	241,613	148,092
Pipe wrap - DHW	20,363	20,363	13,727	6,668
Pipe wrap - Boiler	7,228	7,228	136	66
High Efficiency Pool Heater	38,405	38,405	27,035	13,785
Pool Covers	133,373	0	0	0
Clothes Washer ENERGY STAR, Gas water	34,735	0	0	0

Measure	Technical Potential (MMBtu)	Economic UCT (MMBtu)	Achievable UCT (MMBtu)	Constrained UCT (MMBtu)
heater, Gas dryer				
Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	17,192	0	0	0
Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	17,675	0	0	0
ES Dishwasher, High Temp, Gas Heat, Elec Booster	23,134	23,134	16,285	9,208
ES Dishwasher, High Temp, Gas Heat, Gas Booster	37,342	37,342	26,287	14,863
ES Dishwasher, Low Temp, Gas Heat	42,516	42,516	29,929	16,923
Tank Insulation (gas)	130,721	130,721	97,943	49,938
Pre Rinse Sprayers (gas)	24,980	24,980	1,021	517
Solar Water Heating w/gas auxiliary tank (SEF=1.5)	187,146	0	0	0
Refrigeration Waste Heat Recovery - DWH	14,035	14,035	11,087	5,653
Wastewater, Filtration/Reclamation	135,438	0	0	0
O-zone Generator for Laundry	13,280	13,280	10,161	6,228
Solar pool heater	63,410	63,410	50,319	27,643
HVAC Condenser Heater Recovery Water Heating	33,815	33,815	26,712	14,996
Process Cooling Condenser Heater Recovery Water Heating	54,790	54,790	43,280	24,298
Total	**17,294,774**	**15,259,641**	**8,566,066**	**4,706,903**
Percent of Annual Sales Forecast	**44.5%**	**39.3%**	**22.1%**	**12.1%**

6.3 Commercial Benefit-Cost and Program Budget Estimates

Table 6-9 and Table 6-10 compare the NPV benefits and costs associated with the Achievable UCT and Constrained UCT Scenarios. Both scenarios compared the benefits and costs based on the UCT. However, the constrained scenario's 2% of revenue spending cap on DSM results in reduced program participation and overall NPV benefits.

Table 6-9: 10-Year Benefit-Cost Ratios for Achievable Potential Scenarios – Commercial Sector Only

10-year	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
Achievable UCT	$162,346,019	$61,985,410	2.62	$100,360,609
Constrained UCT	$78,203,120	$29,736,437	2.63	$48,466,683

Table 6-10: 20-Year Benefit-Cost Ratios for Achievable Potential Scenarios– Commercial Sector Only

20-year	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
Achievable UCT	$233,692,358	$93,868,416	2.49	$139,823,942
Constrained UCT	$132,648,516	$48,854,036	2.72	$83,794,480

Annual budgets for the two achievable potential scenarios, broken down by incentive and administrative costs are presented in Table 6-11 and Table 6-12. Table 6-13 shows the revenue requirements for each scenario as a percentage of forecasted sector sales.

Table 6-11: Annual Budgets for Unconstrained Achievable Potential UCT Scenarios– Commercial Sector Only (Millions of Dollars)

	Admin	Incentive	Total
2016	$5.40	$2.98	$8.38
2017	$5.40	$3.04	$8.44
2018	$5.40	$3.10	$8.50
2019	$5.40	$3.16	$8.56
2020	$5.40	$3.22	$8.62
2021	$5.40	$3.30	$8.71
2022	$5.40	$3.37	$8.78
2023	$6.01	$4.35	$10.36
2024	$6.06	$4.44	$10.50
2025	$6.06	$4.53	$10.59
2026	$5.09	$2.68	$7.77
2027	$5.09	$2.73	$7.82
2028	$5.41	$2.91	$8.32
2029	$5.60	$3.03	$8.64
2030	$6.21	$4.14	$10.35
2031	$9.68	$6.40	$16.09
2032	$9.74	$6.56	$16.30
2033	$9.17	$5.60	$14.77
2034	$9.23	$5.73	$14.96
2035	$9.26	$5.86	$15.12

Table 6-12: Annual Budgets for Cost Constrained UCT Scenarios– Commercial Sector Only (Millions of Dollars)

	Admin	Incentive	Total
2016	$2.35	$1.29	$3.64
2017	$2.35	$1.32	$3.68
2018	$2.39	$1.37	$3.76
2019	$2.55	$1.49	$4.04
2020	$2.73	$1.63	$4.36
2021	$2.85	$1.74	$4.59
2022	$2.94	$1.84	$4.78
2023	$2.90	$2.10	$4.99
2024	$3.01	$2.20	$5.21
2025	$3.13	$2.34	$5.47
2026	$3.75	$1.98	$5.73
2027	$3.85	$2.07	$5.91
2028	$3.96	$2.13	$6.10
2029	$4.11	$2.23	$6.34

	Admin	Incentive	Total
2030	$3.95	$2.63	$6.58
2031	$4.19	$2.77	$6.96
2032	$4.39	$2.96	$7.35
2033	$4.82	$2.95	$7.77
2034	$5.06	$3.14	$8.20
2035	$5.33	$3.37	$8.70

Table 6-13: Utility Energy Efficiency Budgets per Scenario as a % of Sector Revenues

	Achievable UCT	Constrained UCT
2016	4.60%	2.00%
2017	4.59%	2.00%
2018	4.52%	2.00%
2019	4.23%	2.00%
2020	3.95%	2.00%
2021	3.79%	2.00%
2022	3.67%	2.00%
2023	4.15%	2.00%
2024	4.03%	2.00%
2025	3.87%	2.00%
2026	2.71%	2.00%
2027	2.64%	2.00%
2028	2.73%	2.00%
2029	2.72%	2.00%
2030	3.14%	2.00%
2031	4.63%	2.00%
2032	4.44%	2.00%
2033	3.80%	2.00%
2034	3.65%	2.00%
2035	3.48%	2.00%

7 Industrial Sector Natural Gas Energy Efficiency Potential Estimates

This section provides natural gas energy efficiency potential estimates for the industrial sector in the DTE Energy service area. Estimates of technical, economic and achievable potential are provided.

According to 2015 historical sales data[30], the industrial sector accounts for under 1% of retail natural gas sales in the DTE Energy service area. The industrial sector is dominated by the automobile industry which represents almost 45% of annual industrial natural gas retail sales. Other key industrial sectors are primary metals, plastics & rubber, and fabricated metals. Industrial MMBtu sales over the period 2007 to 2014 reached their highest level in 2009 of over 1,800,000 MMBtu and their lowest level in 2010 of just over 1,000,000 MMBtu. For this study, industrial natural gas sales are forecast to decrease slightly from over 1,300,000 MMBtu in 2016 to a level of just under 1,270,000 MMBtu in 2035.

7.1 Industrial Energy Efficiency Measures Examined

For the industrial sector, there were 60 energy efficiency measures included in the energy savings potential analysis. Table 7-1 provides a brief description of the types of measures included for each end use in the industrial sector. The list of measures was developed based on a review of the latest MEMD, and measures found in other TRMs and industrial potential studies. For each measure, the analysis considered incremental costs, energy savings, and measure useful measure lives.

Table 7-1: Types of Natural Gas Measures Included in the Industrial Sector Analysis[31]

End Use Type	End Use Description	Measures Included
Conventional Boiler Use	Equipment Improvements	– Boiler Tune-Up – Repair Malfunctioning Steam Traps – Automatic Boiler Blowdown – O2 Burner Controls – Insulate Steam Lines / Condensate Tank – High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%) – Boiler Pipe Insulation – Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%) – Linkageless Controls for Boilers – High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%) – Boiler Reset Controls – Condensing Boiler (<=300,000 Btu/h) (AFUE>90%) – High Efficiency Hot Water Boiler – High Efficiency Steam Boiler
Process Heating	Equipment Improvements	– Process Boiler Tune-Up – Process Dryer Exhaust Rate Control – Regenerative Thermal Oxidizer vs. STO

[30] U.S. Energy Information Administration

[31] Conventional boiler use was grouped into the Facility HVAC end use category for summary purposes. Similarly, agriculture potential was minor and was grouped into the Process Heat end use category for summary purposes

End Use Type	End Use Description	Measures Included
		– Process Boiler Stack Economizer – Repair Malfunctioning Steam Traps – Modulated Boiler Controls for Process – Automatic Boiler Blowdown – O2 Burner Control for Process – Boiler Pipe Insulation – Process Boiler Sequencing – Air Compressor Exhaust Heat Recovery – Refrigeration Heat Recovery – Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%) – Direct Contact Water Heater – Waste-Heat Recovery – Linkageless Controls for Process Boilers – Improved Sensors & Process Controls – Regenerative Thermal Oxidizer vs. CTO – Boiler Reset Controls – High Efficiency Hot Water Boiler – High Efficiency Steam Boiler
Facility HVAC	HVAC Equipment	– Wall Insulation R-7.5 to R13 – EMS install – Demand-Controlled Ventilation – Programmable Thermostats – EMS Optimization – Retrocommissioning – Stack Heat Exchanger (Condensing Economizer) – Stack Heat Exchanger (Standard Economizer) – Infrared Heater (low intensity - two stage) – High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%) – Ceiling Insulation R-11 to R-42 – Destratification Fan – Improved Duct Sealing – Direct Fired Make-up Air System – Gas Unit Heater - Condensing – Truck Loading Dock Seals – Energy Efficient Windows – Roof Insulation R-11 to R-24 – Heat Recovery: Air to Air – Integrated Building Design – Insulate and Seal Ducts (New Aerosol Duct Sealing)
Agriculture	Agriculture Equipment	– IR Film for Greenhouses – Heat Curtains for Greenhouses – Greenhouse Under-Floor/Under-Bench Hydronic Heating – Other Industrial -Grain Dryer

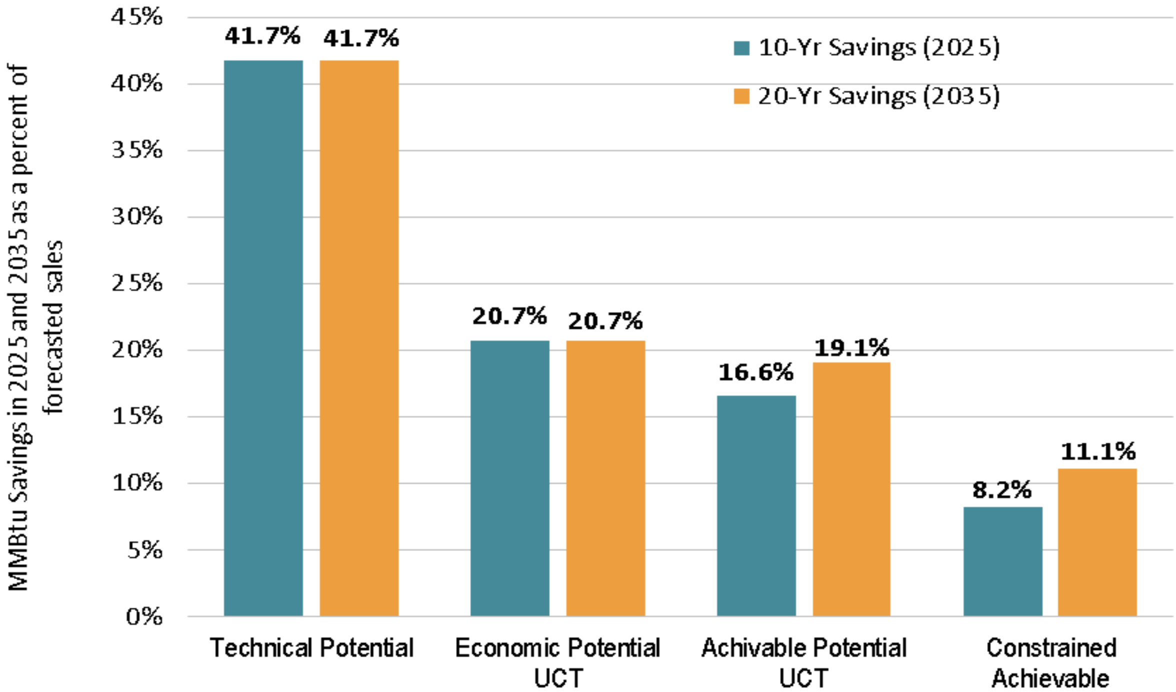
7.2 Industrial Sector Results

This section presents estimates for technical, economic, and achievable natural gas savings potential for the industrial sector. Each of the tables in the technical, economic and achievable sections present the respective potential for energy efficiency savings expressed as cumulative annual savings (MMBtu) and as a percentage of annual industrial MMBtu sales. Data is provided for 10 and 20-year horizons.

7.2.1 Summary of Findings

Figure 7-1 illustrates the estimated savings potential in the DTE Energy service area for each of the scenarios included in this study.

Figure 7-1: Summary of Industrial Natural Gas Energy Efficiency Potential as a % of Sales Forecasts



The potential estimates are expressed as cumulative annual 10-year and 20-year savings, as percentages of the respective 2025 and 2035 forecasts for industrial sector annual natural gas sales. The technical potential is 41.7% in 2025 and 2035. The 10-year and 20-year economic potential is: 20.7% based on the UCT screen, assuming an incentive level equal to 50% of the measure cost.

The 10-year and 20-year achievable potential savings are: 16.6% and 19.1% for the Achievable UCT scenario and 8.2% and 11.1% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Constrained Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on DSM approximately equal to 2% of future annual industrial sector natural gas revenues.

7.2.2 Technical Potential

Technical potential represents the quantification of savings that can be realized if energy-efficiency measures passing the qualitative screening are applied in all feasible instances, regardless of cost. Table 7-2 shows that the technical potential is just under 530,000 MMBtu annually in the industrial sector during the 20 year period from 2016 to 2035 across DTE's service territory, representing 41.7% of 2025 forecast industrial sales and 41.7% of 2035 industrial sales. Process heat and facility HAVC represent approximately equal shares of the potential at 48.3% and 51.7%, respectively, of 20-yr savings.

Table 7-2: Industrial Sector Technical Potential Savings By End Use

End Use	2025 Energy Savings (MMBtu)	% of 2025 Total	2035 Energy Savings (MMBtu)	% of 2035 Total
Process Heat	255,709	48.3%	255,709	48.3%
Facility HVAC	273,555	51.7%	273,555	51.7%
Total	**529,264**		**529,264**	
% of Annual Sales Forecast	***41.7%***		***41.7%***	

7.2.3 Economic Potential

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective. Cost-effectiveness screening is based on the UCT Test. The UCT was used for this study because it is mandated in Michigan to be the primary cost-effectiveness test used when evaluating energy efficiency programs. 88% of all measures that were included in the industrial sector natural gas potential analysis passed the UCT Test.

Table 7-3 indicates that the economic potential based on the UCT screen is nearly 263,000 MMBtu during the 20 year period from 2016 to 2035. This represents 20.7% of industrial sales across the 10-year and 20-year timeframes. Process heat and facility HVAC savings are split about equally, with process heat savings being slightly higher at 51.5%.

Table 7-3: Industrial Sector Economic Potential (UCT) Savings By End Use

End Use	2025 Energy Savings (MMBtu)	% of 2025 Total	2035 Energy Savings (MMBtu)	% of 2033 Total
Process Heat	135,358	51.5%	135,358	51.5%
Facility HVAC	127,525	48.5%	127,525	48.5%
Total	**262,883**		**262,883**	
% of Annual Sales Forecast	***20.7%***		***20.7%***	

7.2.4 Achievable Potential

Achievable potential is an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles. This study estimated achievable potential for two scenarios. The Unconstrained Achievable Potential Scenario with UCT Screening determines the achievable potential of all measures that passed the UCT economic screening assuming incentives equal to 50% of the measure cost. Unlike the economic potential, the industrial unconstrained achievable potential takes into account the estimated market adoption of energy efficiency measures based on the incentive level and the natural replacement cycle of equipment. The second achievable potential scenario, Constrained Achievable Potential Based with UCT Screening, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Unconstrained Achievable UCT scenario.

7.2.4.1 Achievable UCT Scenario

Table 7-4 shows the estimated savings for the Unconstrained Achievable UCT Potential Scenarios over 10 and 20 year time horizons. As noted above, the scenario assumes an incentive level approximately equal to 50% of the incremental measure cost and include an estimate 20-year market adoption rates based on incentive levels and equipment replacement cycles. The 10-year and 20-year Achievable UCT potential savings estimates are approximately 218,000 MMBtu and 251,000 MMBtu. This equates to 16.6% and 19.1% of sector sales in 2025 and 2035.

Table 7-4: Unconstrained Industrial Achievable UCT Potential Natural Gas Energy Savings by End Use

End Use	2025	% of 2025	2035	% of 2035
Process Heat	130,638	59.9%	133,158	53.0%
Facility HVAC	87,402	40.1%	118,110	47.0%
Total	**218,040**		**251,267**	
% of Annual Sales Forecast	***16.6%***		***19.1%***	

7.2.4.2 Constrained UCT Scenario

Although the Unconstrained Achievable UCT assumes incentives are set and capped at 50% of the incremental measure cost, and that measures are typically replaced at the end of their useful life, the Achievable UCT scenario also assumes no DSM spending cap to reach all potential participants. In the Constrained UCT scenario, the analysis assumes a spending cap roughly equal to 2% of DTE Energy's annual natural gas revenues in the industrial sector. To model the impact of a spending cap the market penetration of all cost effective measures was reduced by the ratio of capped spending to uncapped spending that would be required to achieve the Achievable UCT scenario savings potential.

Table 7-5 shows the estimated savings for the Constrained UCT scenario over 10 and 20 year time horizons. The 10-year and 20-year Constrained UCT potential savings estimates are approximately 108,000 MMBtu and 145,000 MMBtu. This equates to 8.2% and 11.1% of sector sales in 2025 and 2035.

Table 7-5: Industrial Constrained Achievable Energy Savings by End Use

	2025	% of 2025	2035	% of 2035
End Use	**Energy (MMBtu)**	**Savings**	**Energy (MMBtu)**	**Savings**
Process Heat	64,710	59.9%	67,545	46.5%
Facility HVAC	43,293	40.1%	77,848	53.5%
Total	**108,003**		**145,393**	
% of Annual Sales Forecast	***8.2%***		***11.1%***	

Figure 7-2 shows the estimated 20-year cumulative annual efficiency savings potential broken out by end use across the entire industrial sector for the Constrained UCT scenario. The Facility HVAC end use shows the largest potential for savings at 54% of total savings, in the Constrained UCT scenario. Process Heat is at 46% of total savings.

Figure 7-2: Industrial Sector 2035 Constrained UCT Potential Savings by End Use

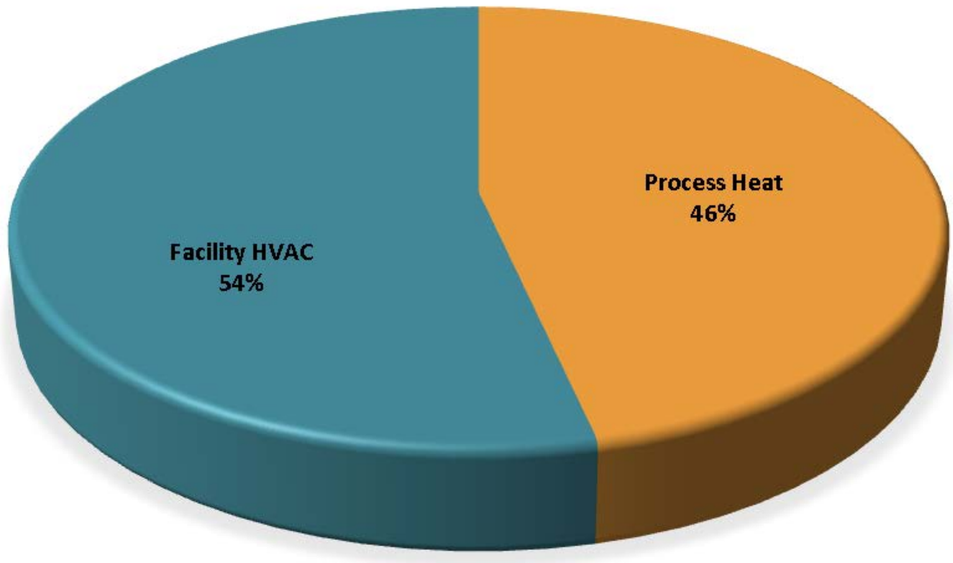
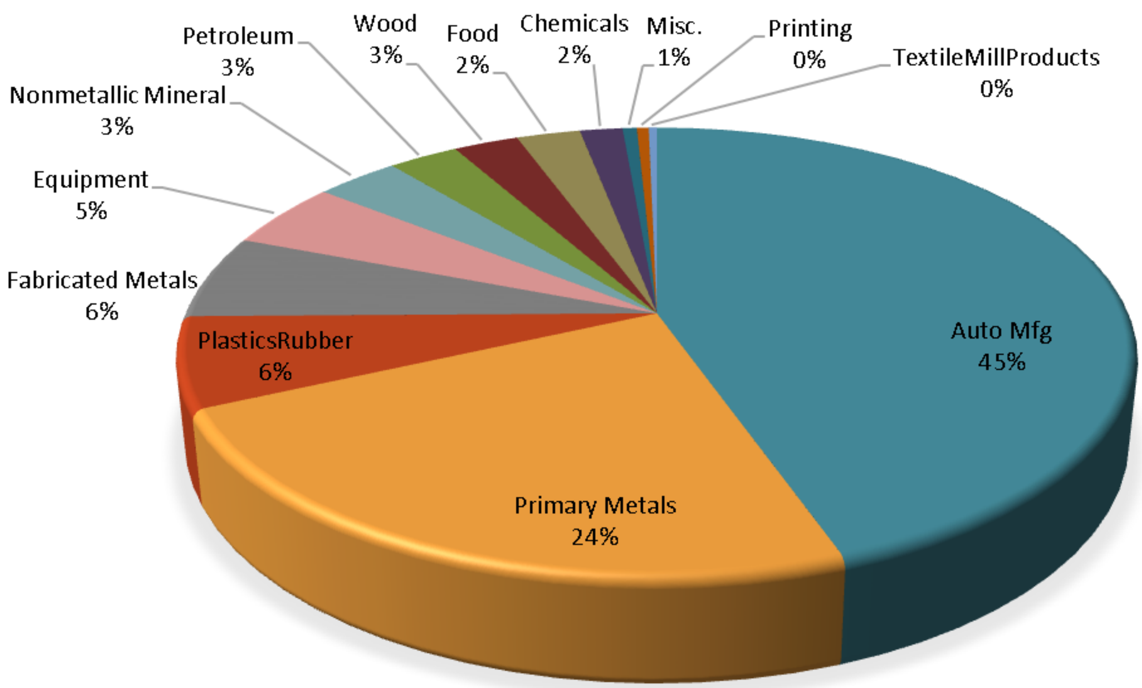


Figure 7-3 shows the breakdown of estimated savings in 2035 by industry type for the Constrained UCT scenario. The majority of savings come from the automobile manufacturing, primary metals, plastics and rubber, and fabricated metals industries; other NAICS codes account for less than 23% of total savings.

Figure 7-3: Industrial Constrained UCT Savings in 2035 by Industry



7.2.4.3 Annual Achievable Potential

Table 7-6 and Table 7-7 show cumulative energy savings for both achievable potential scenarios for each year across the 10-year horizon for the study, broken out by end use.

Table 7-6: Cumulative Annual Industrial Natural Gas Savings in the Unconstrained Achievable UCT Potential Scenario by End Use

	Process Heat	Facility HVAC	Total	% of Annual Sales Forecast
2016	13,064	8,740	21,804	1.7%
2017	26,128	17,480	43,608	3.4%
2018	39,191	26,221	65,412	5.1%
2019	52,255	34,961	87,216	6.8%
2020	65,319	43,701	109,020	8.6%
2021	78,383	52,441	130,824	10.3%
2022	91,447	61,181	152,628	11.6%
2023	104,510	69,921	174,432	13.3%
2024	117,574	78,662	196,236	15.0%
2025	130,638	87,402	218,040	16.6%
2026	130,890	90,473	221,363	16.9%
2027	131,142	93,543	224,685	17.1%
2028	131,394	96,614	228,008	17.4%
2029	131,646	99,685	231,331	17.6%
2030	131,898	102,756	234,654	17.9%
2031	132,150	105,827	237,976	18.1%
2032	132,402	108,897	241,299	18.4%
2033	132,654	111,968	244,622	18.6%
2034	132,906	115,039	247,945	18.9%
2035	133,158	118,110	251,267	19.1%

Table 7-7: Cumulative Annual Industrial Natural Gas Savings in the Constrained UCT Potential Scenario by End Use

	Process Heat	Facility HVAC	Total	% of Annual Sales Forecast
2016	5,129	3,432	8,561	0.7%
2017	10,652	7,127	17,779	1.4%
2018	16,589	11,099	27,688	2.2%
2019	22,985	15,378	38,363	3.0%
2020	29,911	20,011	49,922	3.9%
2021	36,409	24,359	60,769	4.8%
2022	43,118	28,848	71,966	5.5%
2023	50,084	33,508	83,592	6.4%
2024	57,274	38,318	95,593	7.3%
2025	64,710	43,293	108,003	8.2%
2026	65,054	47,489	112,543	8.6%
2027	65,403	51,747	117,150	8.9%
2028	65,755	56,030	121,785	9.3%

	Process Heat	Facility HVAC	Total	% of Annual Sales Forecast
2029	66,113	60,393	126,506	9.6%
2030	66,477	64,839	131,316	10.0%
2031	66,675	67,253	133,929	10.2%
2032	66,883	69,784	136,667	10.4%
2033	67,098	72,400	139,498	10.6%
2034	67,315	75,052	142,368	10.8%
2035	67,545	77,848	145,393	11.1%

7.2.5 Industrial Summary by Measure Group

Table 7-8 below provides an end-use breakdown of the industrial natural gas savings potential estimates for technical and economic potential, and each of the achievable potential scenarios[32]. The table indicates how the savings potential decreases systematically from the technical potential scenario to the Constrained UCT potential scenario as additional limiting factors such as cost-effectiveness requirements and anticipated market adoption at given funding levels are introduced.

Table 7-8: Natural Gas Potential by End-Use and Measure

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Achievable Potential -UCT- (MMBtu)	Constrained Achievable -UCT- (MMBtu)
Conventional Boiler Use				
Boiler Tune-Up	1,204	614	614	304
Repair Malfunctioning Steam Traps	2,662	1,357	1,357	672
Automatic Boiler Blowdown	1,803	919	919	455
O2 Burner Controls	809	412	412	204
Insulate Steam Lines / Condensate Tank	532	271	271	134
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	3,428	699	699	566
Boiler Pipe Insulation	1,291	658	658	326
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	207	59	59	48
Linkageless Controls for Boilers	764	389	389	193
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	1,597	326	326	264
Boiler Reset Controls	3,111	1,586	1,586	786
Condensing Boiler (<=300,000 Btu/h) (AFUE>90%)	738	209	209	169
High Efficiency Hot Water Boiler	1,232	314	314	254
High Efficiency Steam Boiler	1,806	460	0	0
Process Heating				
Process Boiler Tune-Up	31,221	24,058	24,058	11,917

[32] As noted in an earlier footnote, conventional boiler use was grouped into the Facility HVAC end use category for summary purposes. Similarly, agriculture potential was minor and was grouped into the Process Heat end use category for summary purposes

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Achievable Potential -UCT- (MMBtu)	Constrained Achievable -UCT- (MMBtu)
Process Dryer Exhaust Rate Control	29,897	15,240	15,240	7,549
Regenerative Thermal Oxidizer vs. STO	28,728	14,644	14,644	7,254
Process Boiler Stack Economizer	4,041	2,060	2,060	1,020
Repair Malfunctioning Steam Traps	14,961	7,626	7,626	3,778
Modulated Boiler Controls for Process	1,949	993	993	492
Automatic Boiler Blowdown	2,589	1,320	1,320	654
O2 Burner Control for Process	3,679	1,876	1,876	929
Boiler Pipe Insulation	6,088	3,103	3,103	1,537
Process Boiler Sequencing	15,038	11,588	11,588	5,740
Air Compressor Exhaust Heat Recovery	24,506	12,492	12,492	6,187
Refrigeration Heat Recovery	243	124	124	61
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	1,124	318	318	258
Direct Contact Water Heater	14,087	7,181	7,181	3,557
Waste-Heat Recovery	5,998	3,057	3,057	1,514
Linkageless Controls for Process Boilers	3,170	1,616	1,616	800
Improved Sensors & Process Controls	11,146	5,682	5,682	2,814
Regenerative Thermal Oxidizer vs. CTO	16,612	8,468	8,468	4,194
Boiler Reset Controls	12,280	6,260	6,260	3,101
High Efficiency Hot Water Boiler	18,523	4,721	4,721	3,825
High Efficiency Steam Boiler	8,632	2,200	0	0
Facility HVAC				
Wall Insulation R-7.5 to R13	3,353	383	383	190
EMS install	13,829	10,291	10,291	5,098
Demand-Controlled Ventilation	46,468	23,094	23,094	18,713
Programmable Thermostats	5,727	3,755	3,755	1,860
EMS Optimization	1,489	1,108	1,108	549
Retrocommissioning	50,288	23,517	23,517	19,056
Stack Heat Exchanger (Condensing Economizer)	4,183	1,952	1,952	967
Stack Heat Exchanger (Standard Economizer)	2,036	950	950	471
Infrared Heater (low intensity - two stage)	17,098	4,693	4,693	3,802
High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%)	20,383	5,283	5,283	4,281
Ceiling Insulation R-11 to R-42	1,997	684	684	339
Destratification Fan	33,516	25,086	25,086	12,426
Improved Duct Sealing	2,963	1,232	1,232	998
Direct Fired Make-up Air System	2,682	1,251	1,251	620

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Achievable Potential -UCT- (MMBtu)	Constrained Achievable -UCT- (MMBtu)
Gas Unit Heater - Condensing	9,387	1,991	1,991	1,613
Truck Loading Dock Seals	6,718	5,028	5,028	2,490
Energy Efficient Windows	2,414	73	0	0
Roof Insulation R-11 to R-24	96	33	0	0
Heat Recovery: Air to Air	1,881	878	0	0
Integrated Building Design	16,603	3,651	0	0
Insulate and Seal Ducts (New Aerosol Duct Sealing)	9,261	4,321	0	0
Agriculture				
IR Film for Greenhouses	403	247	247	122
Heat Curtains for Greenhouses	411	252	252	125
Greenhouse Under-Floor/Under-Bench Hydronic Heating	182	112	112	55
Other Industrial -Grain Dryer	199	122	122	60
Total	**529,264**	**262,883**	**251,267**	**145,393**
% of Annual Sales Forecast	**41.7%**	**20.7%**	**19.1%**	**11.1%**

7.3 Industrial Benefit-Cost and Program Budget Estimates

Table 7-9 and Table 7-10 compare the NPV benefits and costs associated with the Achievable UCT and Constrained UCT Scenarios. Both scenarios compared the benefits and costs based the UCT. However, the constrained scenario's 2% of revenue spending cap on DSM results in reduced program participation and overall NPV benefits.

Table 7-9: 10-Year Benefit-Cost Ratios for Achievable Potential Scenarios – Industrial Sector Only

10-year	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
Achievable UCT	$5,650,278	$2,824,956	2.00	$2,825,322
Constrained UCT	$2,760,034	$1,372,102	2.01	$1,387,933

Table 7-10: 20-Year Benefit-Cost Ratios for Achievable Potential Scenarios– Industrial Sector Only

20-year	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
Achievable UCT	$7,794,716	$3,664,851	2.13	$4,129,865
Constrained UCT	$5,014,954	$2,280,556	2.20	$2,734,398

Year by year budgets for both achievable potential scenarios, broken out by incentive and administrative costs are depicted in Table 7-11 and Table 7-12. Table 7-13 shows the revenue requirements for each scenario as a percentage of forecasted sector sales.

Table 7-11: Annual Program Budgets Associated with the Achievable UCT Scenario (in millions)

Achievable UCT	Incentives	Admin.	Total Costs
2016	$0.22	$0.16	$0.38
2017	$0.22	$0.16	$0.38

Achievable UCT	Incentives	Admin.	Total Costs
2018	$0.22	$0.16	$0.38
2019	$0.22	$0.17	$0.39
2020	$0.22	$0.17	$0.39
2021	$0.24	$0.20	$0.44
2022	$0.24	$0.21	$0.44
2023	$0.24	$0.21	$0.45
2024	$0.24	$0.22	$0.45
2025	$0.24	$0.22	$0.46
2026	$0.08	$0.12	$0.20
2027	$0.08	$0.13	$0.21
2028	$0.08	$0.13	$0.21
2029	$0.08	$0.13	$0.21
2030	$0.08	$0.13	$0.21
2031	$0.18	$0.24	$0.42
2032	$0.18	$0.25	$0.42
2033	$0.18	$0.25	$0.43
2034	$0.18	$0.27	$0.45
2035	$0.18	$0.27	$0.45

Table 7-12: Annual Program Budgets Associated with the Constrained UCT Scenario (in millions)

Constrained UCT	Incentives	Admin.	Total Costs
2016	$0.09	$0.06	$0.15
2017	$0.09	$0.07	$0.16
2018	$0.10	$0.07	$0.17
2019	$0.11	$0.08	$0.19
2020	$0.12	$0.09	$0.21
2021	$0.12	$0.10	$0.22
2022	$0.12	$0.11	$0.23
2023	$0.13	$0.11	$0.24
2024	$0.13	$0.12	$0.25
2025	$0.14	$0.13	$0.26
2026	$0.11	$0.17	$0.28
2027	$0.11	$0.17	$0.28
2028	$0.11	$0.18	$0.29
2029	$0.11	$0.19	$0.30
2030	$0.12	$0.19	$0.31
2031	$0.14	$0.19	$0.33
2032	$0.14	$0.20	$0.35
2033	$0.15	$0.22	$0.37
2034	$0.16	$0.23	$0.39
2035	$0.17	$0.24	$0.41

Table 7-13: Revenue Requirements per Scenario as a % of sector sales

	Achievable UCT	Constrained UCT
2016	5.09%	2.00%
2017	4.73%	2.00%
2018	4.40%	2.00%
2019	4.09%	2.00%
2020	3.77%	2.00%
2021	4.02%	2.00%
2022	3.89%	2.00%
2023	3.75%	2.00%
2024	3.63%	2.00%
2025	3.51%	2.00%
2026	1.46%	2.00%
2027	1.44%	2.00%
2028	1.43%	2.00%
2029	1.41%	2.00%
2030	1.38%	2.00%
2031	2.54%	2.00%
2032	2.43%	2.00%
2033	2.35%	2.00%
2034	2.32%	2.00%
2035	2.20%	2.00%

APPENDIX A | RESIDENTIAL MEASURE DETAIL

APPENDIX B | COMMERCIAL MEASURE DETAIL

APPENDIX C | INDUSTRIAL MEASURE DETAIL

APPENDIX D | GLOBAL ASSUMPTIONS

DTE Energy

Natural Gas Energy Efficiency Potential Study

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APPENDIX A | RESIDENTIAL MEASURE DETAIL

DTE (Michigan) **Measure Assumption Tab**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Savings	Useful Life	Measure Cost	Measure Description	UCT Ratio
2009	Appliances	ENERGY STAR Dishwasher - gas water heater	SF	All	ROB	135.08	12%	16.28	0.050	0.050	0.8	12%	0.094	10	$10.00	Installation of high efficiency dishwashers in homes with dishwashers and gas water heaters	7.05
2010	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	SF	All	ROB	241.66	35%	84.00	0.012	0.012	1.4	27%	0.369	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with electric water heating and gas dryers	2.22
2012	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	SF	All	ROB	42.29	39%	16.65	0.002	0.002	2.0	29%	0.598	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with gas water heating and gas dryers	1.25
2013	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	SF	All	ROB	398.73	27%	108.20	0.015	0.015	0.8	35%	0.285	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with gas water heating and electric dryers	2.57
2015	Appliances	ENERGY STAR Gas Clothes Dryers	SF	All	ROB	134.72	18%	24.78	0.088	0.088	2.4	18%	0.444	14	$152.00	Installation of high efficiency replacement gas clothes dryers	0.36
2021	Appliances	ENERGY STAR Dishwasher - gas water heater	SF	All	NC	135.08	12%	16.28	0.050	0.050	0.8	12%	0.094	10	$10.00	Installation of high efficiency dishwashers in homes with dishwashers and gas water heaters	7.05
2022	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	SF	All	NC	241.66	35%	84.00	0.012	0.012	1.4	27%	0.369	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with electric water heating and gas dryers	2.22
2024	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	SF	All	NC	42.29	39%	16.65	0.002	0.002	2.0	29%	0.598	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with gas water heating and gas dryers	1.25
2025	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	SF	All	NC	398.73	27%	108.20	0.015	0.015	0.8	35%	0.285	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with gas water heating and electric dryers	2.57
2027	Appliances	ENERGY STAR Gas Clothes Dryers	SF	All	NC	134.72	18%	24.78	0.088	0.088	2.4	18%	0.444	14	$152.00	Installation of high efficiency replacement gas clothes dryers	0.36
2037	Appliances	ENERGY STAR Dishwasher - gas water heater	MF	All	ROB	135.08	12%	16.28	0.050	0.050	0.8	12%	0.094	10	$10.00	Installation of high efficiency dishwashers in homes with dishwashers and gas water heaters	7.05
2038	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	MF	All	ROB	241.66	35%	84.00	0.012	0.012	1.4	27%	0.369	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with electric water heating and gas dryers	2.22
2040	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	MF	All	ROB	42.29	39%	16.65	0.002	0.002	2.0	29%	0.598	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with gas water heating and gas dryers	1.25
2041	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	MF	All	ROB	398.73	27%	108.20	0.015	0.015	0.8	35%	0.285	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with gas water heating and electric dryers	2.57
2043	Appliances	ENERGY STAR Gas Clothes Dryers	MF	All	ROB	134.72	18%	24.78	0.088	0.088	2.4	18%	0.444	14	$152.00	Installation of high efficiency replacement gas clothes dryers	0.36
2049	Appliances	ENERGY STAR Dishwasher - gas water heater	MF	All	NC	135.08	12%	16.28	0.050	0.050	0.8	12%	0.094	10	$10.00	Installation of high efficiency dishwashers in homes with dishwashers and gas water heaters	7.05
2050	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	MF	All	NC	241.66	35%	84.00	0.012	0.012	1.4	27%	0.369	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with electric water heating and gas dryers	2.22
2052	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	MF	All	NC	42.29	39%	16.65	0.002	0.002	2.0	29%	0.598	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with gas water heating and gas dryers	1.25
2053	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	MF	All	NC	398.73	27%	108.20	0.015	0.015	0.8	35%	0.285	11	$36.57	Installation of ENERGY STAR replacement clothes washer in homes with gas water heating and electric dryers	2.57
2055	Appliances	ENERGY STAR Gas Clothes Dryers	MF	All	NC	134.72	18%	24.78	0.088	0.088	2.4	18%	0.444	14	$152.00	Installation of high efficiency replacement gas clothes dryers	0.36
4001	Water Heating	Pipe Wrap - gas water heater	SF	NLI	RETRO	-	-	0.00	0.000	0.000	2.0	65%	1.300	20	$65.00	Installing pipe wrap on hot water lines in homes that have gas water heaters	1.64
4003	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	SF	NLI	RETRO	-	-	0.00	0.000	0.000	36.7	6%	2.200	10	$34.20	Installation of low flow showerheads (1.5 gpm) in hoes with gas water heaters	3.38
4004	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	SF	NLI	RETRO	-	-	0.00	0.000	0.000	36.7	4%	1.470	10	$34.20	Installation of low flow showerheads (1.0 gpm) in hoes with gas water heaters	2.26
4009	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water heater	SF	NLI	RETRO	-	-	0.00	0.000	0.000	3.9	55%	2.104	10	$9.50	Installing 1.0 gpm low flow kitchen faucet aerators in homes with gas water heating	11.64
4010	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water heater	SF	NLI	RETRO	-	-	0.00	0.000	0.000	0.6	54%	0.300	10	$9.50	Installing 1.0 gpm low flow bathroom faucet aerators in homes with gas water heating	1.66
4011	Water Heating	Pipe Wrap - gas water heater	SF	LI	DI	-	-	0.00	0.000	0.000	2.0	65%	1.300	20	$65.00	Installing pipe wrap on hot water lines in homes that have gas water heaters	0.82
4013	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	SF	LI	DI	-	-	0.00	0.000	0.000	36.7	6%	2.200	10	$34.20	Installation of low flow showerheads (1.5 gpm) in hoes with gas water heaters	1.69
4014	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	SF	LI	DI	-	-	0.00	0.000	0.000	36.7	4%	1.470	10	$34.20	Installation of low flow showerheads (1.0 gpm) in hoes with gas water heaters	1.13
4019	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water heater	SF	LI	DI	-	-	0.00	0.000	0.000	3.9	55%	2.104	10	$9.50	Installing 1.0 gpm low flow kitchen faucet aerators in homes with gas water heating	5.82
4020	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water heater	SF	LI	DI	-	-	0.00	0.000	0.000	0.6	54%	0.300	10	$9.50	Installing 1.0 gpm low flow bathroom faucet aerators in homes with gas water heating	0.83
4022	Water Heating	TubSpout with Showerhead 1.5 GPM, gas DHW	SF	All	RETRO	-	-	0.00	0.000	0.000	0.0	-	1.855	10	$48.70	Installation of TubSpout technology in homes with low flow shower heads and gas water heating	2.00
4023	Water Heating	Shower Start 2.0 gpm gas water heater	SF	All	RETRO	-	-	0.00	0.000	0.000	0.4	94%	0.361	10	$38.20	Installation of thermostatic restriction valve on a 2.0 gpm showerhead in homes with a gas water heater	0.50
4026	Water Heating	High Efficiency Gas Water Heater 0.67 EF, <= 55 gallons	SF	All	ROB	-	-	0.00	0.000	0.000	20.0	11%	2.100	13	$440.00	Installing an efficient (0.67 EF) replacement gas storage tank water heater instead of a standard efficiency gas storage tank water heater	0.30
4027	Water Heating	Super Efficiency Gas Water Heater 0.80 EF, <= 55 gallons	SF	All	ROB	-	-	0.00	0.000	0.000	20.0	25%	5.000	13	$520.00	Installing an efficient (0.80 EF) replacement gas storage tank water heater instead of a standard efficiency gas storage tank water heater	0.61
4028	Water Heating	Instant Gas Water Heater	SF	All	ROB	-	-	0.00	0.000	0.000	20.0	27%	5.400	20	$602.00	Installing an efficient replacement instantaneous gas tankless water heater instead of a standard efficiency gas storage tank water heater	0.73
4030	Water Heating	Solar Domestic Hot Water - gas water heater	SF	All	ROB	-	-	0.00	0.000	0.000	20.0	48%	9.500	20	$4,500.00	Installing a solar domestic water heater in homes with gas water heating	0.17
4032	Water Heating	Gravity Film Heat Exchanger GFX gas water heater	SF	All	RETRO	-	-	0.00	0.000	0.000	20.0	5%	1.015	20	$1,022.00	Installing a gravity film heat exchanger in homes with gas water heating	0.08
4033	Water Heating	Pipe Wrap - gas water heater	SF	All	NC	-	-	0.00	0.000	0.000	2.0	65%	1.300	20	$65.00	Installing pipe wrap on hot water lines in homes that have gas water heaters	1.64
4035	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	SF	All	NC	-	-	0.00	0.000	0.000	36.7	6%	2.200	10	$34.20	Installation of low flow showerheads (1.5 gpm) in hoes with gas water heaters	3.38
4036	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	SF	All	NC	-	-	0.00	0.000	0.000	36.7	4%	1.470	10	$34.20	Installation of low flow showerheads (1.0 gpm) in hoes with gas water heaters	2.26
4041	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water heater	SF	All	NC	-	-	0.00	0.000	0.000	3.9	55%	2.104	10	$9.50	Installing 1.0 gpm low flow kitchen faucet aerators in homes with gas water heating	11.64
4042	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water heater	SF	All	NC	-	-	0.00	0.000	0.000	0.6	54%	0.300	10	$9.50	Installing 1.0 gpm low flow bathroom faucet aerators in homes with gas water heating	1.66
4044	Water Heating	TubSpout with Showerhead 1.5 GPM, gas DHW	SF	All	NC	-	-	0.00	0.000	0.000	0.0	-	1.855	10	$48.70	Installation of TubSpout technology in homes with low flow shower heads and gas water heating	2.00
4045	Water Heating	Shower Start 2.0 gpm gas water heater	SF	All	NC	-	-	0.00	0.000	0.000	0.4	94%	0.361	10	$38.20	Installation of thermostatic restriction valve on a 2.0 gpm showerhead in homes with a gas water heater	0.50
4048	Water Heating	High Efficiency Gas Water Heater 0.67 EF, <= 55 gallons	SF	All	NC	-	-	0.00	0.000	0.000	20.0	11%	2.100	13	$440.00	Installing an efficient (0.67 EF) replacement gas storage tank water heater instead of a standard efficiency gas storage tank water heater	0.30

DTE (Michigan) **Measure Assumption Tab**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Savings	Useful Life	Measure Cost	Measure Description	UCT Ratio
4049	Water Heating	Super Efficiency Gas Water Heater 0.80 EF, <= 55 gallons	SF	All	NC	-	-	0.00	0.000	0.000	20.0	25%	5.000	13	$520.00	Installing an efficient (0.80 EF) replacement gas storage tank water heater instead of a standard efficiency gas storage tank water heater	0.61
4050	Water Heating	Instant Gas Water Heater	SF	All	NC	-	-	0.00	0.000	0.000	20.0	27%	5.400	20	$602.00	Installing an efficient replacement instantaneous gas tankless water heater instead of a standard efficiency gas storage tank water heater	0.73
4052	Water Heating	Solar Domestic Hot Water - gas water heater	SF	All	NC	-	-	0.00	0.000	0.000	20.0	48%	9.500	20	$4,500.00	Installing a solar domestic water heater in homes with gas water heating	0.17
4054	Water Heating	Gravity Film Heat Exchanger GFX gas water heater	SF	All	NC	-	-	0.00	0.000	0.000	20.0	5%	1.015	20	$1,022.00	Installing a gravity film heat exchanger in homes with gas water heating	0.08
4055	Water Heating	Pipe Wrap - gas water heater	MF	NLI	RETRO	-	-	0.00	0.000	0.000	2.0	65%	1.300	20	$65.00	Installing pipe wrap on hot water lines in homes that have gas water heaters	1.64
4057	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	MF	NLI	RETRO	-	-	0.00	0.000	0.000	35.9	6%	2.150	10	$34.20	Installation of low flow showerheads (1.5 gpm) in hoes with gas water heaters	3.30
4058	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	MF	NLI	RETRO	-	-	0.00	0.000	0.000	35.9	4%	1.470	10	$34.20	Installation of low flow showerheads (1.0 gpm) in hoes with gas water heaters	2.26
4063	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water heater	MF	NLI	RETRO	-	-	0.00	0.000	0.000	2.8	55%	1.522	10	$9.50	Installing 1.0 gpm low flow kitchen faucet aerators in homes with gas water heating	8.42
4064	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water heater	MF	NLI	RETRO	-	-	0.00	0.000	0.000	0.6	55%	0.310	10	$9.50	Installing 1.0 gpm low flow bathroom faucet aerators in homes with gas water heating	1.72
4065	Water Heating	Pipe Wrap - gas water heater	MF	LI	DI	-	-	0.00	0.000	0.000	2.0	65%	1.300	20	$65.00	Installing pipe wrap on hot water lines in homes that have gas water heaters	0.82
4067	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	MF	LI	DI	-	-	0.00	0.000	0.000	35.9	6%	2.150	10	$34.20	Installation of low flow showerheads (1.5 gpm) in hoes with gas water heaters	1.65
4068	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	MF	LI	DI	-	-	0.00	0.000	0.000	35.9	4%	1.470	10	$34.20	Installation of low flow showerheads (1.0 gpm) in hoes with gas water heaters	1.13
4073	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water heater	MF	LI	DI	-	-	0.00	0.000	0.000	2.8	55%	1.522	10	$9.50	Installing 1.0 gpm low flow kitchen faucet aerators in homes with gas water heating	4.21
4074	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water heater	MF	LI	DI	-	-	0.00	0.000	0.000	0.6	55%	0.310	10	$9.50	Installing 1.0 gpm low flow bathroom faucet aerators in homes with gas water heating	0.86
4076	Water Heating	TubSpout with Showerhead 1.5 GPM, gas DHW	MF	All	RETRO	-	-	0.00	0.000	0.000	0.0	-	1.813	10	$48.70	Installation of TubSpout technology in homes with low flow shower heads and gas water heating	1.96
4077	Water Heating	Shower Start 2.0 gpm gas water heater	MF	All	RETRO	-	-	0.00	0.000	0.000	0.4	94%	0.353	10	$38.20	Installation of thermostatic restriction valve on a 2.0 gpm showerhead in homes with a gas water heater	0.49
4080	Water Heating	High Efficiency Gas Water Heater 0.67 EF, <= 55 gallons	MF	All	ROB	-	-	0.00	0.000	0.000	16.8	10%	1.700	13	$440.00	Installing an efficient (0.67 EF) replacement gas storage tank water heater instead of a standard efficiency gas storage tank water heater	0.24
4081	Water Heating	Super Efficiency Gas Water Heater 0.80 EF, <= 55 gallons	MF	All	ROB	-	-	0.00	0.000	0.000	16.8	25%	4.200	13	$520.00	Installing an efficient (0.80 EF) replacement gas storage tank water heater instead of a standard efficiency gas storage tank water heater	0.51
4082	Water Heating	Instant Gas Water Heater	MF	All	ROB	-	-	0.00	0.000	0.000	16.8	27%	4.500	20	$602.00	Installing an efficient replacement instantaneous gas tankless water heater instead of a standard efficiency gas storage tank water heater	0.61
4084	Water Heating	Solar Domestic Hot Water - gas water heater	MF	All	ROB	-	-	0.00	0.000	0.000	16.8	57%	9.500	20	$4,500.00	Installing a solar domestic water heater in homes with gas water heating	0.17
4086	Water Heating	Gravity Film Heat Exchanger GFX gas water heater	MF	All	RETRO	-	-	0.00	0.000	0.000	16.8	4%	0.658	20	$1,022.00	Installing a gravity film heat exchanger in homes with gas water heating	0.05
4087	Water Heating	Pipe Wrap - gas water heater	MF	All	NC	-	-	0.00	0.000	0.000	2.0	65%	1.300	20	$65.00	Installing pipe wrap on hot water lines in homes that have gas water heaters	1.64
4089	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	MF	All	NC	-	-	0.00	0.000	0.000	35.9	6%	2.150	10	$34.20	Installation of low flow showerheads (1.5 gpm) in hoes with gas water heaters	3.30
4090	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	MF	All	NC	-	-	0.00	0.000	0.000	35.9	4%	1.470	10	$34.20	Installation of low flow showerheads (1.0 gpm) in hoes with gas water heaters	2.26
4095	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water heater	MF	All	NC	-	-	0.00	0.000	0.000	2.8	55%	1.522	10	$9.50	Installing 1.0 gpm low flow kitchen faucet aerators in homes with gas water heating	8.42
4096	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water heater	MF	All	NC	-	-	0.00	0.000	0.000	0.6	55%	0.310	10	$9.50	Installing 1.0 gpm low flow bathroom faucet aerators in homes with gas water heating	1.72
4098	Water Heating	TubSpout with Showerhead 1.5 GPM, gas DHW	MF	All	NC	-	-	0.00	0.000	0.000	0.0	-	1.813	10	$48.70	Installation of TubSpout technology in homes with low flow shower heads and gas water heating	1.96
4099	Water Heating	Shower Start 2.0 gpm gas water heater	MF	All	NC	-	-	0.00	0.000	0.000	0.4	94%	0.353	10	$38.20	Installation of thermostatic restriction valve on a 2.0 gpm showerhead in homes with a gas water heater	0.49
4102	Water Heating	High Efficiency Gas Water Heater 0.67 EF, <= 55 gallons	MF	All	NC	-	-	0.00	0.000	0.000	16.8	10%	1.700	13	$440.00	Installing an efficient (0.67 EF) replacement gas storage tank water heater instead of a standard efficiency gas storage tank water heater	0.24
4103	Water Heating	Super Efficiency Gas Water Heater 0.80 EF, <= 55 gallons	MF	All	NC	-	-	0.00	0.000	0.000	16.8	25%	4.200	13	$520.00	Installing an efficient (0.80 EF) replacement gas storage tank water heater instead of a standard efficiency gas storage tank water heater	0.51
4104	Water Heating	Instant Gas Water Heater	MF	All	NC	-	-	0.00	0.000	0.000	16.8	27%	4.500	20	$602.00	Installing an efficient replacement instantaneous gas tankless water heater instead of a standard efficiency gas storage tank water heater	0.61
4106	Water Heating	Solar Domestic Hot Water - gas water heater	MF	All	NC	-	-	0.00	0.000	0.000	16.8	57%	9.500	20	$4,500.00	Installing a solar domestic water heater in homes with gas water heating	0.17
4108	Water Heating	Gravity Film Heat Exchanger GFX gas water heater	MF	All	NC	-	-	0.00	0.000	0.000	16.8	4%	0.658	20	$1,022.00	Installing a gravity film heat exchanger in homes with gas water heating	0.05
5001	HVAC Shell	Infiltration reduction - 30%	SF	NLI	RETRO	-	-	56.41	0.071	0.112	-	-	6.884	13	$190.08	Air sealing (30% infiltration reduction) in homes with gas heating and central AC	3.00
5002	HVAC Shell	Infiltration reduction - 50%	SF	NLI	RETRO	-	-	96.70	0.119	0.189	-	-	11.435	13	$190.08	Air sealing (50% infiltration reduction) in homes with gas heating and central AC	5.01
5003	HVAC Shell	Crawlspace Wall Insulation	SF	NLI	RETRO	-	-	-46.66	-0.026	-0.027	-	-	3.151	25	$552.11	Installing crawlspace wall insulation in homes with unconditioned crawlspaces and gas heating and central AC	0.33
5004	HVAC Shell	Basement Wall Insulation	SF	NLI	RETRO	-	-	-39.11	-0.048	-0.052	-	-	9.214	25	$1,104.21	Installing basement wall insulation in homes with unconditioned basements and gas heating and central AC	0.64
5005	HVAC Shell	Floor Insulation	SF	NLI	RETRO	-	-	-61.73	-0.025	-0.026	-	-	5.233	25	$819.88	Installing floor wall insulation in homes with unconditioned basements or crawl spaces and gas heating and central AC	0.44
5006	HVAC Shell	Wall Insulation	SF	NLI	RETRO	-	-	110.44	0.096	0.113	-	-	11.168	25	$3,041.11	Installing wall insulation in homes with gas heating and central AC	0.44
5007	HVAC Shell	R-38 Roof Insulation	SF	NLI	RETRO	-	-	42.77	0.046	0.043	-	-	4.233	20	$1,553.26	Installing R-38 roof insulation in homes with poor attic insulation and gas heating and central AC	0.30
5008	HVAC Shell	R-60 Roof Insulation	SF	NLI	RETRO	-	-	60.38	0.065	0.068	-	-	5.967	20	$3,351.78	Installing R-60 roof insulation in homes with mediocre attic insulation and gas heating and central AC	0.20
5009	HVAC Shell	Infiltration reduction - 30%	SF	NLI	RETRO	-	-	29.92	0.000	0.000	-	-	7.155	13	$190.08	Air sealing (30% infiltration reduction) in homes with gas heating and no central AC	2.50
5010	HVAC Shell	Infiltration reduction - 50%	SF	NLI	RETRO	-	-	49.90	0.000	0.000	-	-	11.922	13	$190.08	Air sealing (50% infiltration reduction) in homes with gas heating and no central AC	4.16
5011	HVAC Shell	Crawlspace Wall Insulation	SF	NLI	RETRO	-	-	11.81	0.000	0.000	-	-	4.356	25	$552.11	Installing crawlspace wall insulation in homes with unconditioned crawlspaces and gas heating and no central AC	0.74
5012	HVAC Shell	Basement Wall Insulation	SF	NLI	RETRO	-	-	33.90	0.000	0.000	-	-	9.859	25	$1,104.21	Installing basement wall insulation in homes with unconditioned basements and gas heating and no central AC	0.85
5013	HVAC Shell	Floor Insulation	SF	NLI	RETRO	-	-	20.15	0.000	0.000	-	-	4.215	25	$819.88	Installing floor wall insulation in homes with unconditioned basements or crawl spaces and gas heating and no central AC	0.50
5014	HVAC Shell	Wall Insulation	SF	NLI	RETRO	-	-	46.23	0.000	0.000	-	-	11.498	25	$3,041.11	Installing wall insulation in homes with gas heating and no central AC	0.36

DTE (Michigan) **Measure Assumption Tab**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Savings	Useful Life	Measure Cost	Measure Description	UCT Ratio
5015	HVAC Shell	R-38 Roof Insulation	SF	NLI	RETRO	-	-	17.58	0.000	0.000	-	-	4.737	20	$1,553.26	Installing R-38 roof insulation in homes with poor attic insulation and gas heating and no central AC	0.26
5016	HVAC Shell	R-60 Roof Insulation	SF	NLI	RETRO	-	-	24.59	0.000	0.000	-	-	6.519	20	$3,351.78	Installing R-60 roof insulation in homes with mediocre attic insulation and gas heating and no central AC	0.17
5025	HVAC Shell	Infiltration reduction - 50%	SF	LI	DI	-	-	96.70	0.119	0.189	-	-	11.435	13	$190.08	Air sealing (50% infiltration reduction) in homes with gas heating and central AC	2.50
5026	HVAC Shell	Crawlspace Wall Insulation	SF	LI	DI	-	-	-46.66	-0.026	-0.027	-	-	3.151	25	$552.11	Installing crawlspace wall insulation in homes with unconditioned crawlspaces and gas heating and central AC	0.17
5027	HVAC Shell	Basement Wall Insulation	SF	LI	DI	-	-	-39.11	-0.048	-0.052	-	-	9.214	25	$1,104.21	Installing basement wall insulation in homes with unconditioned basements and gas heating and central AC	0.32
5028	HVAC Shell	Floor Insulation	SF	LI	DI	-	-	-61.73	-0.025	-0.026	-	-	5.233	25	$819.88	Installing floor wall insulation in homes with unconditioned basements or crawl spaces and gas heating and central AC	0.22
5029	HVAC Shell	Wall Insulation	SF	LI	DI	-	-	110.44	0.096	0.113	-	-	11.168	25	$3,041.11	Installing wall insulation in homes with gas heating and central AC	0.22
5030	HVAC Shell	R-38 Roof Insulation	SF	LI	DI	-	-	42.77	0.046	0.043	-	-	4.233	20	$1,553.26	Installing R-38 roof insulation in homes with poor attic insulation and gas heating and central AC	0.15
5031	HVAC Shell	R-60 Roof Insulation	SF	LI	DI	-	-	60.38	0.065	0.068	-	-	5.967	20	$3,351.78	Installing R-60 roof insulation in homes with mediocre attic insulation and gas heating and central AC	0.10
5032	HVAC Shell	Infiltration reduction - 50%	SF	LI	DI	-	-	49.90	0.000	0.000	-	-	11.922	13	$190.08	Air sealing (50% infiltration reduction) in homes with gas heating and no central AC	2.08
5033	HVAC Shell	Crawlspace Wall Insulation	SF	LI	DI	-	-	11.81	0.000	0.000	-	-	4.356	25	$552.11	Installing crawlspace wall insulation in homes with unconditioned crawlspaces and gas heating and no central AC	0.37
5034	HVAC Shell	Basement Wall Insulation	SF	LI	DI	-	-	33.90	0.000	0.000	-	-	9.859	25	$1,104.21	Installing basement wall insulation in homes with unconditioned basements and gas heating and no central AC	0.42
5035	HVAC Shell	Floor Insulation	SF	LI	DI	-	-	20.15	0.000	0.000	-	-	4.215	25	$819.88	Installing floor wall insulation in homes with unconditioned basements or crawl spaces and gas heating and no central AC	0.25
5036	HVAC Shell	Wall Insulation	SF	LI	DI	-	-	46.23	0.000	0.000	-	-	11.498	25	$3,041.11	Installing wall insulation in homes with gas heating and no central AC	0.18
5037	HVAC Shell	R-38 Roof Insulation	SF	LI	DI	-	-	17.58	0.000	0.000	-	-	4.737	20	$1,553.26	Installing R-38 roof insulation in homes with poor attic insulation and gas heating and no central AC	0.13
5038	HVAC Shell	R-60 Roof Insulation	SF	LI	DI	-	-	24.59	0.000	0.000	-	-	6.519	20	$3,351.78	Installing R-60 roof insulation in homes with mediocre attic insulation and gas heating and no central AC	0.08
5046	HVAC Shell	Duct Insulation	SF	All	RETRO	-	-	0.05	0.023	0.025	-	-	2.236	20	$380.16	Adding duct insulation in homes with gas heating and central AC	0.58
5047	HVAC Shell	Duct location	SF	All	RETRO	-	-	75.19	0.070	0.081	-	-	7.871	30	$1,188.00	Moving ductwork from unconditioned space to conditioned space in homes with gas heating and central AC	0.85
5048	HVAC Shell	Duct sealing 15% leakage base	SF	All	RETRO	-	-	18.72	0.028	0.035	-	-	0.923	18	$341.86	Duct sealing (15% leakage reduction) in homes with gas heating and central AC	0.39
5049	HVAC Shell	Duct sealing 30% leakage base	SF	All	RETRO	-	-	57.15	0.074	0.085	-	-	2.368	18	$341.86	Duct sealing (30% leakage reduction) in homes with gas heating and central AC	1.04
5050	HVAC Shell	Door weatherstripping	SF	All	RETRO	-	-	12.80	0.000	0.000	-	-	0.394	5	$86.00	Installing door weatherstripping - savings estimate weighted across heating/cooling combinations	0.19
5051	HVAC Shell	R0 to R19 kneewalls	SF	All	RETRO	-	-	75.95	0.084	0.092	-	-	7.284	20	$172.53	Installing R19 kneewall insulation in homes with no kneewall insulation in homes with gas heating and central AC	4.73
5052	HVAC Shell	R6 to R19 kneewalls	SF	All	RETRO	-	-	25.05	0.027	0.028	-	-	2.995	20	$162.53	Installing R19 kneewall insulation in homes with R6 kneewall insulation in homes with gas heating and central AC	1.94
5053	HVAC Shell	Rim Joist Insulation	SF	All	RETRO	-	-	34.89	0.026	0.030	-	-	3.456	25	$179.92	Installing rim joist insulation in homes with gas heating and central AC	2.24
5055	HVAC Shell	Window Replacement	SF	All	RETRO	-	-	313.16	0.315	0.360	-	-	12.126	25	$1,018.42	Replacing inefficient windows at the end of useful life with efficient windows in homes with gas heating and central AC	2.02
5056	HVAC Shell	Original double hung window with low U storm	SF	All	RETRO	-	-	734.09	0.694	0.807	-	-	25.504	25	$3,564.00	Retrofitting inefficient windows with efficient alternatives in homes with gas heating and central AC	1.25
5057	HVAC Shell	Duct Insulation	SF	All	RETRO	-	-	-13.81	0.000	0.000	-	-	2.239	20	$380.16	Adding duct insulation in homes with gas heating and no central AC	0.44
5058	HVAC Shell	Duct location	SF	All	RETRO	-	-	10.36	0.000	0.000	-	-	9.200	30	$1,188.00	Moving ductwork from unconditioned space to conditioned space in homes with gas heating and no central AC	0.77
5059	HVAC Shell	Duct sealing 15% leakage base	SF	All	RETRO	-	-	4.56	0.000	0.000	-	-	0.927	18	$341.86	Duct sealing (15% leakage reduction) in homes with gas heating and no central AC	0.22
5060	HVAC Shell	Duct sealing 30% leakage base	SF	All	RETRO	-	-	14.43	0.000	0.000	-	-	2.367	18	$341.86	Duct sealing (30% leakage reduction) in homes with gas heating and no central AC	0.57
5061	HVAC Shell	R0 to R19 kneewalls	SF	All	RETRO	-	-	29.82	0.000	0.000	-	-	7.559	20	$172.53	Installing R19 kneewall insulation in homes with no kneewall insulation in homes with gas heating and no central AC	3.76
5062	HVAC Shell	R6 to R19 kneewalls	SF	All	RETRO	-	-	11.13	0.000	0.000	-	-	3.049	20	$162.53	Installing R19 kneewall insulation in homes with R6 kneewall insulation in homes with gas heating and no central AC	1.60
5063	HVAC Shell	Rim Joist Insulation	SF	All	RETRO	-	-	0.00	0.000	0.000	-	-	3.536	25	$179.92	Installing rim joist insulation in homes with gas heating and no central AC	1.79
5064	HVAC Shell	Window Film	SF	All	RETRO	-	-	-36.96	0.000	0.000	-	-	-8.143	10	$365.46	Installing window film on inefficient existing windows in homes with gas heating and no central AC	-1.23
5065	HVAC Shell	Window Replacement	SF	All	RETRO	-	-	51.04	0.000	0.000	-	-	12.479	25	$1,018.42	Replacing inefficient windows at the end of useful life with efficient windows in homes with gas heating and no central AC	1.17
5066	HVAC Shell	Original double hung window with low U storm	SF	All	RETRO	-	-	146.67	0.000	0.000	-	-	25.489	25	$3,564.00	Retrofitting inefficient windows with efficient alternatives in homes with gas heating and no central AC	0.70
5067	HVAC Shell	HW pipe insulation	SF	All	RETRO	-	-	-8.94	0.000	0.000	-	-	29.119	11	$1,404.58	Installing hot water pipe insulation on boiler pipes in homes with boilers	1.16
5068	HVAC Shell	Steam pipe insulation	SF	All	RETRO	-	-	-14.95	0.000	0.000	-	-	49.230	11	$1,404.58	Installing steam pipe insulation on boiler pipes in homes with boilers	1.97
5074	HVAC Shell	R6 to R19 kneewalls	SF	All	RETRO	-	-	555.27	0.028	0.027	-	-	0.590	20	$162.53	Installing R19 kneewall insulation in homes with R6 kneewall insulation in homes with electric heating and central AC	4.09
5076	HVAC Shell	Window Film	SF	All	RETRO	-	-	-1337.08	0.369	0.317	-	-	-0.020	10	$365.46	Installing window film on inefficient existing windows in homes with electric heating and central AC	-1.23
5079	HVAC Shell	Infiltration reduction - 30%	SF	All	NC	-	-	28.31	0.018	0.028	-	-	3.611	13	$190.08	Air sealing (30% infiltration reduction) in homes with gas heating and central AC	1.44
5080	HVAC Shell	Infiltration reduction - 50%	SF	All	NC	-	-	46.02	0.029	0.046	-	-	6.012	13	$190.08	Air sealing (50% infiltration reduction) in homes with gas heating and central AC	2.39
5081	HVAC Shell	Duct Insulation	SF	All	NC	-	-	7.11	0.029	0.030	-	-	1.663	20	$380.16	Adding duct insulation in homes with gas heating and central AC	0.51
5082	HVAC Shell	Duct location	SF	All	NC	-	-	58.05	0.039	0.044	-	-	6.598	30	$1,188.00	Moving ductwork from unconditioned space to conditioned space in homes with gas heating and central AC	0.67
5083	HVAC Shell	Duct sealing 15% leakage base	SF	All	NC	-	-	11.218	0.015	0.018	-	-	0.340	18	$341.86	Duct sealing (15% leakage reduction) in homes with gas heating and central AC	0.18

DTE (Michigan) **Measure Assumption Tab**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Savings	Useful Life	Measure Cost	Measure Description	UCT Ratio
5084	HVAC Shell	Duct sealing 30% leakage base	SF	All	NC	-	-	29.423	0.041	0.046	-	-	0.920	18	$341.86	Duct sealing (30% leakage reduction) in homes with gas heating and central AC	0.48
5085	HVAC Shell	Door weatherstripping	SF	All	NC	-	-	0.000	0.000	0.000	-	-	0.000	5	$86.00	Installing door weatherstripping - savings estimate weighted across heating/cooling combinations	0.00
5086	HVAC Shell	Basement Wall Insulation	SF	All	NC	-	-	-1.652	-0.017	-0.028	-	-	3.651	25	$1,104.21	Installing basement wall insulation in homes with unconditioned basements and gas heating and central AC	0.27
5087	HVAC Shell	Floor Insulation	SF	All	NC	-	-	-6.083	0.000	0.000	-	-	0.642	25	$819.88	Installing floor wall insulation in homes with unconditioned basements or crawl spaces and gas heating and central AC	0.06
5088	HVAC Shell	Crawlspace Wall Insulation	SF	All	NC	-	-	-1.863	0.000	0.000	-	-	0.074	25	$552.11	Installing crawlspace wall insulation in homes with unconditioned crawlspaces and gas heating and central AC	0.01
5089	HVAC Shell	Wall Insulation	SF	All	NC	-	-	34.966	0.000	0.028	-	-	3.249	25	$3,041.11	Installing wall insulation in homes with gas heating and central AC	0.11
5091	HVAC Shell	Window Replacement	SF	All	NC	-	-	75.944	0.007	0.099	-	-	1.305	25	$1,018.42	Installing efficient windows in homes with gas heating and central AC	0.21
5092	HVAC Shell	Infiltration reduction - 30%	MF	NLI	RETRO	-	-	29.948	0.040	0.073	-	-	3.576	13	$101.16	Air sealing (30% infiltration reduction) in homes with gas heating and central AC	2.98
5093	HVAC Shell	Infiltration reduction - 50%	MF	NLI	RETRO	-	-	50.891	0.071	0.130	-	-	5.984	13	$101.16	Air sealing (50% infiltration reduction) in homes with gas heating and central AC	5.04
5094	HVAC Shell	Basement Wall Insulation	MF	NLI	RETRO	-	-	-20.080	-0.019	-0.026	-	-	4.435	25	$581.78	Installing basement wall insulation in homes with unconditioned basements and gas heating and central AC	0.59
5095	HVAC Shell	Wall Insulation	MF	NLI	RETRO	-	-	46.189	0.032	0.039	-	-	6.507	25	$1,670.90	Installing wall insulation in homes with gas heating and central AC	0.42
5096	HVAC Shell	Roof Insulation	MF	NLI	RETRO	-	-	48.543	0.032	0.033	-	-	4.148	25	$638.11	Installing roof insulation in homes with gas heating and central AC	0.77
5097	HVAC Shell	Infiltration reduction - 30%	MF	NLI	RETRO	-	-	14.135	0.000	0.000	-	-	3.445	13	$101.16	Air sealing (30% infiltration reduction) in homes with gas heating and no central AC	2.26
5098	HVAC Shell	Infiltration reduction - 50%	MF	NLI	RETRO	-	-	23.375	0.000	0.000	-	-	5.766	13	$101.16	Air sealing (50% infiltration reduction) in homes with gas heating and no central AC	3.78
5099	HVAC Shell	Basement Wall Insulation	MF	NLI	RETRO	-	-	16.342	0.000	0.000	-	-	4.748	25	$581.78	Installing basement wall insulation in homes with unconditioned basements and gas heating and no central AC	0.78
5100	HVAC Shell	Wall Insulation	MF	NLI	RETRO	-	-	24.402	0.000	0.000	-	-	5.868	25	$1,670.90	Installing wall insulation in homes with gas heating and no central AC	0.34
5101	HVAC Shell	Roof Insulation	MF	NLI	RETRO	-	-	15.625	0.000	0.000	-	-	4.176	25	$638.11	Installing roof insulation in homes with gas heating and no central AC	0.62
5107	HVAC Shell	Infiltration reduction - 50%	MF	LI	DI	-	-	50.891	0.071	0.130	-	-	5.984	13	$101.16	Air sealing (50% infiltration reduction) in homes with gas heating and central AC	2.52
5108	HVAC Shell	Basement Wall Insulation	MF	LI	DI	-	-	-20.080	-0.019	-0.026	-	-	4.435	25	$581.78	Installing basement wall insulation in homes with unconditioned basements and gas heating and central AC	0.30
5109	HVAC Shell	Wall Insulation	MF	LI	DI	-	-	46.189	0.032	0.039	-	-	6.507	25	$1,670.90	Installing wall insulation in homes with gas heating and central AC	0.21
5110	HVAC Shell	Roof Insulation	MF	LI	DI	-	-	48.543	0.032	0.033	-	-	4.148	25	$638.11	Installing roof insulation in homes with gas heating and central AC	0.39
5111	HVAC Shell	Infiltration reduction - 50%	MF	LI	DI	-	-	23.375	0.000	0.000	-	-	5.766	13	$101.16	Air sealing (50% infiltration reduction) in homes with gas heating and no central AC	1.89
5112	HVAC Shell	Basement Wall Insulation	MF	LI	DI	-	-	16.342	0.000	0.000	-	-	4.748	25	$581.78	Installing basement wall insulation in homes with unconditioned basements and gas heating and no central AC	0.39
5113	HVAC Shell	Wall Insulation	MF	LI	DI	-	-	24.402	0.000	0.000	-	-	5.868	25	$1,670.90	Installing wall insulation in homes with gas heating and no central AC	0.17
5114	HVAC Shell	Roof Insulation	MF	LI	DI	-	-	15.625	0.000	0.000	-	-	4.176	25	$638.11	Installing roof insulation in homes with gas heating and no central AC	0.31
5119	HVAC Shell	Duct Insulation	MF	All	RETRO	-	-	40.888	0.064	0.069	-	-	2.426	20	$202.32	Adding duct insulation in homes with gas heating and central AC	1.72
5120	HVAC Shell	Duct location	MF	All	RETRO	-	-	81.138	0.127	0.153	-	-	4.888	30	$632.25	Moving ductwork from unconditioned space to conditioned space in homes with gas heating and central AC	1.32
5121	HVAC Shell	Duct sealing 15% leakage base	MF	All	RETRO	-	-	14.388	0.015	0.016	-	-	0.767	18	$181.94	Duct sealing (15% leakage reduction) in homes with gas heating and central AC	0.53
5122	HVAC Shell	Duct sealing 30% leakage base	MF	All	RETRO	-	-	39.214	0.040	0.044	-	-	2.048	18	$181.94	Duct sealing (30% leakage reduction) in homes with gas heating and central AC	1.43
5123	HVAC Shell	Door weatherstripping	MF	All	RETRO	-	-	9.188	0.003	0.004	-	-	0.213	5	$43.00	Installing door weatherstripping - savings estimate weighted across heating/cooling combinations	0.26
5125	HVAC Shell	Window Replacement	MF	All	RETRO	-	-	150.894	0.143	0.162	-	-	5.972	25	$542.00	Replacing inefficient windows at the end of useful life with efficient windows in homes with gas heating and central AC	1.81
5126	HVAC Shell	Original double hung window with low U storm	MF	All	RETRO	-	-	671.964	0.660	0.734	-	-	46.728	25	$1,896.75	Retrofitting inefficient windows with efficient alternatives in homes with gas heating and central AC	3.30
5127	HVAC Shell	Duct Insulation	MF	All	RETRO	-	-	0.352	0.000	0.000	-	-	2.426	20	$202.32	Adding duct insulation in homes with gas heating and no central AC	0.98
5128	HVAC Shell	Duct location	MF	All	RETRO	-	-	5.559	0.000	0.000	-	-	4.890	30	$632.25	Moving ductwork from unconditioned space to conditioned space in homes with gas heating and no central AC	0.77
5129	HVAC Shell	Duct sealing 15% leakage base	MF	All	RETRO	-	-	3.651	0.000	0.000	-	-	0.766	18	$181.94	Duct sealing (15% leakage reduction) in homes with gas heating and no central AC	0.34
5130	HVAC Shell	Duct sealing 30% leakage base	MF	All	RETRO	-	-	10.076	0.000	0.000	-	-	2.046	18	$181.94	Duct sealing (30% leakage reduction) in homes with gas heating and no central AC	0.92
5131	HVAC Shell	Window Film	MF	All	RETRO	-	-	-36.710	0.000	0.000	-	-	-8.685	10	$194.50	Installing window film on inefficient existing windows in homes with gas heating and no central AC	-2.46
5132	HVAC Shell	Window Replacement	MF	All	RETRO	-	-	23.313	0.000	0.000	-	-	5.725	25	$542.00	Replacing inefficient windows at the end of useful life with efficient windows in homes with gas heating and no central AC	1.01
5133	HVAC Shell	Original double hung window with low U storm	MF	All	RETRO	-	-	240.943	-0.011	-0.012	-	-	46.521	25	$1,896.75	Retrofitting inefficient windows with efficient alternatives in homes with gas heating and no central AC	2.37
5138	HVAC Shell	Window Film	MF	All	RETRO	-	-	-1098.453	0.399	0.419	-	-	0.000	10	$194.50	Installing window film on inefficient existing windows in homes with electric heating and central AC	-1.36
5141	HVAC Shell	Infiltration reduction - 30%	MF	All	NC	-	-	18.306	0.028	0.043	-	-	2.272	13	$101.16	Air sealing (30% infiltration reduction) in homes with gas heating and central AC	1.91
5142	HVAC Shell	Infiltration reduction - 50%	MF	All	NC	-	-	31.138	0.044	0.069	-	-	3.812	13	$101.16	Air sealing (50% infiltration reduction) in homes with gas heating and central AC	3.18
5143	HVAC Shell	Airtight Can Lights	MF	All	NC	-	-	13.859	0.021	0.033	-	-	1.756	15	$459.90	Installing air can lights to reduce infiltration in homes with gas heating and central AC	0.36
5144	HVAC Shell	Duct Insulation	MF	All	NC	-	-	51.471	0.074	0.081	-	-	2.140	20	$202.32	Adding duct insulation in homes with gas heating and central AC	1.74
5145	HVAC Shell	Duct location	MF	All	NC	-	-	83.190	0.127	0.152	-	-	3.581	30	$632.25	Moving ductwork from unconditioned space to conditioned space in homes with gas heating and central AC	1.12
5146	HVAC Shell	Duct sealing 15% leakage base	MF	All	NC	-	-	10.718	0.011	0.011	-	-	0.464	18	$181.94	Duct sealing (15% leakage reduction) in homes with gas heating and central AC	0.35
5147	HVAC Shell	Duct sealing 30% leakage base	MF	All	NC	-	-	29.127	0.031	0.033	-	-	1.244	18	$181.94	Duct sealing (30% leakage reduction) in homes with gas heating and central AC	0.95
5148	HVAC Shell	Door weatherstripping	MF	All	NC	-	-	5.380	0.003	0.003	-	-	0.244	5	$43.00	Installing door weatherstripping - savings estimate weighted across heating/cooling combinations	0.25

DTE (Michigan) **Measure Assumption Tab**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Savings	Useful Life	Measure Cost	Measure Description	UCT Ratio
5149	HVAC Shell	Basement Wall Insulation	MF	All	NC	-	-	-0.871	-0.011	-0.015	-	-	1.924	25	$581.78	Installing basement wall insulation in homes with unconditioned basements and gas heating and central AC	0.26
5150	HVAC Shell	Wall Insulation	MF	All	NC	-	-	13.630	0.012	0.014	-	-	2.116	25	$1,670.90	Installing wall insulation in homes with gas heating and central AC	0.14
5151	HVAC Shell	Roof Insulation	MF	All	NC	-	-	16.723	0.009	0.009	-	-	1.534	25	$638.11	Installing roof insulation in homes with gas heating and central AC	0.28
5154	HVAC Shell	Window Replacement	MF	All	NC	-	-	33.113	0.030	0.030	-	-	0.790	25	$2,878.72	Installing efficient windows in homes with gas heating and central AC	0.06
6004	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	SF	NLI	ROB	1216.000	-	536.032	0.000	0.000	87.3	-	21.805	15	$1,427.65	Installation of 94 AFUE furnace with electronically commutated motor - baseline is 80 AFUE furnace	1.38
6005	HVAC Equipment	High efficiency 98 AFUE furnace with ECM	SF	NLI	ROB	1216.000	-	536.032	0.000	0.000	87.3	-	29.062	15	$1,608.58	Installation of 98 AFUE furnace with electronically commutated motor - baseline is 80 AFUE furnace	1.54
6006	HVAC Equipment	O&M Tune-up - furnace only	SF	NLI	RETRO	0.000	-	0.000	0.000	0.000	87.3	-	6.492	3	$139.00	5% increase in furnace efficiency - in homes with gas furnaces	0.91
6007	HVAC Equipment	Boiler 95% plus AFUE	SF	NLI	ROB	0.000	-	-436.568	0.000	0.000	127.5	-	64.047	20	$2,436.00	Installing 95 AFUE boilers to replace standard boilers - in homes with gas boilers	1.97
6008	HVAC Equipment	Boiler 92% plus AFUE	SF	NLI	ROB	0.000	-	-436.568	0.000	0.000	127.5	-	58.181	20	$1,954.00	Installing 92 AFUE boilers to replace standard boilers - in homes with gas boilers	2.21
6009	HVAC Equipment	Boiler Tune-up	SF	NLI	RETRO	0.000	-	0.000	0.000	0.000	127.5	-	6.979	5	$139.00	Increasing boiler efficiency by 5% - in homes with gas boilers	1.52
6012	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	SF	LI	DI	1216.000	-	536.032	0.000	0.000	87.3	-	21.805	15	$1,427.65	Installation of 94 AFUE furnace with electronically commutated motor - baseline is 80 AFUE furnace	0.69
6013	HVAC Equipment	O&M Tune-up - furnace only	SF	LI	DI	0.000	-	0.000	0.000	0.000	87.3	-	6.492	3	$139.00	5% increase in furnace efficiency - in homes with gas furnaces	0.46
6014	HVAC Equipment	Boiler 92% plus AFUE	SF	LI	DI	0.000	-	-436.568	0.000	0.000	127.5	-	58.181	20	$1,954.00	Installing 92 AFUE boilers to replace standard boilers - in homes with gas boilers	1.10
6015	HVAC Equipment	Boiler Tune-up	SF	LI	DI	0.000	-	0.000	0.000	0.000	127.5	-	6.979	5	$139.00	Increasing boiler efficiency by 5% - in homes with gas boilers	0.76
6021	HVAC Equipment	DFHP - SEER 18 with 95 AFUE furnace - SEER 14 base	SF	All	ROB	6591.974	-	1460.671	0.544	0.544	87.3	-	2.874	15	$1,189.14	Installation of SEER 18/95 AFUE dual fuel heat pump in homes with electric heating/cooling - baseline is 14 SEER/80 AFUE DFHP	1.88
6022	HVAC Equipment	DFHP - SEER 21 with 95 AFUE furnace - SEER 14 base	SF	All	ROB	6591.974	-	2191.006	0.816	0.816	87.3	-	4.311	15	$2,125.65	Installation of SEER 21/95 AFUE dual fuel heat pump in homes with electric heating/cooling - baseline is 14 SEER/80 AFUE DFHP	1.57
6023	HVAC Equipment	Programmable Thermostats Tier 1	SF	All	RETRO	0.000	-	62.811	0.000	0.000	0.0	-	7.516	10	$42.72	Installation of Tier 1 programmable thermostat in homes with gas heating and central AC	10.16
6024	HVAC Equipment	Programmable Thermostats Tier 2	SF	All	RETRO	0.000	-	206.458	0.000	0.000	0.0	-	24.706	10	$161.72	Installation of Tier 2 programmable thermostat in homes with gas heating and central AC	8.83
6025	HVAC Equipment	Programmable Thermostats Tier 3	SF	All	RETRO	1239.623	0.090	111.566	0.000	0.000	87.3	-	7.522	10	$237.99	Installation of Tier 3 programmable thermostat in homes with gas heating and central AC	1.95
6026	HVAC Equipment	Programmable Thermostats Tier 1	SF	All	RETRO	0.000	-	0.000	0.000	0.000	0.0	-	6.857	10	$42.72	Installation of Tier 1 programmable thermostat in homes with gas heating and no AC	8.44
6027	HVAC Equipment	Programmable Thermostats Tier 2	SF	All	RETRO	0.000	-	0.000	0.000	0.000	0.0	-	22.539	10	$161.72	Installation of Tier 2 programmable thermostat in homes with gas heating and no AC	7.33
6028	HVAC Equipment	Programmable Thermostats Tier 3	SF	All	RETRO	0.000	#DIV/0!	0.000	0.000	0.000	87.3	-	7.653	10	$237.99	Installation of Tier 3 programmable thermostat in homes with gas heating and no AC	1.69
6032	HVAC Equipment	Smartphone Behavior Application	SF	All	RETRO	3166.555	0.011	33.249	0.000	0.000	83.0	1%	0.872	1	$5.00	Use of smartphone application to deliver behavioral savings	1.83
6033	HVAC Equipment	Smartphone Behavior Application	SF	All	RETRO			0.000	0.000	0.000	0.0	0%	0.000	1	$5.00	Use of smartphone application to deliver behavioral savings	0.00
6034	HVAC Equipment	Smartphone Behavior Application	SF	All	RETRO			0.000	0.000	0.000	0.0	0%	0.000	1	$5.00	Use of smartphone application to deliver behavioral savings	0.00
6037	HVAC Equipment	Hot water temperature reset	SF	All	RETRO	0.000	-	-3.653	0.000	0.000	127.5	-	7.596	15	$600.00	Retrofitting of existing boiler with temperature reset controls	0.87
6042	HVAC Equipment	DFHP - SEER 18 with 95 AFUE furnace - SEER 14 base	SF	All	NC	4877.719	-	1076.973	0.383	0.383	87.3	-	1.586	15	$1,189.14	Installation of SEER 18/95 AFUE dual fuel heat pump in homes with electric heating/cooling - baseline is 14 SEER/80 AFUE DFHP	1.33

DTE (Michigan) **Measure Assumption Tab**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Savings	Useful Life	Measure Cost	Measure Description	UCT Ratio
6043	HVAC Equipment	DFHP - SEER 21 with 95 AFUE furnace - SEER 14 base	SF	All	NC	4877.719	-	1615.460	0.575	0.575	87.3	-	2.378	15	$2,125.65	Installation of SEER 21/95 AFUE dual fuel heat pump in homes with electric heating/cooling - baseline is 14 SEER/80 AFUE DFHP	1.12
6047	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	SF	All	NC	1216.000	-	499.049	0.000	0.000	87.3	-	12.931	15	$1,427.65	Installation of 94 AFUE furnace with electronically commutated motor - baseline is 80 AFUE furnace	0.93
6048	HVAC Equipment	High efficiency 98 AFUE furnace with ECM	SF	All	NC	1216.000	-	499.049	0.000	0.000	87.3	-	17.235	15	$1,608.58	Installation of 98 AFUE furnace with electronically commutated motor - baseline is 80 AFUE furnace	1.01
6050	HVAC Equipment	Boiler 92% plus AFUE	SF	All	NC	0.000	-	-260.007	0.000	0.000	127.5	-	36.181	15	$1,954.00	Installing 92 AFUE boilers to replace standard boilers - in homes with gas boilers	1.17
6051	HVAC Equipment	Boiler 95% plus AFUE	SF	All	NC	0.000	-	-260.007	0.000	0.000	127.5	-	39.613	15	$2,436.00	Installing 95 AFUE boilers to replace standard boilers - in homes with gas boilers	1.04
6055	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	MF	NLI	ROB	1216.000	-	344.238	0.139	0.139	56.7	-	13.534	15	$1,427.65	Installation of 94 AFUE furnace with electronically commutated motor - baseline is 80 AFUE furnace	1.00
6056	HVAC Equipment	High efficiency 98 AFUE furnace with ECM	MF	NLI	ROB	1216.000	-	344.238	0.139	0.139	56.7	-	18.038	15	$1,608.58	Installation of 98 AFUE furnace with electronically commutated motor - baseline is 80 AFUE furnace	1.08
6057	HVAC Equipment	O&M Tune-up - furnace only	MF	NLI	RETRO	0.000	-	0.000	0.000	0.000	56.7	-	4.133	3	$139.00	5% increase in furnace efficiency - in homes with gas furnaces	0.58
6058	HVAC Equipment	Boiler 92% plus AFUE	MF	NLI	ROB	0.000	-	-672.477	0.000	0.000	82.9	-	39.496	20	$1,954.00	Installing 92 AFUE boilers to replace standard boilers - in homes with gas boilers	1.31
6059	HVAC Equipment	Boiler 95% plus AFUE	MF	NLI	ROB	0.000	-	-672.477	0.000	0.000	82.9	-	46.343	20	$2,436.00	Installing 95 AFUE boilers to replace standard boilers - in homes with gas boilers	1.28
6060	HVAC Equipment	Boiler Tune-up	MF	NLI	RETRO	0.000	-	0.000	0.000	0.000	82.9	-	8.556	5	$139.00	Increasing boiler efficiency by 5% - in homes with gas boilers	1.86
6063	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	MF	LI	DI	1216.000	-	344.238	0.139	0.139	56.7	-	13.534	15	$1,427.65	Installation of 94 AFUE furnace with electronically commutated motor - baseline is 80 AFUE furnace	0.50
6064	HVAC Equipment	O&M Tune-up - furnace only	MF	LI	DI	0.000	-	0.000	0.000	0.000	56.7	-	4.133	3	$139.00	5% increase in furnace efficiency - in homes with gas furnaces	0.29
6065	HVAC Equipment	Boiler 92% plus AFUE	MF	LI	DI	0.000	-	-672.477	0.000	0.000	82.9	-	39.496	20	$1,954.00	Installing 92 AFUE boilers to replace standard boilers - in homes with gas boilers	0.65
6066	HVAC Equipment	Boiler Tune-up	MF	LI	DI	0.000	-	0.000	0.000	0.000	82.9	-	8.556	5	$139.00	Increasing boiler efficiency by 5% - in homes with gas boilers	0.93
6072	HVAC Equipment	DFHP - SEER 18 with 95 AFUE furnace - SEER 14 base	MF	All	ROB	6466.164	-	1318.174	0.531	0.531	56.7	-	2.252	15	$1,189.14	Installation of SEER 18/95 AFUE dual fuel heat pump in homes with electric heating/cooling - baseline is 14 SEER/80 AFUE DFHP	1.72
6073	HVAC Equipment	DFHP - SEER 21 with 95 AFUE furnace - SEER 14 base	MF	All	ROB	6466.164	-	1977.260	0.796	0.796	56.7	-	3.378	15	$2,125.65	Installation of SEER 21/95 AFUE dual fuel heat pump in homes with electric heating/cooling - baseline is 14 SEER/80 AFUE DFHP	1.44
6074	HVAC Equipment	Programmable Thermostats Tier 1	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.0	0%	0.000	10	$50.00	Installation of Tier 1 programmable thermostat in homes with gas heating and central AC	0.00
6075	HVAC Equipment	Programmable Thermostats Tier 2	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.0	0%	0.000	10	$100.00	Installation of Tier 2 programmable thermostat in homes with gas heating and central AC	0.00
6076	HVAC Equipment	Programmable Thermostats Tier 3	MF	All	RETRO	471.631	0.067	31.599	0.000	0.000	56.7	-	2.130	10	$126.66	Installation of Tier 3 programmable thermostat in homes with gas heating and central AC	1.04
6077	HVAC Equipment	Programmable Thermostats Tier 1	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.0	0%	0.000	10	$50.00	Installation of Tier 1 programmable thermostat in homes with gas heating and no AC	0.00
6078	HVAC Equipment	Programmable Thermostats Tier 2	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.0	0%	0.000	10	$100.00	Installation of Tier 2 programmable thermostat in homes with gas heating and no AC	0.00
6079	HVAC Equipment	Programmable Thermostats Tier 3	MF	All	RETRO	0.000	-	0.000	0.000	0.000	56.7	-	2.168	10	$126.66	Installation of Tier 3 programmable thermostat in homes with gas heating and no AC	0.90
6080	HVAC Equipment	Programmable Thermostats Tier 1	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.0	0%	0.000	10	$50.00	Installation of Tier 1 programmable thermostat in homes with electric heating and central AC	0.00
6081	HVAC Equipment	Programmable Thermostats Tier 2	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.0	0%	0.000	10	$100.00	Installation of Tier 2 programmable thermostat in homes with electric heating and central AC	0.00
6083	HVAC Equipment	Smartphone Behavior Application	MF	All	RETRO	1583.278	0.011	16.624	0.000	0.000	41.5	1%	0.436	1	$5.00	Use of smartphone application to deliver behavioral savings	0.92
6084	HVAC Equipment	Smartphone Behavior Application	MF	All	RETRO			0.000	0.000	0.000	0.0	0%	0.000	1	$5.00	Use of smartphone application to deliver behavioral savings	0.00
6085	HVAC Equipment	Smartphone Behavior Application	MF	All	RETRO			0.000	0.000	0.000	0.0	0%	0.000	1	$5.00	Use of smartphone application to deliver behavioral savings	0.00
6091	HVAC Equipment	O2 Trim Control	MF	All	RETRO	0.000	-	0.000	0.000	0.000	82.9	-	2.185	15	$255.00	1.1% improvement in boiler efficiency resulting from the addition of oxygen trim controls - apartment buildings with boilers	0.59
6092	HVAC Equipment	Boiler 85% Ec	MF	All	RETRO	0.000	-	0.000	0.000	0.000	82.9	-	11.311	20	$7,232.27	5% increase in boiler efficiency - in apartments with gas boilers and no central AC	0.13
6093	HVAC Equipment	Boiler turndown control	MF	All	RETRO	0.000	-	-129.352	0.000	0.000	82.9	-	13.229	15	$195.00	Installing boiler turndown controls - in apartment buildings with boilers	4.12
6098	HVAC Equipment	DFHP - SEER 18 with 95 AFUE furnace - SEER 14 base	MF	All	NC	7236.621	-	1410.408	0.584	0.584	56.7	-	3.577	15	$1,189.14	Installation of SEER 18/95 AFUE dual fuel heat pump in homes with electric heating/cooling - baseline is 14 SEER/80 AFUE DFHP	1.93
6099	HVAC Equipment	DFHP - SEER 21 with 95 AFUE furnace - SEER 14 base	MF	All	NC	7236.621	-	2115.613	0.875	0.875	56.7	-	5.365	15	$2,125.65	Installation of SEER 21/95 AFUE dual fuel heat pump in homes with electric heating/cooling - baseline is 14 SEER/80 AFUE DFHP	1.62
6106	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	MF	All	NC	1216.000	-	248.338	0.144	0.144	56.7	-	11.432	15	$1,427.65	Installation of 94 AFUE furnace with electronically commutated motor - baseline is 80 AFUE furnace	0.85
6107	HVAC Equipment	High efficiency 98 AFUE furnace with ECM	MF	All	NC	1216.000	-	253.983	0.144	0.144	56.7	-	14.898	15	$1,608.58	Installation of 98 AFUE furnace with electronically commutated motor - baseline is 80 AFUE furnace	0.90
6109	HVAC Equipment	Boiler 92% plus AFUE	MF	All	NC	0.000	-	-560.533	0.000	0.000	82.9	-	32.978	20	$1,954.00	Installing 92 AFUE boilers to replace standard boilers - in homes with gas boilers	1.09
6110	HVAC Equipment	Boiler 95% plus AFUE	MF	All	NC	0.000	-	-560.560	0.000	0.000	82.9	-	38.545	20	$2,436.00	Installing 95 AFUE boilers to replace standard boilers - in homes with gas boilers	1.06
6111	HVAC Equipment	O2 Trim Control	MF	All	NC	0.000	-	0.000	0.000	0.000	82.9	-	1.629	15	$255.00	1.1% improvement in boiler efficiency resulting from the addition of oxygen trim controls - apartment buildings with boilers	0.44
6112	HVAC Equipment	Boiler 85% Ec	MF	All	NC	0.000	-	0.000	0.000	0.000	82.9	-	8.407	20	$7,232.27	5% increase in boiler efficiency - in apartments with gas boilers and no central AC	0.10
6113	HVAC Equipment	Boiler turndown control	MF	All	NC	0.000	-	-102.555	0.000	0.000	82.9	-	10.004	15	$195.00	Installing boiler turndown controls - in apartment buildings with boilers	3.09
8001	Cross-Cutting	Behavior Modification: Home Energy Reports	SF	All	RETRO	8226.000	0.020	164.520	0.019	0.019	107.5	1%	1.075	1	$6.77	Delivery of home energy reports	3.27
8002	Cross-Cutting	Behavior Modification: Home Energy Reports	SF	All	NC	8226.000	0.020	164.520	0.019	0.019	107.5	1%	1.075	1	$6.77	Delivery of home energy reports	3.27
8003	Cross-Cutting	Behavior Modification: Home Energy Reports	MF	All	RETRO	4113.000	0.020	82.260	0.009	0.009	53.7	1%	0.537	1	$6.77	Delivery of home energy reports	1.64
8004	Cross-Cutting	Behavior Modification: Home Energy Reports	MF	All	NC	4113.000	0.020	82.260	0.009	0.009	53.7	1%	0.537	1	$6.77	Delivery of home energy reports	1.64

The list of sources provided below indicates where key assumptions, algorithms, parameters, etc. were obtained to calculate measure level estimates of energy and demand savings, useful lives, measure cost, and baseline/efficient saturations. The key data sources are provided by residential end-use. Data sources are recorded by measure and can be produced if needed. A list of

End Use	Energy Savings	Demand Savings	EUL	Measure Cost	Base Saturation	EE Saturation
Appliances	**MEMD** Illinois TRM ENERGY STAR calculators GDS calculations	**MEMD** Illinois TRM ENERGY STAR calculators GDS calculations	**MEMD** Illinois TRM ENERGY STAR calculators	**MEMD** Illinois TRM ENERGY STAR calculators	**2013 RBS** **2013 RCASS** 2014 PA Baseline	**2013 RBS** 2014 PA Baseline GDS
Water Heating	**MEMD** GDS calculations	**MEMD** Vermont TRM	**MEMD** Illinois TRM	**MEMD** Illinois TRM	**2013 RBS** 2014 PA Baseline	**2013 RBS** 2014 PA Baseline GDS
HVAC Equipment	**MEMD**	**MEMD**	**MEMD**	**MEMD**	**2015 RCAS** **2013 RBS** **2013 RCASS** GDS	**2015 RCAS** **2013 RBS** **2013 RCASS** GDS
HVAC Shell	**MEMD**	**MEMD**	**MEMD**	**MEMD**	**2015 RCAS** **2013 RBS** **2013 RCASS** GDS	**2015 RCAS** **2013 RBS** **2013 RCASS** GDS
Cross-Cutting	**MEMD** GDS calculations	**MEMD** GDS calculations	**MEMD**	**MEMD**	**GDS**	**GDS**

List of Abbreviations
2013 RBS: DTE Energy Residential Baseline Study: First Quarter 2013
2013 RCASS: DTE Energy 2013 Residential Customer Appliance Saturation Survey
2014 PA Baseline: 2014 Pennsylvania Statewide Act 129 Residential Baseline Study
2015 RCAS: DTE Energy 2015 Residential Customer Appliance Survey

APPENDIX B | COMMERCIAL MEASURE DETAIL

Michigan Commercial Measure Database - Natural Gas

Measure Savings, Cost and Useful Life

DTE (Michigan)	Measure Assumption					
Measure Name	Annual MMBtu Savings	Cost Type: 1=Full 2=Inc.	Cost/Unit Descriptor	Cost/Unit	Effective Measure Life	Direct Utility Test
Water Heating						
Small High Efficiency Gas Water Heater	8.37	2	per heater	$393.33	13	1.3
Large High Efficiency Gas Water Heater	30.83	2	per heater	$1,135.00	13	1.7
Instant Gas Water Heater	60.20	2	per heater	$285.00	20	17.3
Indirect Gas Water Heater	0.18	2	per MBH input capacity	$14.09	15	0.9
Domestic Water Heater Tune-up	0.06	2	per MBH input capacity	$2.50	2	0.3
Low Flow Showerhead	2.20	1	per unit	$25.00	10	4.6
Low Flow Faucet Aerator	3.77	1	per unit	$2.50	10	79.3
Pipe wrap - DHW	0.21	1	per linear foot	$6.00	20	2.9
Pipe wrap - Boiler	0.80	1	per linear foot	$6.62	20	9.9
High Efficiency Pool Heater	0.24	1	per MBtu input capacity	$3.82	15	4.4
Pool Covers	0.09	1	per SF surface area	$7.30	10	0.6
Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	4.43	2	per heater	$400.70	7	0.4
Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	2.15	2	per MBH input capacity	$97.97	7	0.9
Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	2.27	2	per MBH input capacity	$102.03	7	0.9
ES Dishwasher, High Temp, Gas Heat, Elec Booster	29.83	2	per unit	$241.62	16	9.0
ES Dishwasher, High Temp, Gas Heat, Gas Booster	46.88	2	per unit	$622.89	16	5.5
ES Dishwasher, Low Temp, Gas Heat	52.80	2	per linear foot	$171.39	16	22.4
Tank Insulation (gas)	1.91	1	per linear foot	$2.22	15	59.5
Pre Rinse Sprayers (gas)	6.00	2	per MBtu input capacity	$35.00	5	5.2
Solar Water Heating w/gas auxiliary tank (SEF=1.5)	67.68	1	per SF surface area	$26,400.00	20	0.2
Refrigeration Waste Heat Recovery - DWH	9.47	1	Per Unit	$180.00	15	3.6
Wastewater, Filtration/Reclamation	1396.00	1	Per Unit	$150,000.00	20	0.8
O-zone Generator for Laundry	4.21	2	Per Unit	$75.73	10	2.9
Solar pool heater	94.69	2	Per Unit	$5,500.00	20	1.4
HVAC Condenser Heater Recovery Water Heating	14.05	2	Per Unit	$254.00	15	3.8
Process Cooling Condenser Heater Recovery Water Heating	22.65	2	per SF	$254.00	15	6.2
Energy Efficient Windows	11.41	2	100SF	$954.08	25	1.1
Ceiling Insulation	15.32	1	1000 sq ft roof area	$505.68	30	3.0
Wall Insulation	120.78	1	1000 sq ft wall area	$90.86	30	130.4
Roof Insulation	3.56	1	1000 sq ft	$348.95	30	1.0
Integrated Building Design	840.00	2	Per Building	$15,065.37	30	5.5
Building Operator Certification	156.40	2	per participant of 194,500 SF	$407.46	5	11.6
Duct Insulation	2.04	2	Per SF	$3.10	25	60.0
Window Improvements	3.16	1	100 sq ft glazing	$259.16	15	0.9
EMS install	1.39	1	1000 sq ft cond floor area	$1.19	15	81.1
EMS Optimization	3.38	1	1000 sq ft cond floor area	$12.77	20	21.7
HVAC Occupancy Sensors	5.33	2	1000 sq ft cond floor area	$284.83	15	1.3
Retrocommissioning	0.05	1	per sq ft	$0.30	7	6.0
Commissioning	0.04	1	per sq ft	$1.16	7	1.4
Programmable Thermostats	1.80	1	1000 sq ft cond floor area	$115.77	9	0.8
EMS Pump Scheduling Controls	15.03	2	per hp	$3.54	15	294.0
Web enabled EMS	45.71	2	1000 sq ft cond floor area	$136.56	15	23.2
Gas Furnace 92 AFUE	0.24	2	per kBtuh	$9.58	15	1.7
Gas Furnace 95 AFUE	0.30	2	per kBtuh	$9.58	15	2.2
Improved Duct Sealing - Heating	2.32	2	per ton	$107.91	18	1.7
Gas Unit Heater - Condensing (AFUE =93%)	64.94	2	per 200 kBtuh	$2,640.00	19	2.0
Infrared Heater	0.36	2	per kBtuh	$2.20	15	24.9
Boiler Tune-Up	0.03	2	per kBtuh	$0.83	2	0.5
Boiler Reset Controls	0.06	2	per kBtuh	$2.78	15	229.9
Boiler O2 Trim Controls	0.02	2	per kBtuh	$0.85	15	1.4
Repair/Replace malfunctioning steam traps	29.80	2	per unit	$168.00	5	5.4
Destratification Fans (HVLS)	8.35	2	1000 sq ft cond floor area	$362.25	15	1.6
Exhaust Hood Makeup Air	345.86	2	0.000	$5,900.00	20	6.3
Demand Controlled Ventilation	14.87	2	0.000	$75.00	15	13.7

Michigan Commercial Measure Database - Natural Gas

Measure Savings, Cost and Useful Life

DTE (Michigan)	Measure Assumption					
Measure Name	Annual MMBtu Savings	Cost Type: 1=Full 2=Inc.	Cost/Unit Descriptor	Cost/Unit	Effective Measure Life	Direct Utility Test
CKV Hood with Demand Control	0.04	2	cfm	$0.21	20	21.4
Engineered CKV hood	19.01	2	100 cfm red	$191.38	15	6.9
Guest Room Energy Management, Gas Heating	6.10	2	control	$250.00	8	1.9
Boiler Efficiency Improvement 80% to 88%	0.08	2	per kBtuh	$12.31	20	0.5
Condensing Boiler 90% Ec	0.13	2	per kBtuh	$24.62	20	0.5
Boiler turndown control	0.10	2	per kBtuh	$0.65	15	9.6
Boiler Economizer	0.04	2	per kBtuh	$4.50	15	0.6
Sensible ERV (Flat plate HX)	0.05	2	cfm	$2.86	15	0.7
Total ERV (Enthalpy Wheel)	0.06	2	cfm	$3.16	15	0.6
Boiler sequencing	0.05	2	per kBtuh	$21.67	15	0.2
Furnace Tune-Up	0.03	2	per kBtuh	$17.87	3	0.0
Linkageless and O2 Trim Controls	0.05	2	per kBtuh	$2.35	5	0.7
VAV System Conversion	26.88	1	1000 sq ft cond floor area	$604.24	20	3.6
High Efficiency Gas Griddle	14.90	2	per unit	$4,575.00	12	0.2
High Efficiency Gas Combination Oven	40.30	2	per unit	$21,797.00	12	0.1
High Efficiency Gas Convection Oven	30.60	2	per unit	$326.00	12	5.6
High Efficiency Gas Conveyer Oven	80.85	2	per unit	$3,241.00	12	1.5
High Efficiency Gas Rack Oven	157.35	2	per unit	$8,433.50	12	1.1
Power Burner Range	40.80	2	per unit	$1,400.00	7	1.2
High Efficiency Fryer	50.50	2	per unit	$1,477.00	12	2.0
High Efficiency Gas Steamer	205.90	2	per unit	$6,221.00	12	2.0
Large Vat Fryer	57.70	2	per unit	$3,122.00	12	1.1
Flexible Batch Broiler	129.95	2	per unit	$8,517.50	12	0.9

Michigan Commercial Measure Database - Natural Gas

Base Case Factor:

Is the fraction of the end use energy that is applicable for the efficient technology in a given market segment. For example, the forecasted natural gas sales level for a given end use (e.g., space heating) in a commercial or industrial industry type (e.g., office buildings or fabricated metals).

Measure Name	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other
Water Heating									
Small High Efficiency Gas Water Heater	18.7%	18.7%	18.7%	18.7%	15.5%	16.8%	18.7%	12.2%	18.7%
Large High Efficiency Gas Water Heater	37.5%	37.5%	37.5%	37.5%	31.1%	33.8%	37.5%	24.4%	37.5%
Instant Gas Water Heater	18.7%	18.7%	18.7%	18.7%	15.5%	16.8%	18.7%	12.2%	18.7%
Indirect Gas Water Heater	6.4%	6.4%	6.4%	6.4%	5.3%	5.8%	6.4%	4.2%	6.4%
Domestic Water Heater Tune-up	100.0%	100.0%	100.0%	100.0%	93.0%	90.0%	100.0%	65.0%	100.0%
Low Flow Showerhead	0.0%	0.0%	0.0%	0.0%	20.0%	2.0%	0.0%	33.0%	13.0%
Low Flow Faucet Aerator	60.0%	60.0%	5.0%	50.0%	5.0%	15.0%	5.0%	15.0%	26.0%
Pipe wrap - DHW	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Pipe wrap - Boiler	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%
High Efficiency Pool Heater	0.0%	0.0%	0.0%	0.0%	17.0%	10.0%	0.0%	35.0%	0.0%
Pool Covers	0.0%	0.0%	0.0%	0.0%	17.0%	8.0%	0.0%	35.0%	0.0%
Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	0.0%	0.0%	0.0%	0.0%	8.5%	4.0%	0.0%	0.0%	0.0%
Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	0.0%	0.0%	0.0%	0.0%	3.6%	1.7%	0.0%	0.0%	0.0%
Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	0.0%	0.0%	0.0%	0.0%	4.9%	2.3%	0.0%	0.0%	0.0%
ES Dishwasher, High Temp, Gas Heat, Elec Booster	0.0%	0.0%	2.2%	0.0%	2.2%	2.2%	2.2%	2.2%	0.0%
ES Dishwasher, High Temp, Gas Heat, Gas Booster	0.0%	0.0%	3.6%	0.0%	3.6%	3.6%	3.6%	3.6%	0.0%
ES Dishwasher, Low Temp, Gas Heat	0.0%	0.0%	3.1%	0.0%	3.1%	3.1%	3.1%	3.1%	0.0%
Tank Insulation (gas)	56.2%	56.2%	56.2%	56.2%	46.6%	50.6%	56.2%	36.5%	56.2%
Pre Rinse Sprayers (gas)	0.0%	0.0%	10.0%	0.0%	2.0%	2.0%	15.4%	2.0%	0.0%
Solar Water Heating w/gas auxiliary tank (SEF=1.5)	18.7%	18.7%	18.7%	18.7%	15.5%	16.8%	18.7%	12.2%	18.7%
Refrigeration Waste Heat Recovery - DWH	15.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wastewater, Filtration/Reclamation	0.0%	0.0%	0.0%	0.0%	16.7%	8.3%	0.0%	0.0%	8.3%
O-zone Generator for Laundry	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%
Solar pool heater	0.0%	0.0%	0.0%	0.0%	17.0%	10.0%	0.0%	0.0%	0.0%
HVAC Condenser Heater Recovery Water Heating	2.0%	0.0%	0.0%	2.0%	20.0%	2.0%	50.0%	33.0%	13.0%
Process Cooling Condenser Heater Recovery Water Heating	2.0%	0.0%	0.0%	2.0%	20.0%	2.0%	50.0%	33.0%	13.0%
Energy Efficient Windows	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Ceiling Insulation	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Wall Insulation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Roof Insulation	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Integrated Building Design	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Building Operator Certification	19.2%	19.2%	19.2%	19.2%	19.2%	19.2%	19.2%	19.2%	19.2%
Duct Insulation	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%
Window Improvements	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
EMS install	36.0%	36.0%	36.0%	36.0%	36.0%	36.0%	36.0%	36.0%	36.0%
EMS Optimization	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%
HVAC Occupancy Sensors	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Retrocommissioning	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%
Commissioning	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%
Programmable Thermostats	14.0%	23.5%	60.9%	22.6%	5.9%	5.0%	59.6%	12.2%	19.9%
EMS Pump Scheduling Controls	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
Web enabled EMS	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%
Gas Furnace 92 AFUE	17.5%	19.0%	18.5%	18.5%	9.0%	17.5%	18.5%	17.5%	18.5%
Gas Furnace 95 AFUE	17.5%	19.0%	18.5%	18.5%	9.0%	17.5%	18.5%	17.5%	18.5%
Improved Duct Sealing - Heating	35.0%	38.0%	37.0%	37.0%	18.0%	35.0%	37.0%	35.0%	37.0%
Gas Unit Heater - Condensing (AFUE =93%)	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%

Michigan Commercial Measure Database - Natural Gas

Base Case Factor:

Is the fraction of the end use energy that is applicable for the efficient technology in a given market segment. For example, the forecasted natural gas sales level for a given end use (e.g., space heating) in a commercial or industrial industry type (e.g., office buildings or fabricated metals).

Measure Name	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other
Infrared Heater	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Boiler Tune-Up	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%
Boiler Reset Controls	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%
Boiler O2 Trim Controls	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Repair/Replace malfunctioning steam traps	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%
Destratification Fans (HVLS)	100.0%	75.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exhaust Hood Makeup Air	3.0%	0.0%	1.0%	1.0%	20.0%	3.0%	1.0%	3.0%	1.0%
Demand Controlled Ventilation	0.0%	100.0%	100.0%	10.0%	10.0%	0.0%	0.0%	100.0%	10.0%
CKV Hood with Demand Control	1.5%	0.0%	0.5%	0.5%	10.0%	1.5%	0.5%	1.5%	0.5%
Engineered CKV hood	1.5%	0.0%	0.5%	0.5%	10.0%	1.5%	0.5%	1.5%	0.5%
Guest Room Energy Management, Gas Heating	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Boiler Efficiency Improvement 80% to 88%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%
Condensing Boiler 90% Ec	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%
Boiler turndown control	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%
Boiler Economizer	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Sensible ERV (Flat plate HX)	0.0%	0.0%	3.0%	0.0%	1.0%	1.0%	20.0%	3.0%	1.0%
Total ERV (Enthalpy Wheel)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Boiler sequencing	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Furnace Tune-Up	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%
Linkageless and O2 Trim Controls	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
VAV System Conversion	0.0%	0.0%	0.0%	5.0%	0.0%	0.0%	0.0%	5.0%	0.0%
High Efficiency Gas Griddle	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%
High Efficiency Gas Combination Oven	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%
High Efficiency Gas Convection Oven	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
High Efficiency Gas Conveyer Oven	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%
High Efficiency Gas Rack Oven	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%
Power Burner Range	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
High Efficiency Fryer	14.0%	14.0%	14.0%	14.0%	14.0%	14.0%	14.0%	14.0%	14.0%
High Efficiency Gas Steamer	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%
Large Vat Fryer	14.0%	14.0%	14.0%	14.0%	14.0%	14.0%	14.0%	14.0%	14.0%
Flexible Batch Broiler	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%

Michigan Commercial Measure Database - Natural Gas

Savings Factor:
Is the percentage reduction in gas consumption resulting from application of the efficient technology.

Measure Name	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other
Water Heating									
Small High Efficiency Gas Water Heater	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%
Large High Efficiency Gas Water Heater	14.9%	14.9%	14.9%	14.9%	14.9%	14.9%	14.9%	14.9%	14.9%
Instant Gas Water Heater	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%
Indirect Gas Water Heater	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%
Domestic Water Heater Tune-up	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
Low Flow Showerhead	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
Low Flow Faucet Aerator	65.9%	65.9%	65.9%	65.9%	65.9%	65.9%	65.9%	65.9%	65.9%
Pipe wrap - DHW	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
Pipe wrap - Boiler	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
High Efficiency Pool Heater	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%
Pool Covers	23.1%	23.1%	23.1%	23.1%	23.1%	23.1%	23.1%	23.1%	23.1%
Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	26.9%	26.9%	26.9%	26.9%	26.9%	26.9%	26.9%	26.9%	26.9%
Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	31.7%	31.7%	31.7%	31.7%	31.7%	31.7%	31.7%	31.7%	31.7%
Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	23.6%	23.6%	23.6%	23.6%	23.6%	23.6%	23.6%	23.6%	23.6%
ES Dishwasher, High Temp, Gas Heat, Elec Booster	33.2%	33.2%	33.2%	33.2%	33.2%	33.2%	33.2%	33.2%	33.2%
ES Dishwasher, High Temp, Gas Heat, Gas Booster	33.2%	33.2%	33.2%	33.2%	33.2%	33.2%	33.2%	33.2%	33.2%
ES Dishwasher, Low Temp, Gas Heat	43.2%	43.2%	43.2%	43.2%	43.2%	43.2%	43.2%	43.2%	43.2%
Tank Insulation (gas)	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%
Pre Rinse Sprayers (gas)	32.3%	32.3%	32.3%	32.3%	32.3%	32.3%	32.3%	32.3%	32.3%
Solar Water Heating w/gas auxiliary tank (SEF=1.5)	60.7%	60.7%	60.7%	60.7%	60.7%	60.7%	60.7%	60.7%	60.7%
Refrigeration Waste Heat Recovery - DWH	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%
Wastewater, Filtration/Reclamation	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
O-zone Generator for Laundry	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%
Solar pool heater	55.0%	55.0%	55.0%	55.0%	55.0%	55.0%	55.0%	55.0%	55.0%
HVAC Condenser Heater Recovery Water Heating	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%
Process Cooling Condenser Heater Recovery Water Heating	12.8%	12.8%	12.8%	12.8%	12.8%	12.8%	12.8%	12.8%	12.8%
Energy Efficient Windows	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%
Ceiling Insulation	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Wall Insulation	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%
Roof Insulation	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Integrated Building Design	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
Building Operator Certification	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
Duct Insulation	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Window Improvements	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%
EMS install	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
EMS Optimization	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
HVAC Occupancy Sensors	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
Retrocommissioning	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%
Commissioning	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%
Programmable Thermostats	19.2%	19.2%	19.2%	19.2%	19.2%	19.2%	19.2%	19.2%	19.2%
EMS Pump Scheduling Controls	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%
Web enabled EMS	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Gas Furnace 92 AFUE	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Gas Furnace 95 AFUE	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%
Improved Duct Sealing - Heating	14.6%	14.6%	14.6%	14.6%	14.6%	14.6%	14.6%	14.6%	14.6%
Gas Unit Heater - Condensing (AFUE =93%)	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%
Infrared Heater	30.1%	30.1%	30.1%	30.1%	30.1%	30.1%	30.1%	30.1%	30.1%
Boiler Tune-Up	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Boiler Reset Controls	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Boiler O2 Trim Controls	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%

Michigan Commercial Measure Database - Natural Gas

Savings Factor:
Is the percentage reduction in gas consumption resulting from application of the efficient technology.

Measure Name	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other
Repair/Replace malfunctioning steam traps	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Destratification Fans (HVLS)	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%
Exhaust Hood Makeup Air	57.0%	57.0%	57.0%	57.0%	57.0%	57.0%	57.0%	57.0%	57.0%
Demand Controlled Ventilation	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%
CKV Hood with Demand Control	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%
Engineered CKV hood	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%
Guest Room Energy Management, Gas Heating	21.2%	21.2%	21.2%	21.2%	21.2%	21.2%	21.2%	21.2%	21.2%
Boiler Efficiency Improvement 80% to 88%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Condensing Boiler 90% Ec	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Boiler turndown control	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Boiler Economizer	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%
Sensible ERV (Flat plate HX)	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Total ERV (Enthalpy Wheel)	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Boiler sequencing	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
Furnace Tune-Up	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Linkageless and O2 Trim Controls	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
VAV System Conversion	22.7%	22.7%	22.7%	22.7%	22.7%	22.7%	22.7%	22.7%	22.7%
High Efficiency Gas Griddle	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%
High Efficiency Gas Combination Oven	26.3%	26.3%	26.3%	26.3%	26.3%	26.3%	26.3%	26.3%	26.3%
High Efficiency Gas Convection Oven	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%
High Efficiency Gas Conveyer Oven	28.9%	28.9%	28.9%	28.9%	28.9%	28.9%	28.9%	28.9%	28.9%
High Efficiency Gas Rack Oven	37.3%	37.3%	37.3%	37.3%	37.3%	37.3%	37.3%	37.3%	37.3%
Power Burner Range	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%
High Efficiency Fryer	31.0%	31.0%	31.0%	31.0%	31.0%	31.0%	31.0%	31.0%	31.0%
High Efficiency Gas Steamer	76.1%	76.1%	76.1%	76.1%	76.1%	76.1%	76.1%	76.1%	76.1%
Large Vat Fryer	33.6%	33.6%	33.6%	33.6%	33.6%	33.6%	33.6%	33.6%	33.6%
Flexible Batch Broiler	26.1%	26.1%	26.1%	26.1%	26.1%	26.1%	26.1%	26.1%	26.1%

Michigan Commercial Measure Database - Natural Gas

Remaining Factor:

Is the fraction of applicable MMBtu sales associated with equipment not yet converted to the natural gas energy efficiency measure; that is, one minus the fraction of the industry type with energy efficiency measures already installed.

Measure Name	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other
Water Heating									
Small High Efficiency Gas Water Heater	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%
Large High Efficiency Gas Water Heater	96.2%	96.2%	96.2%	96.2%	96.2%	96.2%	96.2%	96.2%	96.2%
Instant Gas Water Heater	96.2%	96.2%	96.2%	96.2%	96.2%	96.2%	96.2%	96.2%	96.2%
Indirect Gas Water Heater	58.0%	58.0%	58.0%	58.0%	58.0%	58.0%	58.0%	58.0%	58.0%
Domestic Water Heater Tune-up	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%
Low Flow Showerhead	91.6%	100.0%	100.0%	62.8%	55.6%	82.0%	100.0%	83.2%	100.0%
Low Flow Faucet Aerator	98.8%	84.4%	94.0%	68.8%	72.4%	62.8%	90.4%	81.4%	74.8%
Pipe wrap - DHW	75.5%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%
Pipe wrap - Boiler	19.0%	19.0%	19.0%	19.0%	41.0%	19.0%	19.0%	19.0%	19.0%
High Efficiency Pool Heater	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%
Pool Covers	89.0%	89.0%	89.0%	89.0%	89.0%	89.0%	89.0%	89.0%	89.0%
Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%
Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%
Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%	80.3%
ES Dishwasher, High Temp, Gas Heat, Elec Booster	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%
ES Dishwasher, High Temp, Gas Heat, Gas Booster	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%
ES Dishwasher, Low Temp, Gas Heat	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%
Tank Insulation (gas)	89.0%	89.0%	89.0%	89.0%	89.0%	89.0%	89.0%	89.0%	89.0%
Pre Rinse Sprayers (gas)	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Solar Water Heating w/gas auxiliary tank (SEF=1.5)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Refrigeration Waste Heat Recovery - DWH	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%
Wastewater, Filtration/Reclamation	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%
O-zone Generator for Laundry	92.7%	92.7%	92.7%	92.7%	92.7%	92.7%	92.7%	92.7%	92.7%
Solar pool heater	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
HVAC Condenser Heater Recovery Water Heating	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%
Process Cooling Condenser Heater Recovery Water Heating	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%
Energy Efficient Windows	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%
Ceiling Insulation	53.8%	28.0%	54.0%	47.0%	23.0%	33.0%	31.0%	39.0%	51.0%
Wall Insulation	40.0%	40.0%	47.0%	42.0%	16.0%	56.0%	44.0%	24.0%	40.0%
Roof Insulation	10.0%	60.0%	10.0%	30.0%	30.0%	30.0%	60.0%	50.0%	60.0%
Integrated Building Design	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Building Operator Certification	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Duct Insulation	0.0%	56.0%	0.0%	56.0%	56.0%	56.0%	56.0%	56.0%	56.0%
Window Improvements	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%
EMS install	72.0%	92.1%	51.0%	90.0%	92.9%	85.2%	100.0%	86.0%	100.0%
EMS Optimization	28.0%	7.9%	49.0%	10.0%	7.1%	14.8%	0.0%	14.0%	0.0%
HVAC Occupancy Sensors	72.0%	92.1%	51.0%	90.0%	92.9%	85.2%	100.0%	86.0%	100.0%
Retrocommissioning	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Commissioning	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Programmable Thermostats	57.0%	11.9%	20.0%	65.0%	78.8%	33.0%	14.0%	62.5%	3.6%
EMS Pump Scheduling Controls	62.0%	62.0%	62.0%	62.0%	62.0%	62.0%	62.0%	62.0%	62.0%
Web enabled EMS	72.0%	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%
Gas Furnace 92 AFUE	72.0%	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%
Gas Furnace 95 AFUE	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
Improved Duct Sealing - Heating	0.0%	60.0%	0.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%
Gas Unit Heater - Condensing (AFUE =93%)	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
Infrared Heater	51.0%	51.0%	51.0%	51.0%	51.0%	51.0%	51.0%	51.0%	51.0%
Boiler Tune-Up	74.0%	74.0%	74.0%	74.0%	74.0%	74.0%	74.0%	74.0%	74.0%

Michigan Commercial Measure Database - Natural Gas

Remaining Factor:

Is the fraction of applicable MMBtu sales associated with equipment not yet converted to the natural gas energy efficiency measure; that is, one minus the fraction of the industry type with energy efficiency measures already installed.

Measure Name	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other
Boiler Reset Controls	55.0%	55.0%	55.0%	55.0%	55.0%	55.0%	55.0%	55.0%	55.0%
Boiler O2 Trim Controls	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Repair/Replace malfunctioning steam traps	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
Destratification Fans (HVLS)	93.0%	93.0%	93.0%	93.0%	93.0%	93.0%	93.0%	93.0%	93.0%
Exhaust Hood Makeup Air	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%
Demand Controlled Ventilation	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%
CKV Hood with Demand Control	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%
Engineered CKV hood	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%
Guest Room Energy Management, Gas Heating	0.0%	0.0%	0.0%	0.0%	78.8%	0.0%	0.0%	0.0%	0.0%
Boiler Efficiency Improvement 80% to 88%	66.0%	66.0%	66.0%	66.0%	66.0%	66.0%	66.0%	66.0%	66.0%
Condensing Boiler 90% Ec	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%
Boiler turndown control	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%
Boiler Economizer	87.0%	87.0%	87.0%	87.0%	87.0%	87.0%	87.0%	87.0%	87.0%
Sensible ERV (Flat plate HX)	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%
Total ERV (Enthalpy Wheel)	98.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Boiler sequencing	83.0%	83.0%	83.0%	83.0%	83.0%	83.0%	83.0%	83.0%	83.0%
Furnace Tune-Up	74.0%	74.0%	74.0%	74.0%	74.0%	74.0%	74.0%	74.0%	74.0%
Linkageless and O2 Trim Controls	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
VAV System Conversion	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
High Efficiency Gas Griddle	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Gas Combination Oven	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Gas Convection Oven	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Gas Conveyer Oven	83.3%	83.3%	83.3%	83.3%	83.3%	83.3%	83.3%	83.3%	83.3%
High Efficiency Gas Rack Oven	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Power Burner Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Fryer	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%
High Efficiency Gas Steamer	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Large Vat Fryer	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%
Flexible Batch Broiler	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Michigan Commercial Measure Database - Natural Gas

Convertible Factor:
Is the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install a heat recovery water heater at all sites.)

Measure Name	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other
Water Heating									
Small High Efficiency Gas Water Heater	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Large High Efficiency Gas Water Heater	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Instant Gas Water Heater	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%
Indirect Gas Water Heater	56.0%	56.0%	56.0%	56.0%	56.0%	56.0%	56.0%	56.0%	56.0%
Domestic Water Heater Tune-up	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Low Flow Showerhead	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
Low Flow Faucet Aerator	90.0%	90.0%	25.0%	90.0%	50.0%	25.0%	25.0%	50.0%	75.0%
Pipe wrap - DHW	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Pipe wrap - Boiler	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Pool Heater	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Pool Covers	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
ES Dishwasher, High Temp, Gas Heat, Elec Booster	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%
ES Dishwasher, High Temp, Gas Heat, Gas Booster	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%
ES Dishwasher, Low Temp, Gas Heat	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%
Tank Insulation (gas)	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%
Pre Rinse Sprayers (gas)	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
Solar Water Heating w/gas auxiliary tank (SEF=1.5)	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%
Refrigeration Waste Heat Recovery - DWH	10.0%	0.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wastewater, Filtration/Reclamation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
O-zone Generator for Laundry	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Solar pool heater	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%	34.0%
HVAC Condenser Heater Recovery Water Heating	10.0%	5.0%	80.0%	10.0%	20.0%	80.0%	80.0%	15.0%	5.0%
Process Cooling Condenser Heater Recovery Water Heating	10.0%	5.0%	80.0%	10.0%	20.0%	80.0%	80.0%	15.0%	5.0%
Energy Efficient Windows	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%
Ceiling Insulation	69.0%	48.0%	50.0%	54.0%	87.0%	78.0%	86.0%	74.0%	57.0%
Wall Insulation	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%
Roof Insulation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Integrated Building Design	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Building Operator Certification	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Duct Insulation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Window Improvements	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
EMS install	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
EMS Optimization	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
HVAC Occupancy Sensors	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Retrocommissioning	54.0%	54.0%	54.0%	54.0%	54.0%	54.0%	54.0%	54.0%	54.0%
Commissioning	71.0%	71.0%	71.0%	71.0%	71.0%	71.0%	71.0%	71.0%	71.0%
Programmable Thermostats	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
EMS Pump Scheduling Controls	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Web enabled EMS	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Gas Furnace 92 AFUE	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Gas Furnace 95 AFUE	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Improved Duct Sealing - Heating	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Gas Unit Heater - Condensing (AFUE =93%)	100.0%	0.0%	65.0%	0.0%	0.0%	0.0%	0.0%	0.0%	35.0%
Infrared Heater	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Boiler Tune-Up	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Michigan Commercial Measure Database - Natural Gas

Convertible Factor:
Is the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install a heat recovery water heater at all sites.)

Measure Name	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other
Boiler Reset Controls	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%
Boiler O2 Trim Controls	100.0%	0.0%	65.0%	0.0%	0.0%	0.0%	0.0%	0.0%	35.0%
Repair/Replace malfunctioning steam traps	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Destratification Fans (HVLS)	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
Exhaust Hood Makeup Air	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Demand Controlled Ventilation	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%
CKV Hood with Demand Control	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Engineered CKV hood	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%
Guest Room Energy Management, Gas Heating	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
Boiler Efficiency Improvement 80% to 88%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Condensing Boiler 90% Ec	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Boiler turndown control	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Boiler Economizer	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%
Sensible ERV (Flat plate HX)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Total ERV (Enthalpy Wheel)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Boiler sequencing	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Furnace Tune-Up	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Linkageless and O2 Trim Controls	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%
VAV System Conversion	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Gas Griddle	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%
High Efficiency Gas Combination Oven	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Gas Convection Oven	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Gas Conveyer Oven	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Gas Rack Oven	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Power Burner Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Fryer	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
High Efficiency Gas Steamer	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Large Vat Fryer	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Flexible Batch Broiler	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Michigan Commercial Measure Database - Natural Gas

Natural Gas Measure Sources

Source Number	Source
1	Michigan Master Database of Deemed Savings - 2013 - Non-Weather Sensitive Commercial
2	Michigan Master Database of Deemed Savings - 2013 - Weather Sensitive Commercial
3	MEMD Workpaper
3	ENERGY STAR Qualified Office Equipment Calculator
4	Efficiency Vermont TRM User Manual No. 2014-87
5	Drain Water Heat Recovery Characterization and Modeling - Final Report, C. Zaloum, M. Lafrance, J Gusdorf, 2007
6	California Energy Commission Codes and Standards Enhancement (CASE) Initative: Analysis of Standards Options for Residential Swimming Pool & Portable Spa Equipment, July 2013
7	Mid-Atlantic TRM Version 4.0 June 2014
8	DC DDOE Natural Gas Efficiency Potential, Dec 2012 Completed by GDS Associates, Inc.
9	Previous GDS Studies
10	Building Commissioning - A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions. Lawrence Berkeley National Laboratory. Report Prepared for: California Energy Commission Public Interest Energy Research (PIER) - July 21, 2009
11	DTE Energy 2013 Commercial Baseline Study - < 1% Saturation of process heat recovery
12	DTE Energy 2013 Commercial Baseline Study - 45% of respondents have HW Temp Reset Controls
13	DTE Energy 2013 Commercial Baseline Study - 62% of respondent combination customers are always on
14	DTE Energy 2013 Commercial Baseline Study - Table 3-12, installations multiplied by 1.2 to account for Some instead of All and gas having higher breakout in customer type
15	DTE Energy 2013 Commercial Baseline Study -11% of respondent combination customers have external tank insulation
16	DTE Energy 2013 Commercial Baseline Study -19% uninsulated boiler pipes overall with a noted 41% opportunity in lodging
17	DTE Energy 2013 Commercial Baseline Study -25% of respondent combination customers have insulated pipes weighted by input capacity
18	DTE Energy 2013 Commercial Baseline Study 39% of windows single pane
19	DTE Energy 2013 Commercial Baseline Study average roof values in comparison to baseline MEMD WX
20	DTE Energy 2013 Commercial Baseline Study Table 3-18, 1/3 of fryers are high efficiency
21	DTE Energy 2013 Commercial Baseline Study Table 3-40, EMS
22	DTE Energy 2013 Commercial Baseline Study Table 3-40, Manual thermostat or Manual ON/OFF
23	DTE Energy 2013 Commercial Baseline Study Table 3-40, Manual thermostat or Manual ON/OFF for Lodging
24	DTE Energy 2013 Commercial Baseline Study Table 3-40, Without EMS
25	DTE Energy 2013 Commercial Baseline Study, 1/3 of fryers are high efficiency
26	DTE Energy 2013 Commercial Baseline Study, 56% uninsulated ducts; Measure applicability from MEMD WX
27	DTE Energy 2013 Commercial Baseline Study, 8% of boilers are condensing
28	DTE Energy 2013 Commercial Baseline Study, Hot Water Boilers < than .88 weighted
29	DTE Energy 2013 Commercial Baseline Study, HVAC systems with economizers from respondents with larger weighted 67% and smaller weighted at 33%
30	DTE Energy 2013 Commercial Baseline Study, Table 3-2 26% have performed maintenace in last year
31	DTE Energy 2013 Commercial Baseline Study, Table 3-2 9 of 9% have performed maintenance in last year
32	DTE Energy 2013 Commercial Baseline Study, Water Heater Age > 10 years 38%
33	EIA, 2003 CBECS, New England, Non Mall saturation, square footage
34	GDS Associates Estimate/Calculation
35	GDS SURVEY
36	GDS Survey; Measure applicability from MEMD WX
37	Independent Assessment of Conservation and Energy Efficiency Potential for Connecticut and the Southwest Connecticut Region, GDS Associates, June 2004
38	Michigan Baseline 2011: Commercial Baseline Report
39	NYSERDA Natural Gas Potential Study
40	GDS Estimate including Water Heating, DHW Generation and Storage Equipment

Michigan Commercial Measure Database - Natural Gas

Measure Savings, Cost and Useful Life, Savings Factor, Remaining Factor Sources

Reference numbers designate source for information from Natural Gas Measure Source List

Measure Name	Annual kWh Savings	Cost/ Unit	Effective Measure Life	Savings Factor	Remaining Factor
Water Heating					
Small High Efficiency Gas Water Heater	1	1	1	3	32
Large High Efficiency Gas Water Heater	1	1	1	3	38
Instant Gas Water Heater	1	1	1	3	38
Indirect Gas Water Heater	1	1	1	3	34
Domestic Water Heater Tune-up	1	1	1	3	31
Low Flow Showerhead	1	1	1	3	14
Low Flow Faucet Aerator	1	1	1	3	14
Pipe wrap - DHW	1	1	1	3	17
Pipe wrap - Boiler	1	1	1	3	16
High Efficiency Pool Heater	1	1	1	3	34
Pool Covers	1	1	1	3	34
Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	1	1	1	3	38
Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	1	1	1	3	38
Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	1	1	1	3	38
ES Dishwasher, High Temp, Gas Heat, Elec Booster	1	1	1	3	38
ES Dishwasher, High Temp, Gas Heat, Gas Booster	1	1	1	3	38
ES Dishwasher, Low Temp, Gas Heat	1	1	1	3	38
Tank Insulation (gas)	1	1	1	1	15
Pre Rinse Sprayers (gas)	1	1	1	1	35
Solar Water Heating w/gas auxiliary tank (SEF=1.5)	8	8	8	8	40
Refrigeration Waste Heat Recovery - DWH	1	1	1	1	11
Wastewater, Filtration/Reclamation	8	8	8	8	34
O-zone Generator for Laundry	1	1	1	1	38
Solar pool heater	9	9	9	9	34
HVAC Condenser Heater Recovery Water Heating	1	1	1	1	11
Process Cooling Condenser Heater Recovery Water Heating	1	1	1	1	11
Energy Efficient Windows	2	2	2	2	18
Ceiling Insulation	2	2	2	2	38
Wall Insulation	2	2	2	2	38
Roof Insulation	2	2	2	2	19
Integrated Building Design	9	9	9	9	38
Building Operator Certification	1	1	1	1	34
Duct Insulation	1	1	1	1	26
Window Improvements	2	2	2	2	18
EMS install	2	2	2	2	24

Michigan Commercial Measure Database - Natural Gas

Measure Savings, Cost and Useful Life, Savings Factor, Remaining Factor Sources

Reference numbers designate source for information from Natural Gas Measure Source List

Measure Name	Annual kWh Savings	Cost/ Unit	Effective Measure Life	Savings Factor	Remaining Factor
EMS Optimization	2	2	2	2	21
HVAC Occupancy Sensors	2	2	2	2	24
Retrocommissioning	9	10	9	9	35
Commissioning	9	10	9	9	33
Programmable Thermostats	2	2	2	2	22
EMS Pump Scheduling Controls	2	2	2	2	13
Web enabled EMS	2	2	2	2	24
Gas Furnace 92 AFUE	2	2	2	2	35
Gas Furnace 95 AFUE	2	2	2	2	34
Improved Duct Sealing - Heating	2	2	2	2	36
Gas Unit Heater - Condensing (AFUE =93%)	9	9	9	9	37
Infrared Heater	2	2	2	2	34
Boiler Tune-Up	2	2	2	2	30
Boiler Reset Controls	2	2	2	2	12
Boiler O2 Trim Controls	2	2	2	2	34
Repair/Replace malfunctioning steam traps	1	1	1	1	34
Destratification Fans (HVLS)	2	2	2	2	34
Exhaust Hood Makeup Air	9	9	9	9	38
Demand Controlled Ventilation	9	9	9	2	38
CKV Hood with Demand Control	2	2	2	2	34
Engineered CKV hood	2	2	2	2	34
Guest Room Energy Management, Gas Heating	2	2	2	2	23
Boiler Efficiency Improvement 80% to 88%	2	2	2	2	28
Condensing Boiler 90% Ec	2	2	2	2	27
Boiler turndown control	2	2	2	2	38
Boiler Economizer	2	2	2	2	29
Sensible ERV (Flat plate HX)	2	2	2	2	38
Total ERV (Enthalpy Wheel)	2	2	2	2	34
Boiler sequencing	2	2	2	2	38
Furnace Tune-Up	2	2	2	2	34
Linkageless and O2 Trim Controls	2	2	2	2	39
VAV System Conversion	2	2	2	2	34
High Efficiency Gas Griddle	1	1	1	1	38
High Efficiency Gas Combination Oven	1	1	1	1	34
High Efficiency Gas Convection Oven	1	1	1	1	38
High Efficiency Gas Conveyer Oven	1	1	1	1	38
High Efficiency Gas Rack Oven	1	1	1	1	34
Power Burner Range	9	9	9	9	38
High Efficiency Fryer	1	1	1	1	20
High Efficiency Gas Steamer	1	1	1	1	38
Large Vat Fryer	1	1	1	1	25
Flexible Batch Broiler	1	1	1	1	34

APPENDIX C | INDUSTRIAL MEASURE DETAIL

Michigan Industrial Measure Database - Natural Gas

Measure Savings, Cost and Useful Life

DTE (Michigan)	Measure Assumption					
Measure Name	Annual MMBTU Savings	Cost Type: 1=Full 2=Inc.	Cost/Unit Descriptor	Cost/Unit	Effective Measure Life	UCT
Conventional Boiler Use						
High Efficiency Hot Water Boiler	0.15	2	per heater	$11.00	20	1.1
Condensing Boiler (<=300,000 Btu/h) (AFUE>90%)	1.00	2	$/unit	$55.59	18	1.4
High Efficiency Steam Boiler	0.10	2	$/kBtu	$12.90	20	0.6
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	1.00	2	per PC	$21.20	25	4.3
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	1.00	2	$/unit	$24.91	18	3.1
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	1.00	2	per mmBtu	$46.99	25	1.9
Boiler Tune-Up	303.90	1	per 100 hp	$850.00	5	10.8
Boiler Pipe Insulation	1.00	1	per mmBtu	$24.25	15	2.9
Boiler Reset Controls	1.00	1	per unit	$47.63	20	1.7
O2 Burner Controls	0.07	1	$/kBtu	$0.85	15	5.7
Linkageless Controls for Boilers	0.07	1	$/kBtu	$1.80	15	2.7
Automatic Boiler Blowdown	0.00	1	$/gal avoided	$0.02	15	6.9
Repair Malfunctioning Steam Traps	1.00	1	per mmBtu	$5.86	5	5.2
Insulate Steam Lines / Condensate Tank	1.00	1	per mmBtu	$14.43	15	4.8
Process Heating						
High Efficiency Hot Water Boiler	0.15	2	per heater	$11.13	20	1.1
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	1.00	2	$/Unit	$24.90	18	3.1
High Efficiency Steam Boiler	0.10	2	$/kBtu	$13.00	20	0.6
Repair Malfunctioning Steam Traps	1.00	1	per mmBtu	$5.86	5	5.2
Direct Contact Water Heater	1.00	1	$/unit	$24.90	20	3.3
Process Boiler Tune-Up	303.90	1	per 100 hp	$850.00	5	10.8
Boiler Pipe Insulation	1.00	1	per unit	$14.05	15	4.9
Boiler Reset Controls	1.00	1	per unit	$47.63	20	1.7
O2 Burner Control for Process	0.07	1	$/kBtu	$0.85	15	5.7
Linkageless Controls for Process Boilers	0.07	1	$/kBtu	$1.80	15	2.7
Waste-Heat Recovery	1.00	1	per unit	$25.00	10	13.0
Regenerative Thermal Oxidizer vs. STO	1.00	1	$/unit	$4.06	10	2.1
Regenerative Thermal Oxidizer vs. CTO	1.00	1	per unit	$34.38	10	1.5
Improved Sensors & Process Controls	1.00	1	per unit	$34.29	5	1.5
Refrigeration Heat Recovery	1.00	1	linear ft	$20.40	15	3.4
Process Boiler Sequencing	39.60	1	$/kBtu	$650.00	15	4.2
Process Boiler Stack Economizer	1.05	1	$/kBtu	$5.00	15	15.2
Automatic Boiler Blowdown	0.00	1	$/gal avoided	$0.02	15	6.9
Modulated Boiler Controls for Process	0.11	1	$/kBtu	$0.65	15	11.2
Air Compressor Exhaust Heat Recovery	4.20	1	$/hp	$75.00	15	3.9
Process Dryer Exhaust Rate Control	0.70	1	$/hp	$2.00	15	24.2
Facility HVAC						
High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%)	1.00	2	$/MMBtu	$19.31	18	4.0
Gas Unit Heater - Condensing	1.00	2	$/MMBtu	$65.27	22	1.3
Infrared Heater (low intensity - two stage)	1.00	2	$/MMBtu	$18.83	17	4.0
Insulate and Seal Ducts (New Aerosl Duct Sealing)	1.00	1	$/MMBtu	$501.67	20	0.2
Stack Heat Exchanger (Standard Economizer)	1.00	1	$/MMBtu	$16.54	20	4.9
Stack Heat Exchanger (Condensing Economizer)	1.00	1	$/MMBtu	$11.16	20	7.3
Heat Recovery: Air to Air	1.00	1	$/MMBtu	$163.93	20	0.5
Direct Fired Make-up Air System	1.00	1	$/MMBtu	$59.01	20	1.4

Michigan Industrial Measure Database - Natural Gas

Measure Savings, Cost and Useful Life

DTE (Michigan)	Measure Assumption					
Measure Name	Annual MMBTU Savings	Cost Type: 1=Full 2=Inc.	Cost/Unit Descriptor	Cost/Unit	Effective Measure Life	UCT
Building Envelope						
Integrated Building Design	840.00	2	$/unit	$166,226.40	30	0.5
Energy Efficient Windows	11.40	2	100SF	$954.08	20	1.0
Ceiling Insulation R-11 to R-42	15.32	1	000 sq ft roof are	$505.68	20	2.5
Wall Insulation R-7.5 to R13	123.42	1	000 sq ft wall are	$100.00	20	100.9
Roof Insulation R-11 to R-24	3.57	1	000 sq ft roof are	$348.95	20	0.8
Truck Loading Dock Seals	40.20	1	per door	$2,857.00	20	1.2
Ventilation						
Demand-Controlled Ventilation	37.16	2	sq ft cond floor	$75.00	15	34.3
Improved Duct Sealing	2.32	2	ton	$107.91	18	1.7
Destratification Fan	8.35	1	sq ft cond floor	$375.00	15	1.5
HVAC Controls						
Programmable Thermostats	20.75	1	sq ft cond floor	$49.71	9	20.3
EMS install	1.37	1	sq ft cond floor	$1.19	15	80.0
EMS Optimization	3.38	1	1000 sq ft	$12.77	17	19.6
Retrocommissioning	0.05	2	sq ft cond floor	$0.30	15	13.0
Agriculture						
Greenhouse Under-Floor/Under-Bench Hydronic Heating	0.34	1	$/sq ft	$12.00	20	2.3
Heat Curtains for Greenhouses	0.13	1	$/sq ft	$2.50	5	1.6
Other Industrial -Grain Dryer	0.35	1	$/100 Bushels	$18.00	15	1.3
IR Film for Greenhouses	0.01	1	$/sq ft	$0.11	5	8.8

Michigan Industrial Measure Database - Natural Gas

Base Case Factor:
Is the fraction of the end use energy that is applicable for the efficient technology in a given market segment.

Measure Name	FOOD	TEXTILE MILL PRODUCTS	WOOD	PAPER	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBER	NONMETALLIC MINERAL	PRIMARY METALS	FABRICATED METALS	MACHINERY	AUTO MFG.	MISC.
Conventional Boiler Use														
High Efficiency Hot Water Boiler	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Condensing Boiler (<=300,000 Btu/h) (AFUE>90%)	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
High Efficiency Steam Boiler	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%
Boiler Tune-Up	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Boiler Pipe Insulation	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Boiler Reset Controls	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
O2 Burner Controls	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Linkageless Controls for Boilers	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Automatic Boiler Blowdown	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%
Repair Malfunctioning Steam Traps	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%
Insulate Steam Lines / Condensate Tank	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%
Process Heating														
High Efficiency Hot Water Boiler	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
High Efficiency Steam Boiler	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%
Repair Malfunctioning Steam Traps	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%
Direct Contact Water Heater	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Process Boiler Tune-Up	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Boiler Pipe Insulation	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Boiler Reset Controls	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
O2 Burner Control for Process	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Linkageless Controls for Process Boilers	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Waste-Heat Recovery	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Regenerative Thermal Oxidizer vs. STO	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Regenerative Thermal Oxidizer vs. CTO	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Improved Sensors & Process Controls	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Refrigeration Heat Recovery	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Process Boiler Sequencing	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Process Boiler Stack Economizer	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Automatic Boiler Blowdown	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Modulated Boiler Controls for Process	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
Air Compressor Exhaust Heat Recovery	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Process Dryer Exhaust Rate Control	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Facility HVAC														
High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%)	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%

Michigan Industrial Measure Database - Natural Gas

Base Case Factor:
Is the fraction of the end use energy that is applicable for the efficient technology in a given market segment.

Measure Name	FOOD	TEXTILE MILL PRODUCTS	WOOD	PAPER	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBER	NONMETALLIC MINERAL	PRIMARY METALS	FABRICATED METALS	MACHINERY	AUTO MFG.	MISC.
Gas Unit Heater - Condensing	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Infrared Heater (low intensity - two stage)	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Insulate and Seal Ducts (New Aerosl Duct Sealing)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Stack Heat Exchanger (Standard Economizer)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Stack Heat Exchanger (Condensing Economizer)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heat Recovery: Air to Air	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Direct Fired Make-up Air System	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Building Envelope														
Integrated Building Design	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Energy Efficient Windows	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Ceiling Insulation R-11 to R-42	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Wall Insulation R-7.5 to R13	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Roof Insulation R-11 to R-24	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Truck Loading Dock Seals	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
Ventilation														
Demand-Controlled Ventilation	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Improved Duct Sealing	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Destratification Fan	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
HVAC Controls														
Programmable Thermostats	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
EMS install	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
EMS Optimization	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Retrocommissioning	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Agriculture														
Greenhouse Under-Floor/Under-Bench Hydronic Heating	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Heat Curtains for Greenhouses	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other Industrial -Grain Dryer	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
IR Film for Greenhouses	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Michigan Industrial Measure Database - Natural Gas

Savings Factor:
Is the percentage reduction in gas consumption resulting from application of the efficient technology.

Measure Name	FOOD	TEXTILE MILL PRODUCTS	WOOD	PAPER	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBER	NONMETALLIC MINERAL	PRIMARY METALS	FABRICATED METALS	MACHINERY	AUTO MFG.	MISC.
Conventional Boiler Use														
High Efficiency Hot Water Boiler	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Condensing Boiler (<=300,000 Btu/h) (AFUE>90%)	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
High Efficiency Steam Boiler	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Boiler Tune-Up	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Boiler Pipe Insulation	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Boiler Reset Controls	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
O2 Burner Controls	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Linkageless Controls for Boilers	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Automatic Boiler Blowdown	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Repair Malfunctioning Steam Traps	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Insulate Steam Lines / Condensate Tank	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Process Heating														
High Efficiency Hot Water Boiler	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
High Efficiency Steam Boiler	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Repair Malfunctioning Steam Traps	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Direct Contact Water Heater	34%	34%	34%	34%	34%	34%	34%	34%	34%	34%	34%	34%	34%	34%
Process Boiler Tune-Up	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Boiler Pipe Insulation	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Boiler Reset Controls	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
O2 Burner Control for Process	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Linkageless Controls for Process Boilers	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Waste-Heat Recovery	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Regenerative Thermal Oxidizer vs. STO	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Regenerative Thermal Oxidizer vs. CTO	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Improved Sensors & Process Controls	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Refrigeration Heat Recovery	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Process Boiler Sequencing	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Process Boiler Stack Economizer	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Automatic Boiler Blowdown	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Modulated Boiler Controls for Process	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Air Compressor Exhaust Heat Recovery	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Process Dryer Exhaust Rate Control	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Facility HVAC														
High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%)	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%

Michigan Industrial Measure Database - Natural Gas

Savings Factor:
Is the percentage reduction in gas consumption resulting from application of the efficient technology.

Measure Name	FOOD	TEXTILE MILL PRODUCTS	WOOD	PAPER	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBER	NONMETALLIC MINERAL	PRIMARY METALS	FABRICATED METALS	MACHINERY	AUTO MFG.	MISC.
Gas Unit Heater - Condensing	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Infrared Heater (low intensity - two stage)	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%
Insulate and Seal Ducts (New Aerosl Duct Sealing)	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Stack Heat Exchanger (Standard Economizer)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Stack Heat Exchanger (Condensing Economizer)	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Heat Recovery: Air to Air	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
Direct Fired Make-up Air System	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
Building Envelope														
Integrated Building Design	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Energy Efficient Windows	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Ceiling Insulation R-11 to R-42	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Wall Insulation R-7.5 to R13	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Roof Insulation R-11 to R-24	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Truck Loading Dock Seals	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Ventilation														
Demand-Controlled Ventilation	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Improved Duct Sealing	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Destratification Fan	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
HVAC Controls														
Programmable Thermostats	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
EMS install	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
EMS Optimization	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Retrocommissioning	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Agriculture														
Greenhouse Under-Floor/Under-Bench Hydronic Heating	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Heat Curtains for Greenhouses	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
Other Industrial -Grain Dryer	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
IR Film for Greenhouses	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%

Michigan Industrial Measure Database - Natural Gas

Remaining Factor:
Is the fraction of applicable sales that are associated with equipment that has not yet been converted to the energy efficiency measure; that is, one minus the fraction of the market segment that already have the energy-efficiency measure installed.

Measure Name	FOOD	TEXTILE MILL PRODUCTS	WOOD	PAPER	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBER	NONMETALLIC MINERAL	PRIMARY METALS	FABRICATED METALS	MACHINERY	AUTO MFG.	MISC.
Conventional Boiler Use														
High Efficiency Hot Water Boiler	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Condensing Boiler (<=300,000 Btu/h) (AFUE>90%)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
High Efficiency Steam Boiler	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Boiler Tune-Up	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Boiler Pipe Insulation	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Boiler Reset Controls	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
O2 Burner Controls	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Linkageless Controls for Boilers	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Automatic Boiler Blowdown	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Repair Malfunctioning Steam Traps	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Insulate Steam Lines / Condensate Tank	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Process Heating														
High Efficiency Hot Water Boiler	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
High Efficiency Steam Boiler	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Repair Malfunctioning Steam Traps	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Direct Contact Water Heater	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Process Boiler Tune-Up	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Boiler Pipe Insulation	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Boiler Reset Controls	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
O2 Burner Control for Process	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Linkageless Controls for Process Boilers	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Waste-Heat Recovery	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Regenerative Thermal Oxidizer vs. STO	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Regenerative Thermal Oxidizer vs. CTO	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Improved Sensors & Process Controls	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Refrigeration Heat Recovery	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Process Boiler Sequencing	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Process Boiler Stack Economizer	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Automatic Boiler Blowdown	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Modulated Boiler Controls for Process	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Air Compressor Exhaust Heat Recovery	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Process Dryer Exhaust Rate Control	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Facility HVAC														
High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%

Michigan Industrial Measure Database - Natural Gas

<u>Remaining Factor:</u>
Is the fraction of applicable sales that are associated with equipment that has not yet been converted to the energy efficiency measure; that is, one minus the fraction of the market segment that already have the energy-efficiency measure installed.

Measure Name	FOOD	TEXTILE MILL PRODUCTS	WOOD	PAPER	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBER	NONMETALLIC MINERAL	PRIMARY METALS	FABRICATED METALS	MACHINERY	AUTO MFG.	MISC.
Gas Unit Heater - Condensing	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Infrared Heater (low intensity - two stage)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Insulate and Seal Ducts (New Aerosl Duct Sealing)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Stack Heat Exchanger (Standard Economizer)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Stack Heat Exchanger (Condensing Economizer)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Heat Recovery: Air to Air	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Direct Fired Make-up Air System	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Building Envelope														
Integrated Building Design	83%	83%	83%	83%	83%	83%	83%	83%	83%	83%	83%	83%	83%	83%
Energy Efficient Windows	29%	29%	29%	29%	29%	29%	29%	29%	29%	29%	29%	29%	29%	29%
Ceiling Insulation R-11 to R-42	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%
Wall Insulation R-7.5 to R13	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Roof Insulation R-11 to R-24	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%
Truck Loading Dock Seals	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Ventilation														
Demand-Controlled Ventilation	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
Improved Duct Sealing	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Destratification Fan	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
HVAC Controls														
Programmable Thermostats	82%	82%	82%	82%	82%	82%	82%	82%	82%	82%	82%	82%	82%	82%
EMS install	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
EMS Optimization	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
Retrocommissioning	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Agriculture														
Greenhouse Under-Floor/Under-Bench Hydronic Heating	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Heat Curtains for Greenhouses	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Other Industrial -Grain Dryer	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
IR Film for Greenhouses	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%

Michigan Industrial Measure Database - Natural Gas

Convertible Factor:

Is the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install VFDs on all motors in a given market segment).

Measure Name	FOOD	TEXTILE MILL PRODUCTS	WOOD	PAPER	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBER	NONMETALLIC MINERAL	PRIMARY METALS	FABRICATED METALS	MACHINERY	AUTO MFG.	MISC.
Conventional Boiler Use														
High Efficiency Hot Water Boiler	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Condensing Boiler (<=300,000 Btu/h) (AFUE>90%)	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
High Efficiency Steam Boiler	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Boiler Tune-Up	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Boiler Pipe Insulation	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Boiler Reset Controls	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
O2 Burner Controls	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Linkageless Controls for Boilers	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Automatic Boiler Blowdown	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Repair Malfunctioning Steam Traps	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Insulate Steam Lines / Condensate Tank	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Process Heating														
High Efficiency Hot Water Boiler	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
High Efficiency Steam Boiler	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Repair Malfunctioning Steam Traps	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Direct Contact Water Heater	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Process Boiler Tune-Up	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Boiler Pipe Insulation	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Boiler Reset Controls	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
O2 Burner Control for Process	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Linkageless Controls for Process Boilers	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Waste-Heat Recovery	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Regenerative Thermal Oxidizer vs. STO	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Regenerative Thermal Oxidizer vs. CTO	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Improved Sensors & Process Controls	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration Heat Recovery	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
Process Boiler Sequencing	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Process Boiler Stack Economizer	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%
Automatic Boiler Blowdown	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%
Modulated Boiler Controls for Process	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%
Air Compressor Exhaust Heat Recovery	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%
Process Dryer Exhaust Rate Control	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%	42%
Facility HVAC														
High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Gas Unit Heater - Condensing	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Infrared Heater (low intensity - two stage)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Michigan Industrial Measure Database - Natural Gas

<u>Convertible Factor:</u>
Is the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install VFDs on all motors in a given market segment).

Measure Name	FOOD	TEXTILE MILL PRODUCTS	WOOD	PAPER	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBER	NONMETALLIC MINERAL	PRIMARY METALS	FABRICATED METALS	MACHINERY	AUTO MFG.	MISC.
Insulate and Seal Ducts (New Aerosl Duct Sealing)	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Stack Heat Exchanger (Standard Economizer)	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
Stack Heat Exchanger (Condensing Economizer)	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
Heat Recovery: Air to Air	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
Direct Fired Make-up Air System	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Building Envelope														
Integrated Building Design	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Energy Efficient Windows	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Ceiling Insulation R-11 to R-42	57%	57%	57%	57%	57%	57%	57%	57%	57%	57%	57%	57%	57%	57%
Wall Insulation R-7.5 to R13	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Roof Insulation R-11 to R-24	43%	43%	43%	43%	43%	43%	43%	43%	43%	43%	43%	43%	43%	43%
Truck Loading Dock Seals	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Ventilation														
Demand-Controlled Ventilation	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%
Improved Duct Sealing	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Destratification Fan	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
HVAC Controls														
Programmable Thermostats	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
EMS install	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
EMS Optimization	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Retrocommissioning	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Agriculture														
Greenhouse Under-Floor/Under-Bench Hydronic Heating	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Heat Curtains for Greenhouses	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Other Industrial -Grain Dryer	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
IR Film for Greenhouses	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%

Michigan Industrial Measure Database - Natural Gas

Natural Gas Measure Sources

Source Number	Source
1	Michigan Master Database of Deemed Savings - 2013 - Non-Weather Sensitive Commercial
2	Michigan Master Database of Deemed Savings - 2013 - Weather Sensitive
3	Federal Energy Management Program (FEMP), Energy Cost Calculator for Electric and Gas Water Heaters
4	GDS Associates estimate based upon review of various customer and vendor surveys, baseline studies and potential studies conducted by GDS in other states
5	Therma-Stor Return On Investment Calculation Form, http://www.thermastor.com/Heat-Recovery-water-Heaters/Heat-Recovery-ROI-Form.pdf
6	Natural Gas Energy Efficiency Resource Development Potential in New York, Final Report for NYSERDA, by Optimal Energy, ACEEE, VEIC, Resource Insight and Energy & Environmental Analysis, October 2006, Appendix C
7	US DOE- Federal Energy Management Program (FEMP): Heat Recovery from Wastewater Using a Gravity-Film Heat Exchanger
8	Food Service Technology Center, Pre-Rinse Spray Valve/Water Cost Calculator
9	Energy Efficiency Potential of Gas-Fired Commercial Hot Water Heating Systems in Restaurants, An Emerging Technology Field Monitoring Study, FSTC Report 5011.07.04, Food Service Technology Center, April 2007
10	US DOE - Energy Efficiency And Renewable Energy - Estimating a Solar Water Heater System's Cost
11	Gene Dedick - East Coast VP Sales - AquaRecycle - ph: 210-325-9258: 1,248,000 lbs/yr = 30 gpm washer-extractor system with lint shaker.
12	http://www.aquarecycle.com/laundry-water-energy-savings.php
13	Commercial Laundry Conservation Technologies, Bill Hoffman, James Riesenberger
14	Trevor Brown Southeastern Laundry/Commercial Laundry Conservation Technologies - Bill Hoffman, James Riesenberger
15	US DOE - Energy Efficiency And Renewable Energy - Determining Gas Swimming Pool Heating Efficiency - http://apps1.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=13170
16	NYSERDA Deemed Savings Database, Rev 09-082006.
17	Revised DEER Measure Cost Summary (05_30_2008) Revised (06_02_2008)
18	Gas Solutions for the Foodservice Industry, http://www.gfen.info/pdf/cookinggas0107.pdf
19	CALIFORNIA STATEWIDE COMMERCIAL SECTOR NATURAL GAS ENERGY EFFICIENCY POTENTIAL STUDY, Study ID #SW061, Prepared for Pacific Gas & Electric Company, Prepared by Mike Rufo and Fred Coito KEMA-XENERGY Inc., May 14, 2003; Questar 2006 DSM Market Characterization Report, Nexant, Appendix D (sq ft) & E (cost/sq ft).
20	Cost of the most common type of steam trap (Inverted bucket trap) according to Grainger catalog ranges from $125 - $147, plus one hour of labor @ $100/hr. http://www.grainger.com/Grainger/ecatalog/N-bkg/No-16/Ntt-inverted+bucket+trap?Ns=List+Price%7C0
21	Greenheck sales representative cost and measure life information on 5,000 CFM model. ($4,500 materials, $1,000 labor, and $400 crane rental (to lift onto roof))
22	http://www.cleanboiler.org/Eff_Improve/Efficiency/Boiler_Reset_Control.asp
23	Measure information from Nexant's "Gas Energy Efficiency Measure Analysis to Support NYSERDA's Con Edison Gas Efficiency Program" reported in August 2005. Savings unit is MMBtu/unit. Baseline efficiency from DOE
24	Natural Gas Boiler/Burner Consortium - http://www.energysolutionscenter.org/boilerburner/Eff_Improve/Efficiency/Oxygen_Control.asp
25	Found a wide range (4% - 16%) of savings estimates based on literature review Used a mid-range savings estimate factor of 10%
26	5% - 10% improvement in energy associated with losses (Optimizing Steam Systems: Saving Energy and Money in Mexican Hotels, by David Jaber, Alliance to Save Energy) GDS estimates that poor insulation represents 15%- 20% of total gas input.
27	Review of various internet sites including Zoo Fans (25%), Big Ass Fan Company (30%) and Energy Wales (20%)
28	Natural Gas Energy Efficiency Resource Development Potential in New York, Final Report for NYSERDA, by Optimal Energy, ACEEE, VEIC, Resource Insight and Energy & Environmental Analysis, October 2006 - Appendix C -MD ENERGY SAVINGS FRACTIONS
29	Flex Your Power, Demand Ventilation Control Reduces Kitchen Fan Energy Consumption by 50% to 70% and makeup air heating energy by 25%: http://www.fypower.org/news/?p=682
30	Natural Gas Energy Efficiency Resource Development Potential in New York, Final Report for NYSERDA, by Optimal Energy, ACEEE, VEIC, Resource Insight and Energy & Environmental Analysis, October 2006 Appendix C - RET ENERGY SAVINGS FRACTIONS. (Average across all building types - varies significantly based on occupancy and ventilation requirements)
31	ACEE, Emerging Energy Saving Technologies & Practices for the Buildings Sector, 2004 (6 zones at $575 per zone) p 102.
32	Assessment of Energy and Capacity Savings Potential in Iowa', Prepared for The Iowa Utility Association February 15, 2008. In Collaboration with Summit Blue Consulting, Nexant, Inc., A-TEC Energy Corporation, and Britt/Makela Group; Natural Gas Energy Efficiency Resource Development Potential in New York, Final Report for NYSERDA, by Optimal Energy, ACEEE, VEIC, Resource Insight and Energy & Environmental Analysis, October 2006 Appendix B p 40-44
33	Actual average project cost provided by NGRID for NY projects
34	ACEE, Emerging Energy Saving Technologies & Practices for the Buildings Sector, 2004
35	Energy Efficiency and Renewable Energy Resource Development Potential in New York State - Final Report, Volume 5 Energy Efficiency Technical Appendices
36	http://www.toolbase.org/Technology-Inventory/HVAC/hvac-smart-zoning-controls
37	Energy Star Cost Calculator, Energy Star Website, www.energystar.gov.
38	GasNetworks Aug08update - "Validating the Impacts of Programmable Thermostats." GasNetworks, January 2007
39	EIA, 2003 CBECS, New England, Non Mall saturation, square footage
40	For Combo Heating / Water Heating Units costs and savings add up similar separate equipment from water heating tab and space heating tab. Literature claims combined system equipment costs are higher, installation costs lower compared to separate systems.
41	Gas Fired water Heater Screening Tool http://bea.ugi.esource.com/BEA1/PA/PA_WaterHeating/PA-41_calc
42	Building Commissioning - A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions. Lawrence Berkeley National Laboratory. Report Prepared for: California Energy Commission Public Interest Energy Research (PIER) - July 21, 2009
43	GDS Natural Gas Energy Efficiency Potential in Massachusetts - April 2009
44	MEMD Support Documentation - 2014 - Workbooks and Algorithms
45	Michigan Baseline 2011: Commercial Baseline Report
46	Codes and Standards Enhancement Initiative for PY2004: Title 20 Standards Development, Analysis of Standards Options for Portable Electric Spas, Davis Energy Group Energy Solutions, May 12, 2004

Michigan Industrial Measure Database - Natural Gas

Natural Gas Measure Sources

Source Number	Source
47	Massachusetts Farm Energy Guides by Farm Sector: Best Management Practices for Greenhouses, 2010
48	Public Service New Mexico Electric Energy Efficiency Potential Study; Itron, Inc., September 2006
49	DTE Energy Commercial Baseline Study; Opinion Dynamics Corporation, October 2010
50	GDS Maine Potential Study (GDS Engineering Estimates)
51	U.S. Energy Information Administration, Model Documentation Report: Industrial Demand Module of the National Energy Modeling System, May 2013.
52	GDS Maryland Gas Potential Study, 2011.
53	Advancing Energy Efficeincy In Arkansas, ACEEE, March 2011, p. 173

Michigan Industrial Measure Database - Natural Gas

Measure Savings, Cost and Useful Life, Savings Factor, Remaining Factor Sources

Reference numbers designate source for information from Natural Gas Source List

Measure Name	Annual MMBTU Savings	Cost/Unit	Effective Measure Life	Savings Factor	Remaining Factor
Building Envelope					
Integrated Building Design	2	2	3	4	45
Energy Efficient Windows	2	2	3	2	45
Ceiling Insulation R-11 to R-42	4	4	3	4	45
Wall Insulation R-7.5 to R13	2	2	3	4	45
Roof Insulation R-11 to R-24	2	2	3	4	45
Truck Loading Dock Seals	2	2	3	4	45
HVAC Controls					
Programmable Thermostats	38	37	3	43	45
EMS install	2	2	3	48	45
EMS Optimization	4	35	3	35	4
Retrocommissioning	4	36	3	48	4
Conventional Boiler Use					
High Efficiency Hot Water Boiler	52	52	52	52	51
Condensing Boiler (<=300,000 Btu/h) (AFUE>90%)	52	52	52	52	51
High Efficiency Steam Boiler	52	52	52	52	51
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	52	52	52	52	51
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	52	52	52	52	51
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	52	52	52	52	51
Boiler Tune-Up	52	52	52	52	51
Boiler Pipe Insulation	52	52	52	52	51
Boiler Reset Controls	52	52	52	52	51
O2 Burner Controls	52	52	52	52	51
Linkageless Controls for Boilers	52	52	52	52	51
Automatic Boiler Blowdown	52	52	52	52	51
Repair Malfunctioning Steam Traps	52	52	52	52	51
Insulate Steam Lines / Condensate Tank	52	52	52	52	51
Process Heating					
High Efficiency Hot Water Boiler	44	44	44	44	3
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	52	52	52	52	51
High Efficiency Steam Boiler	44	44	44	44	3
Repair Malfunctioning Steam Traps	52	52	52	52	51
Direct Contact Water Heater	52	52	52	52	51
Process Boiler Tune-Up	52	52	52	52	51
Boiler Pipe Insulation	52	52	52	52	51
Boiler Reset Controls	52	52	52	52	51
O2 Burner Control for Process	44	44	44	44	3
Linkageless Controls for Process Boilers	44	44	44	44	3
Waste-Heat Recovery	53	53	53	53	51
Regenerative Thermal Oxidizer vs. STO	53	53	53	53	51
Regenerative Thermal Oxidizer vs. CTO	53	53	53	53	51

Michigan Industrial Measure Database - Natural Gas

<u>Measure Savings, Cost and Useful Life, Savings Factor, Remaining Factor Sources</u>

Reference numbers designate source for information from Natural Gas Source List

Measure Name	Annual MMBTU Savings	Cost/Unit	Effective Measure Life	Savings Factor	Remaining Factor
Improved Sensors & Process Controls	53	53	53	53	51
Refrigeration Heat Recovery	53	53	53	53	51
Process Boiler Sequencing	44	44	44	44	3
Process Boiler Stack Economizer	44	44	44	44	3
Automatic Boiler Blowdown	44	44	44	44	3
Modulated Boiler Controls for Process	44	44	44	44	3
Air Compressor Exhaust Heat Recovery	44	44	44	44	3
Process Dryer Exhaust Rate Control	44	44	44	44	3
Facility HVAC					
High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%)	52	52	52	52	51
Gas Unit Heater - Condensing	52	52	52	52	51
Infrared Heater (low intensity - two stage)	52	52	52	52	51
Insulate and Seal Ducts (New Aerosl Duct Sealing)	52	52	52	52	51
Stack Heat Exchanger (Standard Economizer)	52	52	52	52	51
Stack Heat Exchanger (Condensing Economizer)	52	52	52	52	51
Heat Recovery: Air to Air	52	52	52	52	51
Direct Fired Make-up Air System	52	52	52	52	51
Agriculture					
Greenhouse Under-Floor/Under-Bench Hydronic Heating	44	44	44	44	3
Heat Curtains for Greenhouses	44	44	44	44	3
Other Industrial -Grain Dryer	44	44	44	44	3
IR Film for Greenhouses	44	44	44	44	3

APPENDIX D | GLOBAL ASSUMPTIONS

General Modeling Assumptions Avoided Costs

DTE (Michigan)	UCT GLOBAL ASSUMPTIONS

Analysis Start Year	2016
Length of Analysis (Years)	10

Nominal Discount Rate	9.310%
Inflation Rate	2.00%
Reserve Margin Multiplier	14.80%
Carbon Tax Adder ($/kWh)	$0.00
Carbon Tax Adder ($/MMBtu)	$0.00

Avoided Costs (Nominal Dollars)

Data Year	Natural Gas Wholesale Forecast $/MMBTU
2015	
2016	3.83
2017	3.48
2018	3.30
2019	3.55
2020	3.77
2021	3.89
2022	4.01
2023	4.14
2024	4.27
2025	4.41
2026	4.55
2027	4.69
2028	4.84
2029	5.00
2030	5.16
2031	5.32
2032	5.49
2033	5.67
2034	5.85
2035	6.03
2036	6.23
2037	6.42
2038	6.63
2039	6.84
2040	7.06
2041	7.28
2042	7.52
2043	7.75

Data Year	Winter Peak Energy $/kWh	Winter Off-Peak Energy $/kWh	Summer Peak Energy $/kWh	Summer Off-Peak Energy $/kWh	Summer Capacity $/kW-yr	Winter Capacity $/kW-yr	Avoided T&D $/kW-yr
2015	0.034	0.026	0.034	0.026	3.288	0.000	0.000
2016	0.039	0.029	0.039	0.029	32.273	0.000	0.000
2017	0.039	0.028	0.039	0.028	61.519	0.000	0.000
2018	0.040	0.029	0.040	0.029	67.761	0.000	0.000
2019	0.039	0.028	0.039	0.028	63.444	0.000	0.000
2020	0.040	0.028	0.040	0.028	75.921	0.000	0.000
2021	0.054	0.044	0.054	0.044	77.402	0.000	0.000
2022	0.055	0.045	0.055	0.045	77.825	0.000	0.000
2023	0.057	0.047	0.057	0.047	73.439	0.000	0.000
2024	0.061	0.048	0.061	0.048	62.410	0.000	0.000
2025	0.064	0.050	0.064	0.050	66.084	0.000	0.000
2026	0.066	0.051	0.066	0.051	67.996	0.000	0.000
2027	0.066	0.051	0.066	0.051	76.567	0.000	0.000
2028	0.067	0.052	0.067	0.052	82.391	0.000	0.000
2029	0.068	0.054	0.068	0.054	79.780	0.000	0.000
2030	0.070	0.054	0.070	0.054	85.036	0.000	0.000
2031	0.071	0.056	0.071	0.056	90.786	0.000	0.000
2032	0.072	0.057	0.072	0.057	95.647	0.000	0.000
2033	0.073	0.058	0.073	0.058	98.844	0.000	0.000
2034	0.075	0.059	0.075	0.059	104.188	0.000	0.000
2035	0.076	0.060	0.076	0.060	103.676	0.000	0.000
2036	0.078	0.061	0.078	0.061	105.750	0.000	0.000
2037	0.079	0.063	0.079	0.063	107.865	0.000	0.000
2038	0.081	0.064	0.081	0.064	110.022	0.000	0.000
2039	0.083	0.065	0.083	0.065	112.222	0.000	0.000
2040	0.084	0.066	0.084	0.066	114.467	0.000	0.000
2041	0.086	0.068	0.086	0.068	116.756	0.000	0.000
2042	0.088	0.069	0.088	0.069	119.091	0.000	0.000
2043	0.089	0.070	0.089	0.070	121.473	0.000	0.000

Electric Line Losses

	Winter On Peak	Winter Off Peak	Summer On Peak	Summer Off Peak
Residential	1.068	1.068	1.068	1.068
C&I	1.068	1.068	1.068	1.068

Demand Line Losses

Winter Gen.	Summer Gen.	T&D Capacity
1.068	1.068	1.068
1.068	1.068	1.068

APPENDIX E | INCREMENTAL ANNUAL SAVINGS BY SECTOR

Incremental Annual Residential Electric Energy Savings in the Achievable UCT Potential Scenario, by End Use for DTE Energy

Year / End Use	Appliances	Water Heating	HVAC Shell	HVAC Equipment	Cross-Cutting	Total	% of Annual Sales
2016	7,353	115,117	523,753	316,997	283,004	1,246,224	1.1%
2017	8,776	127,301	579,107	350,073	299,868	1,365,125	1.2%
2018	10,530	144,477	637,291	392,069	317,060	1,501,427	1.3%
2019	12,048	158,067	692,668	427,658	333,818	1,624,258	1.5%
2020	13,565	171,658	747,576	463,248	350,170	1,746,218	1.6%
2021	15,080	185,205	801,952	498,761	366,008	1,867,006	1.7%
2022	16,594	198,744	855,782	534,259	381,272	1,986,652	1.8%
2023	18,108	212,276	909,029	569,743	395,907	2,105,062	1.9%
2024	19,621	225,799	961,656	605,212	409,855	2,222,142	1.9%
2025	21,133	239,314	1,013,626	640,667	423,061	2,337,801	2.0%
2026	21,393	245,362	607,788	635,891	421,396	1,931,830	1.7%
2027	22,765	241,044	597,451	634,938	420,040	1,916,238	1.7%
2028	22,718	245,054	547,265	633,986	418,963	1,867,986	1.6%
2029	23,181	242,567	601,880	633,033	418,573	1,919,235	1.6%
2030	23,177	240,082	563,547	632,081	418,486	1,877,373	1.6%
2031	23,172	237,547	531,131	675,218	419,425	1,886,494	1.6%
2032	23,164	235,013	495,097	671,409	420,767	1,845,449	1.6%
2033	23,156	232,479	459,279	684,449	422,478	1,821,840	1.5%
2034	23,148	229,945	437,784	684,345	424,592	1,799,814	1.5%
2035	23,139	227,411	404,253	684,243	427,114	1,766,160	1.5%

Incremental Annual Electric Residential Energy Savings in the Constrained UCT Potential Scenario, by End Use for DTE Energy

Year / End Use	Appliances	Water Heating	HVAC Shell	HVAC Equipment	Cross-Cutting	Total	% of Annual Sales
2016	3,089	48,350	219,982	133,142	118,865	523,429	0.5%
2017	3,476	50,417	229,354	138,646	118,762	540,654	0.5%
2018	3,945	54,127	238,756	146,885	118,784	562,497	0.5%
2019	4,474	58,698	257,220	158,809	123,962	603,162	0.5%
2020	5,037	63,733	277,559	171,995	130,011	648,335	0.6%
2021	5,536	67,988	294,394	183,093	134,360	685,371	0.6%
2022	5,970	71,505	307,897	192,218	137,176	714,767	0.6%
2023	6,413	75,182	321,952	201,787	140,219	745,553	0.7%
2024	6,845	78,772	335,483	211,134	142,982	775,216	0.7%
2025	7,321	82,906	351,151	221,947	146,561	809,885	0.7%
2026	9,473	108,641	269,115	281,558	186,584	855,371	0.7%
2027	10,459	110,746	274,496	291,720	192,986	880,407	0.8%
2028	10,987	118,515	264,672	306,612	202,622	903,407	0.8%

Year / End Use	Appliances	Water Heating	HVAC Shell	HVAC Equipment	Cross-Cutting	Total	% of Annual Sales
2029	11,496	120,294	298,483	313,933	207,578	951,784	0.8%
2030	12,165	126,018	295,803	331,776	219,661	985,424	0.8%
2031	12,589	129,053	288,548	366,827	227,862	1,024,879	0.9%
2032	13,555	137,523	289,718	392,891	246,222	1,079,909	0.9%
2033	14,404	144,616	285,699	425,769	262,807	1,133,294	1.0%
2034	15,253	151,524	288,481	450,953	279,788	1,185,999	1.0%
2035	16,364	160,821	285,880	483,883	302,046	1,248,993	1.0%

Incremental Annual Commercial Natural Gas Energy Savings (MMBtu) in the Achievable UCT Potential Scenario, by End Use for DTE Energy

Year / End Use	Building Envelope	Cooking	HVAC Controls	Space Heating	Water Heating	Total	% of Annual Sales
2016	14,775	21,488	338,205	166,059	67,314	607,841	1.6%
2017	14,775	21,488	338,205	166,059	67,314	607,841	1.6%
2018	14,775	21,488	338,205	166,059	67,314	607,841	1.6%
2019	14,775	21,488	338,205	166,059	67,314	607,841	1.6%
2020	14,775	21,488	338,205	166,059	67,314	607,841	1.6%
2021	17,194	21,488	338,205	166,627	67,365	610,878	1.7%
2022	17,194	21,488	338,205	166,627	67,365	610,878	1.7%
2023	17,194	23,198	497,872	166,627	67,365	772,256	2.1%
2024	17,194	23,198	497,872	168,427	67,365	774,056	2.1%
2025	17,194	23,198	497,872	168,427	67,365	774,056	2.1%
2026	12,154	23,198	204,066	156,410	52,931	448,760	1.2%
2027	12,154	23,198	204,066	156,410	52,931	448,760	1.2%
2028	12,154	42,975	204,066	156,410	52,931	468,536	1.3%
2029	12,154	42,975	204,066	156,410	63,190	478,795	1.3%
2030	12,154	44,686	363,732	156,410	63,190	640,173	1.7%
2031	14,572	44,686	542,260	289,054	80,348	970,920	2.5%
2032	14,572	44,686	542,260	290,853	82,885	975,257	2.6%
2033	14,572	44,686	382,594	290,853	83,973	816,678	2.1%
2034	14,572	44,686	382,594	293,446	83,973	819,270	2.1%
2035	14,572	44,686	382,594	295,081	83,973	820,906	2.1%

Incremental Annual Commercial Natural Gas Energy Savings (MMBtu) in the Constrained UCT Potential Scenario, by End Use for DTE Energy

Year / End Use	Building Envelope	Cooking	HVAC Controls	Space Heating	Water Heating	Total	% of Annual Sales
2016	6,423	9,341	147,025	72,189	29,263	264,241	0.7%
2017	6,441	9,367	147,435	72,390	29,344	264,978	0.7%
2018	6,535	9,504	149,593	73,450	29,774	268,857	0.7%
2019	6,981	10,152	159,787	78,455	31,803	287,178	0.8%
2020	7,478	10,876	171,181	84,050	34,071	307,656	0.8%
2021	9,064	11,328	178,300	87,845	35,515	322,052	0.9%
2022	9,363	11,702	184,182	90,743	36,686	332,676	0.9%
2023	8,289	11,184	240,027	80,332	32,477	372,309	1.0%
2024	8,530	11,509	247,010	83,562	33,422	384,034	1.0%
2025	8,875	11,975	256,997	86,940	34,773	399,560	1.1%
2026	8,966	17,114	150,542	115,386	39,048	331,057	0.9%
2027	9,193	17,548	154,358	118,311	40,038	339,447	0.9%
2028	8,902	31,475	149,458	114,555	38,767	343,156	0.9%
2029	8,923	31,549	149,812	114,826	46,390	351,500	0.9%
2030	7,732	28,428	231,394	99,503	40,200	407,256	1.1%
2031	6,301	19,321	234,457	124,978	34,740	419,796	1.1%
2032	6,566	20,136	244,347	131,061	37,349	439,459	1.1%
2033	7,662	23,495	201,163	152,927	44,152	429,399	1.1%
2034	7,991	24,506	209,813	160,925	46,050	449,285	1.2%
2035	8,384	25,709	220,116	169,768	48,312	472,288	1.2%

Incremental Annual Industrial Natural Gas Energy Savings in the Achievable UCT Potential Scenario, by End Use for DTE Energy

Year / End Use	Process Heating	Facility HVAC	Total	% of Annual Sales
2016	13,567	9,105	22,672	1.7%
2017	13,567	9,105	22,672	1.7%
2018	13,567	9,105	22,672	1.8%
2019	13,567	9,105	22,672	1.8%
2020	13,567	9,105	22,672	1.8%
2021	17,425	9,302	26,726	2.1%
2022	17,425	9,302	26,726	2.1%
2023	17,425	9,302	26,726	2.1%
2024	17,425	9,302	26,726	2.1%
2025	17,425	9,677	27,102	2.1%
2026	10,724	3,889	14,613	1.2%
2027	10,724	3,889	14,613	1.2%
2028	10,724	3,889	14,613	1.2%
2029	10,724	3,889	14,613	1.2%
2030	10,724	3,889	14,613	1.2%
2031	15,977	10,022	25,999	2.0%
2032	15,977	10,022	25,999	2.0%
2033	15,977	10,367	26,345	2.1%
2034	15,993	11,130	27,124	2.1%
2035	15,993	10,755	26,748	2.1%

Incremental Annual Industrial Natural Gas Energy Savings in the Constrained UCT Potential Scenario, by End Use for DTE Energy

Year / End Use	Process Heating	Facility HVAC	Total	% of Annual Sales
2016	5,327	3,575	8,902	0.7%
2017	5,736	3,849	9,585	0.7%
2018	6,166	4,138	10,304	0.8%
2019	6,642	4,457	11,100	0.9%
2020	7,193	4,827	12,019	0.9%
2021	8,668	4,627	13,295	1.1%
2022	8,948	4,777	13,724	1.1%
2023	9,291	4,960	14,251	1.1%
2024	9,590	5,119	14,709	1.2%
2025	9,917	5,508	15,425	1.2%
2026	14,653	5,313	19,966	1.6%
2027	14,868	5,392	20,260	1.6%

Year / End Use	Process Heating	Facility HVAC	Total	% of Annual Sales
2028	14,960	5,425	20,385	1.6%
2029	15,235	5,525	20,760	1.6%
2030	15,525	5,630	21,155	1.7%
2031	12,564	7,881	20,444	1.6%
2032	13,167	8,259	21,426	1.7%
2033	13,611	8,832	22,443	1.8%
2034	13,813	9,613	23,426	1.8%
2035	14,561	9,792	24,353	1.9%