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MICHIGAN PUBLIC SERVICE COMMISSION
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MICHIGAN ECONOMIC DEVELOPMENT CORPORATION
MICHIGAN ENERGY OFFICE
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Readying Michigan to Make Good Energy Decisions: Energy Efficiency

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Presented by

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Preface

The initial draft of the Energy Efficiency Report was released for comment on October 22, 2013. Comments on the draft report were accepted through November 6, 2013. A total of 21 comments, multiple attached documents and hundreds of emails commenting on or providing feedback to the draft report were received prior to the deadline. All of the comments were reviewed and considered in preparation of this final draft. However, several comments advocated for a particular policy and those comments have not been incorporated because this report is intended to be informative and intentionally stops short of making policy recommendations. Based upon the comments received, several revisions have been made throughout the report. Significant revisions that have been made are described below, and many other comments received are addressed throughout the body of this report.

Comments were received regarding the Michigan Electric and Natural Gas Potential Study included as Appendix B to this report. Additional details from the potential study, including the constrained achievable potential have been incorporated addressing those comments. The final *Michigan Electric and Natural Gas Energy Efficiency Potential Study* is included as Appendix B to this report replacing the initial draft. Changes in the savings potential in various scenarios between the initial draft and the final draft have been incorporated into this report.

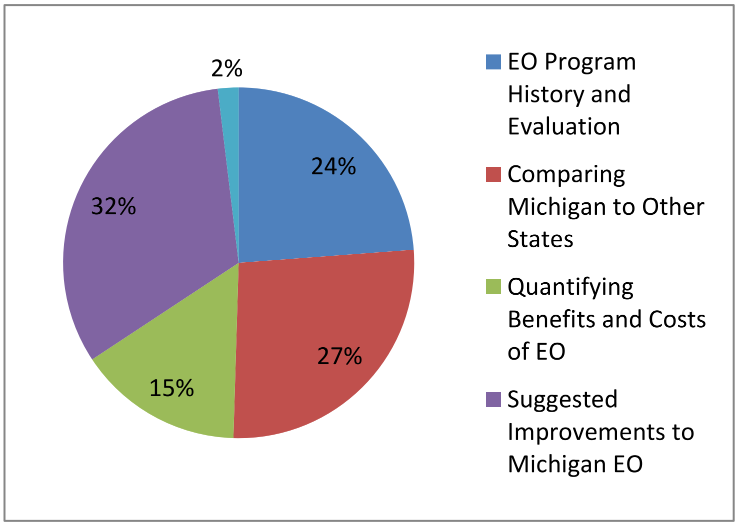
Optimal Energy's *Options for Establishing Energy Efficiency Targets in Michigan: 2016 – 2020* has been included as Appendix E to this report. In addition, the section of this report describing the study has been updated.

Comments were received regarding energy efficiency incentives, decoupling, spending caps, the amount of funding for energy efficiency programs, and suggestions to improve Michigan's energy optimization standard. Additional information has been added to this report to address these comments.

In addition many other less significant revisions have been incorporated throughout the body of this report.

Readying Michigan to Make Good Energy Decisions – Energy Efficiency Executive Summary

The 30 energy efficiency questions posted on the Ensuring Michigan's Energy Future website garnered 87 responses. The comment summary pie chart presents an overview of comments received at the website. Many additional comments regarding energy efficiency were provided at the public energy forums.



Where Michigan Is Today: Michigan's current Energy Optimization (EO) standard required electric providers to ramp up energy savings to 1.0% of the previous year's electricity sales in 2012, and natural gas utilities to ramp up energy savings to 0.75% of the previous year's sales in 2012. The provisions in PA 295 provide for the continuation of the 1.0% energy savings for electric providers and 0.75% energy savings for natural gas providers through 2015. Beyond 2015, the efficiency savings targets would continue at 1.0% energy savings for electric providers and 0.75% for natural gas providers under Michigan's current law. Michigan's electric and gas utilities are, in aggregate, surpassing the standards set forth in PA 295. Natural gas utilities achieved 134% of their targets in 2011, while electric utilities achieved 116% of their targets in 2011. Actual results for 2012 also indicate the targets were met, with natural gas utilities achieving 126% of their targets, and electric utilities achieving 125% of their targets. For each dollar spent on utility EO programs during 2012, it is estimated that customers benefit from approximately $3.83 in avoided energy costs (on a net present value basis). The total estimated savings for the 2012 program year is expected to reach $936 million on a net present value basis, and for the 2013 through 2015 program years, an additional savings of $2.8 billion is expected. Through 2011, Michigan consumers paid approximately $408 million in support of EO programs. Program spending for 2012 was $245 million, and program spending for 2013, 2014 and 2015 is expected to be about the same level as for 2012.

EO Program History and Evaluation

- Michigan utilities are on track to continue to meet the current EO targets.
- Utility EO programs are designed to encourage customers to make their homes or businesses more energy efficient. Utilities collect money from customers in the form of an itemized charge on the customers' bills to fund the EO programs. The programs typically include rebates or incentives to reduce the upfront cost of energy efficiency upgrades such as lighting, furnaces and insulation.

- The objectives of the utility EO programs include delaying the need for new electricity generation, reducing emissions, encouraging local job creation, and lowering customers' utility bills.
- Commenters state that Michigan's EO programs to date have been cost effective.
- PA 295 provides that Michigan EO spending shall have a cap, not to exceed 2% of each utility's annual revenues. The cap provides an incentive for utilities to pursue the most cost-effective EO programs to achieve the energy savings targets.
- EO charges collected from a particular customer class, such as residential, commercial, industrial or low-income, must be spent within that same rate class.
- PA 295 contains provisions allowing non-residential customers to self-direct their own EO programs. Self-directed EO programs are self-funded, and self-directed EO program customers do not pay itemized EO charges to the utility. Self-directed EO programs have only been implemented by a handful of large customers.
- Commenters agree that energy efficiency should be considered a resource in long-term utility planning, however, caution was expressed that future savings may be somewhat more expensive to achieve than in the past, because many cost-effective EO programs have already been implemented. Estimates of the increased cost of future programming are included in the GDS Potential Study and further evaluated by Optimal Energy.

<u>Comparing Michigan EO Programs to Other States</u>

- Many differences exist between state energy efficiency programs related to targets, timing, funding, and applicability making it difficult to directly compare programs between various states.
- Six states have standards that are 2.0% of electric sales or higher and nine (including Michigan) have standards between 1.0% and 1.9%.
- Five of nine states have natural gas standards above 1.0% and three of nine (including Michigan) have standards between 0.5% and 0.9%.
- State standards generally allow a broad range of end-use efficiency programs to count, but differ on whether to include combined heat and power, applications of waste heat, reduced transmission and distribution line losses, and electric generator efficiency upgrades.

<u>Identifying and Quantifying Benefits and Costs of EO</u>

- Benefit-cost tests are typically used to evaluate EO programs. Michigan law requires the utilities to use the utility system resource cost test (USRCT) sometimes referred to as the utility cost test (UCT), or the Program Administrator Cost (PAC) test. The USRCT includes all of the costs and benefits experienced by the utility.

- Some commenters contend that the USRCT does not take into account other benefits that were identified by commenters such as environmental improvement, macro-economic growth, or societal benefits.
- The USRCT also does not take into account costs experienced outside of the utility, such as the customer's investment in new energy efficient equipment such as an upgraded furnace or insulation.
- Energy efficiency could also be used to prevent local reliability problems through geo-targeting.
- Utilizing the USRCT for calculating the benefits and costs synchs up well with revenue requirement (rate making) considerations.
- The report outlines additional methods for identifying and quantifying the benefits of EO programs.
- Michigan is one of the few states that relies on the USRCT (Utility System Resource Cost Test), also known as the Program Administrator Cost (PAC) test, as its primary test. Only one of the eight states surveyed for this report, and five states throughout the United States, use the PAC test as their primary test.

<u>Improving Michigan's EO Programs</u>

- Nearly one quarter of the comments submitted included alternatives for improving Michigan's EO programs.
- Suggested improvements include adding the following specific devices and emerging technologies in utility EO programs:
    - Flue-gas heat recovery systems
    - Combined heat and power systems
    - Geothermal heat pumps
- Additional alternatives for improving Michigan's EO programs included:
    - Providing customers with more detailed and timely data to better tailor their energy use to reflect utility system costs that vary in response to the timing of customer demands.
    - Upgrading building standards and codes.
    - Retaining flexibility and adaptability in EO programming.
    - Improving EO opportunities for all customer classes.
    - Improving low-income EO programming.
    - Integrating EO with utility business models.
    - Integrating EO with an RPS into a larger clean energy standard.
    - Greater consistency across utility programs such as commonality of forms and rebates providing for reduced confusion among contractors and customers.
    - Create incentives or remove the current disincentive for peak reductions and load management in order to reduce system peak loads.

Michigan's EO Potential

The Michigan Public Service Commission, DTE Energy and Consumers Energy worked together to complete a study in 2013 of energy efficiency potential in the state of Michigan. This draft study assesses electric and natural gas energy efficiency potential in Michigan over ten years, from 2014 through 2023. This energy efficiency potential study provides a roadmap for policy makers and identifies the energy efficiency measures having the greatest potential savings and the measures that are the most cost effective. GDS Associates, the consulting firm retained to conduct this study, produced the following estimates of energy efficiency potential:

- Technical potential
- Economic potential
- Achievable potential
- Constrained achievable potential

Summary of Key Findings in the Draft Potential Study

- This study examined 1440 electric energy efficiency measures and 811 natural gas measures in the residential, commercial and industrial sectors combined. The MPSC staff, utilities in Michigan, and stakeholder organizations all had input to the list of measures examined in this study.
- For the State of Michigan overall, the *economic* potential for electricity savings over the next ten years (2014 – 2023) ranges between 30.1% and 33.8% of forecast kWh sales for 2023, producing the potential for a 38.0% - 40.9% reduction in electric demand in 2023. The *achievable* potential for electricity savings over the next ten years (2014 – 2023) is a range of 13.5% to 15.0% of forecast kWh sales for 2023, producing the potential for a 16.1% - 17.0% reduction in electric demand in 2023.
- For the State overall, the *economic* potential for natural gas savings over the next ten years (2014-2023) ranges from 20.4% to 30.1% of forecast MMBtu sales for 2023. The *achievable* potential for natural gas savings over the next ten years (2014 – 2023) is a range of 10.6% to 13.4% of forecast MMBtu sales for 2023.
- For the State overall, the constrained achievable potential scenario limits the spending on energy efficiency to 2% of utility revenues which is equal to the spending caps in the current law, whereas both the economic and achievable potential scenarios would likely require that the current spending cap in PA 295 be raised. The *constrained* achievable potential for electricity savings over the next ten years (2014 -2023) is 5.7% of forecast kWh sales for 2023, producing the potential for a 6.3% reduction in electric demand in 2023. The *constrained* achievable potential for natural gas savings over the next ten years (2014 -2023) is 5.7% of MMBtu sales for 2023.

- The available energy efficiency potential may vary between individual utilities in Michigan, particularly in the territories of rural cooperatives and Michigan's Upper Peninsula.

Energy Efficiency Options and Analysis (Optimal Energy Phase 2 Study)

Building upon the Energy Efficiency Potential Study, Optimal Energy conducted an analysis to facilitate Michigan's development of new energy savings targets. The efficiency potential estimates from GDS Associates' draft potential study was used to develop and present four concrete options for quantified annual energy and capacity targets and funding caps for years 2016-2020. The study also quantifies options for demand targets and explores expanded savings opportunities. Optimal Energy presents options for efficiency savings targets that would result in annual MWh (energy) savings of 0.7% to 24.4%, annual MW (electric demand) savings of 0.7% to 25.4%, and annual natural gas MMBtu savings of 0.6% to 19%. The Optimal Energy Phase 2 Study, *Options for Establishing Energy Efficiency Targets in Michigan: 2016 – 2020*, is included as Appendix E to this report.

Summary

- Michigan's utilities have met or exceeded and are expected to meet near-term EO targets.
- The EO programs in Michigan to date, have been cost-effective. (~2 cents/kWh which is less than 1/3 of the cost of new generation)
- Michigan has the potential to continue to achieve incremental cost-effective savings from energy efficiency.

I. Introduction

A. Summary review of the process

To inform future energy choices, the Governor requested that interested Michiganders communicate information relevant to the policy making process. As Governor Snyder directed, the Michigan Public Service Commission (MPSC) and Michigan Energy Office (MEO) engaged in an information gathering process which provided for both written and oral input from legislators and the public. This process was outlined in Appendix A to Governor Snyder's Special Message on Energy and the Environment (p. 20), entitled *Readying Michigan to Make Good Energy Decisions*.[1] The process includes identifying what information needs to be compiled or developed, and arranging for that information to be generated, as needed. As directed by the governor, these reports are "strictly informational and will not advocate for or recommend any particular outcome or policy."

An Energy Efficiency page was established on the *Ensuring Michigan's Future* website.[2] The web page included 23 questions about energy efficiency policies and programs in Michigan, and invited readers to comment by April 25, 2013. By that date, 30 groups and individuals had submitted a total of 87 responses to the 23 questions. Table 1 presents a brief summary of the respondents. The process asked individuals to identify themselves, but in some cases only first names are provided and commenters did not identify their related professional affiliations, if any.

As Table 1 shows, 20 individuals or groups provided only one response each, one individual filed two responses, Michigan Electric and Gas Association (MEGA) filed three, another individual and the Nature Conservancy filed four each, and four different groups filed five each, including Consumers Energy, DTE Energy, 5 Lakes Energy, and the Michigan Energy Efficiency Contractors Council. Joint responses representing the points of view of multiple Michigan utility companies accounted for 15 responses, and the Natural Resources Defense Council submitted 16.

This report reviews the information provided through the public information-gathering process. Respondents answered questions regarding energy efficiency programs both in Michigan and in other jurisdictions. Specifically, the questions and this report examine Michigan energy providers' energy optimization (EO) programs. Where respondents may have disagreed in important ways, this report examines differences between the assumptions and data used to reach the differing conclusions. The intent is neither to endorse nor criticize any of the mentioned programs. Instead, it is to provide factual information to support public policy decision-making.

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1 http://www.michigan.gov/energy/0,4580,7-230-63817-290530--,00.html

2 The *Ensuring Michigan's Future* website is http://www.michigan.gov/energy, and the link to the Energy Efficiency page is http://www.michigan.gov/energy/0,4580,7-230-54284---,00.html.

Table 1: List of Responses Filed

Name, Organization or Affiliation (if listed)	Number of Responses	Question Numbers
1. Art, Michigan Electric Cooperative Association	1	15
2. Beth	1	15
3. Bill	1	2
4. Brindley Byrd, Michigan Energy Efficiency Contractors Council (MEECC)	5	1, 2, 3, 10, 13
5. Chuck	1	2
6. Consumers Energy	5	3, 12, 16, 19, 22
7. Joint response from Consumers Energy, DTE Energy, and MEGA	15	1, 2, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 17, 18, 21
8. David Meeder, Michigan Energy Options	1	16
9. Douglas, 5 Lakes Energy	5	6, 9, 15, 16, 20
10. DTE Energy	5	3, 6, 16, 19, 22
11. Fred, Great Lakes Energy Member	1	17
12. Fred M, SunSpace Energy Systems, LLC	1	16
13. James	2	5, 6
14. James, Michigan Electric and Gas Association (MEGA)	3	1, 2, 3
15. Jim, Michigan Land Use Institute (MLUI)	1	10
16. JoAnn, Great Lakes Renewable Energy Association (GLREA)	1	6
17. John, Michigan Energy Options	1	16
18. Mark, Better World Builders	1	9
19. Lee, ASME (American Society of Mechanical Engineers?)	1	2
20. Martin, American Council for an Energy Efficient Economy (ACEEE)	1	7
21. Michigan Public Service Commission (MPSC) Staff	1	1
22. Naomi	4	2, 5, 10, 19
23. Peter, Dow Chemical Company	1	10
24. Sidel Systems USA, Inc.	1	1
25. Rebecca Stanfield, Natural Resources Defense Council (NRDC)	17	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 17, 19, 21, 22
26. Rich, The Nature Conservancy	4	2, 6, 10, 19
27. Robert, Association of Businesses Advocating Tariff Equity (ABATE)	1	8
28. Ryan, Thermo Source	1	10
29. Scott	1	9
30. Thom	3	10
Total	**87**	

B. Overview of the questions and responses

Figure 1 shows how the content of the responses falls into four major categories: (1) the existing history with and evaluation of Michigan utility EO programs; (2) comparing Michigan's EO standard to efficiency standards in other states; (3) identifying and quantifying the benefits and costs from EO; and (4) alternatives for improving Michigan EO programs.

Figure 1: Responses by Major Category

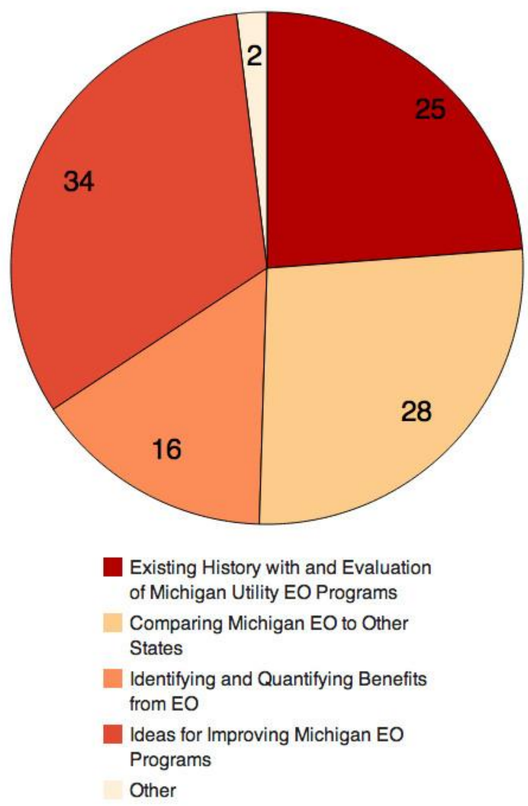

Table 2 briefly summarizes the responses submitted for each of the 23 questions and Table 3 summarizes how the responses relate to the four major content categories. Each major content category is listed in Table 3, and the data shows the total comments related to the category, followed by the breakout, question by question, showing how many of the responses to each question focused on information relevant to the content category. As this data shows, some of the responses to specific questions fall into multiple categories, including some of the responses to questions two through ten, 12, 13, 15, 16, 18, 19, 21 and 22.

Table 2: Summary of Responses Received about Energy Efficiency on *Ensuring Michigan's Future* Website

Question No.	Number of Responses	Response Complete or Partial	Lack of Consensus	Differing Data or Conflicting Information	Further Information Needed	Links to other questions
1	6	Complete				2, 3, 4, 7, 9, 10, 12
2	9	Complete			Yes	1, 3, 4, 6, 7, 10, 11, 13, 14, 16, 18, 19, 22, 23
3	5	Complete	Yes			1, 2, 4, 5, 6, 7, 10, 11, 14
4	2	Complete				2, 3, 5, 7, 12, 14, 15, 16, 18, 19, 22, 23
5	4	Partial				2, 3, 4, 7, 10, 11, 12, 13, 14, 15, 16, 19, 21, 23
6	8	Partial				7, 8, 9, 11, 12, 14, 15, 16, 18, 19, 20, 22.
7	3	Complete	Yes			3, 4, 5, 6, 10, 13, 14, 15, 16, 18, 19, 22
8	3	Complete				18, 20
9	4	Partial				11, 15, 16, 17
10	12	Partial		Yes	Yes	2, 3, 4, 6, 7,13, 14, 15, 16, 18, 19, 22
11	2	Complete				2, 6, 9, 14, 16, 22, 23
12	2	Partial				2, 7, 14, 16, 23
13	3	Complete	Yes			2, 3, 7, 11, 14, 16, 17, 22, 23
14	2	Complete				2, 4, 5, 6, 7, 10, 11, 12, 13, 16, 23
15	4	Partial				4, 5, 6, 7, 9, 10, 17, 19, 22
16	6	Partial				2, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14
17	3	Partial			Yes	2, 3, 4, 6, 9, 13, 15, 19
18	1	Partial				2, 4, 6, 7, 8, 10
19	5	Partial	Yes		Yes	2, 4, 5, 6, 7, 10, 15, 17
20	1	Partial			Yes	6, 8
21	2	Partial				5, 15, 22
22	3	Partial				11, 13, 15, 21
23	2	Partial				12, 13, 14, 15

Table 3: Relating Responses to Major Categories of Comments

Question Number	History of Michigan EO Implementation	Comparing Michigan EO to Other States	Identifying, Quantifying Benefits and Costs of EO	Improving Michigan EO Programming	Other Topics
1	5				
2	2		4	3	
3	5			4	
4	2			1	
5			4	2	
6		3	3	2	2
7		2	2	1	
8	2	2		1	
9		1		3	
10	1	1		4	
11		2			
12	1	2	2		
13		3		2	
14		2			
15	1	1		1	
16	2	1		3	
17				3	
18	1			1	
19	1	3		1	
20		1			
21		2		1	
22	1	2	1	1	
23	1				
Total	**25**	**28**	**16**	**34**	**2**

II. Existing History with and Evaluation of Michigan Utility EO Programs

A. Introduction

Michigan's energy efficiency standards are articulated in Michigan's *Clean, Renewable, and Efficient Energy Act* (Public Act 295 of 2008, MCL460.1077).[3] The law indicates that cost-effectively implementing the standard is intended to:

(a) Diversify the resources used to reliability meet the energy needs of consumers in this state.
(b) Provide greater energy security through the use of indigenous energy resources available within the state.
(c) Encourage private investment in renewable energy and energy efficiency.
(d) Provide improved air quality and other benefits to energy consumers and citizens of this state.[4]

Energy savings targets increase annually in the early years, with goals for efficiency savings identified separately for electric and natural gas utility EO programming.

Electric utilities are required to achieve savings equal to:

- 0.3% of 2007 sales in 2009;
- 0.5% of 2009 sales in 2010;
- 0.75% of 2010 sales in 2011; and,
- 1.0% of previous-year sales each year from 2012 to 2015, and each year thereafter.

Natural gas utilities have targets of:

- 0.1% of 2007 sales in 2009;
- 0.25% of 2009 sales in 2010;
- 0.5% of 2010 sales in 2011; and,
- 0.75% of previous-year sales from 2012 to 2015, and each year thereafter.

The law took effect in the fall of 2008. By mid-2009 the Michigan Public Service Commission issued the first orders intended to implement the energy efficiency provisions of the Act.[5] Among other decisions, those early orders established a Michigan Energy Efficiency Collaborative, to provide opportunities for "electric and gas providers…, energy efficiency experts, equipment installers, and other interested stakeholders… to participate." The initial goals of the Collaborative included:

- Making recommendations for improving energy optimization programs for all providers;

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3 http://legislature.mi.gov/doc.aspx?mcl-460-1077

4 http://legislature.mi.gov/doc.aspx?mcl-460-1001

5 For additional details, see http://michigan.gov/mpsc/0,1607,7-159-52495_53750-217178--,00.html

- Providing program evaluation support and developing any needed re-design and improvements to energy efficiency programs;
- Updating and refining the Michigan Energy Measures Database, on the basis of actual experience; and
- Promoting economic development and job creation in Michigan by providing a forum to connect Michigan manufacturers, suppliers and vendors with utility EO programs.

To date, four work groups have been established under the auspices of the Collaborative, including: (1) Economic Development Forum; (2) Evaluation Workgroup; (3) Low-Income Programs; and (4) Program Design and Implementation.[6] The work groups began meeting in the fall of 2009 and meetings are continuing.

In addition to the request for information in response to the 23 questions posed on the *Ensuring Michigan's Future* Energy Efficiency web page, Michigan has been in the process of obtaining current information about energy efficiency benefits, cost-effectiveness, and projections of the opportunities for continuing utility EO programming, through a series of contracts. The following four reports, attached to this document as Appendixes B, C, D, and E have also been submitted to support this policy information-gathering and review process:

Appendix B: ***Michigan Electric and Natural Gas Energy Efficiency Potential Study***, prepared for Michigan Public Service Commission by GDS Associates (2013), summarizes the benefits of and explores the benefits and costs of continuing utility EO programming in Michigan. Benefits analyzed include "avoided cost savings, non-electric benefits such as water and fossil fuel savings, environmental benefits, economic stimulus, job creation, risk reduction, and energy security" (GDS, 2013a, p. 14). GDS concludes, "[T]here remains significant achievable cost effective potential for electric and natural gas energy efficiency and demand response measures and programs in Michigan." (GDS, 2013a, p. 16). The Potential Study is discussed further in Section IV (C) of this report.

Appendix C: ***Alternative Michigan Energy Savings Goals to Promote Longer Term Savings and Address Small Utility Challenges*****,** report to the Michigan Public Service Commission by Optimal Energy (2013), reviews and assesses how EO program goals and administration can be revised and managed to best promote cost-effective, long-term energy savings, as opposed to focusing more narrowly on short-term, low cost measures. The objective of the Optimal Energy report (2013, p. 4) is to "describe a set of policy options for the Public Service Commission and other Michigan stakeholders to consider in order to reduce the bias to pursue savings that may be the most inexpensive from a first-year perspective, but not necessarily optimal in the longer-term."

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6 The Energy Efficiency Collaborative web page, at http://michigan.gov/mpsc/0,4639,7-159-52495_53750---,00.html, includes links to web pages for each of the four work groups, which provide more detailed information about each of the four work groups.

Appendix D: ***Energy Efficiency Cost-Effectiveness Tests***, by Synapse Energy Economics, Inc. (Malone *et al*., 2013), reviews and summarizes the standard benefit-cost tests used to evaluate energy efficiency measures and programs. This report "addresses current issues with cost-effectiveness screening practices. It summarizes and compares the current energy efficiency cost-effectiveness policies and practices in Michigan and other jurisdictions." It reviews Connecticut, Illinois, Massachusetts, Minnesota, New York, Oregon, Vermont, and Wisconsin and compares Michigan's policies and practices to those jurisdictions (Malone *et al*., 2013, pp. 1, 2). Portions of the Synapse report are incorporated throughout this document.

Appendix E: ***Options for Establishing Energy Efficiency Targets in Michigan: 2016 – 2020***, by Optimal Energy (2013), analyzes options for setting future energy and demand savings for Michigan based upon the results of the GDS Associates *Michigan Electric and Natural Gas Energy Efficiency Potential Study* (Appendix B). This report quantifies four primary options with three sub-options each that could be used to set new savings goals in Michigan. The budget associated with each option is also discussed. Optimal's report is further discussed in Section VI of this report.

B. Summary of Michigan EO program evaluations to date

Multiple respondents referenced the Michigan Public Service Commission's 2012 Report on the Implementation of PA 295 Utility Energy Optimization Programs. Responses to this question show that Michigan's electricity and gas utilities are, on average, surpassing the standards set forth in PA 295. Natural gas utilities achieved 134% of their targets in 2011, while electric utilities achieved 116% of theirs. While results vary from utility to utility, evaluation data shows that Michigan's energy savings targets were met through 2011. A general conclusion reached by the evaluators thus far is that for each dollar spent on the utility EO programs to date, customers will benefit from $3 in avoided energy costs, reaching an estimated total of $1.2 billion as a result of program operations in 2013 through 2015.

Although reports for 2012 savings were not final, Commission Staff endorsed the Energy Optimization program as successful (MPSC Staff, 2013). In 2011, the combined average energy savings for providers met 125% of the targets created in PA 295. That report shows how electric utilities have surpassed Michigan's EO standards each year since implementation and gas utilities have also exceeded legislative targets. Actual results for 2012 also indicate the targets were met, with natural gas utilities achieving 126% of their targets, and electric utilities achieving 125% of their targets.

Commenters agree that the EO programs to date have been cost effective. NRDC's response to question 3 includes summaries of first year and life-cycle program costs and savings for both gas and electric energy optimization programs for Consumers Energy and DTE Energy. NRDC also includes estimated cost of conserved energy prices for Consumers Energy (2 cents per kWh for electricity, and $1.76 per MCF of natural gas) and DTE Energy (1 cent per kWh for its electric portfolio, and $1.50 per MCF for its gas programs).

Responses to question 4 from Michigan utilities and NRDC both provide details about the cost of conserved energy associated with the existing EO programs. Both comments refer to the MPSC evaluation reports (most recently MPSC, 2012), and the NRDC report also refers to a Consumers Energy (2012) report. NRDC relays average 2011 electricity generation costs and natural gas commodity costs as reported by the U.S. Energy Information Administration. Based on those data, NRDC concludes that Michigan's EO programs are cost-effective.

The responses agree about the present cost of conserved energy estimates, but neither addresses the history by class or the history of savings for participants and non-participants, as question 4 asks. The short-term history from 2008 to the present is readily accessible in the annual evaluation reports. There is also useful information for addressing this question in responses to questions about benefit-cost testing.

C. Michigan energy optimization programming by customer class[7]

The utilities' joint response to question 8 discusses Michigan's customer classes extensively, and introduces the concept of the customer option for adopting a self-directed EO plan (MPSC, 2010b). Both the utilities and NRDC discuss some of the specific provisions of Michigan's *Clean, Renewable, and Efficient Energy Act* (2008 PA 295; MCL460.1001 et seq.). NRDC refers to section 71(3)(d), which establishes that charges collected from a customer class must be spent within that same rate class (MCL460.1071).

For the purposes of EO programming, Michigan can be understood as having five customer classes: residential, commercial, industrial, low-income, and self-directed. PA 295, Section 89 provides for low-income class funding through proportional collections from the other four customer classes (MCL460.1089).

Michigan's self-directed class consists of non-residential customers that meet minimum peak demand usage requirements and choose to operate their own energy efficiency programs. These customers must achieve the same energy savings targets established by PA 295. NRDC explains that the MPSC Order in Case No. U-15800 establishes temporary guidelines for self-directed EO plans. Self-directed customers are still obligated to contribute to the low-income class fund, but do not pay the full EO itemized charge (surcharge) (MPSC, 2010b).

Question 18 asks specifically about how Michigan and other jurisdictions have coordinated low-income weatherization programs. One response to that question was provided on the Ensuring Michigan's Future website, as a joint utility response from Consumers Energy, DTE Energy, and MEGA. As the utilities explain, in Michigan a number of low-income programs are assigned to different state agencies and additional support comes from utility-sponsored and ratepayer funded charitable contributions and through non-governmental organizations. The majority of Michigan's weatherization funding comes from the Low Income Home Energy Assistance Program (LIHEAP) and the Weatherization Assistance Program (WAP). LIHEAP is run by the U.S. Department of Health and Human Services and administered by Michigan's Treasury and Department of Human Services. WAP is funded by the U.S.

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7 This issue is also discussed in Part III.C. of this report, comparing Michigan to other states.

Department of Energy and administered by Michigan's Department of Human Services.

D. The role of EO in utility planning

The GDS report (2013a, p. 14) reports "states are turning to energy efficiency as the most reliable, cost-effective, and quickest resource to deploy."

NRDC approaches this issue by examining Michigan's resource planning process. Noting that Michigan's EO plan was adopted to delay construction of new generating capacity, NRDC embraces integrated resource planning proceedings which examine a number of methods, including energy efficiency, to meet new demand. Michigan law (MCL 460.6s)[8] requires a long-range resource plan for generation projects that cost more than $500 million, but NRDC states that few utility facility projects will meet this spending threshold. NRDC recommends that each Michigan utility should undertake integrated resource planning on a regular basis, that the planning process incorporate energy efficiency and renewable energy, and that a certificate of necessity be required for smaller projects. A change in legislation would be needed to require such certificates for smaller projects, though. It should be noted that a change in legislation may be needed to *require* such certificates for larger projects as well.[9]

The utility's joint response to question 10 reviews the logical sequence by which EO measures and programs are explored, analyzing technical, economic, achievable, and program potentials. The GDS study (2013a, p. 32) also explains the systematic approach to modeling and incorporating EO into utility planning. Chapter 5 of the GDS report (pp. 32-45) reviews in detail the process typically used for evaluating EO potential, and GDS Figure 5-1 (p. 35) depicts the process for determining "achievable potential."

The joint utility response also cautions, however, that:

> Future savings… are likely to be somewhat more expensive to achieve than in the past. … A current and rigorous energy efficiency potential study for the state of Michigan that factors in the latest changes in baselines, Michigan Energy Measures Database deemed savings values, and codes and standards, as well as other criteria identified by interested stakeholders, would best serve to inform the planning process.

Figure 5-3 from the GDS report (2013a, p. 41) further illustrates this point, by differentiating between lower-cost measures with higher savings opportunities, mid-range measures in terms of both costs and savings, and higher-cost measures with smaller savings. One of the utilities' concerns is that lower-cost measures with higher savings will be obtained first, leaving more expensive measures with lower savings for later years.

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8 This provision was added by 2008 PA 286 (http://legislature.mi.gov/doc.aspx?mcl-460-6s).

9 See Section 6s(1) of PA 286 of 2008: (http://www.legislature.mi.gov/%28S%28jvxszg552nqqls55um2dbt55%29%29/documents/2007-2008/publicact/pdf/2008-PA-0286.pdf).

The utilities joint response to question 21 points to seven states, including Michigan, that provide some mechanisms whereby energy efficiency savings can qualify as an eligible resource towards meeting renewable portfolio standards (RPS) goals. Each of these states places a cap on the maximum contribution of efficiency savings to the RPS target. Michigan's limit, at 10% of the RPS target, is the lowest, in terms of percentage (NREL, 2012). The utilities support allowing energy efficiency as an RPS resource, noting an NREL study that compares the cost of renewables and energy efficiency. NREL's study shows that the price of energy efficiency programs is significantly cheaper than that of renewables. The joint response supplements this conclusion with two Michigan PSC reports (MPSC 2012a, MPSC 2012b):

> In Michigan, the Michigan Public Service Commission report found that <u>the weighted average energy optimization cost of conserved energy was $20 / MWh, compared to a life cycle cost of $91.19 / MWh for renewable energy</u> [emphasis included in original].

Additionally, the joint response offers that including energy efficiency in an RPS can enhance compliance flexibility and broaden political support. The utilities note that future federal portfolio standards policies are uncertain, and that some federal legislative proposals would allow energy efficiency savings to count towards meeting renewable standards.

In its response to question 22, Consumers Energy states that "flexibility, creativity, and innovation" are all required in the design and operation of energy optimization programs, "to capitalize on emerging opportunities or make rapid mid-course changes, without the delay of regulatory review." Consumers Energy states:

> A regulatory framework that provides utilities a multi-year savings target, the ability to bank savings from one year to the next, a large degree of flexibility, and the ability to carry-over unspent dollars into subsequent years, provides more flexibility to achieve overall savings targets.

DTE Energy says that Michigan's current law does not have a mechanism "to reduce the savings target when energy optimization plans indicate that the costs to customers would exceed a maximum set by the PA 295." But, DTE notes that Michigan's law does provide "some administrative flexibility in the standard to help adapt to unforeseen circumstances." DTE Energy explains:

> Michigan law does allow utilities to spend more than the spending caps with approval from the Michigan Public Service Commission, but there is no mechanism to exceed the customer class [cost] recovery caps.

DTE Energy, like Consumers Energy, supports the idea of "standards that have a high degree of flexibility to deal with unforeseen circumstances and prevent unintended consequences."

DTE Energy further describes provisions of PA 295 and Commission decisions that result in flexibility in EO program design and implementation. DTE Energy lists:

- Energy savings in one year can be rolled forward to the next year, fulfilling up to one third of the subsequent year's goals, but the utility must forgo its financial incentive if it chooses to do so
- A utility or a provider can submit a plan that exceeds the 2% cost cap and receive commission approval if the plan is prudent
- The commission can adjust small utility savings goals and approaches
- The commission can end a program that does not meet the basic cost effectiveness requirements
- A utility can redirect up to 30% of program funds to programs that need additional funding (U-15806 and U-15890)
- A utility can develop new programs and launch them through an "emerging programs" process (U-17049 and U-17050)
- A utility can roll forward unspent funds from one year to the next as long as the overall plan is under the spending cap (U-17049 and U-17050)

DTE Energy's conclusion is that Michigan's current system allows a good deal of flexibility, but "a fundamental issue that could arise over time… is that the <u>cost</u> of energy efficiency programs needs to realistically align with the state's energy efficiency <u>goals</u>" [emphasis in original].

NRDC notes the value of energy efficiency, itself, as a tool that affords utilities and customers with greater flexibility and the ability to "adapt to unforeseen circumstances."

In its response to question 23, MiEIBC notes that Michigan evaluates energy efficiency investments for first year savings to determine compliance with the Energy Optimization Standard, and evaluates investments over the useful life of the measure when considering cost-effectiveness and for reporting the net benefits of the programs. As MiEIBC indicates, the useful life of measures is one of the data elements included in the *MI energy measures database* (MPSC, 2013).

MiEIBC also notes that current accounting practices treat energy efficiency expenditures as recoverable in the first year, rather than stretching them out over multiple years, reflecting the useful lives of the measures. As MiEIBC points out, if the alternative, longer-term cost recovery were applied, it would have the effect of "relaxing the program spending cap, which would enable implementation of more costly but longer-lasting energy efficiency measures."

III. Comparing EO in Michigan to Other States

A. Overview

Sixteen of the 23 questions about energy efficiency ask explicitly for information about policies and experience in other jurisdictions. About one-quarter of all the comments are focused on other states and how Michigan's EO programming and policies compare to other states.

In its response to question 6, the Nature Conservancy references four recent reports from ACEEE, which include comparisons of state standards (Foster, 2012; Sciortino, 2011; Nowak, 2011; and York, 2012). Consumers Energy provides a summary table showing (1) electric and natural gas efficiency standards for over a dozen states and (2) state average electricity costs (in ¢/kWh), drawn from U.S. EIA data. DTE Energy notes that 20 states have adopted energy efficiency resource standards (EERS), which variously apply to electricity, natural gas, or both.

A joint response from the utilities elaborates on the general nature of and objectives intended for energy efficiency programs:

> The standards are met by the utility expending funds on programs designed to encourage customers to make their homes or businesses more energy efficient. The programs typically include rebates or incentives to reduce the upfront cost of energy efficiency upgrades such as furnaces, lighting, motors, and insulation, as well as marketing and outreach to make customers aware and motivated to act. The overarching policy objectives of these programs include, but may not be limited to, delaying the need for electricity generation, reducing pollution, encouraging local job creation, and lowering customer's utility bills.

DTE provides a map showing the states and an Appendix outlining "EERS Policy Details." DTE explains that the state standards "generally allow a broad range of end-use efficiency programs to count," but also points out that the states differ on whether to include combined-heat-and-power, applications of waste-heat, reduced transmission and distribution system line losses, and electric generator efficiency upgrades. Michigan's standard does not explicitly include those categories, but DTE points out that "other states (e.g., Arizona, Rhode Island, Florida, Massachusetts, Maryland, New York) include one or more." Utility comments in response to question 7 provide the following information about other state energy efficiency standards:

- Six states have standards that are 2.0% of electric sales or higher and nine (including Michigan) have standards between 1.0% and 1.9%.
- Five of nine states have natural gas standards above 1.0% and three of nine (including Michigan) have standards between 0.5% and 0.9%.

The Joint Response supports flexible standards:

> Costs and benefits of achieving different standards can vary among utilities based on their size, type, service area, capacity needs, and other factors. Therefore,

> statutory standards should build in flexibility with common sense oversight by the Michigan Public Service Commission (MPSC).

None of the responses to question 6 explicitly identify any correlation between a state's energy efficiency standard and the state's cost of energy or excess generating capacity. Consumers Energy contends data and studies do not demonstrate a correlation; DTE remarks that it could not identify any study that discusses such correlations.

In a joint response to question 7, the utilities report that many states have energy efficiency standards with policy objectives that "include, but may not be limited to, delaying the need for electricity generation, reducing pollution, assisting low-income households, encouraging local job creation, and lowering customer's utility bills." Illinois and Massachusetts, for example, have specific low-income goals. The utilities state that energy efficiency programs are paid for through an itemized customer charge (surcharge), and explain:

> Customers can realize a reduction in their monthly bill (in excess of the surcharge) if they use energy efficiency measures covered by the utility's programs. Customers who do not participate would see an increase in their rates in the near term but could benefit over the long term through the utility avoiding certain costs, such as fuel or deferred capital investments.

The utilities point out that the Michigan standard has dual features: One is the annual targets for electricity and natural gas savings; the other is a spending cap, not to exceed 2% of each utility's annual revenues. This cap is discussed in question 13.The utilities note that some other states have standards higher than Michigan's, but they question whether the higher standards will prove to be "consistently achievable." They also caution that:

> [C]omparing the standards across states can be challenging because of the nuances in the way the standards are defined and how savings are credited. The standards also build in assumptions about load growth, economic activity, weather, demographics, and other factors and, therefore, caution should be used when comparing the percentage targets.

Detroit Edison notes that cost caps exist in Illinois, Michigan, Pennsylvania, and Wisconsin, and "off ramps" for EERS exist in Ohio, New Mexico, and Oregon. For example, Pennsylvania has a spending cap of 2% of utility revenues and Wisconsin has a 1.2% revenue cap. At least one state, Illinois, has a cap on rate increases. Instead of explicit caps, several states restrict expenditures to cost-effective energy efficiency. In comments to the draft report, the utilities add that in the ACEEE 2012 State Energy Efficiency Scorecard, 11 of 51 states were identified as spending more than 2% on energy efficiency, spending an average of 3.03% and saving 1.2% (2010 electric program data).

B. Applying the standard benefit-cost tests

The Synapse report summarizes how state public utility commissions have used benefit-cost tests for energy efficiency:

> Since the inception of ratepayer-funded energy efficiency programs, cost-effectiveness screening practices have been employed to ensure that the use of ratepayer funds results in sufficient benefits. Screening practices have allowed regulators to promote investments in energy efficiency resources that benefit customers, utility systems, and society. In general, historical energy efficiency programs have proven successful with strong cost-effective results, leading to additional investment in energy efficiency resources.

The utilities' joint response to question 14 explains that PA 295 requires that EO program cost-effectiveness be evaluated using the Utility System Resource Cost Test (USRCT) (MCL460.1073(2)). The Joint Response comments that:

> Although there are other methods to score cost effectiveness including the Total Resource Cost (TRC), Participant Cost Test (PCT), Rate Impact Measure (RIM), and Societal Cost Test (SCT), the USRCT is most practical and straightforward to implement.

The USRCT focuses on costs that a utility would incur during a program and the avoided-cost benefits that would result. This is one of five tests used by various jurisdictions. The Joint Response defines each of these tests. The RIM test, for example, measures price changes caused by changes in utility revenues and operating costs associated with a program. The PCT is specific to demand-side management programs, and compares bill savings with the cost of equipment upgrades. This calculation determines how attractive a demand-side program would be to consumers. Finally, the SCT is a variation of the TRC that expands the focus to society as a whole, including environmental and non-energy benefits.

Synapse notes that different tests provide different types of information. Each test is designed to estimate the costs and benefits of efficiency investments from different perspectives. For example, Synapse notes that the SCT includes societal impacts that may include environmental impacts, reduced health care costs, economic development impacts, reduced tax burdens and national security impacts. Synapse reports that the TRC includes all the costs and benefits to the program administrator and the program participants offering the advantage of including the full incremental cost of the efficiency measure, regardless of which portion of that cost is paid for by the utility and which portion is paid for by the participating customer. The USRCT, referred to as the Program Administrator Cost (PAC) test by Synapse, includes all of the costs and benefits incurred by the utility to implement efficiency programs, and all the benefits associated with avoided generation, transmission and distribution costs. Synapse notes that this test is limited to the impacts that would eventually be charged to all customers through the revenue requirements; the costs being those costs passed on to ratepayers for implementing the efficiency programs, and the benefits being the supply-side costs that are avoided and not passed on to ratepayers as a result of the efficiency programs. This test provides an indication of the extent to which utility costs, and therefore average customer bills, will be reduced by energy efficiency.

In sum, each of the five tests examines different costs and benefits. The Joint Response provides an illustration of components measured by each test. As examples, the total resource cost (TRC) test includes as benefits (1) avoided supply costs, other resource savings (e.g., water) and other non-energy benefits, and as costs (2) program administration, program financial incentives and customer contributions; the utility cost test (UCT or USRCT) excludes customer contribution as a cost; and the participant cost test includes bill savings and other resource savings as benefits and only customer contributions as cost.

NRDC provides a similar matrix, which, despite some categorical differences, presents a similar analysis of the five tests. Both the Synapse report and the utilities' joint response to question 14 contain a detailed discussion of each test.

Twenty-nine states use the TRC test, making it the most commonly used cost effectiveness test. Six jurisdictions use SCT, five including Michigan use the USRCT, one uses RIM, and five have no specified primary test (Schiller, 2013). No states use PCT as their primary test, but a number of states supplement their tests with a PCT (Kushler, 2012).

The utilities' joint response sums up its support for the USRCT:

> There is no national consensus on which test is the best for measuring energy efficiency programs. While many utilities use the TRC test, the elements that are measured in the TRC vary widely. However, every state uses some measure of "utility system avoided costs" as a benefit, and every state treats "energy efficiency program costs" as a cost. The USRCT has the advantage of being simpler and much less expensive to calculate, given that the inputs are data that the utility generally already has. The USRCT also incorporates energy efficiency as a supply side investment similar to how other utility decisions are made.

NRDC illustrates why it is difficult to determine the best test by listing a number of under-represented benefits.[10] NRDC notes the difficulty in accounting for each benefit, but insists that cost-benefit tests should attempt to maintain awareness of all benefits. Overall, NRDC finds shortcomings in the USRCT by viewing cost-effectiveness from the perspective of only the utility; thus, it omits placing a value on environmental improvement and the added comfort to customers, and any macro-economic benefits or any societal benefits created by the programs. NRDC identified a January 2013 presentation that includes a slide showing which test is used in each state, and the key features.[11]

Synapse reports that ever since ratepayer-funded energy efficiency programs have been in place, there has been considerable debate about which test is best to use for screening energy

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[10] These benefits include: Utility benefits – reduced arrearages and carrying costs, demand reduction induced price effect, reduced risk; Customer/Participant benefits – increased property value, aesthetics, building durability, comfort, health benefits for participants and society; and Societal benefits – job creation, economic growth from lowering energy costs, environmental benefits.

[11] *See* http://www.meeaconference.org/uploads/file/ppt2013/MES_2013_Thu-01-17/MES_2013_Thu-01-17_Schiller.pdf.

efficiency. However, it should be noted that – while the choice of test is important – it is even more important to ensure that each test is properly applied. Sound screening practices should (a) generally meet the state's energy policy goals, (b) use a screening test that is consistent with the state's energy policy goals, (c) apply the chosen screening test in a way that is internally consistent, (d) use methodologies that are consistent with the perspective of the chosen test, and (e) account for all the costs and benefits that are relevant to the chosen test.

The Joint Response details Michigan's compliance procedures, which includes annual reporting of efficiency program cost-effectiveness using a USRCT. No comparisons to lifecycle or annual saving calculations in other jurisdictions were made by either of the commenters. State to state comparisons of energy efficiency programs is not straightforward as many differences exist between individual jurisdictions.

The Synapse report, included as Appendix D, includes a summary of the cost-effectiveness screening practices in eight states in addition to Michigan. The eight states are Connecticut, Illinois, Massachusetts, Minnesota, New York, Oregon, Vermont, and Wisconsin. For each state, Synapse researched three primary attributes regarding cost effectiveness screening: cost-effectiveness test(s) and their application, the avoided costs included in the primary cost-effectiveness test, and the other program impacts included in the primary cost-effectiveness test.

Synapse reports the following results of the eight states surveyed:

1. All of the states we surveyed provide relatively comprehensive energy efficiency programs according to ACEEE, as they are all ranked within the top 20 most energy efficient states.
2. Cost-effectiveness practices are largely driven by key policy objectives specific to each state.
3. Most states screen for cost-effectiveness using the TRC as the primary test, while a few states rely on the Societal Cost test or the PAC test as the primary test.
4. Most states determine cost-effectiveness at either the portfolio or program level, with one state screening at the measure level and one state screening at the sector level. Most states consider results from additional screening levels in addition to the primary screening level.
5. Several different discount rates are used across the states, although the utility weighted average cost of capital is most frequently used by the states. Other states use low-risk or societal discount rates. We note that different discount rates can have significant impacts on the results of the cost-effectiveness screening.
6. All but one state apply a study period that includes the full useful life of the measures.
7. All states account for avoided costs of energy, capacity, and complying with environmental regulations. However, we did not investigate the extent to which the methodologies, assumptions and results are appropriate or consistent across the states.
8. All but one state account for avoided costs and transmission and distribution.

9. Most states do not account for price suppression effects, with only two states including such benefits.
10. Most states do not account for risk mitigation benefits, with only two states include such benefits.
11. All but one state that uses the TRC test or the Societal Cost test account for the participant-perspective resource benefits: water savings, oil savings, gas savings (for electric utilities), and electric savings (for gas utilities).
12. All but one state at least qualitatively account for the participant-perspective low-income benefits, typically by not requiring that low-income programs or measures pass the state's cost-effectiveness test.
13. States treat the participant-perspective non-energy benefits very differently:
    - One state uses quantified values for non-energy benefits.
    - Two states use adders to represent non-energy benefits.
    - Several states include few or no non-energy benefits, despite using the TRC test or Societal Cost test as the primary test.

C. Implementing energy efficiency programming by customer class

The utilities examine how a number of other jurisdictions, including Iowa (ACEEE, 2013) and California (California Public Utilities Commission, 2012), apply energy efficiency standards to various customer classes. According to the utilities' Joint Response, some states, such as Massachusetts and Illinois, include specific savings or spending targets for the low-income class.

The Joint Response compares sector-specific goals in various jurisdictions. The utilities note that a number of states, including Michigan, have no savings targets for any specific class. California has different class categories (residential, commercial, industrial, and agricultural); it does not allocate any goals for those specific sectors, however. The same is true in Iowa, Wisconsin, and Connecticut.

The utilities' joint response to question 8 explains that Michigan's self-directed class consists of non-residential customers who meet a minimum peak demand usage and choose to operate their own energy efficiency programs. These customers must meet the same minimum energy savings percentage targets established by PA 295.

NRDC explains that the MPSC Order in Case No. U-15800 establishes temporary guidelines for self-directed EO plans. Self-directed customers are still obligated to contribute to the low-income class fund, but do not pay the full EO surcharge (MPSC, 2010b). NRDC further reports that Wisconsin, Vermont, Minnesota, Massachusetts, and Ohio also offer the option of self-directed plan compliance, but some other states, such as Iowa, do not.

The utilities' joint response to question 18 lists 10 jurisdictions in which only one state agency controls the state's low-income program. The response notes, however, that consolidation is not necessary. Operational differences between these programs make different agencies better suited to implement different programs. The Joint Response does provide a small caveat to this recommendation, noting the need for coordination between agencies.

Additionally, many states implement programs through community action agencies (CAAs):

> Thirty states reported that CAAs were their primary local administrator for LIHEAP heating, cooling, and crisis funding, and the majority of states (including Michigan) report that CAAs are the primary customer intake site for weatherization assistance (U.S. Department of Health and Human Services, 2013).

MiEIBC, in its response to question 20, contends that:

> Michigan has followed a practice which is nearly universal among states with active utility energy efficiency programs, which is to place the obligation for providing energy efficiency programs on the distribution utilities. This is the prevalent model, regardless of whether states have "restructured" to allow customer choice or not.

MiEIBC remarks that no state has imposed an energy efficiency requirement on independent energy suppliers. Reasons include their unregulated status and the high turnover in that sector. Instead, energy efficiency programs are funded through the distribution utility, which remains under the purview of the Public Service Commission. Michigan's EO programs place the responsibility for energy efficiency on those regulated distribution utilities.

MiEIBC notes that energy efficiency programs in restructured states should be "non-by-passable," meaning that customers pay to support energy efficiency programs regardless of where they purchase generation. Since customers pay for energy efficiency and are eligible for energy efficiency programs through their distribution rates, Michigan's EO standards are met outside of the retail choice electricity market.

D. Energy efficiency in utility planning

The utilities' joint response to question 10 includes reviews how EO measures and programs are explored in a logical sequence, analyzing technical, economic, achievable, and program potentials. Without citing the source for this data, Consumers provides a table which shows a dozen states, including Michigan, that utilize multi-year planning for energy efficiency programs.

NRDC, in response to question 11, explains that Michigan's annual numerical standard is similar to those implemented in Illinois, Indiana, Ohio, Iowa, Wisconsin, Minnesota, Massachusetts, Oregon, and other states. The utilities' joint response echoes this finding, noting that:

> Numerical standards that explicitly define energy savings targets based on a percentage of retail sales is common practice across the United States. Like Michigan, many states base their savings targets, and associated performance incentives, on cumulative annual savings over a three-year period.

The Joint Response examines some of the same states as NRDC,[12] but also details programs in California (DSIRE, 2013) and Ohio. While the Joint Response illustrates some differences in the enforcement mechanisms, goal-setting processes, and commission responsibilities, each jurisdiction focuses on numerical requirements. The utilities cite a report from ACEEE (2013) as a source for this information.

The timeline for compliance varies in different jurisdictions. New York, for example, has a cumulative goal of 15% load reduction by 2015, but NRDC states that different states' overall targets are often divided into short-term increments. NRDC concludes that a multi-year approach, in practice, is similar to an annual target.

NRDC describes an "all cost-effective" requirement adopted by some states. Found in California, Connecticut, Massachusetts, Rhode Island, Vermont, and Washington, these policies dictate that utilities must capture all cost-effective energy efficiency (Barbose, 2013). However, according to ACEEE's Scorecard (Foster, 2012), each of these states also has either an annual or cumulative numerical energy efficiency resource standard (EERS).

In a response to question 12, Consumers Energy reports that nearly all jurisdictions base energy savings targets on first-year savings. Consumers Energy found just one jurisdiction that expresses savings targets in terms of lifetime savings. According to Consumers Energy, the Public Service Commission of Wisconsin, in Docket 5-GF-191, shifted its focus to lifecycle goals. In that docket, the Wisconsin PSC (in 13 Jan 2012 Order in Case No. 5-GF-191) states:

> The Commission also determined contract goals should be life cycle goals in order to reflect the true value of the savings. Therefore, it is appropriate for [the

12 Both the Joint Response and NRDC provide an assessment of Wisconsin, Illinois, Iowa, and Minnesota.

Statewide Energy Efficiency and Renewable Administration] and the Program Administrator to negotiate gross life cycle four-year contract goals based on the net annual four-year goals adopted by the Commission.

Detroit Edison also refers to multi-year plans, using Iowa as an example.

E. Combining mandates, goals, and incentives

According to responses to question 9 from the Michigan Energy Innovation Business Council (MiEIBC) and the utilities' joint response, Michigan uses both incentives and mandates. Michigan uses a combination of mandates and incentives to encourage utility-initiated energy efficiency. The state mandates savings targets starting in 2009, with annual increases leading to the current level of 1.0% of total annual retail electricity sales and 0.75% of natural gas retail gas sales. Utilities can also earn a performance incentive for exceeding their mandated energy-savings targets. Under PA 295, Section 75 (MCL460.1075), Michigan offers as a financial incentive the lesser of:

> (a) 25% of the net cost reductions experienced by the provider's customers as a result of the implementation of the energy optimization plan or
> (b) 15% of the provider's actual energy efficiency program expenditures for the year.

Nineteen of the twenty-four states with an Energy Efficiency Resource Standard (EERS) supplement their mandates with incentives (Foster, 2012). MiEIBC notes that the six highest ranked states in ACEEE's 2012 *Scorecard* offer incentives in addition to their mandate. MiEIBC asserts, "[P]roviding some type of incentive to utilities for energy efficiency accomplishments helps encourage them to perform well in delivering customer energy efficiency programs."

Five states offer incentives, but no mandate (Foster, 2012). MiEIBC is more critical of this approach, stating:

> That approach of 'incentives available but no mandate' does not appear to be very successful, as none of those five states are in the top 30 in terms of the percent of their annual kWh sales that are saved by energy efficiency programs.

According to MiEIBC, Colorado, in contrast, offers incentives once a utility reaches 80% of its goal. MiEIBC identifies the *DSIRE Database*[13] as an extensive source of data about each state's energy efficiency programs.

[13] That is the *Database of State Incentives for Renewables & Efficiency*, a publicly available web site that strives to maintain an up-to-date index of all U.S. federal and state policies and financial incentives. See www.dsireusa.org.

MiEIBC goes on to describe the reasoning behind incentives:

> It should also be considered that our prevailing utility business model actually punishes a utility for achieving energy efficiency goals because they are selling less of the commodity from which they earn money (kWhs or Btus). As a result, many states have adopted one of two mechanisms for providing a utility with cost recovery for their investments (1) decoupling or (2) energy efficiency incentive payments.

Decoupling involves eliminating the link between a utility's revenues and sales, and Michigan's treatment of decoupling is examined in question 17 and further discussed in Part V.F. of this report. MiEIBC recommends revisiting PA 295 to expand development of a decoupling program. The utilities add that several states combine decoupling along with direct cost recovery and performance incentives.

MiEIBC also recommends looking outside of mandates and incentives to promote energy efficiency. MiEIBC suggests this approach can involve "market transformation" policies that focus on institutional arrangements or transaction rules, such as Energy Star labeling or rebates, and special energy efficiency financing programs like *Michigan Saves*^{SM}.

The utilities' joint response mentions that a common approach used in other jurisdictions is to establish energy savings targets through regulatory or legislative mandates. It adds that in several instances mandates allow for performance incentives when a utility exceeds energy savings targets. The utilities explain that performance incentives help to overcome the "inherent negative financial disincentive utilities otherwise face by reducing energy sales through their energy efficiency programs."

In comments to the draft report, the utilities added that most states use a COMBINATION of the three types of mechanisms used to compensate utilities for investment in energy efficiency: direct cost recovery, fixed cost recovery, and performance incentives. While direct cost recovery is employed in almost all states, 31 states have fixed recovery mechanisms (with 3 pending) and 28 states employ performance incentives (with 3 pending). Of the 31 states with fixed recovery mechanisms, 13 states employ "decoupling" (with 1 pending), which separates utility revenues or profits from sales. The other 18 states use "lost revenue recovery adjustments," which allow utilities to recoup revenue lost to declines in sales attributable to energy efficiency programs. Many states use both fixed recovery mechanisms and performance mechanisms: 10 states use both decoupling and performance incentives, and 14 use both lost revenue recovery and performance incentives (with 2 pending). The utilities contend that sound energy policy needs to remove the disincentive for utilities to support energy efficiency through a combination of program cost recovery, lost margin recovery, and performance incentives.

MEECA also commented in support of efforts to reinstate electric decoupling with appropriate oversight language safeguarding the confidence of shareholders in investor-owned utility long-term financial stability. MEECA also suggests that more elaborate utility performance incentive mechanisms specifically targeting certain types of programming beyond surpassing an overall goal including on-bill financing, community based financing programs, and deeper measures would be desirable.

Detroit Area Green Skills Alliance (DAGSA) also supports on-bill financing and incentives for deeper retrofit measures. In addition, DAGSA would like to see promotion of consumer education and awareness.

NRDC also explains that states typically set EERS program targets based on first-year energy savings. It notes, however, that in a refinement to annual program targets, Michigan has adopted measures to account for lifetime energy savings. NRDC points to MPSC Cases Nos. U-17049 and U-17138, where the MPSC approved incentives that encourage programs with longer life cycles. The orders allow Detroit Edison and Consumers Energy to apply a 10% savings adder for measures with a life of 10 years or more. Consumers Energy also references these dockets, stating, "This adder recognizes the value of the long-life measures by producing additional credit toward the statutory first-year savings targets." Consumers Energy recommends that Michigan continue to focus on first-year savings, but also supports these considerations of lifetime savings.

While EERS statutes typically focus on first-year savings, both NRDC and Consumers Energy note that utilities account for the entirety of a program's lifecycle in the economic benefit-cost assessment of energy efficiency programs. NRDC explains that cost-effectiveness tests are performed on the basis of full lifetime energy savings. Consumers Energy confirms that utilities and regulators judge lifetime savings, but clarifies that the outcomes of the benefit-cost tests for measures and programs are then converted to first-year savings targets.

The utility joint response to question 13 reviews Michigan's spending caps at 2% of revenue (MCL460.1089(7)), and compares Michigan to two other states with formal spending caps on energy efficiency programs.[14] The utilities look favorably upon spending caps:

> Spending caps are important and help balance short- and long-term benefits and costs associated with energy efficiency programs. Standards for energy efficiency programs and related spending caps should be designed in concert with one another and be informed by studies on the energy efficiency potential to ensure the standards are achievable. The standard should fit under an acceptable spending cap to limit short-term impacts on rates.

The utilities also mention a cost cap in Illinois, but this cap is on rate increases, rather than specifically addressing energy efficiency spending. NRDC further explains Illinois' cap:

> The Illinois energy efficiency portfolio standard (EEPS) passed in 2007 does include a hard cap on utility budgets. However, in 2011 the legislature passed complementary legislation requiring the Illinois Power Agency to include in its annual procurement plan for residential and small business customers all energy

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[14] These states are Pennsylvania, with a 2% cap, and Wisconsin, with a 1.2% cap.

> efficiency investment that is cost-effective over and above the savings from the EEPS, as determined through a utility assessment submitted each year.

NRDC therefore classifies Illinois' approach as a "hybrid" model, bridging caps and "all cost-effective" efficiency program models found in California and Massachusetts. Additionally, the utilities describe seven other kinds of constraints that apply in other states and can serve to limit utility budgets for energy efficiency.[15]

Some commenters question the value of spending caps. These include the MEECC response to questions 3 and 13, which highlight some of the difficulties that budget caps can impose on EO trade partners and ratepayer perceptions. NRDC, in its response to question 13, opines that the combination of budget caps and USRCT evaluations function to "undermine progress toward lowering utility system costs." NRDC concludes,

> [An] effect of the spending caps is to force utilities to focus on low-hanging fruit in order to meet savings targets, as opposed to investing in deeper retrofit programs with longer-term savings.
>
> There is ample evidence that constraining budgets for cost-effective energy efficiency investments is counterproductive and creates enormous lost savings opportunities and unintended consequences in program design and delivery.

The utilities express the importance of spending caps, noting that caps serve to limit short-term rate impacts and help maintain affordable rates. The caps, according to their Joint Response, help balance the short and long-term costs and benefits associated with efficiency programs. The Joint Response notes that the cost of achieving efficiency savings is increasing over time.[16] As these programs continue, the utilities stress that caps should be developed with consideration of overall energy efficiency standards, and that standards should remain achievable given the compliance timeframe and funding limits.

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[15] The utilities' Joint Response examines fourteen additional jurisdictions with funding constraints: California, Connecticut, Iowa, Maine, Massachusetts, Minnesota, New Jersey, New Mexico, New York, Ohio, Oregon, Rhode Island, Vermont, and Washington, D.C. (DSIRE, 2012). The different categories of cost constraints the utilities identify include: commission approval of budgets, commission setting the energy efficiency charge, statutes setting the energy efficiency charge, spending minimums, commission budget constraints, consideration of rate impacts, and caps per customer.

[16] The cost and potential savings from future energy efficiency measures is further discussed in responses to question 10.

IV. Identifying and Quantifying Benefits and Costs from EO

A. Overview

As shown in Figure 1 and Table 3, sixteen comments focus on this topic, and most were submitted in response to questions 2, 5, 6, and 7. These comments center on: (1) whether the current tests used by the Commission are appropriate, and if not, what changes state policymakers might entertain; (2) the potential future benefits of EO programs; and (3) reliability and other non-traditional benefits of energy efficiency. The comments reflect a general agreement about appropriate benefit-cost tests and several comments agree that energy efficiency improves system reliability. Less agreement exists over the potential of energy efficiency in the years ahead. Utility comments express concerns that future energy efficiency initiatives will not be as cost-beneficial as the existing ones, but comments from some interest groups expect continuing and even expanded future, cost-effective EO potential.

B. Benefit-cost tests

Utilities can apply different benefit-cost tests to evaluate EO programs. Each test measures benefits and costs from a single perspective. One test, for example measures benefits and costs from the participating customer's perspective while another focuses on the utility's perspective. Michigan law requires utilities to use the utility system resource cost test (USRCT), or what other states often refer to as the utility cost test (UCT) or program administrator cost test (PACT). Consequently, multiple commenters refer to the USRCT.[17] Michigan law both defines this benefit-cost test (MCL460.1013(d)) and directs the MPSC to determine whether each energy provider's EO plan that satisfies the USRCT is reasonable and prudent (MCL460.1073).

The utilities' joint response to question 2 includes a summary of the USRCT and a helpful review of Michigan documents that is responsive to this question. The Synapse report (Malone *et al*., 2013, p. 4) explains:

> The [USRCT] includes all of the costs and benefits experienced by the utility. It includes all the costs incurred by the utility to implement efficiency programs, and all the benefits associated with avoided generation, transmission and distribution costs. This test is limited to the impacts that would eventually be charged to all customers through the revenue requirements; the costs being those costs passed on to ratepayers for implementing the efficiency programs, and the benefits being the supply-side costs that are avoided and not passed on to ratepayers as a result of the efficiency programs. This test provides an indication of the extent to which utility costs, and therefore average customer bills, will be reduced by energy efficiency.

As the utilities note, more states use the total resource cost (TRC) test as the primary benefit-cost test for deciding on energy efficiency programs. The TRC test includes the customer

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[17] This benefit-cost test is one of a series of standardized tests, as explained in the *Standard Practice Manual* most recently published by the California Energy Commission, 2001.

share of energy efficiency costs, which is not included in the USRCT. As expressed in the Synapse report (Malone *et al*., 2013, p. 4), the TRC test "offers the advantage of including the full incremental cost of the efficiency measure, regardless of which portion of that cost is paid for by the utility and which portion is paid for by the participating customer." Thus, the USRCT is more favorable toward EO programs, since compared with the TRC test it typically calculates a higher benefit-to-cost ratio for the same EO programs.

While the MPSC relies on the USRCT as the primary test for evaluating EO programs, the utilities explain that Michigan EO planners also use other tests (i.e., secondary tests) to evaluate EO programs, including the TRC test, the ratepayer impact measure (RIM) test, and the Participant Cost test. No commenters explicitly advise about the appropriate role for secondary tests in EO policy decisions.

Comments do not reflect major disagreement over what kinds of documents policy makers should review to determine the cost effectiveness of the current energy-efficiency programs. Several comments refer to the evaluation analysis and reports, developed by independent energy program evaluators and compiled in reports produced by the utilities, by Efficiency United, [18] and by the MPSC. Commenters did not note any problems from relying on differing data sets or sources in making observations or reaching conclusions about EO programs.

The Nature Conservancy refers to several studies from the Lawrence Berkeley National Laboratories that estimated costs and savings from state energy efficiency programs. The most recent of these studies is *The Future of Utility Customer-Funded Energy Efficiency Programs in the USA: Projected Spending and Savings to 2025*.[19]

The Joint Response comments that utilities and electric and gas cooperatives evaluate EO programs in reports submitted to the state program administrator, Efficiency United and by the MPSC in its supervisory role over the state administrator contract. In other words, utilities complete cost-effectiveness tests and commissions review them during the process of selecting measures and designing programs. The review process also includes independent cost-effectiveness evaluations of program operations and outcomes. These evaluations (1) measure and verify the results achieved and (2) study the delivery process "to ensure that programs are operated effectively and identify opportunities for enhancement." Subsequently, the MPSC analyzes and summarizes these reports annually.[20] The Commission has thus far concluded that Michigan's EO programs are cost-effective.[21] Summaries of annual costs and energy savings, along with program evaluations, are included in these reports.

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[18] Efficiency United delivers energy optimization services to customers on behalf of twenty of Michigan's smaller natural gas and electric utility companies, including investor-owned, municipal, and cooperative (member-owned) utilities. See http://www.efficiencyunited.com/.

[19] See http://emp.lbl.gov/publications/future-utility-customer-funded-energy-efficiency-programs-united-states-projected-spend.

[20] *See* MEGA response to Energy Efficiency Question No.1.

[21] Both Efficiency United and MPSC reports are indexed at this web page: http://www.michigan.gov/mpsc/0,4639,7-159-52495_53472---,00.html.

The Joint Response mentions that the USRCT, which is the primary test used in Michigan, is a credible measurement of the cost effectiveness of EO programs. The utilities point out that the USRCT is simpler than other tests and requires only data that most utilities have readily available.

The utilities also raise the concern that while EO projects can result in long-term benefits, measures that pass the USRCT can sometimes put upward pressure on rates in the near term.[22] That can happen if the measures pass the USRCT but not the RIM test; the utilities contend that this outcome should factor into utility planning and policy development.

Naomi, in a response to question 2, recommends a review of the "best practices" methods for measuring the cost-effectiveness of energy efficiency, as described in the *National Action Plan for Energy Efficiency*.[23] As expressed by the authors, this widely-disseminated document "reviews the issues and approaches involved in considering and adopting cost-effectiveness tests for energy efficiency, including discussing each perspective represented by the five standard cost-effectiveness tests and clarifying key terms."

Finally, NRDC states, in response to question 2:

> Section 73(2) of PA 295 requires that each utility's portfolio of programs be cost-effective as determined by application of the utility system resource cost test (USRCT) which compares the total cost to the utility of administering and delivering the programs, to the total generation, transmission and distribution costs avoided by the programs. This test looks at cost-effectiveness from the perspective of the utility system, and therefore *does not take into consideration the value of environmental improvement, the value of the added comfort or convenience to the customer, any macro-economic benefits (e.g. job growth) or any societal benefits created by the programs.* Even omitting consideration of these critical energy efficiency benefits, however, the programs have created substantially more benefits than costs. [Emphasis added]

NRDC contends that the Michigan utility EO portfolios have been extremely cost effective, even when excluding pertinent benefits, as demonstrated in different reports and utility reports filed with the Commission. For example, an MPSC report aggregated the savings results from all of the state's electric and gas utilities and calculated that for every dollar spent by the utilities, consumers will save an estimated $3.55. The MPSC report also estimates the total

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22 The test that assesses the effect of changes in revenues and operating costs caused by a program on customers' bills and rates is the rate impact measure or RIM.

23 The *National Action Plan for Energy Efficiency* (NAPEE) was a public-private collaborative effort from 2005-2010, facilitated by the U.S. Environmental Protection Agency and Department of Energy, including input from gas and electric utilities, utility regulators, and other partner organizations. The project resulted in the publication of several reports, including best-practices recommendations for utility energy efficiency programs. See http://www.epa.gov/cleanenergy/energy-programs/suca/resources.html.

lifecycle savings for all utility measures for expenditures made during 2011 as $709 million.[24] NRDC remarks that including reliability and environmental benefits from EO programs would increase the value of the annual savings to more than $1 billion per year. Updated data for 2012 indicates that the total estimated savings for the 2012 program year is expected to reach $936 million on a net present value basis, and for the 2013 through 2015 program years, an additional savings of $2.8 billion is expected.

C. Energy efficiency potential

Joint Response comments discuss how EO measures and programs are explored in a logical sequence, analyzing technical, economic, achievable, and program potentials. The utilities believe that EO activities become progressively more constrained over time, by factors such as cost-effectiveness, customer willingness to participate, and program delivery limitations.[25]

Other commenters, however, believe that EO measures will continue to be highly economical. For example, Nature Conservancy's response to question 10 states:

> [S]eparate studies by the McKinsey & Company (2009), the National Academy of Sciences (2010), and the Alliance Commission on National Energy Efficiency Policy (2013) indicate that the potential for energy efficiency is substantial. Electric consumption can be reduced by 20 to 25 percent using technologies that are available today and that will save consumers more on their utility bills than the initial investment in more efficient buildings and appliances. However, policies to remove market barriers (such as inadequate consumer information) described in the reports are needed to realize the full potential.

NRDC concurs, saying:

> All available evidence suggests that Michigan utilities should be able to ramp up to a level of annual electric savings equal to 2% of sales, roughly double what they are currently planning to achieve in 2013.

In response, the utilities counter that data provided in Appendix B of this report and elsewhere clearly tempers the claims that energy efficiency targets could easily increase beyond 1% in the future, by showing the significant added costs of reaching higher targets. The utilities note that the unconstrained achievable scenarios would require dramatically higher investment and itemized charges over the next ten years of $4.68 to $7.53 billion which pose a risk to energy affordability and business competiveness for Michigan, noting that the required spend for energy efficiency programs could be double to triple the current spend.[26]

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24 *2012 Report on the Implementation of P.A. 295 Utility Energy Optimization Programs*, Michigan Public Service Commission Dept. of Licensing and Regulatory Affairs, November 30. 2012.

25 These issues are discussed in part V.B. of this report, beginning on page 31.

26 See Appendix B, Table 1-5, p. 7.

While it's likely true that raising the energy efficiency savings standard would lead to increased spending on energy efficiency programs, the cost per unit of energy efficiency savings is not projected to increase dramatically. The Michigan Electric and Natural Gas Energy Efficiency Potential Study reports an acquisition cost per first year kWh saved for 10 years as ranging from $0.16 per kWh to $0.22 per kWh.[27]

NRDC proposes that, instead of relying on energy-efficiency potential studies, policy makers should examine the activities of the most proactive states in promoting energy efficiency. Although recognizing the differences between jurisdictions, NRDC holds that the long experiences of those states with energy efficiency programs are "highly unlikely to dramatically affect the transferability of results, at least between states with roughly similar climates."

The Michigan Public Service Commission, DTE Energy and Consumers Energy worked together to complete a study in 2013 of energy efficiency potential in the state of Michigan. The draft potential study was made available for stakeholder comment on October 9, 2013. The draft report, "Michigan Electric and Natural Gas Energy Efficiency Potential Study" was included in the initial draft of this report as Appendix B. The final version, "Michigan Electric and Natural Gas Energy Efficiency Potential Study," dated November 5, 2013 is now attached as Appendix B. As reported by GDS Associates, the study examines the potential to reduce electric consumption and peak demand and natural gas consumption through the implementation of energy efficiency technologies and practices in residential, commercial, and industrial facilities in Michigan. This study assesses electric and natural gas energy efficiency potential in Michigan over ten years, from 2014 through 2023.

The study had the following main objectives:

- Evaluate the electric and natural gas energy efficiency budget-constrained, technical, economic and achievable potential savings in the State of Michigan;
- Calculate the economic and achievable potential energy efficiency savings based upon cost effectiveness screening with both the TRC and UCT benefit/cost ratios.

As noted above, the scope of this study distinguishes among four types of energy efficiency potential; (1) technical, (2) economic, (3) achievable potential, and (4) constrained 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. Figure 1-1 below provides a graphical representation of the relationship of the various definitions of energy efficiency potential.

[27] See Appendix B, Table 1-3, p. 7.

Figure 1-1: Types of Energy Efficiency Potential[28]

Not Technically Feasable	Technical Potential		
Not Technically Feasable	Not Cost Effective	Economic Potential	
Not Technically Feasable	Not Cost Effective	Market & Adoption Barriers	Achievable Potential

The constrained achievable potential in this study limits the spending on energy efficiency programs to 2% of utility revenues, which is equal to the spending caps in the current law, whereas both the economic and achievable potential scenarios will likely require that the current spending cap in PA 295 be raised.

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 of future savings
- Projected penetration rates for energy efficiency measures
- Projections of Michigan specific electric and natural gas avoided costs
- Future changes to current energy efficiency codes and standards for buildings and equipment

With respect to non-energy benefits of energy efficiency programs, GDS did include an adder of $9.25 per ton of carbon for reduced emissions of CO_2. Also, 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 some personal choices to implement particular measures that may otherwise not be cost-effective or only marginally so.

Summary of Key Findings in the Draft Potential Study

- This study examined 1440 electric energy efficiency measures and 811 natural gas measures in the residential, commercial and industrial sectors combined. The MPSC staff, utilities in Michigan, and stakeholder organizations all had input to the list of measures examined in this study.
- For the State of Michigan overall, the *economic* potential for electricity savings over the next ten years (2014 – 2023) ranges between 30.1% and 33.8% of forecast kWh sales for 2023, producing the potential for a 38.0% - 40.9%

[28] Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. US EPA. Figure 2-1.

reduction in electric demand in 2023. The *achievable* potential for electricity savings over the next ten years (2014 – 2023) is a range of 13.5% to 15.0% of forecast kWh sales for 2023, producing the potential for a 16.1% - 17.0% reduction in electric demand in 2023.

- For the State overall, the *economic* potential for natural gas savings over the next ten years (2014-2023) ranges from 20.4% to 30.1% of forecast MMBtu sales for 2023. The *achievable* potential for natural gas savings over the next ten years (2014 – 2023) is a range of 10.6% to 13.4% of forecast MMBtu sales for 2023.
- For the State overall, the constrained achievable potential scenario limits the spending on energy efficiency to 2% of utility revenues which is equal to the spending caps in the current law, whereas both the economic and achievable potential scenarios would likely require that the current spending cap in PA 295 be raised. The *constrained* achievable potential for electricity savings over the next ten years (2014 -2023) is 5.7% of forecast kWh sales for 2023, producing the potential for a 6.3% reduction in electric demand in 2023. The *constrained* achievable potential for natural gas savings over the next ten years (2014 -2023) is 5.7% of MMBtu sales for 2023.

The Michigan Electric and Natural Gas Potential Study, final report dated November 5, 2013, is included as Appendix B.

In comments to the draft report, the NRDC submits that the Michigan Electric and Natural Gas Potential Study does not fully represent Michigan's potential. NRDC claims that the achievable potential in Michigan is significantly understated in the potential study due to the limits placed on incentives, inadequately considering emerging LED technology, and the study does not include any estimate of the potential for combined heat and power. NRDC contends that the constrained potential estimates are unrealistically low. NRDC also submits that spending caps cost electric customers billions in higher electricity bills pointing out that Table 1-10 in the potential study clearly shows that the effect of the cap on energy efficiency budgets of 2% of revenues (which is the "constraint" in the "Constrained UCT" scenario) is to slash the net benefits of a 10-year investment from $10.1 billion under the unconstrained UCT test, to $3.7 billion, costing customers $6.4 billion. NRDC comments that capping investment on the cheapest resource available to utilities will force investment in more expensive resources.

D. Unaccounted for benefits in traditional benefit-cost tests

A few commenters identify benefits from EO programs that most benefit-cost tests do not take into account. These benefits include improved utility reliability and a cleaner environment, in addition to customer-specific benefits. Some comments suggest additional considerations of cost-effectiveness:

- NRDC notes several additional benefits from EO programs, which are not included in the USRCT, including "environmental improvement, the value of the added comfort or convenience to the customer, any macro-economic benefits (e.g. job growth) or any societal benefits created by the programs." NRDC also cites the likelihood of additional, uncounted "reliability" benefits.

- MEECC recommends that cost effectiveness should consider the vantage point of the contractors who do energy efficiency work. MEECC expresses the value of including contractors in utility program design, explaining:

  > Because of their intimate knowledge… contractors know ways to improve energy efficiency programs to make them less costly for utilities and more profitable for themselves. Energy efficiency contractors can help find ways through collaboration with utility energy efficiency program designers to increase the cost effectiveness for all stakeholders."

- ACEEE cites electric energy savings data from an MPSC (2012) report and uses that data to estimate environmental emissions reductions associated with those EO efforts, as calculated using the U.S. EPA Power plant Emissions Calculator (EPA, 2012). It estimates that achieving equivalent emissions reductions through pollution control equipment alone would cost over $1 billion, and points out that the estimated environmental benefits are in addition to the economic benefits already identified in the MPSC (2012) report.

- Both ACEEE and NRDC refer to benefits in the form of reduced greenhouse gas emissions, and discuss other jurisdictions' estimates of the value of avoided greenhouse gas emissions, in the absence of any state or federal policies that would assign an explicit value.

- NRDC provides estimates of the economic benefits it forecasts for Michigan at both a 1% and 2% electricity efficiency standard. NRDC discusses how energy efficiency improvements can defer transmission and distribution upgrades, citing evidence of these effects from New York, New England, and California.[29]

The commenters generally agree that energy efficiency efforts can improve reliability by reducing stress on the transmission and distribution (T&D) system. The Joint Response says, for example, "[E]nergy efficiency can be considered part of the [utilities'] proactive efforts to prevent reliability problems." The utilities note that energy efficiency programs are not directly tied to the utilities' other reliability improvement activities, but energy efficiency can act as a "proactive reliability method" by reducing overall energy consumption and peak demand. It added that only a few jurisdictions have used targeted energy efficiency measures to alleviate short-term local reliability issues.

[29] See Gazze and Massarlian, 2011; George and Rourke, 2012; and Neme and Sedano, 2012.

Both the utilities and NRDC refer to geographically-targeted (or geo-targeted) energy efficiency programs that would focus on those areas where current limits to generation or transmission capability result in localized reliability concerns. In particular, existing geo-targeted energy efficiency programs in Vermont (Navigant, 2012) and New York City (citation, not included in utility comments) are cited by the utilities. NRDC refers to reports by Lazar and Baldwin (2011) and Neme and Sedano (2012).

The Joint Response refers to conservation voltage reduction (CVR), which is a utility-side energy efficiency opportunity, especially for heavily loaded distribution circuits. NRDC notes that energy efficiency improvements can result in savings due to line-loss reductions and capacity reserves, too.

The Joint Response discusses reliability in terms of outages only, and does not mention power quality issues. James's comment refers to an expanded definition of reliability that includes more than simply the number and duration of utility outages. The general concern is that the power quality requirements for modern electronic equipment are different and higher than previous electric equipment. Even modest power-quality deviations can eventually cause problems for electronic devices, and even momentary outages can generate extensive costs for various kinds of end users (especially for computer-aided manufacturing and for manufacturing processes that have to waste resources that are in production when any outage occurs).

NRDC remarks that considerable evidence supports the improved reliability that derives from energy efficiency. NRDC also recommends three ways for utilities to maximize the reliability benefits of energy efficiency. They are: (1) measurement of marginal line-loss rates, (2) measurement of passive deferrals of T&D upgrades, and (3) least-cost planning for T&D.

NRDC concurs with the comments of the Joint Response. NRDC states:

> The reliability enhancing benefits of energy efficiency have been extensively documented. Recently, the Regulatory Assistance Project produced two papers detailing the value of energy efficiency investments to reducing peak demand, reducing line-loss, reducing the cost of capacity reserves and reducing the need for new investment in distribution infrastructure.[30]

[30] Jim Lazar and Xavier Baldwin, *Valuing the Contribution of Energy Efficiency to Marginal Line Losses and Reserve Requirements*, August 2011, and Chris Neme and Rich Sedano, *U.S. Experience with Efficiency As a Transmission and Distribution System Resource*, February 2012.

V. Alternatives for Improving Michigan EO Programs

A. Overview

Nearly one-quarter of all the comments about energy efficiency include alternatives for improving Michigan's EO programming. Some of the comments recommend including specific devices and emerging technologies in utility EO program offerings. Examples include flue-gas heat recovery systems, combined heat and power systems, and earth-coupled, water-source heat pumps that are commonly referred to as "geothermal."[31] In comments to the draft report, MECA stressed the value that could be provided by allowing for the incorporation of ground source heat pumps into Michigan's energy efficiency standard. Other comments provide more general EO programming alternatives. Examples include proposals for:

- Linking energy efficiency improvements for residential properties at the time of sale, and recommending provisions for special energy efficiency financing that would be available at the time of sale;[32]
- Benchmarking building energy performance, with something like a miles-per-gallon rating that could be easily understood by building owners and managers;[33]
- Providing customers with more detailed and timely data that customers could use to better tailor their energy use to reflect utility system costs that vary in response to the timing of consumer demands;[34]
- Upgrading building codes and standards to what is presently a voluntary, high-efficiency buildings energy standard known as "Passive House" (Passive House Institute US, 2011);[35] and,
- Encouraging state facilities to adopt the "Architecture 2030 Challenge," which is a voluntary energy efficiency buildings standard which calls for new buildings built by 2030 to use no fossil fuels.[36]

Other themes addressed in the comments include:

- Retaining flexibility and adaptability in EO programming;

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[31] These include comments about flue-gas recovery systems from Sidel Systems USA, Inc., in response to question 1, about geothermal systems from Ryan, Thermo Source in response to question 10, and about CHP from Dow Chemical and NRDC in response to question 10. NRDC cites its published *Issue Paper* report, by Gowrishankar *et al*., 2013. Dow's response also mentions benefits from insulation and air-sealing.

[32] Comment from Lee, ASME, in response to question 2.

[33] Comment from Thom, in response to question 10, suggesting a metric of Btu/square-foot, per degree-days. Heating degree days is a commonly-used measure of weather-related energy demand for heating. A related measure for air conditioning demand is cooling degree days.

[34] Comments by MiEIBC in response to question 19 and comments by Scott in response to question 9.

[35] Comment from James, in response to question 5.

[36] Comment from Joann, GLREA, in response to question 6, which indicates that Illinois, Minnesota, Ohio, and the National Governors Association have adopted this standard.

- Improving EO opportunities for all customer classes, with special attention to low-income programming;
- Leveraging additional, private sources of funding for EO;
- Coordinating EO program offerings for both gas and electric utilities;
- Including non-traditional EO efforts to produce utility system benefits; and,
- Integrating EO with utility business models.

Each of these themes is reviewed in more detail in the following sections.

B. Retaining flexibility and adaptability in EO programming

Michigan utility company comments, in particular, cite flexibility and adaptability as important concerns for future EO programs. In responses to questions 3, 7, and 10, utilities express concerns that energy efficiency is an exhaustible or depleting resource, thus suggesting that flexibility in goals and spending could be required. The utilities' joint response to question 10 states, "Future savings… are likely to be somewhat more expensive to achieve than in the past." And, the joint response to question 7 reports, "DTE Energy estimates it will cost 2.9% of its electric revenue by 2015 and 4.3% by 2020 for each 1% of savings." The utilities point out challenges associated with continuing to meet Michigan's EO standard in a cost-effective manner and within the budget of the legislated 2% cap on utility revenues. For example, DTE Energy predicts higher costs and limited growth in savings for its electric EO program efforts in 2013 through 2015. DTE cites these challenges:

- gradually tightening evaluations of energy efficiency measure and program savings being used in Michigan, including adjustments to account for "free riders;"[37]
- gradually tightening federal mandatory manufacturing standards for appliances and lighting;
- reduced forecasts for future avoided energy costs associated with lower power and capacity prices in Michigan's and the region's electricity markets;
- increasing difficulty in attracting program participants once early adopters have taken advantage of program offerings; and,
- the success of programming in the early years reducing the potential pool of future savings to be tapped.

Bill's response to question 2 also notes a proposed progression in the stringency of Michigan's energy efficiency construction code. He relates the need to verify the accuracy of predicted energy savings and evaluate the cost-effectiveness of incremental efficiency expenditures in buildings. The GDS study (2013a, p. 37) includes a discussion of similar factors, under the rubric of "naturally occurring conservation."

[37] The term "free rider" refers to "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" (GDS, 2013a, p. 10).

Consumers Energy cites some of the same challenges, and both Consumers Energy and joint utility comments identify the importance of the newly published study of Michigan's energy optimization opportunities (GDS, 2013a). Consumers Energy states:

> There is [a] critical need for a comprehensive and industry peer reviewed potential study which accounts for the current baseline conditions, efficiency gains to date, changing codes and standards, as well as up-to-date deemed savings values in order to properly forecast remaining efficiency potential in Michigan.[38]

The joint response to question 10 concludes:

> A current and rigorous energy efficiency potential study for the state of Michigan that factors in the latest changes in baselines, Michigan Energy Measures Database deemed savings values, and codes and standards, as well as other criteria identified by interested stakeholders, would best serve to inform the planning process.

In contrast to the utility's point of view about challenges associated with continuing to achieve or exceed EO standard goals while maintaining spending below current caps, some responses from other parties claim that Michigan could do more. For example, both NRDC and MEECC assert that Michigan could easily double its efficiency standard to 2% per year. In its response to question 3, MEECC states unequivocally that the Michigan standards can be met through 2015. It says that meeting the current standard is "no problem… [and] even higher levels of savings can be achieved." Reports cited in support of this contention include broad-based energy efficiency studies from the Alliance to Save Energy (2013), Electric Power Research Institute (2009), McKinsey & Company (Granade *et al*., 2009), and the National Academy of Sciences (2010). Some of those studies conclude that a large potential remains for achieving cost-effective energy optimization. Also, MLUI provides an excerpt from an Efficiency Vermont report, purporting to show energy efficiency savings as a percent of Vermont's electricity needs from 2000 through 2010, and indicating performance in the past few years achieving savings greater than the existing Michigan standard of 1%.[39] MEECC cites as evidence Michigan's state-wide program evaluation reports (Efficiency United 2012, MPSC 2012a, and MPSC Staff 2013), which MEECC says show that Michigan's EO standards have been surpassed each year.

MEECC also reports that Michigan utilities are "rationing" EO, as a means of keeping within program budgets, but also with the result of obtaining less than the readily-achievable potential. According to MEECC, one Michigan investor-owned utility (IOU) is reducing "incentive and rebate levels to extend the life of its energy efficiency programs" and another

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38 In estimating costs and energy savings, Michigan energy efficiency program administrators and evaluators utilize a shared "deemed savings" database, called the *MI energy measures database*, which uses data from engineering calculations and actual experience to estimate savings from specific energy efficiency measures. See MPSC, 2013.

39 Jim's comment, on behalf of MLUI, refers to providing information from "several studies," but only the single page from Efficiency Vermont is attached. Additional related information is included in the MLUI presentation from the April 22 forum in Traverse City, which is linked here: http://www.michigan.gov/documents/energy/6_-_MLUI_LCV_Voss_418818_7.pdf

IOU "will be turning off its energy optimization program in June." "Both IOUs," says MEECC, "publicly cite high-paced uptake of energy efficiency upgrades by ratepayers as the reason to reduce incentives or close their program." MEECC explains that Michigan's EO spending cap creates problems for energy efficiency contractors:

> Having to reduce rebates or shut down programs causes significant internal restructuring of direct utility staff and implementation contractors hired to design and manage these programs. In the case of reduction, new marketing pieces and campaigns have to be launched; trainings conducted and handled an increase in customer service calls. All of this adds to the cost of administering the programs, thus reducing the amount of savings that could otherwise be achieved.

NRDC is also critical of spending caps. It concludes that spending caps force utilities to make investments on less cost-effective resources, encouraging utilities to focus more exclusively on "low-hanging fruit," rather than long-term savings programs. NRDC introduces a study that models savings for Pennsylvania utility customers in capped and un-capped scenarios. This study (Optimal Energy, 2011) found that customers would save $932 million in a capped scenario, and $1.6 billion without a cap.

NRDC comments also make note of the newly released statewide energy efficiency potential study (GDS, 2013a). However, NRDC also points out some of the difficulties inherent in assessing the statewide achievable potential. NRDC states:

> Moreover, efficiency potential studies have important limitations that tend to lead to systematic under-estimates of achievable potential. Perhaps most notably - and by definition - they cannot fully account for the emergence of new technology, new services, or new efficiency program designs that will increase the savings that will actually be able to be achieved in the future.

Thus, NRDC suggests, "[W]hile efficiency potential studies can provide some valuable insights, it is likely more instructive to examine what leading jurisdictions are actually achieving and/or planning to achieve in the near future."

As the GDS study (2013a, p. 34) of Michigan's EO potential confirms:

> The study scope includes measures and practices that are currently commercially available as well as emerging technologies. The commercially available measures are of the most immediate interest to DSM program planners in Michigan. However, a small number of well documented emerging technologies were considered for each sector. Emerging technology research was focused on measures that are commercially available but may not be widely accepted at the current time.

Another subject that multiple commenters target for flexibility and adaptability is about how standard benefit-cost tests are applied during EO program planning. Responding to question 2, both Chuck and Naomi refer to documents produced by the National Action Plan for Energy Efficiency (2006, Chapter 6), which they say review best-practices in cost-effectiveness testing. The GDS report (2013a, p. 45) includes a primer and the Synapse report (Malone *et al*., 2013) provides more extensive explanations about benefit-cost testing. DTE Energy in responses to questions 14 and 16 explains that the Utility System Resource Cost Test is the primary one used in Michigan, based on assessments of utility costs compared to first year energy savings. As DTE and other parties point out, the requirement for use of the USRCT is incorporated in Michigan's *Clean, Renewable, and Efficient Energy Act* (MCL 460.1073).

Some of the emphasis on flexibility comes in response to question 16, which asks about addressing "long-lifecycle programming such as interest rate buy-downs, home performance programs, industrial whole process programs, and deep savings programs for business customers." The difficulty in pursuing such programs in the context of a utility ratepayer funded EO program is that their inherent program costs can be high relative to first year energy savings. DTE comments,

> [L]ong-lifecycle programs like home energy consultation and weatherization are less cost effective (higher cost per MWh saved) in comparison to other programs in the portfolio. When compared based on <u>lifetime savings</u>…deep savings programs remain the most expensive options.

Consumers Energy discusses some of the deep savings programs that Michigan's utilities offer. According to Consumers Energy, these include a *Home Performance with Energy Star* bonus for residential retrofits and Michigan Saves^{SM} financing which provides interest-rate buy-downs for energy efficiency loans. Consumers Energy also mentions its pilot program, called the *Multiple Measure Pilot*, which offers incentives when multiple energy efficiency measures are applied for simultaneously. Consumers Energy offers this as an example of a graduated incentive program, and expresses the goal of encouraging deeper project savings. In this context, Consumers Energy also mentions property-assessed clean energy (PACE) financing and provides a table that compares deep savings programs in other jurisdictions, including California, Connecticut, District of Columbia, Maryland, New Jersey, and Wisconsin. These programs vary in requirements and incentives. As many of these examples demonstrate, public-private partnerships that create easy access to inexpensive energy efficiency financing can be essential elements for successfully packaging deep-savings projects so that they pass the USRCT.

C. Improving EO opportunities for all customer classes, with special attention to low-income programming

Several comments focus on alternatives for improving EO opportunities for specific customer classes.

Responses from 5 Lakes Energy and SunSpace Energy Systems focus primarily on the residential sector. Both commenters point to the US Department of Energy's "Home Energy Score Team" pilot program. This program models and assesses household energy efficiency and performance. Both commenters recommend that Michigan should monitor this program as it continues to develop. Michigan Energy Options says it is a current partner in this program, and is "working with DOE towards the standardization of metrics on home and commercial performance programs in the state of Michigan."

Comments from Thom, in response to question 10, describe successful experience with a sequence of energy efficiency investments in the Grand Rapids Public Schools.

ABATE comments in response to question 8 recommend extending to all industrial customers the opportunity to opt for self-directed plans. ABATE suggests this would enable greater efficiency in program implementation. In comments to the draft report, ABATE adds that flexibility would be improved if industrial customers were provided the opportunity to opt-out of participation in both electric and natural gas energy efficiency / optimization programs.

MEECC comments describe how energy savings are often “left on the table” during energy efficiency work, where some of the opportunities already identified might not be pursued. MEECC opines that a 2% energy-savings standard can be secured “very easily and with existing technology.” “The issue,” MEECC says, “is to get into more housing units and businesses.”

Question 20 asks about the impact in Michigan and other jurisdictions of retail choice electricity markets. MiEEBC provides the only response to this question, and notes that:

> [T]here is not a fundamental conflict between retail choice and energy efficiency policy… [and] most… retail choice states have specific energy efficiency resource standards, similar to Michigan’s Energy Optimization Standard.

Michigan alternative energy suppliers are not prevented from offering EO services to their customers. Large industrial or commercial customers can opt to implement a self-directed EO plan, which can enable an alternative supplier to provide them with energy optimization services. Further research would be needed to examine what, if any, efficiency programs are offered by alternative suppliers.

Additionally, Michigan Energy Options raises the issue it calls “split fuel,” which arises when a customer has one utility delivering electricity and another delivering natural gas. Although some Michigan consumers receive both gas and electricity from a single provider, either Consumers Energy or DTE Energy, many others have one company providing electricity and another providing natural gas. This, in Michigan Energy Options’ opinion, can result in confusion about EO program offerings, making it more difficult for customers to engage. Michigan Energy Options calls for greater coordination between utilities.

The utility joint response to question 18 concludes by stressing that low-income weatherization programs are important, and have financial and social benefits beyond the energy savings offered. The utilities recommend that funding for these programs remain flexible, leverage all available funding sources, and continue to provide benefits to both utilities and customers.

D. Leveraging additional, private sources of funding for EO

In response to question 6, MiEIBC notes efficiency efforts can benefit by using limited ratepayer funding to leverage additional private-sector funding and low-cost financing. Better World Builders, in its response to question 9, echoes this sentiment with a specific endorsement of the Michigan Saves[SM] program. Better World Builders' comments stress the importance of rebates and loan programs for energy efficiency retrofits. And, Thom's response to question 10 provides a reference to the US Department of Agriculture's Rural Energy for America Program (REAP), suggesting it is an example of an underutilized incentive program which could be another source of non-utility funding.

In this context, it should be noted that the GDS study of Michigan EO potential is based on a standard EO funding model where utility ratepayer funding provides 50% of the incremental cost of higher energy efficiency measures. As the comments on this subject suggest, there can be other means of attracting customer attention and financing improvements. To the extent that utility ratepayer funding can be stretched further by creatively combining utility incentives with other public and private programs, more EO can be achieved within existing spending caps and passing the USRCT.

E. Including non-traditional EO efforts to produce utility system benefits

Questions 15 and 19 are especially focused on non-traditional EO efforts and producing utility system benefits. Comments on these topics were submitted by Consumers Energy, Dow Chemical, DTE Energy, MECA, MiEIBC, the Nature Conservancy, and NRDC.

No commenters analyze the effect of including or not including non-traditional energy efficiency in utility EO programming. Instead, the responses examine various types of non-traditional proposals and make suggestions for further opportunities. Questions to be addressed by policy makers could include the extent to which non-traditional EO might be included in utility EO programming budgets and goals or whether and how to include non-traditional efforts by some other means.

Consumers Energy details some jurisdictions with peak-shaving initiatives.[40] And, Consumers Energy reports that in other states, specific utilities have received Commission approvals for peak-clipping programs without there being a specifically-related energy efficiency program mandate.[41] Consumers Energy discusses a 2007 study that assessed wholesale price savings resulting from peak shaving. This study found a price reduction of 5%-8% with a 3% reduction in peak load for the PJM interconnection (The Brattle Group, 2007). Consumers Energy says that another study by the Brattle Group and a Pennsylvania assessment of wholesale price and cost effectiveness are forthcoming (GDS Associates, 2013a and The Brattle Group, 2010).

Demand response provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods in response to time-based rates or other forms of financial incentives.[42] Consumers Energy discusses difficulties in implementing demand reduction programs under Michigan's existing EO

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[40] These jurisdictions include Delaware, Illinois, Maryland, New Jersey, Ohio, and Pennsylvania.

[41] These jurisdictions include Indiana, Virginia, and Wisconsin.

[42] http://energy.gov/oe/technology-development/smart-grid/demand-response

programs structure and incentives. Michigan's EO program does not, in Consumers Energy's opinion, allow proper incentives for demand response programs. Consumers Energy says that demand response programs do not qualify for EO incentives, and would make it more difficult for utilities to meet their efficiency targets.

DTE Energy agrees with this assessment of demand response programs:

> [I]f an energy optimization plan included investments in demand response, those investments would proportionately increase the energy savings targets for electric providers according to the provisions in PA-295. This has become a significant barrier for including demand response in energy optimization plans. Michigan PA-295 stipulates that if an electric provider uses demand response to achieve energy savings under its energy optimization plan, the minimum energy saving requirements need to be increased so that the ratio of the minimum energy savings to the total program expenditures including both general energy efficiency and demand response remains constant…This has become a significant barrier for electric providers in Michigan to justify the inclusion of demand response programs in their energy optimization plans.

However, DTE Energy reports it has already implemented some demand response programs. DTE Energy estimates the peak-reduction capability of its existing programs is 584 MW. The utility notes that the cost of demand response programs can be compared to the cost of purchasing capacity from the market or building new generating capacity, and that demand response programs will continue to develop, given economic justification.

NRDC posits that savings produced during times of peak demands will prove more cost-effective due to the higher avoided energy and capacity costs. NRDC also discusses MPSC Case No. U-17049, which allows a 1% incentive for peak savings. NRDC's opinion is that peak reductions should not be emphasized over other energy efficiency investments. NRDC states, "The best peak demand reduction strategies are energy efficiency strategies, not load-shifting."

The Nature Conservancy provides two studies that address the cost effectiveness of demand response programs (Hornby, 2011, and Woolf, 2013). These studies provide a framework for cost-effectiveness tests and an estimate of potential savings achievable through demand response techniques. Additionally, DTE Energy provides studies performed by Consolidated Edison Company of New York and the Public Service Commission of Maryland (Consolidated Edison Company of New York, 2012, and Public Service Commission of Maryland, 2012). These studies also address demand-response cost-effectiveness, but DTE Energy cautions that variations in methodology make it difficult to directly compare the results of different studies.

MECA's response discusses the opportunity to decrease system losses. According to MECA, Arkansas, Florida, Iowa, Massachusetts, Maryland, Minnesota, New York, and Vermont include transmission and distribution savings in their EERS. The response estimates that utilities lose from 2% to 15% of generation purchases to line losses. MECA suggests that efficiency savings from decreasing line losses should be a focus for utilities. MECA introduces a report, entitled "Marginal Line Losses," to further detail line losses and technological responses.

The joint utilities detail some other non-traditional programs undertaken by Michigan utilities. These include a "Web Portal Solution," which provides customers with information about energy consumption and comparisons to other customers, and "Smart Energy Drives," which works with community organizations to enroll a number of customers in energy efficiency programs. DTE Energy and Consumers Energy are also developing an Advanced Metering Infrastructure (AMI) and Smart Grid program. The utilities identify some benefits that these systems will allow:

- Deferred capital expenditures and improved asset utilization;
- Reduced generation and environmental impacts; and
- Increased options for managing energy consumption and costs.

These advantages will allow the utilities, in their estimation, to increase energy efficiency savings between 56 and 203 billion kWh by 2030 (Gelling, 2009). MiEIBC endorses the availability of customer data, and points to the White House's "Green Button Initiative." This program encourages utilities to provide customer data on the Internet. MiEIBC notes that no Michigan utility has announced participation in this program, but MiEIBC encourages an effort to make advanced-metering data available to customers. Beth's response also focuses on the availability of customer usage data. She suggests that greater consumer awareness will help consumers lower their electricity usage.

A joint utility response also examines "conservation voltage reduction," (CVR) which allows utilities to optimize system voltage. While utilities in Michigan continue to assess the application of CVR, the joint response also notes that CVR is already being utilized in some other states.[43] MiEIBC expands upon the advantages of CVR, quoting a U.S. DOE report (2012), which reports that CVR can achieve a 4 to 5% reduction in energy consumption.

MiEIBC also addresses the issue of line losses. It suggests the usage of dynamic volt-VAR, which, with the support of real-time sensors, allows utilities to control voltage and reactive power. MiEIBC also identifies opportunities for further efficiency in power generation. MiEIBC explains:

> The premier example is the use of combined heat and power, in which the heat produced to generate electricity is then used either for building heat or industrial process heat. In Michigan, some municipal utilities operate in this fashion with heat provided to customers through a district heating system. … According to the Michigan Public Service Commission's 21st Century Energy Plan, Appendix II, which was the last comprehensive assessment, Michigan has unused combined heat and power potential of more than 675 MW electricity generation capacity.

MiEIBC assesses the efficiency of power generators through the "heat rate" of a facility. This involves a comparison of a facility to similar generators. MiEIBC recommends targeting

[43] The joint response points to CVR programs undertaken by PECO in Pennsylvania and Snohomish Public Utility District in Washington.

generators with a high heat rate for targeted efficiency investments.

F. Integrating EO with utility business models

Another important topic addressed in several comments is how best to integrate EO with utility business models. The crux of this issue is that under long-standing, traditional utility regulation and rate structures, utilities' revenues are determined in large part by charges that vary depending on how much energy consumers use. Under this type of system, utilities can be averse to EO, because conservation and efficiency measures reduce consumer usage and thereby cut into utility revenues and profits. Multiple comments discuss revenue decoupling mechanisms (RDM), which are at least a partial antidote to having profits and sales levels tied directly to one another. Multiple comments cite reports published by American Council for an Energy-Efficient Economy, Regulatory Assistance Project, and NRDC (Morgan, 2012); Center for Climate and Energy Solutions (no date); National Action Plan for Energy Efficiency (2007); and National Renewable Energy Laboratory (NREL, 2009).

The Joint Parties cite the NREL report (2009) which defines decoupling as "a rate adjustment mechanism that breaks the link between the amount of energy a utility sells and the revenue it collects to recover the fixed costs of providing service to customers;" and states that a well-designed decoupling policy "reduces the costs of the ratemaking process [and] reduces costs to consumers without affecting the profit rate to investors." NRDC reports that 25 states have adopted decoupling for one or more electric or natural gas utilities.[44]

The comments of the Joint Parties and the NRDC both support the National Action Plan for Energy Efficiency's recommendation (2007) that decoupling could serve as one component of a comprehensive utility-driven energy efficiency program. However, comments from NRDC and echoed by Fred from Great Lakes Energy caution against rate structures which transfer more costs to fixed charges.

The Joint Parties and NRDC both support decoupling as a mechanism to remove, as the Joint Parties state, the disincentive that utilities have to reducing sales of their product. NRDC refers to this as the "throughput incentive" and states that when sales are higher than a sales projection set in a rate case, the utility earns more than its authorized recovery level, and if sales are lower than the projection it can earn less than its fixed costs to operate the system. The Joint Parties characterize decoupling as a "win-win" but cite the Center for Climate & Energy (no date) explanation of the contradiction between conservation and efficiency goals and the way that utility rates are currently structured.

The Joint Parties rely on the US EPA's National Energy Efficiency Action Plan in discussing a combination of multiple types of cost recovery and incentives. Specifically, the Joint Parties focus on:

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44 Please see a series of maps indicating the status of state decoupling policies as of May 2013; http://www.nrdc.org/energy/decoupling/

(1) Program Cost Recovery – reimbursement of the utility's expenses associated with energy efficiency programs, such as the staff to operate them and the cost of energy-savings products offered to customers;
(2) Lost Margin Recovery – compensation for the profit lost as a result of reduced sales of electricity or natural gas; and

(3) Performance Incentives – positive incentives for investment, with opportunities for utilities to earn more by achieving or exceeding specified energy efficiency targets.

According to the Joint Parties, decoupling is one type of mechanism that can be used to achieve lost margin recovery. Further, positive incentives can help ensure that utilities put the same kind of effort and investment into energy efficiency as they do into other aspects of their business where better performance leads to better earnings. The NRDC comments agree, also citing the National Action Plan, that decoupling is not sufficient, in itself, to create a robust energy efficiency program. However, NRDC discourages particular decoupling mechanism alternatives. NRDC specifically mentions lost revenue adjustment mechanisms, and higher fixed charges in utility rates. NRDC's expressed concern with lost revenue adjustment mechanisms is that they do not eliminate the "throughput incentive," and they are not applied symmetrically in that "found" revenues are generally not refunded to customers. NRDC's expressed concern with higher fixed charges is that they diminish the "price signal" to customers to conserve energy, and increase the payback period for customer investments in energy efficiency, making customer participation in energy efficiency efforts less likely and beneficial.

The joint utility responses and NRDC both reference a 2012 Michigan Court of Appeals decision that denies the Michigan Public Service Commission the authority to approve decoupling mechanism proposals made by electric utilities, while preserving that authority for natural gas utilities.[45]

In light of the Court of Appeals decision, the NRDC comments indicate what the RDM rate adjustments for electric utilities would have been if the proposed decoupling mechanisms had been approved. These adjustments include a 12% reduction in residential rates in the Detroit Edison territory to refund overearnings. The other utilities' adjustments, as reported by NRDC, would have totaled less than 1% in either direction. NRDC also states that Michigan's natural gas utility RDM adjustments have ranged from over 6% downward to 3% upward, though the majority of adjustments have been less than 1% in either direction.

The NRDC comments reference a recent report by Pamela Morgan that concludes, based upon a review of over 1,200 rate adjustments due to decoupling, that adjustments up or down have been modest for both electric and natural gas utilities.[46]

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45 In re Detroit Edison Co. Applications, 296 Mich. App. 101, 817 N.W.2d 630 (2012), holding that PSC exceeded its statutorily granted authority when it authorized the electric utility to adopt a Revenue Decoupling Mechanism (RDM).

46 Morgan, Pamela. A Decade of Decoupling for U.S. Energy Utilities, Rate Impacts, Designs and Observations. December 2012.

Taken together, the responses and the reports that they cite (in particular, the National Action Plan for Energy Efficiency, NREL, and Morgan reports) offer comprehensive discussions of a variety of decoupling mechanisms as well as examples of rate impacts. These resources provide data upon which to base a state-wide decoupling policy for electric and natural gas utilities. Regarding electric decoupling, a threshold challenge will be crafting and enacting language that authorizes the Public Service Commission to accept electric utility decoupling programs.

Additional Michigan-based resources that provide a diversity of policy options regarding decoupling include: Report to the Commission on the Revenue Decoupling Mechanism (RDM) Collaborative,[47] and 2012 Report on the Implementation of P.A. 295 Utility Energy Optimization Programs.[48]

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47 Appendix C to this 2011 Report provides a comprehensive matrix of Revenue Decoupling Mechanisms approved by the Commission. The body of the report offers utility and stakeholder viewpoints on the value of the various decoupling mechanisms approved. http://www.michigan.gov/documents/mpsc/decoupling_report2_15_11_345740_7.pdf?20130901164307

48 This Report (Michigan Public Service Commission, November 2012, pp. 16-17) summarizes some of the consequences of the Michigan Court of Appeals 2012 decision (In re Detroit Edison Co. Applications, 296 Mich. App. 101, 817 N.W.2d 630), which caused the Commission to dismiss pending RDM reconciliation cases without a settlement order. In the case of Detroit Edison, the company had a $127 million over-collection due to the RDM with pending reconciliations for years 2010 and 2011 at the time the cases were dismissed. Consumers Energy had an under-collection of approximately $59.6 million due to the RDM with pending reconciliations for years 2010 and 2011 at the time the cases were dismissed. http://www.michigan.gov/documents/mpsc/2012_EO_Report_404891_7.pdf

VI. Energy Efficiency Options and Analysis (Optimal Energy Phase 2 Study)

The recent potential study completed by GDS Associates (included as Appendix B) indicates that a significant amount of energy efficiency potential exists in Michigan. Building upon the potential study, Optimal Energy completed an analysis to facilitate Michigan's development of new energy savings targets. Optimal's report, Options for Establishing Energy Efficiency Targets in Michigan: 2016 – 2020, included as Appendix E, quantifies four primary options with three sub-options each that could be used to set new savings goals in Michigan. The budget associated with each option is also discussed.

Optimal Energy's Option 1, called Budget Constrained Targets, is based upon the budget constrained scenario in the GDS potential study, where energy efficiency funding was capped at 2% of utility revenue. Optimal's Option 2, Base Achievable Targets (UCT), is based upon the UCT base achievable scenario analyzed in the GDS potential study. Option 3, Base Achievable Targets (TRC) is based upon the TRC base achievable scenario analyzed in the GDS potential study. Option 4 (funded by NRDC), Max Achievable Targets (TRC) is based upon the max achievable scenario analyzed by GDS. For each option, several possibilities for targets were developed for the timeframe of 2016 – 2020.

In summary, Optimal's analysis presents a variety of options based on the following considerations in selecting how to set savings goals:

- whether the budget cap of 2% of revenues should be maintained for the new goal cycle
- whether savings should be assessed based on a first-year, adjusted first-year, or lifecycle savings perspective
- whether the UCT or TRC is the most appropriate cost-effectiveness test to screen energy savings opportunities.

In addition to these factors, Optimal opines that Michigan policymakers should consider whether annual or cumulative savings goals would be preferable.

There are a number of additional considerations that relate to the current goal-setting process as well as future opportunities. Although Michigan has only set energy savings targets in the past, it could consider including demand savings targets as part of the new goal-setting process. Setting demand targets in addition to energy targets could encourage more balanced portfolios that maximize the overall benefits of both energy and demand savings while effectively reducing the future costs of service to customers.

Additionally, the GDS potential study excluded the efficiency potential of several technologies that could provide additional opportunities for energy savings. These technologies include combined heat and power systems (CHP), geothermal heat pumps, fuel switching and on-site solar. Encouraging and allowing the use of these technologies could help Michigan maximize energy savings and increase future savings targets.

Optimal Energy presents options for efficiency savings targets that would result in annual MWh (energy) savings of 0.7% to 24.4%, annual MW (electric demand) savings of 0.7% to 25.4%, and annual natural gas MMBtu savings of 0.6% to 19%.

Table 4: Summary of Numerical Efficiency Savings Target Options for 2016 – 2020

Option	**UCT Constrained**		**UCT Base**		**TRC Base**		**TRC Max**	
	1A & 1B	**1C**	**2A & 2B**	**2C**	**3A & 3B**	**3C**	**4A& 4B**	**4C**
	1st Year & 1st Year Adjusted	**Lifecycle**	**1st Year & 1st Year Adjusted**	**Lifecycle**	**1st Year & 1st Year Adjusted**	**Lifecycle**	**1st Year & 1st Year Adjusted**	**Lifecycle**
Annual % MWh Savings Ramp- up	**2016:** 0.7% **2017:** 0.7% **2018**: 0.7% **2019:** 0.7% **2020:** 0.7%	**2016:** 7.6% **2017:** 7.6% **2018**: 7.6% **2019:** 7.6% **2020:** 7.6%	**2016:** 1.3% **2017:** 1.6% **2018**: 1.9% **2019:** 2.1% **2020:** 2.1%	**2016:** 12.8% **2017:** 15.6% **2018**: 18.4% **2019:** 21.0% **2020:** 21.0%	**2016:** 1.3% **2017:** 1.6% **2018**: 1.8% **2019:** 2.0% **2020:** 2.0%	**2016:** 12.3% **2017:** 14.6% **2018**: 16.8% **2019:** 19.0% **2020:** 19.0%	**2016:** 1.4% **2017:** 1.8% **2018**: 2.2% **2019:** 2.5% **2020:** 2.5%	**2016:** 13.6% **2017:** 17.2% **2018**: 20.8% **2019:** 24.4% **2020:** 24.4%
Annual % MW Savings Ramp-up	**2016:** 0.7% **2017:** 0.7% **2018**: 0.7% **2019:** 0.7% **2020:** 0.7%	**2016:** 7.4% **2017:** 7.4% **2018**: 7.4% **2019:** 7.4% **2020:** 7.4%	**2016:** 1.3% **2017:** 1.6% **2018**: 1.9% **2019:** 2.2% **2020:** 2.2%	**2016:** 12.8% **2017:** 15.6% **2018**: 18.4% **2019:** 21.0% **2020:** 21.0%	**2016:** 1.3% **2017:** 1.6% **2018**: 1.9% **2019:** 2.1% **2020:** 2.1%	**2016:** 12.4% **2017:** 14.8% **2018**: 17.2% **2019:** 19.4% **2020:** 19.4%	**2016:** 1.5% **2017:** 1.9% **2018**: 2.3% **2019:** 2.7% **2020:** 2.7%	**2016:** 13.9% **2017:** 17.8% **2018**: 21.7% **2019:** 25.4% **2020:** 25.4%
Annual % MMBtu Savings Ramp-up	**2016:** 0.6% **2017:** 0.6% **2018**: 0.6% **2019:** 0.6% **2020:** 0.6%	**2016:** 7.8% **2017:** 7.8% **2018**: 7.8% **2019:** 7.8% **2020:** 7.8%	**2016:** 1.0% **2017:** 1.2% **2018**: 1.4% **2019:** 1.6% **2020:** 1.6%	**2016:** 10.4% **2017:** 13.3% **2018**: 16.2% **2019:** 19.0% **2020:** 19.0%	**2016:** 0.9% **2017:** 1.1% **2018**: 1.2% **2019:** 1.3% **2020:** 1.3%	**2016:** 9.2% **2017:** 10.9% **2018**: 12.6% **2019:** 14.3% **2020:** 14.3%	**2016:** 0.9% **2017:** 1.1% **2018**: 1.3% **2019:** 1.5% **2020:** 1.5%	**2016:** 9.8% **2017:** 12.1% **2018**: 14.4% **2019:** 16.7% **2020:** 16.7%
Cumulative % MWh Savings	3.7%	38.2%	9.0%	88.8%	8.7%	81.7%	10.4%	100.4%
Cumulative % MW Savings	3.7%	37.2%	9.2%	86.0%	9.0%	83.2%	11.1%	104.2%
Cumulative % MMBtu Savings	3.2%	39.0%	6.8%	77.9%	5.8%	61.3%	6.3%	69.7%
Measure Life Goal (yrs., e=electric, g=gas)	1A: NA 1B: 10 (e) 12 (g)	NA	2A: N/A 2B: 10 (e) 12 (g)	NA	3A: NA 3B: 10 (e) 11 (g)	NA	4A: NA 4B: 10 (e) 11 (g)	NA
Annual Program Budget ($ million)	$279		$765		$474		$1,100	
Cumulative Program Budget ($ million)	$1,394		$3,825		$2,370		$5,498	
% of Utility Revenue	2.0%		5.5%		3.4%		7.9%	

The full report from Optimal Energy is included as Appendix E.

VII. Summary

Michigan has made significant progress since PA295 was enacted in 2008. The Michigan Public Service Commission and the Michigan Energy Office have taken the lead in ensuring that all aspects of PA295 are implemented to capture the total potential for energy efficiency in Michigan. Some of the noteworthy achievements, as articulated earlier in this report, are:

- Michigan's electricity and gas utilities are, on average, surpassing the standards set forth in PA 295.
- Natural gas utilities achieved 134% of their targets in 2011, while electric utilities achieved 116% of theirs; the combined average energy savings for providers met 125% of the targets created in PA 295. Actual results for 2012 also indicate the targets were met, with natural gas utilities achieving 126% of their targets, and electric utilities achieving 125% of their targets.
- Evaluation data shows that Michigan's energy savings targets were met through 2012.
- For each dollar spent on the utility EO programs during 2011, customers will benefit from $3 in avoided energy costs, and for each dollar spent on utility EO programs during 2012, it is estimated that customers benefit from approximately $3.83 in avoided energy costs (on a net present value basis).
- The total estimated savings for the 2012 program year is expected to reach $936 million on a net present value basis, and for the 2013 through 2015 program years, an additional savings of $2.8 billion is expected.
- Electric utilities have surpassed Michigan's EO standards each year since implementation.
- Estimated cost of conserved energy prices for Consumers Energy (2 cents per kWh for electricity, and $1.76 per MCF of natural gas) and DTE Energy (1 cent per kWh for its electric portfolio, and $1.50 per MCF for its gas programs).
- Based on average 2011 and 2012 electricity generation costs and natural gas commodity costs data, Michigan's EO programs are cost-effective.
- Michigan has the potential to continue to achieve incremental cost-effective savings from energy efficiency.

Bibliography

ACEEE. (2013). *State Energy Efficiency Policy Database: Iowa*. American Council for an Energy-Efficient Economy. 13 Aug 2013. Web. 3 Sep 2013. http://aceee.org/sector/state-policy/iowa

ACEEE. (No Date). *Low-Income Programs*. ACEEE. 12 Sep 2013. http://www.aceee.org/topics/low-income-programs

ACEEE. (No Date). *Michigan Efficiency for a Clean Energy Future* [Fact Sheet]. American Council for an Energy Efficient Economy,123 Solutions for States: Energy, Economy, & Environment. http://www.aceee.org/files/pdf/fact-sheet/123-michigan.pdf

Alliance Commission on National Energy Efficiency Policy. (2013). *Doubling U.S. Energy Productivity by 2030*. Alliance to Save Energy. 7 Feb 2013. http://www.ase.org/sites/default/files/full_commission_report.pdf

Barbose, Galen, *et al*. (2013). "The future of utility customer-funded energy efficiency programs in the USA: projected spending and savings to 2025,"*Energy Efficiency*, 6:475–493. DOI 10.1007/s12053-012-9187-1

Brown, M.A., *et al*. (2007). "Reduced Emissions and Lower Costs: Combining Renewable Energy and Energy Efficiency into a Sustainable Energy Portfolio Standards," *The Electricity Journal*, Volume 20, Issue 4. May. pp. 62-72. Doi:10.1016/j.tej.2007.03.005

California Energy Commission. (2001). *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects*.http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF

California Energy Commission. (2007). *Integrated Energy Policy Report*. California Energy Commission. http://www.energy.ca.gov/2007publications/CEC-100-2007-008/CEC-100-2007-008-CMF.PDF

California Public Utilities Commission. (2012). *2010 − 2011 Energy Efficiency Annual Progress Evaluation Report*.http://www.cpuc.ca.gov/NR/rdonlyres/89718A1B-C3D5-4E30-9A82-74ED155D0485/0/EnergyEfficiencyEvaluationReport.pdf

Center for Climate and Energy Solutions. (No Date). *Decoupling in detail*. http://www.c2es.org/us-states-regions/policy-maps/decoupling/detail

Coalition to Keep Michigan Warm. (2009). *Current Program and Funding Needs for Low Income Heating Assistance in Michigan*. http://efile.mpsc.state.mi.us/efile/docs/15918/0006.pdf

Consolidated Edison Company of New York, Inc. (2012). *Evaluation of Program Performance and Cost Effectiveness of Demand Response Programs*. Case No. 09-E-0115, 10-E-0229, 08-E-1463. 14 Dec 2013. http://magrid.raabassociates.org/Articles/ConEd_DRCostEffectivenessEvals2012.12.pdf

Consortium for Energy Efficiency. (2012). *State of the Efficiency Program Industry: Budgets, Expenditures, and Impacts 2012*. Apr 2012. http://www.cee1.org/annual-industry-reports

Consumers Energy. (2012). *2011 Energy Optimization Annual Report*. In MPSC Case No. U-15805: In the matter, on the Commission's own motion, regarding the regulatory reviews, revisions, determination, and/or approvals necessary for Consumers Energy Company to fully comply with Public Acts 286 and 295 of 2008. Michigan Public Service Commission. http://efile.mpsc.state.mi.us/efile/viewcase.php?casenum=15805&submit.x=-492&submit.y=-303

DSIRE. (2012). *Iowa: Incentives/Policies for Renewables & Efficiency.* Database of State Incentives for Renewables & Efficiency. 6 Nov 2012. Web. 3 Sep 2013. http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=IA12R&re=0&ee=0

DSIRE. (2013). *California: Incentives/Policies for Renewables & Efficiency.* Database of State Incentives for Renewables & Efficiency. 7 Jan 2013. Web. 4 Sep 2013.

Efficiency United. (2012). *Efficiency United 2012 Annual Report*. Efficiency United. 2012. http://www.dleg.state.mi.us/mpsc/electric/eu_annual_report_2012.pdf

EIA (2010). *Status of Electricity Restructuring by State.* United States Department of Energy, Energy Information Administration. http://www.eia.gov/electricity/policies/restructuring/restructure_elect.html

EPA. (2012). eGRID2012 (Emissions & Generation Resource Integrated Database) Version 1.0: Year 2009 Summary Tables. U.S. Environmental Protection Agency. http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2012V1_0_year09_SummaryTables.pdf

EPA. (2012). *Power Plant Emissions Calculator* [Spreadsheet]. U.S. Environmental Protection Agency. http://www.epa.gov/airquality/eere/download.html

EPRI. (2009). *Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.: (2010–2030)*. EPRI. Palo Alto, CA. 2009. http://www.michigan.gov/documents/energy/EPRI_EnergyEfficiencyPotential1-2009_418129_7.pdf

FERC. (2012). *Assessment of Demand Response and Advanced Metering*. Federal Energy Regulatory Commission. http://www.ferc.gov/legal/staff-reports/12-20-12-demand-response.pdf

Foster, Ben, *et al*. (2012). The 2012 State Energy Efficiency Scorecard. ACEEE, Report No. E12C. http://www.aceee.org/research-report/e12c

Gazze, Chris and Madlen Massarlian. (2011). "Planning for Efficiency: Forecasting the Geographic Distribution of Demand Reductions," *Public Utilities Fortnightly*, [insert volume and issue], pp. 36-41.

GDS Associates. (2013a). *Michigan Electric and Natural Gas Energy Efficiency Potential Study*. Prepared for Michigan Public Service Commission, Consumers Energy, DTE Energy. Oct 2013.

GDS Associates. (2013b). *Update on Demand Response Study*. GDS Associates. Feb 2013.

Gelling, Clark W. (2009). *The Smart Grid: Enabling Energy Efficiency and Demand Response*.

George, Anne and Stephen Rourke. *ISO on Background: Energy Efficiency Forecast* [presentation]. ISO New England. http://www.iso-ne.com/nwsiss/pr/2012/ee_forecast_final_12122012_post.pdf

Global Energy Partners, LLC. (2008). *Utility Distribution System Efficiency (DEI): Phase 1*. Northwest Energy Efficiency Alliance. http://neea.org/docs/reports/utility-distribution-system-efficiency-initiative-dei-phase-1-final-report-no-3.pdf

Gowrishankar, Vignesh, *et al*. (2013). *Combined Heat and Power Systems: Improving the Energy Efficiency of Our Manufacturing Plants, Buildings, and Other Facilities*. NRDC. April 2013. http://www.michigan.gov/documents/energy/NRDC_combined-heat-power-IP_419582_7.pdf

Granade, Hannah Choi, *et al*. (2009). *Unlocking Energy Efficiency in the U.S. Economy*. McKinsey & Company. July 2009. http://www.mckinsey.com/client_service/electric_power_and_natural_gas/latest_thinking/unlocking_energy_efficiency_in_the_us_economy

Hledik, Ryan. (2012). *The Current State of U.S Demand Response*. The Brattle Group. Apr 2012.

Hornby, Rick, *et al*. (2011). *A Review of Demand Response Potential in the United States*. U.S. Environmental Protection Agency. 21 Nov 2011. http://www.synapse-energy.com/Downloads/SynapseReport.2011-11.US-EPA.DR-Potential-Lit-Review.11-069.pdf

Ivanov, Chris. (2012). *Marginal Line Losses*. National Rural Electric Cooperative Association, Cooperative Research Network.

Kushler, Martin and Chris Neme. (2010). *Is it Time to Ditch the TRC? Examining Concerns with Current Practice in Benefit-Cost Analysis*. ACEEE. http://www.aceee.org/proceedings-paper/ss10/panel05/paper06

Kushler, Martin, *et al*. (2012). *A National Survey of State Policies and Practices for the Evaluation of Ratepayer Funded Energy Efficiency Programs*.

Lazar, Jim, and Xavier Baldwin. (2011). *Valuing the Contribution of Energy Efficiency to Marginal Line Losses and Reserve Requirements*. Regulatory Assistance Project. Aug 2011. http://www.raponline.org/featured-work/energy-efficiency-resources

LIHEAP Clearinghouse. (2013). *State LIHEAP Administering Agencies by Component*. U.S. Department of Health and Human Services. 12 Sep 2013. Web. http://www.liheap.ncat.org/admintro.htm

Malone, Erin, Tim Woolf, Kenji Takahashi, and Spencer Fields. (2013). *Cost-Effectiveness Tests Section in Energy Efficiency Policy: Summary Report*. Synapse Energy Economics, Inc., Report to Council of Michigan Foundations.

Michigan Community Action Agency Association. (No Date). *MCAAA website*. MCAAA. 24 Mar 2013. Web. http://www.mcaaa.org/

Michigan Department of Human Services. (2013). *Energy & Weatherization*. 12 Sep 2013. Web. 1 Feb 2013. http://michigan.gov/dhs/0,4562,7-124-5453_5531-15420--,00.html

Montana Department of Public Health and Human Services. (2013). *Low Income Energy Assistance*. 26 Mar 2013. Web. 2 Aug 2013.http://www.dphhs.mt.gov/programsservices/energyassistance/index.shtml

Morgan, Pamela. (2012). *A Decade of Decoupling for U.S. Energy Utilities, Rate Impacts, Designs and Observations*. Dec 2012.

MPSC Case No. U-17049: In the matter of the application of THE DETROIT EDISON COMPANY for approval of its Amended Energy Optimization Plan filed pursuant to the provisions of Public Act 295 of 2008. Michigan Public Service Commission. http://efile.mpsc.state.mi.us/efile/viewcase.php?casenum=17049&submit.x=-487&submit.y=-303

MPSC Case No. U-17138: In the matter of the application of CONSUMERS ENERGY COMPANY to amend its energy optimization plan approved in Case No. U-16670. Michigan Public Service Commission. http://efile.mpsc.state.mi.us/efile/viewcase.php?casenum=17138&submit.x=-487&submit.y=-303

MPSC Staff. (2013). *Readying Michigan to Make Good Energy Decisions: Staff Comments to Governor's Task Force*. Michigan Public Service Commission Staff, Energy Efficiency Section, Regulated Energy Division. http://www.michigan.gov/documents/energy/Ensuring_Michigans_Future_419449_7.pdf

MPSC. (2007). *Michigan's 21st Century Electric Energy Plan: Appendix – Volume II*. Michigan Public Service Commission. http://www.michigan.gov/documents/mpsc/energyplan_appendix2_185279_7.pdf

MPSC. (2010a). *Report on Efforts to Reduce Electric Peak Demand*. Michigan Public Service Commission. 27 Dec 2010. http://www.michigan.gov/documents/mpsc/reduce_peak_demand_12_10_341373_7.pdf

MPSC. (2010b). *Self-Directed EO Plan.* Michigan Public Service Commission. 14 Sep 2010. Web. 3 Sep 2013. http://www.michigan.gov/mpsc/0,4639,7-159-52495_54478---,00.html

MPSC. (2012a). *MPSC 2012 Report on PA 295 Energy Optimization Programs*. Michigan Public Service Commission. http://www.michigan.gov/documents/mpsc/2012_EO_Report_404891_7.pdf

MPSC. (2012b). *Report on the implementation of the P.A. 295 Renewable Energy Standard and the Cost-Effectiveness of the Energy Standards*. Michigan Public Service Commission. 15 Feb 2012. http://www.michigan.gov/documents/mpsc/implementation_PA295_renewable_energy2-15-2012_376924_7.pdf

MPSC. (2013). *MI energy measures database* [web page]. Michigan Public Service Commission. http://www.michigan.gov/mpsc/0,4639,7-159-52495_55129---,00.html

Nadal, S. (2006). *Energy Efficiency Resource Standards: Experience and Recommendations*. ACEEE Report E063. http://www.aceee.org/research-report/e063

National Academy of Sciences. (2010). *Real Prospects for Energy Efficiency in the United States*. National Academy of Sciences. http://www.nap.edu/catalog.php?record_id=12621

National Action Plan for Energy Efficiency. (2008). *Vision for 2025: A Framework for Change*. http://www.epa.gov/cleanenergy/documents/suca/vision.pdf

National Action Plan for Energy Efficiency. (2007). *Aligning Utility Incentives with Investment in Energy Efficiency*. Prepared by Val R. Jensen, ICF International. http://www.epa.gov/cleanenergy/documents/suca/incentives.pdf

National Renewable Energy Laboratory. (2009). *Decoupling policies: Options to encourage energy efficiency policies for utilities*. NREL/BR-6A2-46606, December 2009. http://www.nrel.gov/docs/fy10osti/46606.pdf

Navigant Consulting. (2010). Process and Impact Evaluation of Efficiency Vermont's 2007-2009 Geotargeting Program. Prepared for Vermont Department of Public Service. Navigant Consulting, 2010. http://publicservice.vermont.gov/sites/psd/files/Topics/Energy_Efficiency/EVT_Performance_Eval/Navigant_Vermont%20GeoTargeting%202010%20Process%20%20Impact%20Evaluation%20FINAL%20.pdf

Neme, Chris, and Rich Sedano. (2012).*U.S. Experience with Efficiency as a Transmission and Distribution System Resource*. Regulatory Assistance Project. http://www.raponline.org

Northwest Power and Conservation Council. (2010). *Sixth Northwest Conservation and Electric Power Plan*. Northwest Power and Conservation Council. http://www.nwcouncil.org/media/6284/SixthPowerPlan.pdf

Northwest Power and Conservation Council. (2013). *Sixth Power Plan: Mid-Term Assessment Summary*. Northwest Power and Conservation Council. Mar 2013. http://www.nwcouncil.org/media/6662000/2013-05.pdf

Nowak, Seth, *et al*. (2011). *Energy Efficiency Resource Standards: State and Utility Strategies for Higher Energy Savings*. ACEEE, Report No. U113. 15 Jun 2011. http://aceee.org/research-report/u113

NREL. (2009). Decoupling policies: Options to encourage energy efficiency policies for utilities. National Renewable Energy Laboratory. 2009.

NREL. (2012). *Including Alternative Resources in State Renewable Portfolio Standards: Current Design and Implementation Experience*. National Renewable Energy Laboratory. Nov 2012.

Optimal Energy. (2013). *Final Report: Alternative Michigan Energy Savings Goals to Promote Longer Term Savings and Address Small Utility Challenges*. Optimal Energy, Inc., Energy Futures Group. Prepared for Michigan Public Service Commission.

Optimal Energy. (2011). *Pennsylvania 2013 – 2018 Energy Efficiency Goals*. PennFuture. http://www.pennfuture.org/UserFiles/File/FactSheets/Report_Act129goals_20111220.pdf

Osborn, Julie, and Cornelia Kawann. (2001). *Reliability of the U.S. Electricity System: Recent Trends and Current Issues*. Lawrence Berkeley National Laboratory, LBNL-47043. http://emp.lbl.gov/publications/reliability-us-electricity-system-recent-trends-and-current-issues

Pennsylvania Public Utility Commission. (2012). *2011 Annual Report: Alternative Energy Portfolio Standards Act of 2004*. http://www.puc.pa.gov/electric/pdf/AEPS/AEPS_Ann_Rpt_2011.pdf.

Passive House Institute US. (2011). *Passive House Institute US*. http://www.passivehouse.us/passiveHouse/PHIUSHome.html.

PECO Energy Company. (2011). *Quarterly Report to the Pennsylvania Public Utility Commission, For the Period June through August 2011 Program Year Three*.

Potomac Economics (Independent Market Monitor for MISO). (2012). *2011 State of the Market Report for the MISO Electricity Markets.*

Prindle, B. and M. Eldridge. (2007). *The Twin Pillars of Sustainable Energy: Synergies between Energy Efficiency and Renewable Energy Technology and Policy*. ACEEE. http://www.aceee.org/sites/default/files/publications/researchreports/e074.pdf

Public Service Commission of Maryland. (2012). *The EmPower Maryland Energy Efficiency Act Standards Report of 2012 with Data for Compliance Year 2011*. Public Service Commission of Maryland. Mar 2012. http://cdm266901.cdmhost.com/cdm/singleitem/collection/p266901coll7/id/3870/rec/5

Raynolds, Ned, and Richard Cowart. (2000). *The Contribution of Energy Efficiency to the Reliability of the U.S. Electric System*. http://aceee.org/proceedings-paper/ss00/panel09/paper29

Schiller, Steve. (2013). *Cost Effectiveness Screening Issues and Options for Energy Efficiency*. Lawrence Berkeley National Laboratory. http://www.meeaconference.org/uploads/file/ppt2013/MES_2013_Thu-01-17/MES_2013_Thu-01-17_Schiller.pdf

Sciortino, *et al*. (2011). *Energy Efficiency Resource Standards: A Progress Report on State Experience*. ACEEE, Report No. U112. 15 Jun 2011. http://aceee.org/research-report/u112

Solo, Michael J. (2013). *DTE Electric Company Response to the Michigan Public Service Commission request for Comments in Case No. U-16020, Aggregators of Retail Customers in Wholesale Electric Markets*. In MPSC Case No. U-16020: In the matter of the joint request of The Detroit Edison Company, Indiana Michigan Power Company, and the Michigan Electric and Gas Association to initiate an investigation of the licensing rules and regulations needed to address the effect of the participation of Michigan retail customers, including those associated with Aggregators of retail customers in an RTO wholesale market. Michigan Public Service Commission. http://efile.mpsc.state.mi.us/efile/docs/16020/0050.pdf

Strom, Ray. (2012). *Public Utilities Commission of Ohio, Ohio's Energy Efficiency and Alternative Energy Requirements*. Sep 2012.

The Brattle Group. (2010). *Demand Response in the Midwest ISO*. The Brattle Group. Jan 2010.

The Brattle Group. (2007). *Quantifying Demand Response Benefits in PJM*. The Brattle Group. Jan 2007.

U.S. Department of Energy. (2009). *Application of Automated Controls for Voltage and Reactive Power Management – Initial Results*. U.S. Department of Energy. http://www.smartgrid.gov/sites/default/files/doc/files/VVO%20Report%20-%20Final.pdf

U.S. Department of Energy. (2012). *Demand Reductions from the Application of Advanced Metering Infrastructure, Pricing Programs, and Customer-Based Systems – Initial Results*. U.S. Department of Energy.

Wisconsin Department of Administration, Division of Energy Services. (2011). *Wisconsin Public Benefits Home Energy Plus Programs Annual Report July 1, 2010 – June 30, 2011*. 26 Mar 2013. Web. http://homeenergyplus.wi.gov/_docview.asp?docid=23001

Wisconsin PSC Case No. 5-GF-191: Quadrennial Planning Process. Public Service Commission of Wisconsin. http://psc.wi.gov/apps40/dockets/content/detail.aspx?dockt_id=5-GF-191

Wisconsin PSC. 13 Jan. 2012. Order in Case No. 5-GF-191: Quadrennial Planning Process. Wisconsin Public Service Commission. http://psc.wi.gov/apps40/dockets/content/detail.aspx?dockt_id=5-GF-191

Woolf, Tim, *et al*. (2013). *A Framework for Evaluating the Cost-Effectiveness of Demand Response*. National Forum on the National Action Plan on Demand Response. http://www.synapse-energy.com/Downloads/SynapseReport.2013-02.LBL.DR-Cost-Effectiveness.11-106A.pdf

Woolf, Tim, *et al*. (Synapse Energy Economics, Inc.). (2012). *Energy Efficiency Cost-Effectiveness Screening: How to Properly Account for 'Other Program Impacts' and Environmental Compliance Costs*. Regulatory Assistance Project. http://www.raponline.org

York, Dan, *et al*. (2012). *A National Review of Natural Gas Energy Efficiency Programs*. ACEEE, Report No. U121. http://aceee.org/research-report/u121

Appendices

Appendix A: An Overview of the Michigan Court of Appeals' Treatment of Michigan's Clean, Renewable, and Efficient Energy Act

Appendix B: *Michigan Electric and Natural Gas Energy Efficiency Potential Study*, Prepared for Michigan Public Service Commission by GDS Associates

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<u>Appendix A</u>

An Overview of the Michigan Court of Appeals' Treatment of Michigan's *Clean, Renewable, and Efficient Energy Act*

This background document provides an overview of the treatment that the Michigan Court of Appeals has afforded the 2008 *Clean, Renewable, and Efficient Energy Act* ("the Act") specifically with respect to utility-filed Energy Optimization ("EO") plans.[49]

<u>Energy Optimization Plans Under the Act</u>

Public Act 295, the *Clean, Renewable, and Efficient Energy Act* (MCL 460.1001 *et al*.), states (Sec. 1(2)):

> The purpose of this act is to promote the development of clean energy, renewable energy, and energy optimization through the implementation of a clean, renewable, and energy efficient standard that will cost-effectively do all of the following:
>
> (a) Diversify the resources used to reliably meet the energy needs of consumers in this state.
> (b) Provide greater energy security through the use of indigenous energy resources available within the state.
> (c) Encourage private investment in renewable energy and energy efficiency.
> (d) Provide improved air quality and other benefits to energy consumers and citizens of this state.
>
> The Act (MCL 460.1005(e)) defines "energy optimization" as all of the following:
>
> (i) Energy efficiency.
>
> (ii) Load management, to the extent that the load management reduces overall energy usage.
>
> (iii) Energy conservation, but only to the extent that the decreases in the consumption of electricity produced by energy conservation are objectively measurable and attributable to an energy optimization plan.

Citing the statute, the Court of Appeals described Energy Optimization ("EO") Plans in the following manner:

> Broadly speaking, an energy optimization plan is designed to reduce the demand for energy and provide for load management, thereby reducing the future costs of

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[49] While Renewable Energy Plans were also at issue before the Court of Appeals, this document is limited to energy efficiency, which is within the scope of work on for this report.

> providing service to customers, "[i]n particular ... to delay the need for constructing new electric generating facilities and thereby protect consumers from incurring the costs of such construction." MCL 460.1071(2). See also MCL 460.1001(2).

In re Review of Consumers Energy Co. Renewable Energy Plan, 293 Mich. App. 254, 258-59, 820 N.W.2d 170, 173-74 (2011) appeal denied, 490 Mich. 1001, 807 N.W.2d 319 (2012). See also, In re Michigan Consol. Gas Co's Compliance With 2008 PA 286 & 295, 294 Mich. App. 119, 122, 818 N.W.2d 354, 357 (2011)

After the passage of the Act, the Michigan Public Service Commission ("PSC") issued temporary implementation orders and opened cases for all regulated electric and natural gas utilities.

Contested Issues

In two separate cases, the Association of Businesses Advocating Tariff Equity ("ABATE") appealed the PSC's acceptance of EO and Renewable Energy plans submitted by regulated utilities to the Michigan Court of Appeals. Those cases are:

(1) In re Review of Consumers Energy Co. Renewable Energy Plan, 293 Mich. App. 254, 820 N.W.2d 170 (2011), appeal denied, 490 Mich. 1001, 807 N.W.2d 319 (2012); and

(2) In re Michigan Consol. Gas Co's Compliance With 2008 PA 286 & 295, 294 Mich. App. 119, 122, 818 N.W.2d 354, 357 (2011).

In both appeals, ABATE alleged that the Michigan PSC misinterpreted the Act and argued that the Act:

(1) Does not subject natural gas transportation-only customers to EO plan surcharges of gas transportation providers; and

(2) Applies an exemption from surcharges for natural gas EO plans for electric customers who file self-directed EO plans; and

In both cases, the court rejected ABATE's arguments and affirmed the PSC's interpretation of the Act.

Standard of Review

The court first explained that the standard of review applied to PSC decisions is narrow and well-defined and that "all rates, fares, charges, classification and joint rates, regulations, practices, and services prescribed by the PSC are presumed, prima facie, to be lawful and reasonable." In re Review of Consumers Energy Co. Renewable Energy Plan, 293 Mich. App. 254, 267, 820 N.W.2d 170, 178 (2011) appeal denied, 490 Mich. 1001, 807 N.W.2d 319 (2012) (citing to *Michigan Consolidated Gas Co. v. Public Service Comm.*, 389 Mich. 624, 635–636, 209 N.W.2d 210 (1973).

With respect to review of PSC factual determinations, judicial review of administrative agency decisions must "not invade the province of exclusive administrative fact-finding by displacing an agency's choice between two reasonably differing views." *Employment Relations Comm. v. Detroit Symphony Orchestra*, 393 Mich. 116, 124 [223 N.W.2d 283] (1974)

Finally, with respect to statutory interpretation, the court stated that its primary goal is to "give effect to the intent of the Legislature…If the statutory language is unambiguous, the Legislature is presumed to have intended the meaning expressed in the statute." *Briggs Tax Serv., LLC v. Detroit Pub. Schools*, 485 Mich. 69, 76, 780 N.W.2d 753 (2010).

Substantive Determinations

1. Whether [natural gas] transportation-only customers should be subjected to EO plan surcharges

As to ABATE's first claim, the court held that the PSC correctly found that gas transportation customers are "natural gas customers" under the statute and therefore, a portion of the natural gas providers' EO plan costs could be charged back to the providers' gas transportation customers. In re Review of Consumers Energy, 293 Mich. App. 254, 269, 820 N.W.2d 170, 179 (2011)

The court relied on its analysis in an earlier unpublished opinion in which it reviewed the PSC's temporary implementation order of the Act. In that case the court agreed with the PSC that

> the Legislature intended to include natural gas transportation customers in the providers' energy optimization plans (either administered internally or run by the PSC's program administrator) and to count the transportation revenues for purposes of determining the size of the plans and the ability to implement the true-up mechanism. In re Temp. Order to Implement 2008 Pa 295, 290640, 2010 WL 4026100 (Mich. Ct. App. Oct. 14, 2010).

In reviewing the testimony in the Michigan Consolidated Gas Co. case, the court stated that it appeared as if the utility "planned that gas transportation customers would benefit from its energy optimization plan and take part in its incentives programs, even though the transportation customers receive gas commodity from a different source." In re Michigan Consol. Gas Co 294 Mich. App. 133, 818 N.W.2d 363.

2. Whether the exemption for self-directed plans applies to electric and gas providers

As to ABATE's second concern - whether an eligible electric customer, who files a self-directed energy optimization plan with its electric provider is exempt from the surcharges of only its electric provider or from both its gas and electric providers – the court again relied upon its analysis in its opinion reviewing the PSC's implementation order and agreed with the PSC's interpretation of the Act.

On this issue the PSC found that it was highly unlikely that the Legislature would have, in a section of the Act dealing explicitly with electric customers who file self-directed electric energy optimization plans, provided a loophole by which an electric sales customer who elects to do a self-directed electric program can avoid not only the electric surcharge, but also any gas surcharges assessed to gas sales customers. In re Temp. Order, 290640, 2010 WL 4026100.

> The court agreed with the PSC that the purpose of the statutory provision is to provide alternative forms of provider-based energy optimization plans, and provide coverage for the cost of funding the plans. A self-directed energy plan obviates the need for the customer to participate in its electric provider's optimization plan, and effectively replaces it. In re Michigan Consol. Gas Co's Compliance With 2008 PA 286 & 295, 294 Mich. App. 119, 135, 818 N.W.2d 354, 364 (2011)

Thus, the Court of Appeals denied ABATE's interpretation of the Act's exemption provision.

Conclusion

The court determined that the PSC correctly interpreted the Act when it held that natural gas transportation-only customers are subject to EO plan surcharges; and that electric customers who file self-directed plans are exempt only from electric surcharges.

Appendix B: Michigan Electric and Natural Gas Energy Efficiency Potential Study

Draft Prepared by GDS Associates

GDS Associates, Inc.
Engineers and Consultants

MICHIGAN ELECTRIC AND NATURAL GAS ENERGY EFFICIENCY POTENTIAL STUDY

FINAL REPORT

Prepared for:

MICHIGAN PUBLIC SERVICE COMMISSION

Consumers Energy
Count on Us

DTE Energy

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1 EXECUTIVE SUMMARY

1.1 BACKGROUND

The Michigan Public Service Commission, DTE Energy and Consumers Energy worked together to complete this 2013 study of energy efficiency potential in the state of Michigan. This energy efficiency potential study provides a roadmap for policy makers and identifies the energy efficiency measures having the greatest potential 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 Associates, the consulting firm retained to conduct this study, produced the following estimates of energy efficiency potential:

- Technical potential
- Economic potential
- Achievable potential

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

1. **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.
2. **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 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.
3. **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, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.[1] Achievable savings potential savings is a subset of economic potential.

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

[1] These definitions are from the November 2007 National Action Plan for Energy Efficiency "Guide for Conducting Energy Efficiency Potential Studies"

incremental measure cost and no spending cap. Cost effectiveness of measures was determined with the Utility Cost Test.

2) **Scenario #2**: For the second scenario, achievable potential is based on measure cost effectiveness screening using the Total Resource Cost Test with utility incentives again equal to 50% of measure costs.
3) **Scenario #3**: The third scenario is a subset of Achievable Scenario #1(based on UCT). While scenario #1 assumed no spending cap on efficiency measures, Achievable Scenario #3 assumed a spending cap of approximately 2% of annual utility revenues. The third scenario assumes a spending cap of 2% of annual utility revenue in order to align the scenario with the existing legislation in the state of Michigan. According to Public Act 295 of 2008, gas and electric utilities are not permitted (without specific approval from the Commission) to spend more than 2.0% of retail sales in attempting to comply with the energy optimization performance standard.

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

- The five-year period from January 1, 2014 through December 31, 2018
- The ten-year period from January 1, 2014 through December 31, 2023

All results were developed using customized residential, commercial and industrial sector-level potential assessment analytic models and Michigan-specific cost effectiveness criteria including the most recent Michigan-specific avoided cost projections for electricity and 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) Michigan Energy Measures Database (MEMD)
2) Energy efficiency baseline studies conducted by DTE Energy and Consumers Energy
3) 2009 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 electric and 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 electric and natural gas savings for the State of Michigan. 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.

1.2 STUDY SCOPE

The study examines the potential to reduce electric consumption and peak demand and natural gas consumption through the implementation of energy efficiency technologies and practices in residential, commercial, and industrial facilities in Michigan. This study assesses electric and natural gas energy efficiency potential in Michigan over ten years, from 2014 through 2023.

The study had the following main objectives:

[2] This is the latest publicly available CBECS data released by the Energy Information Administration (EIA).

- Evaluate the electric and natural gas energy efficiency technical, economic and achievable potential savings in the State of Michigan;
- Calculate the economic and achievable potential energy efficiency savings based upon cost effectiveness screening with both the TRC and UCT benefit/cost ratios.

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. 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[3]

Not Technically Feasable	Technical Potential		
Not Technically Feasable	Not Cost Effective	Economic Potential	
Not Technically Feasable	Not Cost Effective	Market & Adoption Barriers	Achievable Potential

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 of future savings
- Projected penetration rates for energy efficiency measures
- Projections of Michigan specific electric and 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 most commercially available measures, these measure lists are not exhaustive.

With respect to non-energy benefits of energy efficiency programs, GDS did include an adder of $9.25 per ton of carbon for reduced emissions of CO2. This is the expected value for reduced carbon emissions based upon equal weighting of a scenario with no carbon taxes and a scenario where a carbon tax of $18.50 per ton is implemented in the future.

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

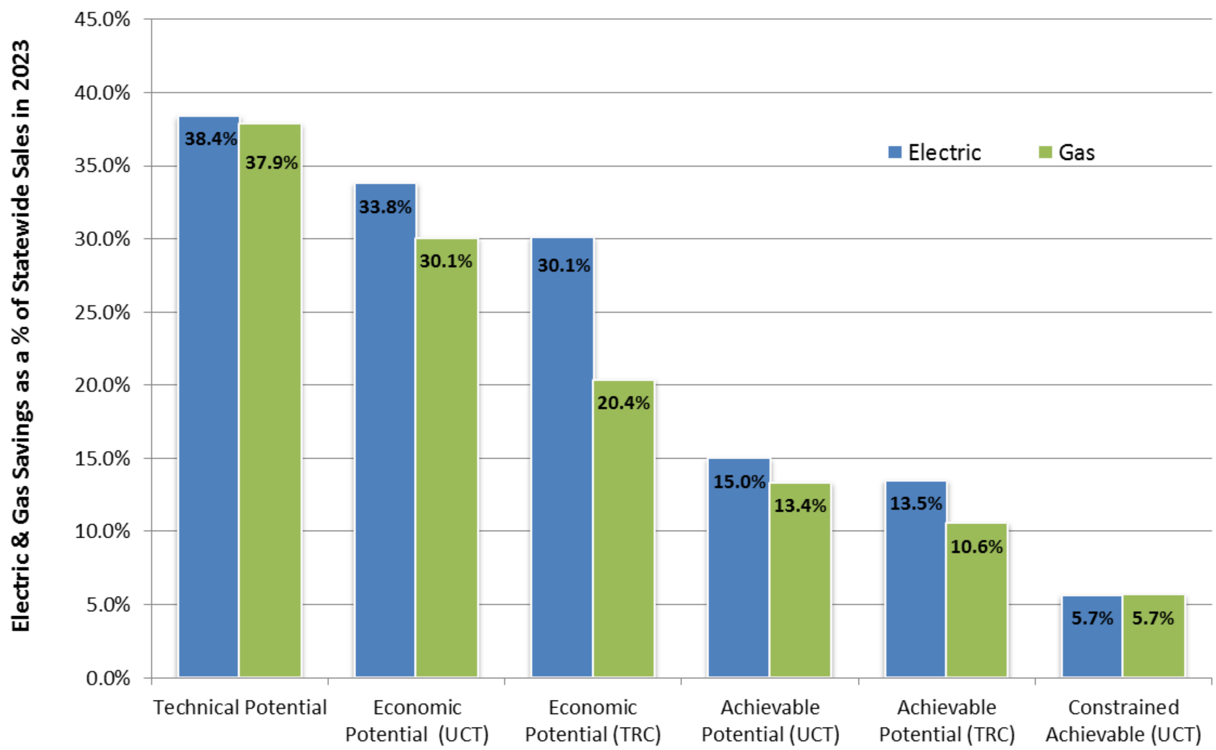
1.3 SUMMARY OF RESULTS

This study examined 1,417 electric energy efficiency measures and 922 natural gas measures in the residential, commercial and industrial sectors combined.

[3] Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. US EPA. Figure 2-1.

Figure 1-2 below shows that cost effective electric energy efficiency resources can play a significantly expanded role in Michigan's energy resource mix over the next five and ten years. For the State of Michigan overall, the achievable potential for electricity savings based on the UCT in 2023 is 15.0% of forecast kWh sales for 2023. For the State overall, the achievable potential for natural gas savings based on the UCT in 2023 is also 13.4% of forecast MMBtu sales for 2023.

Figure 1-2: Electric & Gas Energy Efficiency Potential Savings Summary



Tables 1-1 and 1-2 present additional detail, providing the energy efficiency savings potential for all scenarios over a period of 5 and 10 years, respectively.

Table 1-1: Summary of Technical, Economic and Achievable Electric and Gas Energy Savings for 2018

END USE	TECHNICAL POTENTIAL	ECONOMIC POTENTIAL (UCT)	ECONOMIC POTENTIAL (TRC)	ACHIEVABLE POTENTIAL (UCT)	ACHIEVABLE POTENTIAL (TRC)	CONSTRAINED ACHIEVABLE (UCT)
Electric Sales MWh						
Savings % - Residential	45.8%	41.3%	39.8%	10.7%	10.5%	4.3%
Savings % - Commercial	48.5%	44.9%	37.4%	12.2%	10.5%	3.1%
Savings % - Industrial	27.0%	21.0%	19.3%	4.9%	4.5%	2.3%
Savings % - Total	**40.7%**	**36.1%**	**32.4%**	**9.4%**	**8.6%**	**3.2%**
Savings mWh - Residential	15,481,730	13,967,946	13,466,463	3,622,394	3,549,596	1,465,036
Savings mWh -	18,525,217	17,186,647	14,282,862	4,651,994	4,004,548	1,188,821

END USE	TECHNICAL POTENTIAL	ECONOMIC POTENTIAL (UCT)	ECONOMIC POTENTIAL (TRC)	ACHIEVABLE POTENTIAL (UCT)	ACHIEVABLE POTENTIAL (TRC)	CONSTRAINED ACHIEVABLE (UCT)
Commercial						
Savings mWh - Industrial	9,180,717	7,133,458	6,568,017	1,674,490	1,537,639	785,903
Savings mWh - Total	**43,187,664**	**38,288,051**	**34,317,341**	**9,948,878**	**9,091,783**	**3,439,760**
Electric Demand MW						
Savings % - Residential	42.7%	38.9%	41.0%	8.4%	8.9%	3.4%
Savings % - Commercial	53.8%	49.9%	42.3%	12.2%	10.6%	3.1%
Savings % - Industrial	40.6%	30.8%	27.4%	6.7%	6.3%	3.1%
Savings % - Total	**47.0%**	**42.1%**	**39.2%**	**9.7%**	**9.2%**	**3.2%**
Savings MW - Residential	4,274	3,895	4,106	839	892	340
Savings MW - Commercial	5,715	5,300	4,496	1,292	1,127	334
Savings MW - Industrial	1,790	1,360	1210	296	278.5	138
Savings MW - Total	**11,779**	**10,555**	**9,812**	**2,426**	**2,298**	**812**
Natural Gas Sales MMBtu						
Savings % - Residential	45.9%	34.8%	19.4%	9.4%	7.1%	3.8%
Savings % - Commercial	34.6%	29.8%	24.2%	6.1%	5.4%	3.1%
Savings % - Industrial	16.1%	13.0%	12.1%	2.7%	2.5%	0.7%
Savings % - Total	**35.2%**	**27.8%**	**18.8%**	**6.8%**	**5.5%**	**2.8%**
Savings MMBtu - Residential	136,706,666	103,587,007	57,885,592	27,930,065	21,296,093	11,332,060
Savings MMBtu - Commercial	58,904,392	50,760,002	41,188,176	10,382,936	9,274,379	5,309,780
Savings MMBtu - Industrial	26,183,022	21,190,526	19,611,597	4,451,220	3,986,192	1,070,312
Savings MMBtu - Total	**221,794,080**	**175,537,535**	**118,685,365**	**42,764,221**	**34,556,665**	**17,712,153**

Table 1-2: Summary of Technical, Economic and Achievable Electric and Gas Energy Savings for 2023

END USE	TECHNICAL POTENTIAL	ECONOMIC POTENTIAL (UCT)	ECONOMIC POTENTIAL (TRC)	ACHIEVABLE POTENTIAL (UCT)	ACHIEVABLE POTENTIAL (TRC)	CONSTRAINED ACHIEVABLE (UCT)
Electric Sales MWh						
Savings % - Residential	39.7%	35.2%	33.7%	14.7%	14.3%	5.9%
Savings % - Commercial	48.0%	44.5%	37.0%	20.8%	17.6%	6.0%
Savings % - Industrial	26.4%	20.5%	18.9%	8.9%	8.1%	5.0%
Savings % - Total	**38.4%**	**33.8%**	**30.1%**	**15.0%**	**13.5%**	**5.7%**
Savings mWh - Residential	13,697,929	12,146,247	11,644,006	5,070,834	4,946,942	2,044,561
Savings mWh - Commercial	18,601,147	17,251,862	14,344,326	8,057,699	6,835,102	2,326,054
Savings mWh - Industrial	9,180,717	7,133,458	6,568,017	3,087,742	2,816,429	1,735,830
Savings mWh - Total	**41,479,793**	**36,531,567**	**32,556,350**	**16,216,275**	**14,598,473**	**6,106,445**
Electric Demand MW						
Savings % - Residential	40.5%	36.7%	38.9%	13.1%	14.1%	5.3%
Savings % - Commercial	53.2%	49.3%	41.9%	22.6%	19.7%	6.8%
Savings % - Industrial	39.7%	30.2%	26.9%	12.7%	12.0%	7.4%
Savings % - Total	**45.7%**	**40.9%**	**38.0%**	**17.0%**	**16.1%**	**6.3%**
Savings MW - Residential	4,138	3,758	3,980	1,338	1,447	540
Savings MW - Commercial	5,741	5,325	4,519	2,433	2,128	737
Savings MW - Industrial	1,790	1,360	1210	571	539.2	335
Savings MW - Total	**11,669**	**10,442**	**9,709**	**4,342**	**4,114**	**1,613**
Natural Gas Sales MMBtu						
Savings % - Residential	51.0%	38.9%	22.1%	18.9%	14.0%	7.7%
Savings % - Commercial	34.9%	30.1%	24.4%	12.3%	11.0%	6.3%
Savings % - Industrial	17.1%	13.8%	12.8%	4.4%	3.9%	1.3%
Savings % - Total	**37.9%**	**30.1%**	**20.4%**	**13.4%**	**10.6%**	**5.7%**
Savings MMBtu - Residential	143,271,591	109,298,652	62,091,152	53,178,705	39,326,470	21,495,414
Savings MMBtu - Commercial	59,047,573	50,950,115	41,298,436	20,766,093	18,548,759	10,743,415
Savings MMBtu -	26,183,022	21,190,526	19,611,597	6,677,438	6,013,211	2,038,818

END USE	TECHNICAL POTENTIAL	ECONOMIC POTENTIAL (UCT)	ECONOMIC POTENTIAL (TRC)	ACHIEVABLE POTENTIAL (UCT)	ACHIEVABLE POTENTIAL (TRC)	CONSTRAINED ACHIEVABLE (UCT)
Industrial						
Savings MMBtu - Total	**228,502,186**	**181,439,293**	**123,001,185**	**80,622,236**	**63,888,440**	**34,277,647**

Last, the five-year and ten-year budgets and acquisition costs for the achievable potential scenarios for electric and natural gas energy efficiency savings are shown in Table 1-3 and 1-4.

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 electric and natural gas savings for the three 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 energy efficiency savings.

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

ALL SECTORS COMBINED	5 - YEAR EE BUDGET	10-YEAR EE BUDGET	ACQUISITION COST PER FIRST YEAR KWH SAVED - 5 YEARS	ACQUISITION COST PER FIRST YEAR KWH SAVED - 10 YEARS
Achievable UCT	$2,644,861,311	$5,019,681,110	$0.24	$0.22
Achievable TRC	$1,678,655,015	$3,285,131,139	$0.16	$0.16
Constrained UCT	$860,355,319	$1,774,960,027	$0.22	$0.20

Table 1-4: 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	5 - YEAR EE BUDGET	10-YEAR EE BUDGET	ACQUISITION COST PER FIRST YEAR MMBTU SAVED - 5 YEARS	ACQUISITION COST PER FIRST YEAR MMBTU SAVED - 10 YEARS
Achievable UCT	$1,256,502,449	$2,506,262,004	$26.37	$25.57
Achievable TRC	$698,817,669	$1,395,301,521	$17.56	$16.86
Constrained UCT	$506,943,484	$1,031,893,201	$25.87	$24.92

Table 1-5 presents the sum of the utility energy efficiency budgets (not present valued) for five and ten years for each achievable potential scenario for electric and natural gas measures combined. The net present value budgets for five and ten years are provided in Tables 1-9 and 1-10.

Table 1-5: Achievable Potential Scenarios; Total Budgets for Electric and Natural Gas Savings Combined (Budgets Are Not in Present Value Dollars)

ALL SECTORS COMBINED	5 - YEAR EE BUDGET	10-YEAR EE BUDGET
Achievable UCT	$3,901,363,759	$7,525,943,114
Achievable TRC	$2,377,472,684	$4,680,432,660
Constrained UCT	$1,367,298,803	$2,806,853,228

Tables 1-6, 1-7 and 1-8 present the annual utility budgets in total and by sector required to achieve the savings levels in each achievable potential scenario. These tables also present annual information on the percent of annual utility revenues needed each year to fund acquiring the energy savings levels for each achievable potential scenario.

Table 1-6: Annual Program Budgets Associated with the Achievable UCT Scenario (in millions)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Residential	$310.3	$335.5	$339.7	$343.3	$344.6	$345.8	$345.6	$346.9	$346.1	$345.3
Commercial	$299.8	$363.6	$367.5	$367.6	$311.8	$318.5	$293.3	$298.1	$308.0	$307.0
Industrial	$72.4	$107.8	$125.1	$124.5	$87.7	$88.0	$69.4	$69.5	$70.4	$72.8
Total Budgets	***$682.5***	***$807.0***	***$832.4***	***$835.4***	***$744.1***	***$752.2***	**$708.3**	**$714.5**	**$724.5**	**$725.1**
% of Annual Revenue	*5.1%*	*6.0%*	*6.1%*	*6.1%*	*5.3%*	*5.3%*	*5.0%*	*5.0%*	*5.0%*	*4.9%*

Table 1-7: Annual Program Budgets Associated with the Achievable TRC Scenario (in millions)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Residential	$211.2	$236.4	$239.8	$242.6	$243.1	$243.7	$243.0	$243.8	$242.7	$241.7
Commercial	$138.8	$182.3	$198.1	$198.2	$162.8	$168.9	$152.9	$157.3	$166.2	$166.3
Industrial	$50.4	$66.2	$74.2	$74.3	$59.1	$59.6	$55.5	$52.0	$53.1	$56.2
Total Budgets	***$400.4***	***$484.9***	***$512.1***	***$515.0***	***$465.0***	***$472.2***	**$451.3**	**$453.1**	**$462.1**	**$464.2**
% of Annual Revenue	*3.0%*	*3.6%*	*3.8%*	*3.7%*	*3.3%*	*3.4%*	*3.2%*	*3.1%*	*3.2%*	*3.2%*

Table 1-8: Annual Program Budgets Associated with the Constrained UCT Scenario (in millions)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Residential	$136.3	$135.2	$135.5	$136.3	$137.0	$137.8	$138.6	$139.4	$140.2	$141.0
Commercial	$92.8	$93.7	$95.4	$96.9	$98.4	$100.0	$101.6	$103.2	$104.9	$106.5
Industrial	$40.7	$41.2	$42.0	$42.7	$43.2	$43.9	$44.5	$45.2	$46.0	$46.7
Total Budgets	***$269.8***	***$270.1***	***$272.9***	***$275.8***	***$278.7***	***$281.7***	**$284.7**	**$287.8**	**$291.0**	**$294.2**
% of Annual Revenue	*2.0%*	*2.0%*	*2.0%*	*2.0%*	*2.0%*	*2.0%*	*2.0%*	*2.0%*	*2.0%*	*2.0%*

1.4 Energy Efficiency Potential Savings Detail By Sector

Note that Sections 6, 7 and 8 of this report include additional detail about the electric and natural gas energy efficiency savings potential in Michigan by 2023.

1.5 Cost Effectiveness Findings

This study examines economic potential scenarios using the Total Resource Cost (TRC) test and the Utility Cost Test (UCT). This energy efficiency potential study concludes that significant cost effective electric and natural gas energy efficiency potential remains in in Michigan. Tables 1-9 and 1-10 show the preliminary present value benefits, costs and benefit-cost ratios for the Achievable Potential scenarios examined in this study.

Table 1-9: Benefit-Cost Ratios for Achievable Potential Scenarios For 2014 to 2018 Time Period

ACHIEVABLE POTENTIAL SCENARIOS	NPV $ BENEFITS	NPV $ COSTS	BENEFIT/COST RATIO	NET BENEFITS
Achievable UCT	$8,819,456,909	$3,452,121,731	2.55	$5,367,335,178
Achievable TRC	$9,090,916,601	$3,542,860,326	2.57	$5,548,056,275
Constrained UCT	$3,134,114,985	$1,212,231,599	2.59	$1,921,883,386

Table 1-10: Benefit-Cost Ratios for Achievable Potential Scenarios For 2014 to 2023 Time Period

ACHIEVABLE POTENTIAL SCENARIOS	NPV $ BENEFITS	NPV $ COSTS	BENEFIT/COST RATIO	NET BENEFITS
Achievable UCT	$15,854,685,097	$5,807,771,171	2.73	$10,046,913,925
Achievable TRC	$16,434,033,885	$6,063,428,268	2.71	$10,370,605,616
Constrained UCT	$5,996,092,253	$2,145,524,086	2.79	$3,850,568,167

In addition, GDS did calculate TRC and UCT benefit/cost ratios for each individual energy efficiency measure considered in this study. Only measures that had a 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 need to be cost effective in Michigan. However, for consistency in this report, GDS has excluded all non-cost effective measures from estimates of economic and achievable potential energy efficiency savings.

1.6 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: Introduction highlights the purpose of this study and the importance of energy efficiency.

Section 4: Characterization of Electric and Natural Gas Energy Consumption in Michigan provides an overview of the economic/demographic characteristics of Michigan and a brief discussion of the historical and forecasted electric and natural gas energy sales by sector as well as electric peak demand.

Section 5: Potential Study Methodology details the approach used to develop the estimates of technical, economic and achievable potential savings for electric and natural gas energy efficiency savings.

Section 6: Residential Electric and Natural Gas Energy Efficiency Potential Estimates (2013-2022) provides a breakdown of the technical, economic, and achievable energy efficiency savings potential in the residential sector.

Section 7: Commercial Sector Electric and Natural Gas Energy Efficiency Potential Estimates (2014-2023) provides a breakdown of the technical, economic, and achievable energy efficiency savings potential in the commercial sector.

Section 8: Industrial Sector Electric and Natural Gas Energy Efficiency Potential Estimates (2014-2023) provides a breakdown of the technical, economic, and achievable energy efficiency savings potential in the industrial sector.

2 GLOSSARY OF TERMS[4]

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

ACHIEVABLE POTENTIAL: The November 2007 National Action Plan for Energy Efficiency "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.

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).

AVOIDED COSTS: For purposes of this report, the electric avoided costs are defined as the generation, transmission and distribution costs that can be avoided in the future if the consumption of electricity or natural gas can be reduced with energy efficiency or demand response programs. For a natural gas utility, the avoided costs include the cost of the natural gas commodity and any other natural gas infrastructure costs that can be reduced with energy efficiency programs.

BASE ACHIEVABLE POTENTIAL: For purposes of this study, an achievable potential scenario which assumes incentives are set to 50% of the incremental or full measure cost.

BASE CASE EQUIPMENT END-USE INTENSITY: The electricity or natural gas used per customer per year by each base-case technology in each market segment. This is the consumption of the electric or natural gas energy using equipment that the efficient technology replaces or affects. For example, if the efficient measure is a high efficiency light bulb (CFL), the base end-use intensity would be the annual kWh use per bulb per household associated with an incandescent or halogen light bulb that provides equivalent lumens to the CFL.

BASE CASE FACTOR: The fraction of the market that is applicable for the efficient technology in a given market segment. For example, for the residential electric clothes washer measure, this would be the fraction of all residential customers that have an electric clothes washer in their household.

CAPITAL RECOVERY RATE (CRR): The return of invested capital expressed as an annual rate; often applied in a physical sense to wasting assets with a finite economic life.[5]

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

CONSTRAINED ACHIEVABLE: An achievable potential scenario which assumes a lower level of incentives or lower annual program budgets than in the base case scenario.

[4] Potential definitions taken from National Action Plan for Energy Efficiency (2007). "Guide for Conducting Energy Efficiency Potential Studies." Prepared by Philip Mosenthal and Jeffrey Loiter, Optimal Energy, Inc.
[5] Accuval. http://www.accuval.net/insights/glossary/

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 lives and, as a result, their savings drop off over time.

COMMERCIAL SECTOR: Comprised of non-manufacturing premises typically used to sell a product or provide a service, where electricity is consumed primarily for lighting, space cooling and heating, office equipment, refrigeration and other end uses. Business types are included in Section 5 – Methodology.

DEMAND RESPONSE: Refers to electric demand resources involving dynamic hourly load response to market conditions, such as curtailment or load control programs.

EARLY REPLACEMENT: Refers to an energy 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.

ECONOMIC POTENTIAL: The November 2007 National Action Plan for Energy Efficiency "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. Both technical and economic potential are theoretical numbers that 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, 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).

ENERGY USE INTENSITY (EUI): A unit of measurement that describes a building's energy use. EUI represents the energy consumed by a building relative to its size.[6]

FREE DRIVER: Individuals or businesses that adopt an energy efficient product or service because of an energy efficiency program, but are difficult to identify either because they do not receive an incentive or are not aware of the program.

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.

[6] See http://www.energystar.gov/index.cfm?fuseaction=buildingcontest.eui

GROSS SAVINGS: Gross energy (or demand) savings are the change in energy consumption or demand that results directly from program-promoted actions (e.g., installing energy-efficient lighting) taken by program participants regardless of the extent or nature of program influence on their actions.

INCENTIVE COSTS: A rebate or some form of payment used to encourage people 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 or demand response measures happening in that specific year.

INDUSTRIAL SECTOR: Comprised of manufacturing premises typically used for producing and processing goods, where electricity is consumed primarily for operating motors, process cooling and heating, and space heating, ventilation, and air conditioning (HVAC). Business types are included in section 5 – Methodology.

MAXIMUM (OR MAX) ACHIEVABLE: An achievable potential scenario which assumes incentives for program participants are equal to 100% of measure incremental or full costs.

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. Examples are higher-efficiency central air conditioners, occupancy sensor control of lighting, and retro-commissioning. In some cases, bundles of technologies or practices may be modeled as single measures. For example, an ENERGY STAR® ™ home package may be treated as a single measure.

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. It is the amount of energy needed to heat one pound of water by one degree Fahrenheit. 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.

NET-TO-GROSS RATIO: A factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts

NET SAVINGS: Net energy or demand savings refer to the portion of gross savings that is attributable to the program. This involves separating out the impacts that are a result of other influences, such as consumer self-motivation. Given the range of influences on consumers' energy consumption, attributing changes to one cause (i.e., a particular program) or another can be quite complex.

NON INCENTIVE COST: 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.)

NONPARTICIPANT SPILLOVER: Savings from efficiency projects implemented by those who did not directly participate in a program, but which nonetheless occurred due to the influence of the program.

PARTICIPANT COST: The cost to the participant to participate in an energy efficiency program.

PARTICIPANT SPILLOVER: Additional energy efficiency actions taken by program participants as a result of program influence, but actions that go beyond those directly subsidized or required by the program.[7]

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).

PROGRAM POTENTIAL: The November 2007 National Action Plan for Energy Efficiency 'Guide for Conducting Energy Efficiency Potential Studies" refers to the efficiency potential possible given specific program funding levels and designs as program potential. Often, program potential studies are referred to as "achievable" in contrast to "maximum achievable." In effect, they estimate the achievable potential from a given set of programs and funding. Program potential studies can consider scenarios ranging from a single program to a full portfolio of programs. A typical potential study may report a range of results based on different program funding levels.

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.

RESOURCE ACQUISITION COSTS: The cost of energy savings associated with energy efficiency programs, generally expressed in costs per first year or per lifetime MWH saved ($/MWh), kWh ($/kWh), or MMBtu ($/MMBtu) in this report.

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 (also called "early retirement") 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.

SOCIETAL COST TEST: Measures the net benefits of the energy efficiency program for a region or service area as a whole. Costs included in the SCT are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program. The SCT may also include non-energy costs, such as reduced customer comfort levels. The benefits included are the avoided costs of energy and capacity, plus environmental and other non-energy benefits that are not currently valued by the market.

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. It is often estimated as a "snapshot" in

[7] The definitions of participant and nonparticipant spillover were obtained from the National Action Plan for Energy Efficiency Report titled "Model Energy Efficiency Program Impact Evaluation Guide", November 2007, page ES-4.

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.

TOTAL RESOURCE COST TEST: The TRC measures the net benefits of the energy efficiency program for a region or service area as a whole from the combined perspective of the utility and program participants. Costs included in the TRC are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program. Costs include all costs for the utility and the participants. The benefits included are the avoided costs of energy and capacity plus any quantifiable non-energy benefits (such as reduced emissions of carbon dioxide).

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 costs of energy and capacity.

3 INTRODUCTION

This report assesses the potential for electric and natural gas energy efficiency programs to assist Michigan in meeting future energy service needs. This section of the report provides the following information:

- Defines the term "energy efficiency";
- Describes the general benefits of energy efficiency programs;
- Provides results of similar energy efficiency potential studies conducted in other states; and,
- Describes contents of the Sections of this report.

The purpose of this energy efficiency potential study is to provide a detailed assessment of the technical, economic and achievable potential for electric and natural gas energy efficiency Michigan. This study has examined a full array of energy efficiency technologies and energy efficient building practices that are technically achievable. The results of this study can be used to develop energy efficiency goals for Michigan in the short and long-term. The strategies that will be developed based on this potential study will guide direction and scope of utility administered energy efficiency programs in reducing electric and natural gas energy consumption in Michigan.

3.1 INTRODUCTION TO ENERGY EFFICIENCY

Efficient energy use, often referred to as energy efficiency, is using less energy to provide the same level of energy service. An example would be insulating a home or business in order to use less heating and cooling energy to achieve the same inside temperature. Another example would be installing fluorescent lighting in place of less efficient halogen or incandescent lights to attain the same level of illumination. Energy efficiency can be achieved through more efficient technologies and/or processes as well as through changes in individual behavior.

3.1.1 General Benefits of Energy Efficiency

There are a number of benefits that accrue to the State of Michigan due to electric and natural gas energy efficiency programs. These benefits include avoided cost savings, non-electric benefits such as water and fossil fuel savings, environmental benefits, economic stimulus, job creation, risk reduction, and energy security.

Avoided electric energy and capacity costs are based upon the costs an electric utility would incur to construct and operate new electric power plants or to purchase power from another source. These avoided costs of electricity include both fixed and variable costs that can be directly avoided through a reduction in electricity usage. The energy component includes the costs associated with the production of electricity, while the capacity component includes costs associated with the capability to deliver electric energy during peak periods. Capacity costs consist primarily of the costs associated with building peaking generation facilities. The forecasts of electric energy and capacity avoided costs and natural gas avoided costs used in this study were provided to GDS by the Michigan Public Service Commission. Avoided costs for natural gas include the avoided costs of the natural gas commodity and any other savings on the natural gas distribution system for operations and maintenance expenses or natural gas infrastructure expenditures.

At the consumer level, energy efficient products often cost more than their standard efficiency counterparts, but this additional cost is balanced by lower energy consumption and lower energy bills. Over time, the money saved from energy efficient products will pay consumers back for their initial investment as well as save them money on their electric and natural gas bills. Although some energy efficient technologies are complex and expensive, such as installing new high efficiency windows or a high efficiency boiler, many are simple and inexpensive. Installing compact fluorescent lighting or low-flow water devices, for example, can be done by most individuals.

Although the reduction in electric and natural gas costs is the primary benefit to be gained from investments in energy efficiency, the electric and natural gas utilities in Michigan, their consumers, and society as a whole can also benefit in other ways. Many electric efficiency measures also deliver non-energy benefits. For example, low-flow water devices and efficient clothes washers also reduce water consumption.[8] Similarly, weatherization measures that improve the building shell not only save on air conditioning costs in the summer, but also can save the customer money on space heating fuels, such as natural gas or propane. Reducing electricity consumption also reduces harmful emissions from power plants, such as SO_X, NO_X, CO_2 and particulates into the environment.[9]

Energy efficiency programs create both direct and indirect jobs. The manufacture and installation of energy efficiency products involves the manufacturing sector as well as research and development, service, and installation of jobs. These are skilled positions that are not easily outsourced to other states and countries. The creation of indirect jobs is more difficult to quantify, but result from households and businesses experiencing increased discretionary income from reduced energy bills. These savings produce multiplier effects, such as increased investment in other goods and services driving job creation in other markets.

Energy efficiency reduces risks associated with fuel price volatility, unanticipated capital cost increases, environmental regulations, supply shortages, and energy security. Aggressive energy efficiency programs can help eliminate or postpone the risk associated with committing to large investments for generation facilities a decade or more before they are needed. Energy efficiency is also not subject to the same supply and transportation constraints that impact fossil fuels. Finally, energy efficiency reduces competition between states and utilities for fuels, and reduces dependence on fuels imported from other states or countries to support electricity production. Energy efficiency can help meet future demand increases and reduce dependence on out-of-state or overseas resources.

3.2 THE MICHIGAN CONTEXT

3.2.1 Continuing Customer Growth

The annual kWh sales and electric system peak load for the State of Michigan is projected to increase over the next decade. From 2002 to 2011, the number of residential electric utility customers in Michigan remained fairly constant, growing at a rate of approximately 0.1% annually.[10] The electric load forecasts for Michigan developed by GDS indicates that the number of electric consumers in Michigan will continue to increase at a rate of 0.34% per year from 2014 through 2023 (the timeframe for this study) creating further growth in system electricity sales and peak demand. Natural gas sales, however, are projected to decrease slightly at a rate of -0.88% per year from 2014 to 2023. This report assesses the potential for electric and natural gas energy efficiency programs to assist the State of Michigan in meeting future electric and natural gas energy service needs.

3.2.2 Energy Efficiency Activity

Making homes and buildings more energy efficient is seen as a key strategy for addressing energy security, reducing reliance on fossil fuels from other countries, assisting consumers to lower energy bills, and addressing concerns about climate change. Faced with rapidly increasing energy prices, constraints in

[8] The ENERGY STAR web site (www.energystar.gov) states that "ENERGY STAR qualified clothes washers use about 37% less energy and use over 50% less water than regular washers".

[9] The 2012 ENERGY STAR Annual Report states that 18,000 organizations across the US partnered with the US Environmental Protection Administration to improve energy efficiency while also realizing significant environmental and financial benefits. These EPA partners and individuals helped achieve energy savings while preventing more than 1.8 billion metric tons of GHG and saving over $230 billion on utility bills. Consumers and businesses that also partnered with ENERGY STAR also reduced their utility bills by $24 billion. With the help of ENERGY STAR, Americans were able to prevent 242 million metric tons of GHG during 2012, providing over $5.8 billion in benefits to society.

[10] This is the compound average annual growth rate for residential electric customers in Michigan.

energy supply and demand, and energy reliability concerns, states are turning to energy efficiency as the most reliable, cost-effective, and quickest resource to deploy.[11]

3.2.3 Recent Energy Efficiency Potential Studies

Table 3-1 below provides the results from a GDS review of recent energy efficiency potential studies conducted throughout the United States. It is useful to examine these results to understand if they are similar to this latest study for Michigan.

Table 3-1: Results of Recent Energy Efficiency Potential Studies in the US

STATE	STUDY YEAR	AUTHOR	STUDY PERIOD	# OF YEARS	ACHIEVABLE POTENTIAL
Missouri	2011	ACEEE (1)	2011-2020	10	6.4%
District of Columbia	2013	GDS (2)	2014-2023	10	29%
New Hampshire	2009	GDS (3)	2009-2018	10	20.5%
Rhode Island	2008	KEMA (4)	2009-2018	10	9.0%
Vermont	2011	GDS/Cadmus (5)	2012-2021	10	14.3%
New York City	2010	Global Energy Partners (6)	2011-2018	8	15%
USA	2009	McKinsey & Company (7)	2011-2020	10	23.0%
Pennsylvania	2012	Statewide Evaluator (8)	2013-2023	10	17.3%

Note 1: The ACEEE energy efficiency potential study builds on several energy efficiency potential studies conducted in Missouri from 2008 through 2011 and analyzes a specific suite of energy efficiency policies and programs.

Note 2: The July 2013 District of Columbia potential study evaluated the maximum achievable potential scenario where incentives equaled 100% of measure incremental costs.

Note 3: The 2009 New Hampshire potential study figure presented here is maximum achievable potential. Maximum Achievable potential is defined in this study as the maximum penetration of an efficient measure that would be adopted absent consideration of cost or customer behavior.

Note 4: This 2010 KEMA report titled "Opportunity for Energy Efficiency That Is Cheaper Than Supply In Rhode Island" examined technical, economic and achievable potential for electric energy efficiency savings. Here is the definition of achievable potential used in that report: "Achievable program potential refers to the amount of cost-effective savings that are estimated to occur in response to a specific funded set of program activities. Achievable potential reflects *net* savings — in other words incremental savings over and above those projected to occur naturally from future changes in codes and standards or from other market activities outside of National Grid's efficiency program interventions and efforts. Achievable potential is estimated at the program level – namely groups of measures are bundled into program offerings

Note 5: The 2011 Vermont study figure presented here is maximum achievable potential. Achievable potential in this study is defined as the amount of energy use that 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 efficiency equipment).

Note 6: The 2010 New York City potential study figure provided here is maximum achievable potential.

Note 7: The 2009 McKinsey & Company potential study only includes energy efficiency measures that can be hard-wired and excludes the impacts of all behavior-based programs.

Note 8: The 2012 Pennsylvania potential study figure provided here is maximum achievable potential.

A 2012 report by the American Council for an Energy Efficient Economy (ACEEE) offers information regarding the current savings and spending related to energy efficiency by state.[12] Based on self-reported

[11] The December 2008 National Action Plan for Energy Efficiency (NAPEE) "Vision for 2025: A Framework for Change" states that "the long-term aspirational goal for the Action Plan is to achieve all cost-effective energy efficiency by the year 2025. Based on studies, the efficiency resource available may be able to meet 50% or more of the expected load growth over this time frame, similar to meeting 20% of electricity consumption and 10 percent of natural gas consumption. The benefits from achieving this magnitude of energy efficiency nationally can be estimated to be more than $100 billion in lower energy bills in 2025 than would otherwise occur, over $500 billion in net savings, and substantial reductions in greenhouse gas emissions."

[12] American Council for an Energy Efficient Economy, "The 2010 State Energy Efficiency Scorecard", Report #E107, October 2010.

data, the eleven states annually spent more than 2% of electric sales revenue on electric energy efficiency programs in 2011. GDS has also examined actual energy efficiency savings data for 2010 and 2011 from the US Energy Information Administration (EIA) on the top twenty energy efficiency electric utilities. These top twenty utilities saved over 2% of annual kWh sales in 2010 with their energy efficiency programs, and 3.8% of annual kWh sales in 2011. These percentage savings are attributable to energy efficiency measures installed in a one-year time frame and demonstrate what can be accomplished with full-scale and aggressive implementation of programs.

3.3 COST-EFFECTIVENESS FINDINGS

The Total Resource Cost Test and Utility Cost Test calculations in this study follow the prescribed methodology detailed in the latest version of the California Standard Practice Manual (CA SPM). The California Standard Practice Manual establishes standard procedures for cost-effectiveness evaluations for utility-sponsored or public benefits programs and is generally considered to be an authoritative source for defining cost-effectiveness criteria and methodology. This manual is often referenced by many other states and utilities.

The GDS cost effectiveness screening tool used for this study quantifies all of the benefits and costs included in these two tests (TRC and UCT tests). For purposes of this study, quantified benefits of the TRC Test include electric energy and capacity avoided supply costs, avoided electric transmission and distribution avoided costs, and alternative fuel and water savings. GDS has also included a risk adjusted value for reduced carbon emissions valued at $9.25 per ton of carbon emissions avoided.[13] Costs include the specified measure cost (incremental or full cost, as applicable), any increase in supply costs (electric or fossil fuel), as well as operation and maintenance costs. In addition, the GDS screening tool is capable of evaluation of cost-effectiveness based on various market replacement approaches, including replace-on-burnout, retrofit, and early retirement.

The forecast of electric and natural gas avoided costs of energy and generation capacity were obtained from the Michigan PSC. The value for electric T&D avoided costs were obtained from a report from the New York Public Service Commission based on the upstate New York region.

This energy efficiency potential study concludes that there remains significant achievable cost effective potential for electric and natural gas energy efficiency measures and programs in Michigan. Tables 3-2, 3-3 and 3-4 show benefit-cost ratios for the three scenarios examined in this study for the five and ten-year implementation periods starting in 2014.

Table 3-2: Scenario #1: Utility Cost Test Benefit-Cost Ratios for the Achievable Potential Scenario Based on UCT Screening (50% Incentives) For 5-Year and 10-Year Implementation Periods

ACHIEVABLE POTENTIAL SCENARIOS	UCT $ BENEFITS	UCT $ COSTS	UCT BENEFIT/COST RATIO
5-yr period	$8,819,456,909	$3,452,121,731	2.55
10-yr period	$15,854,685,097	$5,807,771,171	2.73

13 This value represents the expected value for reduced carbon emissions based on an equal weighting of a scenario with no carbon taxes and a scenario where carbon is valued at $18.50 per ton of reduced emissions. The $18.50 per ton figure was obtained from a recent filing by Commonwealth Edison in Illinois.

Table 3-3: Scenario #2: TRC Test Benefit-Cost Ratios for the Achievable Potential Scenario Based on TRC Screening For 5-Year and 10-Year Implementation Periods

ACHIEVABLE POTENTIAL SCENARIOS	TRC $ BENEFITS	TRC $ COSTS	TRC BENEFIT/COST RATIO
5-yr period	$9,090,916,601	$3,542,860,326	2.57
10-yr period	$16,434,033,885	$6,063,428,268	2.71

Table 3-4: Scenario #3: Benefit-Cost Ratios for the Constrained Achievable Potential Scenario Based on the UCT Test for 5-Year and 10-Year Implementation Periods

ACHIEVABLE POTENTIAL SCENARIOS	UCT $ BENEFITS	UCT $ COSTS	UCT BENEFIT/COST RATIO
5-yr period	$3,134,114,985	$1,212,231,599	2.59
10-yr period	$5,996,092,253	$2,145,524,086	2.79

4 CHARACTERIZATION OF ELECTRICITY AND NATURAL GAS CONSUMPTION IN MICHIGAN

This chapter provides up-to-date historical and forecast information on electricity and natural gas consumption, consumption by market segment and by energy end use, and electric and natural gas customers in the State of Michigan. This chapter also provides an overview of the number of households and housing units in Michigan. Developing this information is a fundamental part of any energy efficiency potential study. It is necessary to understand how energy is consumed in a state or region before one can assess the energy efficiency savings potential that remains to be tapped.

4.1 MICHIGAN ELECTRIC AND NATURAL GAS UTILITIES

There are multiple utilities that provide electric and natural gas to Michigan customers. According to data from the Michigan Public Service Commission, Michigan has 8 investor-owned electric utilities, 41 municipal electric utilities, and 10 electric distribution cooperatives. There are 6 utilities in Michigan that provide piped natural gas to consumers. The two largest electric utilities are DTE Energy Company (DTE) and Consumers Energy. These two utilities provide approximately 92% of electric energy sales in the State.

Figure 4-1 shows the service areas for electric distribution utilities in Michigan, with the largest two companies, DTE and Consumers Energy taking up much of the geographic region of the state. Note that the size of utility service areas varies greatly. Figure 4-2 displays the service areas of the utilities that distribute piped natural gas throughout the state.

Figure 4-1: Michigan Electric Utility Service Territories

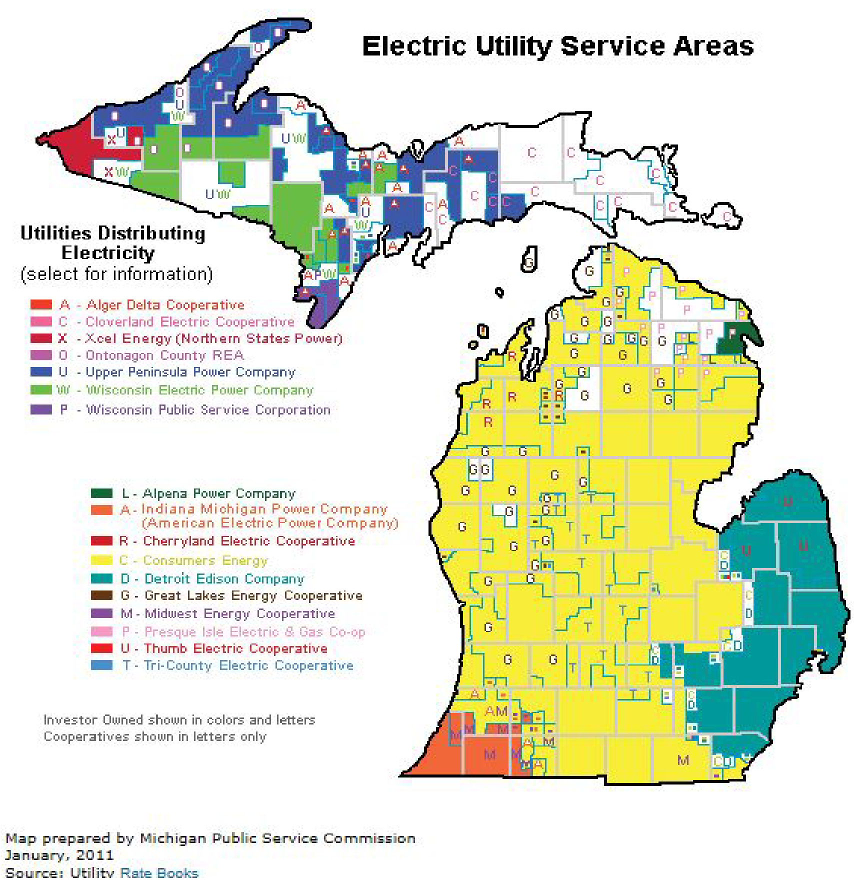
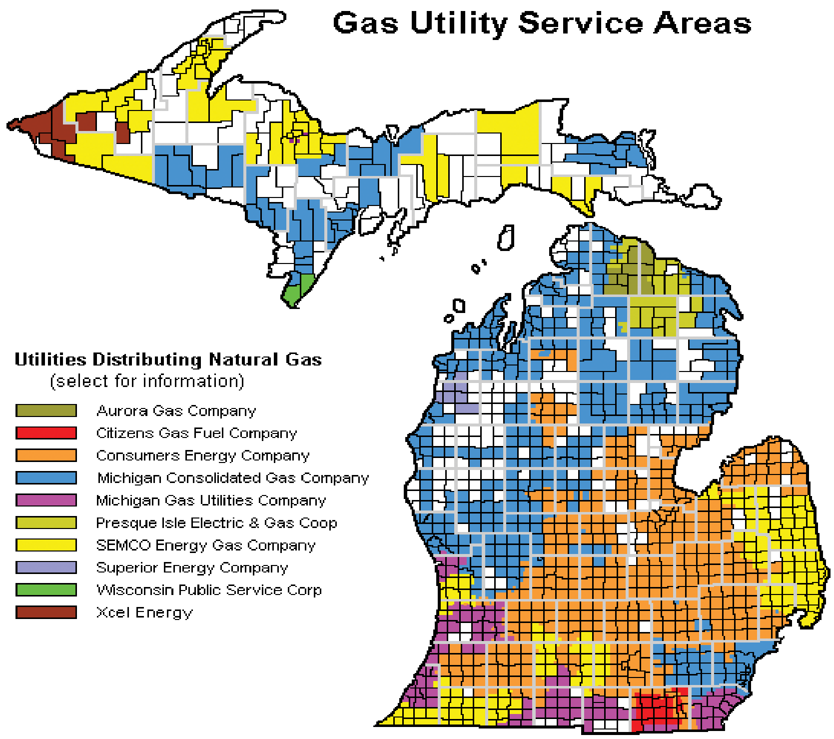


Figure 4-2: Michigan Natural Gas Utility Service Territories



Map prepared by Michigan Public Service Commission May, 1999 - Revised January, 2011

4.1.1 Detroit Edison Energy Company (DTE)

The DTE Energy provides electricity mainly in southeastern Michigan and provides natural gas services throughout the state of Michigan. DTE supplies electricity and natural gas to 2.1 million and 1.2 million customers respectively throughout the entire state.

4.1.2 Consumers Energy

Consumers Energy is one of the largest combined utilities (electric and natural gas) in the country, providing services to a population of 6.8 million of the 10 million citizens in the states.

4.2 ECONOMIC/DEMOGRAPHIC CHARACTERISTIC

Michigan is located in the Great Lakes and the Midwestern region of the United States. It is the 11th largest state. It borders Wisconsin, Ohio, Indiana, Minnesota, and Canada. Michigan is 96,810 square miles, bordering four of the Great Lakes: Lake Michigan, Lake Superior, Lake Huron, and Lake Erie. Michigan's population is 9,883,635 residents[14], ranking Michigan as the 8th most populated state in the country.

According to an estimate done by the Census Bureau, during the year 2012, there were about 175 people per square mile in the state of Michigan. The state's population distribution by age is as follows:

- Under 5 – 7.6%
- Ages 5-19 – 22.6%
- Ages 19-65 - 46.8%
- Above 65 – 23%

[14] U.S. Department of Commerce, Bureau of the Census, at www.census .gov on October 7, 2013.

The estimated number of Michigan housing units from the 2010 census was 4,532,233. Table 4-1 and Table 4-2 provides historical and forecast data for the number of electric and natural gas customers by sector in Michigan.

Table 4-1: Number of Electric Customers by Market Sector

YEAR	RESIDENTIAL ELECTRIC CUSTOMERS	COMMERCIAL ELECTRIC CUSTOMERS	INDUSTRIAL ELECTRIC CUSTOMERS	TOTAL ELECTRIC CUSTOMERS
2003	4,216,573	483,168	14,224	**4,713,965**
2004	4,248,920	504,754	14,322	**4,767,996**
2005	4,284,083	509,964	13,390	**4,807,437**
2006	4,299,273	514,049	13,317	**4,826,639**
2007	4,298,455	518,058	13,227	**4,829,740**
2008	4,290,313	518,776	12,776	**4,821,865**
2009	4,253,786	520,551	13,065	**4,787,402**
2010	4,245,158	520,233	12,827	**4,778,218**
2011	4,249,136	521,322	12,961	**4,783,419**
2012	4,249,100	520,674	12,829	**4,782,603**
2013	4,251,335	522,599	13,070	**4,787,004**
2014	4,258,028	524,034	13,108	**4,795,170**
2015	4,266,512	525,411	13,127	**4,805,050**
2016	4,277,366	526,820	13,139	**4,817,325**
2017	4,289,689	528,188	13,146	**4,831,023**
2018	4,305,113	529,714	13,153	**4,847,980**
2019	4,321,703	531,212	13,160	**4,866,075**
2020	4,338,945	532,660	13,166	**4,884,771**
2021	4,356,733	534,067	13,171	**4,903,971**
2022	4,375,466	535,463	13,177	**4,924,106**
2023	4,395,035	536,848	13,183	**4,945,066**
2024	4,415,254	535,425	13,189	**4,963,868**

Table 4-2: Number of Natural Gas Customers by Market Sector

YEAR	RESIDENTIAL NATURAL GAS CUSTOMERS	COMMERCIAL NATURAL GAS CUSTOMERS	INDUSTRIAL NATURAL GAS CUSTOMERS	TOTAL NATURAL GAS CUSTOMERS
2002	3,110,743	247,818	10,468	**3,369,029**
2003	3,140,021	246,123	10,378	**3,396,522**
2004	3,161,370	246,991	10,088	**3,418,449**
2005	3,187,583	253,415	10,049	**3,451,047**
2006	3,193,920	254,923	9,885	**3,458,728**
2007	3,188,152	253,139	9,728	**3,451,019**
2008	3,172,623	252,382	10,563	**3,435,568**
2009	3,169,026	252,017	18,186	**3,439,229**

YEAR	RESIDENTIAL NATURAL GAS CUSTOMERS	COMMERCIAL NATURAL GAS CUSTOMERS	INDUSTRIAL NATURAL GAS CUSTOMERS	TOTAL NATURAL GAS CUSTOMERS
2010	3,152,468	249,309	9,332	**3,411,109**
2011	3,153,895	249,456	9,088	**3,412,439**
2012	3,163,925	249,850	8,833	**3,422,609**
2013	3,173,955	250,245	8,579	**3,432,779**
2014	3,183,986	250,639	8,324	**3,442,949**
2015	3,197,789	251,082	8,287	**3,457,158**
2016	3,213,198	251,775	8,250	**3,473,222**
2017	3,228,297	251,653	8,212	**3,488,162**
2018	3,243,686	253,195	8,175	**3,505,055**
2019	3,258,606	253,389	8,152	**3,520,147**
2020	3,273,842	253,972	8,120	**3,535,934**
2021	3,289,150	254,559	8,087	**3,551,796**
2022	3,304,524	255,350	8,064	**3,567,938**
2023	3,319,876	255,751	8,035	**3,583,663**
2024	3,335,417	256,451	8,005	**3,599,873**

4.3 COMMERCIAL AND INDUSTRIAL SECTOR BASELINE SEGMENTATION FINDINGS

This section provides detailed information on the breakdown of commercial and industrial electricity and natural gas sales in Michigan by market segment and end use.

4.3.1 Electricity Sales by Sector, by EDC

Figure 4-3 and Table 4-3 show historical and forecast electricity sales by sector (in millions of kWh) for the State of Michigan for the period 2002 to 2024. Both DTE Energy and Consumers Energy do not have electric sales and peak load forecasts that exclude all impacts of their current energy efficiency programs. As a result, the forecast of annual electric sales for Michigan shown below do reflect the impacts of current energy efficiency programs.

Figure 4-3: Michigan Annual Electric Sales

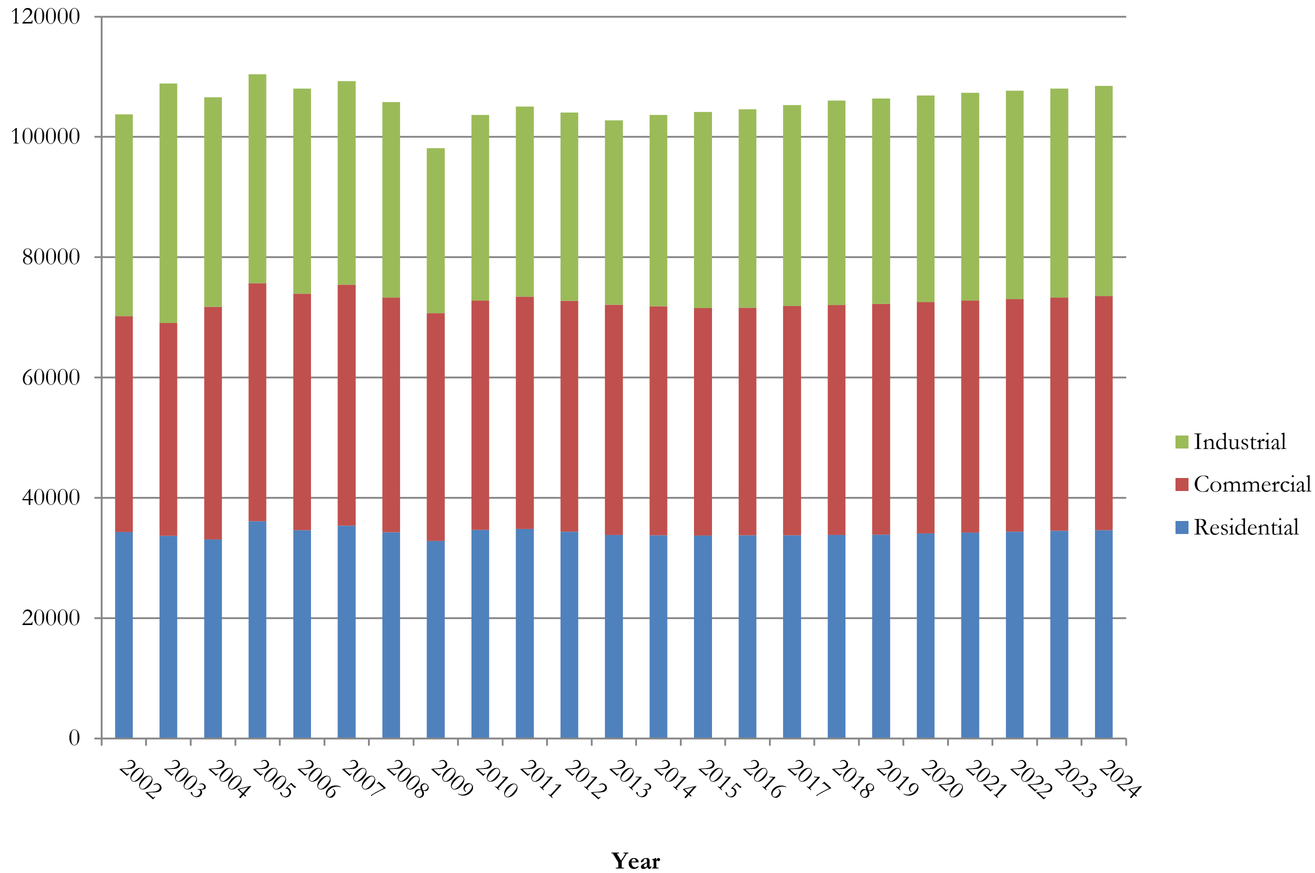


Table 4-3: Michigan Actual and Projected Electric GWh Sales by Sector

Year	Residential	Commercial	Industrial	Total
2002	34,336	35,880	33,537	**103,753**
2003	33,669	35,391	39,813	**108,873**
2004	33,104	38,632	34,867	**106,603**
2005	36,095	39,600	34,745	**110,440**
2006	34,622	39,299	34,093	**108,014**
2007	35,366	40,047	33,879	**109,292**
2008	34,297	38,974	32,505	**105,776**
2009	32,854	37,870	27,391	**98,115**
2010	34,681	38,123	30,841	**103,645**
2011	34,811	38,613	31,624	**105,048**
2012	34,400	38,367	31,305	**104,072**
2013	33,812	38,289	30,669	**102,770**
2014	33,775	38,075	31,795	**103,645**
2015	33,726	37,822	32,582	**104,130**
2016	33,797	37,807	32,987	**104,591**
2017	33,780	38,114	33,380	**105,274**

YEAR	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	TOTAL
2018	33,804	38,236	34,022	**106,062**
2019	33,903	38,349	34,149	**106,401**
2020	34,073	38,458	34,370	**106,901**
2021	34,239	38,561	34,548	**107,348**
2022	34,390	38,660	34,637	**107,687**
2023	34,503	38,789	34,746	**108,038**
2024	34,612	38,947	34,928	**108,487**

4.3.2 Natural Gas Sales by Sector, by EDC

Figure 4-4 presents historical and forecast natural gas sales by sector for the State of Michigan (in MMbtu) for the period 2002 to 2022. The commercial sector is the largest sector of natural gas sales, followed by residential and industrial. Table 4-4 presents historical and forecast data in numerical format for natural gas sales in Michigan by sector for the period 2002 to 2024. Both DTE Energy and Consumers Energy do not have natural gas sales forecasts that exclude all impacts of their current energy efficiency programs. As a result, the forecast of annual natural gas sales for Michigan shown below do reflect the impacts of current energy efficiency programs. GDS also points out that the forecast of natural gas sales for Michigan does not include natural gas used for electric generation.

Figure 4-4: Michigan Natural Gas Sales Forecast (MMBtu)

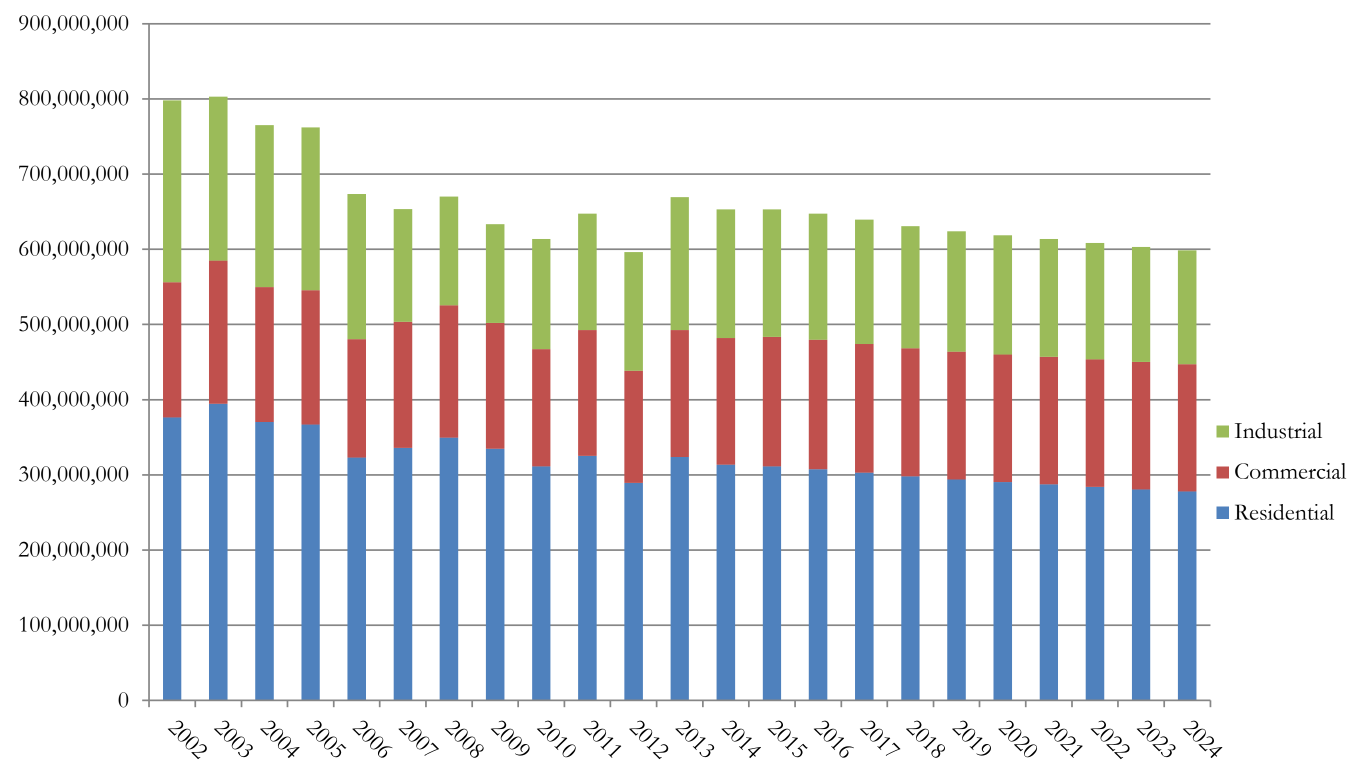


Table 4-4: Michigan Actual and Projected Natural Gas Sales by Sector (MMBtu)

YEAR	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	TOTAL
2002	376,223,595	180,058,230	241,564,059	**797,845,884**
2003	394,436,064	190,409,967	218,156,796	**803,002,827**
2004	370,350,552	179,219,370	215,342,523	**764,912,445**
2005	366,871,329	178,641,375	216,404,397	**761,917,101**
2006	323,031,687	157,435,608	192,843,684	**673,310,979**
2007	335,985,936	167,506,020	149,956,455	**653,448,411**
2008	349,614,342	176,066,484	144,429,186	**670,110,012**
2009	334,636,599	167,447,709	131,459,592	**633,543,900**
2010	311,329,590	155,854,050	146,648,073	**613,831,713**
2011	325,318,092	167,329,041	154,557,909	**647,205,042**
2012	289,473,172	149,024,502	157,851,969	**596,349,643**
2013	323,647,940	169,062,257	176,487,735	**669,197,931**
2014	313,567,812	168,397,349	170,990,963	**652,956,125**
2015	311,401,049	171,899,663	169,809,411	**653,110,123**
2016	307,589,232	172,012,348	167,730,797	**647,332,377**
2017	302,872,404	171,290,048	165,158,674	**639,321,127**
2018	297,889,970	170,273,089	162,441,714	**630,604,773**
2019	293,841,544	169,924,537	160,234,076	**624,000,158**
2020	290,497,097	169,632,911	158,410,323	**618,540,331**
2021	287,348,809	169,585,551	156,693,537	**613,627,897**
2022	284,092,085	169,475,200	154,917,620	**608,484,904**
2023	280,795,642	169,324,020	153,120,044	**603,239,706**
2024	277,777,232	169,401,943	151,474,082	**598,653,258**

4.3.3 Electricity Consumption by Market Segment

Figure 4-5 shows the breakdown of electricity consumption by building type for the commercial sector. Figure 4-6 shows a similar breakdown of sales by industrial market segment for the industrial sector. The Office market sector (29%) consumes the largest share of commercial electricity consumption, followed by Other (21%) and Retail (11%). In the industrial sector, Transportation Equipment (25% of annual industrial electricity sales) is the largest sector, followed by Primary Metals (20%) and Chemistry (10%).

Figure 4-5: 2014 Commercial Electricity Consumption by Market Segment

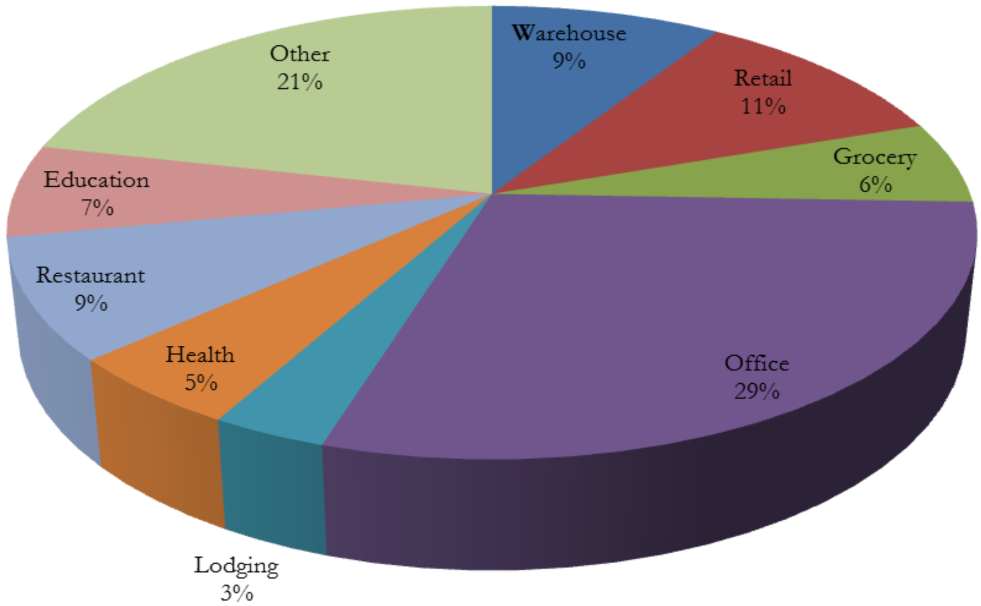


Figure 4-6: 2014 Electric Industrial Energy Consumption by Market Segment

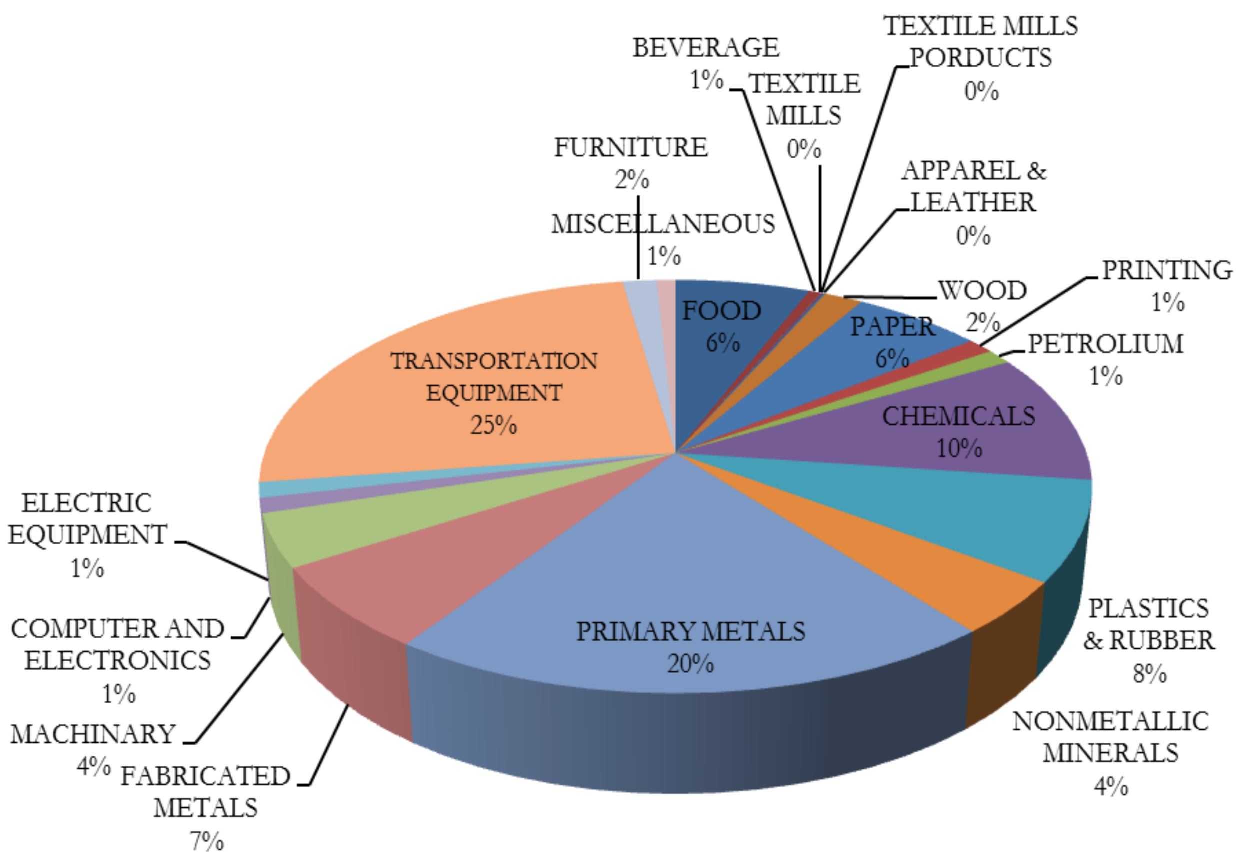


Table 4-5: 2014 Electric Industrial Energy Consumption by Segment

SEGMENT	CONSUMPTION (MWH)	ELECTRICITY SHARE
Food	1,944,291	6%
Beverage	171,696	1%
Textile Mills	3,070	0%
Textile Mill Products	51,185	0%
Apparel & Leather	19,863	0%
Wood	551,294	2%
Paper	1,871,906	6%
Printing	383,711	1%
Petroleum	378,873	1%
Chemicals	3,238,019	10%
Plastics & Rubber	2,481,706	8%
Nonmetallic Minerals	1,342,118	4%
Primary Metals	6,515,086	20%
Fabricated Metals	2,102,667	7%
Machinery	1,321,084	4%
Computer & Electronics	368,783	1%
Electric Equipment	380,700	1%
Transportation Equipment	7,904,144	25%
Furniture	492,726	2%
Miscellaneous	271,813	1%
Total	**31,794,736**	**100%**

4.3.4 Electric Consumption by End-Use

Table 4-6 shows the breakdown of electric energy consumption by commercial market segment by end use. Tables 4-7, 4-8, and 4-9 show the same breakdown for the industrial sector by market segment. Lighting is the largest end use for the commercial sector (37% of commercial sector electricity consumption), followed by cooling (14%), and then by ventilation (13%). As for the industrial sector, machine drives represent the largest end use, followed by process heating and facility HVAC.

Table 4-6: Breakdown of Michigan Commercial Electricity Sales by Market Segment and End-Use

	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other	Total
Lighting	54%	42%	22%	39%	54%	42%	19%	31%	32%	**37%**
Cooling	6%	15%	6%	14%	10%	14%	13%	21%	17%	**14%**
Ventilation	8%	9%	3%	9%	6%	16%	11%	22%	24%	**13%**
Water Heating	1%	5%	1%	1%	4%	1%	5%	3%	1%	**2%**
Refrigeration	14%	7%	55%	5%	4%	3%	32%	5%	9%	**12%**
Space Heating	1%	8%	3%	5%	6%	3%	5%	4%	4%	**4%**
Office Equipment	3%	2%	3%	15%	3%	5%	2%	9%	2%	**7%**
Miscellaneous	13%	12%	6%	13%	12%	15%	13%	6%	11%	**12%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4-7: Electric Industrial Energy Consumption by End Use (Table 1 of 3)

	Food	Beverage	Textile Mills	Textile Mill Products	Apparel & Leather	Wood	Paper
Conventional Boiler Use	3%	2%	1%	1%	1%	1%	2%
Process Heating	5%	6%	7%	9%	6%	6%	3%
Process Cooling and Refrigeration	28%	26%	9%	6%	4%	1%	1%
Machine Drive	43%	34%	54%	47%	36%	72%	75%
Electro-Chemical Processes	0%	0%	1%	1%	1%	1%	1%
Other Process Use	1%	2%	3%	1%	2%	1%	4%
Facility HVAC (g)	8%	10%	12%	16%	26%	6%	4%
Facility Lighting	8%	8%	8%	15%	16%	8%	4%
Other Facility Support	2%	2%	2%	3%	4%	2%	1%
Onsite Transportation	0%	0%	0%	0%	0%	0%	0%
Other Non-process Use	0%	0%	0%	0%	0%	1%	0%
End Use Not Reported	2%	9%	3%	1%	4%	2%	4%
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4-8: Electric Industrial Energy Consumption by End Use (Table 2 of 3)

	Printing	Petroleum	Chemicals	Plastics & Rubbers	Nonmetallic Mineral	Primary Metals
Conventional Boiler Use	1%	1%	1%	1%	0%	0%
Process Heating	4%	0%	4%	18%	26%	32%
Process Cooling and Refrigeration	5%	5%	8%	11%	3%	1%
Machine Drive	46%	83%	59%	43%	54%	28%
Electro-Chemical Processes	1%	0%	15%	0%	1%	26%
Other Process Use	1%	2%	1%	3%	2%	3%
Facility HVAC (g)	24%	4%	6%	10%	6%	4%
Facility Lighting	9%	3%	4%	8%	5%	3%
Other Facility Support	3%	1%	1%	2%	1%	1%
Onsite Transportation	0%	0%	0%	0%	0%	0%
Other Non-process Use	1%	0%	0%	0%	0%	0%
End Use Not Reported	4%	2%	1%	2%	1%	0%
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4-9: Electric Industrial Energy Consumption by End Use (Table 3 of 3)

	FABRICATED METALS	MACHINERY	COMPUTERS & ELECTRONICS	ELEC. EQUIP.	TRANS EQUIP.	FURNITURE	MISC.	TOTAL INDUSTRIAL
Conventional Boiler Use	0%	1%	1%	1%	1%	1%	1%	**277,716**
Process Heating	21%	11%	10%	15%	11%	5%	11%	**4,816,452**
Process Cooling and Refrigeration	3%	3%	9%	4%	5%	1%	5%	**1,868,622**
Machine Drive	41%	40%	23%	37%	36%	47%	30%	**13,500,396**
Electro-Chemical Processes	3%	0%	2%	5%	2%	1%	5%	**2,521,134**
Other Process Use	3%	3%	5%	4%	4%	2%	3%	**889,721**
Facility HVAC (g)	9%	20%	30%	15%	19%	18%	25%	**3,445,271**
Facility Lighting	11%	15%	12%	10%	15%	17%	14%	**2,754,603**
Other Facility Support	2%	4%	5%	7%	3%	4%	4%	**716,870**
Onsite Transportation	0%	0%	0%	0%	1%	1%	0%	**93,715**
Other Non-process Use	0%	1%	1%	0%	1%	1%	0%	**175,298**
End Use Not Reported	6%	1%	4%	0%	3%	4%	1%	**734,938**
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**31,794,736**

4.3.5 Natural Gas Consumption by Market Segment

Figure 4-7 shows the breakdown of Michigan natural gas sales by commercial market segment. Figure 4-8 and Table 4-10 show a similar breakdown for the industrial market segment. The Other segment (23%) consumes the largest share of the commercial sector natural gas consumption, followed by the Office (21%) and Education (15%) market segments. In the industrial sector, the Chemicals (21%) market segment consumes the largest amount of natural gas, followed by Transportation Equipment (19%) and Primary Metals (13%). 2010 EIA MECS End Use Data was used to obtain end use percentage breakdowns of electricity and natural gas use for each major industrial NAICS category at the national level. 2011 Census data for each major industrial NAICS category was used to obtain electricity use and fuel consumption as well as value of product shipments for each category. This was used to generate MWh of electricity per dollar of product shipped and MMBtu of natural gas per dollar of product shipped for each NAICS category, and these ratios were multiplied by the Michigan-specific values of product shipped per NAICS category to obtain estimated 2011 MWh of electricity consumption and MMBtu of natural gas consumption per NAICS category in Michigan and percent of total industrial electricity and natural gas consumption represented by each NAICS category. These NAICS category percentages were then multiplied by forecasted Michigan Industrial electricity and gas consumption for 2014 and 2023 to assign the forecasted consumption to each NAICS category. The end use percentage breakdowns were then applied to forecast total consumption for each SIC category to obtain estimated electricity and natural gas consumption for each end use in each Industrial NAICS category for 2014 and 2023.

Figure 4-7: Natural Gas Commercial Energy Consumption by Market Segment

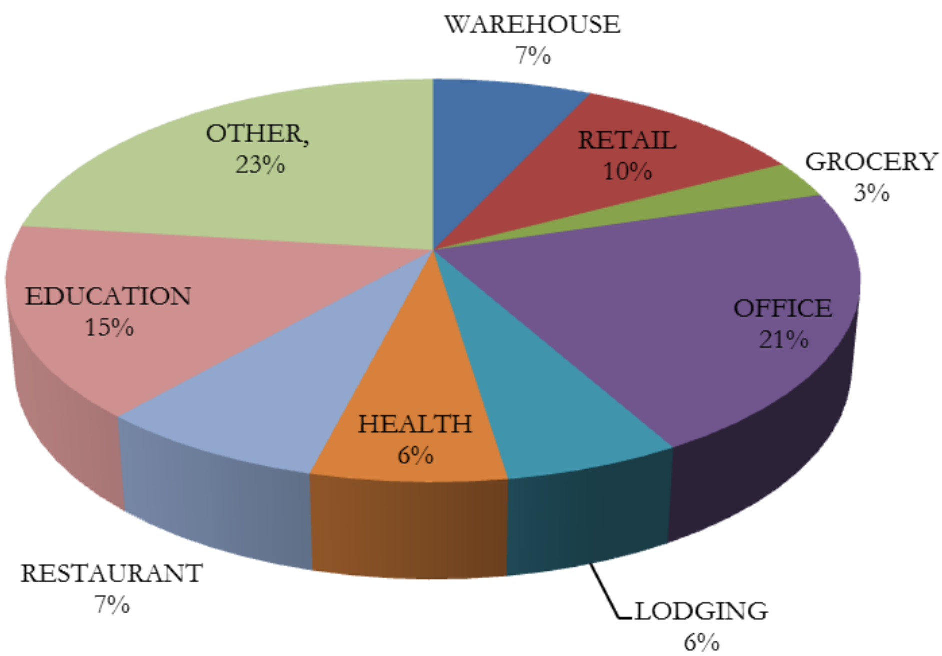


Figure 4-8: Natural Gas Industrial Energy Consumption by Market Segment

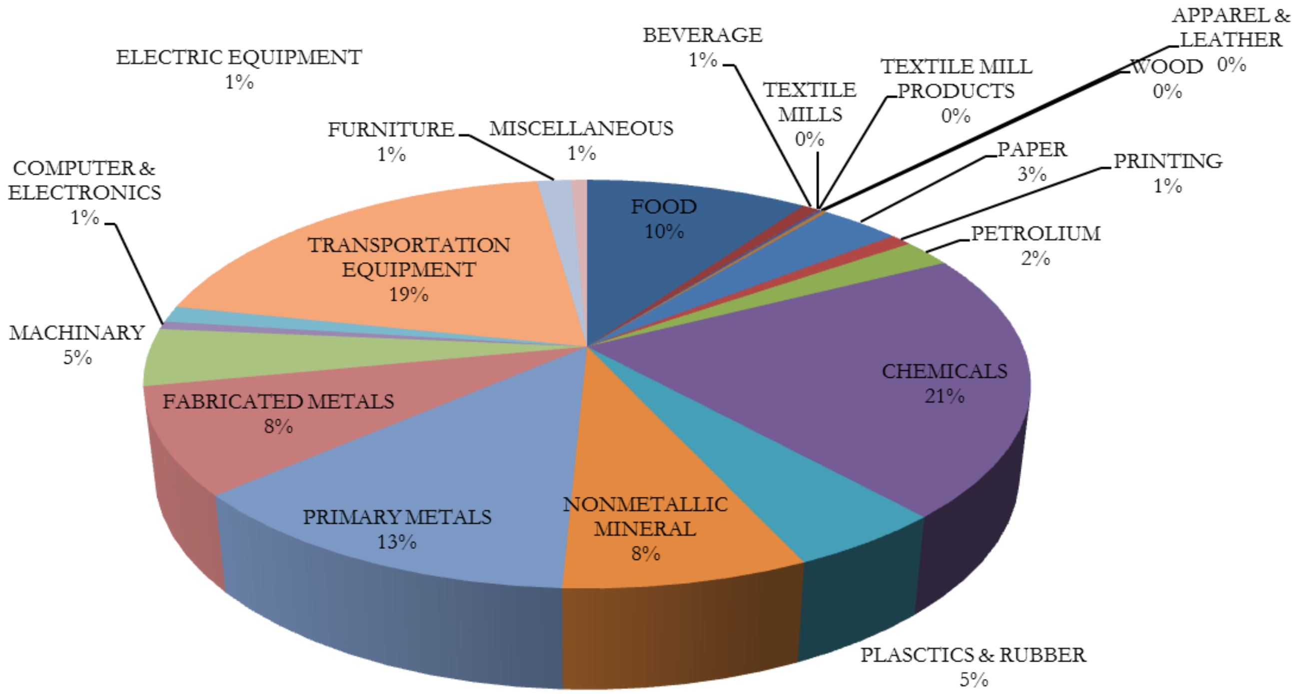


Table 4-10: Natural Gas Industrial Energy Consumption by Market Segment

SEGMENT	CONSUMPTION (MWH)	ELECTRICITY SHARE
Food	16,642,808	10%
Beverage	1,224,421	1%
Textile Mills	13,049	0%
Textile Mill Products	274,779	0%
Apparel & Leather	104,123	0%
Wood	331,865	0%
Paper	5,978,556	3%
Printing	1,635,620	1%
Petroleum	3,749,816	2%
Chemicals	36,124,119	21%
Plastics & Rubber	8,302,233	5%
Nonmetallic Minerals	12,978,192	8%
Primary Metals	21,883,749	13%
Fabricated Metals	14,532,992	8%
Machinery	7,828,921	5%
Computer & Electronics	1,082,742	1%
Electric Equipment	2,198,993	1%
Transportation Equipment	33,526,892	19%
Furniture	2,534,560	1%
Miscellaneous	1,212,561	1%

SEGMENT	CONSUMPTION (MWH)	ELECTRICITY SHARE
Total	**172,160,990**	**100%**

4.3.6 Natural Gas Consumption by End-Use

Table 4-11 shows the breakdown of natural gas consumption by commercial market segment by end use. Tables 4-12, 4-13, and 4-14 show the same breakdown for the industrial sector. The largest natural gas end use in the commercial sector is space heating, followed by water heating and cooking. In the industrial sector, the largest end use is process heating.

Table 4-11: Natural Gas Commercial Energy Consumption by End-Use

	WAREHOUSE	RETAIL	GROCERY	OFFICE	LODGING	HEALTH	RESTAURANT	EDUCATION	OTHER
Space Heating	84%	71%	69%	86%	30%	56%	27%	77%	85%
Water Heating	3%	7%	5%	5%	58%	30%	23%	14%	4%
Cooking	0%	9%	21%	1%	7%	4%	45%	2%	8%
Other	13%	13%	5%	9%	6%	9%	6%	7%	0%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**98%**

Table 4-12: Natural Gas Industrial Energy Consumption by End-Use (Table 1 of 3)

	FOOD	BEVERAGE	TEXTILE MILLS	TEXTILE MILL PRODUCTS	APPAREL & LEATHER	WOOD	PAPER
Conventional Boiler Use	28%	24%	26%	25%	25%	6%	13%
Process Heating	30%	24%	35%	38%	25%	62%	30%
CHP and/or Cogeneration Process	29%	41%	29%	25%	25%	18%	48%
Facility HVAC (g)	6%	11%	6%	13%	25%	12%	4%
Process Cooling and Refrigeration	0%	0%	0%	0%	0%	0%	0%
Machine Drive	1%	0%	0%	0%	0%	3%	3%
Other Process Use	1%	0%	0%	0%	0%	0%	1%
End Use Not Reported	1%	0%	3%	0%	0%	0%	2%
Other Facility Support	3%	0%	0%	0%	0%	0%	0%
Other Non-process Use	0%	0%	0%	0%	0%	0%	0%
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4-13: Natural Gas Industrial Energy Consumption by End-Use (Table 2 of 3)

	Printing	Petroleum	Chemicals	Plastics & Rubbers	Nonmetallic Minerals	Primary Metals
Conventional Boiler Use	10%	12%	17%	19%	1%	4%
Process Heating	45%	56%	35%	35%	87%	75%
CHP and/or Cogeneration Process	13%	22%	39%	24%	3%	8%
Facility HVAC (g)	29%	0%	1%	22%	6%	7%
Process Cooling and Refrigeration	0%	1%	0%	0%	0%	1%
Machine Drive	3%	2%	4%	0%	1%	2%
Other Process Use	0%	3%	3%	0%	0%	3%
End Use Not Reported	0%	4%	0%	0%	2%	0%
Other Facility Support	0%	0%	0%	1%	0%	1%
Other Non-process Use	0%	0%	0%	0%	0%	0%
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4-14: Natural Gas Industrial Energy Consumption by End-Use (Table 3 of 3)

	Fabricated Metals	Machinery	Computers & Electronics	Elec. Equip.	Trans Equip.	Furniture	Misc.	Total Industrial
Conventional Boiler Use	8%	4%	27%	11%	11%	0%	13%	**20,759,627**
Process Heating	63%	41%	12%	54%	35%	46%	27%	**79,914,353**
CHP and/or Cogeneration Process	7%	4%	7%	9%	14%	8%	20%	**33,762,602**
Facility HVAC (g)	20%	48%	44%	20%	33%	46%	40%	**26,638,960**
Process Cooling and Refrigeration	0%	0%	0%	0%	0%	0%	0%	**362,627**
Machine Drive	1%	1%	0%	0%	0%	0%	0%	**2,515,680**
Other Process Use	1%	0%	2%	0%	6%	0%	0%	**4,008,079**
End Use Not Reported	0%	0%	5%	3%	1%	0%	0%	**1,165,518**
Other Facility Support	1%	1%	2%	3%	2%	0%	0%	**1,754,341**
Other Non-process Use	0%	0%	0%	0%	0%	0%	0%	**109,175**
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**170,990,963**

4.4 CURRENT MICHIGAN EDC ENERGY EFFICIENCY PROGRAMS

4.4.1 Current DTE Energy Efficiency Programs

DTE Energy provides several energy efficiency programs to Michigan electric and natural gas customers in the residential, commercial and industrial markets.

4.4.1.1 Residential Programs

Residential Energy Efficiency Program (Electric)

DTE offers energy audit discounts and rebates for the installation of energy efficiency improvements. Eligible measures and equipment includes: programmable thermostats, energy audits, insulation, central ac systems, appliance recycling, and air sealing.

Residential Energy Efficiency Program (Gas)

Rebate levels vary according to whether the customer receives MichCon gas, DTE electric service, or both. Eligible measures and equipment include the following high efficiency appliances: clothes washers, dehumidifiers, programmable thermostats, energy audits, insulation, high efficiency room air conditioners, appliance recycling, furnaces, boilers, air sealing, and energy audit. Rebate amounts can also vary based on equipment size and efficiency level. Participation is first come-first serve, and an energy audit should be completed prior to equipment installations.

4.4.1.2 Commercial/ Industrial Programs

Commercial and Industrial Energy Efficiency Program (Electric)

DTE Energy's commercial 'Your Energy Savings Program' provides incentives to commercial and industrial customers who utilize energy efficiency upgrades in their facilities. Some energy efficient technologies eligible for this program include refrigerators, heat pumps, programmable thermostats, vending machine controls, and LED lighting. Custom incentives are based on estimated annual energy savings. Final applications are to be received within 60 days after project completion or by November 30 of the program's year, whichever comes first.

Commercial and Industrial Energy Efficiency Program (Gas)

DTE Energy's commercial 'Your Energy Savings Program' provides prescriptive incentives, mainly on a per unit basis. Some energy efficient technologies eligible for this program include water heaters, equipment insulations, boilers, tankless water heaters, steam system upgrades, windows/roofs, and several other pieces of equipment. Custom incentives are based on annual energy savings and apply to all energy efficiency improvement measures that are not eligible for a prescriptive incentive. The New Construction and Remodeling Program provide assistance in design and incentives for more efficient buildings that purchase and install energy-efficiency equipment.

Participants qualifying for energy efficiency measures in the DTE's service area can participate in the program only by having these measures installed in a business facility. This energy program will only pay incentives for energy saved in facilities in the DTE service areas. Final applications received within 60 days after project completion or by December 15 of the program year, whichever comes first.

Commercial New Construction Energy Efficiency Program

New construction and remodeling projects must entail a facility improvement that verifiable electrical savings (kWh) and/or natural gas energy savings (MCF). This utility rebate program provides incentives for comprehensive measures/whole buildings applicable in commercial, industrial, and construction sectors. Some incentives include: 10% - 20% energy savings: $0.08 per kWh and $4.00 per MCF, 20% - 30% energy savings: $0.10 per kWh and $6.00 per MCF, 30% or more energy savings: $0.12 per kWh and $8.00 per MCF. All non-prescriptive measures must pass a Total Resource Cost (TRC) Test.

4.4.1.3 Solar Programs

Solar Current Programs

Incentives through the Solar Currents program are offered to electric customers that install photovoltaic systems that have capacities within the range 1kW-20kW. For residential customers, the program offers both an up-front rebate of $0.20 per DC watt and a production incentive of $0.03 per kilowatt-hour (kWh) for the renewable energy credits (RECs) until August 31, 2029. Non-residential customers are eligible for incentives for photovoltaic equipment that are $0.13/Watt upfront and $0.02/Watt for the payment of Renewable Energy Credits (RECs).

This program is being offered as part of DTE Energy's compliance plan under the state Renewable Portfolio Standard. Funding for this will be in four rounds, with 500 kW of installations expected per round. Pricing is reviewed after each offering. For the first round of offerings, 1.5 MW is reserved for residential systems, and 0.5 MW is reserved for non-residential. The four application periods will open according to the following dates, respectively: 01/07/2013, 06/24/2013, 01/2014, and 06/2014.

4.4.2 Current Consumers Energy Efficiency Programs

Consumer Energy provides several energy efficiency programs regarding electric and gas for both commercial and residential markets.

4.4.2.1 Residential Programs

Residential Energy Efficiency Program (Electric)

Customers must install equipment in the Consumers Energy service area and receive electric service from Consumers Energy for the appliance purchased in order to apply for rebates. Heat pumps, central air conditioners, building insulation, and clothes washers are just several eligible pieces of equipment that can receive incentives.

Residential Energy Efficiency Program (Gas)

High efficiency furnaces, boilers, water heating units, insulation, windows, doors, energy audits and comprehensive improvements are eligible under this program. Residential Gas customers will be eligible to apply for a range of rebates.

4.4.2.2 Commercial Programs

Commercial Energy and Efficiency (Electric)

Incentives are available for energy efficiency equipment upgrades and are paid based on quantity, size, and efficiency of the equipment. Incentives are available for projects where the payback period is within 1 to 10 years. A bonus incentive of 15% may be available to customers who purchase equipment manufactured in Michigan.

Commercial Energy and Efficiency (Gas)

Incentives are available for energy efficiency equipment upgrades and are paid based on the quantity, size and efficiency of the equipment. Energy efficiency projects that have a payback year between 1-10 years may receive an incentive. A bonus incentive of 15% may be available to customers who purchase equipment manufactured in Michigan. Equipment measures not available for incentives are as follows: fuel switching, projects that involve peak-seeking, and changes in operational and/or maintenance practices.

5 POTENTIAL STUDY METHODOLOGY

This section describes the overall methodology that was utilized by GDS to develop the energy efficiency potential study for the State of Michigan. The main objective of this energy efficiency potential study is to quantify the technical, economic and achievable potential for electric and natural gas energy efficiency savings in Michigan. This report provides estimates of the potential kWh and kW electric savings and MMBtu 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.

Energy efficiency potential studies involve a number of analytical steps to produce estimates of each type of energy efficiency potential: technical, economic, and achievable. This study utilizes benefit/cost screening tools for the residential and non-residential sectors to assess the cost effectiveness of energy efficiency measures. These cost effectiveness screening tools are Excel-based models that integrate technology-specific impacts and costs, customer characteristics, utility avoided cost forecasts and more. Excel was used as the modeling platform to provide transparency to the estimation process and allow for simple customization based on Michigan's unique characteristics and the availability of specific model input data. The major analytical steps and an overview of the potential savings are summarized below, and specific changes in methodology from one sector to another have been noted throughout this section.

- Measure List Development
- Measure Characterization
- Load Forecast Development and Disaggregation
- Potential Savings Overview
- Technical Potential
- Measure Cost-Effectiveness Screening
- Economic Potential
- Achievable Potential

5.1 MEASURE LIST DEVELOPMENT

The energy efficiency measures included in this study cover energy efficiency measures included in the Michigan energy measures database (MEMD), additional measures suggested by interested stakeholders, as well as other measures based on the GDS Team's existing knowledge and current databases of electric and natural gas end-use technologies and energy efficiency measures. The study scope includes measures and practices that are currently commercially available as well as emerging technologies. The commercially available measures are of the most immediate interest to DSM program planners in Michigan. However, a small number of well documented emerging technologies were considered for each sector. Emerging technology research was focused on measures that are commercially available but may not be widely accepted at the current time. In June 2013, the GDS Team provided the energy efficiency measure lists for each sector to interested stakeholders for review and comment. These measure lists were then reviewed, discussed and updated as necessary. A complete listing of the energy efficiency measures included in this study is provided in the Appendices of this report.

In addition, this study includes measures that could be relatively easily substituted for, or applied to, existing technologies on a retrofit or replace-on-burnout basis. Replace-on-burnout applies to equipment replacements that are made normally in the market when a piece of equipment is at the end of its useful life. A retrofit measure is eligible to be replaced at any time in the life of the equipment or building. Replace-on-burnout measures are generally characterized by incremental measure costs and savings (*e.g.* the costs and savings of a high-efficiency versus standard efficiency air conditioner); whereas retrofit measures are generally characterized by full costs and savings (e.g. the full costs and savings associated with adding ceiling insulation into an existing attic). For new construction, energy efficiency measures can be implemented when each new home or building is constructed, thus the rate of availability is a direct function of the rate of new construction.

5.2 MEASURE CHARACTERIZATION

A significant amount of data is needed to estimate the kWh, kW and MMBtu savings potential for individual energy efficiency and demand response measures or programs across the entire existing residential and non-residential sectors in Michigan. GDS used Michigan specific data wherever it was available and up-to-date. Considerable effort was expended to identify, review, and document all available data sources.[15] This review has allowed the development of reasonable and supportable assumptions regarding: measure lives; measure installed incremental or full costs (as appropriate); and electric and natural gas savings and saturations for each energy efficiency measure included in the final list of measures in this study.

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. The incremental cost is calculated as the difference between the cost of high efficiency and standard (code compliant) equipment. However, for retrofit measures, the measure cost was considered to be the "full" cost of the measure, as the baseline scenario assumes the consumer would do nothing. 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:

- Michigan Energy Measures Database
- Secondary sources such as the American Council for an Energy-Efficient Economy ("ACEEE"), Department of Energy ("DOE"), Energy Information Administration ("EIA"), ENERGY STAR, Air Conditioning Contractors of America ("ACCA") and other technical potential studies and Technical Reference Manuals

Measure Costs: Measure costs represent either incremental or full costs, and typically include the incremental cost of measure installation. For purposes of this study, nominal measures costs were held constant over time. This general assumption is being made due to the fact that historically many measure costs (e.g., CFL bulbs, Energy Star appliances, etc.) have declined over time, while some measure costs have increased over time (e.g., fiberglass insulation). The one exception to this general assumption was that LED bulb costs were assumed to decline over time. This exception was included as directed by the Public Staff of the Michigan Public Service Commission (MPSC), and is grounded by the observation of rapidly declining LED bulb costs over the last several years, as well as the relatively high contribution of LED bulbs to the overall estimates of savings potential. Cost estimates were obtained from the following types of data sources:

- Michigan Energy Measures Database
- Secondary sources such as ACEEE, ENERGY STAR, NREL, NEEP Incremental Cost Study Report, and other technical potential studies and Technical Reference Manuals
- Retail store pricing (such as web sites of Home Depot and Lowe's) and industry experts

[15] 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.

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:

- Michigan Energy Measures Database
- 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 electric and 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:

- 2011 Michigan Residential Baseline Study conducted by the MPSC
- Energy efficiency baseline studies conducted by DTE Energy and Consumers 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 (MECS)
- 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.

5.3 FORECAST DISAGGREGATION FOR THE COMMERCIAL AND INDUSTRIAL SECTORS

For the commercial sector, the baseline electric and natural gas load forecasts were disaggregated by combining sales breakdowns by business type provided by DTE Energy with regional energy use estimates by business type available from the U.S. Energy Information Administration (EIA)[16] 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 electric and natural gas sales forecasts provide the foundation for the development of energy efficiency potential estimates for the commercial sector. It was not necessary to develop a disaggregated residential sales forecast because a bottom-up approach was used for the residential sector.

For the industrial sector, the baseline electric and natural gas demand forecasts were disaggregated by industry type and then by end use. The industry type breakdowns are based on Michigan value of shipments data and U.S. energy intensity data (consumption per $ of value shipped) by industry from the U.S. Census Bureau's Annual Survey of Manufacturers. Further dis-aggregation by end use is based on data from the EIA's 2010 Manufacturing Energy Consumption Survey (MECS) The disaggregated forecast data provides the foundation for the development of energy efficiency potential estimates for the industrial sector.

[16] 2003 EIA Commercial Building Energy Consumption Survey (CBECS), East North Central and Midwest Regions.

5.4 ROLE OF NATURALLY OCCURRING CONSERVATION

Naturally occurring conservation exists through government intervention, improved manufacturing efficiencies, building energy codes, market demand, and increased energy efficiency implementation by early adopters, who will implement measures without explicit monetary incentives. The impacts of new Federal government mandated energy efficiency standards have already been reflected in the baseline data for equipment unit energy consumption being used for this potential study. These new government standards, such as the new standards included in the Federal government's December 2007 Energy Independence and Security Act (EISA)[17], can significantly increase naturally occurring potential through tax incentives, stimulus funding or stricter manufacturing standards. These forces cause certain sector end-use energy consumption values to improve across the baseline forecast. It is important to account for these forces as thoroughly as possible to ensure the energy efficiency potential is not double-counted, by over-stating the potential that could occur for end-uses where codes and standards are reducing baseline unit energy consumption. In addition, GDS has reflected the impacts of new EISA lighting standards that went into effect starting in 2012, as well as changes to other federal baseline standards across a variety of end uses. These adjustments reduce energy efficiency potential starting in the years these standards come into effect, and in subsequent years.

5.5 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 percent 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 5-1 below illustrates the three most common types of energy efficiency potential.

Figure 5-1: Types of Energy Efficiency Potential[18]

Not Technically Feasable	Technical Potential		
Not Technically Feasable	Not Cost Effective	Economic Potential	
Not Technically Feasable	Not Cost Effective	Market & Adoption Barriers	Achievable Potential

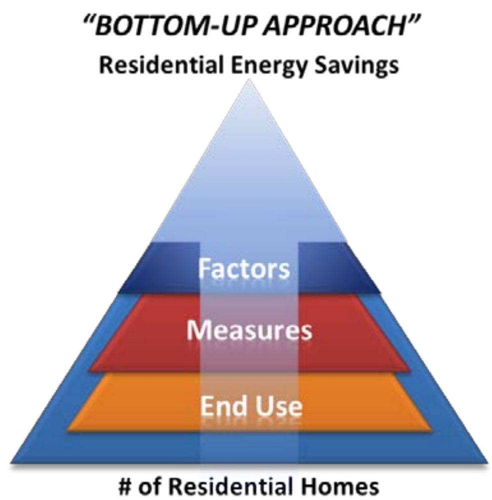
5.6 TECHNICAL POTENTIAL

The GDS Team has used the energy efficiency potential definitions included on pages 2-4 of the November 2007 National Action Plan for Energy Efficiency (NAPEE) Guide for Conducting Energy Efficiency Potential Studies. 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.[19]

[17] PUBLIC LAW 110–140—DEC. 19, 2007. Energy Independence and Security Act of 2007
[18] Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. US EPA. Figure 2-1.
[19] National Action Plan for Energy Efficiency, "Guide for Conducting Energy Efficiency Potential Studies", page 2-4

In general, this study utilizes a "bottom-up" approach in the residential sector to calculate the potential of an energy efficiency measure or set of measures as illustrated in Figure 5-2 below. A bottom-up approach was used for the residential sector due to the amount of data available for this sector from DTE Energy and Consumers Energy, from Federal government surveys and research done in nearby states. A bottom-up approach first starts with the savings and costs associated with replacing one piece of equipment with its high efficiency counterpart, and then multiplies these values by the number of measures available to be installed throughout the life of the program. The bottom-up approach is applicable in the residential sector because of better secondary data availability and greater homogeneity of the building and equipment stock to which measures are applied, compared to the non-residential sector. However, this methodology was not utilized in the non-residential sector. For the non-residential sector, a "top-down" approach was used for developing the technical potential estimates. The "top down" approach builds an energy use profile based on estimates of kWh sales by business segment and end use. Savings factors for energy efficiency measures are then applied to applicable end use energy estimates after assumptions are made regarding the fraction of sales that are associated with inefficient equipment and the technical/engineering feasibility of each energy efficiency measure.

Figure 5-2: Residential Sector Savings Methodology - Bottom Up Approach



As shown in Figure 5-2, the methodology starts at the bottom based on the number of residential customers (splitting them into single-family, multi-family and manufactured housing types as well as existing homes vs. new construction). From that point, estimates of the size of the eligible market in Michigan were developed for each energy efficiency measure. For example, energy efficiency measures that affect electric space heating are only applicable to those homes in Michigan that have electric space heating.

As noted previously, to obtain up-to-date appliance and end-use saturation data, the study made extensive use of the energy efficiency baseline studies provided by the MPSC, DTE Energy and Consumers Energy. The study relied primarily on the statewide baseline studies completed by Cadmus in 2011 for the commercial and residential sectors. The DTE and Consumers Energy baseline studies for the residential sector were used in a few instances because the utility baseline studies contained some details lacking in the statewide residential study. The surveys collected detailed data on the current saturation of electricity and natural gas consuming equipment in the DTE Energy and Consumers Energy service areas and the energy efficiency level of HVAC equipment, appliances, and building shell characteristics. Estimates of energy efficient equipment saturations were based on several sources, including data collected from the 2009 RECS and the baseline studies provided by the Michigan utilities.

The goal of the approach is to determine how many households that a specific measure applies to (base case factor), then of that group, the fraction of households/buildings which do not have the energy efficient version of the measure being installed (remaining factor). In instances where technical reasons do not permit the installation of the efficient equipment in all eligible households an applicability factor is used to limit the potential. Alternative water heating technologies (efficient water heater tanks, heat pump water heaters or solar water heating systems) are then utilized to meet the remaining market potential. The last factor to be applied is the savings factor, which is the percentage savings achieved from installing the efficient measure over a standard measure.

In developing the overall potential electricity savings, the analysis accounts for the interactive effects of measures designed to impact the same end-use. For instance, if a home were to properly seal all ductwork, the overall space heating and cooling consumption in that home would decrease. As a result, the remaining potential for energy savings derived from a heating/cooling equipment upgrade would be reduced. In instances where there are two (or more) competing technologies for the same electrical (or natural gas) end use, such as heat pump water heaters, water heater efficiency measures and high-efficiency electric storage water heaters, in most cases an equal percentage of the available population is assigned to each measure using the applicability factor[20]. In the event that one of the competing measures is not found to be cost-effective, the homes/buildings assigned to that measure are transitioned over any of the remaining cost effective alternatives.

The savings estimates per base unit are determined by comparing the high-efficiency equipment to current installed equipment for existing construction retrofits or to current equipment code standards for replace-on-burnout and new construction scenarios.

5.7 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 in Equation 5-1 below.

Equation 5-1: Core Equation for Residential Sector Technical Potential

$$\text{Technical Potential of Efficient Measure} = \text{Total Number of Households} \times \text{Base Case Equipment End Use Intensity} \times \text{Saturation Share} \times \text{Applicability Factor} \times \text{Savings Factor}$$

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** = annual energy consumption (kWh or MMBtu) used per customer, per year, by each base-case technology in each market segment. This is the consumption of energy using equipment that efficient technology replaces or affects. This variable fully accounts for any known building characteristics in the service area, such as average square footage of homes in Michigan.
- **Saturation Share** = this variable has two parts: the first is the fraction of the end use energy that is applicable for the efficient technology in a given market segment. For example, for natural gas residential water heating, this would be the fraction of all residential gas customers that have gas water heating in their household; the second is the share of the end use gas energy that is applicable for the efficient technology that has not yet been converted to an efficient technology.

[20] GDS used its professional judgment in some cases to assign unequal applicability factors to attempt to avoid overstating or understating the potential of the set of competing technologies.

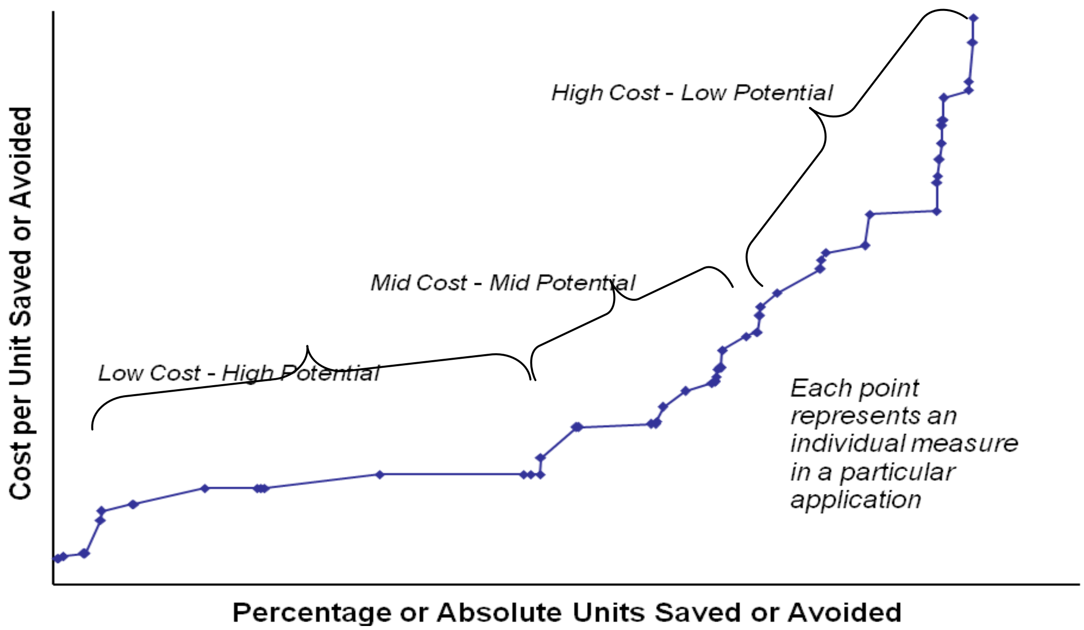
- **Applicability Factor** = this factor ensures that a household cannot receive two of the same type of measure. For example, if we assume there are two tiers of efficient natural gas furnaces, one which yields 10% savings and another which yields 20% savings, a household that needs to replace its inefficient natural gas furnace could either receive the unit which yields 10% savings or the unit which yields 20% savings, but could not receive both units. In general, GDS applies an even distribution to the same type of measure across eligible households when applying this factor. GDS may, in some cases, assign unbalanced applicability factors, if it believes an even distribution is inappropriate[21]. The applicability factor also captures the fraction of applicable units technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to add wall insulation in all homes because the original construction of some homes does not allow for wall insulation to be installed without requiring major reconstruction of the house, which would be an additional cost that does not yield any energy benefits).
- **Savings Factor** = the percentage of energy consumption reduction resulting from application of the efficient technology. The savings factor is a general term used to illustrate the calculation of a measure's technical potential. The Excel-based model GDS uses fully integrates the necessary assumptions to determine the measure-level savings, given the **Base Case Equipment End-use Intensity**, and the expected savings of each technology.

Technical energy efficiency potential in the residential sector is calculated in two steps. In the first step, all measures are treated *independently*; that is, the savings of each measure are not reduced or otherwise adjusted for overlap between competing or interacting measures. By analyzing measures independently, no assumptions are made about the combinations or order in which they might be installed in customer buildings. However, the cumulative technical potential cannot be estimated by adding the savings from the individual savings estimates because some savings would be double-counted. For example, the savings from a measure that reduces heat loss from a building, such as insulation, are partially dependent on other measures that affect the efficiency of the system being used to heat the building, such as a high-efficiency furnace; the more efficient the furnace, the less energy saved from the installation of the insulation. In the second step, adjustments are made to account for such interactive effects. The adjustments for interactive effects were made by upgrading the baseline conditions while holding the savings percentages constant. The upgraded baseline conditions vary by measure and assume some measures (such as weatherization measures) are installed to increase the building efficiency prior to the installation of the measure that is subject to the baseline adjustment (ex. high efficiency furnaces).

Finally, the GDS Team has developed a supply curve to show the amount of energy efficiency savings available at different cost levels. The residential sector supply curve is included in an appendix of this report. A generic example of a supply curve is shown in Figure 5-3. As shown in the figure, a supply curve typically consists of two axes; one that captures the cost per unit of saving a resource (e.g., dollars per lifetime kWh or MMBtu saved) and another that shows the amount of savings that could be achieved at each level of cost. The curve is typically built up across individual measures that are applied to specific base-case practices or technologies by market segment. Savings measures are sorted based on a metric of cost. Total savings available at various levels of cost are calculated incrementally with respect to measures that precede them. Supply curves typically, but not always, end up reflecting diminishing returns, i.e., costs increase rapidly and savings decrease significantly at the end of the curve.

[21] For example, if historical data indicates a technology has been able to garner a large share of the market GDS may assign a higher applicability factor to this technology in order to properly reflect this knowledge.

Figure 5-3: Generic Example of a Supply Curve



As noted above, the cost portion of this energy efficiency supply curve is represented in dollars per unit of lifetime energy savings. Costs are annualized (often referred to as levelized) in supply curves. For example, electric energy efficiency supply curves usually present levelized costs per lifetime kWh saved by multiplying the initial investment in an efficient technology or program by the capital recovery rate (CRR), and then dividing that amount by annual kWh savings:

Therefore,

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

5.8 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 in Equation 5-2.

Equation 5-2: Core Equation for Commercial Sector Technical Potential

Where:

- **Total end-use kWh or natural gas sales by commercial sector and by building type** = the forecasted electric or 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, with fluorescent lighting, this would be the fraction of all lighting kWh in a given industry type that is associated with fluorescent fixtures.

- **Remaining factor** = the fraction of applicable kWh or natural gas sales associated with equipment not yet converted to the electric or 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 variable-frequency drives (VFDs) on all motors.
- **Savings factor** = the fraction of electric or natural gas consumption reduced by application of the efficient technology.

For the commercial sector, the development of the energy efficiency technical potential estimate begins with a disaggregated energy sales forecast over the ten year forecast horizon (2013 to 2022). The commercial sector energy sales forecast is broken down by building type, then by electric or natural gas end use. Then a savings factor is applied to end use electricity or natural gas sales to determine the potential electricity or natural gas savings for each end use. 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

Similar to the residential sector, technical electric or natural gas energy efficiency savings potential in the commercial sector is calculated in two steps. In the first step, all measures are treated *independently*; that is, the savings of each measure are not reduced or otherwise adjusted for overlap between competing or synergistic measures. By treating measures independently, their relative economics are analyzed without making assumptions about the order or combinations in which they might be implemented in customer buildings. However, the total technical potential across measures cannot be estimated by summing the individual measure potentials directly because some savings would be double-counted. For example, the savings from a weatherization measure, such as low-e ENERGY STAR windows, are partially dependent on other measures that affect the efficiency of the system being used to cool or heat the building, such as high-efficiency space heating equipment or high-efficiency air conditioning systems; the more efficient the space heating equipment or electric air conditioner, the less energy saved from the installation of low-e ENERGY STAR windows. Accordingly, the second step is to rank the measures based on a metric of cost-effectiveness (using the Total Resource Cost test and Utility Cost Test cost effectiveness tests) and adjust savings for interactive effects so that total savings are calculated incrementally with respect to measures that precede them.

5.9 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). How the auto industry uses energy is very different from how a plastics manufacturer does. 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.

5.10 INDUSTRIAL SECTOR SEGMENTATION & END USE BREAKDOWN

Estimates of energy efficiency potential were developed employing a top-down approach using economic data for key industrial segments (Primarily 3 digit NAICS codes) in Michigan to develop industry-specific energy use estimates based on national energy intensities for each industry. Value of shipments data for Michigan is available from the U.S. Census Bureau. This economic data was used in conjunction with energy use estimates from the 2010 Manufacturing Energy Consumption Survey[22] which is produced by the Energy Information Administration (EIA), to develop estimates of industrial electric and natural gas energy use by industry type and end use.

Industrial baseline energy consumption data was advanced to 2013 and future years based upon the observed historical trend in Michigan's industrial consumption and EIA's industrial electricity and natural gas consumption forecast for the U.S. (i.e., Annual Energy Outlook 2013).

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

- **Indirect Uses – Boilers**
  - Conventional boiler use
- **Direct Uses - Process**
  - Process heating (e.g., kilns, furnaces, ovens, strip heaters)
  - Process cooling & refrigeration
  - Machine drive
  - Electro-chemical processes
  - Other direct process use
- **Direct Uses – Non-process**
  - Facility heating, ventilation and air conditioning
  - Facility lighting
  - Other facility support (e.g., cooking, water heating, office equipment)
- **Other Non-process Use**

5.11 DEVELOPMENT OF POTENTIAL ESTIMATES

Estimates of industrial energy use by industry type and end use served as the foundation upon which energy efficiency potential estimates were calculated. The basic equation for determining technical potential is shown below.

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

Where:

22 http://www.eia.gov/emeu/mecs/contents.html

- Total end-use sales by industry type = the forecasted electric or 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 fluorescent lighting, this would be the fraction of all lighting kWh in a given industry type that is associated with fluorescent fixtures.
- Remaining factor = the fraction of applicable sales associated with equipment not yet converted to the electric 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 variable-frequency drives (VFDs) on all motors.
- Savings factor = the fraction of energy consumption reduced by application of the efficient technology.

5.12 ECONOMIC POTENTIAL

Economic potential refers to the subset of the technical potential that is economically cost-effective (based on screening with the cost effectiveness tests utilized for this Michigan study) 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 National Action Plan for Energy Efficiency (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.

5.13 DETERMINING COST-EFFECTIVENESS

GDS Team examined measure cost effectiveness scenarios based on the Total Resource Cost (TRC) test and the Utility Cost Test.

Total Resource Cost Test[23]

The TRC measures the net benefits of the energy efficiency program for the region as a whole. Costs included in the TRC are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program, regardless of who pays these costs. The benefits included are the avoided costs of energy (as with the Utility Cost Test and the Rate Impact Measure Test) as well as non-energy benefits. GDS did include a benefit of $9.25 per ton of reduced carbon emission. This risk adjusted value represents the expected value of a scenario with no carbon taxes and a scenario with carbon taxes of $18.50 per ton.

The primary purpose of the TRC test is to evaluate the net benefits of energy efficiency measures to the region or State as a whole. Unlike the Utility Cost Test, the Rate Impact Measure (RIM) test or the Participant Cost Test (PCT), the TRC does not take the view of individual stakeholders. It does not

[23] It is important to note that the Michigan PSC staff, GDS Associates and staff from DTE Energy and Consumers Energy decided not to include any unquantifiable non-energy benefits in the calculation of the TRC Test (beyond savings water, avoided carbon emissions, and O&M savings). While other non-energy benefits may be present, they have not been quantified in the state of Michigan and were not available for inclusion in this study.

include bill savings and incentive payments, as they yield an intra-regional transfer of zero ("benefits" to customers and "costs" to the utility that cancel each other on a regional level). For some utilities, the region considered may be limited strictly to its own service territory, ignoring benefits (and costs) to neighboring areas (a distribution-only utility may, for example, consider only the impacts to its distribution system). In other cases, the region is defined as the state as a whole, allowing the TRC to include benefits to other stakeholders (e.g., other utilities, water utilities, local communities). The TRC is useful for jurisdictions wishing to value energy efficiency as a resource not just for the utility, but for the entire region. Thus the TRC is the most frequently used primary test in the United States. The TRC may be considered the sum of the PCT and RIM, that is, the participant and non-participant cost-effectiveness tests. The TRC is also useful when energy efficiency might fall through the cracks taken from the perspective of individual stakeholders, but would yield benefits on a wider regional level

Utility Cost Test

The Utility Cost Test (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. Depending on the jurisdiction and type of utility, the "avoided costs" can include avoided or reduced wholesale electricity or natural gas purchases, generation costs, power plant construction, transmission and distribution facilities, ancillary service and system operating costs, and other components.

Table 5-1 below shows the key assumptions used by GDS in the development of the economic and achievable potential estimates based upon cost effectiveness screening using the Total Resource Cost (TRC) test and the Utility Cost test (UCT):

Table 5-1: Key Assumptions Used by GDS in the Development of Measure-Level Screening

KEY ASSUMPTION	USED IN UCT SCREENING	USED IN TRC SCREENING
Utility weighted average cost of capital for the discount rate	Yes	Yes
Forecasts of electric and natural gas energy and capacity avoided costs provided to GDS by the staff of the Michigan Public Service Commission	Yes	Yes
Forecast of electric T&D avoided costs per kW/year based on 2009 study by the New York Public Service Commission	Yes	Yes
Average line losses provided by Michigan utilities	Yes	Yes
MISO planning reserve margin	Yes	Yes
Electricity and natural gas savings benefits both valued in the cost effectiveness test for electric or natural gas energy efficiency programs	Yes	Yes
Value of avoided bulb purchases for high efficiency light bulbs	No	Yes
Water savings where applicable	No	Yes

KEY ASSUMPTION	USED IN UCT SCREENING	USED IN TRC SCREENING
Tax credits	No	Yes
Non-energy benefits (adder of $9.25 per ton of carbon emissions avoided)	No	Yes

Based on discussions with DTE Energy, Consumers Energy and staff of the Michigan Public Service Commission during October 2013, GDS has used average line losses to adjust kWh and kW savings at the customer meter to the generation level of the electric grid. DTE Energy and Consumers Energy recognize that in theory it would be appropriate to use marginal line losses instead of average line losses for this adjustment of savings. Because no studies or data exist at DTE Energy or Consumers Energy relating to marginal line losses on the Michigan electric grid, the study Team decided to use average line losses.

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 three achievable potential scenarios is a reasonable target based on the current financial incentive levels for program participants used by DTE Energy and Consumers 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.[24] Also, the majority of energy efficiency programs offered by NYSERDA offer no incentives to consumers. In addition, the NYSERDA electric energy efficiency achievable potential study completed by Optimal Energy in 2006 assumed incentive levels in the range of 20% to 50%.

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.[25] 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.
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 National Action Plan for Energy Efficiency Report titled "Customer Incentives for Energy Efficiency Through Program

[24] GDS Associates 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).
[25] 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.

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."

5.14 ACHIEVABLE POTENTIAL

Achievable potential was determined as the amount of energy and demand 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:

4) **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 Utility Cost Test. 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 2014 to 2023 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.
5) **Scenario #2**: For the second scenario, achievable potential is based on measure cost effectiveness screening using the Total Resource Cost Test with utility incentives again equal to 50% of measure costs. GDS calculated the savings and costs associated with the 50% incentive level. Year-by-year estimates of achievable potential for the period 2014 to 2023 were estimated by applying market penetration curves to this long-term penetration rate estimate. Any differences between Achievable Scenario #1 and Achievable Scenario #2 result from the varied measures that pass the Utility Cost Test compared to the Total Resource Cost Test
6) **Scenario #3**: The third scenario is a subset of Achievable Scenario #1(based on UCT). While scenario #1 assumed no spending cap on efficiency measures, Achievable Scenario #3 assumed a spending cap of approximately 2% of utility 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 three scenarios due to the available budget for this potential study[26].

For new construction, energy efficiency measures can be implemented when each new home or building is constructed, thus the rate of availability is a direct function of the rate of new construction. For existing buildings, determining the annual rate of availability of savings is more complex. Energy

[26] None of the three scenarios is considered a "maximum" achievable scenario. Maximum achievable scenarios assume 100% incentives. The three scenarios included in the report assume 50% incentives. This approach approximates the level incentives currently offered by Michigan utilities.

efficiency potential in the existing stock of buildings can be captured over time through two principal processes:

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")
2) At any time in the life of the equipment or building (referred to as "retrofit")

For the replace-on-burnout measures, existing equipment is assumed to be replaced with high-efficiency equipment at the time a consumer is shopping for a new appliance or other energy consuming equipment, 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 is 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.

5.15 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 measure 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.

RESIDENTIAL

As noted earlier in the report, there are approximately 1,900 residential measures included in this study. Due to the wide variety of measures across multiple end-uses, GDS employed varied, measures-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.[27] 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. Based on available market adoption surveys with program administrators in the Northeast, GDS assigned end-use specific market adoption curves to the residential measures included in this analysis.[28] Examples of the impact of incentives on payback and maximum market adoption rates are demonstrated in the table below. These curves reflect measures that have significant gas and electric achievable potential over the next 10 years.[29]

Once the long-term market adoption rate was determined, GDS estimated the time interval required to reach the ultimate maximum adoption rate. In general, measures that required less up-front cost from

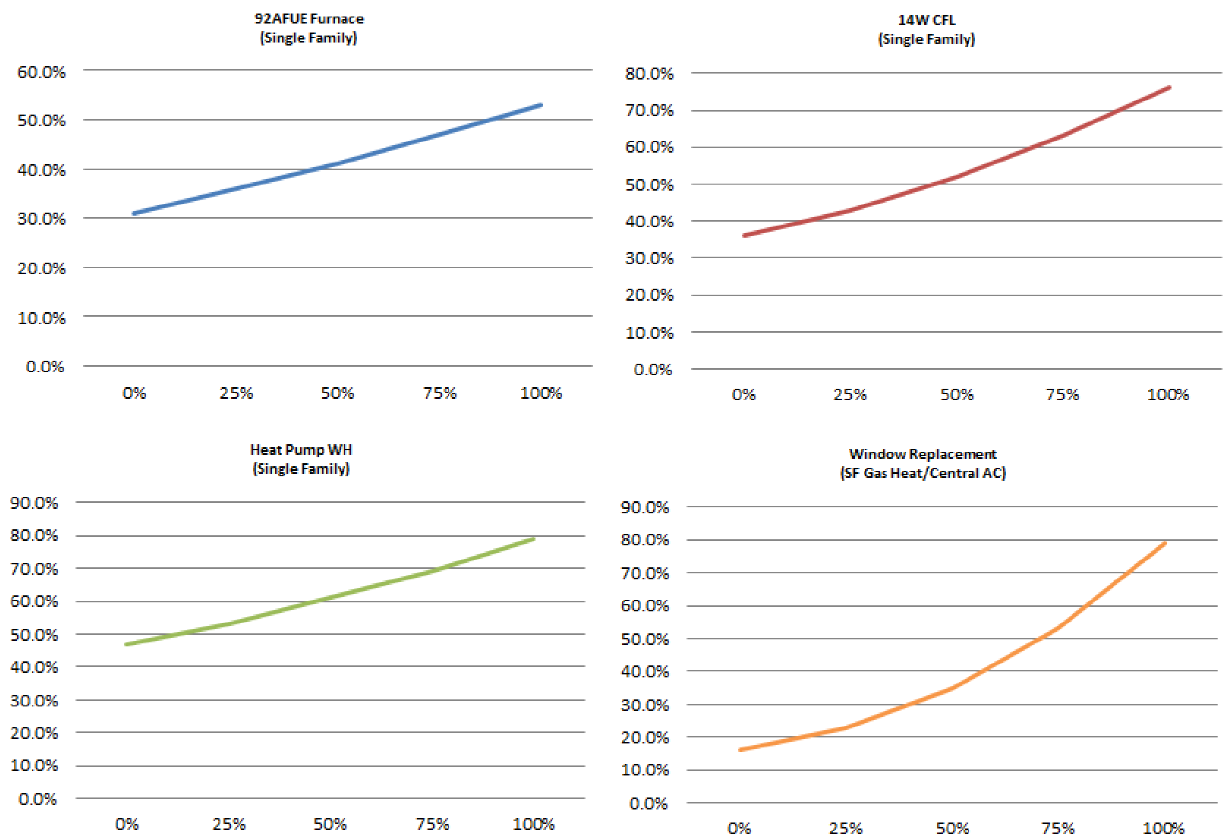
[27] Massachusetts Multifamily Market Characterization and Potential Study Volume I. May 2012. Cadmus Group. & Appliance Recycling Program Process Evaluation and Market Characterization. Volume I. CALMAC Study ID# SCE0337.01. September 2012. Cadmus.

[28] Massachusetts Multifamily Market Characterization and Potential Study Volume I. May 2012. Cadmus Group. This study presents market adoption curves based on the perspective of both multifamily property managers as well as utility energy efficiency program administrators. Both groups of study participants provide support for the contention that increased incentives/reduced payback result in higher maximum adoption rates. GDS selected the adoption curves based on the feedback of program administrators…. GDS encourages Michigan to conduct similar research with program participants and program administrators to refine these market adoption estimates in future analyses.

[29] Where current energy efficiency saturation data exceeded the estimated maximum market adoption, GDS assumed future efficiency installations would occur at the current EE saturation percentage so that the long-term market saturation of energy efficiency measures would not decrease over the study time-frame.

the participant reached their maximum adoption rate over a period of 2-3 years, and continued at the maximum rate for the remainder of the study. Measures with a more substantial cost to the participant required more time to ramp-up, and would not reach their maximum adoption rate until later in the study period. GDS exercised its professional judgment in estimating the time to reach the ultimate market adoption rate.

Figure 5-4: Example Residential Maximum Adoption Rates – Based on Incentive



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.

The market penetration of residential lighting was also strategically adjusted to account for the expected decline in LED bulbs costs over the next decade and an anticipated shift in market adoption from CFL bulbs to LED bulbs. Because LED bulb prices are expected to decline significantly over the next several years, decreasing to typical CFL bulb incremental cost levels, GDS assumed the maximum adoption rate for LED bulbs to be similar to those used for CFL bulbs. Additionally, GDS relied on future unit penetration rates for various lighting sources to model the long term shift towards increased market penetration of LED bulbs compared to CFL bulbs.[30] The table below shows the year-by-year shifting market penetration of CFL and LED bulbs estimated in this analysis. By 2018, LED bulbs are expected to be installed at a greater rate than their CFL counterparts.

[30] Fox, Jamie. Does LED Lighting Have a Tipping Point? IMS Research. April 2012.

Table 5-2. CFL vs. LED Market Penetration Share of Anticipated High Efficiency Residential Lighting Installations

	2014	2015	2106	2017	2018	2019	2020	2021	2022	2023
CFL	32%	39%	45%	50%	53%	58%	64%	66%	68%	70%
LED	68%	61%	55%	50%	47%	42%	36%	34%	32%	30%

Last, for appliance recycling measures GDS compared the harvest rate (total number of recycled appliances relative to the total residential population) of several utility appliance recycling programs nationwide. Based on each utilities most successful reported year, an average harvest rate for various appliance recycling measures was estimated. GDS then calculated a long-term market adoption rate for the appliance recycling measures that would create a similar harvest rate for Michigan's appliance recycling programs. Because appliance recycling programs do not require any participants costs and require customer willingness to remove secondary, operational equipment from their homes, this approach was selected in favor of the incentive/payback curves utilized for the more traditional rebated measures included in the analysis.

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.[31] That study reported the following results:[32]

Table 5-3. Adoption Factors by Equipment and Incentive Level

EQUIPMENT TYPE	0%	50%	75%	100%
Lighting	54%	66%	70%	75%
AC / HVAC	49%	63%	68%	74%
Motors	58%	69%	73%	77%
Variable Speed	47%	66%	67%	69%
Refrigeration	57%	65%	71%	76%
Energy Mgmt System	44%	59%	67%	74%
Food Service	49%	66%	69%	73%
Process Measures	57%	65%	67%	69%
Water Heating	56%	67%	74%	80%
Overall	**52%**	**65%**	**69%**	**74%**

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. Those paths are shown below in Table 5-4.

Table 5-4: Path to Achieving Long Term Market Penetration (% of Long Term Market Potential)

[31] Assessment of Nonresidential Electric and Natural Gas Energy Efficiency Potential (2010–2029), Prepared for DTE Energy by The Cadmus Group, Inc.
[32] Ibid., p. 35.

YEAR	1	2	3	4	5	6	7	8	9	10
Full Cost Measure	5%	15%	20%	20%	10%	10%	5%	5%	5%	5%
Incremental Cost Measure	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%

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.

6 RESIDENTIAL ELECTRIC AND NATURAL GAS ENERGY EFFICIENCY POTENTIAL ESTIMATES

This section provides electric and natural gas energy efficiency potential estimates for the residential sector in Michigan which includes all residential buildings. Estimates of technical, economic and achievable potential are provided. Electric and natural gas potential are presented as separate sections, but interactive effects and measures that yield both electric and natural gas savings are fully accounted for in the analysis.

6.1 RESIDENTIAL ELECTRIC POTENTIAL

According to 2011 historical sales data, the residential sector accounts for approximately 89% of total customers and 33% of total energy sales. The average residential consumer uses approximately 7,900 kWh per year. From 2002-2011, the residential sector sales and customers have experienced minimal growth. This analysis assumes residential MWh sales increase at roughly 0.25% annually based upon the based on Michigan utility load forecasts. The residential electric 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.

6.1.1 Energy Efficiency Measures Examined

For the residential sector, there were 1119 total electric savings measures included in the potential energy savings analysis[33]. Table 6-1 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 Michigan Energy Measure Database (MEMD) and measures found in other residential potential studies and TRMs from the Midwest. Measure data includes incremental costs, electricity energy and demand savings, gas and water savings, and measure life.

Table 6-1: Measures and Programs Included in the Electric Residential Sector Analysis

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
HVAC Envelope	Building Envelope Upgrades	• Air/duct Sealing • Duct Insulation • Improved Insulation (Wall, Ceiling, and Floor) • Efficient Windows • Window Film • ENERGY STAR Doors • Cool Roofs • Low Income Weatherization Package
HVAC Equipment	Heating/Cooling/Ventilation Equipment	• Existing Central AC Tune-Up • Efficient Air-Source Heat Pump • Dual Fuel Heat Pumps • Geothermal Heat Pumps • Ductless Mini-split Systems • Efficient Central AC Systems • Programmable Thermostats • Efficient Room Air Conditioners • Room Air Conditioner Recycling

[33] This total represents the number of unique electric energy efficiency measures and all permutations of these unique measures. For example, there are 76 permutations of the "Improved Duct Sealing" measure to account for the various housing types, heating/cooling combinations, and construction types.

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
		• Whole House Fans • Efficient Chillers • Chiller Controls • Efficient Furnace Fans
Water Heating	Domestic Hot Water	• Heat Pump Water Heater • Solar Water Heater • Low Flow Showerhead/Faucet Aerator • Gravity Film Heat Exchangers • Pipe Wrap • Tank Wrap
Lighting	Interior/Exterior Lighting	• Specialty CFLs • Standard CFLs • LED Lighting • Efficient Exterior Lighting • Efficient Torchiere Lamps • Efficient Fluorescent Tube Lighting • LED Night Lights • Occupancy Sensors • Holiday Lighting • Efficient Multifamily Common Area Lighting
Appliances	High-Efficiency Appliances / Retirement of Inefficient Appliances	• ENERGY STAR Clothes Washers • ENERGY STAR Refrigerator • ENERGY STAR Freezers • ENERGY STAR Dishwashers • ENERGY STAR Dehumidifiers • Heat Pump Dryers • Secondary Refrigerator/Freezer Turn-In • 2nd Dehumidifier Turn-In
Electronics	High Efficiency Consumer Electronics	• Controlled Power Strips • Efficient Set-Top Boxes • ENERGY STAR Desktops • Efficient Laptops • Efficient Televisions • LCD Monitors
Behavioral	Consumer Response to Feedback from Utility	• Direct (Real-Time) Feedback • Indirect Feedback
Other	Efficient Pool Equipment	• Efficient Pool Pump Motors

6.1.2 Overview of Residential Electric Energy Efficiency Potential

This section presents estimates for electric 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 (MWh), percentage of savings by end use, and savings as a percentage of forecast sales. Data is provided on a 5-year and 10-year time horizon for Michigan.

This energy efficiency potential study considers the impacts of the Energy and Independence and Security Act (EISA) as an improving code standard for the residential sector. The EISA improves the baseline efficiency of several types of lighting products, including CFL or LED bulbs. Other known increases to federal minimum efficiency standards over the time period studied have also been accounted for in the analysis. These included changes to the efficiency standards central air conditioners, electric water heaters, and appliances.

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:

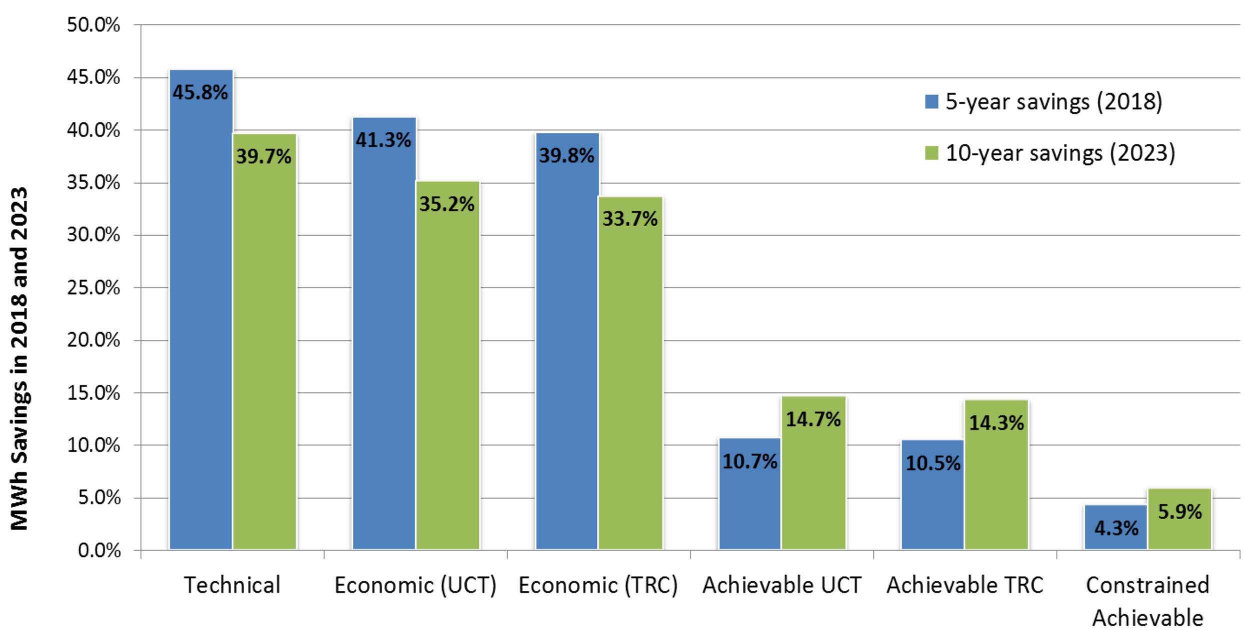
- Uncertainty about economic and fuel price forecasts used as inputs to the electric and natural gas sales forecasts
- The accuracy of results generated by building energy simulation modeling software
- The lack of availability of up-to-date efficiency saturation data for Michigan
- Changes to codes 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 LED lighting.

GDS has addressed the areas of uncertainty as robustly as possible given the time and budget constraints of this project. For example, GDS assumes increasing market adoption of LEDs over the life of the study because LED costs are expected to decrease over time. 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. Weather-sensitive measure savings estimates from the MEMD were also adjusted to account for known changes to federal standards.

SUMMARY OF FINDINGS

Figure 6-1 illustrates the estimated savings potential for each of the scenarios included in this study.

Figure 6-1: Summary of Residential Electric Energy Efficiency Potential as a % of 2018 and 2023 Sales Forecasts



The potential estimates are expressed as cumulative 5-year and 10-year savings, as percentages of the respective 2018 and 2023 sector sales. The technical potential is 45.8% in 2018 and 39.7% in 2023.[34] The 5-year and 10-year economic potential is 41.3% and 35.2% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 39.8% in 2018 and 33.7% in 2023. The slight drop from technical potential to economic potential indicates that most measures are cost-effective, particularly when screening based on the UCT.

The 5-year and 10-year achievable potential savings are: 10.7% and 14.7% for the Achievable UCT scenario; 10.5% and 14.3% for the Achievable TRC scenario; and 4.3% and 5.9% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, 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 electric and gas retail sales.

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 6-2 shows that it is technically feasible to save nearly 15.5 million MWh in the residential sector between 2014 to 2018, as well as approximately 13.7 million MWh during the 10 year period from 2014 to 2023 statewide, representing 45.8% of 5-year residential sales, and 39.7% of 10-year residential sales.[35] Lighting represents the greatest contributor to the potential at 42-33% of savings, while Appliances, Electronics, and HVAC Equipment end uses each contribute 9-21% of the savings. Table 6-3 shows the demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 4,274 MW and 4,138 MW, respectively, which is 42.7% and 40.5% of the peak forecast.

Table 6-2: Residential Sector Technical Potential Energy Savings by End Use

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
Appliances	1,915,506	12%	1,931,055	14%
Electronics	1,354,281	9%	1,392,980	10%
Lighting	6,561,055	42%	4,567,580	33%
Water Heating	1,350,089	9%	1,393,193	10%
Other	178,956	1%	182,695	1%
HVAC (Envelope)	888,701	6%	914,396	7%
HVAC (Equipment)	2,806,002	18%	2,879,504	21%
Behavioral Programs	427,140	3%	436,525	3%
Total	**15,481,730**	**100%**	**13,697,929**	**100%**
% of Annual Sales Forecast	*45.8%*		*39.7%*	

[34] Technical and Economic Potential may decrease in 2023, relative to 2018, due to the expected impacts of EISA and a 2020 provision that is expected to make CFL bulbs, or technology of similar efficacy, the baseline. As a result, all savings associated with CFL bulbs replacing general service incandescent were modeled to decrease to 0 kWh by 2021.

[35] Technical potential represents the potential for all inefficient measures to be implemented "over-night." The only growth in potential over the 5 and 10 year time period is related to new construction. As noted in the prior footnote, CFLs were expected to become the baseline after 2020. As a result, lighting potential decreases between 2018 and 2023.

Table 6-3: Residential Sector Technical Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summer	**MW**	**MW**
Total	**4,274**	**4,138**
% of Peak	*42.7%*	*40.5%*

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. 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. Because the TRC includes participant costs, it goes beyond utility resource acquisition and looks at the measure/program from a more broad perspective. 79% of all measures that were included in the electric potential analysis passed the UCT and 68% of all measures passed the TRC Test.

Table 6-4 indicates that the economic potential based on the UCT screen is nearly 14.0 million MWh during the 5 year period from 2014 to 2018, and the economic potential more than 12.1 million MWh during the 10 year period from 2014 to 2023. This represents 41.3% and 35.2% of residential sales across the respective 5-year and 10-year timeframes. Similar to the technical potential scenario, lighting represents the greatest contributor to the potential at 43-33% of savings, while the HVAC Equipment, appliances, electronics, and water heating end uses each contribute between 9-20% of the savings. Table 6-5 shows the demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 3,895 MW and 3,758 MW, respectively, which is 38.9% and 36.7% of the peak forecast.

Table 6-4: Residential Sector Economic Potential (UCT) Energy Savings by End Use

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
Appliances	1,786,674	13%	1,796,237	15%
Electronics	1,287,615	9%	1,325,226	11%
Lighting	6,049,085	43%	4,043,252	33%
Water Heating	1,346,481	10%	1,390,609	11%
Other	178,956	1%	182,695	2%
HVAC (Envelope)	585,197	4%	597,812	5%
HVAC (Equipment)	2,306,799	17%	2,373,890	20%
Behavioral Programs	427,140	3%	436,525	4%
Total	**13,967,946**	**100%**	**12,146,247**	**100%**
% of Annual Sales Forecast	*41.3%*		*35.2%*	

Table 6-5: Residential Sector Economic Potential (UCT) Demand Savings

SUMMER PEAK DEMAND		
	2018	2023
Summary	MW	MW
Total	3,895	3,758
% of Peak	*38.9%*	*36.7%*

Table 6-6 demonstrates that the economic potential based on the TRC screen is lower than the economic potential based on the UCT screen. In 2023, economic potential based on the TRC cost-effectiveness screening is approximately 500,000 MWh lower than the economic potential based on the UCT. The biggest decline in economic potential between the two screens occurred in the HVAC (Equipment) end-use where measure costs are high and incentive amounts can significantly impact cost-effectiveness.

Table 6-6: Residential Sector Economic Potential (TRC) Energy Savings by End Use

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
Appliances	1,786,674	13%	1,796,237	15%
Electronics	1,287,615	10%	1,325,226	11%
Lighting	5,944,376	44%	3,938,543	34%
Water Heating	1,346,481	10%	1,390,609	12%
Other	178,956	1%	182,695	2%
HVAC (Envelope)	502,389	4%	511,252	4%
HVAC (Equipment)	2,021,744	15%	2,092,466	18%
Behavioral Programs	398,228	3%	406,978	3%
Total	13,466,463	100%	11,644,006	100%
% of Annual Sales Forecast	*39.8%*		*33.7%*	

Table 6-7: Residential Sector Economic Potential (TRC) Demand Savings

SUMMER PEAK DEMAND		
	2018	2023
Summary	MW	MW
Total	4,106	3,980
% of Peak	*41.0%*	*38.9%*

6.1.1 Achievable Electric Potential Savings in the Residential Sector

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, administrative costs were assumed to be equivalent to 20% of incremental measures costs.

This is based on a published review of typical program administrator costs of several utility energy efficiency programs nationwide.[36]

This study estimated achievable potential for three 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.[37] The second scenario, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

6.1.1.1 Achievable UCT vs. Achievable TRC

Tables 6-8 through Table 6-11 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume 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. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is roughly 125,000 MWh greater, over the next decade, than the achievable TRC scenario.

Table 6-8: Residential Achievable UCT Potential Electric Energy Savings by End Use

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
Appliances	366,811	10%	673,510	13%
Electronics	749,078	21%	854,883	17%
Lighting	1,386,345	38%	1,493,016	29%
Water Heating	262,683	7%	594,697	12%
Other	43,585	1%	96,303	2%
HVAC (Envelope)	196,173	5%	395,204	8%
HVAC (Equipment)	344,252	10%	679,549	13%
Behavioral Programs	273,467	8%	283,672	6%
Total	**3,622,394**	100%	**5,070,834**	**100%**
% of Annual Sales Forecast	*10.7%*		*14.7%*	

Table 6-9: Residential Achievable UCT Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	**839**	**1,338**
% of Peak	*8.4%*	*13.1%*

[36] PacifiCorp Assessment of Long-Term, System-Wide Potential for Demand-Side and Other Supplemental Resources. Volume II. Prepared by Cadmus. March 2013. Appendix B-4.

[37] 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 6-10: Residential Achievable TRC Potential Electric Energy Savings by End Use

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
Appliances	366,811	10%	673,510	14%
Electronics	749,078	21%	854,883	17%
Lighting	1,353,255	38%	1,440,074	29%
Water Heating	262,683	7%	594,697	12%
Other	43,585	1%	96,303	2%
HVAC (Envelope)	170,658	5%	344,028	7%
HVAC (Equipment)	339,401	10%	670,349	14%
Behavioral Programs	264,123	7%	273,098	6%
Total	**3,549,596**	**100%**	**4,946,942**	**100%**
% of Annual Sales Forecast	*10.5%*		*14.3%*	

Table 6-11: Residential Achievable TRC Potential Demand Savings

SUMMER PEAK DEMAND		
	2018	**2023**
Summary	**MW**	**MW**
Total	**892**	**1,447**
% of Peak	*8.9%*	*14.1%*

The 5-year and 10-year Achievable UCT potential savings estimates are approximately 3.62 million MWh and 5.07 million MWh. This equates to 10.7% and 14.7% of sector sales in 2018 and 2023. By comparison, the respective 5-year and 10-year Achievable TRC potential savings estimates are approximately 3.55 million MWh and 4.95 million MWh. This equates to 10.5% and 14.7% of sector sales in 2018 and 2023. The five and ten year demand savings estimates in the Achievable UCT and Achievable TRC scenarios are depicted in Tables 6-9 and 6-11, respectively.

6.1.1.1 Achievable UCT vs. Constrained UCT

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 Michigan utility revenue.

Table 6-12 shows the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizon. The 5-year and 10-year Achievable UCT potential savings estimates are approximately 1.5 million MWh and 2.04 million MWh. This equates to 4.3% and 5.9% of sector sales in 2018 and 2023. The five and ten year demand savings estimates in the Constrained UCT scenario are depicted in Table 6-13.

Table 6-12: Residential Constrained Achievable Savings Potential Energy Savings by End Use

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
End Use	**Energy (MWh)**	**Savings**	**Energy (MWh)**	**Savings**
Appliances	148,073	10%	270,375	13.2%

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
Electronics	302,513	21%	344,280	16.8%
Lighting	561,760	38%	600,765	29.4%
Water Heating	106,457	7%	240,207	11.7%
Other	17,662	1%	38,902	1.9%
HVAC (Envelope)	79,846	5%	160,036	7.8%
HVAC (Equipment)	139,962	10%	274,607	13.4%
Behavioral Programs	108,763	7%	115,389	5.6%
Total	**1,465,036**	**100%**	**2,044,561**	**100.0%**
% of Annual Sales Forecast	*4.3%*		*5.9%*	

Table 6-13: Residential Constrained Achievable Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	2023
Summary	MW	MW
Total	**340**	**540**
% of Peak	*3.4%*	*5.3%*

Figure 6-2 shows the percentage of electric savings by each end use for the Constrained UCT scenario. The lighting end use shows the largest potential for savings with 29.4% of total electric savings, followed by the appliances and HVAC Equipment end uses at 16.8% and 13.4%, respectively.

Figure 6-2: Residential Sector 2023 Constrained UCT Electric Potential Savings, by End Use

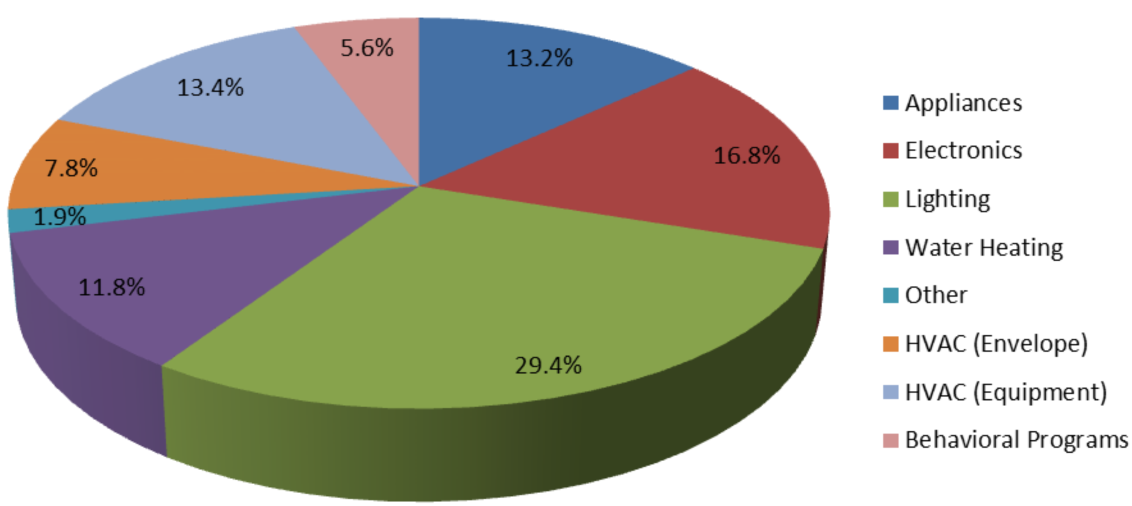
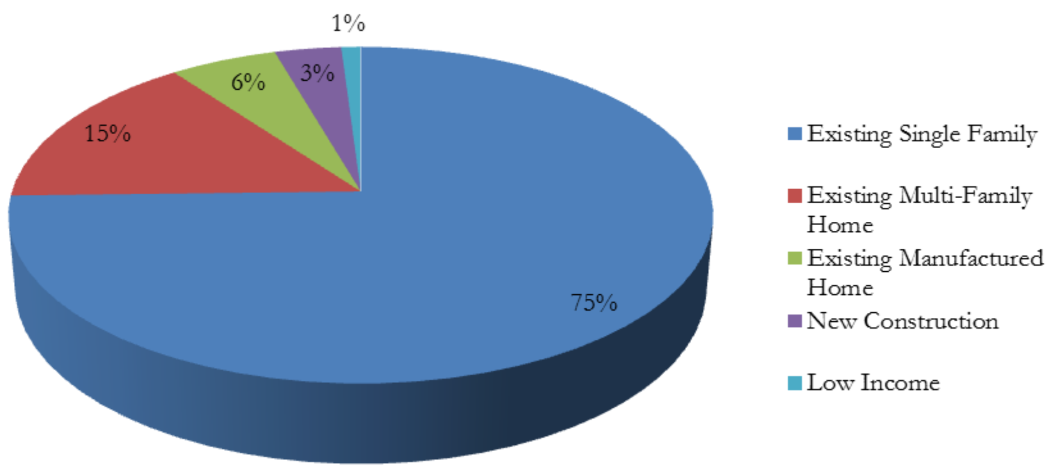


Figure 6-3 shows the breakdown of estimated savings in 2023 by housing type, low-income designation and new construction measures, for the Achievable UCT potential scenario. The savings are largely coming from existing/turnover measures, meaning energy efficient equipment is installed in replacement of existing equipment that has failed. The existing single-family housing and existing multi-family housing types lead the way with 75% of savings and 15% savings, respectively, followed by and 6%

coming from existing manufactured homes. New construction measures account for 3% of total savings and low-income measures account for 1% of total savings. The low-income measures represent only those measures typically included in the Michigan Weatherization Assistance Program to low-income households, and do not represent the combined “low-income potential” in Michigan. There is also low-income potential that is subsumed by the other 99% of the savings associated with the “non-low-income” measures. For example, low income households could realize additional LED lighting and/or behavioral program energy efficiency savings, even though they may not be offered under the traditional umbrella of low-income programs.

Figure 6-3: Residential Constrained Achievable Savings in 2023, by Housing Type, Low-Income Designation and New Construction Measures



6.1.2 Annual Achievable Electric Savings Potential

Table 6-14, Table 6-15 and Table 6-16 shows cumulative annual energy savings (MWh) for all three 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 later, in Section 6.3. Table 6-17, Table 6-18 and Table 6-19 shows cumulative annual demand (MW) savings for all three 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 later, in Section 6.3.

Table 6-14: Cumulative Annual Residential Energy Savings in the Achievable UCT Potential Scenario, by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	42,168	121,659	202,452	284,548	366,811	449,136	531,497	613,886	661,226	673,510
Electronics	122,694	286,807	451,582	616,766	749,078	830,288	849,138	851,396	853,258	854,883
Lighting	216,439	517,636	810,134	1,098,793	1,386,345	1,668,918	1,944,916	1,247,934	1,411,284	1,493,016
Water Heating	41,463	89,732	142,629	200,126	262,683	329,925	396,279	462,138	528,285	594,697
Other	6,869	14,716	23,561	33,393	43,585	54,095	64,621	75,160	85,721	96,303
HVAC (Envelope)	38,831	77,884	117,126	156,545	196,173	235,906	275,673	315,469	355,316	395,204
HVAC (Equipment)	64,568	131,910	201,006	272,172	344,252	412,858	481,800	551,056	620,301	679,549
Behavioral Programs	97,238	192,172	225,558	254,177	273,467	283,188	283,367	283,463	283,567	283,672
Total	**630,268**	**1,432,515**	**2,174,047**	**2,916,521**	**3,622,394**	**4,264,314**	**4,827,291**	**4,400,502**	**4,798,958**	**5,070,834**
% of Annual Forecast Sales	*1.9%*	*4.2%*	*6.4%*	*8.6%*	*10.7%*	*12.6%*	*14.2%*	*12.9%*	*14.0%*	*14.7%*

Table 6-15: Cumulative Annual Residential Energy Savings in the Achievable TRC Potential Scenario, by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	42,168	121,659	202,452	284,548	366,811	449,136	531,497	613,886	661,226	673,510
Electronics	122,694	286,807	451,582	616,766	749,078	830,288	849,138	851,396	853,258	854,883
Lighting	209,821	504,401	790,281	1,072,322	1,353,255	1,629,211	1,898,592	1,194,991	1,358,341	1,440,074
Water Heating	41,463	89,732	142,629	200,126	262,683	329,925	396,279	462,138	528,285	594,697
Other	6,869	14,716	23,561	33,393	43,585	54,095	64,621	75,160	85,721	96,303
HVAC (Envelope)	33,749	67,712	101,852	136,158	170,658	205,263	239,901	274,566	309,277	344,028
HVAC (Equipment)	62,694	128,578	196,755	267,562	339,401	407,578	475,809	544,059	612,183	670,349
Behavioral Programs	98,489	193,009	222,067	247,183	264,123	272,657	272,818	272,905	273,001	273,098
Total	**617,947**	**1,406,612**	**2,131,178**	**2,858,058**	**3,549,596**	**4,178,152**	**4,728,653**	**4,289,102**	**4,681,294**	**4,946,942**
% of Annual Forecast Sales	*1.8%*	*4.2%*	*6.3%*	*8.5%*	*10.5%*	*12.3%*	*13.9%*	*12.5%*	*13.6%*	*14.3%*

Table 6-16: Cumulative Annual Residential Energy Savings in the Constrained UCT Potential Scenario, by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	18,519	50,537	82,767	115,359	148,073	180,880	213,908	247,006	264,976	270,375
Electronics	53,883	119,986	185,719	251,295	302,513	333,331	338,776	339,966	341,858	344,280
Lighting	95,053	216,372	332,853	447,415	561,760	674,378	785,076	503,705	569,614	600,765
Water Heating	18,209	37,651	58,753	81,579	106,457	133,253	159,820	186,276	213,074	240,207
Other	3,017	6,177	9,706	13,609	17,662	21,851	26,071	30,305	34,582	38,902
HVAC (Envelope)	17,053	32,784	48,438	64,087	79,846	95,680	111,627	127,614	143,751	160,036
HVAC (Equipment)	28,356	55,481	83,045	111,297	139,962	167,136	194,776	222,610	250,681	274,607
Behavioral Programs	42,704	77,924	90,646	101,108	108,763	112,752	113,383	113,707	114,526	115,389
Total	**276,794**	**596,912**	**891,927**	**1,185,749**	**1,465,036**	**1,719,262**	**1,943,438**	**1,771,191**	**1,933,063**	**2,044,561**
% of Annual Forecast Sales	*0.8%*	*1.8%*	*2.6%*	*3.5%*	*4.3%*	*5.1%*	*5.7%*	*5.2%*	*5.6%*	*5.9%*

Table 6-17: Cumulative Annual Residential Demand Savings in the Achievable UCT Potential Scenario, by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	6	17	28	39	51	63	74	86	98	98
Electronics	23	52	82	111	139	158	163	164	164	164
Lighting	25	60	94	128	162	194	227	135	161	161
Water Heating	6	13	21	29	39	48	57	64	80	80
Other	4	9	15	21	27	34	41	47	61	61
HVAC (Envelope)	32	65	97	130	163	196	228	261	327	327
HVAC (Equipment)	42	84	128	172	217	255	292	329	403	403
Behavioral Programs	16	30	35	39	41	43	43	43	43	43
Total	**154**	**331**	**499**	**670**	**839**	**991**	**1,124**	**1,129**	**1,338**	**1,338**
% of Annual Forecast Sales	*1.5%*	*3.3%*	*5.0%*	*6.7%*	*8.4%*	*9.9%*	*11.1%*	*11.1%*	*13.1%*	*13.1%*

Table 6-18: Cumulative Annual Residential Demand Savings in the Achievable TRC Potential Scenario, by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	6	17	28	39	51	63	74	86	94	98
Electronics	23	52	82	111	139	158	163	164	164	164
Lighting	25	60	94	128	162	194	227	135	153	161
Water Heating	6	13	21	29	39	48	57	64	72	80
Other	4	9	15	21	27	34	41	47	54	61
HVAC (Envelope)	30	60	90	120	151	181	211	242	272	303
HVAC (Equipment)	54	109	166	225	284	335	386	437	487	538
Behavioral Programs	16	31	35	39	41	42	42	42	42	42
Total	**165**	**352**	**531**	**712**	**892**	**1,056**	**1,201**	**1,217**	**1,339**	**1,447**
% of Annual Forecast Sales	*1.6%*	*3.5%*	*5.3%*	*7.1%*	*8.9%*	*10.5%*	*11.9%*	*12.0%*	*13.1%*	*14.1%*

Table 6-19: Cumulative Annual Residential Demand Savings in the Constrained UCT Potential Scenario, by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	3	7	11	16	21	25	30	34	38	40
Electronics	10	22	34	45	56	64	65	65	66	66
Lighting	11	25	39	52	65	79	91	55	62	65
Water Heating	3	6	9	12	16	19	23	26	29	32
Other	2	4	6	9	11	14	16	19	22	24
HVAC (Envelope)	14	27	40	53	66	79	92	106	119	132
HVAC (Equipment)	18	35	53	70	88	103	118	133	148	163
Behavioral Programs	7	12	14	15	16	17	17	17	17	17
Total	**68**	**138**	**206**	**273**	**340**	**400**	**453**	**455**	**500**	**540**
% of Annual Forecast Sales	*0.7%*	*1.4%*	*2.0%*	*2.7%*	*3.4%*	*4.0%*	*4.5%*	*4.5%*	*4.9%*	*5.3%*

6.1.3 Residential Electric Savings Summary by Measure Group

Table 6-20 provides an end-use breakdown of the residential electric savings potential estimates for technical and economic potential, and each of the three achievable potential scenarios. 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 6-20: Breakdown of Residential Cumulative Annual Electric Savings Potential for Technical, Economic and Achievable Potential, by End Use for Michigan

End Use	Technical Potential (MWh)	Economic Potential -UCT- (MWh)	Economic Potential -TRC- (MWh)	Achievable Potential -UCT- (MWh)	Achievable Potential -TRC- (MWh)	Constrained Achievable –UCT-(MWh)
Appliances						
ENERGY STAR Refrigerators	177,216	177,216	177,216	35,527	35,527	14,321
ENERGY STAR Freezers	68,256	68,256	68,256	20,772	20,772	8,377
ENERGY STAR Clothes Washers	36,910	0	0	0	0	0
ENERGY STAR Dishwashers	33,314	0	0	0	0	0
ENERGY STAR Dehumidifiers	115,083	115,083	115,083	55,602	55,602	22,468
Heat Pump Dryer	64,594	0	0	0	0	0
2nd Refrigerator Turn-In	1,338,562	1,338,562	1,338,562	523,648	523,648	209,987
2nd Freezer Turn-In	94,465	94,465	94,465	36,956	36,956	14,820
2nd Dehumidifier Turn-In	2,654	2,654	2,654	1,004	1,004	403
Electronics						
Controlled Power Strips	99,152	0	0	0	0	0
Efficient Set Top Box	184,053	184,053	184,053	114,535	114,535	46,146
Efficient Desktop PCs	325,626	325,626	325,626	178,022	178,022	71,920
Efficient Laptop PCs	49,906	81,304	81,304	35,185	35,185	14,215
Efficient Televisions	617,351	617,351	617,351	447,761	447,761	180,017
Efficient Computer Monitors	116,891	116,891	116,891	79,380	79,380	31,982
Lighting						
Specialty CFL Bulbs	1,697,182	1,697,182	1,697,182	632,114	632,114	253,403
Standard Screw-In CFL Bulbs	74,338	74,338	74,338	33,798	33,798	13,499
LED Screw-In Bulbs	505,347	505,347	505,347	261,450	261,450	105,624
Specialty LED Bulbs	810,552	810,552	810,552	136,979	136,979	55,304
Exterior Lighting - CFL Bulbs	0	0	0	0	0	0
Exterior Lighting - LED Bulbs	358,353	358,353	358,353	210,558	210,558	84,985
Efficient Torchiere Floor Lamps	421,159	421,159	421,159	117,308	117,308	47,380
Efficient Fluorescent Tube	181,345	0	0	0	0	0

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC POTENTIAL -UCT- (MWH)	ECONOMIC POTENTIAL -TRC- (MWH)	ACHIEVABLE POTENTIAL -UCT- (MWH)	ACHIEVABLE POTENTIAL -TRC- (MWH)	CONSTRAINED ACHIEVABLE –UCT-(MWH)
Lighting						
LED Night Lights	27,001	27,001	27,001	15,178	15,178	6,124
Occupancy Sensors	212,086	0	0	0	0	0
Holiday Lights	97,240	0	0	0	0	0
Multifamily Common Areas	182,976	149,320	44,611	85,632	32,689	34,445
Water Heating						
Heat Pump Water Heater	575,030	1,150,060	1,150,060	415,300	415,300	167,673
Solar Water Heating	450,528	0	0	0	0	0
Gravity Film Heat Exchanger	127,171	0	0	0	0	0
Pipe Wrap	15,019	15,019	15,019	10,714	10,714	0
Low Flow Showerheads	93,813	93,813	93,813	71,455	71,455	4,307
Shower Starters (with LF Showerheads)	25,983	25,983	25,983	17,834	17,834	28,899
Low Flow Faucet Aerators	105,649	105,733	105,733	79,394	79,394	7,212
Other						
Efficient Pool Pump Motors	182,695	182,695	182,695	96,303	96,303	38,902
HVAC (Envelope)						
Ceiling/Attic Insulation	87,119	68,141	60,096	53,344	47,041	21,604
Wall Insulation	63,858	16,044	7,950	9,892	5,844	4,004
Floor Insulation	(33,946)	437	25	101	6	41
Basement Wall Insulation	(7,331)	7,049	1,535	4,932	1,087	1,997
Crawlspace Wall Insulation	(1,220)	4,146	418	1,220	102	494
Air Sealing	50,656	35,864	37,192	26,851	27,996	10,867
Duct Sealing	16,540	17,273	14,747	12,450	10,331	5,039
Duct Insulation	7,465	8,203	8,757	5,798	6,235	2,344
Duct Location (move into conditioned space)	30,081	40,917	17,712	16,967	5,934	6,867
ENERGY STAR Windows	263,771	270,538	306,702	177,032	201,379	71,698
Window Film	122,980	118,769	49,196	78,143	32,367	31,648
ENERGY STAR Doors	65,374	0	0	0	0	0
Cool Roof	95,434	462	462	68	68	27
Low Income Weatherization Package	155,032	11,385	7,876	8,998	6,230	3,644
Steam Pipe Insulation	(1,417)	(1,417)	(1,417)	(591)	(591)	(238)
HVAC (Equipment)						
ENERGY STAR Air Source Heat Pumps	38,547	40,843	40,595	9,444	9,449	3,820

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC POTENTIAL -UCT- (MWH)	ECONOMIC POTENTIAL -TRC- (MWH)	ACHIEVABLE POTENTIAL -UCT- (MWH)	ACHIEVABLE POTENTIAL -TRC- (MWH)	CONSTRAINED ACHIEVABLE –UCT-(MWH)
ENERGY STAR Dual Fuel Heat Pumps	29,542	29,542	30,259	7,348	7,599	2,971
Geothermal Heat Pumps	16,061	0	0	0	0	0
ENERGY STAR Central Air Conditioners	1,045,448	1,045,448	1,050,054	203,190	204,230	82,278
ENERGY STAR Room Air Conditioners	60,860	60,860	60,860	11,537	11,537	4,664
Room Air Conditioner Recycling	13,412	13,412	13,412	4,937	4,937	1,980
Central AC Tune-Up	82,810	82,810	81,905	21,261	24,153	8,566
Ductless Mini-Split Systems	215,552	15,740	17,044	4,166	4,533	1,684
Thermostat setback strategies	230,904	210,221	210,221	109,911	109,911	44,099
Whole House Fans	264,362	0	0	0	0	0
Efficient Chillers	44,659	44,659	44,659	11,791	11,791	4,730
Chiller Controls	679	679	679	364	364	147
Efficient Furnaces	775,125	762,124	0	249,211	0	100,908
Efficient Furnace Fans	112,094	136,841	614,917	67,086	303,764	27,139
Efficient Boilers	(49,097)	(67,818)	(69,788)	(19,940)	(20,744)	(8,073)
Boiler Controls	(1,452)	(1,472)	(2,351)	(758)	(1,174)	(307)
Behavioral Programs						
Direct Feedback (In-Home Energy Display)	229,932	229,932	191,825	129,116	112,531	52,290
Indirect Feedback (Monthly Energy Use Reports)	206,593	206,593	215,153	154,556	160,568	63,099
Total	**13,697,929**	**12,146,247**	**11,644,006**	**5,070,834**	**4,946,942**	**2,044,561**
% of Annual 2022 Sales Forecast	*39.7%*	*35.2%*	*33.7%*	*14.7%*	*14.3%*	*5.9%*
Note: Measures in the above Table with "0" achievable potential are ones that did not pass the Economic screening						

Table 6-21 provides a list of the Top 10 residential electric savings measures for the Achievable UCT scenario. The table provides the measures ranked according to the electric savings potential. The column to the far right shows the results of the measure level cost-effectiveness screening test using the UCT to screen the measures. The measures in the table are representative of a group of comparable measures falling under the umbrella of the measure categories provided in the table. This means that there are a range of UCT ratios for measure iterations that fall into a single measure category. For example, "Specialty LED Bulbs" is a measure category which consists of several measure iterations to account for bulb type and wattage and housing type. The table presents an average of the UCT ratios for all measures which are part of the measure categories in the Top 10.

The Top 10 measures combine to yield an estimated 3.3 million MWh savings. This accounts for nearly 65% of the total residential electric savings in the Achievable UCT scenario.

Table 6-21: Top 10 Residential Electric Savings Measures in the Achievable UCT Scenario

Measure		2023 Energy (MWh)	% of Sector Savings	UCT Ratio
1	Specialty CFL Bulbs	632,114	12.5%	3.78
2	2nd Refrigerator Turn-In	523,648	10.3%	5.56
3	Efficient Televisions	447,761	8.8%	114.97
4	Heat Pump Water Heater	415,300	8.2%	5.43
5	LED Screw-In Bulbs	251,464	5.0%	2.92
6	Efficient Furnaces (Furnace Fans)	249,211	4.9%	21.32
7	Exterior Lighting - LED Bulbs	210,558	4.1%	8.11
8	ENERGY STAR Central Air Conditioners	203,190	4.0%	2.72
9	Efficient Desktop PCs	178,022	3.5%	4.00
10	ENERGY STAR Windows	177,032	3.5%	2.12
Total		3,288,300	64.8%	

6.2 Residential Natural Gas Potential

Natural gas consumption forecasts for the residential, commercial and institutional segments of the Michigan economy indicate that natural gas demand will decrease from nearly 653 million MMBTu in 2014 to 603 million MMBTu in 2023 (representing a compound average annual rate of growth of -0.9%)[38]. The residential sector is expected to decline more rapidly compared to the state as a whole, with a forecasted average annual growth rate for 2014 to 2023 of -1.2%. The residential gas 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.

6.2.1 Energy Efficiency Measures Examined

For the residential sector, there were 791 natural gas savings measures included in the potential gas savings analysis[39]. Table 6-22 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 in the Midwest. Measure data includes incremental costs, electricity energy and demand savings, gas and water savings, and measure life.

Table 6-22: Measures and Programs Included in the Gas Residential Sector Analysis

End Use Type	End Use Description	Measures Included
HVAC Envelope	Building Envelope Upgrades	• Air/duct Sealing • Duct Insulation • Improved Insulation (Wall, Ceiling, and Floor) • Efficient Windows • Window film • ENERGY STAR doors • Cool Roofs • Low Income Weatherization Package

[38] Estimated for statewide sales based on Michigan utility load forecast data and historical sales.
[39] This total represents the number of unique energy efficiency measures and all permutations of these unique measures. For example, there are 15 permutations of the "Setback Thermostat" measure to account for the various housing types, heating/cooling combinations, and construction types.

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
HVAC Equipment	Heating/Cooling/Ventilation Equipment	• Existing Gas Furnace/Boiler Tune-up • Efficient Gas Furnaces • Efficient Gas Boilers • Boiler Controls • Set Back Thermostats
Water Heating	Domestic Hot Water	• Efficient Gas Storage Tank WH • Tankless Gas WH • Low Flow Showerhead/Faucet Aerator • Pipe Wrap • Gravity Film Heat Exchangers
Appliances	High-Efficiency Appliances / Retirement of Inefficient Appliances	• ENERGY STAR Clothes Washers • ENERGY STAR Dishwashers
Behavioral	Consumer Response to Feedback from Utility	• Direct (Real-Time) Feedback • Indirect Feedback

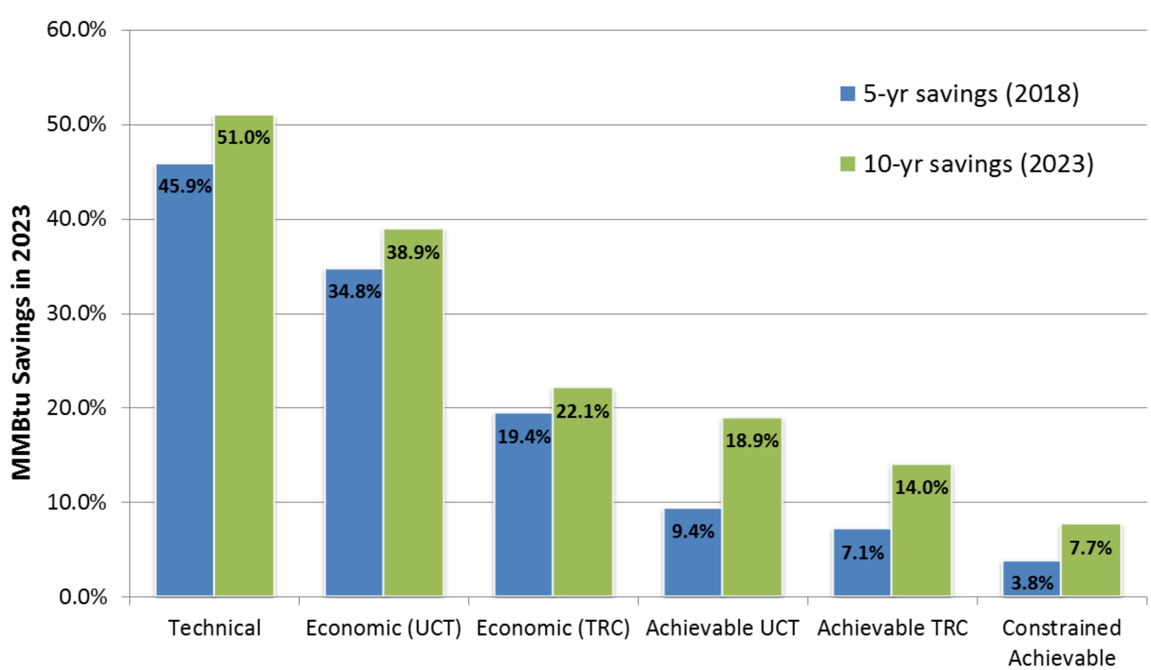
6.2.2 Overview of Residential Natural Gas Energy Efficiency Potential

This section presents estimates for 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 5-year and 10-year time horizon for Michigan.

SUMMARY OF FINDINGS

Figure 6-4 illustrates the estimated savings potential for each of the scenarios included in this study.

Figure 6-4: Summary of Residential Energy Efficiency Potential as a % of 2018 and 2023 Sales Forecasts



The potential estimates are expressed as cumulative 5-year and 10-year savings, as percentages of the respective 2018 and 2023 sector sales. The technical potential is 45.9% in 2018 and 51.0% in 2023. The

5-year and 10-year economic potential is 34.8% and 38.9% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 19.4% in 2018 and 22.1% in 2023. The significant drop from technical between the two economic potential scenarios indicates that most measures are cost-effective when screening based on the UCT, but fall below the threshold of cost-effectiveness when screening based on the TRC Test.

The 5-year and 10-year achievable potential savings are: 9.4% and 18.9% for the Achievable UCT scenario; 7.1% and 14.0% for the Achievable TRC scenario; and 3.8% and 7.7% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, 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.

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 6-23 shows that it is technically feasible to save about 136.7 million MMBtu in the residential sector between 2014 and 2018 and approximately 143.3 million MMBtu during the 10 year period from 2014 to 2023 across Michigan, representing 45.9% of 2018 residential sales, and 51.0% of 2023 residential sales. The HVAC Envelope end use represents the greatest contributor to the potential at 44% of 10-yr savings, while the HVAC Equipment end use contributes 40% of the 10-yr savings, and the Water Heating end use contributes 19% of the 10-yr savings. Conversely, the lighting end use yields a 5% gain in consumption. While there is significant potential for electric savings in the lighting end use, this potential would produce a negative impact on natural gas potential, due to increased heating requirements associated with efficiency lighting.[40] Other measures such as efficient air conditioners and efficient electric water heaters also increase heating requirements due to the minor reductions in heat losses associated with these measures.

Table 6-23: Residential Sector Technical Potential MMBtu Savings by End Use

END USE	2018 SAVINGS (MMBTU)	% OF 2018 SAVINGS	2023 SAVINGS (MMBTU)	% OF 2023 SAVINGS
Appliances	1,338,540	1%	1,370,972	1%
Electronics	0	0%	0	0%
Lighting	-10,132,368	-7%	-7,413,995	-5%
Water Heating	25,653,133	19%	26,569,703	19%
Other	0	0%	0	0%
HVAC (Envelope)	61,077,744	45%	62,401,101	44%
HVAC (Equipment)	55,510,229	41%	57,012,809	40%
Behavioral Programs	3,259,386	2%	3,331,000	2%
Total	**136,706,666**	**100%**	**143,271,591**	**100%**
% of Annual Sales Forecast	*45.9%*		*51.0%*	

[40] High efficiency lighting reduces the amount of waste heat that is released during hours of lighting operation. The reduction in waste heat places a greater burden on heating equipment (electric and gas) to meet the winter heating load requirements.

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. 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. Because the TRC includes participant costs, it goes beyond utility resource acquisition and looks at the measure/program from a more broad perspective. 77% of all measures that were included in the electric potential analysis passed the UCT and 62% of all measures passed the TRC Test.

Table 6-24 indicates that the economic potential based on the UCT screen is nearly 103.4 million MMBtu during the 5 year period from 2014 to 2018. The economic potential increases to nearly 109.3 million MMBtu during the 10 year period from 2014 to 2023. This represents 34.8% and 38.9% of residential sales across the respective 2018 and 2023 sales. The HVAC Equipment end use represents the greatest contributor to the potential at 52% of the 10-yr savings, while the HVAC Envelope and Water Heating end use contributes 31% and 20% of the 10-yr savings.

Table 6-24: Statewide Residential Sector Economic Potential (UCT) MMBtu Savings by End Use

END USE	2018 SAVINGS (MMBTU)	% OF 2018 SAVINGS	2023 SAVINGS (MMBTU)	% OF 2023 SAVINGS
Appliances	0	0%	0	0%
Electronics	0	0%	0	0%
Lighting	-8,860,565	-9%	-6,116,785	-6%
Water Heating	21,196,030	20%	21,902,671	20%
Other	0	0%	0	0%
HVAC (Envelope)	32,652,145	32%	33,635,009	31%
HVAC (Equipment)	55,340,011	53%	56,546,757	52%
Behavioral Programs	3,259,386	3%	3,331,000	3%
Total	**103,587,007**	**100%**	**109,298,652**	**100%**
% of Annual Sales Forecast	*34.8%*		*38.9%*	

Table 6-25 demonstrates that the economic potential based on the TRC screen is lower than the economic potential based on the UCT screen. In 2023, economic potential based on the TRC cost-effectiveness screening is approximately 47 million MMBtu lower than the economic potential based on the UCT. The biggest decline in economic potential between the two screens occurred in the HVAC (Equipment) end-use where measure costs are high and incentive amounts can significantly impact cost-effectiveness.

Table 6-25: Statewide Residential Sector Economic Potential (TRC) MMBtu Savings by End Use

END USE	2018 SAVINGS (MMBTU)	% OF 2018 SAVINGS	2023 SAVINGS (MMBTU)	% OF 2023 SAVINGS
Appliances	0	0%	0	0%
Electronics	0	0%	0	0%
Lighting	-8,684,361	-15%	-5,940,582	-10%

END USE	2018 SAVINGS (MMBTU)	% OF 2018 SAVINGS	2023 SAVINGS (MMBTU)	% OF 2023 SAVINGS
Water Heating	8,100,414	14%	8,425,883	14%
Other	0	0%	0	0%
HVAC (Envelope)	28,284,493	49%	28,933,758	47%
HVAC (Equipment)	27,188,515	47%	27,609,723	44%
Behavioral Programs	2,996,531	5%	3,062,371	5%
Total	**57,885,592**	**100%**	**62,091,152**	**100%**
% of Annual Sales Forecast	*19.4%*		*22.1%*	

6.2.3 Achievable Natural Gas Potential Savings in the Residential Sector

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.). As noted in Section 6.1.3, administrative costs were assumed to be equivalent to 20% of incremental measures costs.

This study estimated achievable potential for three 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. The second scenario, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

6.2.3.1 Achievable UCT vs. Achievable TRC

Tables 6-26 and 6-27 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume an incentive level approximately equal to 50% of the incremental measure cost and include estimated 10-year market adoption rates based on incentive levels and equipment replacement cycles. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is 13.8 million MMBTu greater, over the next decade, than the achievable TRC scenario.

Table 6-26: Residential Achievable UCT Natural Gas Potential Savings by End Use

END USE	2018 ENERGY (MMBTU)	% OF 2018 SAVINGS	2023 ENERGY (MMBTU)	% OF 2023 SAVINGS
Appliances	0	0%	0	0%
Electronics	0	0%	0	0%
Lighting	-2,078,125	-7%	-2,129,625	-4%
Water Heating	5,487,630	20%	9,244,933	17%
Other	0	0%	0	0%
HVAC (Envelope)	10,288,230	37%	20,959,241	39%

END USE	2018 ENERGY (MMBTU)	% OF 2018 SAVINGS	2023 ENERGY (MMBTU)	% OF 2023 SAVINGS
HVAC (Equipment)	12,193,400	44%	22,978,405	43%
Behavioral Programs	2,038,931	7%	2,125,751	4%
Total	**27,930,065**	**100%**	**53,178,705**	**100%**
% of Annual Sales Forecast	*9.4%*		*18.9%*	

Table 6-27: Residential Achievable TRC Potential Natural Gas Savings by End Use

END USE	2018 ENERGY (MMBTU)	% OF 2018 SAVINGS	2023 ENERGY (MMBTU)	% OF 2023 SAVINGS
Appliances	0	0%	0	0%
Electronics	0	0%	0	0%
Lighting	-2,022,443	-9%	-2,040,534	-5%
Water Heating	4,218,934	20%	6,659,203	17%
Other	0	0%	0	0%
HVAC (Envelope)	9,276,023	44%	18,911,780	48%
HVAC (Equipment)	7,875,910	37%	13,772,046	35%
Behavioral Programs	1,947,669	9%	2,023,974	5%
Total	**21,296,093**	**100%**	**39,326,470**	**100%**
% of Annual Sales Forecast	*7.1%*		*14.0%*	

The 5-year and 10-year Achievable UCT potential savings estimates are approximately 27.9 million MMBtu and 53.2 million MMBtu. This equates to 9.4% and 18.9% of sector sales in 2018 and 2023. By comparison, the respective 5-year and 10-year Achievable TRC potential savings estimates are approximately 21.3 million MMBtu and 39.3 million MMBtu. This equates to 7.1% and 14.0% of sector sales in 2018 and 2023.

6.2.3.2 Achievable UCT vs. Constrained UCT

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 Michigan utility revenue.

Table 6-28 shows the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizons. The 5-year and 10-year Achievable UCT potential savings estimates are approximately 11.4 million MMBTu and 21.5 million MMBTu. This equates to 3.8% and 7.7% of sector sales in 2018 and 2023.

Table 6-28: Residential Constrained Achievable Potential Natural Gas Savings by End Use

END USE	2018 ENERGY (MMBTU)	% OF 2018 SAVINGS	2023 ENERGY (MMBTU)	% OF 2023 SAVINGS
Appliances	0	0%	0	0%
Electronics	0	0%	0	0%

END USE	2018 ENERGY (MMBTU)	% OF 2018 SAVINGS	2023 ENERGY (MMBTU)	% OF 2023 SAVINGS
Lighting	-842,158	-7%	-856,494	-4%
Water Heating	2,226,078	20%	3,733,128	17%
Other	0	0%	0	0%
HVAC (Envelope)	4,184,483	37%	8,483,866	39%
HVAC (Equipment)	4,952,718	44%	9,270,666	43%
Behavioral Programs	810,938	7%	864,248	4%
Total	**11,332,060**	**100%**	**21,495,414**	**100%**
% of Annual Sales Forecast	*3.8%*		*7.7%*	

Figure 6-5 shows the estimated 10-year cumulative efficiency savings for the Constrained UCT Achievable potential scenario, broken out by end use across the entire residential sector. The HVAC Equipment end use shows the largest potential for savings at nearly 9.3 million MMBtu, or 43% of total savings. This figure also illustrates the negative impact on natural gas potential, due to increased heating requirements associated with efficiency lighting.

Figure 6-5: Residential Sector 2023 Achievable Potential Savings for the Constrained UCT Scenario, by End Use

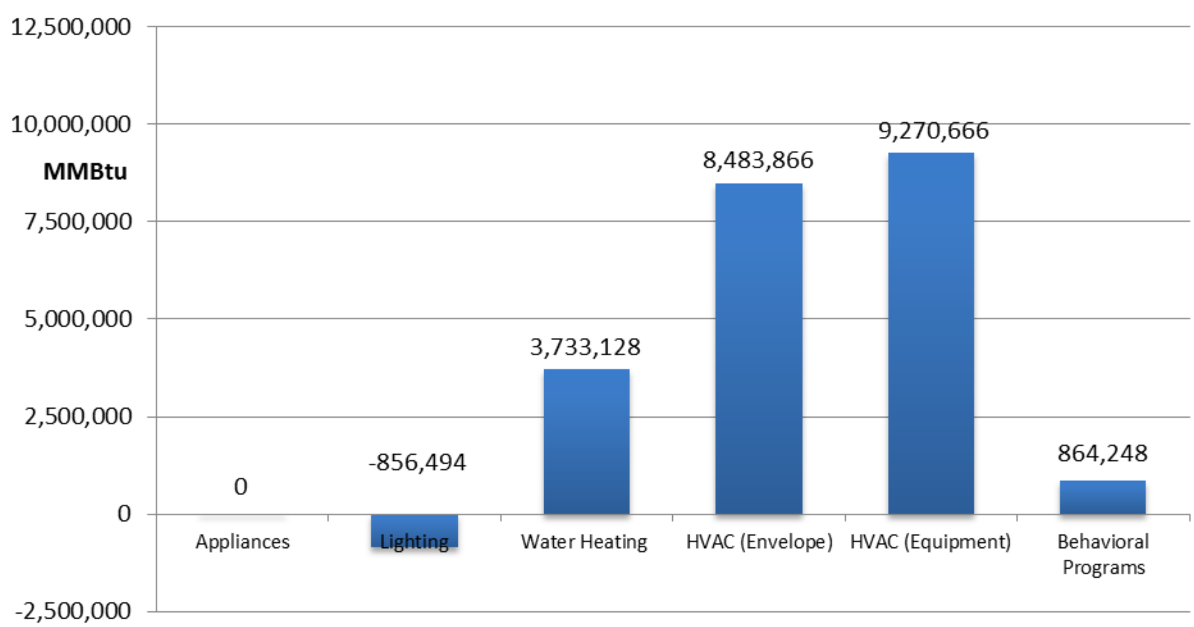
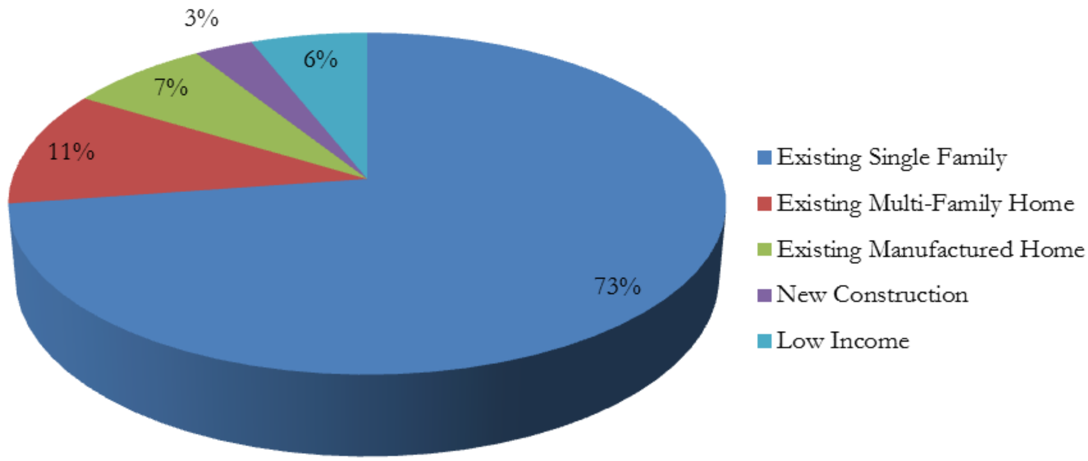


Figure 6-6 shows the breakdown of estimated savings in 2023 by housing type, low-income designation and new construction measures, for the Base Achievable potential scenario. The savings are largely coming from existing/turnover measures, meaning energy efficient equipment is installed in replacement of existing equipment that has failed. The existing single-family housing and existing multi-family housing types lead the way with 73% of savings and 11% savings, respectively, followed by and 7% coming from manufactured. New construction measures account for 3% of total savings and low-income measures account for 6% of total savings. As noted in the electric potential portion of this section, the low-income measures represent only those measures typically included in the Michigan Weatherization Assistance Program to low-income households, and do not represent the combined "low-income potential" in Michigan. There is also low-income potential that is subsumed by the other 93% of the savings associated with the "non-low-income" measures. For example, low income households could realize additional behavioral program energy efficiency savings, even though they may not be offered under the traditional umbrella of low-income programs.

Figure 6-6: Residential Constrained UCT Achievable Savings in 2023, by Housing Type, Low-Income Designation and New Construction Measures



6.2.4 Annual Achievable Natural Gas Savings Potential

Table 6-29, Table 6-30 and Table 6-31 shows cumulative annual energy savings for all three 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 later, in Section 1.3.

Table 6-29: Cumulative Annual Residential Energy Savings in the Achievable UCT Potential Scenario, by End Use for Michigan

END-USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	0	0	0	0	0	0	0	0	0	0
Electronics	0	0	0	0	0	0	0	0	0	0
Lighting	-327,250	-780,489	-1,218,481	-1,649,639	-2,078,125	-2,498,033	-2,906,848	-1,797,661	-2,031,566	-2,129,625
Water Heating	898,853	2,041,306	3,187,584	4,335,557	5,487,630	6,636,700	7,446,562	8,044,718	8,644,039	9,244,933
Other	0	0	0	0	0	0	0	0	0	0
HVAC (Envelope)	1,967,707	3,987,284	6,053,543	8,164,559	10,288,230	12,416,866	14,548,080	16,681,552	18,818,770	20,959,241
HVAC (Equipment)	2,402,498	4,942,165	7,495,237	9,836,729	12,193,400	14,506,779	16,828,641	19,159,724	21,496,017	22,978,405
Behavioral Programs	671,261	1,345,436	1,630,274	1,874,486	2,038,931	2,121,830	2,123,319	2,124,095	2,124,911	2,125,751
Total	**5,613,070**	**11,535,702**	**17,148,156**	**22,561,693**	**27,930,065**	**33,184,142**	**38,039,753**	**44,212,427**	**49,052,171**	**53,178,705**
% of Annual Forecast Sales	*1.8%*	*3.7%*	*5.6%*	*7.4%*	*9.4%*	*11.3%*	*13.1%*	*15.4%*	*17.3%*	*18.9%*

Table 6-30: Cumulative Annual Residential Energy Savings in the Achievable TRC Potential Scenario, by End Use for Michigan

END-USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	0	0	0	0	0	0	0	0	0	0
Electronics	0	0	0	0	0	0	0	0	0	0
Lighting	-316,113	-758,216	-1,185,072	-1,605,093	-2,022,443	-2,431,214	-2,828,893	-1,708,570	-1,942,475	-2,040,534
Water Heating	651,832	1,544,678	2,437,437	3,327,692	4,218,934	5,106,002	5,653,199	5,988,148	6,323,308	6,659,203
Other	0	0	0	0	0	0	0	0	0	0
HVAC (Envelope)	1,768,472	3,587,495	5,451,406	7,358,198	9,276,023	11,198,197	13,122,719	15,049,208	16,979,017	18,911,780
HVAC (Equipment)	1,589,392	3,322,981	5,064,813	6,472,775	7,875,910	9,223,907	10,572,720	11,922,919	13,275,612	13,772,046
Behavioral Programs	675,726	1,341,107	1,588,993	1,803,290	1,947,669	2,020,431	2,021,757	2,022,455	2,023,207	2,023,974
Total	**4,369,309**	**9,038,046**	**13,357,577**	**17,356,862**	**21,296,093**	**25,117,323**	**28,541,502**	**33,274,160**	**36,658,669**	**39,326,470**
% of Annual Forecast Sales	*1.4%*	*2.9%*	*4.3%*	*5.7%*	*7.1%*	*8.5%*	*9.8%*	*11.6%*	*12.9%*	*14.0%*

Table 6-31: Cumulative Annual Residential Energy Savings in the Constrained UCT Potential Scenario, by End Use for Michigan

END-USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	0	0	0	0	0	0	0	0	0	0
Electronics	0	0	0	0	0	0	0	0	0	0
Lighting	-143,718	-326,278	-500,661	-671,771	-842,158	-1,009,511	-1,173,483	-725,824	-820,140	-856,494
Water Heating	394,748	854,916	1,312,192	1,767,926	2,226,078	2,683,996	2,995,732	3,235,446	3,481,515	3,733,128
Other	0	0	0	0	0	0	0	0	0	0
HVAC (Envelope)	864,155	1,677,619	2,501,897	3,339,949	4,184,483	5,032,763	5,887,408	6,744,497	7,609,997	8,483,866
HVAC (Equipment)	1,055,101	2,078,052	3,096,531	4,016,679	4,952,718	5,872,321	6,804,229	7,741,775	8,689,787	9,270,666
Behavioral Programs	294,797	546,360	656,042	745,878	810,938	844,711	849,338	851,874	857,876	864,248
Total	**2,465,083**	**4,830,669**	**7,066,001**	**9,198,660**	**11,332,060**	**13,424,280**	**15,363,223**	**17,847,768**	**19,819,035**	**21,495,414**
% of Annual Forecast Sales	*0.8%*	*1.6%*	*2.3%*	*3.0%*	*3.8%*	*4.6%*	*5.3%*	*6.2%*	*7.0%*	*7.7%*

6.2.5 Residential Gas Savings Summary by Measure Group

Table 6-32 provides an end-use breakdown of the residential natural gas savings potential estimates for technical and economic potential, and each of the three achievable potential scenarios. The table indicates how the savings potential decreases systematically from the technical potential scenario to the Constrained Achievable potential scenario as additional limiting factors such as cost-effectiveness requirements and anticipated market adoption at given funding levels are introduced.

Table 6-32: Breakdown of Residential Cumulative Annual Gas Savings Potential for Technical, Economic and Achievable Potential, by End Use for Michigan

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Economic Potential -TRC- (MMBtu)	Achievable Potential -UCT- (MMBtu)	Achievable Potential -TRC- (MMBtu)	Constrained Achievable –UCT- (MMBtu)
Appliances						
ENERGY STAR Clothes Washers	1,234,592	0	0	0	0	0
ENERGY STAR Dishwashers	136,380	0	0	0	0	0
Lighting						
Specialty CFL Bulbs	(2,818,389)	(2,818,389)	(2,818,389)	(1,049,706)	(1,049,706)	(420,809)
Standard Screw-In CFL Bulbs	(123,447)	(123,447)	(123,447)	(56,126)	(56,126)	(22,416)
LED Screw-In Bulbs	(839,194)	(839,194)	(839,194)	(434,171)	(434,171)	(175,402)
Specialty LED Bulbs	(1,346,026)	(1,346,026)	(1,346,026)	(227,472)	(227,472)	(91,839)
Efficient Torchiere Floor Lamps	0	0	0	0	0	0
LED Night Lights	0	0	0	0	0	0
Occupancy Sensors	(699,389)	(699,389)	(699,389)	(194,805)	(194,805)	(78,681)
Multifamily Common Areas	0	0	0	0	0	0
Water Heating						
Heat Pump Water Heater	(937,885)	(1,875,770)	(1,875,770)	(677,363)	(677,363)	(273,478)
Solar Water Heating	6,308,684	0	0	0	0	0
Efficient Gas Tank Water Heater	2,390,659	4,710,334	0	903,474	0	365,775
Instant Gas Water Heater	4,449,282	8,766,454	0	1,682,256	0	681,066
Gravity Film Heat Exchanger	3,654,347	0	0	0	0	0
Tank Wrap	402,962	0	0	0	0	0
Pipe Wrap	4,490,184	4,490,184	4,490,184	3,379,323	3,379,323	1,358,602
Low Flow Showerheads	2,420,283	2,420,283	2,420,283	1,710,710	1,710,710	692,048

END USE	TECHNICAL POTENTIAL (MMBTU)	ECONOMIC POTENTIAL -UCT- (MMBTU)	ECONOMIC POTENTIAL -TRC- (MMBTU)	ACHIEVABLE POTENTIAL -UCT- (MMBTU)	ACHIEVABLE POTENTIAL -TRC- (MMBTU)	CONSTRAINED ACHIEVABLE –UCT- (MMBTU)
Shower Starters (with LF Showerheads)	670,558	670,558	670,558	381,890	381,890	154,602
Low Flow Faucet Aerators	2,720,628	2,720,628	2,720,628	1,864,643	1,864,643	754,513
HVAC (Envelope)						
Ceiling/Attic Insulation	8,793,191	6,531,553	6,285,828	5,116,847	4,934,267	2,072,302
Wall Insulation	6,478,320	1,467,957	967,501	897,835	741,842	363,387
Floor Insulation	4,180,390	58,371	3,271	13,434	763	5,438
Basement Wall Insulation	4,848,933	521,801	0	370,467	0	150,040
Crawlspace Wall Insulation	732,748	234,277	131,712	69,809	39,036	28,272
Air Sealing	5,055,511	3,890,293	4,134,004	2,912,164	3,106,999	1,178,685
Duct Sealing	926,669	917,545	798,866	673,328	575,709	272,468
Duct Insulation	1,283,485	817,873	499,623	515,340	264,091	208,544
Duct Location (move into conditioned space)	2,731,764	5,070,233	494,952	2,206,441	109,957	893,602
ENERGY STAR Windows	11,391,071	11,315,653	11,593,836	7,423,076	7,606,883	3,006,358
Window Film	(2,734,062)	(2,490,902)	(1,066,129)	(1,638,868)	(701,410)	(663,746)
ENERGY STAR Doors	4,684,290	0	0	0	0	0
Cool Roof	(1,606,570)	(3,109)	(3,109)	(455)	(455)	(183)
Low Income Weatherization Package	10,740,502	408,605	198,543	322,703	156,977	130,695
Steam Pipe Insulation	4,894,860	4,894,860	4,894,860	2,077,121	2,077,121	838,004
HVAC (Equipment)						
ENERGY STAR Dual Fuel Heat Pumps	133,965	133,965	148,237	37,007	41,211	14,956
Geothermal Heat Pumps	5	0	0	0	0	0
ENERGY STAR Central Air Conditioners	(2,285,365)	(2,285,365)	(2,256,845)	(445,214)	(440,955)	(180,282)
Thermostat setback strategies	18,747,726	17,176,758	17,176,758	9,046,475	9,046,475	3,629,645
Whole House Fans	(73,794)	0	0	0	0	0
Efficient Furnaces	30,685,133	29,858,475	0	9,799,103	0	3,968,134
Efficient Furnace Fans	(145,631)	(186,675)	(825,900)	(91,255)	(407,667)	(36,913)

END USE	TECHNICAL POTENTIAL (MMBTU)	ECONOMIC POTENTIAL -UCT- (MMBTU)	ECONOMIC POTENTIAL -TRC- (MMBTU)	ACHIEVABLE POTENTIAL -UCT- (MMBTU)	ACHIEVABLE POTENTIAL -TRC- (MMBTU)	CONSTRAINED ACHIEVABLE –UCT- (MMBTU)
Furnace Tune-Up	1,314,898	1,333,155	1,979,372	677,252	1,057,878	274,277
Efficient Boilers	5,018,901	6,941,197	6,728,478	2,129,003	2,098,723	862,039
Boiler Tune-up	1,708,874	1,872,413	2,353,522	934,724	1,174,224	377,984
Boiler Controls	1,908,098	1,702,834	2,306,100	891,310	1,202,157	360,825
Behavioral Programs						
Direct Feedback (In-Home Energy Display)	1,962,884	1,962,884	1,637,568	1,102,241	960,653	446,393
Indirect Feedback (Monthly Energy Use Reports)	1,368,116	1,368,116	1,424,803	1,023,510	1,063,321	417,855
Total	**143,271,591**	**109,298,652**	**62,091,152**	**53,178,705**	**39,326,470**	**21,495,414**
% of Annual 2022 Sales Forecast	*51.0%*	*38.9%*	*22.1%*	*18.9%*	*14.0%*	*7.7%*
Note: Measures in the above table with "0" potential are ones that did not pass the economic screen.						

Table 6-33 provides a list of the Top 10 residential gas savings measures for the Achievable UCT scenario. The table provides the measures ranked according to the gas savings potential. The column to the far right shows the results of the measure level cost-effectiveness screening test using the UCT to screen the measures. The measures in the table are representative of a group of comparable measures falling under the umbrella of the measure categories provided in the table. This means that there are a range of UCT ratios for measure iterations that fall into a single measure category. For example, "ENERGY STAR Windows" is a measure category which consists of several measure iterations to account for various types of efficient windows options and housing types. The table presents an average of the UCT ratios for all measures which are part of the measure categories in the Top 10.

The Top 10 measures combine to yield an estimated 46 million MMBtu savings. This accounts for more than 85% of the total residential gas savings in the Achievable UCT scenario.

Table 6-33: Top 10 Residential Gas Savings Measures in the Achievable UCT Scenario

MEASURE		2023 ENERGY (MMBTU)	% OF SECTOR SAVINGS	UCT RATIO
1	**Efficient Furnaces**	9,799,103	18.4%	1.13
2	**Thermostat setback strategies**	9,046,475	17.0%	21.98
3	**ENERGY STAR Windows**	7,423,076	14.0%	2.12
4	**Ceiling/Attic Insulation**	5,116,847	9.6%	4.68
5	**Pipe Wrap**	3,379,323	6.4%	15.68
6	**Air Sealing**	2,912,164	5.5%	6.77
7	**Duct Location (move into conditioned space)**	2,206,441	4.1%	2.15
8	**Efficient Boilers**	2,129,003	4.0%	1.59
9	**Steam Pipe Insulation**	2,077,121	3.9%	2.80

MEASURE		2023 ENERGY (MMBTU)	% OF SECTOR SAVINGS	UCT RATIO
10	Low Flow Faucet Aerators	1,864,643	3.5%	12.71
Total		**45,954,196**	**86.4%**	

6.3 ACHIEVABLE POTENTIAL BENEFITS & COSTS

The tables below provide the net present value (NPV) benefits and costs associated with the three achievable potential scenarios for the residential sector at the 5-year and 10-year periods. Table 6-34 and Table 6-35 compares the NPV benefits and costs associated with the Achievable UCT and Achievable TRC Scenarios. Both the UCT and TRC scenario benefits include avoided energy supply and demand costs, while the Achievable TRC scenario benefits also include O&M benefits, tax credits, water benefits and a carbon tax adder. The NPV costs in the Achievable UCT scenario includes only program administrator costs (incentives paid, staff labor, marketing, etc.) whereas the Achievable TRC scenario costs include both participant and program administrator costs.

Table 6-34: 5-Year Benefit-Cost Ratios for Achievable UCT vs. Achievable TRC Scenarios – Residential Sector Only

5-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO	NET BENEFITS
Achievable UCT	$3,432,366,723	$1,479,443,493	2.32	$1,952,923,230
Achievable TRC	$3,914,509,646	$1,721,305,829	2.27	$2,193,203,817

Table 6-35: 10-Year Benefit-Cost Ratios for Achievable UCT vs. Achievable TRC Scenarios – Residential Sector Only

10-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO	NET BENEFITS
Achievable UCT	$6,258,559,134	$2,603,870,491	2.40	$3,654,688,643
Achievable TRC	$7,166,982,222	$3,032,912,928	2.36	$4,134,069,295

Table 6-36 and Table 6-37 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 6-36: 5-Year Benefit-Cost Ratios for Achievable UCT vs. Constrained UCT Scenarios – Residential Sector Only

5-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO	NET BENEFITS
Achievable UCT	$3,432,366,723	$1,479,443,493	2.32	$1,952,923,230
Constrained UCT	$1,397,166,850	$603,003,744	2.32	$794,163,107

Table 6-37: 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	$6,258,559,134	$2,603,870,491	2.40	$3,654,688,643
Constrained UCT	$2,535,305,373	$1,055,704,104	2.40	$1,479,601,269

Year by year budgets for all three scenarios, broken out by incentive and administrative costs are depicted in Tables 6-38 through 6-40. Table 6-41 shows the revenue requirements for each scenario as a percentage of forecasted sector sales.

Table 6-38: Annual Program Budgets Associated with the Achievable UCT Scenario (in millions)

ACHIEVABLE UCT	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$222.9	$241.4	$244.4	$247.0	$247.9	$248.8	$248.6	$249.6	$249.0	$248.4
Admin.	$87.3	$94.1	$95.3	$96.3	$96.7	$97.0	$97.0	$97.4	$97.1	$96.9
Total Costs	$310.3	$335.5	$339.7	$343.3	$344.6	$345.8	$345.6	$346.9	$346.1	$345.3

Table 6-39: Annual Program Budgets Associated with the Achievable TRC Scenario (in millions)

ACHIEVABLE TRC	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$171.0	$173.5	$175.4	$175.8	$176.2	$175.7	$176.3	$175.6	$174.8	$171.0
Admin.	$65.4	$66.3	$67.1	$67.3	$67.4	$67.2	$67.5	$67.2	$66.9	$65.4
Total Costs	$236.4	$239.8	$242.6	$243.1	$243.7	$243.0	$243.8	$242.7	$241.7	$236.4

Table 6-40: Annual Program Budgets Associated with the Constrained UCT Scenario (in millions)

CONSTRAINED UCT	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$97.3	$97.5	$98.1	$98.6	$99.1	$99.7	$100.3	$100.8	$101.4	$97.3
Admin.	$37.9	$38.0	$38.2	$38.4	$38.7	$38.9	$39.1	$39.3	$39.6	$37.9
Total Costs	$135.2	$135.5	$136.3	$137.0	$137.8	$138.6	$139.4	$140.2	$141.0	$135.2

Table 6-41: Annual Achievable Scenario Budgets as a % of Annual Sector Revenue

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Achievable UCT	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	4.9%	4.9%	5.0%
Achievable TRC	3.5%	3.5%	3.6%	3.5%	3.5%	3.5%	3.5%	3.5%	3.4%	3.5%
Constrained UCT	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%

7 COMMERCIAL ELECTRIC AND NATURAL GAS ENERGY EFFICIENCY POTENTIAL ESTIMATES

This section provides electric and natural gas energy efficiency potential estimates for the commercial sector in Michigan. Estimates of technical, economic and achievable potential are provided in separate sections for electric and natural gas.

7.1 COMMERCIAL ELECTRIC ENERGY EFFICIENCY POTENTIAL

According to 2012 historical sales data[41], the commercial sector accounts for approximately 37% of retail electric sales in Michigan, but only 11% of the total retail customers. The average commercial electric customer in Michigan consumes roughly 74,000 kWh annually. Comparatively, the average residential consumer in Michigan uses approximately 8,200 kWh per year. Commercial kWh sales over the period 2002 to 2012 have increased by a total of 6.9%, peaking at 40,047 million kWh in 2007 and then declining to a 2012 level of 38,367 million kWh. For this study, commercial electric sales are estimated to remain relatively stable at their 2012 level over the 10 year study period of 2014 – 2023.[42]

7.1.1 Electric Energy Efficiency Measures Examined

For the commercial sector, there were 182 unique energy efficiency measures included in the electric energy savings potential analysis. Table 7-1 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 Michigan Energy Measures Database (MEMD), measures found in other Technical Reference Manuals (TRMs) and measures included in other commercial energy efficiency potential studies. For each measure, the analysis considered incremental costs, energy and demand savings, and measure useful lives.

Table 7-1: Types of Electric Energy Efficiency Measures Included in the Commercial Sector Analysis

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
Appliances, Computers & Office Equipment	Office Equipment Improvements	• Appliances • High Efficiency Office Equipment • Smart Power Strips • Computer Energy Management Controls
Compressed Air	Compressor Equipment	• Efficient Air Compressors • Automatic Drains • Cycling and High Efficiency Dryers • Low Pressure Drop-Filters • Air-Entraining Air Nozzles • Receiver Capacity Addition • Compressed Air Audits, Leak Repair, and Flow Control • Barrel Wraps
Cooking	Cooking Equipment Improvements	• Efficient Cooking Equipment
Envelope	Space Heating and Space Cooling	• Building Envelope Improvements • Cool Roofing • Integrated Building Design
HVAC Controls	Space Cooling and Space Heating	• Programmable Thermostats • EMS Installation/Optimization • Hotel Guest Room Occupancy Control System • Retrocommissioning & Commissioning

[41] U.S. Energy Information Administration

[42] GDS forecast based on kWh sales forecasts provided by DTE Energy and Consumers Energy (CE) and historical commercial kWh sales trends for the state as a whole.

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
Lighting	Lighting Improvements	• Efficient Lighting Equipment • Fixture Retrofits • Ballast Replacement • Premium Efficiency T8 and T5 • High Bay Lighting Equipment • LED Bulbs and Fixtures • Light Tube • CFL Retrofits • Lighting Controls • Efficient Design for New Construction
Other	Transformer Equipment Other	• Efficient Transformers • Vending Miser for Non-Refrig Equip • Optimized Snow and Ice Melt Controls • EC Plug Fans in Data Centers • Engine Block Heater Timer • NEMA Premium Efficiency Motors
Pools	Pool Equipment	• Efficient Equipment and Controls • Heat Pump Pool Heaters • Solar Water Heating
Refrigeration	Refrigeration Improvements	• Vending Misers • Refrigerated Case Covers • Economizers • Efficient Refrigeration • Upgrades Motors and Controls • Door Heater Controls • Efficient Compressors and Controls • Door Gaskets and Door Retrofits • Refrigerant Charging Correction • Ice-Makers
Space Cooling	Cooling System Upgrades	• Efficient Chillers • Efficient Cooling Equipment • Ground/Water Source Heat Pump • Chiller Tune-up/Diagnostics • High Efficiency Pumps
Space Heating	Heating System Improvements	• Efficient Heating Equipment • Ground/Water Source Heat Pump • Efficient Heating Pumps, Motors, and Controls
Ventilation	Ventilation Equipment	• Enthalpy Economizer • Variable Speed Drive Controls • Improved Duct Sealing • Electronically-Commutated Permanent Magnet Motors • Destratification Fans • Controlled Ventilation Optimization • Demand Controlled Ventilation • High Performance Air Filters
Water Heating	Water Heating Improvements	• Efficient Equipment • High Efficiency HW Appliances • Ozone Laundry System • Low Flow Equipment • Pipe and Tank Insulation • Heat Recovery Systems • Efficient HW Pump and Controls • Solar Water Heating System

7.1.2 Technical and Economic Potential Electric Savings

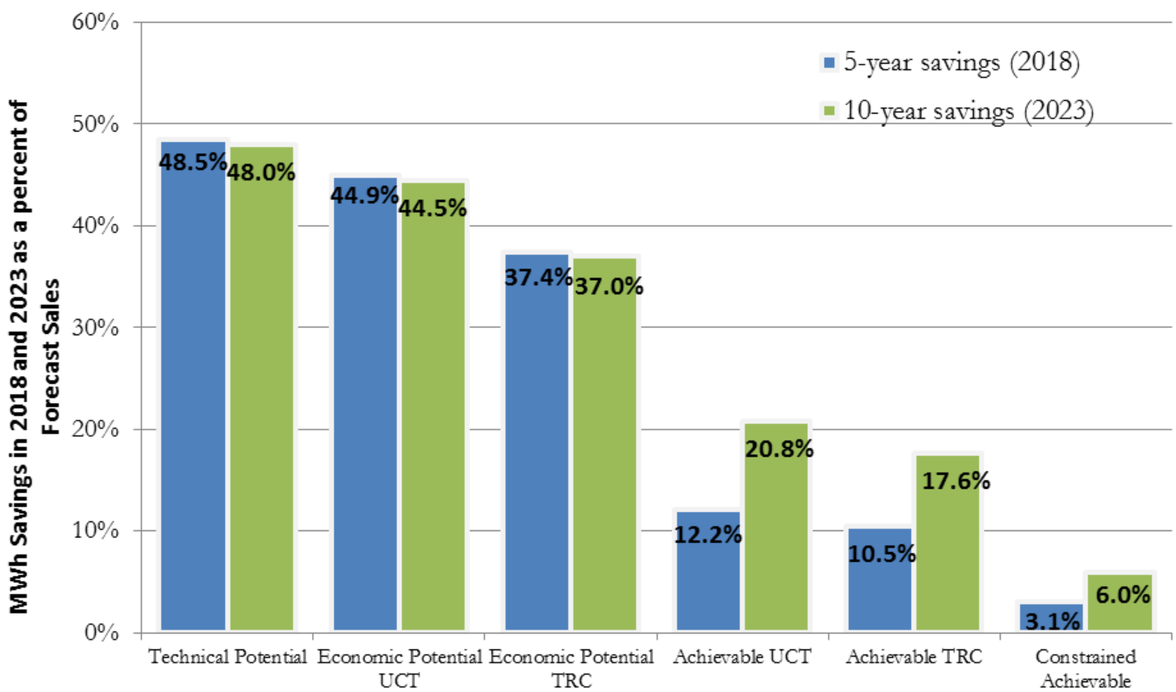
This section presents estimates for electric technical, economic, and achievable savings potential for the commercial sector. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative annual savings (MWh) and percentage of commercial sector forecast annual MWh sales. Data is provided for a 5 and 10-year horizon for Michigan

This energy efficiency potential study considers the impacts of the December 2007 Energy and Independence and Security Act (EISA) as an improving code standard for the commercial sector. EISA improves the baseline efficiency of compact fluorescent lamps (CFL), general service fluorescent lamps (GSFL), high intensity discharge (HID) lamps and ballasts and motors, all applicable in the commercial sector.

SUMMARY OF FINDINGS

Figure 7-1 illustrates the estimated energy efficiency savings potential in Michigan for each of the scenarios included in this study.

Figure 7-1: Summary of Commercial Electric Energy Efficiency Potential as a % of Sales Forecasts



The potential savings estimates are expressed as cumulative annual 5-year and 10-year savings, as percentages of the respective 2018 and 2023 commercial sector sales forecasts. The technical potential is 48.5% in 2018 and 48.0% in 2023. The 5-year and 10-year economic potential is 44.9% and 44.5% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 37.4% in 2018 and 37.0% in 2023. The slight drop from technical potential to economic potential indicates that most measures are cost-effective.

The 5-year and 10-year achievable potential savings are: 12.2% and 20.8% for the Achievable UCT scenario; 10.5% and 17.6% for the Achievable TRC scenario; and 3.1% and 6.0% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, the Constrained Achievable scenario is a subset of the Achievable UCT scenario, assuming a spending cap on non-residential DSM approximately equal to 2% of future annual commercial and industrial revenue. The percent of the non-residential spending cap allocated to the commercial sector is based on the percentage of total non-residential UCT savings that the commercial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found.

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 it is technically feasible to save approximately 18.5 million MWh annually in the commercial sector by 2018, and approximately 18.6 million MWh annually by 2023 across Michigan, representing 48.5% of the commercial sales forecast in 2018, and 48.0% of the commercial sales forecast in 2023. Lighting represents the majority of the energy efficiency savings potential at over 40% of 10-yr savings, followed by Refrigeration and Ventilation at over 10% each, while cooking, pools, and space heating represent the smallest shares, each with 1 percent or less of 10-yr savings. Table 7-3 shows the demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings technical potential is 5,715 MW and 5,741 MW, respectively, which is 53.8% and 53.2% of the peak forecasts for 2018 and 2023 respectively.

Table 7-2: Commercial Sector Technical Potential Electric Energy Savings by End Use

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
Appliances, Computers, Office Equipment	928,899	5%	933,013	5%
Compressed Air	621,671	3%	621,671	3%
Cooking	128,779	1%	129,374	1%
Envelope	500,791	3%	512,810	3%
HVAC Controls	464,362	3%	465,570	3%
Lighting	7,967,141	43%	7,995,560	43%
Other	646,701	3%	649,564	3%
Pools	25,847	0%	25,946	0%
Refrigeration	3,466,859	19%	3,478,837	19%
Space Cooling	425,425	2%	426,706	2%
Space Heating	256,066	1%	256,850	1%
Ventilation	2,741,339	15%	2,752,763	15%
Water Heating	351,337	2%	352,481	2%
Total	**18,525,217**	**100%**	**18,601,147**	**100%**
% of Annual Sales Forecast	*48.5%*		*48.0%*	

Table 7-3: Commercial Sector Technical Potential Electric Demand Savings

	Summer Peak Demand	
	2018	2023
Summary	MW	MW
Total	5,715	5,741
% of Forecast Peak	*53.8%*	*53.2%*

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential and only includes measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. 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. The TRC Test was also included because it also considers the cost assumed by the participant as well as all utility costs. Eighty seven percent of all measures that were included in the electric potential analysis passed the UCT and 76% of all measures passed the TRC Test.

Table 7-4 indicates that the economic potential based on the UCT screen is approximately 17.2 million MWh annually by 2018, and the economic potential increases to 17.3 million MWh annually by 2023. This represents 44.9% and 44.5% of commercial sales in 2018 and 2023. Lighting, refrigeration, and ventilation make up a majority of the savings. Table 7-5 shows the peak demand savings economic potential in 2018 and 2023. The five and ten year summer peak demand savings economic potential is 5,300 MW and 5,325 MW, respectively, which is 49.9% and 49.3% of the peak forecasts in 2018 and 2013 respectively.

Table 7-4: Commercial Sector Economic Potential (UCT) Electric Energy Savings by End Use

End Use	2018 Energy Savings (MWh)	% of 2018 Total	2023 Energy Savings (MWh)	% of 2023 Total
Appliances, Computers, Office Equipment	712,442	4%	715,598	4%
Compressed Air	620,398	4%	620,398	4%
Cooking	122,452	1%	123,019	1%
Envelope	221,331	1%	226,643	1%
HVAC Controls	464,362	3%	465,570	3%
Lighting	7,706,402	45%	7,733,891	45%
Other	646,701	4%	649,564	4%
Pools	25,847	0%	25,946	0%
Refrigeration	3,418,820	20%	3,430,632	20%
Space Cooling	277,063	2%	277,898	2%
Space Heating	175,846	1%	176,384	1%
Ventilation	2,453,815	14%	2,464,040	14%
Water Heating	341,168	2%	342,278	2%
Total	**17,186,647**	**100%**	**17,251,862**	**100%**
% of Annual Sales Forecast	*44.9%*		*44.5%*	

Table 7-5: Commercial Sector Economic Potential (UCT) Electric Demand Savings

	Summer Peak Demand	
	2018	**2023**
Summary	**MW**	**MW**
Total	**5,300**	**5,325**
% of Peak	*49.9%*	*49.3%*

Table 7-6 shows that the economic potential based on the TRC screen is nearly 14.3 million MWh annually by 2018, and the economic potential increases less than 100,000 MWh by 2023. This represents 37.4% of the commercial MWh sales forecast for 2018 and 37.0% for 2023. As with UCT economic potential, lighting, refrigeration, and ventilation again make up a majority of the economic TRC savings potential. Table 7-7 shows the economic demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 4,496 MW and 4,519 MW, respectively, which is 42.3% and 41.9% of the peak forecasts for the commercial sector for those years.

Table 7-6: Commercial Sector Economic Potential (TRC) Electric Savings by End Use

End Use	2018 Energy Savings (MWh)	% of 2018 Total	2023 Energy Savings (MWh)	% of 2023 Total
Appliances, Computers, Office Equipment	693,228	5%	696,295	5%
Compressed Air	620,398	4%	620,398	4%
Cooking	108,343	1%	108,844	1%
Envelope	108,078	1%	113,390	1%
HVAC Controls	464,362	3%	465,570	3%
Lighting	5,389,648	38%	5,414,894	38%
Other	619,740	4%	622,524	4%
Pools	25,847	0%	25,946	0%
Refrigeration	3,376,105	24%	3,387,734	24%
Space Cooling	276,636	2%	277,469	2%
Space Heating	54,889	0%	55,480	0%
Ventilation	2,208,697	15%	2,217,793	15%
Water Heating	336,890	2%	337,989	2%
Total	**14,282,862**	**100%**	**14,344,326**	**100%**
% of Annual Sales Forecast	*37.4%*		*37.0%*	

Table 7-7: Commercial Sector Economic Potential Electric Demand Savings

	Summer Peak Demand	
	2018	**2023**
Summary	**MW**	**MW**
Total	**4,496**	**4,519**
% of Peak	*42.3%*	*41.9%*

7.1.3 Achievable Potential Savings in the Commercial Sector

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 three 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, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third 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.

7.1.3.1 UCT vs. TRC

Tables 7-8 through 7-11 show the estimated cumulative annual savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume an incentive level approximately equal to 50% of the incremental measure cost and include estimated 10-year market adoption rates based on incentive levels and equipment replacement cycles. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is approximately 1 million MWh greater over the next decade, than the achievable TRC scenario.

Table 7-8: Commercial Achievable UCT Potential Electric Energy Savings by End Use

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
Appliances, Computers, Office Equipment	185,083	4%	355,308	4%
Compressed Air	221,662	5%	329,391	4%
Cooking	32,946	1%	65,892	1%
Envelope	13,634	0%	20,618	0%
HVAC Controls	194,726	4%	278,618	3%
Lighting	1,850,030	40%	3,511,776	44%
Other	101,445	2%	185,126	2%
Pools	9,231	0%	15,656	0%
Refrigeration	1,242,660	27%	1,958,394	24%
Space Cooling	73,050	2%	112,157	1%
Space Heating	61,225	1%	89,739	1%
Ventilation	554,381	12%	963,128	12%
Water Heating	111,923	2%	171,896	2%
Total	**4,651,994**	**100%**	**8,057,699**	**100%**
% of Annual Sales Forecast	***12.2%***		***20.8%***	

Table 7-9: Commercial Achievable UCT Potential Electric Demand Savings

	Summer Peak Demand	
	2018	2023
Summary	MW	MW
Total	1,292	2,433
% of Peak	*12.2%*	*22.6%*

Table 7-10: Commercial Achievable TRC Potential Electric Energy Savings by End Use

End Use	2018 Energy Savings (MWh)	% of 2018 Total	2023 Energy Savings (MWh)	% of 2023 Total
Appliances, Computers, Office Equipment	183,669	5%	352,481	5%
Compressed Air	221,662	6%	329,391	5%
Cooking	29,293	1%	58,586	1%
Envelope	10,967	0%	16,213	0%
HVAC Controls	194,726	5%	278,618	4%
Lighting	1,328,909	33%	2,503,571	37%
Other	89,843	2%	168,312	2%
Pools	9,231	0%	15,656	0%
Refrigeration	1,229,658	31%	1,934,311	28%
Space Cooling	72,972	2%	112,002	2%
Space Heating	12,378	0%	19,957	0%
Ventilation	511,177	13%	876,720	13%
Water Heating	110,063	3%	169,284	2%
Total	4,004,548	100%	6,835,102	100%
% of Annual Sales Forecast	*10.5%*		*17.6%*	

Table 7-11: Commercial Achievable TRC Potential Electric Demand Savings

	Summer Peak Demand	
	2018	2023
Summary	MW	MW
Total	1,127	2,128
% of Peak	*10.6%*	*19.7%*

7.1.3.2 Achievable UCT vs. Constrained UCT

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 utility spending cap approximately equal to 2% of Michigan annual utility revenues. The percent of the non-residential spending cap allocated to the commercial sector is based on the percentage of total non-residential UCT savings that the commercial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found. 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.

Tables 7-12 and 7-13 show the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizons. The 5-year and 10-year Constrained UCT potential cumulative annual savings estimates are nearly 1.2 million MWh and just over 2.3 million MWh respectively. This equates to 3.1% and 6.0% of sector sales in 2018 and 2023. The five and ten year demand savings estimates in the Constrained UCT scenario are presented in Table 7-13.

Table 7-12: Commercial Constrained Achievable Electric Energy Efficiency Savings by End Use

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
Appliances, Computers, Office Equipment	25,948	2%	53,848	2%
Compressed Air	48,550	4%	77,566	3%
Cooking	141,079	12%	272,520	12%
Envelope	15,300	1%	24,241	1%
HVAC Controls	313,066	26%	567,974	24%
Lighting	47,828	4%	114,952	5%
Other	3,418	0%	5,612	0%
Pools	28,098	2%	47,084	2%
Refrigeration	8,522	1%	18,977	1%
Space Cooling	477,777	40%	1,009,373	43%
Space Heating	2,342	0%	4,371	0%
Ventilation	58,556	5%	98,082	4%
Water Heating	18,338	2%	31,455	1%
Total	**1,188,821**	**100%**	**2,326,054**	**100%**
% of Annual Sales Forecast	*3.1%*		*6.0%*	

Table 7-13: Commercial Constrained Achievable Electric Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	334	737
% of Peak	*3.1%*	*6.8%*

Figure 7-2 shows the estimated 10-year cumulative annual energy efficiency savings potential broken out by end use across the entire commercial sector for the Constrained UCT scenario. The space cooling end use shows the largest potential for energy efficiency savings by a wide margin at nearly 1,010,000 MWh annually, or 43% of total savings, in the Constrained UCT scenario, with HVAC Controls and Cooking end uses accounting for 24% and 12% respectively.

Figure 7-2: Commercial Sector 2023 Constrained UCT Potential Savings by End Use

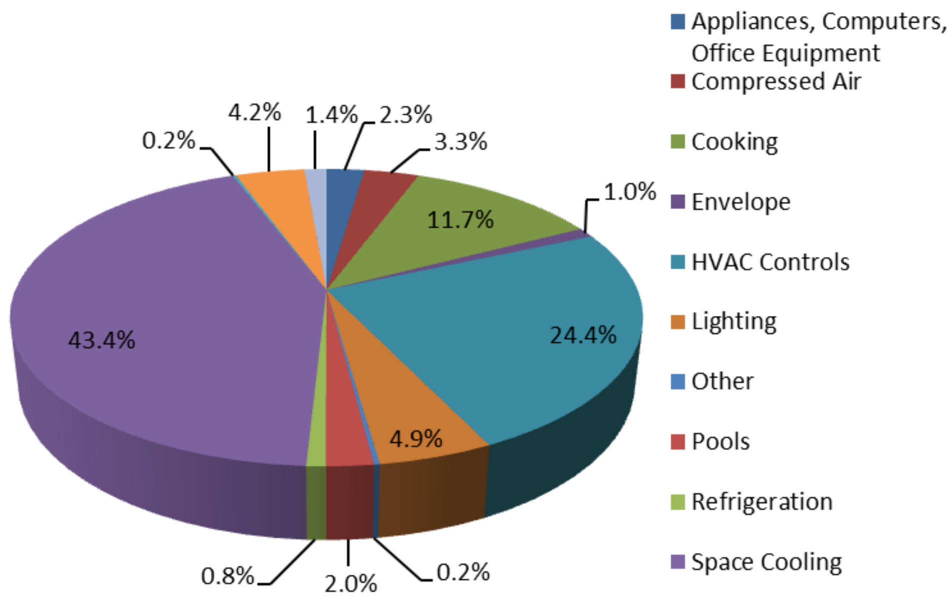
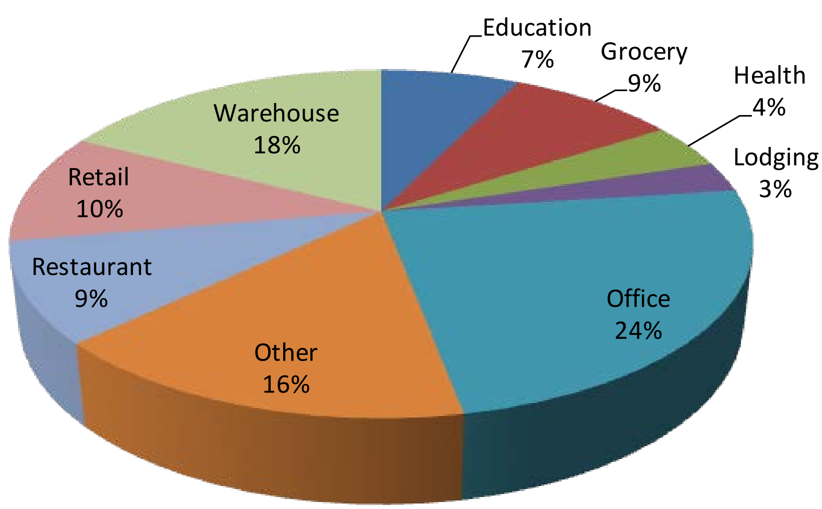


Figure 7-3 shows the breakdown of estimated savings in 2023 by building type for the Constrained UCT scenario. The vast majority of savings come from existing/turnover measures, meaning energy efficient equipment is installed to replace existing equipment that has failed, with less than 1% of savings potential coming from new construction. Approximately 24% of the potential savings are found in Offices, followed by 18% in Warehouses and 16% in Other building types.

Figure 7-3: Commercial Constrained UCT Savings in 2023 by Building Type



7.1.4 Cumulative Annual Achievable Electric Savings Potential

Tables 7-14, Table 7-15 and Table 7-16 show cumulative annual electric energy savings for all achievable scenarios for each year across the 10-year horizon for the study, broken out by end use. Table 7-17, Table 7-18 and Table 7-19 shows cumulative annual demand (MW) savings for all three achievable potential scenarios for each year across the 10-year time horizon for the study, broken out by end use.

Table 7-14: Cumulative Annual Commercial Sector Electric Energy Savings in the Achievable UCT Potential Scenario by End Use (MWH)

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances, Computers, Office Equipment	33,674	71,062	110,307	149,552	185,083	220,613	254,287	287,961	321,634	355,308
Compressed Air	18,698	65,878	127,300	188,723	221,662	254,601	273,298	291,996	310,694	329,391
Cooking	6,589	13,178	19,768	26,357	32,946	39,535	46,124	52,714	59,303	65,892
Envelope	1,230	4,124	7,848	11,573	13,634	15,696	16,927	18,157	19,388	20,618
HVAC Controls	14,007	55,724	111,294	166,865	194,726	222,588	236,596	250,603	264,611	278,618
Lighting	365,551	757,358	1,130,550	1,503,418	1,850,030	2,196,642	2,530,126	2,857,343	3,184,560	3,511,776
Other	16,292	37,025	59,979	82,932	101,445	119,957	136,249	152,541	168,834	185,126
Pools	1,215	3,131	5,398	7,665	9,231	10,797	12,011	13,226	14,441	15,656
Refrigeration	129,974	391,679	719,250	1,046,820	1,242,660	1,438,499	1,568,473	1,698,447	1,828,420	1,958,394
Space Cooling	6,973	22,431	42,133	61,834	73,050	84,265	91,238	98,211	105,184	112,157
Space Heating	4,885	17,948	35,099	52,251	61,225	70,199	75,084	79,969	84,854	89,739
Ventilation	78,109	192,626	325,347	458,068	554,381	650,694	728,802	806,911	885,019	963,128
Water Heating	10,696	34,379	64,556	94,733	111,923	129,112	139,808	150,504	161,200	171,896
Total	**687,893**	**1,666,542**	**2,758,829**	**3,850,790**	**4,651,994**	**5,453,199**	**6,109,024**	**6,758,582**	**7,408,141**	**8,057,699**
% of Annual Sales Forecast	*1.8%*	*4.4%*	*7.3%*	*10.1%*	*12.2%*	*14.2%*	*15.9%*	*17.5%*	*19.2%*	*20.8%*

Table 7-15: Cumulative Annual Commercial Sector Electric Energy Savings in the Achievable TRC Potential Scenario by End Use (MWH)

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances, Computers, Office Equipment	33,391	70,496	109,458	148,421	183,669	218,917	252,308	285,699	319,090	352,481
Compressed Air	18,698	65,878	127,300	188,723	221,662	254,601	273,298	291,996	310,694	329,391
Cooking	5,859	11,717	17,576	23,435	29,293	35,152	41,011	46,869	52,728	58,586
Envelope	906	3,243	6,294	9,346	10,967	12,588	13,495	14,401	15,307	16,213
HVAC Controls	14,007	55,724	111,294	166,865	194,726	222,588	236,596	250,603	264,611	278,618
Lighting	251,108	528,472	804,297	1,079,731	1,328,909	1,578,087	1,814,138	2,043,949	2,273,760	2,503,571
Other	15,409	33,662	53,337	73,012	89,843	106,675	122,084	137,493	152,903	168,312
Pools	1,215	3,131	5,398	7,665	9,231	10,797	12,011	13,226	14,441	15,656
Refrigeration	127,805	386,862	711,545	1,036,227	1,229,658	1,423,089	1,550,895	1,678,700	1,806,506	1,934,311
Space Cooling	6,957	22,400	42,086	61,772	72,972	84,172	91,130	98,087	105,045	112,002
Space Heating	1,396	3,991	7,187	10,382	12,378	14,373	15,769	17,165	18,561	19,957
Ventilation	69,468	175,344	299,424	423,505	511,177	598,849	668,316	737,784	807,252	876,720
Water Heating	10,573	33,857	63,496	93,135	110,063	126,991	137,564	148,137	158,711	169,284
Total	**556,793**	**1,394,779**	**2,358,693**	**3,322,217**	**4,004,548**	**4,686,880**	**5,228,615**	**5,764,110**	**6,299,606**	**6,835,102**
% of Annual Sales Forecast	*1.5%*	*3.7%*	*6.2%*	*8.7%*	*10.5%*	*12.2%*	*13.6%*	*14.9%*	*16.3%*	*17.6%*

Table 7-16: Cumulative Annual Commercial Sector Electric Energy Savings in Constrained UCT Potential Scenario by End Use (MWH)

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances, Computers, Office Equipment	9,670	18,462	27,764	37,212	47,828	60,243	74,541	88,791	101,390	114,952
Compressed Air	5,370	16,203	30,799	45,736	58,556	68,009	77,522	84,729	91,117	98,082
Cooking	1,892	3,442	5,004	6,590	8,522	10,439	12,574	14,718	16,825	18,977
Envelope	353	1,034	1,917	2,813	3,418	4,018	4,416	4,817	5,210	5,612
HVAC Controls	4,023	13,832	27,004	40,382	48,550	56,659	61,197	65,909	71,427	77,566
Lighting	104,979	197,115	284,957	374,791	477,777	579,870	689,041	796,729	901,243	1,009,373
Other	4,679	9,554	14,995	20,521	25,948	31,346	37,014	42,774	48,401	53,848
Pools	349	800	1,337	1,883	2,342	2,797	3,191	3,586	3,975	4,371
Refrigeration	37,326	98,867	176,504	255,365	313,066	374,510	425,146	475,781	520,452	567,974
Space Cooling	2,002	5,638	10,307	15,050	18,338	21,602	23,862	26,130	28,442	31,455
Space Heating	1,403	4,475	8,540	12,669	15,300	17,912	19,494	21,084	22,646	24,241
Ventilation	22,431	49,361	80,819	112,477	141,079	169,450	195,809	221,625	246,969	272,520
Water Heating	3,072	8,641	15,794	23,058	28,098	33,101	36,597	40,118	43,579	47,084
Total	**197,549**	**427,423**	**685,739**	**948,548**	**1,188,821**	**1,429,958**	**1,660,405**	**1,886,791**	**2,101,676**	**2,326,054**
% of Annual Sales Forecast	*0.5%*	*1.1%*	*1.8%*	*2.5%*	*3.1%*	*3.7%*	*4.3%*	*4.9%*	*5.4%*	*6.0%*

Table 7-17: Cumulative Annual Commercial Sector Electric Demand Savings in the Achievable UCT Potential Scenario by End Use (MW)

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances, Computers, Office Equipment	99	199	298	398	497	597	696	796	895	994
Compressed Air	4	14	27	41	48	55	58	62	66	69
Cooking	2	5	7	9	11	14	16	18	21	23
Envelope	1	2	3	5	6	7	7	8	8	9
HVAC Controls	0	1	1	1	2	2	2	2	2	3
Lighting	74	156	233	310	380	450	516	581	645	710
Other	7	14	21	28	34	41	48	55	62	69
Pools	1	2	3	4	5	6	6	7	8	9
Refrigeration	13	39	71	102	122	141	155	168	182	195
Space Cooling	2	4	6	8	10	11	13	15	17	19
Space Heating	2	8	15	22	25	29	31	33	36	38
Ventilation	27	55	82	109	136	164	191	218	245	273
Water Heating	2	5	9	13	15	18	19	21	23	24
Total	**234**	**501**	**775**	**1,050**	**1,292**	**1,534**	**1,760**	**1,984**	**2,209**	**2,433**
% of Annual Demand Forecast	*2.2%*	*4.7%*	*7.3%*	*9.9%*	*12.2%*	*14.4%*	*16.5%*	*18.5%*	*20.6%*	*22.6%*

Table 7-18: Cumulative Annual Commercial Sector Electric Demand Savings in the Achievable TRC Potential Scenario by End Use (MW)

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances, Computers, Office Equipment	99	199	298	398	497	597	696	795	895	994
Compressed Air	4	14	27	41	48	55	58	62	66	69
Cooking	2	4	6	8	11	13	15	17	19	21
Envelope	0	1	3	4	5	5	6	6	6	7
HVAC Controls	0	1	1	1	2	2	2	2	2	3
Lighting	52	111	171	230	282	334	382	429	476	523
Other	7	14	21	28	34	41	48	55	62	69
Pools	1	2	3	4	5	6	6	7	8	9
Refrigeration	13	38	70	101	120	140	153	166	179	192
Space Cooling	2	4	6	8	10	11	13	15	17	18
Space Heating	1	1	2	2	3	3	4	4	5	5
Ventilation	19	39	58	78	97	117	136	155	175	194
Water Heating	2	5	9	13	15	17	19	20	22	24
Total	**202**	**432**	**674**	**915**	**1,127**	**1,340**	**1,538**	**1,735**	**1,931**	**2,128**
% of Annual Demand Forecast	*1.9%*	*4.1%*	*6.4%*	*8.6%*	*10.6%*	*12.6%*	*14.4%*	*16.2%*	*18.0%*	*19.7%*

Table 7-19: Cumulative Annual Commercial Sector Electric Demand Savings in Constrained UCT Potential Scenario by End Use (MW)

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances, Computers, Office Equipment	29	52	76	100	129	164	205	245	282	322
Compressed Air	1	3	7	10	12	14	16	18	19	20
Cooking	1	1	2	2	3	4	4	5	6	7
Envelope	0	0	1	1	1	2	2	2	2	2
HVAC Controls	0	0	0	0	0	1	1	1	1	1
Lighting	21	41	59	77	98	119	141	163	183	205
Other	2	4	5	7	9	11	13	16	18	21
Pools	0	0	1	1	1	1	2	2	2	2
Refrigeration	4	10	17	25	31	37	42	47	52	57
Space Cooling	1	1	1	2	2	3	4	4	5	5
Space Heating	1	2	4	5	6	7	8	9	10	10
Ventilation	8	14	21	27	35	43	52	61	70	79
Water Heating	0	1	2	3	4	5	5	6	6	7
Total	**67**	**130**	**195**	**261**	**334**	**411**	**495**	**578**	**656**	**737**
% of Annual Demand Forecast	*0.6%*	*1.2%*	*1.8%*	*2.5%*	*3.1%*	*3.8%*	*4.6%*	*5.4%*	*6.1%*	*6.8%*

7.1.5 Commercial Electric Savings Summary by Measure Group

Table 7-20 below provides an end-use breakdown of the commercial electric savings potential estimates for technical and economic potential, and each of the three achievable potential scenarios. 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 7-20: Commercial Sector Cumulative Annual Electric Savings Potential by End-Use and Measure by 2023

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC UCT (MWH)	ECONOMIC TRC (MWH)	ACHIEVABLE UCT (MWH)	ACHIEVABLE TRC (MWH)	CONSTRAINED ACHIEVABLE (MWH)
Appliances, Computers, Office Equipment						
Office Equipment / Appliances	640,360	640,360	621,057	318,165	315,337	102,909
PC Network Energy Management Controls replacing no central control	75,238	75,238	75,238	37,143	37,143	12,044
"Smart" Power Strip/Monitor Power Management Software/UPS	217,415	0	0	0	0	0
Compressed Air						
Barrel Wraps Inj Mold and Extruders	93,709	93,709	93,709	44,716	44,716	14,252
Compressed Air Audits & Leak Repair	155,844	155,844	155,844	100,609	100,609	32,850
Dryers/Receiver Capacity/Outdoor Air Intake	32,774	31,501	31,501	14,387	14,387	4,066
Efficient Air Compressors	81,772	81,772	81,772	26,103	26,103	7,518
Nozzles / Automatic Drains/Drop Filters/Flow Control	256,562	256,562	256,562	143,119	143,119	39,274
Variable Displacement Air Compressor	1,011	1,011	1,011	457	457	123
Cooking						
HE Fryer	6,356	0	0	0	0	0
HE Griddle	11,074	11,074	0	5,620	0	1,619
HE Holding Cabinet	37,962	37,962	37,962	19,850	19,850	5,717
HE Oven	12,717	12,717	9,617	6,914	5,228	1,991
HE Steamer	57,242	57,242	57,242	31,122	31,122	8,963
Induction Cooktops	4,024	4,024	4,024	2,386	2,386	687
Envelope						
Integrated Building Design	10,624	10,624	10,624	1,911	1,911	550
Windows, Insulation, Cool Roofing	502,187	216,019	102,766	18,708	14,302	5,062
HVAC Controls						
EMS Installation / Optimization	239,210	239,210	239,210	147,259	147,259	39,523
Hotel Guest Room Occupancy Control System	2,546	2,546	2,546	1,531	1,531	460

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC UCT (MWH)	ECONOMIC TRC (MWH)	ACHIEVABLE UCT (MWH)	ACHIEVABLE TRC (MWH)	CONSTRAINED ACHIEVABLE (MWH)
Programmable Thermostats	92,486	92,486	92,486	48,493	48,493	13,110
Retrocommissioning / Commissioning	131,328	131,328	131,328	81,335	81,335	24,473
Lighting						
CFL Lighting Efficiency	400,586	400,586	400,549	216,558	216,558	65,913
Fluorescent Tube Lighting Efficiency	2,541,825	2,541,825	970,283	802,591	222,908	229,439
LED Lighting Efficiency	809,494	567,337	550,531	255,499	244,584	74,053
Lighting Controls and Design	3,999,642	3,980,129	3,492,753	2,125,176	1,819,521	607,726
Other Lighting Efficiency	244,014	244,014	778	111,953	0	32,242
Other						
Commercial Clothes washers - Non-Water Heating Savings	2,227	2,227	0	842	0	260
EC Plug Fans	16,065	16,065	16,065	6,914	6,914	1,991
Engine Block Heater Timer	30,710	30,710	30,710	19,825	19,825	6,291
NEMA Premium Transformer	531,700	531,700	531,700	113,135	113,135	32,582
Optimized Snow and Ice Melt Controls	44,049	44,049	44,049	28,437	28,437	7,632
Vendor Miser for Non-Refrig Equipment	24,813	24,813	0	15,971	0	5,090
Pools						
Energy Efficient Pool Pump with controls	14,857	14,857	14,857	8,513	8,513	2,452
Heat Pump Pool Heater	6,978	6,978	6,978	4,505	4,505	1,209
High efficiency spas/hot tubs	222	222	222	127	127	37
Solar Pool Heating	3,889	3,889	3,889	2,511	2,511	674
Refrigeration						
Commercial Ice-makers	26,532	0	0	0	0	0
Commercial Refrigerators/Freezers	93,160	93,160	58,023	51,181	31,879	14,740
Door Heater Controls	358,316	358,316	358,316	201,090	201,090	53,970
Efficient compressors/condensers	41,764	39,296	39,296	15,810	15,810	4,553
Fan motors & controls	1,073,482	1,068,494	1,060,703	588,324	583,523	162,134

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC UCT (MWH)	ECONOMIC TRC (MWH)	ACHIEVABLE UCT (MWH)	ACHIEVABLE TRC (MWH)	CONSTRAINED ACHIEVABLE (MWH)
Floating Head Pressure Control	79,686	79,686	79,686	52,245	52,245	14,022
Refrigerated Case Covers	22,698	22,698	22,698	14,993	14,993	4,861
Refrigeration Economizer, Refrigerant charging correction	15,932	1,715	1,745	1,133	1,152	366
Refrigeration Savings due to Lighting Savings	14,624	14,624	14,624	8,050	8,050	2,318
Refrigerator/Freezer Door Modifications	1,537,397	1,537,397	1,537,397	883,813	883,813	272,963
Vending Miser for Soft Drink Vending Machines	215,245	215,245	215,245	141,757	141,757	38,046
Space Cooling						
Air-Cooled and Water-Cooled Chillers	72,219	72,219	72,219	15,502	15,502	4,465
Chilled Hot Water Reset	122,109	122,109	122,109	75,171	75,171	20,993
Ductless/GSHP/PTAC/WLHP	154,077	5,269	4,840	1,902	1,747	548
High Efficiency AC - Unitary & Split Systems	27,415	27,415	27,415	9,897	9,897	2,850
High Efficiency Pumps	50,886	50,886	50,886	9,685	9,685	2,599
Space Heating						
Ductless/ASHP / GSHP/PTAC/WLHP Systems	226,055	145,590	24,686	77,347	7,565	20,907
ECM motors on furnaces	8,496	8,496	8,496	1,617	1,617	434
High Efficiency Pumps / VFD's on Pumps	22,298	22,298	22,298	10,775	10,775	2,900
Ventilation						
Controlled Ventilation Optimization, Enthalpy Economizer, Improved Duct Sealing	1,395,267	1,134,696	888,449	466,907	380,498	134,467
Destratification Fan	28,152	0	0	0	0	0
Electronically-Commutated Permanent Magnet Motors (ECPMs)	170,724	170,724	170,724	68,995	68,995	19,870
High Performance Air Filters	554,183	554,183	554,183	63,142	63,142	20,467
Variable Speed Drive Control	604,438	604,438	604,438	364,084	364,084	97,716
Water Heating						
Booster Water Heater	6,783	0	0	0	0	0
Clothes Washer/Ozone Commercial Laundry	2,969	1,055	1,711	462	898	142
Dishwasher	3,509	3,509	3,509	1,289	1,289	371

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC UCT (MWH)	ECONOMIC TRC (MWH)	ACHIEVABLE UCT (MWH)	ACHIEVABLE TRC (MWH)	CONSTRAINED ACHIEVABLE (MWH)
Efficient Hot Water Pump	30,449	30,449	30,449	9,553	9,553	2,564
Heat Pump Water Heater	69,588	69,588	69,588	30,662	30,662	8,830
Drainwater / Heat Recovery	4,946	4,946	0	3,048	0	824
High Efficiency Electric Water Heater	18,579	18,579	18,579	9,428	9,428	2,715
Insulation	128,833	128,833	128,833	84,797	84,797	22,758
Low Flow Measures	77,391	77,391	77,391	28,186	28,186	7,679
Hot Water Circulation Pump Time-Clock	443	443	443	205	205	55
Point of Use Water Heating	1,506	0	0	0	0	0
Solar Water Heating System	7,486	7,486	7,486	4,267	4,267	1,145
Total	**18,601,147**	**17,251,862**	**14,344,326**	**8,057,699**	**6,835,102**	**2,326,054**
% of Annual Sales Forecast	**47.95%**	**44.48%**	**36.98%**	**20.77%**	**17.62%**	**6.00%**
Note: Measures in the above Table with "0" achievable potential are ones that did not pass the SCT Test.						

Table 7-21 provides a list of the Top 10 commercial electric savings measures for the Achievable UCT scenario. The table provides the measures ranked according to the electric savings potential. The column to the far right shows the results of the measure level cost-effectiveness screening test using the UCT to screen the measures. The measures in the table are representative of a group of comparable measures falling under the umbrella of the measure categories provided in the table. This means that there are a range of UCT ratios for measure iterations that fall into a single measure category. For example, "Specialty LED Bulbs" is a measure category which consists of several measure iterations to account for bulb type and wattage and housing type. The table presents an average of the UCT ratios for all measures which are part of the measure categories in the Top 10.

The Top 10 commercial sector energy efficiency measures combine to yield an estimated 6.2 million MWh savings. This accounts for 77% of the total commercial electric savings in the Achievable UCT scenario.

Table 7-21: Top 10 Commercial Sector Electric Savings Measures in the Achievable UCT Scenario by 2023

MEASURE	2023 ENERGY (MWH)	% OF SECTOR SAVINGS	UCT RATIO
Lighting Controls and Design	2,125,176	26.4%	9.2
Refrigerator/Freezer Door Modifications	883,813	11.0%	4.0
Fluorescent Tube Lighting Efficiency	802,591	10.0%	2.3
Fan motors & controls	588,324	7.3%	6.9
Controlled Ventilation Optimization, Enthalpy Economizer, Improved Duct Sealing	466,907	5.8%	1.8
Variable Speed Drive Control	364,084	4.5%	2.6
Office Equipment / Appliances	318,165	3.9%	10.7
LED Lighting Efficiency	255,499	3.2%	5.4
CFL Lighting Efficiency	216,558	2.7%	16.6
Door Heater Controls	201,090	2.5%	4.8
Total	**6,222,205**	**77.2%**	**6.5**

7.2 COMMERCIAL SECTOR NATURAL GAS ENERGY EFFICIENCY POTENTIAL

The GDS Associates natural gas consumption forecasts for the residential, commercial and industrial segments of the Michigan economy indicates that annual natural gas use will decrease by about 10% from 669.2 trillion BTU in 2013 to 603.2 trillion BTU in 2023.[43] Over that same period commercial natural gas use is expected to remain relatively stable varying annually between a range of 168.4 trillion BTU and 172.0 trillion BTU.

7.2.1 Natural Gas Energy Efficiency Measures Examined

For the commercial sector, there were 86 unique natural gas energy efficiency measures included in the potential gas savings analysis. Table 7-22 provides a brief description of the types of natural gas energy efficiency measures included for each end use in the commercial sector. The list of measures was developed based on a review of the Michigan Energy Measures Database (MEMD), and measures found in other Technical Reference Manuals (TRMs) and measures listed in other commercial sector energy efficiency

[43] GDS applied a forecast trends to actual deliveries by customer classes as reported by the U.S. Energy Information Administration (EIA). The annual sales forecast trends are based the EAI's Long term Reference Case forecast of natural gas consumption for the East North Central Region (Illinois, Indiana, Michigan, Ohio, and Wisconsin) as reported in the EIA 2013 Annual Energy Outlook.

potential studies. For each measure, the analysis considered incremental costs, energy and demand savings, and useful measure life.

Table 7-22: Natural Gas Energy Efficiency Measures and Programs 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 Cooking Equipment
HVAC Controls	Space Heating	• EMS Installation/Optimization • Zoning • Commissioning & Retrocommissioning • Programmable Thermostats
Space Heating	Heating System Improvements	• Efficient Heating Equipment • Improved Duct Sealing • Pipe and Tank Insulation • Heating System Controls & Tune-up • Boiler Upgrades • Steam Trap Repair • Destratification Fans • Ventilation Controls • Heat Recovery • Thermostat Upgrades and Controls • Energy Recovery Ventilator
Space & Water Heating	Equipment Improvements	• High Efficiency Combined Space and Water Heating Equipment
Water Heating	Water Heating Improvements	• Efficient Water Heating Equipment • Heat Recovery Systems • Pipe Insulation & Pool Covers • Low Flow Equipment • Water Heater Controls & Tune-ups • Solar Water Heating System • Ozone Laundry System • Efficient Pool Heaters • Solar Pool Water Heater • Efficient HW Appliances

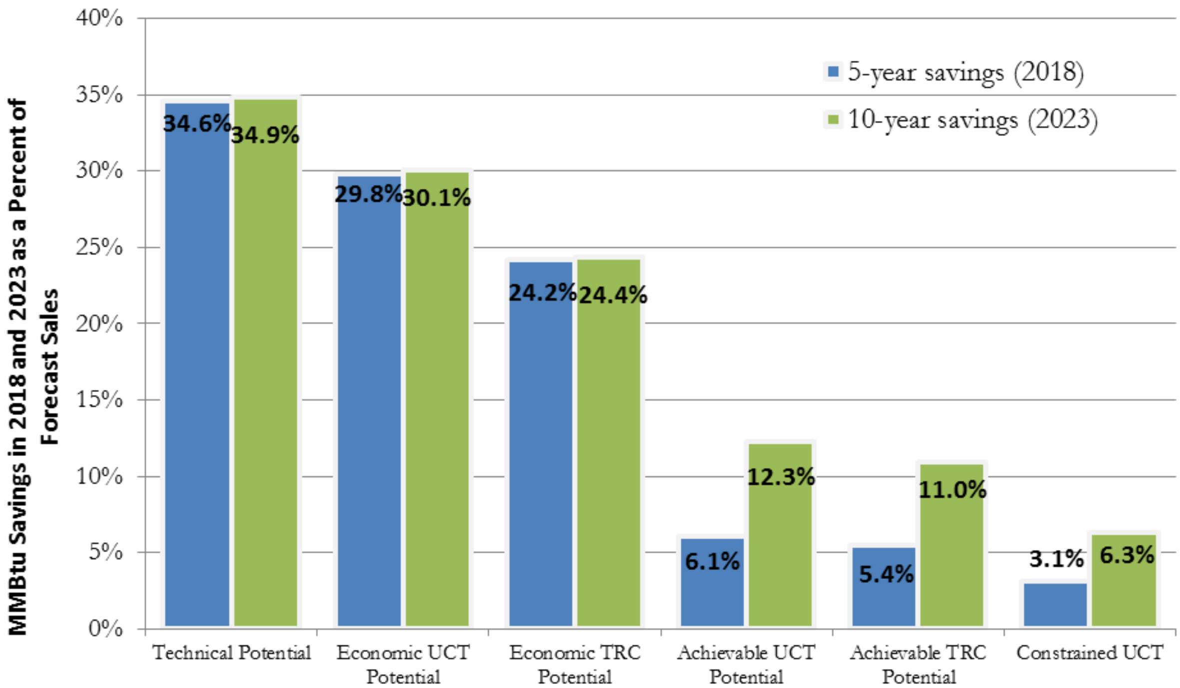
7.2.2 Technical and Economic Potential Natural Gas Savings

This section presents estimates for natural gas energy efficiency technical, economic, and achievable potential for the commercial sector (commercial and institutional combined). 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 percentage of forecast annual natural gas sales for the commercial sector. Data is provided for a 5 and 10-year horizon for Michigan.

SUMMARY OF FINDINGS

Figure 7-4 illustrates the estimated energy efficiency savings potential for each of all the scenarios included in this study.

Figure 7-4: Summary of Commercial Natural Gas Energy Efficiency Potential as a % Sales Forecasts



The potential estimates are expressed as cumulative annual 5-year and 10-year savings, as percentages of the respective 2018 and 2023 commercial sector natural gas sales forecasts. The technical potential is 34.6% in 2018 and 34.9% in 2023. The 5-year and 10-year economic potential is 29.8% and 30.1% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 24.2% in 2018 and 24.4% in 2023. The slight drop from technical potential to economic potential indicates that most measures are cost-effective.

The 5-year and 10-year achievable potential savings are: 6.1% and 12.3% for the Achievable UCT scenario; 5.4% and 11.0% for the Achievable TRC scenario; and 3.1% and 6.3% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, the Constrained Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on non-residential DSM approximately equal to 2% of future annual commercial and industrial revenue. The percent of the non-residential spending cap allocated to the commercial sector is based on the percentage of total non-residential UCT savings that the commercial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found.

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 or cost effectiveness. Table 7-23 shows that it is technically feasible to save nearly 58.9 million MMBtu (on a cumulative annual basis) in the commercial sector between 2014 and 2018 and approximately 59 million MMBtu during the 10 year period from 2014 to 2023 across Michigan, representing approximately 34.6% of the commercial sales forecast for 2018, and 34.9% of 10-year commercial sales forecast. HVAC Controls and Space Heating energy efficiency measures represent the majority of the potential at 36% and 27% of 10-yr savings, respectively, while cooking and space and water heating energy efficiency measures represent the smallest share each with 6% and 0.1% of 10-yr savings respectively.

Table 7-23: Commercial Sector Natural Gas Technical Potential MMBtu Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Space Heating	15,624,610	27%	15,667,637	27%
Building Envelope	8,008,290	14%	8,008,290	14%
Water Heating	10,914,990	19%	10,945,006	19%
HVAC Controls	21,055,539	36%	21,116,594	36%
Space & Water Heating	49,645	0.1%	49,781	0.1%
Cooking	3,261,157	6%	3,270,105	6%
Lighting	-9,838	0.0%	-9,840	0.0%
Total	**58,904,392**	**100%**	**59,047,573**	**100%**
Percent of Annual Sales Forecast	*34.6%*		*34.9%*	

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential only includes measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. 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. Because the TRC includes participant costs as well as all utility costs, it goes beyond utility resource acquisition and looks at the measure/program from a broader perspective. 75% of all measures that were included in the natural gas potential analysis passed the UCT and 63% of all measures passed the TRC Test.

Table 7-24 indicates that the economic potential based on the UCT screen is more than 50.7 million MMBtu by 2018, and the economic potential increases to 50.9 million MMBtu by 2023. This represents 29.8% and 30.1% of commercial sales across the respective 5-year and 10-year timeframes. The HVAC Controls measures make up a majority of the savings, followed by Space Heating.

Table 7-24: Commercial Sector Economic Natural Gas UCT Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Space Heating	13,752,800	27%	13,790,393	27%
Building Envelope	5,636,708	11%	5,710,915	11%
Water Heating	7,883,447	16%	7,905,197	16%
HVAC Controls	20,675,963	41%	20,724,787	41%
Space & Water Heating	49,645	0%	49,781	0%
Cooking	2,770,955	5%	2,778,558	5%
Lighting	-9,516	0%	-9,518	0%
Total	**50,760,002**	**100%**	**50,950,115**	**100%**
Percent of Annual Sales Forecast	*29.8%*		*30.1%*	

Table 7-25 shows that the economic potential based on the TRC screen is more than 41.1 million MMBtu during the 5 year period from 2014 to 2018, and the economic potential increases slightly to 41.3 million MMBtu during the 10 year period from 2014 to 2023. This represents 24.2% and 24.4% of commercial sales across the respective 5-year and 10-year timeframes. Again Space Heating and HVAC Controls make up the majority of the Economic TRC savings with HVAC Controls representing the largest economic TRC potential.

Table 7-25: Commercial Sector Economic Natural Gas TRC Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Space Heating	13,287,678	32%	13,324,269	32%
Building Envelope	2,098,196	5%	2,098,196	5%
Water Heating	6,219,338	15%	6,236,441	15%
HVAC Controls	18,088,560	44%	18,141,011	44%
Space & Water Heating	49,645	0%	49,781	0%
Cooking	1,450,344	4%	1,454,324	4%
Lighting	-5,585	0%	-5,587	0%
Total	**41,188,176**	**100%**	**41,298,436**	**100%**
Percent of Annual Sales Forecast	*24.2%*		*24.4%*	

7.2.3 Achievable Potential Savings in the Commercial Sector

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 three 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, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

7.2.3.1 UCT vs. TRC

Tables 7-26 and 7-27 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume 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. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is 2.2 MMBtu greater, over the next decade, than the achievable TRC scenario.

Table 7-26: Commercial Achievable UCT Natural Gas Potential Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Space Heating	2,527,332	24%	5,083,771	24%
Building Envelope	235,323	2%	470,646	2%
Water Heating	1,409,729	14%	2,812,285	14%
HVAC Controls	5,438,920	52%	10,848,733	52%

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Space & Water Heating	12,262	0%	24,525	0%
Cooking	760,904	7%	1,528,979	7%
Lighting	-1,533	0%	-2,846	0%
Total	**10,382,936**	**100%**	**20,766,093**	**100%**
Percent of Annual Sales Forecast	*6.1%*		*12.3%*	

Table 7-27: Commercial Achievable TRC Natural Gas Potential Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Space Heating	2,397,548	26%	4,795,096	26%
Building Envelope	81,778	1%	163,556	1%
Water Heating	1,131,606	12%	2,263,213	12%
HVAC Controls	5,260,279	57%	10,520,558	57%
Space & Water Heating	12,262	0%	24,525	0%
Cooking	391,666	4%	783,332	4%
Lighting	-760	0%	-1,520	0%
Total	**9,274,379**	**100%**	**18,548,759**	**100%**
Percent of Annual Sales Forecast	*5.4%*		*11.0%*	

7.2.3.2 Achievable UCT vs. Constrained UCT

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 Michigan annual natural gas utility revenue. The percent of the non-residential spending cap allocated to the commercial sector is based on the percentage of total non-residential UCT savings that the commercial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found. 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 7-28 shows the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizons. The 5-year and 10-year Constrained UCT potential savings estimates are approximately 5.3 million MMBtu and 10.7 million MMBtu. This equates to 3.1% and 6.3% of commercial sector natural gas sales in 2018 and 2023.

Table 7-28: Commercial Constrained UCT Natural Gas Achievable Energy Savings by End Use

End Use	2018 Energy Savings (MMBtu)	% of 2018 Total	2023 Energy Savings (MMBtu)	% of 2023 Total
Space Heating	1,292,370	24%	2,613,597	24%
Building Envelope	120,334	2%	243,240	2%
Water Heating	720,875	14%	1,457,290	14%
HVAC Controls	2,781,233	52%	5,630,643	52%
Space & Water Heating	6,270	0%	12,675	0%
Cooking	389,094	7%	786,784	7%
Lighting	-397	0%	-814	0%
Total	**5,309,780**	**100%**	**10,743,415**	**100%**
Percent of Annual Sales Forecast	*3.1%*		*6.3%*	

Figure 7-5 shows the estimated 10-year cumulative natural gas energy efficiency savings potential broken out by end use across the entire commercial sector. HVAC Controls show the largest potential for savings at 5.6 million MMBtu, or 52% of total savings, in the Constrained UCT Achievable scenario.

Figure 7-5: Commercial Sector 2023 Constrained UCT Achievable Potential Natural Gas Savings by End Use

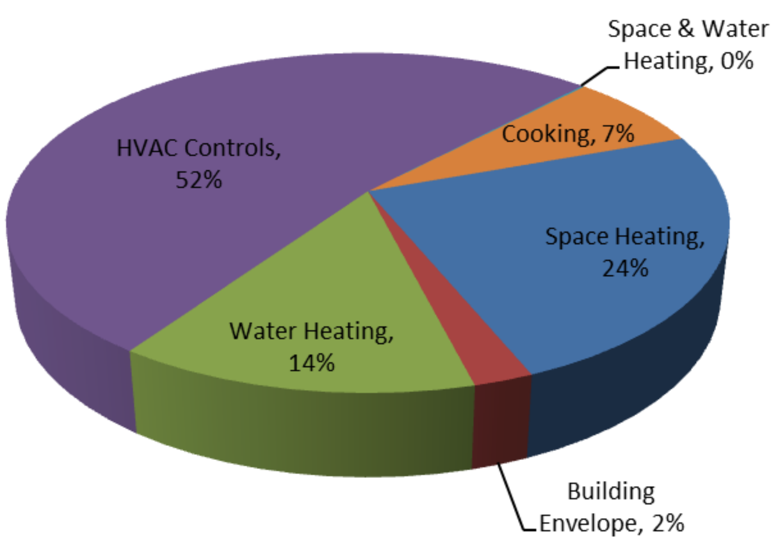
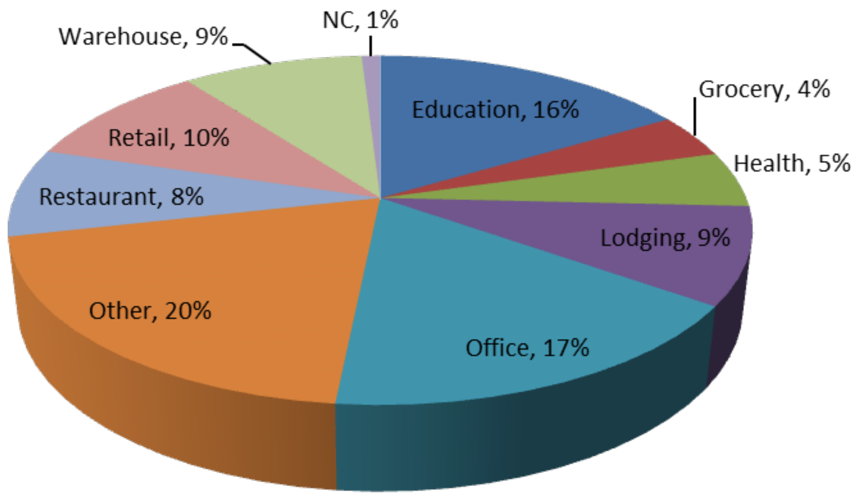


Figure 7-6 shows the breakdown of estimated natural gas savings in 2023 by building type for the Constrained UCT Achievable scenario. The vast majority of savings come from existing/turnover measures, meaning energy efficient equipment is installed in replacement of existing equipment that has failed, with about 1% of savings potential coming from new construction. The 'Offices' and 'Other' categories represent the largest potential savings at 17% and 20% respectively.

Figure 7-6: Commercial Constrained UCT Achievable Natural gas Potential Savings in 2023 by Building Type



7.2.4 Annual Achievable Natural Gas Savings Potential

Tables 7-29, Table 7-30 and Table 7-31 show cumulative energy savings for all achievable scenarios for each year across the 10-year horizon for the study, broken out by end use.

Table 7-29: Cumulative Annual Commercial Natural Gas Savings in the Achievable UCT Potential Scenario, by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Space Heating	505,466	1,010,933	1,516,399	2,021,866	2,527,332	3,032,798	3,538,265	4,043,731	4,549,198	5,054,664
Building Envelope	47,065	94,129	141,194	188,258	235,323	282,387	329,452	376,516	423,581	470,646
Water Heating	281,946	563,891	845,837	1,127,783	1,409,729	1,691,674	1,973,620	2,255,566	2,537,511	2,819,457
HVAC Controls	1,087,784	2,175,568	3,263,352	4,351,136	5,438,920	6,526,704	7,614,488	8,702,272	9,790,056	10,877,840
Space & Water Heating	2,452	4,905	7,357	9,810	12,262	14,715	17,167	19,620	22,072	24,525
Cooking	152,181	304,361	456,542	608,723	760,904	913,084	1,065,265	1,217,446	1,369,627	1,521,807
Lighting	-373	-746	-1,008	-1,271	-1,533	-1,796	-2,059	-2,321	-2,584	-2,846
Total	**2,076,521**	**4,153,042**	**6,229,673**	**8,306,305**	**10,382,936**	**12,459,567**	**14,536,199**	**16,612,830**	**18,689,461**	**20,766,093**
% of Annual Sales Forecast	*1.2%*	*2.4%*	*3.6%*	*4.8%*	*6.1%*	*7.3%*	*8.6%*	*9.8%*	*11.0%*	*12.3%*

Table 7-30: Cumulative Annual Commercial Natural Gas Savings in the Achievable TRC Potential Scenario, by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Space Heating	479,510	959,019	1,438,529	1,918,038	2,397,548	2,877,057	3,356,567	3,836,076	4,315,586	4,795,096
Building Envelope	16,356	32,711	49,067	65,422	81,778	98,133	114,489	130,845	147,200	163,556
Water Heating	226,321	452,643	678,964	905,285	1,131,606	1,357,928	1,584,249	1,810,570	2,036,891	2,263,213
HVAC Controls	1,052,056	2,104,112	3,156,167	4,208,223	5,260,279	6,312,335	7,364,390	8,416,446	9,468,502	10,520,558
Space & Water Heating	2,452	4,905	7,357	9,810	12,262	14,715	17,167	19,620	22,072	24,525
Cooking	78,333	156,666	235,000	313,333	391,666	469,999	548,333	626,666	704,999	783,332
Lighting	-152	-304	-456	-608	-760	-912	-1,064	-1,216	-1,368	-1,520
Total	**1,854,876**	**3,709,752**	**5,564,628**	**7,419,504**	**9,274,379**	**11,129,255**	**12,984,131**	**14,839,007**	**16,693,883**	**18,548,759**
% of Annual Sales Forecast	*1.1%*	*2.2%*	*3.2%*	*4.3%*	*5.4%*	*6.5%*	*7.7%*	*8.8%*	*9.9%*	*11.0%*

Table 7-31: Cumulative Annual Commercial Natural Gas Savings in Constrained Achievable Potential Scenario by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2018	2019	2020	2021	2023
Space Heating	256,489	510,744	767,133	1,027,653	1,292,370	1,560,633	1,833,429	2,095,955	2,354,082	2,613,597
Building Envelope	23,882	47,556	71,429	95,686	120,334	145,277	170,622	195,048	219,082	243,240
Water Heating	143,068	284,890	427,901	573,218	720,875	870,354	1,022,272	1,168,626	1,312,597	1,457,290
HVAC Controls	551,975	1,099,142	1,650,900	2,211,550	2,781,233	3,357,730	3,943,517	4,511,471	5,069,239	5,630,643
Space & Water Heating	1,244	2,478	3,722	4,986	6,270	7,570	8,891	10,164	11,416	12,675
Cooking	77,221	153,770	230,961	309,395	389,094	469,746	551,697	630,805	708,605	786,784
Lighting	-107	-195	-257	-320	-397	-474	-559	-644	-728	-814
Total	**1,053,773**	**2,098,385**	**3,151,789**	**4,222,167**	**5,309,780**	**6,410,836**	**7,529,869**	**8,611,423**	**9,674,293**	**10,743,415**
% of Annual Sales Forecast	*0.6%*	*1.2%*	*1.8%*	*2.5%*	*3.1%*	*3.8%*	*4.4%*	*5.1%*	*5.7%*	*6.3%*

7.2.5 Commercial Savings Summary

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

Table 7-32: Cumulative Annual Natural Gas Potential by End-Use and Measure by 2023

END USE	TECHNICAL POTENTIAL (MMBTU)	ECONOMIC POTENTIAL -UCT- (MMBTU)	ECONOMIC POTENTIAL -TRC- (MMBTU)	ACHIEVABLE POTENTIAL -UCT- (MMBTU)	ACHIEVABLE POTENTIAL -TRC- (MMBTU)	CONSTRAINED ACHIEVABLE –UCT- (MMBTU)
Building Envelope						
Energy Efficient Windows	2,527,092	2,606,377	0	65,610	0	33,909
Greenhouse Curtains/Film	2,134,571	157,031	157,031	0	0	0
Insulation Upgrades	2,860,091	2,799,094	1,941,166	313,101	163,556	161,817
Integrated Building Design	148,413	148,413	0	91,935	0	47,514
Truck Loading Dock Seals	338,123	0	0	0	0	0
Space Heating						
Boiler Modifications/Controls	2,024,237	1,289,152	1,204,178	501,466	478,001	260,085
Condensing Boiler & Efficiency Improvements	968,985	0	0	0	0	0
Demand Controlled Ventilation	5,798,651	5,798,651	5,798,651	2,345,939	2,345,939	1,212,432
Destratification Fans	2,030,198	2,030,198	2,030,198	799,636	799,636	413,269
Gas Furnace	1,003,319	1,003,319	1,003,319	373,864	373,864	193,221
Gas Unit Heater	534,530	534,530	534,530	162,375	162,375	83,919
Guest Room Energy Management	414,392	381,149	0	236,103	0	122,342
Heat Recovery/ERV	139,932	0	0	0	0	0
Infrared Heater	107,083	107,083	107,083	18,120	18,120	9,365
Makeup Air	1,215,491	1,215,491	1,215,491	332,415	332,415	171,799
Pipe Insulation/Duct Sealing	1,261,180	1,261,180	1,261,180	284,746	284,746	147,163
Tune-up/Steam Trap Repair	169,638	169,638	169,638	0	0	0
HVAC Controls						
Commissioning/Retrocommissioning	4,766,120	4,766,147	4,773,400	2,952,390	2,956,883	1,533,321
EMS Install/Optimization	9,627,692	9,235,859	9,235,859	5,382,715	5,382,715	2,781,905
Programmable Thermostat	4,131,752	4,131,752	4,131,752	2,180,960	2,180,960	1,128,444
Zoning	2,591,030	2,591,030	0	361,775	0	186,973

END USE	TECHNICAL POTENTIAL (MMBTU)	ECONOMIC POTENTIAL -UCT- (MMBTU)	ECONOMIC POTENTIAL -TRC- (MMBTU)	ACHIEVABLE POTENTIAL -UCT- (MMBTU)	ACHIEVABLE POTENTIAL -TRC- (MMBTU)	CONSTRAINED ACHIEVABLE –UCT- (MMBTU)
Cooking						
High Efficiency Fryer	876,851	719,773	0	476,733	0	246,386
High Efficiency Gas Broiler	93,600	69,879	0	50,889	0	26,301
High Efficiency Gas Ovens	588,015	266,094	109,725	161,582	61,761	83,509
High Efficiency Gas Griddle	214,275	0	0	0	0	0
High Efficiency Gas Steamer	1,327,180	1,327,180	1,327,180	721,571	721,571	372,924
Power Burner Range	170,183	142,194	0	111,031	0	57,664
Water Heating						
Circulation Pump Time Clocks	749,404	749,404	749,404	346,537	346,537	179,098
Clothes Washer ENERGY STAR	306,521	0	100,427	0	60,087	0
Stand Alone Commercial Water Heaters	541,885	159,327	159,327	63,436	63,436	32,785
ES Dishwasher	489,713	489,713	489,713	179,857	179,857	92,954
Heat Recovery Water Heater/GFX	1,537,068	1,537,068	909,492	620,335	408,781	320,603
Indirect Water Heaters	451,984	451,984	0	174,093	0	89,975
Low Flow Aerators/Showerheads/Nozzles	973,772	973,772	973,772	73,273	73,273	38,002
On-Demand, Tankless Water Heater	1,901,498	933,988	726,976	310,415	241,614	160,429
Ozone Laundry System/Generator	776,210	776,210	776,210	344,634	344,634	178,114
Pipe wrap/Tune-up	714,609	219,165	219,165	71,576	71,576	36,992
Pool Measures (including Solar)	1,131,955	1,131,955	1,131,955	473,418	473,418	244,673
Solar Water Heating	887,777	0	0	0	0	0
Wastewater, Filtration/Reclamation	482,611	482,611	0	161,884	0	83,665
Space & Water Heating						
Combination Water Heater/Boiler	45,063	45,063	45,063	24,525	24,525	12,675
Combination Water Heater/Furnace	4,718	4,718	4,718	0	0	0

END USE	TECHNICAL POTENTIAL (MMBTU)	ECONOMIC POTENTIAL -UCT- (MMBTU)	ECONOMIC POTENTIAL -TRC- (MMBTU)	ACHIEVABLE POTENTIAL -UCT- (MMBTU)	ACHIEVABLE POTENTIAL -TRC- (MMBTU)	CONSTRAINED ACHIEVABLE –UCT- (MMBTU)
Lighting						
Lighting	-9,840	-9,518	-5,587	-2,846	-1,520	-814
Total	**59,047,573**	**50,950,115**	**41,298,436**	**20,766,093**	**18,548,759**	**10,743,415**
% of Annual Sales Forecast	**34.9%**	**30.1%**	**24.4%**	**12.3%**	**11.0%**	**6.3%**
Note: Measures in the Table with "0" in the Economic or Achievable Potentials are ones that did not pass the TRC or UCT.						

Table 7-33 provides a list of the Top 10 commercial natural gas savings measures for the Achievable UCT scenario. The table provides the measures ranked highest to lowest according to the cumulative annual natural gas savings potential. The column to the far right shows the results of the measure level cost-effectiveness screening test using the UCT to screen the measures. The measures in the table are representative of a group of comparable measures falling under the umbrella of the measure categories provided in the table. This means that there are a range of UCT ratios for measure iterations that fall into a single measure category. For example, "Heat Recovery Water Heater/GFX" is a measure category which consists of water heater recovery systems including gray water heat exchangers. The table presents an average of the UCT ratios for all measures which are part of the measure categories in the Top 10.

The Top 10 measures combine to yield an estimated 16,400,000 MMBtu savings. This accounts for 79.2% of the total commercial gas savings in the Achievable UCT scenario.

Table 7-33: Top 10 Commercial Natural Gas Savings Measures in the Achievable UCT Scenario

MEASURE	2023 ENERGY (MMBTU)	% OF SECTOR SAVINGS	UCT RATIO
EMS install/Optimization	5,382,715	25.9%	42.6
Commissioning/Retrocommissioning	2,952,390	14.2%	8.1
Demand Controlled Ventilation	2,345,939	11.3%	24.7
Programmable Thermostat	2,180,960	10.5%	33.7
Destratification Fans	799,636	3.9%	2.3
High Efficiency Gas Steamer	721,571	3.5%	2.7
Heat Recovery Water Heater/GFX	620,335	3.0%	3.4
Boiler Modifications/Controls	501,466	2.4%	2.1
High Efficiency Fryer	476,733	2.3%	1.3
Pool Measures (including Solar)	473,418	2.3%	4.0
Total	**16,455,163**	**79.2%**	**12.5**

7.3 ACHIEVABLE POTENTIAL BENEFITS & COSTS

The tables below provide the net present value (NPV) benefits and costs associated with the three achievable potential scenarios for the commercial sector at the 5-year and 10-year periods. Tables 7-34 and 7-35 compare the 5 and 10 year NPV benefits and costs associated with the Achievable UCT and Achievable TRC Scenarios. Both the UCT and TRC scenario benefits include avoided energy supply and demand costs, while the Achievable TRC scenario benefits also include water savings benefits, and carbon tax adder. The NPV costs in the Achievable UCT scenario includes only program administrator costs (incentives paid, staff labor, marketing, etc.) whereas the Achievable TRC scenario costs include both participant and program administrator costs.

Table 7-34: 5-Year Benefit-Cost Ratios for Achievable Potential Scenarios – Commercial Sector Only

5-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO	NET BENEFITS
Achievable UCT	$3,926,211,328	$1,514,585,402	2.59	$ 2,411,625,926
Achievable TRC	$3,590,040,097	$1,331,359,508	2.70	$ 2,258,680,589

Table 7-35: 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	$7,120,951,471	$2,506,173,980	2.84	$ 4,614,777,491
Achievable TRC	$6,556,350,912	$2,235,299,451	2.93	$ 4,321,051,461

Tables 7-36 and 7-37 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 7-36: 5-Year Benefit-Cost Ratios for Achievable Potential Scenarios – Commercial Sector Only

5-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO	NET BENEFITS
Achievable UCT	$3,926,211,328	$1,514,585,402	2.59	$ 2,411,625,926
Constrained UCT	$1,111,987,608	$422,340,965	2.63	$ 689,646,644

Table 7-37: 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	$7,120,951,471	$2,506,173,980	2.84	$ 4,614,777,491
Constrained UCT	$2,196,078,237	$757,273,804	2.90	$ 1,438,804,433

Year by year budgets for all three scenarios, broken out by incentive and administrative costs are presented in Tables 7-38 through 7-40. Table 7-41 shows the revenue requirements for each scenario as a percentage of forecasted sector sales.

Table 7-38: Year By Year Budgets for Achievable Potential TRC Scenarios– Commercial Sector Only (Millions of Dollars)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Admin	$ 39.7	$ 52.1	$ 56.6	$ 56.6	$ 46.5	$ 48.3	$ 43.7	$ 45.0	$ 47.5	$ 47.5
Incentive	$ 99.2	$130.2	$141.5	$141.6	$116.3	$120.7	$109.2	$112.4	$118.7	$118.8
Total	$138.8	$182.3	$198.1	$198.2	$162.8	$168.9	$152.9	$157.3	$166.2	$166.3

Table 7-39: Year By Year Budgets for Achievable Potential UCT Scenarios– Commercial Sector Only (Millions of Dollars)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Admin	$ 85.7	$103.9	$105.0	$105.0	$ 89.1	$ 91.0	$ 83.8	$ 85.2	$ 88.0	$ 87.7
Incentive	$214.2	$259.7	$262.5	$262.6	$222.7	$227.5	$209.5	$212.9	$220.0	$219.3
Total	$299.8	$363.6	$367.5	$367.6	$311.8	$318.5	$293.3	$298.1	$308.0	$307.0

Table 7-40: Year By Year Budgets for Cost Constrained UCT Scenarios– Commercial Sector Only (Millions of Dollars)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Admin	$ 26.5	$ 26.8	$ 27.2	$ 27.7	$ 28.1	$ 28.6	$ 29.0	$ 29.5	$ 30.0	$ 30.4
Incentive	$ 66.3	$ 66.9	$ 68.1	$ 69.2	$ 70.3	$ 71.4	$ 72.6	$ 73.7	$ 74.9	$ 76.1
Total	$ 92.8	$ 93.7	$ 95.4	$ 96.9	$ 98.4	$ 100.0	$101.6	$103.2	$104.9	$106.5

Table 7-41: Utility Energy Efficiency Budgets per Scenario as a % of Sector Revenues

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Achievable UCT	6.5%	7.9%	7.8%	7.7%	6.4%	6.4%	5.8%	5.8%	5.9%	5.8%
Achievable TRC	3.0%	3.9%	4.2%	4.1%	3.3%	3.4%	3.0%	3.1%	3.2%	3.2%
Constrained UCT	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%

8 INDUSTRIAL SECTOR ELECTRIC AND NATURAL GAS ENERGY EFFICIENCY POTENTIAL ESTIMATES

This section provides electric and natural gas energy efficiency potential estimates for the industrial sector in Michigan. Estimates of technical, economic and achievable potential are provided in separate sections for electric and natural gas.

8.1 INDUSTRIAL ELECTRIC ENERGY EFFICIENCY POTENTIAL

According to 2012 historical sales data[44], the industrial sector accounts for approximately 30% of retail electric sales in Michigan. This sector is dominated by the transportation equipment industry which represents almost 25% of industrial electric retail sales. Other key industrial sectors are primary metals and chemicals. Industrial kWh sales over the period 2002 to 2012 reached their highest level in 2003 of almost 40,000 GWh and their lowest level in 2009 of about 27,000 GWh. Since 2009 Industrial sales have rebounded, increasing by 14% to 31,306 GWh in 2012. For this study, industrial electric sales are forecast to continue to increase reaching a level of almost 35,000 GWh in 2023, which represents a compound annual growth rate of slightly less than 1%.[45]

8.1.1 Electric Energy Efficiency Measures Examined

For the industrial sector, there were 116 unique energy efficiency measures included in the energy savings potential analysis. Table 8-1 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 Michigan Energy Measures Database (MEMD), and measures found in other Technical Reference Manuals (TRMs) and industrial potential studies. For each measure, the analysis considered incremental costs, energy and demand savings, and measure useful measure lives.

Table 8-1: Types of Electric Measures Included in the Industrial Sector Analysis

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
Building Envelope	Building Envelope Improvements	• Wall Insulation R-7.5 to R13 • Below Grade Insulation • Ceiling Insulation R-11 to R-42 • Roof Insulation R-11 to R-24 • Cool Roofing • Energy Efficient Windows
Computers & Office Equipment	Equipment Improvements	• Energy Star Office equipment including computers, monitors, copiers, multi-function machines • PC Network Energy Management Controls replacing no central control • Energy Star Compliant Single Door Refrigerator • Energy Efficient "Smart" Power Strip for PC/Monitor/Printer • EZ Save Monitor Power Management System • Energy Star UPS
Lighting	Lighting Improvements	• CFL Screw in Specialty (& Standard) • CFL Screw-in, Fixtures, and Floods • LED Exit Sign • LED Pin Based Lamp & LED Screw-Ins • Daylight Dimming

44 U.S. Energy Information Administration

45 GDS forecast based on sales forecasts provided by DTE and CE and historical industrial sales trends for the state as a whole.

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
		• HID Fixture Upgrade - Pulse Start Metal Halide • Central Lighting Control • High Intensity Fluorescent Fixture (replacing HID) • Stairwell Bi-Level Control • LED Wallpacks • LED Downlights • Remote Mounted Occupancy Sensor • Switching Controls for Multilevel Lighting (Non-HID) • LED Replacing Halogen Incandescent • Controls for H.I.F. • Controls for HID (Hi/Lo) • New Fluorescent Fixtures T5/HP T8 reduced wattage (replacing T12) • Induction Fluorescent • Fluorescent Fixture with Reflectors • Lamp & Ballast Retrofit (HPT8 Replacing T12) • Lamp & Ballast Retrofit (Low Wattage HPT8 Replacing Standard T8) • CFL Exterior Lighting • LED Outdoor Area Fixture (Parking Light or Street Light) • LED Specialty • LED Screw-in • T5 HP replacing T12 • Switch Mounted Occupancy Sensor • Illuminated Signs to LED • CFL Fixture • CFL Flood • 42W 8 lamp Hi Bay CFL • Light Tube • LED Exterior Flood and Spotlight • Fluorescent Fixture with Reflectors • Lamp & Ballast Retrofit (HPT8 Replacing Standard T8) • Lamp & Ballast Retrofit (HPT8 Replacing Standard 12) • New Fluorescent Fixtures T5/HP T8 (replacing T8)
Machine Drive	Machine Drive Improvements	• Compressed Air - Advanced Compressor Controls • Advanced Lubricants • Compressed Air System Management • Pump System Efficiency Improvements • Motor System Optimization (Including ASD) • Electric Supply System Improvements • Sensors & Controls • Fan System Improvements • Advanced Efficient Motors • Industrial Motor Management • Energy Information System
Other		• NEMA Premium Transformer, three-phase • NEMA Premium Transformer, single-phase • Optimized Snow and Ice Melt Controls • Engine Block Heat Timer

End Use Type	End Use Description	Measures Included
		• Electrically Commutated Plug Fans in Data Centers • Vendor Miser for Non-Refrigerated Equipment
Process Cooling and Refrigeration	Process Cooling and Refrigeration Improvements	• Improved Refrigeration • Electric Supply System Improvements • Sensors & Controls • Energy Information System
Process Heating	Heating Improvements	• Electric Supply System Improvements • Sensors & Controls • Energy Information System
HVAC Controls	HVAC Control Improvements	• EMS Optimization • EMS install • Programmable Thermostats
Space Cooling - Chillers	Cooling System Upgrades	• Efficient Chilled water Pump • Chilled Hot Water Reset • Water-Cooled Screw Chiller > 300 ton • Air-Cooled Recip Chiller • Water-Cooled Centrifugal Chiller > 300 ton • Air-Cooled Screw Chiller • Water-Cooled Screw Chiller 150 – 300 ton • Water-Cooled Centrifugal Chiller 150 – 300 ton • Water-Cooled Screw Chiller < 150 ton • Water-Cooled Centrifugal Chiller < 150 ton • High Efficiency Pumps
Space Cooling – Unitary and Split AC	Cooling System Upgrades	• Water Loop Heat Pump (WLHP) – Cooling • High Efficiency AC – Unitary & Split Systems • Ductless (mini split) – Cooling • Ground Source Heat Pump - Cooling
Space Heating	Heating System Improvements	• VFD Pump • High Efficiency Pumps • ECM Motors on Furnaces • Water Loop Heat Pump (WLHP) - Heating • Ground Source Heat Pump – Heating • High Efficiency Heat Pump • Ductless (mini split) – Heating
Ventilation	Ventilation Equipment	• Electronically-Commutated Permanent Magnet Motors (ECPMs) • Demand-Controlled Ventilation • High Performance Air Filters • Variable Speed Drive Control, 15 HP • Variable Speed Drive Control, 5 HP • Variable Speed Drive Control, 40 HP • Controlled Ventilation Optimization • Improved Duct Sealing • Enthalpy Economizer • Destratification Fan
Water Heating	Water Heating Improvements	• Low Flow Faucet Aerator • Tank Insulation (electric) • Heat Pump Water Heater • Efficient Hot Water Pump • Hot Water Circulation Pump Time-Clock • Hot Water (DHW) Pipe Insulation • High Efficiency Electric Water Heater • Solar Water Heating System

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
		• Drain Water Heat Recovery Water Heater • Point of Use Water Heating

8.1.2 Technical and Economic Potential Electric Savings

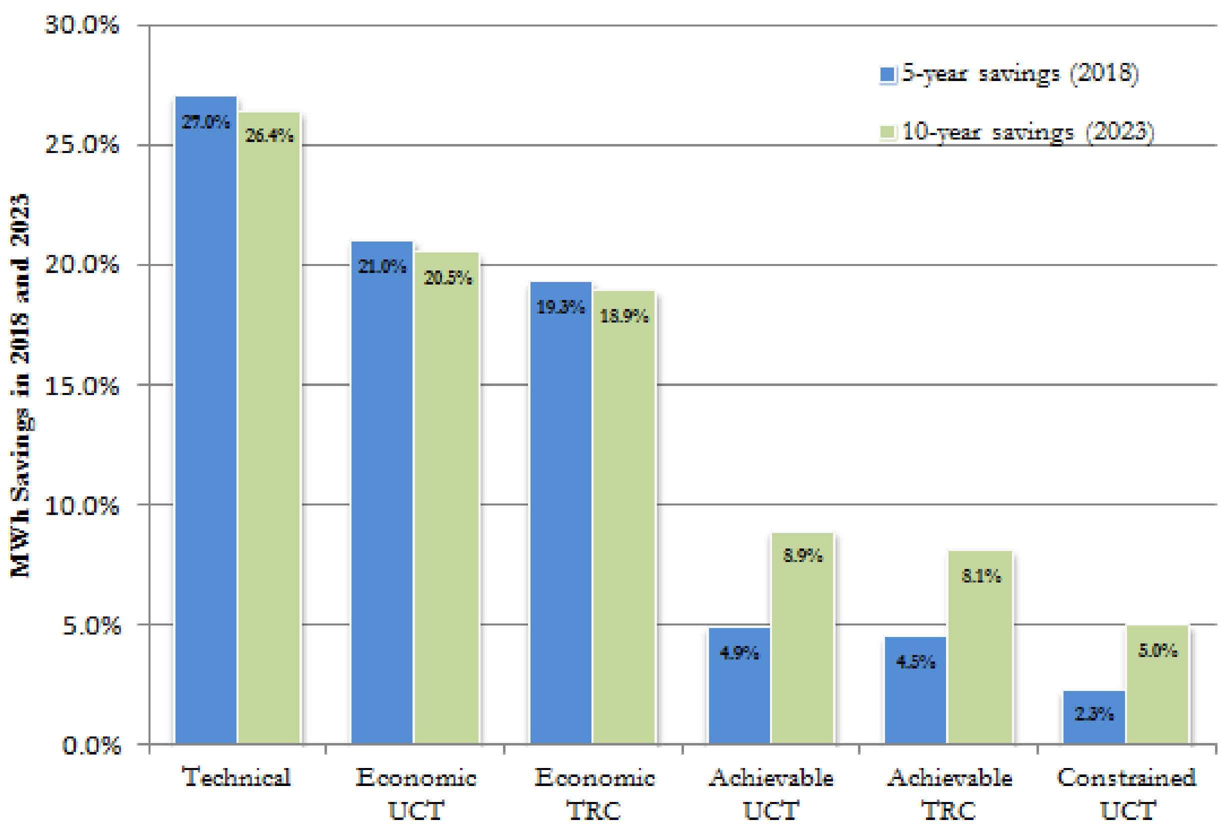
This section presents estimates for electric technical, economic, and achievable savings potential for the industrial sector. Each of the tables in the technical, economic and achievable sections present the respective potential for energy efficiency savings expressed as cumulative annual savings (MWh) and percentage of annual kWh sales. Data is provided for a 5 and 10-year horizon for Michigan

This energy efficiency potential study considers the impacts of the December 2007 Energy and Independence and Security Act (EISA) as an improving code standard for the industrial sector. EISA improves the baseline efficiency of compact fluorescent lamps (CFL), general service fluorescent lamps (GSFL), high intensity discharge (HID) lamps and ballasts and motors, all applicable in the industrial sector.

SUMMARY OF FINDINGS

Figure 8-1 illustrates the estimated savings potential in Michigan for each of the scenarios included in this study.

Figure 8-1: Summary of Industrial Electric Energy Efficiency Potential as a % of Sales Forecasts



The potential estimates are expressed as cumulative annual 5-year and 10-year savings, as percentages of the respective 2018 and 2023 forecasts for industrial sector sales. The technical potential is 27.0% in 2018 and 26.4% in 2023. The 5-year and 10-year economic potential is: 21% and 20.5% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 19.3% in 2018 and 18.9% in 2023. The slight drop from technical potential to economic potential indicates that most measures are cost-effective.

The 5-year and 10-year achievable potential savings are: 4.9% and 8.9% for the Achievable UCT scenario; 4.5% and 8.1% for the Achievable TRC scenario; and 2.3% and 5.0% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, the Constrained Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on non-residential DSM approximately equal to 2% of future annual industrial revenue. The percent of the non-residential spending cap allocated to the industrial sector is based on the percentage of total non-residential UCT savings that the industrial sector represents. This presumes that the total non-residential spending cap will allocated at the sector level based on where the savings opportunities are found.

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 8-2 shows that the technical potential is more than 9.1 million MWh annually in the industrial sector during the 10 year period from 2014 to 2023 across Michigan, representing 27.0% of 2018 forecast industrial sales and 26.4% of 2023 industrial sales. Machine Drive represents the majority of the potential at 36% of 10-yr savings, while water heating, space heating and office equipment represent the smallest shares, each with less than 2 percent of 10-yr savings. Table 8-3 shows the annual (summer) peak demand savings potential in 2018 and 2023. The ten year summer peak demand savings potential is 1,790 MW, which is 40.6% of the 5-year peak forecast and 39.7% of the 10-year peak forecast.

Table 8-2: Industrial Sector Technical Potential Savings By End Use

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
Machine Drive	3,344,311	36%	3,344,311	36%
Ventilation	1,720,439	19%	1,720,439	19%
Lighting	1,663,985	18%	1,663,985	18%
HVAC Controls	364,007	4%	364,007	4%
Process	571,628	6%	571,628	6%
Space Cooling - Chillers	540,901	6%	540,901	6%
Appliances, Computers, Office Equipment	79,561	1%	79,561	1%
Envelope	527,313	6%	527,313	6%
Water Heating	64,490	1%	64,490	1%
Other	108,263	1%	108,263	1%
Space Heating	195,819	2%	195,819	2%
Total	**9,180,717**	**100%**	**9,180,717**	**100%**
% of Annual Sales Forecast	*27.0%*		*26.4%*	

Table 8-3: Industrial Sector Technical Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	**1,790**	**1,790**
% of Peak	*40.6%*	*39.7%*

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. 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. The TRC Test was also included because it also considers the cost assumed by the participant. 86% of all measures that were included in the electric potential analysis passed the UCT and 73% of all measures passed the TRC Test.

Table 8-4 indicates that the economic potential based on the UCT screen is slightly more than 7.1 million MWh during the 10 year period from 2014 to 2023. This represents 21.0% and 20.5% of industrial sales across the respective 5-year and 10-year timeframes. Machine drive, lighting and process end uses make up a majority of the savings. Table 8-5 shows the economic demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 1,360 MW, respectively, which is 30.8% and 30.2% of the 5-year and 10-year peak forecasts.

Table 8-4: Industrial Sector Economic Potential (UCT) Savings By End Use

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
Machine Drive	3,344,311	47%	3,344,311	47%
Lighting	1,585,959	22%	1,585,959	22%
Ventilation	801,060	11%	801,060	11%
Process	571,628	8%	571,628	8%
HVAC Controls	364,007	5%	364,007	5%
Space Cooling	227,400	2%	227,400	2%
Space Heating	108,263	1%	108,263	1%
Other	162,932	1%	162,932	1%
Appliances, Computers, Office Equipment	70,706	1%	70,706	1%
Water Heating	64,468	1%	64,468	1%
Envelope	32,801	1%	32,801	1%
Total	**7,133,458**	**100%**	**7,133,458**	**100%**

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
% of Annual Sales Forecast	*21.0%*		*20.5%*	

Table 8-5: Industrial Sector Economic Potential (UCT) Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	**1,360**	**1,360**
% of Peak	*30.8%*	*30.2%*

Table 8-6 shows that the economic potential based on the TRC screen is over 6.5 million MWh during the 10 year period from 2014 to 2023. This represents 19.3% and 18.9% of industrial sales in 2018 and 2023 respectively. As with UCT machine drive, lighting and process again make up a majority of the economic TRC savings potential. Table 8-7 shows the demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 1,210 MW, which is 27.5% and 26.9% of the 5-year and 10-year peak forecasts.

Table 8-6: Industrial Sector Economic Potential (TRC) Savings By End Use

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
Machine Drive	3,344,311	51%	3,344,311	51%
Lighting	1,164,015	18%	1,164,015	18%
Ventilation	672,929	10%	672,929	10%
Process	571,628	9%	571,628	9%
HVAC Controls	364,007	6%	364,007	6%
Space Cooling	165,956	2%	165,956	2%
Envelope	32,838	0%	32,838	0%
Other	107,408	2%	107,408	2%
Appliances, Computers, Office Equipment	68,628	1%	68,628	1%
Water Heating	53,484	1%	53,484	1%
Space Heating	22,812	0%	22,812	0%
Total	**6,568,017**	**100%**	**6,568,017**	**100%**
% of Annual Sales Forecast	*19.3%*		*18.9%*	

Table 8-7: Industrial Sector Economic Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**

Total	**1,210**	**1,210**
% of Peak	*27.5%*	*26.9%*

8.1.3 Achievable Potential Savings in the Industrial Sector

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 three 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 industrial 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, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

8.1.3.1 UCT vs. TRC

Tables 8-8 through 8-11 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume 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. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is 0.27 million MWh greater, over the next decade, than the achievable TRC scenario.

Table 8-8: Industrial Achievable UCT Potential Electric Energy Savings by End Use

	2018	% OF 2018	2023	% OF 2023
Machine Drive	672,522	40%	1,345,044	44%
Lighting	433,232	26%	798,405	26%
Ventilation	212,221	13%	354,445	11%
HVAC Controls	151,334	9%	216,191	7%
Process	101,464	6%	202,927	4%
Space Cooling	43,943	3%	66,723	2%
Space Heating	7,166	1%	10,789	0%
Other	14,279	1%	27,129	1%
Appliances, Computers, Office Equipment	18,255	0%	35,045	1%
Water Heating	18,555	1%	28,881	1%
Envelope	1,520	0%	2,172	0%
Total	1,674,490	100%	3,087,742	100%
% of Annual Sales Forecast	*4.9%*		*8.9%*	

Table 8-9: Industrial Achievable UCT Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**

	SUMMER PEAK DEMAND	
Summary	MW	MW
Total	295.8	571.1
% of Peak	*6.7%*	*12.7%*

Table 8-10: Industrial Achievable TRC Potential Electric Energy Savings by End Use

	2018	% OF 2018	2023	% OF 2023
Machine Drive	672,522	44%	1,345,044	48%
Lighting	332,748	22%	597,430	21%
Ventilation	183,798	12%	296,042	11%
HVAC Controls	148,907	10%	212,894	8%
Process	101,464	7%	202,927	7%
Space Cooling	42,949	3%	65,132	2%
Office Equip	18,103	1%	34,741	1%
Space Heat	6,352	0%	9,161	0%
Other	13,893	1%	26,576	1%
Water Heating	14,277	1%	22,728	1%
Envelope	2,628	0%	3,754	0%
Total	1,537,639	100%	2,816,429	100%
% of Annual Sales Forecast	*4.5%*		*8.1%*	

Table 8-11: Industrial Achievable TRC Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	2023
Summary	MW	MW
Total	278.5	539.2
% of Peak	*6.3%*	*12.0%*

8.1.3.2 Achievable UCT vs. Constrained UCT

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 Michigan annual utility revenues. The percent of the non-residential spending cap allocated to the industrial sector is based on the percentage of total non-residential UCT savings that the industrial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found. 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.

Tables 8-12 and 8-13 show the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizons. The 5-year and 10-year Constrained UCT potential savings estimates are approximately 786 thousand MWh and 1.7 million MWh. This equates to 2.3% and 5.0% of sector sales in 2018 and 2023. The five and ten year summer demand savings estimates in the Constrained UCT scenario are 138.1 MW and 334.9 MW, respectively, which is 3.1% and 7.4% of the peak forecast in 2018 and 2023.

Table 8-12: Industrial Constrained Achievable Energy Savings by End Use

	2018	% of 2018	2023	% of 2023
End Use	**Energy (MWh)**	**Savings**	**Energy (MWh)**	**Savings**
Machine Drive	326,294	41%	785,827	45%
Lighting	204,780	26%	450,985	26%
Ventilation	95,201	12%	187,716	11%
HVAC Controls	65,900	8%	107,366	6%
Process	47,335	6%	113,998	7%
Space Cooling	19,350	2%	34,036	2%
Computers & Office Equipment	8,437	1%	19,449	1%
Building Envelope	662	0%	1,097	0%
Water Heating	8,209	1%	14,884	1%
Other	2,474	1%	15,007	1%
Space Heating	3,151	0%	5,484	0%
Total	**785,903**	**100%**	**1,735,830**	**100%**
% of Annual Sales Forecast	*2.3%*		*5.0%*	

Table 8-13: Industrial Constrained Achievable Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	**138.1**	**334.9**
% of Peak	*3.1%*	*7.4%*

Figure 8-2 shows the estimated 10-year cumulative annual efficiency savings potential broken out by end use across the entire industrial sector for the Constrained UCT scenario. The Machine Drive end use shows the largest potential for savings at just over 0.78 million MWh, or 45% of total savings, in the Constrained UCT scenario. Lighting is second at just over 0.45 million MWh, or 26% of total savings.

Figure 8-2: Industrial Sector 2023 Constrained UCT Potential Savings by End Use

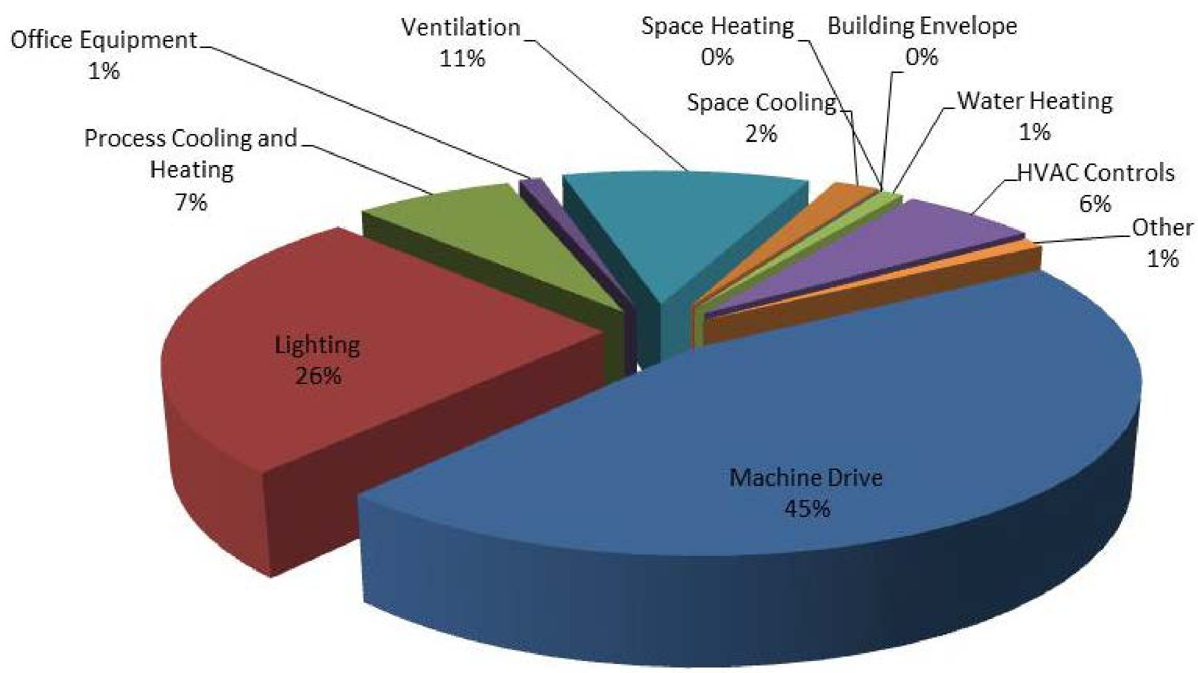
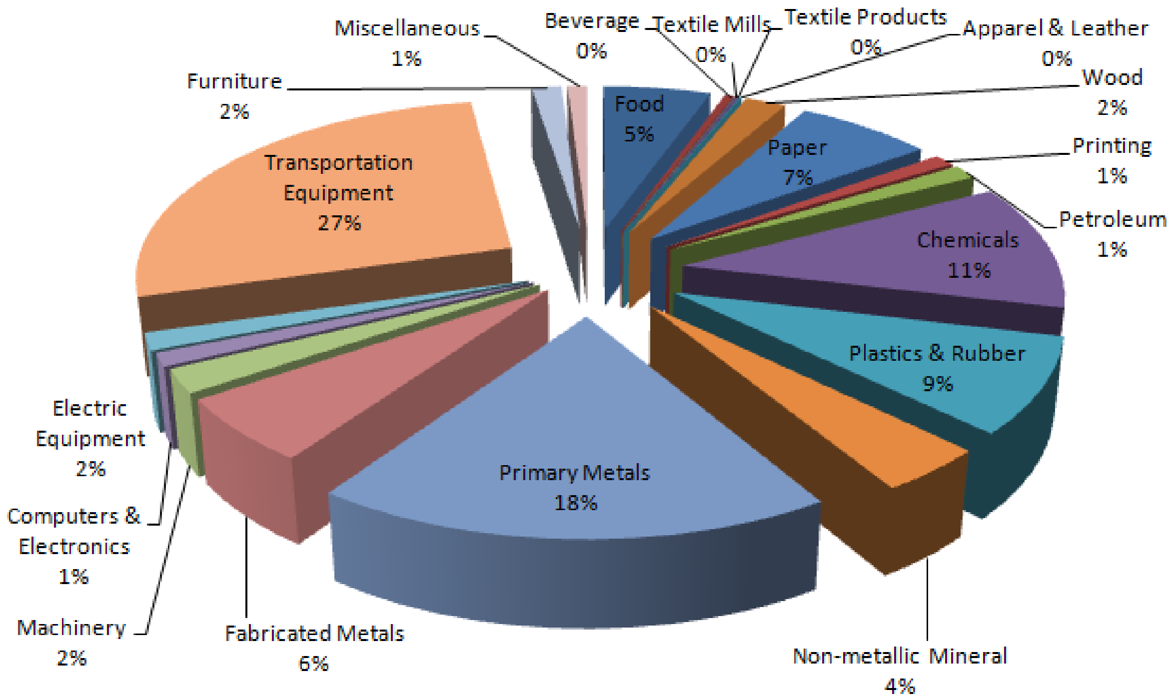


Figure 8-3 shows the breakdown of estimated savings in 2023 by building type for the Constrained UCT scenario. The vast majority of savings come from the transportation equipment, primary metals, chemicals, plastics and rubber, fabricated metals, paper, and food industries; with the other SIC codes accounting for less than 20% of total savings.

Figure 8-3: Industrial Constrained UCT Savings in 2023 by Industry



8.1.4 Annual Achievable Electric Savings Potential

Tables 8-14, Table 8-15 and Table 8-16 show cumulative energy savings for all achievable scenarios for each year across the 10-year horizon for the study, broken out by end use.

Table 8-14: Cumulative Annual Industrial Energy Savings in the Achievable UCT Potential Scenario by End Use

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Machine Drive	134,504	269,009	403,513	538,017	672,522	807,026	941,530	1,076,035	1,210,539	1,345,044
Lighting	73,540	162,764	258,175	353,546	433,232	512,918	584,761	655,973	727,185	798,405
Ventilation	26,695	70,889	123,833	176,776	212,221	247,665	274,360	301,055	327,750	354,445
HVAC Controls	10,810	43,238	86,476	129,714	151,334	172,953	183,762	194,572	205,381	216,191
Process	20,293	40,585	60,878	81,171	101,464	121,756	1420,49	162,342	182,635	202,927
Space Cooling	4,027	13,345	25,308	37,271	43,943	50,616	54,643	58,669	62,696	66,723
Office Equip	3321	7009	10,880	14,750	18,255	21,759	25,081	28,402	31,724	35,045
Space Heat	636	2,158	4,123	6,087	7,166	8,245	8,881	9,517	10,153	10,789
Other	2534	5426	8496	11566	14279	16992	19526	22060	24594	27129
Water Heat	1,860	5,776	10,721	15,666	18,555	21,443	23,302	25,162	27,021	28,881
Envelope	109	434	869	1,303	1,520	1,738	1,846	1,955	2,064	2,172
Total	**278,327**	**620,633**	**993,271**	**1,365,870**	**1,674,490**	**1,983,110**	**2,259,741**	**2,535,741**	**2,811,742**	**3,087,742**
% of Annual Sales Forecast	*0.9%*	*1.9%*	*3.0%*	*4.1%*	*4.9%*	*5.8%*	*6.6%*	*7.3%*	*8.1%*	*8.9%*

Table 8-15: Cumulative Annual Industrial Energy Savings in the Achievable TRC Potential Scenario by End Use

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Machine Drive	134,504	269,009	403,513	538,017	672,522	807,026	941,530	1,076,035	1,210,539	1,345,044
Lighting	53,443	122,571	197,885	273,159	332,748	392,337	444,084	495,199	546,315	597,430
Ventilation	20,660	59,208	106,701	154,194	183,798	213,402	234,062	254,722	275,382	296,042
HVAC Controls	10,674	42,579	85,098	127,617	148,907	170,196	180,870	191,545	202,219	212,894
Process	20,293	40,585	60,878	81,171	101,464	121,756	142,049	162,342	182,635	202,927
Space Cooling	3,917	13,026	24,731	36,436	42,949	49,462	53,380	57,297	61,215	65,132
Office Equip	3,291	6,948	10,788	14,629	18,103	21,577	24,868	28,159	31,450	34,741
Space Heat	473	1,832	3,634	5,436	6,352	7,268	7,741	8,214	8,688	9,161
Other	2,507	5,315	8,275	11,235	13,893	16,550	19,057	21,563	24,070	26,576
Water Heat	1,545	4,546	8,275	12,004	14,277	16,549	18,094	19,639	21,183	22,728

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Envelope	188	751	1,502	2,253	2,628	3,003	3,191	3,379	3,567	3,754
Total	**251,495**	**566,371**	**911,280**	**1,256,150**	**1,537,639**	**1,819,128**	**2,068,926**	**2,318,094**	**2,567,261**	**2,816,429**
% of Annual Sales Forecast	*0.8%*	*1.7%*	*2.8%*	*3.8%*	*4.5%*	*5.3%*	*6.0%*	*6.7%*	*7.4%*	*8.1%*

Table 8-16: Cumulative Annual Industrial Energy Savings in Constrained UCT Potential Scenario by End Use

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Machine Drive	80,205	140,224	194,641	250,427	326,294	403,355	498,013	594,477	691,256	785,827
Ventilation	43,430	82,862	121,091	160,266	204,780	249,995	300,069	350,650	401,396	450,985
Lighting	15,306	34,268	54,864	75,978	95,201	114,727	132,791	151,200	169,669	187,716
HVAC Controls	6,198	20,112	36,932	54,175	65,900	77,810	85,125	92,579	100,058	107,366
Process	11,635	20,342	28,236	36,329	47,335	58,514	72,246	86,239	100,279	113,998
Space Cooling	2,309	6,307	10,961	15,732	19,350	23,026	25,751	28,528	31,314	34,036
Computers & Office Equipment	1,904	3,487	4,992	6,536	8,437	10,367	12,615	14,905	17,203	19,449
Other	1,453	2,694	3,888	5,112	6,584	8,078	9,793	11,541	13,294	15,007
Water Heating	1,066	2,747	4,670	6,643	8,209	9,800	11,058	12,341	13,627	14,884
Space Heat	365	1,018	1,782	2,565	3,151	3,745	4,175	4,614	5,054	5,484
Building Envelope	62	202	371	544	662	782	855	930	1,005	1,079
Total	163,933	314,261	462,429	614,306	785,903	960,200	1,152,491	1,348,004	1,544,154	1,735,830
% of Annual Sales Forecast	0.5%	1.0%	1.4%	1.8%	2.3%	2.8%	3.4%	3.9%	4.5%	5.0%

Table 8-17: Cumulative Annual Industrial Demand Savings in the Achievable UCT Potential Scenario by End Use

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Machine Drive	23.2	46.5	69.7	92.9	116.2	139.4	162.6	185.8	209.1	232.3
Lighting	14.6	33.2	53.4	73.5	89.6	105.7	119.8	133.7	147.7	161.8
Process	3.5	7.0	10.5	14.0	17.5	21.0	24.5	28.0	31.5	35.0
Ventilation	2.4	4.9	7.3	9.8	12.2	14.7	17.2	19.6	22.0	24.5
Space Cooling	1.2	2.7	4.4	6.1	7.4	8.8	10.0	11.1	12.3	13.5
HVAC Controls	0.1	0.4	0.7	1.1	1.2	1.4	1.5	1.6	1.7	1.8
Other	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	7.9
Office Equipment	9.1	18.3	27.4	36.6	45.7	54.9	64.0	73.2	82.3	91.5
Space Heating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Heating	0.2	0.6	1.0	1.5	1.7	2.0	2.2	2.4	2.6	2.8
Building Envelope	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Total	**55.2**	**115.1**	**176.9**	**238.7**	**295.8**	**352.8**	**407.5**	**462.0**	**516.5**	**571.1**
% of Annual Sales Forecast	1.3%	2.7%	4.1%	5.4%	6.7%	7.9%	9.2%	10.3%	11.5%	12.7%

Table 8-18: Cumulative Annual Industrial Demand Savings in the Achievable TRC Potential Scenario by End Use

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Machine Drive	23.2	46.5	69.7	92.9	116.2	139.4	162.6	185.8	209.1	232.3
Lighting	10.5	25.0	41.5	58.1	70.6	83.1	93.6	104.0	114.5	125.0
Process	3.5	7.0	10.5	14.0	17.5	21.0	24.5	28.0	31.5	35.0
Ventilation	2.4	4.9	7.3	9.8	12.2	14.7	17.2	19.6	22.0	24.5
Space Cooling	0.2	0.3	0.5	0.7	0.9	1.1	1.2	1.4	1.5	1.7
HVAC Controls	0.1	0.4	0.7	1.1	1.2	1.4	1.5	1.6	1.7	1.8
Other	1.2	2.5	3.7	4.9	6.2	7.4	8.6	9.9	11.1	12.3
Office Equipment	9.7	19.4	29.2	38.9	48.6	58.3	68.1	77.8	87.5	97.2
Space Heating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Heating	0.2	0.6	1.0	1.5	1.8	2.1	2.3	2.5	2.7	2.9
Building Envelope	0.6	1.3	1.9	2.6	3.2	3.9	4.5	5.2	5.8	6.4
Total	**51.7**	**107.8**	**166.2**	**224.5**	**278.5**	**332.4**	**384.1**	**435.8**	**487.5**	**539.2**
% of Annual Demand Forecast	1.2%	2.5%	3.8%	5.1%	6.3%	7.5%	8.6%	9.7%	10.9%	12.0%

Table 8-19: Cumulative Annual Industrial Demand Savings in Constrained UCT Potential Scenario by End Use

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Machine Drive	13.3	22.7	31.5	40.9	55.6	68.6	87.3	103.8	120.2	135.5
Lighting	8.4	16.4	24.1	32.1	41.0	50.0	59.7	69.6	79.3	89.0
Process	2.0	3.5	4.9	6.3	8.2	10.1	12.5	14.9	17.3	19.7
Ventilation	1.4	2.4	3.4	4.4	5.7	7.1	8.8	10.5	12.2	13.8
Space Cooling	0.7	1.3	2.0	2.7	3.4	4.1	4.9	5.8	6.6	7.4
HVAC Controls	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9
Other	0.5	0.8	1.1	1.4	1.9	2.3	2.9	3.5	4.2	4.7
Office Equipment	5.2	9.2	12.7	16.4	21.1	27.2	36.0	45.0	54.1	62.5
Space Heating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Heating	0.1	0.3	0.4	0.6	0.8	0.9	1.1	1.2	1.3	1.4
Building Envelope	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Total	**31.6**	**56.8**	**80.4**	**105.2**	**138.1**	**171.0**	**214.0**	**255.1**	**296.0**	**334.9**
% of Annual Demand Forecast	0.8%	1.3%	1.9%	2.4%	3.1%	3.8%	4.8%	5.7%	6.6%	7.4%

8.1.5 Industrial Electric Savings Summary by Measure Group

Table 8-20 below provides an end-use breakdown of the industrial electric savings potential estimates for technical and economic potential, and each of the three achievable potential scenarios. 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 8-20 Electric Potential by End-Use and Measure

End Use	Technical Potential (MWh)	Economic Potential -UCT- (MWh)	Economic Potential -TRC- (MWh)	Achievable Potential -UCT- (MWh)	Achievable Potential -TRC- (MWh)	Constrained Achievable -UCT- (MWh)
Water Heating						
Low Flow Faucet Aerator	16,458	16,458	16,458	3,542	3,542	1,759
Heat Pump Water Heater	15,728	15,728	15,728	6,620	6,620	3,719
Tank Insulation (electric)	14,885	14,885	14,885	9,940	9,940	4,937
Solar Water Heating System	10,539	10,539	0	6,007	0	0
High Efficiency Electric Water Heater	3,177	3,177	3,177	1,543	1,543	867
Efficient Hot Water Pump	3,005	3,005	3,005	943	943	468
Drain water Heat Recovery Water Heater	446	446	0	147	0	82
Hot Water (DHW) Pipe Insulation	174	174	174	113	113	56
Hot Water Circulation Pump Time-Clock	56	56	56	26	26	13
Point of Use Water Heating	22	0	0	0	0	0
Ventilation						
Enthalpy Economizer	895,829	0	0	0	0	22,196
Demand-Controlled Ventilation	196,425	196,425	196,425	84,211	84,211	47,307
High Performance Air Filters	145,378	145,378	145,378	16,564	16,564	9,305
Improved Duct Sealing	139,823	0	0	0	0	0
Variable Speed Drive Control, 5 HP	96,838	96,838	96,838	58,331	58,331	28,968
Variable Speed Drive Control, 40 HP	96,838	96,838	96,838	58,331	58,331	28,968
Variable Speed Drive Control, 15 HP	96,838	96,838	96,838	58,331	58,331	28,968
Electronically-Commutated Permanent Magnet Motors (ECPMs)	38,207	38,207	38,207	15,441	15,441	8,674
Destratification Fan	11,858	0	0	0	0	0
Controlled Ventilation Optimization	2,405	2,405	2,405	943	943	530
Space Cooling - Chillers						
Chilled Hot Water Reset	59,940	59,940	104,809	36,899	64,521	23,479
Efficient Chilled Water Pump	18,897	18,897	33,042	3,596	6,289	2,288

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC POTENTIAL -UCT- (MWH)	ECONOMIC POTENTIAL -TRC- (MWH)	ACHIEVABLE POTENTIAL -UCT- (MWH)	ACHIEVABLE POTENTIAL -TRC- (MWH)	CONSTRAINED ACHIEVABLE -UCT- (MWH)
Air-Cooled Screw Chiller	14,824	14,824	14,824	3,202	3,202	1,799
Air-Cooled Recip Chiller	14,604	14,604	14,604	3,155	3,155	1,772
High Efficiency Pumps	3,001	3,001	12,378	571	2,356	509
Water-Cooled Centrifugal Chiller < 150 ton	2,932	2,932	2,932	633	633	356
Water-Cooled Centrifugal Chiller > 300 ton	2,929	2,929	2,929	633	633	355
Water-Cooled Centrifugal Chiller 150 - 300 ton	2,908	2,908	2,908	628	628	353
Water-Cooled Screw Chiller > 300 ton	2,755	2,755	2,755	595	595	334
Water-Cooled Screw Chiller 150 - 300 ton	2,527	2,527	2,527	546	546	307
Water-Cooled Screw Chiller < 150 ton	2,019	2,019	2,019	436	436	245
Space Cooling - Unitary and Split AC						
Ground Source Heat Pump - Cooling	170,048	19,588	0	4,972	0	0
Ductless (mini split) - Cooling	169,368	0	0	0	0	0
High Efficiency AC - Unitary & Split Systems	63,112	63,112	0	22,784	0	12,799
Water Loop Heat Pump (WLHP) - Cooling	11,039	11,039	11,039	3,985	3,985	2,239
Lighting						
New Fluorescent Fixtures T5/HP T8 (replacing T12)	128,982	128,982	0	49,603	0	28,701
Induction Fluorescent	104,252	104,252	104,252	53,870	53,870	31,170
High Intensity Fluorescent Fixture (replacing HID)	94,044	94,044	94,044	45,294	45,294	26,208
T5 HP replacing T12	86,105	86,105	0	41,392	0	23,950
LED Exterior Flood and Spotlight	69,735	3,953	0	2,567	0	0
LED Wallpack	66,853	66,853	66,853	28,945	28,945	16,748
42W 8 lamp Hi Bay CFL	63,350	63,350	0	34,099	0	19,730
CFL Exterior Lighting	58,985	58,985	58,985	28,141	28,141	16,283
Light Tube	58,510	58,510	0	26,947	0	15,592
New Fluorescent Fixtures T5/HP T8 reduced wattage (replacing T8)	43,239	43,239	43,239	0	0	0

End Use	Technical Potential (MWh)	Economic Potential -UCT- (MWh)	Economic Potential -TRC- (MWh)	Achievable Potential -UCT- (MWh)	Achievable Potential -TRC- (MWh)	Constrained Achievable -UCT- (MWh)
HID Fixture Upgrade - Pulse Start Metal Halide	41,385	41,385	41,385	9,515	9,515	5,506
Lamp & Ballast Retrofit (HPT8 Replacing T12)	41,380	41,380	41,380	19,892	19,892	11,299
Fluorescent Fixture with Reflectors	12,814	12,814	12,814	0	0	0
Lamp & Ballast Retrofit (Low Wattage HPT8 Replacing Standard T8)	11,223	11,223	11,223	0	0	0
LED Specialty	10,936	10,936	10,936	6,504	6,504	3,763
CFL Screw in Specialty	10,115	10,115	10,115	6,015	6,015	3,480
LED Outdoor Area Fixture (Parking Light or Street Light)	10,028	10,028	10,028	5,010	5,010	2,899
CFL Screw-in	6,576	6,576	6,576	3,911	3,911	2,045
LED Screw In	7,919	7,919	7,919	3,140	3,140	1,817
Lamp & Ballast Retrofit (HPT8 Replacing Standard T8)	7,576	11,223	0	0	0	0
LED Pin Based Lamp	7,299	7,299	7,299	2,894	2,894	1,674
LED Exit Sign	4,231	4,231	4,231	285	285	165
Illuminated Signs to LED	3,953	0	0	0	0	1,486
CFL Fixture	1,259	1,259	1,259	624	624	325
CFL Flood	1,029	1,029	1,029	612	612	354
LED Replacing Halogen Incandescent	954	954	954	567	567	328
LED Downlight	839	839	839	483	483	280
Lighting Controls						
Daylight Dimming	241,517	241,517	241,517	156,853	156,853	80,234
Central Lighting Control	138,674	138,674	138,674	75,052	75,052	43,427
Switching Controls for Multilevel Lighting (Non-HID)	89,312	89,312	89,312	48,073	48,073	27,816
Switch Mounted Occupancy Sensor	73,469	73,469	0	46,359	0	26,824
Remote Mounted Occupancy Sensor	73,469	73,469	73,469	46,359	46,359	26,824
Stairwell Bi-Level Control	68,331	68,331	68,331	44,132	44,132	25,536
Controls for H.I.F.	17,350	17,350	17,350	11,268	11,268	6,520

End Use	Technical Potential (MWh)	Economic Potential -UCT- (MWh)	Economic Potential -TRC- (MWh)	Achievable Potential -UCT- (MWh)	Achievable Potential -TRC- (MWh)	Constrained Achievable -UCT- (MWh)
Controls for HID (Hi/Lo)	8,291	0	0	0	0	0
Appliances, Computers, Office Equipment						
Energy Star office equipment including computers, monitors, copiers, multi-function machines.	61,212	61,212	61,212	31,080	31,080	17,460
Energy Efficient "Smart" Power Strip for PC/Monitor/Printer	7,839	0	0	0	0	0
PC Network Energy Management Controls replacing no central control	7,416	7,416	7,416	3,661	3,661	1,818
Energy Star Compliant Single Door Refrigerator	2,078	2,078	0	304	0	171
EZ Save Monitor Power Management Software	753	0	0	0	0	0
Energy Star UPS	263	0	0	0	0	0
Building Envelope						
Cool Roofing	291,304	0	0	0	0	0
Energy Efficient Windows	97,752	0	0	0	0	0
Ceiling Insulation R-11 to R-42	81,842	0	0	0	0	0
Wall Insulation R-7.5 to R13	29,969	29,969	31,280	1,457	1,521	736
Roof Insulation R-11 to R-24	24,134	0	0	0	0	0
Below Grade Insulation	2,311	2,311	2,423	683	716	343
HVAC Controls						
EMS install	239,198	239,198	239,198	147,252	147,252	73,129
Programmable Thermostats	99,062	99,062	99,062	53,089	53,089	73,129
EMS Optimization	25,747	25,747	25,747	15,850	15,850	7,872
Space Heating						
Ductless (mini split) - Heating	93,982	0	0	0	0	0
Ground Source Heat Pump - Heating	62,548	0	0	0	0	0
VFD Pump	14,151	14,151	14,151	7,663	7,663	3,805
High Efficiency Heat Pump	11,967	28,754	0	0	0	0
ECM motors on furnaces	6,289	6,289	6,289	1,197	1,197	594

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC POTENTIAL -UCT- (MWH)	ECONOMIC POTENTIAL -TRC- (MWH)	ACHIEVABLE POTENTIAL -UCT- (MWH)	ACHIEVABLE POTENTIAL -TRC- (MWH)	CONSTRAINED ACHIEVABLE -UCT- (MWH)
Water Loop Heat Pump (WLHP) - Heating	4,510	4,510	0	1,628	0	915
High Efficiency Pumps	2,372	2,372	2,372	301	301	169
Other						
NEMA Premium Transformer, three-phase	59,972	59,972	59,972	12,761	12,761	7,169
NEMA Premium Transformer, single-phase	38,231	38,231	38,231	8,135	8,135	4,570
Optimized Snow and Ice Melt Controls	4,682	4,682	4,682	3,022	3,022	1,501
Engine Block Heater Timer	3,306	3,306	3,306	2,135	2,135	1,199
Electrically Commutated Plug Fans in data centers	1,217	1,217	1,217	524	524	294
Vendor Miser for Non-Refrig Equipment	855	855	0	552	0	274
Process Heating						
Electric Supply System Improvements	115,369	115,369	115,369	39,233	39,233	22,040
Sensors & Controls	112,867	112,867	112,867	38,378	38,378	21,559
Energy Information System	36,807	36,807	36,807	12,514	12,514	7,030
Process Cooling and Refrigeration						
Improved Refrigeration	132,031	132,031	132,031	48,585	48,585	27,294
Electric Supply System Improvements	76,090	76,090	76,090	27,995	27,995	15,727
Sensors & Controls	74,287	74,287	74,287	27,329	27,329	15,353
Energy Information System	24,176	24,176	24,176	8,893	8,893	4,996
Machine Drive						
Motor System Optimization (Including ASD)	1,595,219	1,595,219	1,595,219	612,224	612,224	357,685
Pump System Efficiency Improvements	387,428	387,428	387,428	148,984	148,984	87,042
Compressed Air System Management	324,440	324,440	324,440	187,765	187,765	109,700
Electric Supply System Improvements	278,666	278,666	278,666	106,905	106,905	62,458
Sensors & Controls	272,349	272,349	272,349	104,474	104,474	61,038
Advanced Efficient Motors	162,603	162,603	162,603	37,425	37,425	21,865
Energy Information System	86,616	86,616	86,616	33,224	33,224	19,411

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC POTENTIAL -UCT- (MWH)	ECONOMIC POTENTIAL -TRC- (MWH)	ACHIEVABLE POTENTIAL -UCT- (MWH)	ACHIEVABLE POTENTIAL -TRC- (MWH)	CONSTRAINED ACHIEVABLE -UCT- (MWH)
Industrial Motor Management	69,714	69,714	69,714	40,112	40,112	23,435
Compressed Air - Advanced Compressor Controls	67,391	67,391	67,391	26,002	26,002	15,191
Advanced Lubricants	51,830	51,830	51,830	29,847	29,847	17,438
Fan System Improvements	48,056	48,056	48,056	18,082	18,082	10,564
Total	**9,180,717**	**7,133,458**	**6,568,017**	**3,087,742**	**2,816,429**	**1,735,830**
% of Annual Sales Forecast	**26.4%**	**20.5%**	**18.9%**	**8.9%**	**8.1%**	**5.0%**
Note: Measures in the above Table with "0" achievable potential are ones that did not pass the SCT Test.						

Table 8-21 provides a list of the Top 10 industrial electric savings measures for the Achievable UCT scenario. The table provides the measures ranked according to the electric savings potential. The column to the far right shows the results of the measure level cost-effectiveness screening test using the UCT to screen the measures. The table presents an average of the UCT ratios for all measures which are part of the measure categories in the Top 10.

The Top 10 measures combine to yield an estimated 1,682,050 MWh savings. This accounts for 54% of the total industrial electric savings in the Achievable UCT scenario.

Table 8-21: Top 10 Industrial Electric Savings Measures in the Achievable UCT Scenario

MEASURE	2023 ENERGY (MWH)	% OF SECTOR SAVINGS	UCT RATIO
1. Motor System Optimization (Including ASD)	612,224	20%	18.88
2. Compressed Air System Management	187,765	6%	16,869.70
3. Daylight Dimming	156,853	5%	7.57
4. Pump System Efficiency Improvements	148,984	5%	22.06
5. EMS install	147,252	5%	87.52
6. Electric Supply System Improvements (Motors)	106,905	3%	17.61
7. Sensors & Controls (Motors)	104,474	3%	12.63
8. Demand-Controlled Ventilation	84,211	3%	5.00
9. Central Lighting Control	75,052	2%	7.54
10. Variable Speed Drive Control, 40 HP	58,331	2%	2.69
Total	**1,682,050**	**54%**	

8.2 INDUSTRIAL NATURAL GAS POTENTIAL

The GDS Associates natural gas consumption forecasts for the residential, commercial and industrial segments of the Michigan economy indicates that annual natural gas consumption will decrease by about 10% from 656.2 trillion BTU in 2013 to 587.2 trillion BTU in 2023.[46] Over that same period industrial natural gas use is expected to decline by about 4% from 2012 levels.

8.2.1 Natural Gas Energy Efficiency Measures Examined

For the industrial sector, there were 44 unique natural gas energy efficiency measures included in the potential natural gas savings analysis. Table 8-18 provides a brief description of the types of natural gas energy efficiency measures included for each end use in the industrial sector. The list of measures was developed based on a review of the Michigan Energy Measures Database (MEMD), and measures found in other Technical Reference Manuals (TRMs) and industrial potential studies. For each measure, the analysis considered incremental costs, energy savings, and useful measure life.

[46] GDS applied a forecast trends to actual deliveries by customer classes as reported by the U.S. Energy Information Administration (EIA). The annual sales forecast trends are based the EIA's Long term Reference Case forecast of natural gas consumption for the East North Central Region (Illinois, Indiana, Michigan, Ohio, and Wisconsin) as reported in the EIA 2013 Annual Energy Outlook.

Table 8-22: Measures and Programs Included in the Industrial Sector Analysis

END USE TYPE	END USE DESCRIPTION	MEASURES/PROGRAMS INCLUDED
Building Envelope	Building Insulation & Air Sealing	• Wall Insulation R-7.5 to R13 • Below Grade Insulation • Ceiling Insulation R-11 to R-42 • Energy Efficient Windows • Roof Insulation R-11 to R-24
Conventional Boiler Use	Boiler Improvements	• Insulate Steam Lines / Condensate Tank • Repair Malfunctioning Steam Traps • High Efficiency Hot Water Boiler (>300,000 Btu/h) • Condensing Boiler (>300,000 Btu/h) (EF>90%) • Boiler Pipe Insulation • High Efficiency Steam Boiler (>300,000 Btu/h) • Boiler Reset Controls • Boiler Blowdown Heat Exchanger (Steam) • High Efficiency Hot Water Boiler (<=300,000 Btu/h) • Boiler Tune-Up • High Efficiency Steam Boiler (<=300,000 Btu/h) • Condensing Boiler (<=300,000 Btu/h) • Boiler O2 Trim Controls • Electronic Parallel Positioning Controls (linkage less)
Facility HVAC	HVAC improvements	• Stack Heat Exchanger (Condensing Economizer) • Stack Heat Exchanger (Standard Economizer) • High Efficiency Furnace (<=300,000 Btu/h) • Infrared Heater (low intensity - two stage) • Direct Fired Make-up Air System • Gas Unit Heater - Condensing • Heat Recovery: Air to Air • Insulate and Seal Ducts (New Aerosl Duct Sealing)
HVAC Controls	HVAC Controls Improvement	• EMS Optimization • EMS install • Programmable Thermostats
Process Heating	Process Heating Improvements	• Regenerative Thermal Oxidizer vs. STO • Boiler Pipe Insulation • High Efficiency Hot Water Boiler (>300,000 Btu/h)

END USE TYPE	END USE DESCRIPTION	MEASURES/PROGRAMS INCLUDED
		• Condensing Boiler (>300,000 Btu/h) (EF>90%) • High Efficiency Steam Boiler (>300,000 Btu/h) • Boiler Reset Controls • Boiler Tune-Up • Regenerative Thermal Oxidizer vs. CTO • Improved Sensors & Process Controls • Boiler O2 Trim Controls • Electronic Parallel Positioning Controls (linkage less) • Waste-Heat Recovery
Ventilation	Ventilation & Fans	• Demand-Controlled Ventilation • Controlled Ventilation Optimization • Improved Duct Sealing • Destratification Fan

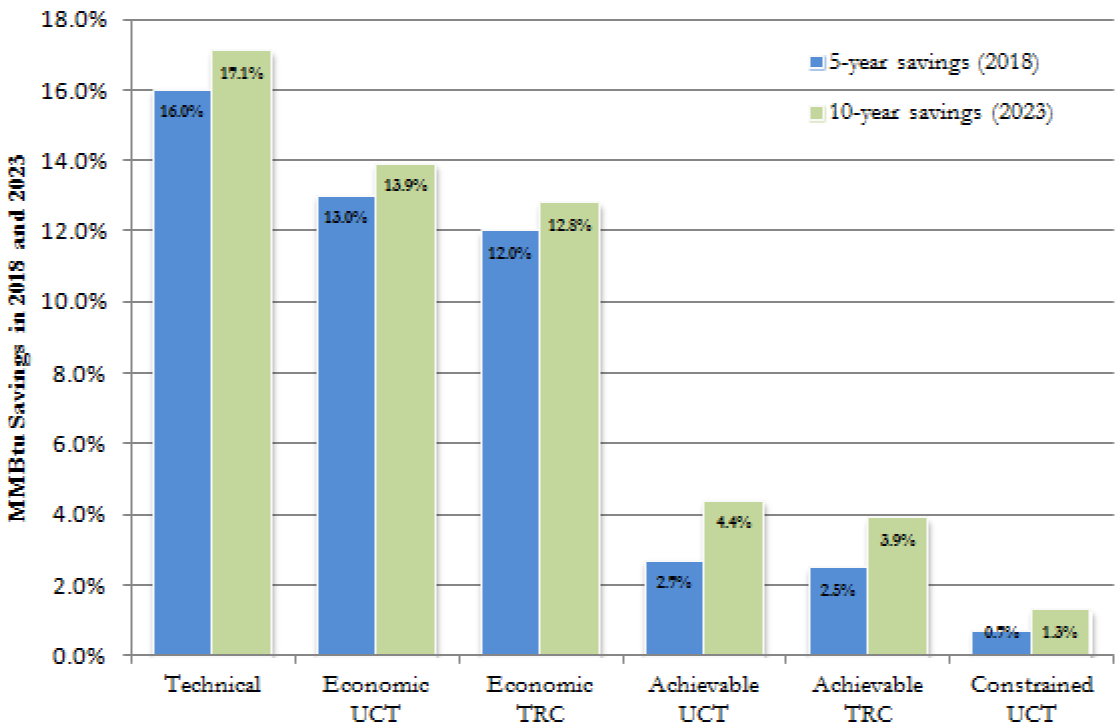
8.2.2 Technical and Economic Potential Natural Gas Savings

This section presents estimates for natural gas technical, economic, and achievable potential for the industrial sector. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative savings (MMBtu) and percentage of sales. Data is provided for a 5 and 10-year horizon for Michigan

SUMMARY OF FINDINGS

Figure 8-4 illustrates the estimated savings potential for each of all the scenarios included in this study.

Figure 8-4: Summary of Industrial Natural Gas Energy Efficiency Potential as a % Sales Forecasts



The potential estimates are expressed as cumulative 5-year and 10-year savings, as percentages of the respective 2018 and 2023 industrial sector sales. The technical potential is 16.0% in 2018 and 17.1% in 2023. The 5-year and 10-year economic potential is 13.0% and 13.9% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 12.0% in 2018 and 12.8% in 2023. The slight drop from technical potential to economic potential indicates that most measures are cost-effective.

The 5-year and 10-year achievable potential savings are: 2.7% and 4.4% for the Achievable UCT scenario; 2.5% and 3.9% for the Achievable TRC scenario; and 0.7% and 1.3% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, the Constrained Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on non-residential DSM approximately equal to 2% of future annual industrial and industrial revenue. The percent of the non-residential spending cap allocated to the industrial sector is based on the percentage of total non-residential UCT savings that the industrial sector represents. This presumes that the total non-residential spending cap will allocated at the sector level based on where the savings opportunities are found.

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 8-23 shows that it is technically feasible to save over 26 million MMBtu during the 10 year period from 2013 to 2023 across Michigan, representing just over 16.0% and 17.1% of 2018 and 2023 sector sales, respectively. Process heating represents the majority of the potential at 41% of 10-yr savings, while ventilation and Ventilation represent the smallest share with 3 percent of 10-yr savings.

Table 8-23: Industrial Sector Technical Potential MMBtu Savings By End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	11,449,066	44%	11,449,066	44%
Facility HVAC	7,623,712	29%	7,623,712	29%
Conventional Boiler Use	3,225,394	12%	3,225,394	12%
Envelope	2,728,383	10%	2,728,383	10%
HVAC Controls	1,796,940	7%	1,796,940	7%
Ventilation	893,366	3%	893,366	3%
Lighting	-1,533,839	-6%	-1,533,839	-6%
Total	**26,183,022**	**100%**	**26,183,022**	**100%**
Percent of Annual Sales Forecast	16.0%		17.1%	

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. 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. Because the TRC includes participant costs, it goes beyond utility resource acquisition and looks at the measure/program from a more broad perspective. 77% of all measures that were included in the electric potential analysis passed the UCT and 75% of all measures passed the TRC Test.

Table 8-24 indicates that the economic potential based on the UCT screen is just over 21 million MMBTu during the 10 year period from 2014 to 2023. This represents 13.0% and 13.9% of industrial sales in 2018 and 2023. Process heating again makes up a majority of the savings.

Table 8-24: Industrial Sector Economic Natural Gas UCT Savings By End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	10,011,269	47%	10,011,269	47%
Facility HVAC	6,362,046	30%	6,362,046	30%
HVAC Controls	3,069,341	14%	3,069,341	14%
Conventional Boiler Use	1,796,940	8%	1,796,940	8%
Ventilation	893,366	4%	893,366	4%
Envelope	574,166	3%	574,166	3%
Lighting	-1,516,602	-7%	-1,516,602	-7%
Total	**21,190,526**	**100%**	**21,190,526**	**100%**
Percent of Annual Sales Forecast	13.0%		13.9%	

Table 8-25 shows that the economic potential based on the TRC screen is over 19 million MMBtu during the 10 year period from 2014 to 2023. This represents 12.0% and 12.8% of industrial sales in

2018 and 2023. As with UCT process heating measures continue to makes up a majority of the savings potential.

Table 8-25: Industrial Sector Economic Natural Gas TRC Savings By End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	8,400,649	43%	8,400,649	43%
Facility HVAC	6,362,046	32%	6,362,046	32%
HVAC Controls	3,071,321	16%	3,071,321	16%
Conventional Boiler Use	1,796,940	9%	1,796,940	9%
Ventilation	893,366	5%	893,366	5%
Envelope	574,166	3%	574,166	3%
Lighting	-1,486,891	-8%	-1,486,891	-8%
Total	**19,611,597**	**100%**	**19,611,597**	**100%**
Percent of Annual Sales Forecast	12.0%		12.8%	

8.2.3 Achievable Potential Savings in the Industrial Sector

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 three 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 industrial 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, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

8.2.3.1 UCT vs. TRC

Tables 8-26 and 8-27 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume 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. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is slightly less than eight million MMBtu greater, over the next decade, than the achievable TRC scenario.

Table 8-26: Industrial Achievable UCT Natural Gas Potential Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	2,187,112	49%	3,295,968	49%
Facility HVAC	1,004,760	23%	1,664,228	25%
HVAC Controls	747,065	17%	1,067,236	16%
Conventional Boiler Use	603,287	14%	933,864	14%
Ventilation	211,567	5%	366,527	5%

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Envelope	79,173	2%	113,104	2%
Lighting	-381,744	-9%	-763,489	-11%
Total	4,451,220	**100%**	6,677,438	**100%**
Percent of Annual Sales Forecast	2.7%		4.4%	

Table 8-27 Industrial Achievable TRC Natural Gas Potential Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	1,721,341	43%	2,630,580	44%
Facility HVAC	1,004,760	25%	1,664,228	28%
Conventional Boiler Use	747,065	19%	1,067,236	18%
Ventilation	603,859	15%	934,681	16%
HVAC Controls	211,567	5%	366,527	6%
Envelope	79,173	2%	113,104	2%
Lighting	-381,573	-10%	-763,146	-13%
Total	**3,986,192**	**100%**	**6,013,211**	**100%**
Percent of Annual Sales Forecast	2.5%		3.9%	

8.2.3.2 Achievable UCT vs. Constrained UCT

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 Michigan utility revenue. The percent of the non-residential spending cap allocated to the industrial sector is based on the percentage of total non-residential UCT savings that the industrial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found. 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 8-28 shows the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizons. The 5-year and 10-year Constrained UCT potential savings estimates are approximately 1,070 thousand MMBtu and 2,039 thousand MMBtu. This equates to 0.7% and 1.3% of sector sales in 2018 and 2023.

Table 8-28: Industrial Constrained UCT Natural Gas Achievable Energy Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	592,610	55%	1,145,569	56%
Facility HVAC	248,601	23%	538,481	26%
Conventional Boiler Use	170,224	16%	306,447	15%
Ventilation	165,198	15%	330,310	16%

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
HVAC Controls	53,730	5%	122,272	6%
Envelope	18,040	2%	32,477	2%
Lighting	-178,091	-17%	-436,739	-21%
Total	**1,070,312**	**100%**	**2,038,818**	**100%**
Percent of Annual Sales Forecast	0.7%		1.3%	

Figure 8-5 shows the estimated 10-year cumulative natural efficiency savings potential broken out by end use across the entire industrial sector. The Process Heating end use shows the largest potential for savings by a wide margin at over 1.1 million MMBtu, or 56% of total savings, in the Constrained UCT Achievable scenario.

Figure 8-5: Industrial Sector 2023 Constrained UCT Achievable Potential Savings by End Use

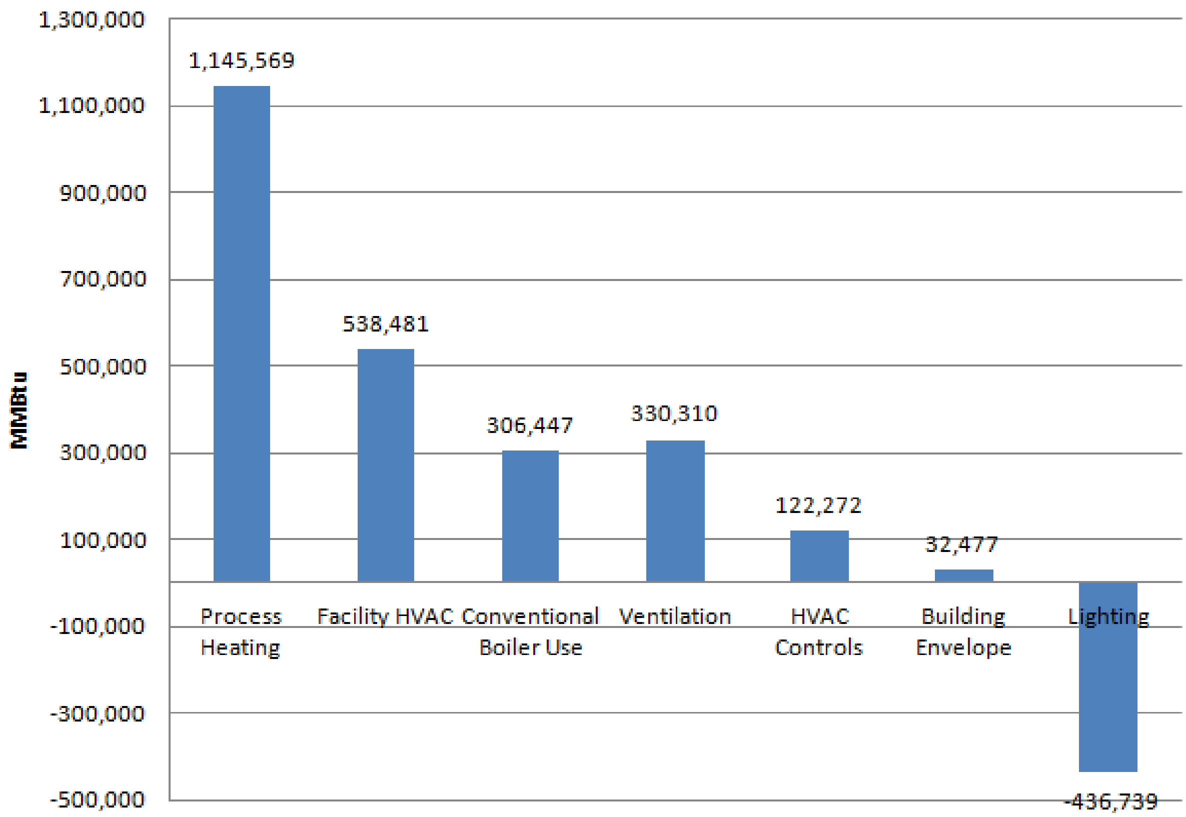
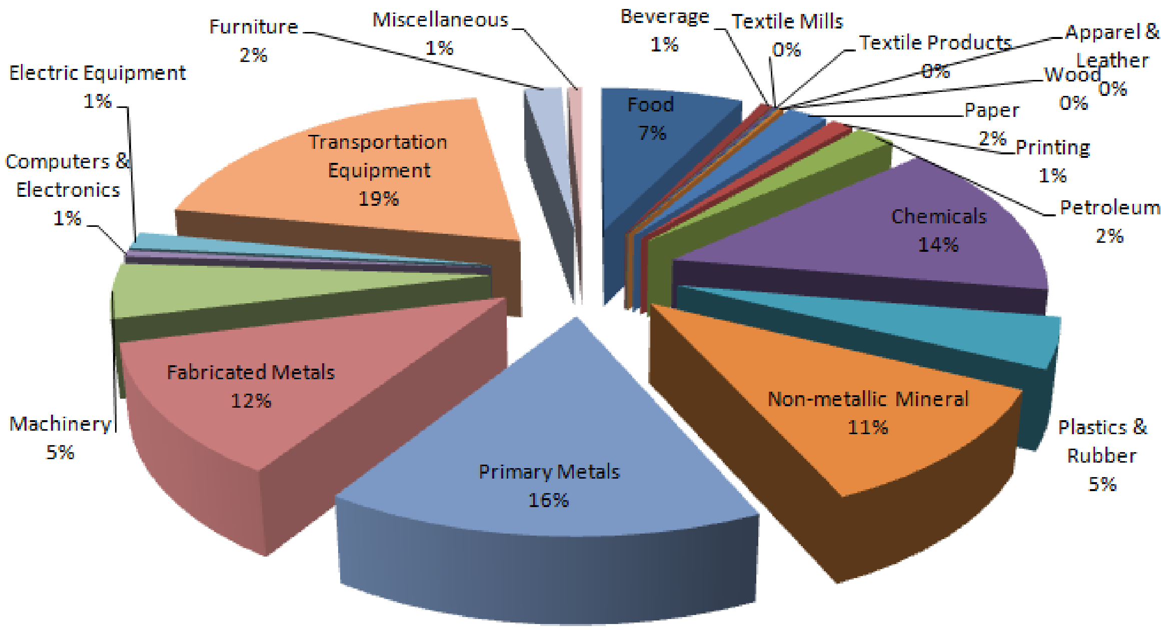


Figure 8-6 shows the breakdown of estimated natural gas savings in 2023 by industry type for the Constrained UCT Achievable scenario. The vast majority of savings come from the transportation equipment, primary metals, chemicals, fabricated metals, non-metallic minerals, and food industries, with all other SIC codes accounting for less than 25% of savings.

Figure 8-6: Industrial Constrained UCT Achievable Potential Savings in 2023 by Industry



8.2.4 Annual Achievable Natural Gas Savings Potential

Tables 8-29, Table 8-30 and Table 8-31 show cumulative energy savings for all achievable scenarios for each year across the 10-year horizon for the study, broken out by end use.

Table 8-29: Cumulative Annual Industrial Natural Gas Savings in the Achievable UCT Potential Scenario, by End Use for Michigan

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Process Heat	194,815	659,194	1,258,354	1,857,515	2,187,112	2,516,709	2,711,523	2,906,338	3,101,153	3,295,968
Facility HVAC	123,261	332,846	585,591	838,337	1,004,760	1,171,183	1,294,444	1,417,705	1,540,967	1,664,228
HVAC Controls	53,362	213,447	426,895	640,342	747,065	853,789	907,151	960,513	1,013,874	1,067,236
Conventional Boiler Use	59,298	186,773	348,337	509,900	603,287	696,673	755,971	815,268	874,566	933,864
Ventilation	29,577	73,305	124,110	174,915	211,567	248,220	277,797	307,374	336,951	366,527
Envelope	5,655	22,621	45,242	67,862	79,173	90,483	96,138	101,793	107,449	113,104
Lighting	(76,348)	(152,697)	(229,046)	(305,395)	(381,744)	(458,093)	(534,442)	(610,791)	(687,140)	(763,489)
Total	**389,620**	**1,335,488**	**2,559,482**	**3,783,476**	**4,451,220**	**5,118,963**	**5,508,582**	**5,898,201**	**6,287,819**	**6,677,438**
% of Annual Sales Forecast	*0.2%*	*0.8%*	*1.5%*	*2.3%*	*2.7%*	*3.2%*	*3.5%*	*3.8%*	*4.1%*	*4.4%*

Table 8-30: Cumulative Annual Industrial Natural Gas Savings in the Achievable TRC Potential Scenario, by End Use for Michigan

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Process Heat	161,545	526,116	992,199	1,458,283	1,721,341	1,984,399	2,145,944	2,307,490	2,469,035	2,630,580
Facility HVAC	123,261	332,846	585,591	838,337	1,004,760	1,171,183	1,294,444	1,417,705	1,540,967	1,664,228
HVAC Controls	53,362	213,447	426,895	640,342	747,065	853,789	907,151	960,513	1,013,874	1,067,236
Conventional Boiler Use	59,339	186,936	348,664	510,391	603,859	697,327	756,666	816,004	875,343	934,681
Ventilation	29,577	73,305	124,110	174,915	211,567	248,220	277,797	307,374	336,951	366,527
Envelope	5,655	22,621	45,242	67,862	79,173	90,483	96,138	101,793	107,449	113,104
Lighting	(76,314)	(152,629)	(228,943)	(305,258)	(381,573)	(457,887)	(534,202)	(610,516)	(686,831)	(763,146)
Total	**356,425**	**1,202,642**	**2,293,758**	**3,384,872**	**3,986,192**	**4,587,514**	**4,943,938**	**5,300,363**	**5,656,787**	**6,013,211**
% of Annual Sales Forecast	*0.2%*	*0.7%*	*1.4%*	*2.0%*	*2.5%*	*2.9%*	*3.1%*	*3.4%*	*3.7%*	*3.9%*

Table 8-31: Cumulative Annual Industrial Natural Gas Savings in Constrained Achievable Potential Scenario by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Process Heat	113,268	232,321	353,177	475,207	592,610	710,404	819,060	927,372	1,036,158	1,145,569
Facility HVAC	62,049	108,569	152,708	197,276	248,601	300,097	359,619	418,953	478,546	538,481
HVAC Controls	26,862	62,395	99,671	137,310	170,224	203,247	229,015	254,701	280,500	306,447
Conventional Boiler Use	34,327	66,867	99,314	132,077	165,198	198,428	231,358	264,183	297,152	330,310
Ventilation	14,889	24,595	33,467	42,426	53,730	65,071	79,354	93,591	107,890	122,272
Envelope	2,847	6,613	10,563	14,552	18,040	21,540	24,271	26,993	29,727	32,477
Lighting	(43,775)	(76,534)	(106,235)	(136,682)	(178,091)	(220,151)	(271,815)	(324,465)	(377,287)	(436,739)
Total	**210,467**	**424,825**	**642,666**	**862,166**	**1,070,312**	**1,278,635**	**1,470,860**	**1,661,328**	**1,852,687**	**2,038,818**
% of Annual Sales Forecast	*0.1%*	*0.3%*	*0.4%*	*0.5%*	*0.7%*	*0.8%*	*0.9%*	*1.1%*	*1.2%*	*1.3%*

8.2.5 Industrial Savings Summary

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

Table 8-32: Natural Gas Potential by End-Use and Measure

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Economic Potential -TRC- (MMBtu)	Achievable Potential -UCT- (MMBtu)	Achievable Potential -TRC- (MMBtu)	Constrained Achievable -UCT- (MMBtu)
Conventional Boiler Use						
Insulate Steam Lines / Condensate Tank	83,878	83,878	83,878	34,652	34,652	11,443
Repair Malfunctioning Steam Traps	419,389	419,389	419,389	173,260	173,260	57,213
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	539,964	539,964	539,964	89,229	89,229	37,230
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	32,637	32,637	32,637	7,491	7,491	3,125
Boiler Pipe Insulation	210,169	210,169	210,169	86,826	86,826	28,671
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	251,634	251,634	251,634	41,582	41,582	17,350
Boiler Reset Controls	511,569	511,569	511,569	211,342	211,342	69,788
Boiler Blowdown Heat Exchanger (Steam)	261,211	261,211	261,211	107,913	107,913	35,634
High Efficiency Hot Water Boiler (<=300,000 Btu/h) (AFUE = 85%-90%)	194,079	194,079	194,079	40,089	40,089	16,727
Boiler Tune-Up	164,071	164,071	166,051	67,782	68,600	22,382
High Efficiency Steam Boiler (<=300,000 Btu/h) (AFUE >=82%)	284,426	284,426	284,426	47,001	47,001	19,611
Condensing Boiler (<=300,000 Btu/h) (AFUE>90%)	116,314	116,314	116,314	26,696	26,696	11,138
Boiler O2 Trim Controls	78,224	0	0	0	0	0
Electronic Parallel Positioning Controls (linkage less)	77,830	0	0	0	0	0
Process Heating						
Regenerative Thermal Oxidizer vs. STO	815,809	815,809	815,809	337,031	337,031	111,776
Boiler Pipe Insulation	848,957	848,957	848,957	350,725	350,725	116,317
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	2,120,091	2,120,091	2,120,091	350,345	350,345	146,812
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	376,904	376,904	376,904	86,505	86,505	36,250

END USE	TECHNICAL POTENTIAL (MMBTU)	ECONOMIC POTENTIAL -UCT- (MMBTU)	ECONOMIC POTENTIAL -TRC- (MMBTU)	ACHIEVABLE POTENTIAL -UCT- (MMBTU)	ACHIEVABLE POTENTIAL -TRC- (MMBTU)	CONSTRAINED ACHIEVABLE -UCT- (MMBTU)
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	989,276	989,276	989,276	163,478	163,478	68,505
Boiler Reset Controls	1,992,335	1,992,335	1,992,335	823,083	823,083	272,974
Boiler Tune-Up	729,934	729,934	729,934	301,554	301,554	100,010
Regenerative Thermal Oxidizer vs. CTO	527,344	527,344	527,344	217,859	217,859	72,252
Improved Sensors & Process Controls	1,610,620	1,610,620	0	665,387	0	220,674
Boiler O2 Trim Controls	310,217	0	0	0	0	0
Electronic Parallel Positioning Controls (linkage less)	308,653	0	0	0	0	0
Waste-Heat Recovery	818,927	0	0	0	0	0
Facility HVAC						
Stack Heat Exchanger (Condensing Economizer)	570,220	570,220	570,220	208,558	208,558	59,885
Stack Heat Exchanger (Standard Economizer)	277,633	277,633	277,633	101,544	101,544	29,158
High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%)	1,740,448	1,740,448	1,740,448	353,649	353,649	128,309
Infrared Heater (low intensity - two stage)	1,459,915	1,459,915	1,459,915	314,096	314,096	113,958
Direct Fired Make-up Air System	1,512,309	1,512,309	1,512,309	553,127	553,127	158,825
Gas Unit Heater - Condensing	801,522	801,522	801,522	133,253	133,253	48,346
Heat Recovery: Air to Air	470,878	0	0	0	0	0
Insulate and Seal Ducts (New Aerosol Duct Sealing)	790,787	0	0	0	0	0
Building Envelope						
Wall Insulation R-7.5 to R13	159,032	159,032	159,032	7,733	7,733	2,220
Below Grade Insulation	7,912	0	0	0	0	0
Ceiling Insulation R-11 to R-42	415,134	415,134	415,134	105,371	105,371	30,256
Energy Efficient Windows	1,896,822	0	0	0	0	0
Roof Insulation R-11 to R-24	249,483	0	0	0	0	0
Ventilation						
Improved Duct Sealing	653,831	653,831	653,831	225,009	225,009	81,636

END USE	TECHNICAL POTENTIAL (MMBTU)	ECONOMIC POTENTIAL -UCT- (MMBTU)	ECONOMIC POTENTIAL -TRC- (MMBTU)	ACHIEVABLE POTENTIAL -UCT- (MMBTU)	ACHIEVABLE POTENTIAL -TRC- (MMBTU)	CONSTRAINED ACHIEVABLE -UCT- (MMBTU)
Destratification Fan	239,535	239,535	239,535	141,519	141,519	40,636
HVAC Controls						
EMS Optimization	127,103	127,103	127,103	78,245	78,245	22,467
EMS install	1,180,814	1,180,814	1,180,814	726,916	726,916	208,727
Programmable Thermostats	489,024	489,024	489,024	262,075	262,075	75,252
Lighting						
Induction Fluorescent	-1,533,839	-1,516,602	-1,486,891	-763,489	-763,146	-436,739
Total	**26,183,022**	**21,190,526**	**19,611,597**	**6,677,438**	**6,013,211**	**2,038,818**
% of Annual Sales Forecast	**17.1%**	**13.9%**	**12.8%**	**4.4%**	**3.9%**	**1.3%**
Note: Measures in the above Table with "0" achievable potential are ones that did not pass the SCT Test.						

Table 8-33 provides a list of the Top 10 industrial natural gas savings measures for the Achievable UCT scenario. The table provides the measures ranked according to the electric savings potential. The column to the far right shows the results of the measure level cost-effectiveness screening test using the UCT to screen the measures.

The Top 10 measures combine to yield an estimated 4,775,915 MMBtu savings. This accounts for 64% of the total industrial electric savings in the Achievable UCT scenario.

Table 8-33: Top 10 Industrial Gas Savings Measures in the Achievable UCT Scenario

MEASURE	2023 ENERGY (MMBTU)	% OF SECTOR SAVINGS	UCT RATIO
1. Boiler Reset Controls	823,083	11%	2.59
2. EMS Install	726,916	10%	18.81
3. Improved Sensors & Process Controls	665,387	9%	1.20
4. Direct Fired Make-up Air System	553,127	7%	1.99
5. High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%)	353,649	5%	5.69
6. Boiler Pipe Insulation	350,725	5%	4.00
7. High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	350,345	5%	2.11
8. Regenerative Thermal Oxidizer vs. STO	337,031	5%	17.61
9. Infrared Heater (low intensity - two stage)	314,096	4%	5.61
10. Boiler Tune-Up	301,554	4%	2.29
Total	**4,775,915**	**64%**	

8.3 ACHIEVABLE POTENTIAL BENEFITS & COSTS

The tables below provide the net present value (NPV) benefits and costs associated with the three achievable potential scenarios for the industrial sector at the 5-year and 10-year periods. Tables 8-33 and 8-34 compare the 5 and 10 year NPV benefits and costs associated with the Achievable UCT and Achievable TRC Scenarios. Both the UCT and TRC scenario benefits include avoided energy supply and demand costs, while the Achievable TRC scenario benefits also include water savings benefits. The NPV costs in the Achievable UCT scenario includes only program administrator costs (incentives paid, staff labor, marketing, etc.) whereas the Achievable TRC scenario costs include both participant and program administrator costs.

Table 8-34: 5-Year Benefit-Cost Ratios for Achievable Potential Scenarios – Industrial Sector Only

5-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO	NET BENEFITS
Achievable UCT	$1,460,878,857	$458,092,836	3.19	$1,002,786,022
Achievable TRC	$1,586,366,858	$490,194,989	3.24	$1,096,171,869

Table 8-35: 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	$2,475,174,491	$697,726,700	3.55	$1,777,447,791
Achievable TRC	$2,710,700,750	$795,215,890	3.41	$1,915,484,860

Tables 8-35 and 8-36 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 8-36: 5-Year Benefit-Cost Ratios for Achievable Potential Scenarios – Industrial Sector Only

5-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO	NET BENEFITS
Achievable UCT	$1,460,878,857	$458,092,836	3.19	$1,002,786,022
Constrained UCT	$624,960,526	$186,886,891	3.34	$438,073,636

Table 8-37: 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	$2,475,174,491	$697,726,700	3.55	$1,777,447,791
Constrained UCT	$1,264,708,643	$332,546,178	3.34	$932,162,465

Year by year budgets for all three scenarios, broken out by incentive and administrative costs are depicted in Tables 8-37 through 8-39. Table 8-40 shows the revenue requirements for each scenario as a percentage of forecasted sector sales.

Table 8-38: Annual Program Budgets Associated with the Achievable UCT Scenario (in millions)

ACHIEVABLE UCT	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$51.2	$76.5	$88.9	$88.5	$62.2	$62.4	$49.1	$49.2	$49.8	$51.5
Admin.	$21.1	$31.3	$36.2	$36.0	$25.5	$25.6	$20.3	$20.3	$20.6	$21.3
Total Costs	*$72.4*	*$107.8*	*$125.1*	*$124.5*	*$87.7*	*$88.0*	*$69.4*	*$69.5*	*$70.4*	*$72.8*

Table 8-39: Annual Program Budgets Associated with the Achievable TRC Scenario (in millions)

ACHIEVABLE TRC	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$35.5	$46.8	$52.5	$52.6	$41.8	$42.1	$39.2	$36.7	$37.5	$39.7
Admin.	$14.9	$19.4	$21.7	$21.7	$17.4	$17.5	$15.3	$15.3	$15.7	$16.5
Total Costs	*$50.4*	*$66.2*	*$74.2*	*$74.3*	*$59.1*	*$59.6*	*$55.5*	*$52.0*	*$53.1*	*$56.2*

Table 8-40: Annual Program Budgets Associated with the Constrained UCT Scenario (in millions)

CONSTRAINED UCT	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$28.8	$29.2	$29.7	$30.2	$30.6	$31.1	$31.5	$32.0	$32.6	$33.1
Admin.	$11.9	$12.0	$12.3	$12.5	$12.6	$12.8	$13.0	$13.2	$13.4	$13.6
Total Costs	*$40.7*	*$41.2*	*$42.0*	*$42.7*	*$43.2*	*$43.9*	*$44.5*	*$45.2*	*$46.0*	*$46.7*

Table 8-41: Revenue Requirements per Scenario as a % of sector sales

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Achievable UCT	3.5%	5.2%	5.9%	5.8%	4.0%	3.9%	3.0%	3.0%	3.0%	3.1%
Achievable TRC	2.5%	3.4%	3.7%	3.7%	2.8%	2.8%	2.5%	2.3%	2.4%	2.4%
Constrained UCT	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%

Appendix C: Alternative Michigan Energy Savings Goals to Promote Longer Term Savings and Address Small Utility Challenges

Prepared by Optimal Energy

FINAL REPORT:

ALTERNATIVE MICHIGAN ENERGY SAVINGS GOALS TO PROMOTE LONGER TERM SAVINGS AND ADDRESS SMALL UTILITY CHALLENGES

Prepared for

Michigan Public Service Commission

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Contents

INTRODUCTION

In Michigan and every other jurisdiction in North America policy-makers give utilities and/or non-utility administrators of efficiency programs a high level set of performance goals, usually including some measure of the amount of energy savings that will be produced. Ideally, those goals should be expressed in a manner that is most consistent with public policy objectives. That is, they would encourage efficiency program administrators to optimize their efficiency program portfolios in ways that maximize achievement of those objectives.

There are typically a wide range of policy objectives associated with legislative and/or regulatory requirements for utilities or non-utility administrators to promote end use efficiency. However, the most common and often the most important of those is to maximize net economic benefits. That is particularly important in jurisdictions in which spending on cost-effective efficiency programs is capped in some way.[1]

One important element affecting the value of efficiency investments is the longevity of the savings that the investments produce.[2] Some efficiency programs produce savings that are relatively short-lived, either because they rely on behavioral change that doesn't persist for long periods of time absent continued or additional efficiency program support, or because they promote measures that do not last very long before they wear out and need to be replaced. Examples of the latter are programs that promote the sale, purchase and/or installation of compact fluorescent light bulbs (CFLs), low flow showerheads and other hot water conservation measures, advanced or "smart" power strips, and steam traps. Other programs produce savings that are much longer-lived because they focus on measures that are either permanent (e.g. the orientation of a new building) or have very long lives (e.g. building insulation, HVAC equipment and some appliances).

Thus, ideally, savings goals should be articulated in ways that place greater value on longer-lived savings and less value on short-lived savings, or at least on capturing those savings that offer the largest lifecycle net economic benefits. Unfortunately, in Michigan and many other jurisdictions across North America, savings goals are expressed as the amount of savings that efficiency measures will produce just in their first year of functionality. That sends a less than ideal signal to utilities charged with designing and implementing efficiency programs. Specifically, it encourages them to maximize first year savings rather than maximizing lifetime savings or the value of the benefits provided over the entire lives of the efficiency measures.

Consider, for example, the hypothetical decision a utility must make when deciding whether to promote an efficiency measure that saves 20 therms of gas for just one year and costs $10 (i.e. $0.50 per unit of first year savings and $0.50 per unit of lifetime savings) or a measure

[1] Some states require utilities or other program administrators to pursue all cost-effective efficiency investments regardless of budgetary requirements. While they endeavor to keep spending as low as possible, the obligation to capture all cost-effective efficiency is the over-riding obligation. In Michigan and many other states, spending is capped either legislatively or through regulatory processes.

[2] Longevity of savings is also closely related to other policy objectives, such as minimizing emissions of air pollutants.

that saves 100 therms per year for 20 years and costs $200 (i.e. $2.00 per unit of first year savings and $0.10 per unit of lifetime savings). All other things being equal, the low cost per unit of first year savings creates an incentive that encourages utilities to invest much more in the first measure even though the second measure provides five times as much value over its life.[3]

The Michigan Public Service Commission is keenly aware of this problem and has commissioned the Optimal team to help it assess alternatives to traditional first year savings goals. Using data from both DTE and Consumers Energy as well as some other states, this report provides several key pieces of information to help illuminate the issue:

1. 2012 Consumers Energy and DTE Efficiency Program Results:
   We look at the overall portfolio-wide average measure life for each utility's electric and gas portfolios to provide a sense of the most recent year's mix of shorter-term and longer-term measures and programs. In addition, we calculate the cost per unit of annual and lifetime energy savings for individual programs and rank the programs to see which are the most and least expensive from an annual and lifetime perspective.
2. 2013 – 2015 Consumers Energy and DTE Efficiency Program Plans:
   We examine the two utilities' previously filed plans, assessing which programs and which measures are expected to make the greatest contributions to the achievement of the utilities' goals for the period 2013 – 2015. This includes a comparison of future planned program mixes to the 2012 results to determine whether the mix of savings from longer-term and shorter-term measures is projected to change significantly for each utility over time.
3. Jurisdictional Comparison:
   We compare the average measure life of the Michigan utilities to those of utilities in several other jurisdictions, both in the Midwest and for a couple of nation-leading jurisdictions in New England to provide a sense of how the mix of short and long-term measures and programs of the two Michigan utilities compare to their peers.

Based on this analysis, we then describe a set of policy options for the Public Service Commission and other Michigan stakeholders to consider in order to reduce the bias to pursue savings that may be the most inexpensive from a first-year perspective, but not necessarily optimal in the longer-term.

Following this, we also explore another issue: whether savings goals are significantly more difficult for small cooperative and municipal utilities to achieve than for the larger investor-owned utilities. This analysis included reviewing current performance toward goals for all Michigan utilities, and analyzing whether performance appears to have a strong correlation with utility size and resources. We also considered the achievements of some small utilities outside of Michigan to inform this analysis.

[3] The factor of five is calculated without any discounting of future benefits. However, even if future benefits were discounted using a 5% real annual discount rate, the second measure would be far preferable, providing more than three times the lifetime benefits.

IMPACT OF FIRST-YEAR SAVINGS GOALS AND OPTIONS FOR CHANGING THEM

ANALYSIS OF 2012 DATA

DTE

The tables below show the data for annual and lifetime savings, as well as costs, for the DTE electric and gas efficiency programs.

Table 1: DTE 2012 Actual Electric Savings, Costs, $/MWh, and Rank in $/MWh by Program[4]

		Savings (MWh)			Program Cost/MWh			
Program	Average Measure Life	Annual	Lifetime	Program Cost	Annual	Rank	Lifetime	Rank
Residential								
HVAC	11.24	3,300	37,092	$1,000,000	$303	10	$27	8
Multifamily	9.42	10,900	102,678	$1,700,000	$156	7	$17	7
Administrative				$2,289,000				
Appliance Rec.	8.00	45,600	364,800	$4,400,000	$96	3	$12	6
Audit & Wx	9.63	17,700	170,451	$5,000,000	$282	8	$29	9
Low-Income	9.59	21,200	203,308	$6,200,000	$292	9	$30	10
ENERGY STAR	9.06	201,100	1,821,966	$12,100,000	$60	1	$7	1
Res. Subtotal	**9.01**	**299,800**	**2,700,295**	**$32,700,000**	**$109**		**$12**	
C&I								
Administrative				$2,216,000				
Non-Prescriptive	10.79	113,000	1,219,270	$13,400,000	$119	6	$11	5
Prescriptive	11.40	133,100	1,517,340	$12,200,000	$92	2	$8	2
C&I Subtotal	**11.09**	**246,100**	**2,729,249**	**$27,700,000**	**$113**		**$10**	
Ed. & Awareness	10.80	19,800	213,840	$2,200,000	$111	5	$10	4
Pilot Program	10.80	35,500	383,400	$3,900,000	$110	4	$10	3
TOTAL	**10.07**	**601,200**	**6,054,084**	**$69,700,000**	**$116**		**$12**	

[4] Energy Optimization 2012 Annual Report.

Table 2: DTE 2012 Actual Gas Savings (Thousand Mcf), Costs, $/Mcf, and Rank in $/Mcf by Program[5]

		Savings (Thousand Mcf)		Program Cost	Program Cost/Mcf			
Program	Average Measure Life	Annual	Lifetime		Annual	Rank	Lifetime	Rank
Residential								
ENERGY STAR	11.08	28.7	318	$300,000	$10.45	3	$0.94	4
Multifamily	15.61	49.1	766	$600,000	$12.22	4	$0.78	3
Low-Income	12.08	140.4	1,696	$6,000,000	$42.74	9	$3.54	9
Audit & Wx	15.11	200.8	3,034	$4,800,000	$23.90	7	$1.58	5
HVAC	15.06	225.3	3,393	$6,300,000	$27.96	8	$1.86	6
Administrative				$1,358,000				
Residential Subtotal	**14.29**	**644.4**	**9,208**	**$19,400,000**	**$30.11**		**$2.11**	
C&I								
C&I Non-Prescriptive	10.38	256.8	2,666	$1,800,000	$7.01	1	$0.68	1
C&I Prescriptive	10.62	464.4	4,932	$3,400,000	$7.32	2	$0.69	2
Administrative				$580,000				
C&I Subtotal	**10.53**	**721.2**	**7,598**	**$5,800,000**	**$8.04**		**$0.76**	
Education and Awareness	10.00	38.7	387	$800,000	$20.67	6	$2.07	8
Pilot Program	10.00	69.7	697	$1,400,000	$20.09	5	$2.01	7
TOTAL	**12.68**	**1,474**	**18,690**	**$28,600,000**	**$19.40**		**$1.53**	

At the program level, there does not appear to have been a dramatic difference between the ranking of electric or gas programs by dollars spent per unit of first year energy saved versus per unit of lifetime energy saved. Some programs exhibited a difference that is worth noting. For example, on the electric side, the Appliance Recycling Program was relatively inexpensive from a first-year savings perspective (rank = #3) but was more expensive from a lifetime perspective (rank = #6). The eight-year measure life is the shortest of any of the electric programs. This indicates that while the immediate savings that resulted from investing in this program may have been significant, the total long-term savings from these investments were relatively smaller. Similarly, on the gas side, the HVAC program moved up in the rankings when considered from a longer-term perspective. This program ranked near the bottom from a first-year perspective (rank = #8), but moves closer to the middle of the pack from a lifetime perspective (rank = #6) because of its relatively long measure life (15.06 years). However, the rankings of most other programs did not change much when comparing costs per unit of first year savings vs. costs per unit of lifetime savings. Put another way, most of the programs that

[5] Energy Optimization 2012 Annual Report.

were least expensive in terms of achieving first-year savings were also the least expensive for achieving longer-term (lifetime) savings.

That is not a surprising result when one considers that the range in average measure lives across the two program portfolios was relatively narrow (all electric programs have average lives between 8 and 11.4 years; all gas programs have lives between 10 and 15.6 years). However, as discussed further below, the range in measure lives across the utility's program portfolio can be expected to be more diverse in 2013 and beyond. The introduction of the residential behavior program with a measure life of just one year, by itself, significantly changes the range of average program lives.

Further, though not reflected in the DTE's plans, the reality of 2020 EISA lighting efficiency requirements effectively means that no new CFL installation will produce savings beyond 2020.[6] That means that though DTE's recent plan assumes CFLs will have a 9 year life regardless of the year in which they are installed, its 2013 program will produce savings for only 7 years, its 2014 program for only 6 years and its 2015 program for only 5 years. On the other end of the spectrum, the Michigan Efficiency Measures Database (MEMD) has measures life assumptions of just 20 years for measures like insulation which can remain unchanged in buildings for far longer periods. Many other jurisdictions assume at least a 25 or 30 year life for such measures. Shortening the lives of CFLs installed in future years, and increasing the lives of other long-lived measures for which such increases would be appropriate, could also start to affect the calculus of which programs in future years provide the biggest lifetime savings per dollar invested.

It is also important to understand that many of the programs listed in Tables 1 and 2 promote a wide variety of efficiency measures. Thus, it is possible that the current focus on first year savings might have led to the inclusion of substantial savings from some very short lived measures in some programs that dramatically reduces the overall weighted average program measure life. If this was the case, shifting just those few measures to longer lived measures could result in significant shifts in program rankings that are obscured by the more aggregated data. Given available data for 2012, we have not been able to tease out any such potential issues.

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[6] CFL savings estimates are predicated on the assumption that they replace either incandescent or halogen lamps which have much shorter lives (typically on the order of 1 year) than CFLs (assumed in the MEMD to be 9 years). The 9 year savings life assumptions for CFLs implicitly assumes that had the incandescent or halogen not been replaced by a CFL, that the customer would have replaced burned out incandescent or halogen lamps with new incandescents or halogens for the next nine years. However, by 2020, when much more stringent lighting efficiency standards go into effect, the baseline scenario could no longer be continued replacement with incandescent or halogen lamps. Instead, most experts believe that they would have to purchase a CFL (or perhaps and LED) at that time. Thus, if incandescent or halogen lamps last only about a year, the measure life of a CFL cannot be longer than the period between when the CFL is installed and 2020 (or perhaps 2021 if one wanted to make assumptions about stockpiling of products before the new lighting standards go into effect).

Consumers Energy

The tables below show the data for annual and lifetime savings, as well as costs, for Consumers Energy's electric and gas efficiency programs.

Table 3: CE 2012 Actual Electric Savings, Costs, $/MWh, and Rank in $/MWh by Program[7]

Program	Average Measure Life	Savings (MWh) Annual	Savings (MWh) Lifetime	Program Cost	Cost/MWh Annual	Rank	Cost/MWh Lifetime	Rank
Residential								
ENERGY STAR Lighting	9.01	78,996	711,487	$6,203,651	$79	1	$9	1
ENERGY STAR Appliances	11.32	1,447	16,382	$277,610	$192	6	$17	6
HVAC and Water Heating	13.73	5,284	72,559	$2,179,519	$412	8	$30	8
Income Qualified	9.75	3,677	35,866	$1,563,654	$425	9	$44	9
Appliance Recycling	8.04	40,269	323,579	$4,153,407	$103	2	$13	5
Multifamily	9.74	6,127	59,700	$2,824,536	$461	10	$47	11
Think! Energy	9.64	2,244	21,631	$589,873	$263	7	$27	7
HP with ENERGY STAR	13.38	1,707	22,843	$3,537,620	$2,072	13	$155	13
Home Energy Analysis	9.14	4,852	44,362	$3,150,029	$649	11	$71	12
New Home Construction	17.39	179	3,121	$147,390	$821	12	$47	10
Residential Subtotal	**9.06**	**144,782**	**1,311,529**	**$24,627,289**	**$170**		**$19**	
C&I								
Comp. & Custom Bus. Solutions	12.12	145,367	1,761,853	$20,637,393	$142	5	$12	2
Small Business Direct Install	10.04	75,651	759,541	$9,508,822	$126	3	$13	4
Bus Multifamily Direct Install	10.67	5,365	57,240	$698,162	$130	4	$12	3
C&I Subtotal	**11.46**	**226,384**	**2,594,355**	**$30,844,377**	**$136**		**$12**	
TOTAL	**10.52**	**371,166**	**3,905,884**	**$55,471,666**	**$149**		**$14**	

[7] Residential Savings and Measure Lives: Cadmus, "Residential Energy Optimization Certification Report: 2012 Program Year." C&I Savings and Measure Lives: Correspondence from Benjamin M. Ruhl, August 2, 2013. Costs: Consumers Energy: 2012 Energy Optimization Annual Report.

Table 4: CE 2012 Actual Gas Savings (Thousand Mcf), Costs, $/Mcf, and Rank in $/Mcf by Program[8]

Program	Average Measure Life	Savings (Thousand Mcf) Annual	Savings (Thousand Mcf) Lifetime	Program Cost	Cost/Mcf Annual	Rank	Cost/Mcf Lifetime	Rank
Residential								
ENERGY STAR Appliances	11.46	47.5	545	$243,367	$5.12	2	$0.45	2
HVAC and Water Heating	13.44	363.3	4,882	$8,164,392	$22.47	7	$1.67	6
Income Qualified	9.28	180.7	1,676	$10,463,836	$57.91	11	$6.24	11
Multifamily	9.81	230.3	2,258	$2,547,681	$11.06	4	$1.13	4
Think! Energy	12.00	50.9	610	$1,056,603	$20.77	6	$1.73	7
HP with ENERGY STAR	16.2	141.7	2,295	$6,087,006	$42.96	9	$2.65	10
Home Energy Analysis	10.26	109.3	1,122	$1,491,359	$13.64	5	$1.33	5
New Home Construction	18.68	8.5	158	$394,265	$46.63	10	$2.50	9
Residential Subtotal	**11.97**	**1,132.2**	**13,547**	**$30,448,509**	**$26.89**		**$2.25**	
C&I								
Comp. & Custom Bus Solutions	15.14	556.6	7,638	$6,054,667	$10.88	3	$0.79	3
Small Business Direct Install	9.43	475.9	4,383	$1,889,574	$3.97	1	$0.43	1
Bus Multifamily Direct Install	12.05	64.2	775	$1,506,954	$23.48	8	$1.95	8
C&I Subtotal	**11.67**	**1,096.6**	**12,796**	**$9,451,195**	$8.62		$0.74	
TOTAL	**11.82**	**2,228.8**	**26,343**	**$39,899,704**	**$17.90**		**$1.52**	

As was the case for DTE, there does not appear to have been a dramatic difference between the ranking of most electric or gas programs by dollars spent per unit of first year energy saved versus per unit of lifetime energy saved. There was one exception. Specifically, on the electric side, the Appliance Recycling Program was relatively inexpensive from a first-year savings perspective (rank = #2) but was more expensive from a lifetime perspective (rank = #5). The eight-year measure life is the shortest of any of the electric programs. This indicates that while the immediate savings that resulted from investing in this program may have been significant, the total long-term savings from these investments are relatively smaller. However, the rankings of most other programs did not change appreciably when comparing costs per unit of first year savings vs. costs per unit of lifetime savings. Put another way, most of the programs that were least expensive in terms of achieving first-year savings were also the least expensive for achieving longer-term (lifetime) savings.

Again, that is not a surprising result when one considers that, as was the case with DTE in 2012, the range in average measure lives across the two program portfolios was relatively

[8] Residential Savings and Measure Lives: Cadmus, "Residential Energy Optimization Certification Report: 2012 Program Year." C&I Savings and Measure Lives: Correspondence from Benjamin M. Ruhl, August 2, 2013. Costs: Consumers Energy: 2012 Energy Optimization Annual Report.

narrow. However, as mentioned above and discussed further below, the range in measure lives across the utility's program portfolio can be expected to grow in 2013 and beyond.

Further, though not reflected in Consumers' plans, the reality of 2020 EISA lighting efficiency requirements effectively means that no new CFL installation will produce savings beyond 2020.[9] That means that though Consumers' recent plan assumes CFLs will have a 9 year life regardless of the year in which they are installed, its 2013 program will produce savings for only 7 years, its 2014 program for only 6 years and its 2015 program for only 5 years. On the other end of the spectrum, the Michigan Efficiency Measures Database (MEMD) has measures life assumptions of just 20 years for measures like insulation which can remain unchanged in buildings for far longer periods. Many other jurisdictions assume at least a 25 or 30 year life for such measures. Shortening the lives of CFLs installed in future years, and increasing the lives of other long-lived measures for which such increases would be appropriate, could also start to affect the calculus of which programs in future years provide the biggest lifetime savings per dollar invested.

Again, as noted above, it is also important to understand that many of the programs listed in Tables 1 and 2 promote a wide variety of efficiency measures. Put another way, the average program measure life can mask significant differences between the lives of savings within the program. Given available data for 2012, we have not been able to tease out any such potential issues.

[9] CFL savings estimates are predicated on the assumption that they replace either incandescent or halogen lamps which have much shorter lives (typically on the order of 1 year) than CFLs (assumed in the MEMD to be 9 years). The 9 year savings life assumptions for CFLs implicitly assumes that had the incandescent or halogen not been replaced by a CFL, that the customer would have replaced burned out incandescent or halogen lamps with new incandescents or halogens for the next nine years. However, by 2020, when much more stringent lighting efficiency standards go into effect, the baseline scenario could no longer be continued replacement with incandescent or halogen lamps. Instead, most experts believe that they would have to purchase a CFL (or perhaps and LED) at that time. Thus, if incandescent or halogen lamps last only about a year, the measure life of a CFL cannot be longer than the period between when the CFL is installed and 2020 (or perhaps 2021 if one wanted to make assumptions about stockpiling of products before the new lighting standards go into effect).

2013 – 2015 FORECAST TRENDS

In this section we present the results of our analysis of the two utilities' forecast savings for 2013 to 2015. It should be noted that we have not verified that the assumptions used by the utilities in their forecasts are accurate or consistent with the Michigan Efficiency Measures Database (MEMD).[10]

DTE

In 2012, DTE filed an update to its 2012-2015 electric DSM plan. In the table below we present the forecast 2013 savings mix by program.

[10] We make this point in part because in reviewing Consumers' forecast savings by measure for 2013 through 2015 we noted that the forecast appeared to assume that most gas measures in its home retrofit program had a life of only 10 years. That is clearly too short for many measures, particularly insulation measures. This is the only example of a case in which we noticed something that appeared significantly "off". However, as noted, we did not attempt to conduct a thorough review of all assumptions in the measure-level forecast.

Table 5: DTE 2013 Forecast Electric Savings, Costs, $/MWh, and Rank in $/MWh by Program[11]

Program	Average Meas. Life	Savings (MWh) Annual	Savings (MWh) Lifetime	Program Cost	Program Cost/MWh Annual	Rank	Program Cost/MWh Lifetime	Rank
Residential								
Res. ENERGY STAR Products	8.8	143,956	1,261,815	$12,426,000	$86	2	$10	3
Appliance Recycling	8.0	34,687	277,496	$4,961,000	$143	8	$18	9
HVAC	15.0	2,526	37,973	$1,221,000	$483	17	$32	12
Multifamily	8.9	4,818	42,770	$1,479,000	$307	13	$35	13
Home Energy Consultation	9.1	8,247	75,183	$3,216,000	$390	15	$43	16
Audit and Weatherization	16.6	140	2,324	$469,000	$3,350	18	$202	18
School Program	9.0	2,735	24,615	$463,000	$169	11	$19	10
Behavior Programs	1.0	23,106	23,106	$2,229,000	$96	3	$96	17
Emerg. Meas. & Approaches	15.0	143	2,145	$910,000	$6,364	19	$424	19
Admin. & Infrastructure				$1,728,000				
Residential Subtotal	**7.9**	**220,358**	**1,746,209**	**$29,102,000**	**$132**		**$17**	
Low Income								
LI-Nonprofit	12.4	8,154	101,319	$3,835,000	$470	16	$38	14
LI-MF	8.9	2,405	21,349	$664,000	$276	12	$31	11
LI-HEC	9.1	6,109	55,692	$2,144,000	$351	14	$38	15
LI -Admin & Infrastructure				$677,000				
Low Income Subtotal	**10.7**	**16,668**	**178,016**	**$7,321,000**	**$439**		**$41**	
Commercial & Industrial (C&I)								
Prescriptive	11.8	108,903	1,283,651	$12,168,000	$112	4	$9	2
Non-Prescriptive	10.0	81,837	820,461	$13,580,000	$166	10	$17	8
Emerging Meas. & Approaches	10.0	5,286	52,860	$834,000	$158	9	$16	7
Energy Star Retail Lighting	2.0	28,214	56,428	$481,000	$17	1	$9	1
Multifamily Common Areas	10.3	5,482	56,280	$737,000	$134	7	$13	6
Admin. & Infrastructure				$1,655,000				
C&I Subtotal	**9.7**	**229,722**	**2,235,958**	**$29,455,000**	**$128**		**$13**	
Other Programs and Costs								
Pilot Program	10.0	25,968	259,680	$3,265,000	$126	6	$13	5
Education Program	10.0	15,581	155,810	$1,786,000	$115	5	$11	4
EM&V				$3,425,000				
Admin. & Infrastructure				$1,447,000				
Other Prog. & Costs Subtotal	**10.0**	**41,549**	**415,490**	**$9,923,000**	**$239**		**$24**	
TOTAL	**9.0**	**508,297**	**4,575,673**	**75,801,000**	**$149**		**$17**	

[11] Costs and annual savings: Docket Number U-17049, Exhibit A-4 of witness V.M. Campbell. Lifetime savings and average measure lives based on measure level data provided in an Excel spreadsheet by DTE in response to NRDC/DE-6 in U-17049.

The average measure life of DTE's efficiency portfolio savings is forecast to be about 10% lower in the 2013 than it was in 2012. Three factors appear to drive this change. The first is the addition of a full scale residential behavior program (O Power) which is forecast to provide about 4% of total first year saving, but with a savings life of just one year. The second is the addition of a C&I retail lighting program which is forecast to provide approximately 5% of total first years savings, but with a savings life of just two years. As Table 5 shows, the addition of these two programs illustrates how the relative rank of a program in cost per first year savings can be very different than the rank in terms of cost per lifetime savings. Finally, DTE has estimated that an average measure life of 10 years for the 2013 C&I non-prescriptive program – a little lower than the nearly 10.8 year average life experienced in 2012. This could be a result of choices to include more short-lived measures encouraged by the current goals structure, but that would require more detailed analysis at the measure level to confirm.

In general, the mix of savings forecast by DTE for 2014 and 2015 is very similar to the mix shown above for 2013. As a result, the average measure life for the portfolio of savings is forecast by DTE to be very similar (only very slightly higher) in 2014 and 2015 to what it is forecast to be for 2012. The four year trend in average measure life from 2012 through 2015 is provided in the table below.

Table 6: DTE Portfolio-Level Electric Average Measure Life, 2012 - 2015

Year	2012	2013	2014	2015
Average Life	10.1	9.0	9.2	9.2

As noted above, some similarities in the ranking of efficiency programs by cost per unit of first year savings and cost per unit of lifetime savings may mask significant differences between measures within programs. In other words, the effect of articulating goals as lifetime savings rather than as first year savings may be even greater than suggested by the program comparisons provided above. We have not conducted an exhaustive assessment of the potential impacts at the measure level. However, to gain some insight into that issue we did look at how the ranking of measures within DTE's C&I Prescriptive program forecast for 2013 (in terms of rebate cost per unit of savings) changed when moving from a focus on first year savings to a focus on annual savings. Table 7 shows 12 program measures whose rank changed by more than 50% (in either direction) when shifting from a rebate per first year savings metric to a rebate per lifetime savings metric. Some changed quite substantially. For example, high performance glazing was the 81st cheapest measure in terms of rebate cost per first year kWh saved, but 33rd cheapest per lifetime kWh saved.[12] If the assumed life for this measure was increased to 30 years (20 seems conservative, at least for some types of commercial buildings), it would move into the top 15 measures in terms of cost per lifetime kWh. At the other end of the spectrum, low watt T8 lamps, which rank 14th and 15th per first year kWh, rank 73rd and 74th per lifetime kWh. These examples illustrate why it may be plausible that the utilities would

[12] There were 117 C&I Prescriptive program measures analyzed in DTE's most recent EO plan. Some of the measures are simply different variations (by size, applicable market, applicable baseline condition, etc.) of the same technology. Thus, the number of measure types is considerably smaller.

consider not only changing their emphasis on different programs if a lifetime savings goal was adopted, but also consider changing emphasis on different measures within programs.

Table 7: Selected DTE Forecast 2013 C&I Prescriptive Program Measure Rankings (Incentive $/kWh)

Measure	Measure Life	Incentives $ per kWh Saved		Measure Rank (out of 117)	
		1st Year	Lifetime	1st Year	Lifetime
Barrel Wraps Inj Mold and Extruders	5	0.0222	0.0044	4	13
Low Watt T8 lamps	5	0.0556	0.0111	14	73
LW T8 U-Lamp, replacing Standard T8	5	0.0556	0.0111	15	74
Anti Sweat Heater Control	15	0.0597	0.0040	22	9
ECM Motors for Walk-in Refrigeration Cases	15	0.0651	0.0043	24	12
LED Exit Signs Electronic Fixtures (Retrofit Only)	15	0.0691	0.0046	26	16
LED Refrigerated Case Lighting	16	0.0725	0.0045	31	14
Motors 1 to 5 HP	15	0.0736	0.0049	33	19
LED Auto Traffic Signals	6	0.0808	0.0135	35	81
Night Covers (vertical)	5	0.0831	0.0166	42	87
LED recessed down light - ENERGY STAR qualified	15	0.0855	0.0057	45	29
High Performance Glazing CI E	20	0.1333	0.0067	81	33

Consumers Energy

In 2011, Consumers filed its plan for 2012 through 2015. In the tables below we present the forecast 2013 savings mix by program.

Table 8: CE 2013 Forecast Electric Savings, Costs, $/MWh, and Rank in $/MWh by Program[13]

Program	Average Measure Life	Savings (MWh) Annual	Savings (MWh) Lifetime	Program Cost	Program Cost/MWh Annual	Rank	Program Cost/MWh Lifetime	Rank
Residential								
Appliance Recycling	8.2	43,840	357,905	$3,908,231	$89	2	$11	3
Energy Education	9.0	1,846	16,614	$595,197	$322	8	$36	8
Multifamily Direct Install	9.1	5,758	52,285	$3,792,197	$659	10	$73	11
Energy Star Appliances	10.2	877	8,965	$407,277	$464	9	$45	9
Energy Star Lighting	9.0	59,439	535,061	$4,823,220	$81	1	$9	1
HVAC and Water Heating	10.5	4,842	50,983	$3,570,035	$737	11	$70	10
Inc. Qualified Assistance	8.8	1,540	13,481	$1,520,858	$988	12	$113	12
New Construction	13.0	101	1,313	$242,808	$2,404	13	$185	13
Existing Home Retrofit	9.2	21,251	196,071	$5,418,296	$255	6	$28	7
Residential Pilots	10.0	6,322	63,220	$1,456,285	$230	5	$23	6
Residential Subtotal	**8.9**	**145,816**	**1,295,899**	**$25,734,403**	**$176**		**$20**	
Business				$0				
Custom & Prescriptive	12.5	210,142	2,621,193	$23,918,655	$114	3	$9	2
Small Bus. Direct Install	12.1	31,110	374,876	$8,280,094	$266	7	$22	5
Business Pilots	11.0	10,536	115,896	$1,855,571	$176	4	$16	4
Business Subtotal	**12.4**	**251,788**	**3,111,965**	**$34,054,320**	**$135**		**$11**	
TOTAL	**11.1**	**397,604**	**4,407,864**	**$59,788,724**	**$150**		**$14**	

[13] Costs and annual savings: Consumers Energy 2012-2015 Amended Energy Optimization Plan. Lifetime savings and average measure lives based on measure level data provided by Consumers in response to NRDC data request #23 in MPSC Case No. U-16670.

Table 9: CE 2013 Forecast Gas Savings (Thousand Mcf), Costs, $/Mcf, and Rank in $/Mcf by Program[14]

Program	Average Measure Life	Savings (Thousand Mcf) Annual	Savings (Thousand Mcf) Lifetime	Program Cost	Program Cost/Mcf Annual	Rank	Program Cost/Mcf Lifetime	Rank
Residential								
Appliance Recycling	10.0	17.3	173	$99,019	$5.72	2	$0.57	3
Energy Education	12.0	31.8	381	$980,712	$30.88	10	$2.57	11
Multifamily Direct Install	12.3	272.2	3,337	$2,316,511	$8.51	4	$0.69	4
Energy Star Appliances	12.0	95.9	1,148	$204,233	$2.13	1	$0.18	1
HVAC and Water Heating	15.8	423.4	6,686	$9,272,221	$21.90	7	$1.39	7
Inc. Qualified Assistance	12.9	64.4	831	$9,928,667	$154.25	12	$11.95	12
New Construction	13.0	6.4	83	$249,380	$39.12	11	$3.01	10
Existing Home Retrofit	10.6	274.5	2,910	$6,036,507	$21.99	8	$2.08	8
Residential Pilots	10.0	58.7	587	$1,687,544	$28.77	9	$2.88	9
Residential Subtotal	**13.0**	**1,244.5**	**16,136**	**$30,840,072**	**$24.78**		$1.91	
Business								
Custom & Prescriptive	12.3	728.1	8,920	$8,737,465	$12.00	5	$0.98	5
Small Bus. Direct Install	8.9	127.5	1,133	$1,046,694	$8.21	3	$0.92	2
Business Pilots	11.0	33.4	368	$579,638	$17.33	6	$1.58	6
Business Subtotal	**11.7**	**889.1**	10,421	**$10,363,797**	**$11.66**		**$1.00**	
TOTAL	**12.4**	**2,133.6**	**26,556**	**$41,203,868**	**$19.31**		**$1.55**	

In general, the mix of savings forecast by Consumers for 2014 and 2015 is very similar to the mix shown above for 2013. As a result, the average measure life for the portfolio of savings is forecast by Consumers to be nearly identical in 2014 and 2015 to what it is forecast to be for 2013. The four year trend in average measure life from 2012 through 2015 is provided in the tables below. For both electricity and gas it appears as if Consumers' is projecting that average measure lives will increase modestly over 2012 levels.

[14] Costs and annual savings: Consumers Energy 2012-2015 Amended Energy Optimization Plan. Lifetime savings and average measure lives based on measure level data provided by Consumers in response to NRDC data request #23 in MPSC Case No. U-16670.

Table 10: CE Portfolio-Level Electric Average Measure Life, 2012 - 2015

Year	2012	2013	2014	2015
Average Life	10.5	11.1	11.1	11.1

Table 11: CE Portfolio-Level Gas Average Measure Life, 2012 - 2015

Year	2012	2013	2014	2015
Average Life	11.8	12.4	12.3	12.2

As noted above, some similarities in the ranking of efficiency programs by cost per unit of first year savings and cost per unit of lifetime savings may mask significant differences between measures within programs. In other words, the effect of articulating goals as lifetime savings rather than as first year savings may be even greater than suggested by the program comparisons provided above. We have not conducted an exhaustive assessment of the potential impacts at the measure level. However, to gain some insight into that issue we did look at how the ranking of measures within CE's C&I Prescriptive program forecast for 2013 (in terms of rebate cost per unit of savings) changed when moving from a focus on first year savings to a focus on annual savings. Table 12 shows 12 program measures whose rank changed by more than 50% (in either direction) when shifting from a rebate per first year savings metric to a rebate per lifetime savings metric. Some changed quite substantially. For example, specialty CFLs were the 5th cheapest measure in terms of rebate cost per first year kWh saved, but 41st cheapest (out of 49 measures) per lifetime kWh saved.[15] These examples illustrate why it may be plausible that the utilities would consider not only changing their emphasis on different programs if a lifetime savings goal was adopted, but also consider changing emphasis on different measures within programs.

[15] There were 117 C&I Presciptive program measures analyzed in DTE's most recent EO plan. Some of the measures are simply different variations (by size, applicable market, applicable baseline condition, etc.) of the same technology. Thus, the number of measure types is considerably smaller.

Table 12: Selected CE Forecast 2013 C&I Prescriptive Program Measure Rankings (Incentive $/kWh)

Measure	Measure Life	Incentive $ per kWh Saved		Measure Rank (out of 49)	
		1st Year	Lifetime	1st Year	Lifetime
CFL Screw in (30 watts or less) P - 2013	2	0.0104	0.0052	2	11
Compact Fluorescents: Screw-in, 31-115 W	2	0.0177	0.0089	3	23
4-foot Standard T8 to Reduced Wattage T8 (lamp only)	12	0.0358	0.0030	4	2
CFL Specialty (down-light, 3-way, dimmable)	2	0.0404	0.0202	5	41
VFD on HVAC Fans and Pumps	15	0.0542	0.0036	6	3
Network Power Management Software	5	0.0565	0.0113	7	31
Recessed Downlight Fixture (LED)	15	0.0570	0.0038	8	4
Anti Sweat Heater Controls	15	0.0597	0.0040	10	5
VFD for Process Pumping, <= 50 HP	15	0.0620	0.0041	11	6
Demand Control Ventilation - Electric Customers	15	0.0643	0.0043	13	7
Demand Control Ventilation - Combination Customers	15	0.0648	0.0043	14	8
LED, T-1, or Electroluminescent Exit Signs	15	0.0689	0.0046	16	9

JURISDICTIONAL COMPARISON

In the table below we provide a comparison between the 2012 actual and 2013 to 2015 forecast average electric efficiency portfolio savings life for DTE, Consumers and several other efficiency program administrators in New England and the Midwest. It should be noted that it is not always very easy to obtain such information because it is not commonly reported. Indeed, we do not have sufficient data from other jurisdictions to present a comparable table for gas efficiency program portfolios. This underscores the reality that Michigan's historic focus on first year savings is not unique to the state or even its region.

Table 73: Electric Average Measure Lives in Various Jurisdictions

Program Administrator	Source	2012	2013	2014	2015
DTE	2012 Actuals, 2013-15 Plan	10.1	8.8	9.0	9.0
Consumers Energy	2012 Actuals, 2013-15 Plan	10.5	11.1	11.1	11.1
Efficiency Vermont[16]	2012 Actuals	11.2	n.a.	n.a.	n.a.
NSTAR (MA)[17]	2012 Actuals	11.7	n.a.	n.a.	n.a.
Commonwealth Edison (IL) [18]	PY4-PY6 Plan 6/2011 to 5/2014)	8.6	n.a.		
Focus on Energy (WI)[19]	2012 Actuals	11.0	n.a.	n.a.	n.a.

Average measures lives for the six program administrators for which we've acquired data range from a little less than 9 years to a little more than 12 years. DTE's forecast average measure life for 2013 to 2015 is at the low end of that range and notably about 20% lower than Consumers' average for the same time period. Consumers' average life appears to be consistent with most of the others. However, it should be emphasized that average measure life calculations for portfolios of efficiency programs are necessarily a function of assumptions used for the savings lives of many different efficiency measures. While Consumers and DTE presumably use the same MEMD assumptions, some of the differences between their average portfolio savings lives and those of program administrators in other jurisdictions might be a function of different assumptions for the same measures. As discussed above, there are examples in the MEMD of measure life assumptions which appear to be conservatively low (e.g. insulation measures) as well as examples that appear to be high (e.g. CFLs). We recommend that these and perhaps some other lifetime assumptions in the MEMD be re-examined, particularly if Michigan policies begin placing more emphasis on lifetime savings.

OPTIONS FOR REMOVING BIAS TO PURSUE CHEAP SHORT-LIVED SAVINGS

Ultimately, there are two policy "levers" for addressing these perverse incentives to pursue short-term savings that are inherent in goals articulated as first year savings. The first is to redefine savings goals in a way that encourages greater consideration of the lifetime benefits of efficiency measures. The second is to establish shareholder incentive metrics that do the same thing. In general, we believe both should be changed, starting with the goals themselves because they are the root of the problem. If the goals are unchanged (i.e. remain articulated as first year savings) and utilities are provided shareholder incentives that are based on some measure of lifetime savings or benefits, they will perceive themselves as being in the position of having to meet two different, sometimes competing, objectives. That would likely lead to some

[16] Efficiency Vermont 2012 Savings Claim Summary.

[17] Northeast Utilities (parent of NSTAR), "Energy Efficiency Programs," http://www.nu.com/responsible_energy/our-business/energy-efficiency-programs.html.

[18] Based on lifetime savings data over the PY4 to PY6 plan period provided by Com Ed in a personal communication. Lifetime savings were divided by annual savings for the same plan period as filed by Com Ed in Illinois Docket Number 10-0570.

[19] The Cadmus Group, Focus on Energy Calendar Year 2012 Evaluation Report, Volume 1; April 30, 2013.

improvement in outcomes (i.e. more investment in long-live savings), but not as much as if the fundamental goals were corrected or changed.

There are several different ways to adjust savings goals so that they better encourage utilities to maximize the lifetime benefits of efficiency programs. What follows is a discussion of the following options:

1. Lifetime savings goals
2. Discounted lifetime savings goals
3. Net present value of net benefits
4. Cumulative annual savings goals over a multi-year period
5. 1st year savings goals with limits on quantity of savings from short-lived measures
6. 1st year savings goals with bonuses/penalties for long/short-lived measures
7. 1st year savings goal with average measure life adjustment factor

Lifetime Savings

Under a lifetime savings goal, program administrators' performance would be measured relative to the total savings they produce over the life of the efficiency measures that they cause to have installed. For example, if a furnace saves 100 therms of gas per year for 20 years, then the lifetime savings for that measure would be 2000 therms.

The advantages of this metric of performance are that it is conceptually easy to explain and understand, simple to calculate using data that program administrators already routinely collect and evaluate (all TRMs have both annual savings and measure life as key components), and clearly values all of the savings that efficiency measures will produce over their lives. It also preserves utility flexibility in being able to choose a balanced portfolio that can support short-lived measures as well, if appropriate, so long as they have a plan that meets the overall target.

Depending on one's perspective, there is one *potential* disadvantage to this metric: it treats savings 10 or 20 years from now as just as valuable as savings this year. Put another way, it does not discount the value of future years' savings. Thus, while it fixes the problem that first year savings goals have of not valuing future years' savings at all, relative to the net present value calculation that is typically used for cost-effectiveness screening, a lifetime savings goal *may* sometimes over-value future years' benefits. We say sometimes "*may*" rather than "*will*" because the avoided costs used to value savings can also change over time and are often higher in the long term than in the short term. If avoided costs are increasing at roughly the same annual rate as the discount rate, a lifetime savings metric would be a very good proxy for the economic benefits of efficiency investments.

The Canadian province of Ontario began using lifetime savings in 2012 as its principal metric for measuring the effectiveness of its two gas utilities' efficiency program performance. The Wisconsin Focus on Energy program switched to goals expressed as lifetime savings in 2013.

Discounted Lifetime Savings

Discounted lifetime savings is the same as the lifetime savings metric except that a real discount rate (i.e. excluding inflationary effects) is applied to future year savings so that the farther out in time you go the less value is attached to each year's worth of savings. For example, using a 5% real discount rate, an efficient furnace that saved 100 therms/year for 20 years would have a discounted lifetime value of 1309 therms.[20]

As with the lifetime savings metric discussed above, this metric clearly values all of the savings that efficiency measures will produce over their lives rather than just the first year of savings. One *potential* additional advantage of this metric *could* be a better reflection of the economic value of the savings because savings that will occur many years out in the future would be valued less than those that occur in the near term. Economists – and most consumers – value a dollar today more than a dollar they will receive next year and value a dollar they will receive next year more than a dollar they will receive in ten years. However, it is important to remember that savings are not necessarily the same as dollars. Their value is a function of *both* how far out in the future they will occur and what the utility's avoided costs are in future years. Changes in forecast avoided costs over time could potentially offset (or even more than offset) the effects of discounting, so discounting will not necessarily lead to more accurate valuing of future year savings.

One major disadvantage of using discounted lifetime saving is that it is complicated. It would require additional development of discounting factors for every different possible measure life (i.e. rather than just multiplying annual savings by measure life to obtain lifetime savings, you must also multiply that product by a discounting factor that is a function of measure life and discount rate). Further, those discounting factors could change over time as the real discount rate changes.[21] They may also be different even between utilities in the same state, making comparisons of performance difficult. Another important disadvantage is that it is difficult to explain and understand. Finally, as discussed above, depending on how avoided costs change over time, discounted lifetime savings may not be a more accurate reflection of the lifecycle value of efficiency than undiscounted lifetime savings. Many experts believe that concerns about climate change are likely to make efficiency savings in the longer term even more important than today, and that additional costs not fully captured now in avoided costs will likely be imposed (e.g., a carbon tax). This would also lead one to consider not discounting physical units of future savings as inappropriately discounting efficiency resources that may actually be worth more in the future than current models suggest.

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[20] Using a 5% discount rate, 1 unit of savings is worth 13.09 units over 20 years, 10.90 units over 15 years, 8.11 units over 10 years and 4.55 units over 5 years.

[21] A utility's cost of capital is often used as a nominal discount rate. However, that can change over time – as can the inflation rate which needs to be subtracted from it to produce a real discount rate.

We are not aware of any jurisdiction that uses discounted lifetime savings as a performance target.

Net Present Value of Net Benefits

In one sense, the best way to ensure that savings from both short and long-lived measures are valued in proportion to the benefits that they provide is to base goals on the computation of net economic benefits. Such calculations are routinely performed in most jurisdictions to justify programs during the planning process and to retrospectively assess the benefits that were actually achieved.

The obvious advantage of this approach is that it adjusts not only for the live of the savings, but also for the value to the system of savings in different years, the value of savings during different seasons and times of day, and for the cost of acquiring the savings.

However, there are a variety of disadvantages of using this approach to set high level goals. First, the very attributes that ensure that it provides exactly the right weighting to different measures also ensure that it would be complex to administer, with the potential for significant disagreements over not only annual savings levels and measures lives, but also avoided costs, load shapes, measure costs, etc. That can add significantly to annual savings verification processes. Second, it is unclear how to objectively set economic benefits targets without extensive analysis. There is a wealth of information on how difficult different levels of first year savings are to achieve from numerous states. There is almost as much information regarding typical portfolio average measure lives. Both sets of insights are largely transferable from one jurisdiction to the next. There is much less information about what it takes to achieve $100 million in net benefits. Moreover, because of significant variations in avoided costs, any such information could be difficult to transfer from one jurisdiction to another. Third, the key variable of avoided costs can differ between utilities in the same state and change non-trivially from year to year. That makes it difficult to benchmark and adopt a single metric for an entire jurisdiction, to determine appropriate goals for more than a year or two at a time, or to assess trends in performance over time. We believe this is problematic because, while in theory goals based on net benefits can be adjusted annually whenever avoided costs change, and adjusted between utilities with differing avoided costs, we believe this would add unnecessary transactional costs and analyses, and reduce the overall transparency of the Michigan efficiency efforts and direct comparability between utility performance.

The province of Ontario used to use TRC net benefits as the principal performance metric for its gas portfolio, but switched to lifetime savings in 2012 in large part because of direct experience with the concerns articulated above. Some other jurisdictions (e.g. Connecticut, Massachusetts and Vermont) have net or gross economic benefits as one of the metrics used to judge program administrators' performance, but our experience has been that those metrics are usually established by first setting a 1st year savings target, determining how that target is likely to be met or could be met with an acceptable mix of programs, and then calculating the economic benefits that mix of programs would produce. In other words, such goals are usually driven primarily by first year savings goals rather than developed independently.

Cumulative Annual Savings over Multi-Year Period

Under a cumulative annual savings goal, an efficiency program administrator would be measured relative to the annual savings that are still being realized in the final year of a multi-year period. For example, if a program administrator caused one efficient furnace that produced 100 therms of savings for 20 years to be installed in each of the five years of a program (five furnaces total), then the cumulative annual savings in year 5 would be 500 therms. On the other hand, if a program designed to influence efficiency or conservation behavior produced 10 therms of savings that lasted only one year, after five years of implementation of the program the cumulative annual savings would still only be 10 therms because only the savings produced in year 5 would still be in effect in year 5 (savings produced from the program in years 1, 2, 3 and 4 would have ended).

The principal advantage of this type of metric is that it discounts the savings produced in the early years of a multi-year period by measures with very short lives.[22] An additional side benefit – not associated with trying to promote long-lived measures – is that multi-year goals offer program administrators greater flexibility in designing and managing their efficiency programs.

However, there are a number of disadvantages with regard to addressing the lifecycle benefits of efficiency measures. First, the metric will not make any distinction between the value of measures with moderate lives and the value of those with long or very long lives. Most jurisdictions are unlikely to establish goals over multi-year periods of more than five years. Thus, even for measures implemented in the first year of a multi-year period, there would be no difference in value assigned to measures with lives of 5 years relative to measures that will produce savings for 10, 20 or 30 years. Moreover, as you progress through a multi-year period the cumulative annual savings metric will not even discount the benefits of the most short-lived measures. For example, in the last year of a multi-year period, a behavior program that produces savings with a life of only one year will be valued just as much as a program that produces savings over 10, 20 or 30 years. Finally, this type of approach can create perverse

[22] Note that this is the only advantage associated with the cumulative annual savings aspect of this type of goal. There are other advantages of having multi-year goals rather than annual goals. These include the ability to manage variability in market response to programs over time, better incentives to address efficiency opportunities that take a number of years to reach fruition, better incentives to invest in research and development and better incentives to invest in program approaches that may cost more in the short run per unit of savings realized but have good pay-offs over a longer-term. We don't focus on those advantages here because they are not unique to a cumulative annual savings goal. One could have, for example, a multi-year goal that is focused on lifetime savings (i.e. where lifetime savings achieved through programs run over a 3 or 5 year period are the metric of concern) rather than cumulative annual savings. Indeed, there are jurisdictions (e.g. Vermont) which have multi-year (3 years in Vermont's case) targets that focus on the sum of first year (not cumulative and still persisting) annual savings.

incentives both early in the period as well as toward the end of the period, unless it is somehow combined with annual goals. For example, all things being equal a goal-maximizing utility would decline to promote *any measure with a measure life shorter than the remaining period no matter how cost-effective it might be, and then pursue as much of that short-lived measure in the last year or few years of the period, even it is was relatively more expensive on a life-cycle basis.* An example of this would be for a utility to pursue no behavioral programs in years 1-4, and then shift a large portion of its portfolio to investing in a behavior program only in year 5. Not only would this likely result in worse long term net benefits maximization, but limits the benefits of consistency in terms of customer and trade ally marketing and relations, and the effects of market transformation over time.

The European Union recently adopted a cumulative annual savings obligation covering the period 2014 through 2020.

1st Year Savings Goals with Limits on Savings from Short-Lived Measures

One option to address concerns that goals expressed as 1st year savings provide inappropriate incentives to promote inexpensive short-lived savings is to put a cap on the amount of savings from such measures that can be counted towards the first year savings target. For example, one could require that no more than 10% of savings come from measures with lives of five years or less.

This approach has the obvious advantage of curbing incentives that first year savings targets provide to promote inexpensive and very short-lived savings. It is also relatively simple and easy to understand. Finally, it maintains the principal advantage of continuing to express savings in first year terms – namely, that first year savings are easy to understand and easy to put into context. In particular, when savings targets are expressed as a percent of annual energy sales, it is easy for everyone to understand how much of a contribution new savings from a set of programs is contributing to overall energy needs.[23]

However, there are disadvantages to this approach as well. In short, it is a blunt instrument. Consider the example provided above. If the only constraint imposed is a limit on the amount of savings from measures with a life of five years or less, no distinction is made between measures with lives of 6 or 7 years and measures with lives of 20 or 30 years, even though savings from the latter group can last three to four times as long as savings from the former group. Similarly, no distinction is made between measures with lives of 1 or 5 years, even though savings from the latter group are worth five times as much as savings from the former group. This problem can theoretically be reduced by having a number of different constraints (see discussion below). However, as the number constraints increases, the administrative complexity for an efficiency program portfolio also increases. Another disadvantage of a limit on short-term savings is that it doesn't distinguish between the relative cost-effectiveness of different short-lived efficiency measures. If an efficiency measure with a life of only one or two years is very inexpensive per unit of first year savings, but relatively expensive per unit of

[23] Though what should really matter is what cumulative annual savings are as a percent of sales over a multi-year period, as that is most relevant to longer-term planning.

lifetime savings, then finding a way to limit the promotion of that measure (absent a mandate to pursue all cost-effective savings) may be a good idea. Alternatively, if an efficiency measure with a life of five years is not only very inexpensive per unit of first year savings but also has by far the lowest cost per unit of lifetime savings, then constraining its promotion would work against overall policy objectives.

The approach to limiting the portion of savings that can come from short-lived measures has been used in several European countries.

1st Year Savings Goals with Bonuses/Penalties for Long/Short-Lived Measures

Another option for addressing concerns about the signals that a 1st year savings goal send, without fully jettisoning the use of a 1st year savings goal, is to provide bonuses for long-lived measures and penalties for short-lived measures. For example, one could require that 1st year savings from measures with lives of 5 years or less be multiplied by 0.5 and savings from measures with lives of 15 years or more to be multiplied by 1.5. Under such a scheme, an efficient furnace that saves 100 therms/year for 20 years would count as 150 therms towards a first year savings target and a behavior program that saved 20 therms for only one year would count as 10 therms towards the first year savings target.

This approach has the obvious advantages of reducing incentives to promote resources that are inexpensive on a first year basis but that are not (relatively) as cost-effective on a lifecycle basis while increasing incentives for resources that are cheaper on a life-cycle basis. It also maintains the principal advantage of expressing savings in first year terms – that first year savings are easy to understand and easy to put into context.

However, it is still a somewhat blunt instrument. If there is a single threshold for defining a "short-lived measure" and a single penalty multiplier for such measures, as well as a single threshold for defining a long-lived measure, some perverse signals can be sent. For example, in the example provided above, a program administrator would consider a measure with a life of 6 years to be more than twice as valuable as a measure with a life of 5 years (2.5 after the 50% multiplier is applied). On the other hand, the program administrator would see the same value in a measure with a life of one year as in a measure with a life of 5 years and the same value in a measure with a life of 6 years as in a measure with the live of 14 years. Among other things, this will also put a lot of pressure on the determination of appropriate measure life assumptions for measures that are at or very close to the threshold levels for penalties and bonuses.

This approach of providing penalty multipliers to short-lived measures and bonus multipliers to long-live measures has been used in Denmark (measures with a life of less than 4 years got a 0.5 multiplier and some[24] measures with a life of over 15 years got a 1.5 multiplier.)

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[24] The 1.5 multiplier applied only to measures with lives of over 15 years that saved fuels not covered by a carbon emissions cap and trading system.

1st Year Savings Goal with Average Measure Life Adjustment Factor

A third way to continue to use 1st years savings as the way of expressing savings goals while sending better signals regarding the longevity of savings is to establish an average measure life expectation and related total savings adjustment factor that is applied at the portfolio level, along with the 1st year savings target. For example, if the goal was to achieve first year savings of 100,000 MWh with an average life of 10 years, and the program administrator achieved only 90,000 but with an average life of 12 years, the savings achieved would be given a 20% bonus (i.e. a multiplier of 12 divided by the expected 10) and the goal would have been exceeded (108,000 MWh after adjustment). Conversely, if 110,000 MWh of first year savings was achieved but with an average measure life of only 8 years, a 20% penalty (i.e. a multiplier of 8 divided by the expected 10) would be applied to the savings and the goal would not have been met (88,000 MWh after adjustment).

This approach is functionally the same as setting a lifetime savings target, except that it builds on an explicit 1st year savings goal and an average measure life expectation. The scalable nature of the adjustment factor eliminates any of the disadvantages associated with the "blunt instruments" described above. Thus, it retains the communication advantages of a 1st year savings goal while providing exactly the right level of incentive to all efficiency measures regardless of their useful life – a 3-year measure is worth exactly three times as much as a 1-year measure; a 10-year measure is worth exactly twice as much as a 5-year measure; an 18-year measure is worth exactly three times as much as a 6-year measure; etc. Further, we believe that preserving consistency with expressing goals as annual has some value for purposes of transparency, comparability among jurisdictions, and potentially for legal and regulatory reasons.

We do not see any significant disadvantages to this approach. However, we are unaware of any jurisdictions that have adopted it to date.

Summary

There are a variety of different approaches one could use to either change first year savings goals or replace them with alternative metrics (like lifetimes savings goals), each of which has different advantages and disadvantages which we have discussed above. Note that the examples we used in the discussions were illustrative only.

Ultimately, our view is that the last option discussed – a first year savings goal with an average measure life assumption and related, proportional first year savings adjustment factor applied at the portfolio level – is the best. It strikes the best balance between clarity of objectives, ease of implementation and sending the right signals regarding the relative benefits of measures with different lives.

Note that it is also possible to combine some of the approaches discussed above. For example, one could combine the use of first year savings goals with average measure life adjustment factors (our preferred approach) with a multi-year savings target. Under this example, utilities could be required to meet a four-year savings goal of 4% with an average measure life of 12 years and proportional adjustments for deviations from that average life,[25] rather than having four one-year goals of 1% savings with the same 12 year measure life adjustment factor.[26] That combination would provide the benefits of the measure life adjustment factor approach while also providing utilities with the flexibility advantages of a multi-year savings target.

25 Under this approach, we presume that first year savings would still be calculated and adjusted (using the benchmark measure life) annually, with the four annual values then summed to determine whether the 4-year goal was met.

26 Note that the time periods, savings levels and measure lives used in this example are not recommended values for any of those parameters. They are used for illustrative purposes only.

APPLICABILITY OF SAVINGS GOALS TO SMALL UTILITIES

Analysis of small utilities' efficiency program savings goals and performance data suggests that savings targets similar to those of large utilities are achievable. With a savings goal of 1% of sales in 2012 (following a 3 year ramp-up period), the average percent of this goal achieved by the 57 small electric utilities was 111%. The 4 small gas utilities achieved an average of 153% of a 0.75% four year savings target.

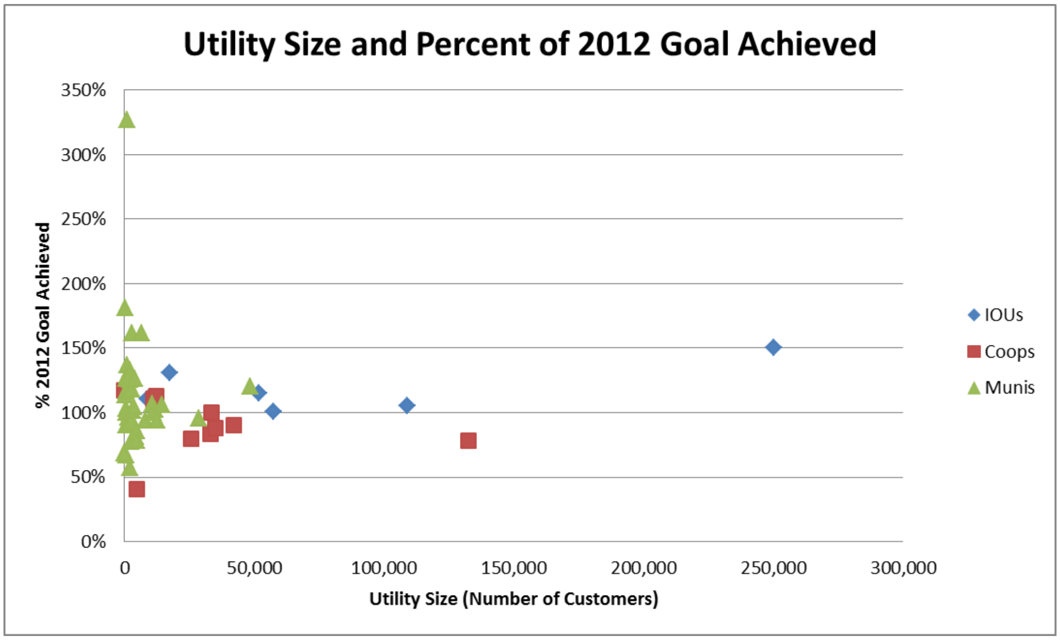
VARIATION IN GOAL ACHIEVEMENT

Savings performance does vary by type of small utilities (IOU, Coop, Muni) as well as the utilities' participation in Efficiency United (EU). While the average achievement of electric IOUs and Munis was well above 100 percent (119 and 115% respectively), the average achievement for Co-ops was 90%. Overall, the utilities that are part of Efficiency United achieved greater savings than the non-EU utilities (122 and 105 percent respectively). While the percent of goal achievement was widely spread and ranged from 40 to 327% for non-EU utilities, every EU utility met over 100% of the savings target with a range of 102 to 182%. The success of small utilities that are members of EU suggests that those underachieving utilities may be able to reach goals by participating in Efficiency United. By choosing not to join EU, utilities should be confident that they can achieve goals on their own choose not to join EU this should be because they are confident that they can achieve goals on their own.

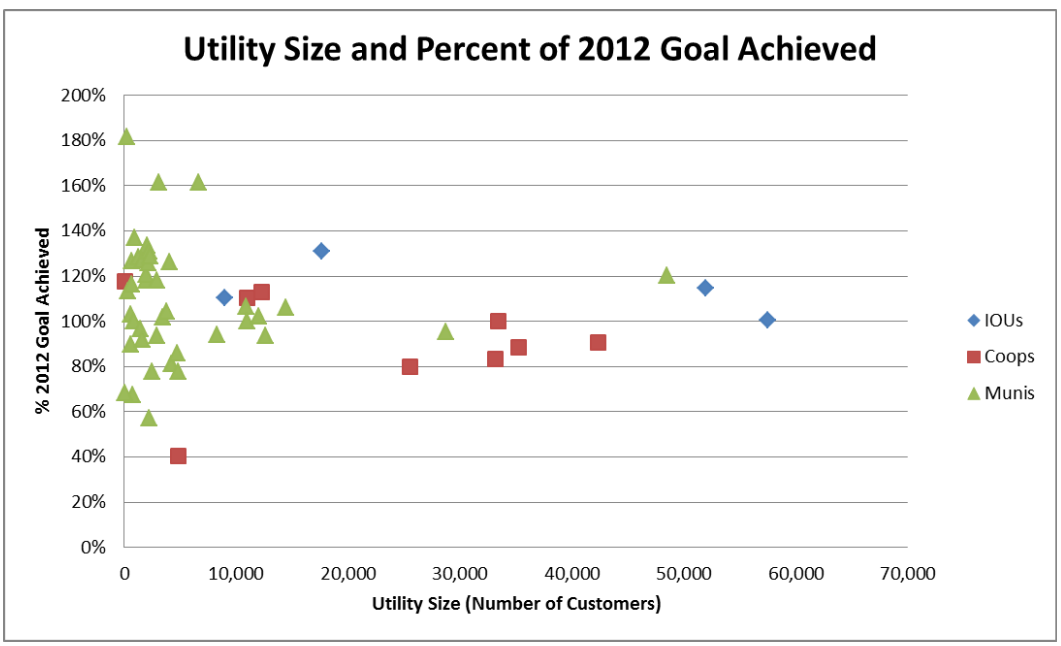
GOAL ACHIEVEMENT AS A FUNCTION OF UTILITY SIZE

Data on the number of customers was only available for electric IOUs and Coops. Rough estimates of utility size for Michigan's Munis were estimate based on the number of households reported in U.S. Census data from 2010.[27] Analysis of the data suggests that utility size does not appear to be a primary driver of performance outcomes. The average percent of the target achieved for the smallest half of utilities is 98% while the larger half achieved an average of 104%; however, it is likely that those utilities that did not meet goals were randomly distributed rather than related to utility size. For example, both the largest and the smallest utility achieved well over 100% of the savings goal (151 and 118%). Yet, the achievement percentage of the two median sized utilities came to an average of 92 percent. As demonstrated by the table below, a linear relationship between utility size and goal achievement is difficult to discern.

[27] For Detroit DPL, the customer estimate of 115 was taken from a Detroit News article. Nichols, Darren A., "DTE to Take Over Detroit Electricity Service." *The Detroit News.* June 27, 2013.



Removing the three largest utilities and the utility that achieved over 300% of its saving goal provides an even clearer picture of the lack of relationship between utility size and goal achievement.



Although the data analyzed suggests that small utilities are meeting their performance goals, we have not obtained data sufficient to scrutinize the source of the savings in terms of individual programs and measures. It is possible that some utilities have been effectively cream skimming (e.g., achieving savings mostly from CFLs) and that achieve goals while offering more comprehensive programs might be a greater challenge. We hope to be able to obtain and analyze this data and include discussion of results in a final report. However, we believe the goals overall are not so aggressive that we are overly concerned about this issue or about small utilities running out of low hanging fruit any time soon.

SMALL UTILITY PERFORMANCE BEYOND MICHIGAN

Performance outcomes from communities participating in Efficiency Smart largely corroborate the results in Michigan described above. Efficiency Smart is a program of energy efficiency services offered to 49 municipal electric providers, primarily in Ohio, that are members of American Municipal Power, Inc. (AMP). In 2012, the second year of Efficiency Smart's operation, the program achieved more than 140% of its performance target for that year and almost 75% of its three-year energy savings goal.[28] In 2012, Efficiency Smart achieved more than 140 percent of its performance target. The three-year service period, beginning in 2011, was designed to save participants 81,000 megawatt-hours (MWh) of energy by the end of 2013.[29] Efficiency Smart exceeded this level of savings in March, and has turned its attention to individual savings targets for each of its participating municipalities. As of July 15, 2013, 34 participating communities had achieved at least 70% of their energy savings goal, with 22 of those municipalities already surpassing 100% of their savings target.[30]

CONCLUSION

Analysis of savings goals and achievements of small utilities in Michigan suggests that statewide savings goals are appropriate and attainable. On average, Michigan's small utilities met over 100% of the savings goal of 1% of retail sales in 2012. Additionally, all individual utilities participating in Efficiency United met over 100 percent of savings targets. Those utilities that are struggling to meet statewide goals have the option of participating in Efficiency United as a way to improve performance. Therefore, we recommend that the MPSC hold the state's small utilities to the same saving goals and standards as those developed for larger IOUs. A forthcoming analysis for the Michigan PSC will analyze whether goals post 2015 should be increased, decreased, or held the same, and whether the structure of the targets should be changed (such as the use of lifecycle energy targets or the addition of peak demand targets). If ultimately there is a decision to increase current goals substantially, we will review whether these higher goals are still achievable by the smallest utilities. However, at this stage we believe the current goals are sufficiently achievable by all utilities regardless of size.

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28 Efficiency Smart, "2012 Annual Report—Energizing the Future." Accessed July 29, 2013. http://www.efficiencysmart.org/Media/Documents/Publications/2012%20Efficiency%20Smart%20Annual%20Report.pdf.

29 AMP's Newsroom, "AMP/VEIC Execute New Efficiency Smart Contract." July 15, 2013. http://amppartners.org/newsroom/amp-veic-execute-efficiency-smart-contract/.

30 Ibid.

Appendix D: Energy Efficiency Cost-Effectiveness Tests

Initial Draft Prepared by Synapse Energy Economics

Introduction

The Office of the Governor and his designees are developing a report for Michigan citizens and policymakers that factually describes and summarizes energy optimization programs set forth in Public Act 295 of 2008. Synapse Energy Economics, Inc. (Synapse) has been hired by the Council of Michigan Foundations (CMF) to draft this report focusing on cost-effectiveness tests used for evaluating the economics of energy efficiency and demand response programs.

Cost-Effectiveness Tests Section of Energy Efficiency Policy Report

1. Introduction

This section of the energy efficiency policy summary report addresses current issues with cost-effectiveness screening practices. It summarizes and compares the current energy efficiency cost-effectiveness policies and practices in Michigan and other jurisdictions.

Subsection 2 provides an overview of the general practices and methodologies used for energy efficiency screening in the US. This provides an important foundation for understanding the practices used across states. Appendix B discusses best practices for select, relevant issues in cost-effectiveness screening practices. Subsection 2 also defines the cost-effectiveness screening practices that were surveyed and reviewed in Michigan and other jurisdictions.

Subsection 3 describes Michigan’s energy efficiency cost-effectiveness screening policies and practices in detail, including a summary of Act 295’s policy goals.

Subsection 4 provides the results of our survey on cost-effectiveness testing policies and practices conducted for the following states: Connecticut, Illinois, Massachusetts, Minnesota, New York, Oregon, Vermont, and Wisconsin. This subsection includes a table summarizing the results of the survey, indicating the current cost-effectiveness tests, primary policies, and key assumptions used across the states (see Table 2). It also includes a description of the policy contexts in each state that have resulted in the specific practices used by that state, based upon interviews with commission staff and reviews of relevant legislation and commission orders. This policy context provides useful information regarding the reasons why each state has chosen its specific screening practices.

Subsection 5 compares Michigan’s current cost-effectiveness screening practices with the practices used in other states. It summarizes key findings from the state surveys and research, and discusses the advantages and disadvantages of certain screening practices. This subsection also discusses how Michigan’s cost-effectiveness tests are meeting the current and any possible future state public policy goals in comparison to other states’ practices.

2. Cost-Effectiveness Tests Fundamentals

2.1 Background on the Evolution of Energy Efficiency Programs and the Increasing Importance of Screening for Cost-Effectiveness

Since the inception of ratepayer-funded energy efficiency programs, cost-effectiveness screening practices have been employed to ensure that the use of ratepayer funds results in sufficient benefits. Screening practices have allowed regulators to promote investments in energy efficiency resources that benefit customers, utility systems, and society. In general, historical energy efficiency programs have proven successful with strong cost-effective results, leading to additional investment in energy efficiency resources.

Increasingly, energy efficiency resources are viewed as a means to curb expensive power supply, mitigate the need for increasing transmission and distribution (T&D) investments, and reduce environmental impacts, particularly with regard to climate change. Consequently, many states have adopted increasingly aggressive energy efficiency standards, or requirements that program administrators procure all available cost-effective energy efficiency.

In response, energy efficiency programs are evolving in order to meet increasingly aggressive savings goals. For example, a growing number of program administrators are implementing more comprehensive programs (e.g., whole house retrofits) that may incur higher up-front costs than other more traditional energy efficiency programs (e.g., lighting), but that produce larger, longer-term benefits. Some administrators are also implementing programs for traditionally underserved market segments such as multi-family residents and small businesses. These developments in efficiency goals and efficiency program designs warrant increased scrutiny of the practices and methodologies used to screen energy efficiency for cost-effectiveness.

2.2 Overview of the Tests Used for Efficiency Screening

There are three tests used most often across the country to determine the cost-effectiveness of energy efficiency programs: the Program Administrator Cost (PAC)[1] test, the Total Resource Cost (TRC) test, and the Societal Cost test. Each of these tests combines the various costs and benefits of energy efficiency programs in different ways, depending upon which costs and which benefits pertain to different parties. The costs and benefits of these tests are summarized in Table 1, below.

Table 1: Components of the Energy Efficiency Cost-Effectiveness Tests

	PAC Test	TRC Test	Societal Cost Test
Energy Efficiency Program Benefits:			
Avoided Energy Costs	Yes	Yes	Yes
Avoided Capacity Costs	Yes	Yes	Yes

[1] The Program Administrator Cost test is also called the Utility System Resource Cost Test (USRCT) as referred to in Michigan Public Act 295.

Avoided Transmission and Distribution Costs	Yes	Yes	Yes
Wholesale Market Price Suppression Effects	Yes	Yes	Yes
Avoided Cost of Environmental Compliance	Yes	Yes	Yes
Reduced Risk	Yes	Yes	Yes
Other Resource Savings (e.g., water, oil, gas)	---	Yes	Yes
Non-Energy Benefits (utility-perspective)	Yes	Yes	Yes
Non-Energy Benefits (participant-perspective)	---	Yes	Yes
Non-Energy Benefits (societal-perspective)	---	---	Yes
Energy Efficiency Program Costs:			
Program Administrator Costs	Yes	Yes	Yes
EE Measure Cost: Program Financial Incentive	Yes	Yes	Yes
EE Measure Cost: Participant Contribution	---	Yes	Yes

It is important to recognize that the different tests provide different types of information. Each test is designed to estimate the costs and benefits of efficiency investments from different perspectives. While all of these different perspectives may be considered relevant and important, and warrant consideration, states typically use one of these tests as the primary test to determine whether to invest ratepayer funds in energy efficiency programs.

- The Societal Cost test includes all impacts to all members of society.[2] It includes all the costs and benefits of the TRC test, but also includes societal impacts. These impacts typically fall within the following categories: environmental impacts; reduced health care costs; economic development impacts; reduced tax burdens; and national security impacts.
- The TRC test includes all the costs and benefits to the program administrator and the program participants. It includes all of the costs and benefits of the PAC test, but also includes participant costs and participant benefits. It offers the advantage of including the full incremental cost of the efficiency measure, regardless of which portion of that cost is paid for by the utility and which portion is paid for by the participating customer.
- The PAC test includes all of the costs and benefits experienced by the utility. It includes all the costs incurred by the utility to implement efficiency programs, and all the benefits associated with avoided generation, transmission and distribution costs. This test is limited to the impacts that would eventually be charged to all customers through the revenue requirements; the costs being those costs passed on to ratepayers for implementing the efficiency programs, and the benefits being the supply-side costs that are avoided and not passed on to ratepayers as a result of the efficiency programs. This test provides an indication of the extent to which utility costs, and therefore average customer bills, will be reduced by energy efficiency.

[2] The Societal Cost test can be defined using different boundaries, e.g., the societal impacts within the state, the country, or the world. Since greenhouse gas emissions from the electricity industry have global impacts, the Societal Cost test should include global costs and benefits.

Ever since ratepayer-funded energy efficiency programs have been in place, there has been considerable debate about which test is best to use for screening energy efficiency. However, it should be noted that – while the choice of test is important – it is even more important to ensure that each test is properly applied. This means they are applied in a way that: achieves its underlying objectives; is internally consistent; accounts for the full value of energy efficiency resources; and uses appropriate planning methodologies and assumptions.

2.3 Accounting for Other Program Impacts

One of the more challenging aspects of applying cost-effectiveness tests is properly accounting for "other program impacts" (OPIs). This term is used to describe two important types of impacts of energy efficiency programs. First, it includes non-energy benefits (NEBs), which includes those benefits that are not part of the costs, or the avoided costs, of the energy efficiency provided by the utility. Second, OPIs also include "other fuel savings," which are the savings of fuels that are not provided by the utility that funds the efficiency program. (Synapse 2012b).

There is a wide range of OPIs associated with energy efficiency programs. OPIs are categorized by the perspective of the party that experiences the impact: the utility, the participant, or society at large:

- Utility-perspective OPIs include financial benefits to the utility from reducing customer bills, including for example, reduced arrearages and bad debt, and improved customer services.
- Participant-perspective OPIs include a variety of NEBs to the program participants, including for example, reduced operation and maintenance (O&M) costs, improved comfort, improved health and safety, increased worker and student productivity, and utility-related benefits (e.g., reduced termination and reconnection). Some of these NEBs can be particularly significant for low-income program participants. Participant perspective OPIs also include reduced water use and other fuel savings.
- Societal-perspective OPIs include those non-energy benefits that accrue to society, including for example, environmental benefits, reduced health care costs, economic development impacts, reduced tax burdens, and national security impacts.

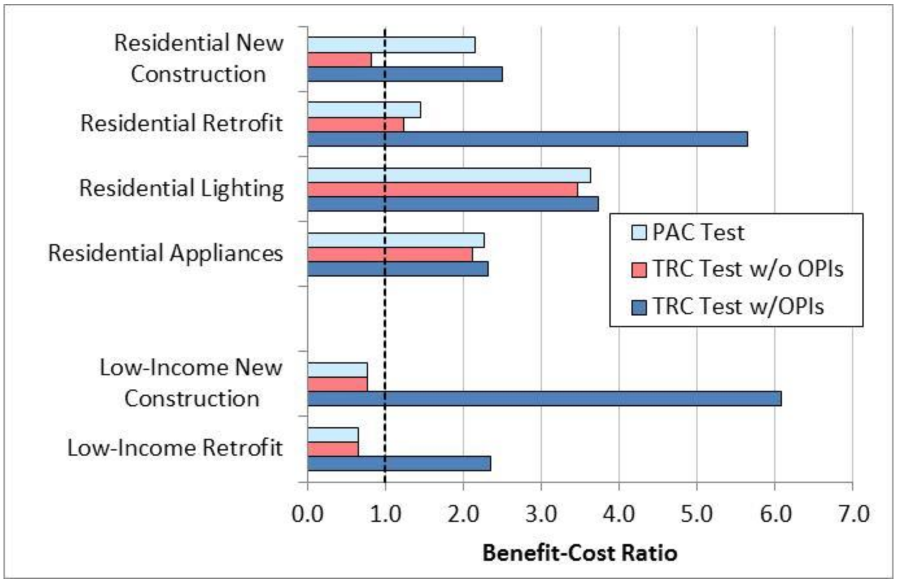
OPIs should technically be included in cost-effectiveness tests for which the relevant costs and benefits are applicable:

- When using the Societal Cost test, the utility-perspective, participant-perspective, and societal-perspective OPIs should be included.
- When using the TRC test, the utility-perspective and participant-perspective OPIs should be included to the greatest extent possible.
- When using the PAC test, the utility-perspective OPIs should be included to the greatest extent possible.

If any one test includes some of the costs (or benefits) from one perspective, but excludes some of the costs (or benefits) from that same perspective, then the test results will be skewed, i.e., they will not provide an accurate indication of cost-effectiveness from that perspective. This concern has been particularly problematic with regard to the TRC test. The TRC test includes the impacts to both the utility and the program participant, and therefore should account for all of the costs and all the benefits that are experienced by the utility and the participants. This requires including all of the participant-perspective OPIs. (Synapse 2012b; Neme and Kushler 2010).

The importance of adequately accounting for OPIs is apparent in many program administrators' energy efficiency screening results. Figure 1 presents the planned cost-effectiveness results for an electric utility in Massachusetts for energy efficiency programs planned for implementation in 2012. The figure presents the benefit-cost ratios under the PAC test, the TRC test with OPIs included, and the TRC test without OPIs included.

Figure 1: Cost-Effectiveness Analysis Implications of OPIs; PAC and TRC Tests



Source: Synapse 2012a.

Note that if the OPIs are not included in the TRC test, then the low-income, residential new construction and residential retrofit programs are all at risk of being inaccurately deemed not cost-effective. These energy efficiency programs are especially important because they help to support more comprehensive efficiency services to a more diverse set of residential customers, which promotes greater customer equity, both within the residential sector and between the residential and other sectors. Promoting customer equity is an important objective underlying the energy efficiency programs.

2.4 Attributes Surveyed in Each Jurisdiction

We researched the cost-effectiveness screening practices in eight states, in addition to Michigan. As mentioned above, the eight surveyed states include Connecticut, Illinois, Massachusetts, Minnesota, New York, Oregon, Vermont, and Wisconsin. For each state, we researched three primary attributes regarding cost-effectiveness screening: cost-effectiveness test(s) and their application, the avoided costs included in the primary cost-effectiveness test, and the OPIs included in the primary cost-effectiveness test. The specific attributes we identified for each state are defined and discussed below.

Cost-Effectiveness Test(s) and Methodologies

- *Primary test*: the primary test, as identified in Section 2.2 above, the state relies on to screen for cost-effectiveness.
- *Secondary test*: the secondary tests or combination of tests that the state uses to inform the cost-effectiveness review process, as applicable.
- *Screening level*: the level at which the primary test is applied to determine cost-effectiveness: either the portfolio, program, project, or measure level. In some instances, a state may screen for cost-effectiveness at multiple levels to inform the review process.
- *Discount rate*: an interest rate applied to a stream of future costs and/or monetized benefits to convert those values to a common period, typically the current or near-term year, to reflect the time value of money. (NEEP 2011, p 15).
- *Study period*: the length of time over which benefits from energy efficiency measures are included in benefit-cost analysis. The study period typically corresponds to measures that have the longest measure life, but not always.[3]

Avoided Costs Included in the Primary Cost-Effectiveness Test

- *Definition of Avoided Costs*: In the context of energy efficiency, avoided costs are the costs that are avoided by the implementation of an energy efficiency measure, program, or practice. Such costs are used in benefit-cost analyses of energy efficiency measures and programs. Because efficiency activity reduces the need for electric generation, these costs include those associated with the cost of electric generation, transmission, distribution, and reliability. Typically, costs associated with avoided energy and generation capacity are calculated. Other costs avoided by the efficiency activity can also be included, among them the value of avoided emissions not already embedded in the generation cost, impact of the demand reduction on the overall market price for electricity, avoided fuel or water, etc. (NEEP 2011, p 8).
- *Avoided Costs in the Survey*: Our survey specifically reviewed whether the following avoided costs are included in a state's energy efficiency benefit-cost analyses: capacity costs, energy costs, transmission and distribution (T&D) costs, environmental compliance costs, price suppression, reduced line losses, reduced risk, and any other avoided costs. Other avoided costs were not specifically defined; rather this category provided an opportunity to account for state-specific avoided costs that may not be captured in the previous avoided costs.
- *Avoided Cost of Environmental Compliance*: It is now common practice to include the cost of complying with some environmental regulations within the costs avoided by energy efficiency resources (e.g., the cost of purchasing SO_2 and NO_X allowances and the cost of purchasing CO_2 allowances to comply with the Regional Greenhouse Gas Initiative).[4] However, it is less common to fully account for the costs of complying with forthcoming or anticipated environmental regulations, particularly regulations related to climate change. The costs of environmental

[3] Note that measure life as used in Table 2, below, implies that the study period is determined by the measures with the longest measure lives. The actual measure lives for measures with useful lives shorter than the longest measure life are used in benefit-cost analyses.

[4] Michigan does not purchase CO_2 allowances, nor is there any requirement for Michigan to purchase CO_2 allowances at this time.

compliance will eventually be borne by the utility and passed on to ratepayers, and therefore should be included in the PAC, the TRC and the Societal Cost tests. These costs are different from environmental externalities, which include only the environmental costs that occur after all environmental regulations have been met. (Synapse 2012b.)

- *Price Suppression Effect*: In regions of the country with organized wholesale energy and capacity markets, reduced energy and capacity demands from energy efficiency savings lead to reduced wholesale energy and capacity prices. Because wholesale energy and capacity markets provide a single clearing price to all wholesale suppliers, and therefore all customers purchasing power in the relevant time period, the reductions in wholesale energy and capacity clearing prices represent a benefit experienced by all customers of those markets. Over time, price suppression benefits dissipate as market participants respond to the lower clearing price, thereby shifting the supply curve and causing prices to rise back towards initial market prices.[5]
- *Reduced Risk*: Energy efficiency can mitigate the various risks associated with conventional power plants, including risks associated with fuel prices, construction costs, planning, reliability, new regulations, wholesale market operations, T&D constraints, and water constraints. Risk mitigation benefits of energy efficiency resources can be recognized either through system modeling when calculating avoided costs; through risk adjustments to the energy efficiency benefits; or through risk adjustments to the discount rate used in the cost-effectiveness analysis. Risk mitigation benefits will eventually impact utility costs and be passed on to ratepayers, therefore they should be included in the PAC, the TRC and the Societal Cost tests. (Synapse 2012a.)

Other Program Impacts Included in the Primary Cost-Effectiveness Test

- *Other Program Impacts*. The survey identified whether each state accounts for OPIs in the primary cost-effectiveness tests. For each category of OPIs, we also identified how the OPIs are accounted for (i.e., whether OPIs are quantified directly, accounted for through an adder, or considered qualitatively).
- *Utility-Perspective OPIs*: Utility-perspective OPIs are indirect costs or savings to the utility, and eventually its ratepayers. Such OPIs include benefits and costs associated with arrearages and bad debt, and improved customer service.
- *Participant-Perspective OPIs*: Participants in both low-income and non-low-income programs can realize a variety of OPIs from energy efficiency programs. The specific categories of OPIs that were surveyed are: resource savings, low-income benefits, equipment and operation and maintenance benefits, improved comfort, increased health and safety, increased property value, and utility-related benefits. While this categorization could be further divided, we found this breakout appropriate for the survey's purposes.
- *Societal-Perspective OPIs:* Societal-Perspective OPIs are indirect program effects beyond those realized by utilities, their ratepayers, or program participants, but accrue to society at large. Such OPIs include benefits and costs associated with environmental impacts, economic development, national security, and healthcare.

[5] In the New England Avoided Energy Supply Costs study (AESC), the forecast of price suppression effects accounts for this dissipation (Synapse 2013a, p 7-2).

We will also provide each state's 2012 ACEEE Scorecard ranking, which is intended to indicate the comprehensiveness and aggressiveness of each state's historical energy efficiency programs. The ACEEE Scorecard ranks states on their policy and program efforts, documents best practices, and provides recommendations for ways in which states can improve their energy efficiency performance. The scorecard serves as a benchmark for state efforts on energy efficiency policies and programs each year, encouraging them to continue strengthening efficiency commitments. The 2012 ACEEE Scorecard is the sixth edition of this report, with the 2013 ACEEE Scorecard expected to be released in October 2013. (ACEEE 2012b, p v).

3. Michigan's Cost-Effectiveness Tests

Approved on October 6, 2008, Public Act 295 of 2008, also known as the Clean, Renewable, and Efficient Energy Act, is Michigan's premier legislation on Demand-Side Management (DSM) programs. Prior to Act 295, energy efficiency programs had not been in operation in Michigan since 1992, and even then were limited in scope. Therefore, much of Michigan's current energy efficiency cost-effectiveness policies and practices stem from the goal of simply getting the programs quickly, but efficiently designed and implemented to comply with Act 295.

The purpose of Act 295 is clearly stated as "to promote the development of clean energy, renewable energy, and energy optimization through the implementation of a clean, renewable, and energy efficient standard that will cost-effectively do all of the following: (a) diversify the resources used to reliably meet the energy needs of consumers in this state; (b) provide greater energy security through the use of indigenous energy resources available within the state; (c) encourage private investment in renewable energy and energy efficiency; and(d) provide improved air quality and other benefits to energy consumers and citizens of this state." (Act 295, §1). Specifically for energy optimization, the overall goal is to "reduce the future costs of provider service to customer," meaning to reduce the cost of electricity services to customers (Act 295, §71).

Because Act 295's goal for energy optimization focuses on the cost of utility service, the act requires the use of the Program Administrator Cost test, also called the Utility System Resource Cost test. Through subsequent orders and approval of energy optimization plans, the Michigan Public Service Commission (MI PSC) has further detailed the state's cost-effectiveness screening practices. Specifically, the MI PSC requires that the program administrators provide the results of multiple cost-effectiveness tests, including the TRC test, the RIM test, and the Participant Cost test, in order to provide the MI PSC with sufficient information to support the distribution of energy optimization funds among the portfolio of proposed programs, and to ensure that the programs are reasonable and prudent Act 295 requires that the portfolio of programs collectively demonstrate cost-effectiveness under the PAC test, excluding program offerings to low-income residential customers. (Act 295, §71(3)(g); §73(2)). The MI PSC has also required that the utilities provide the results of cost-effectiveness tests at the program and measure levels, again to ensure equitable distribution of energy optimization funds among the proposed programs.

To date, the savings goals for Michigan utilities have been relatively low, and the absence of energy efficiency programs since 1992 provided program administrators with significant energy efficiency savings potential. Therefore, the programs have had little difficultly demonstrating cost-effectiveness at the portfolio, program, or measure levels for any of the cost-effectiveness tests. With three full years of program implementation completed, cost-effectiveness results may begin to be challenged. The MI PSC has allowed program administrators to determine the discount rate used to net present value the future stream of energy efficiency benefits. The program administrators have chosen to rely on the weighted average cost of capital to discount benefits, which has typically been around 8%. The Consumers Energy uniform discount rate in its 2011 energy efficiency annual report was 9.78%. (Consumers Energy 2012, p 18). The deemed savings database used in Michigan previously capped measure lives at 20 years. The cap was lifted with the 2013 version of the deemed savings database to allow for the full lifetime of the measures installed, thereby setting the study period over which the cost-effectiveness tests are applied. Michigan's energy efficiency collaborative has been investigating ways to remove such structural biases against energy efficiency programs by encouraging more permanent energy efficiency measures with longer measure lives.

The MI PSC has specified that the PAC test analysis take "into account the avoided supply costs of energy and demand, the reduction in transmission, distribution, generation, future carbon tax, and capacity valued at marginal costs for the periods when there is a load reduction… At the option of the provider, either the cost-based value provided by the commission or the MISO market-based value can be used as a determinant in estimating the avoided cost." (MI PSC 2008, Att. E, pp 4-5). Michigan also accounts for avoided costs associated with line losses. The avoided supply costs of future carbon tax has been included for renewable energy programs only, and has not been included in cost-effectiveness testing for energy efficiency programs. While the MI PSC allows for the inclusion of avoided costs associated with future environmental compliance regulations, the Michigan utilities currently do not include such benefits in their cost-effectiveness analyses. The avoided transmission and distribution costs included in energy efficiency cost-effectiveness analysis are specific to each utility and could be relatively low. For example, Consumers Energy has noted that the current utility system structure would need to change substantially before the cost of building new transmission and distribution could be avoided. In its 2011 benefit cost analysis, the company used a $5 per kW T&D avoided cost value, with essentially reflects reduce maintenance costs. (Consumers Energy 2012, p 19;).

Benefits associated with price suppression and reduced risk have not been included in cost-effectiveness screening, nor addressed by the MI PSC. Act 295 acknowledges the other program impacts that accrue to low-income customers by excluding low-income programs from cost-effectiveness requirements (Act 295, §71(3)(g)). Additionally, natural gas savings are accounted for only in the natural gas programs. The MI PSC has not required the inclusion of any other non-energy benefits in energy efficiency cost-effectiveness screenings because it relies on the PAC test, which does not consider such impacts on participants. While utility-perspective other program impacts could be included as part of the PAC test results, the MI PSC has not addressed them to date.

4. Other Jurisdiction's Cost-Effectiveness Tests

4.1 Summary of Survey Results

In addition to Michigan, we researched the cost-effectiveness screening practices in eight states across the United States. The results of the state surveys are summarized in Table 2. We provide additional detail for each state in the tables in Appendix A.

To provide context for each state's energy efficiency practices, we conducted interviews with state public utility commission staff. The goal of these interviews was for commission staff to provide the anecdotal background on how its state developed the energy efficiency screening policies and practices currently in place, focusing on areas where states differ from each other. The interviews also aim to capture the bigger picture policy context that influences energy efficiency screening policy decisions and practices within each state. Each state's section, below, provides a historical overview of the state's energy efficiency cost-effectiveness policy, followed by a summary of a few specific aspects of the state's screening practices. The few specific aspects we focus on are intended to highlight practices that differ across states or explain why certain benefits are omitted by a state.

To summarize, our survey indicates that:

1. All of the states we surveyed provide relatively comprehensive energy efficiency programs according to ACEEE, as they are all ranked within the top 20 most energy efficient states.
2. Cost-effectiveness practices are largely driven by key policy objectives specific to each state. We summarize these objectives in the second row of Table 2.
3. Most states screen for cost-effectiveness using the TRC as the primary test, while a few states rely on the Societal Cost test or the PAC test as the primary test.
4. Most states determine cost-effectiveness at either the portfolio or program level, with one state screening at the measure level and one state screening at the sector level. Most states consider results from additional screening levels in addition to the primary screening level.
5. Several different discount rates are used across the states, although the utility weighted average cost of capital is most frequently used by the states. Other states use low-risk or societal discount rates. We note that different discount rates can have significant impacts on the results of the cost-effectiveness screening.
6. All but one state apply a study period that includes the full useful life of the measures.
7. All states account for avoided costs of energy, capacity, and complying with environmental regulations. However, we did not investigate the extent to which the methodologies, assumptions and results are appropriate or consistent across the states.
8. All but one state account for avoided costs and transmission and distribution.
9. Most states do not account for price suppression effects, with only two states including such benefits.
10. Most states do not account for risk mitigation benefits, with only two states include such benefits.

11. All but one state that uses the TRC test or the Societal Cost test account for the participant-perspective resource benefits: water savings, oil savings, gas savings (for electric utilities), and electric savings (for gas utilities).
12. All but one state at least qualitatively account for the participant-perspective low-income benefits, typically by not requiring that low-income programs or measures pass the state's cost-effectiveness test.
13. States treat the participant-perspective non-energy benefits very differently:
    - One state uses quantified values for non-energy benefits.
    - Two states use adders to represent non-energy benefits.
    - Several states include few or no non-energy benefits, despite using the TRC test or Societal Cost test as the primary test.

4.2 Connecticut

The Program Administrator Cost test[6] has been the primary cost-effectiveness test in Connecticut for many years. As far back as 1998, the Connecticut Department of Public Utility Control (CT DPUC)[7] stated that it "has repeatedly endorsed the utility cost test as the preferred method to evaluating conservation programs. Its logic is sound, its priorities are straightforward, and it will result in more conservation for lower cost to electric customers" (CT DPUC 1999, pp 18-20). Specifically to this last point, the CT DPUC has relied on the PAC test due to the test's focus on the electric system's cost and benefits, which is the driving energy efficiency policy in the state.

For instance, in 2003, southwestern Connecticut experienced capacity system constraints due to generation comprised of older, inefficient, fossil fueled units, and to strain on the system during periods of peak demand. To help mitigate increases in electricity demand, the CT DPUC stated that it would look much more closely at the value that each energy efficiency program provides. The CT DPUC directed the utilities to undertake efforts to maximize electric savings in all programs. The most cost-effective programs were expanded while those that were less cost-effective were phased out, reduced, or eliminated. (CT DPUC 1999, p 4).

The CT DPUC has also focused on electric system benefits due to the desire to avoid cross-subsidization from electric or gas customers to oil customers. The CT DPUC previously stated that program administrators should "continually strive to reduce inter fuel subsidies and match the funding sources to those receiving the benefits." (Personal Communication with CT DEEP Staff; CT PUC 2011, p 14). Recent legislation may alter the CT DPUC's focus on the electricity system, as the state's statute for assessment of conservation and load management programs now requires that utilities provide programs that offer "similar efficiency measures that save more than one fuel resource or otherwise coordinate programs targeted at saving more than one fuel resource." CT G.L. 16-245m (d)(1), (d)(5).

The CT DPUC has addressed risk associated with energy efficiency programs in the context of discount rates. The CT DPUC stated that a 5% discount rate is extremely low because conservation is not a risk free investment. The CT DPUC directed that the discount rate be no lower than 7% for benefit-cost analysis to reflect the risk associated with energy efficiency programs. (CT DPUC 2010, p 59). Connecticut does not associate risk benefits with energy efficiency investments, and therefore does not include such benefits in cost-effectiveness testing (Personal Communication with CT DEEP Staff).

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[6] The PAC test or Utility Cost test is referred to as the Electric System test in Connecticut.

[7] The Connecticut Department of Energy and Environmental Protection (DEEP) was established on July 1, 2011 with the consolidation of the Department of Environmental Protection, the Department of Public Utility Control, and energy policy staff from other areas of state government. The Public Utilities Regulatory Authority (PURA) replaces the former Department of Public Utility Control along with the Bureau of Energy and Technology Policy. PURA is part of the Energy Branch of DEEP, and is statutorily charged with regulating the rates and services of Connecticut's investor owned electricity, natural gas, water and telecommunication companies and is the franchising authority for the state's cable television companies. (DEEP 2013; PURA 2013).

Other program impacts have been addressed by the CT DPUC on a limited basis in that it has repeatedly approved non-cost-effective low-income programs. For example, in 1999, the CT DPUC recognized "the benefits of energy conservation to low-income customers, such as a reduction in hardship customers and a reduction in uncollectible bills, which are not included in the benefit/cost ratios" (CT DPUC 1999, p 3). More recently, the CT DPUC stated that it continues to believe there are significant opportunities to improve energy efficiency for low-income customers, despite the fact that the low-income program is an all fuels program whereby electric customers subsidize oil measures (CT DPUC 2010, p 15).

4.3 Illinois

The Illinois Public Utilities Act requires the state of Illinois to balance achievement of a number of policy goals, stating that "electric utilities are required to use cost-effective energy efficiency and demand-response measures to reduce delivery load. Requiring investment in cost-effective energy efficiency and demand-response measures will reduce direct and indirect costs to consumers by decreasing environmental impacts and by avoiding or delaying the need for new generation, transmission, and distribution infrastructure." (220 ILCS 5/8-103, § 8-103(a)). The act further states that utilities shall demonstrate that its overall portfolio of energy efficiency and demand-response measures are cost-effective using the total resource cost test and represent a diverse cross-section of opportunities for customers of all rate classes to participate in the programs. (220 ILCS 5/8-103, § 8-103(f)(5)). As such, Illinois relies on the TRC test to screen for cost-effectiveness as it takes into account both the direct and indirect costs to consumers and the utility infrastructure.

Illinois operates two types of energy efficiency programs: those programs that are consistent with 220 ILCS 5/8-103, § 8-103 ("Section 8-103 programs"), and those programs that are consistent with 220 ILCS 5/16-111.5B ("IPA programs").[8] The level at which cost-effectiveness is determined depends on the type of program in consideration. Section 8-103 energy efficiency resources are required to pass the TRC test at the portfolio level, while IPA energy efficiency resources are required to pass the TRC test at the program level.

While the portfolio and program levels are specified in the Illinois Public Utilities Act, the ICC has allowed program administrator discretion on this cost-effectiveness screening practice. Specifically in its approval of Ameren Illinois' energy efficiency plan filings, the ICC stated that "evaluating cost-effectiveness on a portfolio level is necessary to ensure that Ameren not be penalized for planning assumptions that turn out to be inaccurate. The Commission concludes it is appropriate to apply the TRC

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[8] The two types of programs have different goals and delivery structures. The programs are still the subject of stakeholder working groups, which are working through ways to integrate the types of programs. (Personal Communication with ICC Staff; ICC 2013). It should be noted that one utility, MidAmerican Energy Company, offers energy efficiency programs in Illinois pursuant to Section 8-408 of the Illinois Public Utilities Act. (220 ILCS 5/8-408). Section 8-408 applies to small (i.e., fewer than 200,000 customers) multi-jurisdictional utilities, and requires each program to be cost-effective, with the exception of reasonable low-income programs. (220 ILCS 5/8-408, § 8-408(a)). The ICC has required only cost-effective measures in Section 8-408 energy efficiency plans, unless extenuating circumstances are shown that would justify inclusion of such cost-ineffective measures. (ICC 2012a, pp 17-18). MidAmerican uses the Societal Cost test.

test at the portfolio level, but Ameren Illinois should be allowed to apply it at the measure or program level if it so chooses." (ICC 2010a, p 30).

Illinois program administrators account for program benefits over the lifetime of the energy efficiency measures installed, and rely on the weighted average cost of capital to discount the stream of future benefits. (Ameren 2013b, Testimony of Andrew Cottrell, p 10; 20 ILCS 3855/1-10). The weighted average cost of capital is the chosen discount rate because it represents the utility's cost of procuring energy, and therefore parallels energy efficiency resources with alternative supply resources. (Personal Communication with ICC Staff).

In its calculation of avoided costs, Illinois program administrators include the avoided costs of energy, capacity, transmission and distribution, environmental compliance, and line losses. (Ameren 2013b, pp 25-29; Testimony of Andrew Cottrell, pp 9-10). With regard to the avoided costs associated with environmental compliance, the Illinois definition of the TRC test specifically states that, "in calculating avoided costs of power and energy that an electric utility would otherwise have had to acquire, reasonable estimates shall be included of financial costs likely to be imposed by future regulations and legislation on emissions of greenhouse gases." (20 ILCS 3855/1-10).

The ICC has specifically rejected price suppression benefits, finding that the party proposing to include the benefits did not provide adequate basis for deviating from the ICC's past practice of not including such benefits. (ICC 2012b, p 270).

Avoided risk benefits are only included to the extent that they are reflected in MISO or PJM market prices used in avoided energy cost estimates. (Personal Communication with ICC Staff). On a preliminary basis, Ameren considered using a 1.2 TRC test benefit-cost ratio to screen measures to compensate for risk and to ensure that the entire portfolio of programs remained cost-effective with a TRC test benefit-cost ratio of 1.0. However, Ameren did not include such a proposal in its final plan filing with the ICC. (Ameren 2013a, p 22).

Regarding other program impacts, Illinois accounts for benefits to low-income customers by not requiring that such measures meet the TRC test. (220 ILCS 5/8-103, §8-103(a)). For example, the Illinois Department of Commerce and Economic Opportunity's (DCEO) energy efficiency plan submitted in August 2013 states that, "though standards are in place in DCEO's low income programs to assure that products being installed are energy efficient, some of the requirements are primarily for health and safety, comfort and building durability." (DCEO 2013, Testimony of David Baker, p 8).

Further, Illinois legislation stipulates that TRC test benefits include other quantifiable societal benefits, including avoided natural gas utility costs. (20 ILCS 3855/1-10). In practice, this has amounted to program administrators quantifying natural gas and water savings. (Ameren 2013b, pp 24-25). For the first time in their three-year energy efficiency plan filings, the Illinois program administrators are flirting with the idea of accounting for participant OPIs. For example, Ameren initially included a 10% adder in its preliminary energy efficiency plan to account for non-energy benefits (Ameren 2013a, p 22). Similarly, DCEO indicated in its plan filed with the ICC that it is not clear whether non-energy benefits will be included in the TRC calculations, so it provided TRC values both with and without NEBs for certain programs. (DCEO 2013, Testimony of Stefano Galiasso, p 9). The ICC has not yet conducted its review of or issued its decision on the Section 8-103 plans, nor have other program administrators proposed to include such an adder or adjustment in past Section 8-103 plan filings, so it is not yet certain whether or how the ICC will address the inclusion of non-energy benefits. (Personal Communication with ICC Staff).

4.4 Massachusetts

Massachusetts' has been evaluating energy efficiency cost-effectiveness since the late 1980s. However, its fundamental energy efficiency policy was advanced in 1997 with the state's electricity restructuring act, which required the Massachusetts Department of Public Utilities (MA DPU) to ensure that energy efficiency programs are delivered in a cost-effective manner (MA Restructuring Act). In response, the MA DPU opened an investigation to establish the methods and procedures to evaluate and approve energy efficiency programs (MA DTE 1999a). The end result of this investigation was a set of energy efficiency guidelines that address the energy efficiency topics for which the MA DPU has primary responsibility, including energy efficiency program cost-effectiveness (MA DTE 1999b; MA DTE 2000).

In 2008, the An Act Relative to Green Communities (MA GCA) significantly advanced energy efficiency in Massachusetts by requiring that energy efficiency programs capture all available cost-effective efficiency opportunities, which has become the state's driving energy efficiency policy (MA G.L. c 25 § 21(a)). Again in response to the act, the MA DPU opened an investigation to update the previously established energy efficiency guidelines to account for the new legislation (MA DPU 2008). In 2012, the MA DPU again revisited the energy efficiency guidelines to address specific issues associated with energy efficiency program benefits and regulatory filings (MA DPU 2011a; MA DPU 2012).

Risk benefits are not explicitly taken into account in the Massachusetts cost-effectiveness screening, as it has never explicitly been addressed by the MA DPU. However, the MA DPU has acknowledged that energy efficiency resources are a low-risk investment. In both of the MA DPU's investigations following the restructuring act and MA GCA, the MA DPU found that a low-risk discount rate is most appropriate for calculating the present value of the costs and benefits in the TRC test because it reflects the low-risk nature of energy efficiency investments. (MA DPU 2009a, pp 21-23).

Massachusetts explicitly requires that the avoided cost of complying with current and reasonably anticipated future environmental regulations be included in the energy efficiency cost-effectiveness analysis. The DPU also requires that these avoided costs account for the relatively stringent requirements to reduce greenhouse gas emissions required in the Global Warming Solutions Act (GWSA). (MA DPU 2009a.) However, the DPU has yet to determine a methodology to estimate the value of these avoided costs of environmental compliance (MA DPU 2012). Therefore, these potentially significant benefits are not currently accounted for when screening energy efficiency in Massachusetts.

Massachusetts' energy efficiency guidelines have always required that participant-perspective OPIs be quantified to the extent reasonably possible. The MA DPU specifically rejected the use of an adder to account for participant-specific economic benefits, and instead required that any known, quantifiable, and significant end-use benefits to program participants be included in cost-effectiveness analyses. (MA DTE 1999b, p 14).

4.5 Minnesota

The utilities in Minnesota administer energy efficiency programs through implementation of their three-year Conservation Improvement Program (CIP) plans pursuant to Minnesota Statue 216B.241. This statute requires that each utility achieve an annual energy-savings goal of 1.5% of gross annual retail energy sales. It further requires that the Minnesota Department of Commerce (MN DOC) evaluate the CIP plans on how well the goals were met. (MN Statue 216B.241, subd. 1c.(a)).

Minnesota Statue requires that the Minnesota Department of Commerce, Division of Energy Resources (MN DER) consider the costs and benefits to ratepayers, the utility, participants, and society. (MN Statue 216B.241, subd. 1c.(f)). As such, the investor-owned utilities provide the results of the Societal Cost, PAC, Participant Cost, and RIM tests.[9] (Personal Communication with MN DER Staff). Although the statute requires utilities to provide cost-effectiveness results from all of the stated perspectives, the MN DER focuses on the Societal Cost test for approval purposes, as the Societal Cost test measures the ratio of overall benefits and costs to society of energy conservation improvements (MN DER 2010, p 7).

In April 2012, the MN DER announced a policy for the electric and gas utilities' 2013-2015 CIP plans that cost-effective screening would be primarily evaluated at the segment level, rather than the program level, which was the previous screening level. Segments are generally equivalent to customer sectors, and include business; residential; low-income; renewable energy; and assessments. Existing programs were grandfathered in and allowed to be non-cost-effective, so long as the segment in which they resided in still passed the Societal Cost test. (MN DER 2012, pp 9-10). In addition, the MN DER also reviews cost-effectiveness results at the portfolio and program levels, and sometimes at the measure level. (Personal Communication with MN DER Staff).

Both a societal discount rate and a utility discount rate are used in Minnesota. Since environmental costs are not captured and reflected in market prices, the MN DER has found it necessary to impute and impose a societal discount rate to discount the future stream of benefits resulting from avoided environmental damage. The Minnesota societal discount rate is based on the US Treasury's 20-year constant maturity rate, which was 2.67% as of January 3, 2012. The MN DER Staff found that the US Treasury's 20-year constant maturity rate captures the market's expectations regarding inflation, along with a small risk factor. The MN DER Staff concluded that a rate including inflation expectations and a small risk factor is a reasonable method for estimating a social discount rate for externalities. (MN DER Staff 2012).

The utility discount rate in Minnesota is a utility's weighted cost of capital approved in the utility's most recent rate case. While the weighted cost of capital varies by utility, Xcel Energy's weighted cost of capital was 7.04% in its 2010 rate case. Since the utility discount rate is the utility's cost for its capital, MN DER Staff found it a reasonable measure of the value society places on a utility investment. (MN DER Staff 2012).

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[9] Sometimes the utilities will also provide the results of the TRC test, but it is not required by statute. (Personal Communication with MN DER Staff).

For the Societal Cost test, residential programs use the societal discount rate, and commercial programs use the utility discount rate. The Participant Cost test uses the societal discount rate, and the PAC test uses the utility discount rate. The rationale for such an application is that a societal discount rate would reflect a residential customer's likely opportunity costs (i.e., the return on investment that a residential customer would likely give up in order to invest in CIP). Similarly, the utility discount rate represents an attempt to reflect in a simple manner a reasonable estimate of a business customer's opportunity costs, although the utility discount rate may be lower than the actual discount rate for a particular commercial or industrial customer. (MN DER Staff 2012).

The period over which the cost-effectiveness tests are applied is generally capped at 15 years in Minnesota. The MN DER Staff have stated that, in most cases, the maximum life used is limited to 15 years for the following reasons: (a) benefits are more uncertain the further out in time the model is extended; (b) benefit streams diminish further out in time and have lesser effects on cost-effectiveness than more current years; (c) the further out in time the model is extended, the more uncertain it becomes that current ratepayers, who are funding CIP, receive the full benefits of CIP; and (d) if a project cannot pay for itself within 15 years, ratepayers should instead be funding other, more cost-effective projects. (MN DER Staff 2012; Personal Communication with MN DER Staff).

Electric utilities in Minnesota account for the avoided costs of energy, capacity, T&D, and environmental compliance. While the MN DER provides the inputs for a number of cost-effectiveness screening assumptions, it does not provide electric utility avoided costs as they can vary significantly between utilities. (MN DER 2012, pp 10-11). Line losses are also included in Minnesota's benefit-cost analyses. Typically the utilities will provide line loss values, and if not (typically with smaller municipal utilities and electric cooperatives), the MN DER assumes 8%. Price suppression and reduced risk have not been addressed by the MN DER or the Minnesota Public Utilities Commission (MN PUC). (Personal Communication with MN DER Staff).

The MN PUC provides the environmental externality values that should be used by the utilities in their CIPs. The MN PUC provides high and low ranges of values at the urban, metropolitan fringe, and rural levels for sulfur dioxide, particulate matter, carbon dioxide, nitrogen oxides, lead, and carbon monoxide, adjusted annually for inflation. The MN PUC previously established an estimate of the likely range of costs of future carbon dioxide regulation on electricity generation of $9 per ton to $34 per ton for carbon dioxide emitted in 2012 and thereafter. This range of values is updated annually. (MN PUC 2013). The utilities will use these values in some instances, but have generally been more focused on including benefits associated with avoided energy, capacity, and T&D, and may not account for the avoided cost of future environmental compliance. (Personal Communication with MN DER Staff).

Minnesota accounts for other program benefits in its cost-effectiveness analyses through its treatment of low-income programs. The MN DER has previously not required low-income programs to pass the Societal Cost test due to their unique purpose and the spending requirement for low-income projects; however, the cost-effectiveness of the programs is still evaluated. (MN DER 2012, p 10). While other non-energy benefits have been discussed and considered by the MN DER, no other non-energy benefits are included in Minnesota energy efficiency cost-effectiveness analyses. Instead, the state has been more focused on other program challenges, and has limited resource available to devote to the development of non-energy benefits. (Personal Communication with MN DER Staff).

4.6 New York

New York's primary energy efficiency policy was founded in its current form on June 23, 2008 through a New York Public Service Commission (NY PSC) order that adopts energy efficiency targets and establishes a process for approval of energy efficiency programs administered by the state's electric utilities and New York State Energy Research and Development Authority (NYSERDA). Among other findings, the order requires the use of the TRC test for cost-effectiveness screening.

As stated in this initial order, the overarching policy that drives New York's energy efficiency practices focuses on maximizing the cost-effective use of limited funding. In attaining New York's Energy Efficiency Portfolio Standard's (EEPS) objectives, the NY PSC stated that "careful attention to program benefit-cost ratios is very important as there is a need to achieve the maximum return on each incremental energy efficiency investment in the context of also achieving other public interest policy objectives and to reduce rate impacts on customers" (NY PSC 2008, p 2).

This policy explains New York's decision to screen programs at the measure level: "The requirement that all measures have a TRC score of at least 1.0 except for some promotional extremely low cost or incidental measures is an important safeguard that ensures that ratepayer funds are spent wisely and efficiently" (NY PSC 2009, p 15).

The NY PSC continued to refine the state's energy efficiency policy through subsequent orders, while the NY PSC Staff defined the technical practices associated with the commission's policies. For example, the NY PSC Staff instructed program administrators to use the utility weighted average cost of capital (WACC) to discount energy efficiency benefits. This is likely because the utility WACC is used for supply side investments, and the NY PSC Staff felt energy efficiency resources are the alternative to supply side resources. (Personal Communication with NY DPS Staff).

The NY PSC has never included wholesale market price suppression as a benefit of energy efficiency programs for cost-effectiveness screening. It was not mentioned or intended in the 2008 order promulgating the TRC with carbon adder as the chief screening test. It was discussed in a 2011 NY PSC Staff white paper that reviewed energy efficiency programs and issues. NY PSC Staff noted briefly that any price suppression would be a transfer payment and not a resource savings. NY PSC Staff noted "the countervailing effect that occurs on the part of the supply side" – leading to only moderate and temporary effects. Lower current and prospective market prices could cause "potential new supply entrants to be dissuaded from entering a market" and "retirements of existing generators may be accelerated." Over the long-term, "a new supply/demand equilibrium is reached, and the price reduction is completely eliminated" (NY DPS 2011, p 31). In the NY PSC's response to the NY PSC Staff white paper, the Commission noted that various TRC test changes discussed in the paper or comments would raise or lower TRC test benefit-cost ratios, and concluded that they would not consider revisions to the TRC test at that time (NY PSC 2011c, p 6).

Similarly, the NY PSC and NY PSC Staff have never included energy efficiency benefits associated with reduced risk as a benefit of energy efficiency programs for cost-effectiveness screening. It was not mentioned or intended in the 2008 order promulgating the TRC with carbon adder as the chief screening test. The order responding to the white paper, however, at length discussed reduced risk of supply disruptions or gas price jumps as a major reason to continue the programs despite current low natural gas prices (NY PSC 2011c, p 5).

The NY PSC has placed emphasis on the benefits associated with avoided costs; therefore, many non-energy benefits have not been explicitly addressed by the NY PSC. However, the NY PSC has generally recognized and considered low-income specific benefits in deciding on funding for utility low-income programs. Specifically, the NY PSC has previously approved non-cost-effective low-income programs, indicating that low-income energy efficiency programs are a beneficial use of energy efficiency funding. (NY DPS 2011, p 37; NY PSC 2010, pp 64-65). Additionally, in TRC screening, the NY PSC Staff will sometimes subtract reduced O&M costs from upfront measure costs as appropriate. For example, reduced O&M costs associated from long-life lighting measures and savings from oil and water may be subtracted from measure costs.

4.7 Oregon

Oregon's consumer-owned utilities must comply with the Northwest Power and Conservation Council's (NPCC) energy efficiency and conservation targets. For efficiency, the most recent targets were established in NPCC's Sixth Northwest Power Plan, which calls for Northwestern states to meet 85% of future regional load growth with energy efficiency and conservation. On the other hand, for investor owned utilities, the plan is advisory but not mandatory. As such, for IOUs, Oregon is committed to procuring all cost-effective energy efficiency measures (Sixth Northwest Power Plan, p 6; Personal Communication with ETO Staff). The Public Utility Commission of Oregon (OR PUC) is interested in the long-term success of energy efficiency in Oregon but sees a need to pace acquisition in order to maintain a delivery infrastructure and moderate rate impact. Thus, the Energy Trust of Oregon, a non-profit created in 1999 to help establish consistency in funding for efficiency and renewable resources, has a twenty-year acquisition schedule (ETO Website 2013).

Since the early 1990s, energy efficiency programs in Oregon have been screened for cost-effectiveness primarily with the Total Resource Cost test at the program level (OR PUC 1994). The Energy Trust of Oregon also screens energy efficiency resources using the Program Administrator Cost test to inform its cost-effectiveness review process (ETO Methodology 2011).

Oregon accounts for the TRC test benefits that accrue over the full life of the energy efficiency measures installed (Personal Communication with ETO Staff). All programs use a discount rate equal to the risk-adjusted cost of capital for utilities, which is established by utilities during each iteration of the IRP process. As of 2009, the rate was 5.2%.

The TRC test used in Oregon includes all other program impacts that are reasonably quantifiable, such as avoided capacity, energy, T&D, line loss, and risk costs, in addition to any resource benefits, including benefits associated with water and gas savings. Although Oregon does not explicitly utilize a carbon price in cost-effectiveness screening, the avoided cost of environmental compliance is embedded in the price forecasts utilized by utilities (Personal Communication with ETO Staff). Additionally, Oregon accounts for risk avoidance by adjusting the benefits of energy efficiency programs for their risk hedge values developed by the NPCC. In the NPCC 5th Power Plan from 2005, the Council evaluated over 1,000 plans against a large number of future conditions and determined that conservation measures above the cost-effectiveness threshold lower cost without adding risk. As such, the Council determined a range of risk avoidance values from $5/MWh of risk avoidance for discretionary programs and $10/MWh for lost opportunity programs (Fifth Northwest Power Plan 2005).

Oregon accounts for all other program impacts that are reasonably quantifiable, and includes a 10% adder in the TRC to reflect benefits that cannot be quantified (OR PUC 1994). This adder works as a "catch-all," accounting for unspecified benefits that accrue directly to participants and are not readily quantifiable.

4.8 Vermont

Vermont's energy efficiency policy is centered on the state's least cost integrated planning mandate, which stipulates that utilities must plan to meet "the public's need for energy services, after safety concerns are addressed, at the lowest present value life cycle cost, including environmental and economic costs, through a strategy combining investments and expenditures on energy supply, transmission and distribution capacity, transmission and distribution efficiency, and comprehensive energy efficiency programs" (30 VSA § 218c). The requirement to include environmental costs lead the Vermont Public Service Board (VT PSB) to its decision to use the Societal Cost test in evaluating energy efficiency programs, because costs in the Societal Cost test include environmental impact, changes in customer satisfaction, local economic impact and risk exposure (VT PSB 1990a, Volume II, Module 4, paragraphs 560, 564). Specifically, the VT PSB concluded that "economic efficiency and environmental integrity are benefits that society values, and evaluation of any DSM program must consider the net change in these benefits to assure that such a program is in society's best interest" (VT PSB 1990a, Volume II, Module 4, paragraph 587).

The use of the Societal Cost test explains Vermont's approach to including other program impacts. Vermont quantifies as many OPIs as can be readily calculated, including operation and maintenance benefits, water savings, and other fuel savings. To account for additional non-energy benefits, a 15% adder is applied to program benefits, and an additional 15% adder is applied to low-income program benefits. The decision to use adders of 15% was based on a literature review conducted by the Vermont Department of Public Service (VT DPS 2011, pp 3-5). In adopting the adders, the VT PSB stated that "while there is a high degree of uncertainty surrounding the magnitude of non-energy benefits, it is clear that the current value of zero is incorrect, and that 15% is on the lower end of the range of estimates" (VT PSB 2012b, p 26).

4.9 Wisconsin

The history of cost-effectiveness screening for energy efficiency programs in Wisconsin provides insight into the state's current cost-effectiveness practices. Legislation from 2005 mandated that funding for energy efficiency programs be capped at 1.2% of operating revenues for gas and electric utilities, but also allowed the Wisconsin Public Service Commission (WI PSC) to request more funding at a future date. As such, following its typical planning process, the WI PSC approached the Joint Committee on Finance and requested additional energy efficiency program funding to meet the level of funding anticipated to be needed to capture all the cost-effective energy efficiency. Soon thereafter, due to state policy decisions beyond the WI PSC's jurisdiction, funding levels for energy efficiency programs were reduced back to the 1.2% operating revenue cap. However, the cost-effectiveness screening policies and practices were not adjusted to reflect the change in funding levels, and continued to operate with the goal of procuring all cost-effective energy efficiency. Now, Wisconsin's primary energy efficiency cost-effectiveness policy is to procure all cost-effectiveness energy efficiency up to the funding cap. (Personal Communication with WI PSC Staff).

Additionally, Wisconsin's screening procedures are informed by certain priorities established by different state and commission policies. According to Wisconsin Act 141, the purpose of energy efficiency programs is to "help achieve environmentally sound and adequate energy supplies at reasonable cost," with a focus on those resources that reduce overall energy use and peak demand. (WI Legislature 196, §69.196.374(2)(a)2)). Further, the WI PSC regulations explain that "the program administrator shall assign priority status to implementing programs that reduce growth in electric and natural gas demand usage, facilitate energy efficiency and renewable resource market development, help market providers achieve higher levels of energy efficiency, promote energy reliability and adequacy, avoid adverse environmental impacts from the use of energy, and promote rural economic development." (WI PSC 2007, §137.05(11)).

As such, Focus on Energy, Wisconsin's energy efficiency program administrator, primarily utilizes what the state refers to as a "modified" TRC test. It is applied at the portfolio level, and accounts for the benefits that accrue over the effective useful life of the measures installed. Both the Wisconsin program administrator and program evaluator apply a low-risk discount rate of 2%, which represents the public sector cost of borrowing and was decided upon by the WI PSC after considering stakeholder feedback on various discount rates.

The WI PSC also requires the program administrator and evaluator to provide the results of two other cost-effectiveness tests: the PAC test, used to inform program design, and an "expanded" version of the TRC test, used to assess additional energy efficiency benefits (WI PSC 2007, §137.05(12)). More specifically, the WI PSC states that "the modified TRC test does not provide useful guidance for appropriate program design, so the Commission finds it reasonable to require that programs must pass the Utility/Administrator test in order to ensure that the benefits ratepayers receive from these programs exceed the programs' costs." Additionally, "the Commission recognizes that other non-economic externalities are also significant, so the expanded test must also be applied at the portfolio level." Wisconsin's "expanded" TRC test falls somewhere in between what are traditionally defined as the TRC test and the Societal Cost test. It includes additional benefits that flow through the economy, including job creation, additional emissions, mercury reductions, increases in comforts, decreases in operation and maintenance costs, etc. The results of the expanded TRC test are only provided every couple of years. (WI PSC 2010; Personal Communication with WI PSC Staff).

In its application of the modified TRC test, Focus on Energy accounts for the avoided costs associated with energy, capacity, line losses, and environmental compliance. Wisconsin does not account for avoided transmission and distribution costs, price suppression or reduced risk. The avoided capacity costs are based on the cost of a new peaking plant and, as of 2012, avoided energy costs are calculated based on a forward-looking average of the locational marginal prices across Wisconsin nodes, and based on MISO data (WI PSC 2012b). Included in these valuations are avoided capacity, line loss and environmental compliance costs. Wisconsin includes a levelized carbon value of $30 per ton in assessing the emissions benefits of a given resource. Additionally, because Focus on Energy offers joint gas and electric programs, gas benefits are calculated and included in the modified TRC test analysis. Other participant-perspective OPIs are excluded from the modified TRC test, and are only included in the expanded TRC test.

5. Comparison of Michigan's Screening Practices to Other Jurisdictions

5.1 Cost-Effectiveness Tests

Michigan is one of the few states that relies on the PAC test as its primary test. In fact, only one of the eight states we surveyed, and only five states throughout the United States use the PAC test as their primary test. Five out of the eight states surveyed rely on the TRC test, and 29 states in the United States use the TRC test as the primary cost-effectiveness test. Two out of the eight states surveyed, and 6 states in the United States rely on the Societal Cost test as the primary cost-effectiveness test (ACEEE 2012a, p 13). Below we discuss the advantages and disadvantages of the three primary cost-effectiveness tests.

The Societal Cost test is the most comprehensive test, and is most appropriate for those states that wish to give consideration to the societal benefits of energy efficiency programs, particularly the environmental and health benefits. The disadvantages of this test are that some stakeholders may view the scope as outside the interests and jurisdiction of regulatory commissions; some of the societal impacts are uncertain and difficult to forecast; and this test could increase the range of cost-effective programs, which might lead to higher cost impacts on utility customers.

The TRC test is the next most comprehensive test, and is the most widely used test. Regulators and legislators are apparently drawn to this test because it intends to evaluate the majority of the costs and benefits for all ratepayers. However, the TRC test creates a dilemma for policymakers. In order to be internally consistent the test must include other program impacts on the program participants, but regulators are often wary of doing so because some of the costs are uncertain and difficult to quantify. In addition, some stakeholders are concerned that including OPIs in the assessment of energy efficiency could lead to utility customers paying higher costs for efficiency programs in order to pay for other program benefits that are not in their interest and should not be paid for through utility rates.

The PAC test is most appropriate for those states that want to limit the energy efficiency cost-effectiveness analysis to the impacts on revenue requirements. There are many advantages to this test: it is consistent with the way that supply-side investments are evaluated; it includes costs that are relatively easy to identify and quantify; and it includes the energy costs and energy benefits that are most important to utility regulators. Probably the most important benefit of the PAC test is that it provides legislators, regulators, consumer advocates and others with confidence that the energy efficiency programs will result in lower costs to utility customers. This is an extremely important consideration, particularly for those states that seek to implement all cost-effectiveness energy efficiency resources.

However, relying on the PAC test has one significant disadvantage in that the costs and benefits to energy efficiency program participants are not taken into consideration. There are two implications of this. First, by not including the participant's cost the PAC test does not include the full incremental cost of efficiency measures, which may be important to policymakers who may be concerned about the total economic impact of the energy efficiency programs. Second, the PAC test does not include the other program benefits of efficiency measure, some of which are clearly important to policy makers. The other program benefits that are typically most important to regulators are (a) those benefits that pertain to low-income customers, because of the significant public policy implications of this sector; and (b) the other fuel savings, because these savings are important to promote comprehensive, whole-house, one-stop-shopping residential retrofit programs as well as new construction programs where customers tend to use multiple fuels.

5.2 Secondary Test

In addition to relying on the PAC test as its primary cost-effectiveness test, Michigan also considers the results of the TRC, RIM, and Participant Cost tests. Michigan's approach to considering multiple cost-effectiveness tests is comprehensive. Five out of the eight surveyed states consider secondary cost-effectiveness tests, three of which consider multiple cost-effectiveness tests. The TRC and PAC tests are most commonly used by these states as their secondary screening tests. Three states rely on the primary test only, and do not consider the results of other cost-effectiveness tests.

The advantage to using multiple screening tests is that multiple policy objectives can be evaluated through different tests. For example, Wisconsin uses the TRC test as its primary cost-effectiveness test, but uses the PAC test to help inform program design (e.g., whether an incentive level is appropriate) and whether ratepayer funding is spent wisely. Applying multiple tests allows for balancing achievement of various key public policy objectives, such as accounting for the full incremental cost of the efficiency measure, accounting for other program impacts, and accounting for societal benefits, or ensuring a net reduction in costs to customers.

The downside to using multiple screening tests is that it still leaves the ultimate question of which programs to implement, and that, in practice, it is more common and straightforward to use a single, primary test to answer this ultimate question. Further, preparing and analyzing multiple test results is cumbersome, and places additional administrative burdens on the utilities, regulators, and stakeholders.

5.3 Screening Level

Michigan applies its cost-effectiveness tests primarily at the portfolio level, but also considers screening results at the program and measure levels. As the primary screening level, four of the surveyed states screen for cost-effectiveness at the program level, three consider the portfolio level, one state screens at the sector level, and one state screens at the measure level.[10] Six of the surveyed states consider cost-effectiveness results at other screening levels, while two states do not. Across the country, 30 states apply cost-effectiveness tests at the portfolio level, 30 states apply cost-effectiveness tests at the program level, and 13 states apply cost-effectiveness test at the measure level (ACEEE 2012a, p 31).

Evaluating cost-effectiveness at the measure level means that each individual component (i.e., measure, equipment, or other action) of an efficiency program must be cost-effective. Screening at the measure level is the most restrictive application of the cost-effectiveness tests, and can create a barrier to greater savings levels. (NAPEE 2008, pp.3-9, 3-10).

Evaluation at the program level means that collectively the measures under a program must be cost-effective, but some measures can be uneconomical if there are other measures that more than make up for them. While non-cost-effective measures may reduce a program's overall cost-effectiveness, the program administrator may be able to achieve greater overall savings through the combination of measures. Additionally, a measure may not be cost-effective on its own, but may become cost-effective when combined with other efforts. (NAPEE 2008, pp 3-9, 3-10).

Evaluating cost-effectiveness at the portfolio level means that all of the programs taken together must be cost-effective, but individual programs can be positive or negative. This is the most flexible application of cost-effectiveness testing, as program administrators have the ability to experiment with different strategies and technologies that may not be immediately cost-effective or require further testing, such as pilot programs, market transformation programs, or emerging technologies. (NAPEE 2008, pp 3-9, 3-10).

Further, the advantages and disadvantages of applying multiple screening levels are similar to applying multiple cost-effectiveness tests. The advantage is that regulators can ensure cost-effectiveness at the most granular level, or the highest level. The disadvantage is that it can result in an overwhelming level of analysis, especially when provided at the measure level.

5.4 Discount Rate

To discount the future stream of benefits, Michigan relies on the utility weighted average cost of capital. Five of the surveyed states also rely on the weighted average cost of capital, two states use a low-risk rate, and two states rely on a societal discount rate.[11] As indicated in Table 2, there is a wide range of discount rates used, both in terms of the rationale for the discount rate and the values chosen for a given rationale. Even states that use the same rationale for choosing a discount rate (e.g., relying on the

[10] Note that Illinois relies on both the portfolio and program level screening results, depending on the statue to which a program corresponds. (220 ILCS 5/8-103,§103(a); 5/16-111.5B).

[11] Note that Minnesota relies on both a societal discount rate utility discount rate in its primary cost-effectiveness test. (MN DER Staff 2012, Inputs 11-13; Xcel 2012a, p 481).

weighted cost of capital) have very different values for the actual rates used (e.g., 3.93% to 10% for the weighted cost of capital).

Discount rates are commonly used to compare future streams of costs in a consistent way, by estimating the present value of the costs and expressing them in a common reference year. The choice of discount rate will have a significant impact on the present value of costs and benefits; relatively high discount rates will significantly reduce the value of costs and benefits in the later years of the study period, while relatively low discount rates will reduce that value by much less. A discount rate of zero means that costs and benefits in future years are valued as much as costs and benefits today. The choice of discount rates is especially important for energy efficiency resources, whose costs are typically incurred in early years while benefits are experienced in later years.

Discount rates are used to account for two interdependent concepts: the time value of money and the riskiness of the investment (Synapse 2012b). The time value of money is captured in the cost of capital that an investor uses to finance an investment; and the cost of capital is one of the key determinants of the discount rate. The riskiness of an investment is an indication of the project risk and or portfolio risk; and those investments that are expected to have a low project risk or portfolio risk can be discounted using a relatively low discount rate to reflect that risk.

Energy efficiency programs financed by a system benefits charge, or a similar fully-reconciling charge, represent a funding source with a low financial risk. Energy efficiency resources also represent low project and portfolio risk. A state could account for the low risk of energy efficiency resources by applying a low-risk discount rate. A low-risk discount rate could, for example, be based on a general indicator of low-risk investments, such as US Treasury bonds. To account for the low project risk, a state could reduce the low-risk discount rate further solely on the basis of the cost of capital.

In some cases, a state will chose a discount rate based on the cost-effectiveness test. For example, in Vermont and Minnesota, the societal discount rate is chosen because the state has chosen to use the Societal Cost test to screen energy efficiency. While there is sound logic in applying a societal discount rate when using the Societal Cost test, it is not entirely clear what the societal discount rate represents in these cases. First, there is a range of discount rates that could be used to reflect society's perspective. Second, it is not clear to what extent this choice of discount rate is intended to account for reduced financial, project and/or portfolio risk.

5.5 Avoided costs

Energy efficiency resources have the potential to avoid a number of utility system costs, thereby producing substantial benefits to utilities and customers. Michigan does not include two avoided costs in its cost-effectiveness analyses: price suppression benefits and reduced risk benefits.

The advantages to these two avoided costs are the same. These two types of avoided costs provide important benefits, and should be accounted for in cost-effectiveness screening. Otherwise, the cost-effectiveness test results are skewed against energy efficiency as not all benefits are incorporated.

Therefore, the advantage of including the avoided costs in cost-effectiveness testing is that it provides for a complete representation of energy efficiency resources benefits.

The only disadvantage of including these types of avoided costs may be that they are difficult to estimate, or the results may be seen as too uncertain to include in the cost-effectiveness analysis.

Below, we provide a more detailed comparison analysis as well as the rationale for including these two benefits. Appendix B provides additional information on best practices for some of the issues identified below.

Price Suppression

Michigan, along with six out of the eight states in our survey, does not include the benefits of market price suppression in its cost-effectiveness screening. Only Massachusetts and Connecticut incorporate price suppression benefits, which are developed for the states as part of New England's regional avoided energy supply cost study (see Synapse 2013a).

Wholesale market price suppression effects could be included as a benefit of energy efficiency in regions with competitive wholesale electric markets. Even a small reduction in a market clearing price can result in significant cost reductions across the entire market. States could include price suppression effects as a benefit of energy efficiency because it represents a reduction in costs to wholesale electric customers, which are passed on to retail electric customers. This benefit could be included in the PAC test, the TRC test, and the Societal Cost test.[12]

Reduced Risk

Most of the states we surveyed, including Michigan, do not recognize that energy efficiency may reduce risks on the utility system associated with supply-side resources. Only Oregon and Vermont account for the benefits associated with reduced risk, which they accomplish by applying an adder of 10% and 15% to program benefits, respectively. Additionally, Oregon accounts for risk avoidance using specific dollar per MWh saved factors, which are based on the risk hedge values of certain efficiency programs.

Energy efficiency can mitigate the various risks associated with large, conventional power plants. A recent study evaluated the costs and risks of various energy resources, and found that energy efficiency is the least cost and least risky electricity resource (Ceres 2012). Given the potential value of reduced risk and the many ways that energy efficiency can reduce utility system risks, states could consider explicitly accounting for the risk benefits of energy efficiency.

5.6 Other Program Impacts

OPIs could be included in cost-effectiveness tests for which the relevant costs and benefits are applicable. If any one test includes some of the costs (or benefits) from one perspective, but excludes

[12] A recent study by ACEEE evaluated wholesale price mitigation impacts from energy efficiency programs for Ohio. See ACEEE 2013.

some of the costs (or benefits) from that same perspective, then the test results may be skewed; i.e., they may not provide an accurate indication of cost-effectiveness from that perspective. (Synapse 2012b; Neme and Kushler 2010).

The states in our survey use different approaches for including OPIs in cost-effectiveness analyses, with some states not including such benefits at all. Below we discuss three important categories of OPIs.

Resource benefits

Michigan does not account for savings from other resources such as natural gas and water that participants can experience from energy efficiency resources, primarily because the state relies on the PAC test which does not take into account participant benefits. Except for Connecticut, which also relies on the PAC test as its primary cost-effectiveness test, all of the states in our survey except for Minnesota quantify other resource savings to some extent.

Among the participant-perspective OPIs that could be included in the TRC test, other fuel savings deserve particular consideration. First, this type of OPI tends to have one of the biggest impacts on the cost-effectiveness of certain programs. Second, this type of OPI tends to support important public policy goals of regulators and other stakeholders. Other fuel savings are important because they help justify comprehensive residential retrofit and residential new construction programs that are designed to treat multiple fuels in customers' homes. (Synapse 2012b, p 24).

Michigan could include resource benefits in its PAC test results as an alternative scenario as it is an important public policy goal. The advantage of including such benefits is that it allows for a more comprehensive analysis. Resource benefits could be included in Michigan's TRC test results as well.

Utility OPIs

Michigan does not include the non-energy benefits that accrue to utilities as a result of energy efficiency resources. Most of the states in our survey do not include such benefits either, although Massachusetts does directly quantify utility-perspective OPIs, and Vermont and Oregon account for such benefits through a 15% and 10% adder applied to program benefits, respectively.

Because Michigan relies on the PAC test, its cost-effectiveness analyses could include utility-perspective OPIs. Utility-perspective OPIs are generally considered to be small relative to other OPIs. However, some studies have identified significant benefits associated with reduced shutoffs and reconnects, as well as bad debt write offs and carrying costs on arrearages. In addition, utility-perspective OPIs can be significantly larger for low-income customers, particularly in states where low-income customers are offered discounted rates or shutoff protection provisions that can sometimes result in large arrearages.

Similar to avoided costs, the advantage of including utility OPIs is simply that it is more accurate and comprehensive to include them.

<u>Participant OPIs</u>

Michigan effectively considers a portion of participant-perspective OPIs in the PAC test analysis by permitting low-income programs to be less cost-effective. Our survey results indicate that states treat the participant-perspective OPIs very differently. Massachusetts is the only state in our survey that directly quantifies utility- and participant-perspective OPIs, while Vermont and Oregon apply a 15% adder and 10% adder to their benefits, respectively. Several states include few or no non-energy benefits, despite using the TRC test or Societal Cost test as the primary test. However, some of these states consider resource benefits and qualitatively consider low-income benefits.

While Michigan should not include participant-perspective OPIs in its PAC test as that would be inconsistent with the test's perspective, it could in its TRC test and Participant Cost test analyses. As mentioned above, OPIs could be included in cost-effectiveness tests for which the relevant costs and benefits are applicable. If a state has chosen to use the TRC test as the primary screening test, then the cost-effectiveness analysis could include utility- and participant-perspective OPIs. The TRC test should not be used to screen energy efficiency resources if participant-perspective OPIs are not adequately accounted for. The TRC test includes all the costs to program participants, and therefore it must also include all the benefits to program participants in order to maintain internal consistency. Otherwise the test results may be inherently skewed against energy efficiency.

References

Multiple States

ACEEE 2012a. American Council for an Energy Efficient Economy, "A National Survey of State Policies and Practices for the Evaluation of Ratepayer-funded Energy Efficiency Programs," February 2012, available at: http://www.aceee.org/research-report/u122.

ACEEE 2012b. American Council for an Energy Efficient Economy, "The 2012 State Energy Efficiency Scorecard," Report Number E12C, October 2012, available at: http://www.aceee.org/sites/default/files/publications/researchreports/e12c.pdf.

ACEEE 2013. American Council for an Energy Efficient Economy, "Ohio's Energy Efficiency Resource Standard: Impacts on the Ohio Wholesale Electricity Market and Benefits to the State," Report Number E138, April 2013, available at: http://www.aceee.org/research-report/e138.

CA PUC 2001. California Public Utilities Commission, "California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects," October 2001, available at: http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF.

Daykin et al. 2012. Elizabeth Daykin, The Cadmus Group; Jessica Aiona, The Cadmus Group; Brian Hedman, Hedman Consulting, "Whose Perspective? The Impact of the Utility Cost Test," December 11, 2012, available at: http://www.cadmusgroup.com/wp-content/uploads/2012/11/TRC_UCT-Paper_12DEC11.pdf.

Eckman 2011. Tom Eckman, "Some Thoughts on Treating Energy Efficiency as a Resource," ElectricityPolicy.com, May 2, 1011, available at: http://www.electricitypolicy.com/archives/3118-some-thoughts-on-treating-energy-efficiency-as-a-resource.

ENE 2009. Environment Northeast, "Energy Efficiency: Engine of Economic Growth," October 2009, available at: http://www.env-ne.org/public/resources/pdf/ENE_EnergyEfficiencyEngineofEconomicGrowth_FINAL.pdf.

Haeri and Khawaja 2013. Hossein Haeri and M. Sami Khawaja, "Valuing Energy Efficiency: The Search for a Better Yardstick," Public Utilities Fortnightly, July 2013, available at: http://www.fortnightly.com/fortnightly/2013/07/valuing-energy-efficiency?authkey=aa2986b87d0fbbce625f243752a462709bf972274a13deb4b7cc4cdcefdd6a5a.

NAPEE 2008. National Action Plan for Energy Efficiency, "Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices Technical Methods, and Emerging Issues for Policy-Makers," November 2008, available at: http://www.epa.gov/cleanenergy/documents/suca/cost-effectiveness.pdf.

Neme and Kushler 2010. Chris Neme and Marty Kushler, "Is it Time to Ditch the TRC? Examining Concerns with Current Practice in Benefit-Cost Analysis." 2010 ACEEE Summer Study on Energy Efficiency in Buildings, available at: http://aceee.org/proceedings-paper/ss10/panel05/paper06.

NEEP 2011. Northeast Energy Efficiency Partnerships, "Glossary of Terms, Version 2.1," July 2011, available at: http://www.neep.org/Assets/uploads/files/emv/emv-products/EMV_Glossary_Version_2.1.pdf.

RAP 2013. Regulatory Assistance Project, "Recognizing the Full Value of Energy Efficiency: What's Under the Feel-Good Frosting of the World's Most Valuable Layer Cake of Benefits," September 2013, available at: http://www.raponline.org/document/download/id/6739.

Synapse 2011. Synapse Energy Economics, Inc., "Avoided Energy Supply Costs in New England: 2011 Report," July 21, 2011, amended August 11, 2011, available at: http://www.synapse-energy.com/Downloads/SynapseReport.2011-07.AESC.AESC-Study-2011.11-014.pdf.

Synapse 2012a. Synapse Energy Economics, Inc., "Best Practices in Energy Efficiency Program Screening: How to Ensure that the Value of Energy Efficiency is Properly Accounted For," prepared for the National Home Performance Council, July 2012, available at: http://www.synapse-energy.com/Downloads/SynapseReport.2012-07.NHPC.EE-Program-Screening.12-040.pdf.

Synapse 2012b. Synapse Energy Economics, Inc., "Energy Efficiency Cost-Effectiveness Screening: How to Properly Account for Other Program Impacts and Environmental Compliance Costs," prepared for Regulatory Assistance Project, November 2012, available at: http://www.synapse-energy.com/Downloads/SynapseReport.2012-11.RAP.EE-Cost-Effectiveness-Screening.12-014.pdf.

Synapse 2013a. Synapse Energy Economics, Inc., "Avoided Energy Supply Costs in New England: 2013 Report," July 12, 2013, available at: http://www.synapse-energy.com/Downloads/SynapseReport.2013-07.AESC.AESC-2013.13-029-Report.pdf

Synapse 2013b. Synapse Energy Economics, Inc., "Energy Efficiency Cost-Effectiveness Screening in the Northeast and Mid-Atlantic States," prepared for the Northeast Energy Efficiency Partnerships EM&V Forum, Forthcoming.

Connecticut

CT G.L. 16-245m. Connecticut General Laws, 16-245M, "Conservation and Load Management Program; Charge Assessed Against Electric Customers to Fund Program; Scope and Purpose of Program, available at: http://www.lawserver.com/law/state/connecticut/ct-laws/connecticut_statutes_16-245m.

Connecticut Utilities 2011. Connecticut Utilities, "2012 Electric and Natural Gas Conservation and Load Management Plan," Docket No. 11-10-03, September 30, 2011, available at: http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/2fa1f8d01cfc0cc785257981007276d4/$FILE/2012%20CLM%20Electric%20and%20Gas%20Plan%20FINAL.pdf.

DEEP 2012. Department of Energy and Environmental Protection, "Final Determination to Approve 2012 Conservation and Load Management Expanded Plan and Budget," July 19, 2012, available at: http://www.ctenergyinfo.com/7-19-12%20Final%20Determination%20Expanded%20Plan.pdf.

DEEP 2013. Department of Energy and Environmental Protection, "About Us," accessed on August 15, 2013, available at: http://www.ct.gov/deep/cwp/view.asp?a=2690&q=322476&deepNav_GID=1511.

CT DPUC 1998. Department of Public Utility Control, "DPUC Review of the Connecticut Light and Power Company's 1998 and 1999 Conservation and Load Management Program, Budgets and Conservation Adjustment Mechanism," Docket No. 97-10-23, March 25, 1998, available at: http://www.dpuc.state.ct.us/electric.nsf/60a3df2c610b4cd6852575b3005ce06c/7ffc4cb5809da9ed8525730d0050bd2c?OpenDocument.

CT DPUC 1999. Department of Public Utility Control, "DPUC Review of the Connecticut Light and Power Company's 1999 Conservation and Load Management Programs," Docket No. 98-11-02, June 30, 1999, available at: http://www.dpuc.state.ct.us/electric.nsf/60a3df2c610b4cd6852575b3005ce06c/7ffc4cb5809da9ed8525730d0050bd2c?OpenDocument.

CT DPUC 2003. Department of Public Utility Control, "DPUC Review of the Connecticut Light and Power Company's and the United Illuminating Company's Conservation and Load Management Programs and Budgets for Year 2003 and 2004," Docket No. 03-01-01, May 28, 2003, available at: http://www.dpuc.state.ct.us/electric.nsf/60a3df2c610b4cd6852575b3005ce06c/7ffc4cb5809da9ed8525730d0050bd2c?OpenDocument.

CT DPUC 2010. Department of Public Utility Control, "DPUC Review of the Connecticut Energy Efficiency Fund's 2010 Conservation and Load Management Plan for 2010; DPUC Review of the Connecticut Gas Utilities Forecast of Demand and Supply 2009 – 2013 and Joint Conservation Plan," Dockets 09-10-03 and 08-10-02, March 17, 2010, available at: http://www.dpuc.state.ct.us/DOCKHIST.NSF/$FormDocketElectricView?OpenForm&Start=1&Count=1000&Expand=3&Seq=29&scrollTop=11.

CT DPUC 2011. Department of Public Utility Control, "DPUC Review of the Connecticut Energy Efficiency Fund's Conservation and Load Management Plan for 2011," Docket 10-10-03, January 6, 2011, available at: http://www.dpuc.state.ct.us/DOCKHIST.NSF/$FormDocketElectricView?OpenForm&Start=1&Count=1000&Expand=3&Seq=29&scrollTop=11.

Personal Communication with CT DEEP Staff. Personal Communication with Mark Quinlin of the Department of Energy and Environmental Protection, August 2013.

PURA 2013. Public Utilities Regulatory Authority, "About Us," accessed on August 15, 2013, available at: http://www.ct.gov/pura/cwp/view.asp?a=3157&q=404410&puraNav_GID=1702.

Senate Bill No. 1243, Public Act No. 11-80, "An Act Concerning the Establishment of the Department of Energy and Environmental Protection and Planning for Connecticut's Energy Future," available at: http://www.cga.ct.gov/2011/act/pa/pdf/2011PA-00080-R00SB-01243-PA.pdf.

Illinois

20 ILCS 3855. Illinois Power Agency Act, 20 ILCS 3855, available at: http://www.ilga.gov/legislation/ilcs/ilcs5.asp?ActID=2934&ChapterID=5.

220 ILCS 5. Illinois Public Utilities Act. Illinois Public Utilities Act, 220 ILCS 5, particularly §§ 8-103, 8-103A, 8-104, 8-408, 16-111.5B, available at: http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ChapterID=23&ActID=1277.

DCEO 2013. Illinois Department of Commerce and Economic Opportunity, "Approval of its Energy Efficiency Portfolio and Plan Pursuant to Sections 8-103(e) and (f) and 8-104(e) and (f) of the Public Utilities Act," Docket No. 13-0499, August 30, 2013, available at: http://www.icc.illinois.gov/docket/Documents.aspx?no=13-0499.

Ameren 2013a. Ameren Illinois, "Ameren Illinois 2014-2017 Preliminary Portfolio Modeling for the Illinois Stakeholder Advisory Group," April 30, 2013, available at: http://www.ilsag.info/mm_2013_4_30.html.

Ameren 2013b. Ameren Illinois, "Electric and Gas Energy Efficiency and Demand-Response Plan, Program Years: June 1, 2014 – May 31, 2017 (Plan 3)," Case No. 13-0498, August 30, 2013, available at: http://www.icc.illinois.gov/docket/CaseDetails.aspx?no=13-0498.

ComEd 2010. Commonwealth Edison Company, "2011-2013 Energy Efficiency and Demand Response Plan," Case No. 10-0570, October 1, 2010, available at: http://www.icc.illinois.gov/docket/files.aspx?no=10-0570&docId=156250.

ComEd 2013a. Commonwealth Edison Company, "2014-2016 Energy Efficiency and Demand Response Plan," Case No. 13-0495, August 30, 2013, available at: http://www.icc.illinois.gov/docket/files.aspx?no=13-0495&docId=202448

ComEd 2013b. Commonwealth Edison Company, "Load Forecast for Five-Year Planning Period June 2014 – May 2019," Revised August 9, 2013, available at: http://www2.illinois.gov/ipa/Documents/ComEd%20Load%20Forecast.pdf.

ICC 2010a. Illinois Commerce Commission, "Verified Petition for Approval of Integrated Electric and Natural Gas Energy Efficiency Plan," Case No. 10-0568, December 21, 2010, available at: http://www.icc.illinois.gov/docket/casedetails.aspx?no=10-0568.

ICC 2010b. Illinois Commerce Commission, "Approval of the Energy Efficiency and Demand Response Plan Pursuant to Section 8-103(f) of the Public Utilities Act," Case No. 10-0570, December 21, 2010, available at: http://www.icc.illinois.gov/docket/casedetails.aspx?no=10-0568.

ICC 2012a. Illinois Commerce Commission, "Evaluation of MidAmerican Energy Company Energy Efficiency Programs," Case No. 12-0132, October 17, 2012, available at: http://www.icc.illinois.gov/docket/files.aspx?no=12-0132&docId=188712.

ICC 2012b. Illinois Commerce Commission, "Illinois Power Agency, Petition for Approval of Procurement Plan," Case No. 12-0544, December 19, 2012, available at: http://www.icc.illinois.gov/docket/files.aspx?no=12-0544&docId=191574.

ICC 2013. Illinois Commerce Commission, "Energy Efficiency Workshops 16-111.5B," website accessed on September 23, 2013, available at: http://www.icc.illinois.gov/electricity/EnergyEfficiencyWorkshops161115B.aspx

Personal Communication with ICC Staff. Personal Communication with Jennifer Hinman, David Brightwell, and Thomas Kennedy of the Illinois Commerce Commission, September 2013.

Massachusetts

MA G.L. c. 25. Massachusetts' An Act Relative to Green Communities, Acts of 2008, Chapter 169, Section 11; MA G.L. c. 25, §§ 19-22, available at: https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169.

MA Restructuring Act. Massachusetts' An Act Relative to Restructuring the Electric Utility Industry in the Commonwealth, Regulating the Provision of Electricity and Other Services, and Promoting Enhanced Consumer Protections Therein," Acts of 1997, Chapter 164, available at: https://malegislature.gov/Laws/SessionLaws/Acts/1997/Chapter164.

MA DPU 2008. Massachusetts Department of Public Utilities, "Investigation of the Department of Public Utilities on its Own Motion into Updating its Energy Efficiency Guidelines Consistent with An Act Relative to Green Communities," D.P.U. 08-50, August 22, 2008, available at: http://www.env.state.ma.us/dpu/docs/electric/08-50/82208dpunoi.pdf.

MA DPU 2009a. Massachusetts Department of Public Utilities, "Investigation of the Department of Public Utilities on its Own Motion into Updating its Energy Efficiency Guidelines Consistent with An Act Relative to Green Communities," D.P.U. 08-50-A, March 16, 2009, available at: http://www.env.state.ma.us/dpu/docs/electric/08-50/31609dpuord.pdf.

MA DPU 2009b. Massachusetts Department of Public Utilities, "Investigation of the Department of Public Utilities on its Own Motion into Updating its Energy Efficiency Guidelines Consistent with An Act Relative to Green Communities," D.P.U. 08-50-B, October 26, 2009, available at: http://www.env.state.ma.us/dpu/docs/electric/08-50/102609dpuord.pdf.

MA DPU 2011a. Massachusetts Department of Public Utilities, "Investigation of the Department of Public Utilities on its Own Motion into Updating its Energy Efficiency Guidelines," D.P.U. 11-120, November 29, 2011, available at: http://www.env.state.ma.us/dpu/docs/electric/11-120/112911dpuvord.pdf.

MA DPU 2012. Massachusetts Department of Public Utilities, "Investigation of the Department of Public Utilities on its Own Motion into Updating its Energy Efficiency Guidelines," D.P.U. 11-120, Phase II, May 25, 2012, available at: http://www.env.state.ma.us/dpu/docs/electric/11-120/52512dpuord.pdf.

MA DPU 2013a. Massachusetts Department of Public Utilities, "Order Approving Revised Energy Efficiency Guidelines," D.P.U. 11-120-A, Phase II, January 31, 2013, Appendix A, available at:http://www.env.state.ma.us/dpu/docs/electric/11-120/13113dpuord.pdf

MA DPU 2013b. Massachusetts Department of Public Utilities, "Approval of the Three-Year Energy Efficiency Plans for 2013 through 2015," D.P.U. 12-100 through D.P.U. 12-111, January 31, 2013, available at: http://www.env.state.ma.us/dpu/docs/gas/12-100/13113dpuord.pdf

MA DTE 1999a. Massachusetts Department of Telecommunications and Energy, "Investigation by the Department of Telecommunications and Energy of its Own Motion to Establish Methods and Procedures to Evaluate and Approve Energy Efficiency Programs, pursuant to G.L. c. 25, § 19 and c. 25A, § 11G," D.P.U. 98-100, January 8, 1999, available at: http://www.env.state.ma.us/dpu/docs/electric/98-100/98-100.pdf.

MA DTE 1999b. Massachusetts Department of Telecommunications and Energy, "Investigation by the Department of Telecommunications and Energy of its Own Motion to Establish Methods and Procedures to Evaluate and Approve Energy Efficiency Programs, pursuant to G.L. c. 25, § 19 and c. 25A, § 11G," D.P.U. 98-100, November 4, 1999, available at: http://www.env.state.ma.us/dpu/docs/electric/98-100/order.pdf.

MA DTE 2000. Massachusetts Department of Telecommunications and Energy, "Investigation by the Department of Telecommunications and Energy of its Own Motion to Establish Methods and Procedures to Evaluate and Approve Energy Efficiency Programs, pursuant to G.L. c. 25, § 19 and c. 25A, § 11G," D.P.U. 98-100, February 7, 2000, available at: http://www.env.state.ma.us/dpu/docs/electric/98-100/finalguidelinesorder.pdf.

MA TRM 2012. Massachusetts Technical Reference Manual, 2013-2015 Program Years - Plan Version, October 2012, available at:http://www.env.state.ma.us/dpu/docs/electric/12-107/11212clcptnapn.pdf

NMR 2011. NMR Group, Inc., Tetra Tech, "Massachusetts Program Administrators: Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation," August 15, 2011, available at: http://www.rieermc.ri.gov/documents/evaluationstudies/2011/Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation(76).pdf.

Personal Communication with MA DPU Staff. Personal Communication with Barry Perlmutter of the Massachusetts Department of Public Utilities, August 2013.

Tetra Tech 2012. Tetra Tech, "Massachusetts Program Administrators: Final Report – Commercial and Industrial Non-Energy Impacts Study," June 29, 2012, available at: http://www.maeeac.org/Docs/8.1_EMV%20Page/2012/2012%20General%20Studies%20&%20Presentations/DNV%20KEMA%20Final%20MA%20NEI%20REPORT%20June%2029%202012.pdf.

Michigan

Act 295. Public Act No. 295 of 2008, “Clean, Renewable, and Efficient Energy Act,” effective October 6, 2008, available at: http://www.legislature.mi.gov/documents/2007-2008/publicact/pdf/2008-PA-0295.pdf

Consumers Energy 2012. Consumers Energy Company, “Consumers Energy 2011 Energy Optimization Annual Report,” Case No. U-16736, May 31, 2012, available at: http://efile.mpsc.state.mi.us/efile/docs/16736/0001.pdf

Detroit Edison 2009. Detroit Edison Company, “The Detroit Edison Company’s Energy Optimization Plan Application,” Case No. U-15806-EO, March 4, 2009, available at: http://efile.mpsc.state.mi.us/efile/docs/15806/0025.pdf

MI PSC 2008. Michigan Public Service Commission, Temporary Order, Case No. U-15800, December 4, 2008, available at: http://efile.mpsc.state.mi.us/efile/docs/15800/0001.pdf

Personal Communication with MI PSC Staff. Personal Communication with Robert Ozar of the Michigan Public Service Commission, September 19, 2013.

Minnesota

MN Rules 7690.0550. Minnesota Administrative Rules, “Program Status Report,” available at: https://www.revisor.mn.gov/rules/?id=7690.0550.

MN Rules 7690.1200. Minnesota Administrative Rules, “Biennial Program Approval, Disapproval, Modification,” available at: https://www.revisor.mn.gov/rules/?id=7690.1200

MN Statute 216B.241. The 2012 Minnesota Statutes, “216B.241 Energy Conservation Improvement,” available at: https://www.revisor.mn.gov/statutes/?id=216B.241.

MN DOC 2011. Minnesota Department of Commerce, “Decision Before the Commissioner of the Minnesota Department of Commerce in the Matter of Great Plains Natural Gas Co.’s 2010 CIP Status Report,” Docket No. G004/CIP-09-649.01, October 14, 2011, available at: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={6CF20051-93DA-45D6-A4AD-CB10FC60208C}&documentTitle=201110-67366-01.

MN DER 2010. Minnesota Department of Commerce, Division of Energy Resources, “Decision in the Matter of Great Plains Natural Gas Co.’s 2010 CIP Status Report,” Docket No. G004/CIP-09-649.01, Issued October 14, 2011, available at: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=viewDocument&do

cumentId={6CF20051-93DA-45D6-A4AD-CB10FC60208C}&documentTitle=201110-67366-01&userType=public.

MN DER 2012. Minnesota Department of Commerce, Division of Energy Resources, “Decision in the Matter of the Implementation of Northern States Power Company, a Minnesota Corporation’s 2013/2014/2015 Triennial Natural Gas and Electric Conservation Improvement,” Docket No. E,G002/CIP-12-447, Issued October 1, 2012, available at: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={D700BB53-5F13-4687-8DD6-7A974806A5C3}&documentTitle=201210-79121-01.

MN DER Staff 2012. Minnesota Department of Commerce, Division of Energy Resources, “Analysis, Recommendations, and Proposed Decision of the Staff,” Attachment A, “Inputs to BENCOST For Natural Gas CIPs for the 2013-2015 Conservation Improvement Program Triennium,” Docket No. G007,G011/CIP-12-548, September 6, 2012, available at: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={8E4475FA-5CFC-4697-AE1C-9E4D95245B04}&documentTitle=20129-78436-01.

MN PUC 2013. Minnesota Public Utilities Commission, “In the Matter of the Investigation into Environmental and Socioeconomic Costs Under Minn. Stat. §216B.2422, Subd. 3, Docket Nos. E-999/CI-93-583 and E-999/CI-00-1636; Notice of Updated Environmental Externality Values,” June 5, 2013, available at: http://www.puc.state.mn.us/portal/groups/public/documents/pdf_files/014339.pdf.

Personal Communication with MN DER Staff. Personal Communication with Jessica Burdette of the Minnesota Department of Commerce, Division of Energy Resources, September 2013.

Xcel 2012a. Xcel Energy, “2013/2014/2015 Minnesota Electric and Natural Gas Conservation Improvement Program,” Docket No. E, G002/CIP-12-447, June 1, 2012, available at: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={3E047356-E91F-4FAC-87A6-82959BD7145F}&documentTitle=20126-75251-01.

Xcel 2012b. Xcel Energy, “Division of Energy Resources Information Request No. 1, Docket No. E,G002/CIP-12-447,” July 23, 2012, available at: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={0A2A5A9F-2ADB-443C-BC75-7E8F81E9EF33}&documentTitle=20127-77080-01.

New York

ConEdison 2013. Consolidated Edison Company of New York, Inc., “Report of Consolidated Edison Company of New York, Inc. on the Assessment of the Potential for a Customer-Funded Steam Energy Efficiency Incentive Program,” PSC Case Nos. 09-S-0794 and 09-S-0029, January 29, 2013.

NYSERDA 2011. New York State Energy Research and Development Authority, "Energy Efficiency Portfolio Standard: Supplemental Revision to the System Benefit Charge (SBC) Operating Plan (2012-2015)," December 22, 2011.

NY DPS 2011. New York Department of Public Service Staff, "Energy Efficiency Portfolio Standard Program Review White Paper," CASE 07-M-0548, July 6, 2011, available at: http://www3.dps.ny.gov/W/PSCWeb.nsf/0/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument.

NY PSC 2008. New York Public Service Commission, "Order Establishing Energy Efficiency Portfolio Standard and Approving Programs," Case 07-M-0548, June 23, 2008, available at: http://www3.dps.ny.gov/W/PSCWeb.nsf/0/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument.

NY PSC 2009a. New York Public Service Commission, "Order Approving "Fast Track" Utility-Administered Electric Energy Efficiency Programs with Modifications," Case 07-M-0548, January 16, 2009, available at: http://www3.dps.ny.gov/W/PSCWeb.nsf/0/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument.

NY PSC 2009b. New York Public Service Commission, "Order Approving Multifamily Energy Efficiency Programs with Modifications," Case 07-M-0548, July 27, 2009, available at: http://www3.dps.ny.gov/W/PSCWeb.nsf/All/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument.

NY PSC 2010. New York Public Service Commission, "Order Approving Certain Commercial and Industrial Residential; and Low-Income Residential Customer Energy Efficiency Programs with Modifications," Case 07-M-0548, January 4, 2010, available at: http://www3.dps.ny.gov/W/PSCWeb.nsf/All/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument.

NY PSC 2011a. New York Public Service Commission, "Order Approving Modifications to the Energy Efficiency Portfolio Standard (EEPS) Program to Streamline and Increase Flexibility in Administration," Case 07-M-0548, June 20, 2011, available at: http://www3.dps.ny.gov/W/PSCWeb.nsf/0/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument.

NY PSC 2011b. New York Public Service Commission, "Order Approving Modifications to the Technical Manual," Case 07-M-0548, July 18, 2011, available at: http://www3.dps.ny.gov/W/PSCWeb.nsf/0/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument.

NY PSC 2011c. New York Public Service Commission, "Order Authorizing Efficiency Programs, Revising Incentive Mechanism, and Establishing a Surcharge Schedule," Cases 07-M-0548 and 07-G-0141, October 25, 2011, available at: http://www3.dps.ny.gov/W/PSCWeb.nsf/0/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument.

Personal Communication NY DPS Staff. Personal Communication with Harvey Tress of New York State Department of Public Service, various dates and emails, May through August 2013.

Oregon

ETO Methodology 2011. Energy Trust of Oregon, “4.06.000-P Cost-Effectiveness Policy and General Methodology for Energy Trust of Oregon,” December 16, 2011, available at: http://energytrust.org/library/policies/4.06.000.pdf

ETO Risk Avoidance 2005. Risk Avoidance Value for Energy Efficiency, a summary of Risk Avoidance Value in the 5th Power Plan prepared for the Energy Trust of Oregon staff, November 2005

ETO Website 2013. Energy Trust of Oregon, "Who We Are," accessed on September 17, 2013, available at: http://energytrust.org/about/who-we-are/

OR PUC 1994. Public Utility Commission of Oregon, "In the Mater of the Investigation into the Calculation and Use of Cost-Effectives Levels for Conservation," Docket UM 551, Order 94-590, April 6, 1994, available at: http://apps.puc.state.or.us/edockets/docket.asp?DocketID=4744.

Personal Communication with ETO Staff. Personal Communication with Fred Gordon of the Energy Trust of Oregon, September 2013.

Personal Communication with OR PUC staff. Personal Communication with Lynn Kittilson of the Oregon Public Utilities Commission, January 20, 2009.

Fifth Northwest Power Plan 2005. Northwest Power and Conservation Council Sixth Northwest Power Plan, "Appendix P: Treatment of Uncertainty and Risk," *The Fifth Northwest Electric Power and Conservation Plan*, May 2005, available at: http://www.nwcouncil.org/energy/powerplan/5/plan/

Sixth Northwest Power Plan 2010. Northwest Power and Conservation Council Sixth Northwest Power Plan, "Statement of Basis and Purpose for the Sixth Power Plan and Response to Comments on the Draft Sixth Power Plan," April 2010, available at: http://www.nwcouncil.org/media/6278/Final_Statement_of_Basis_and_Purpose_Sixth_Power_Plan_April_2010.pdf

Vermont

Efficiency Vermont 2011. Efficiency Vermont, "Policy 1029: Efficiency Cost-Effectiveness Analysis Policy and Practice," May 23, 2011, available at:http://www.greenmountainpower.com/upload/photos/372EVT_-_Cost_Effectiveness_Analysis_Policy.pdf.

Personal Communication with VEIC Staff. Personal Communication with Erik Brown of Vermont Energy Investment Corporation, April 2013.

Personal Communication with VT PSD Staff. Personal Communication with Walter Poor of the Vermont Public Service Department, August 2013.

VT DPS 2011. Vermont Department of Public Service, "Department of Public Service Comments in the Cost-Effectiveness Screening of Efficiency Measure Workshop Process Related to Non-Energy Benefits, Discount Rate, Risk Adjustment, and Low-Income Adders," December 9, 2011, available at: http://psb.vermont.gov/docketsandprojects/eeu/screening.

VT PSB 1990a. Vermont Public Service Board, "Board Decision Adopting (as modified) Hearing Officer's Report and Proposal for Decision," Docket 5270, April 16, 1990.

VT PSB 1990b. Vermont Public Service Board, "Process & Administration of an EEU Order of Appointment," Docket 5270, June 1, 1990.

VT PSB 2011. Vermont Public Service Board, "Order Re: EEU Avoided Costs," Docket EEU-2011-02, October 17, 2011, available at:http://psb.vermont.gov/sites/psb/files/orders/2011/2011-2/EEU-2011-02.ORD2011avoidedcosts.pdf.

VT PSB 2012a. Vermont Public Service Board, "Order Re: Cost-Effectiveness Screening of Heating and Process-Fuel Efficiency Measures and Modifications to State Cost-Effectiveness Screening Tool," February 7, 2012, available at:http://psb.vermont.gov/sites/psb/files/orders/2012/2012-4/OrderReCostEffectivenessScreeningofHeating.pdf.

VT PSB 2012b. Vermont Public Service Board, "Order Re: EEU Avoided Costs for Transmission & Distribution," Docket EEU-2011-02, December 13, 2012.

30 VSA § 209. Vermont Statutes Annotated, Title 30, Chapter 5, 30 VSA § 209, "Jurisdiction; general scope," available at: http://www.leg.state.vt.us/statutes/fullsection.cfm?Title=30&Chapter=005&Section=00209.

30 VSA § 218c. Vermont Statutes Annotated, Title 30, Chapter 5, 30 VSA § 218c, "Least cost integrated planning," available at: http://www.leg.state.vt.us/statutes/fullsection.cfm?Title=30&Chapter=005&Section=00218c.

Volz, James, et al., "Memorandum: Adoption of Revised Avoided Costs for Energy Efficiency Screening," November 30, 2009.

Wisconsin

Cadmus 2012. The Cadmus Group, "Focus on Energy: Calendar Year 2012 Evaluation Report", August 28, 2013, available at: http://www.focusonenergy.com/sites/default/files/FOC_XC_CY%2012%20Report%20Volume%20I%20Final_08-28-2013.pdf.

Personal Communication with WI PSC Staff. Personal Communication with Carol Stemrich of the Wisconsin Public Service Commission, September 2013.

WI Legislature 196. Wisconsin State Legislature, "Chapter 196, Regulation of Public Utilities," available at: https://docs.legis.wisconsin.gov/statutes/statutes/196/374/3/e/2.

WI PSC 2007. Public Service Commission of Wisconsin, "Chapter PSC 137: Energy Efficiency and Renewable Resource Programs," July 2007, available at: http://docs.legis.wisconsin.gov/code/admin_code/psc/137.

WI PSC 2010. Public Service Commission of Wisconsin, "Quadrennial Planning Process Order," Docket 5-GF-191, PSC REF# 141173, November 10, 2010, available at: http://www.aceee.org/files/state/WI_5-GF-191_Order.pdf.

WI PSC 2012a. Public Service Commission of Wisconsin, "Final Strategic Energy Assessment: Energy 2018," Docket 5-ES-106, PSC Ref# 176432, November 2012, available at: http://psc.wi.gov/hotTopics/sea.htm.

WI PSC 2012b. Public Service Commission of Wisconsin, "Quadrennial Planning Process Order," Docket 5-GF-191, PSC REF# 166932, June 20, 2020, available at: http://psc.wi.gov/apps35/ERF_view/viewdoc.aspx?docid=166932.

Appendix A – State Cost-Effectiveness Survey Results

Table A.1: Michigan

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		Reduce the future costs of service to customers	**Source**: Act 295, § 71(1)(a); Personal Communication with MI PSC Staff. **Note**: "The overall goal of an energy optimization plan shall be to reduce the future costs of provider service to customers. In particular, an EO plan shall be designed to delay the need for constructing new electric generating facilities and thereby protect consumers from incurring the costs of such construction." The state's immediate goal was to quickly and efficiency implement programs as there were previously none.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Program Administrator Cost Test	**Source**: Act 295, § 73(2). **Note**: "The commission shall not approve a proposed energy optimization plan unless the commission determines that the EO plan meets the utility system resource cost test and is reasonable and prudent."
	Other Test(s) considered (if applicable)	TRC, RIM, Participant Cost	**Source**: MI PSC 2008, Appendix E, 1.e. **Note**: "In order to provide the Commission with sufficient information to support the proposed distribution of energy optimization funds among the portfolio of proposed programs, the filed plan will include multiple cost-effectiveness tests for individual programs including: USRCT, Total Resource Cost Test, Rate Impact Measure Test and Participant Cost Tests."
	Level at which Test(s) is applied	Portfolio	**Source**: MI PSC 2008, Appendix E, 2.a. **Note**: "Cost effective means that the overall plan being evaluated meets the Utility System Resource Cost Test."
	Other level(s) at which Test(s) is applied (if applicable)	Program, Measure	**Source**: MI PSC 2008, Appendix E, 1.e; Personal Communication with MI PSC Staff. **Note**: "In order to provide the Commission with sufficient information to support the proposed distribution of energy optimization funds among the portfolio of proposed programs, the filed plan will include multiple cost-effectiveness tests for individual programs."
	Discount rate used in Test(s)	Utility WACC	**Source**: Consumers Energy 2012, p 18; Detroit Edison 2009, Morgan Testimony, RAM-17; Personal Communication with MI PSC Staff. **Note**: The discount rate is based on a utility's weighted average cost of capital, which varies by utility. The utilities' typical discounts rates range between 7% and 10%, and are about 8% on average. Consumers Energy uses a discount rate of 9.78% for both energy efficiency programs and supply side resources.
	Study period over which Test(s) is applied	Measure Life	**Source**: Personal Communication with MI PSC Staff. **Note**: The deemed savings database previously limited measure lives to 20 years, but that cap has since been lifted to allow for the full lifetime of the measures installed.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source**: MI PSC 2008, Appendix E, 2.f. **Note**: The Utility Cost Test takes into account the avoided supply costs of demand and capacity valued at marginal costs for the periods when there is a load reduction. At the option of the provider, either the cost-based value provided by the commission or the MISO market-based value can be used as a determinant in estimating the avoided cost.
	Energy Costs	Yes	**Source**: MI PSC 2008, Appendix E, 2.f. **Note**: The Utility Cost Test takes into account the avoided supply costs of energy and generation. At the option of the provider, either the cost-based value provided by the commission or the MISO market-based value can be used as a determinant in estimating the avoided cost.
	T&D Costs	Yes	**Source**: MI PSC 2008, Appendix E, 2.f; Personal Communication with MI PSC Staff. **Note**: The Utility Cost Test takes into account the reduction in transmission and distribution, although the avoided cost varies by utility and can be relatively low.
	Environmental Compliance	No	**Source**: MI PSC 2008, Appendix E, 2.f; Personal Communication with MI PSC Staff. **Note**: The avoided supply costs of future carbon tax has been included for renewable energy programs, but not for energy efficiency programs. Current environmental compliance costs are embedded in avoided energy costs.
	Price Suppression	No	
	Line Loss Costs	Yes	**Source**: Personal Communication with MI PSC Staff; Consumers Energy 2012, pp 18-19. **Note:** The Utility Cost Test takes into account the avoided cost of transmission and distribution line losses. For example, the Consumers Energy line loss study was used to value losses at the secondary, primary, and transmission voltage levels.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source**: Act 295, § 71(3)(g). **Note**: Low-income program offerings are excluded from the cost-effectiveness requirement.
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	No	**Source**: Personal Communication with MI PSC Staff. **Note:** Natural gas savings are quantified in natural gas programs, but are not included in electric energy efficiency programs.
	Low-Income	Yes - Qualitative	**Source**: Act 295, § 71(3)(g). **Note**: Low-income program offerings are excluded from the cost-effectiveness requirement.
	Equipment	No	
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Table A.2: Connecticut

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		Focus on electric system impacts only	**Source:** CT DPUC 1999.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Program Administrator Cost Test	**Source**: DEEP 2012, pp 19-20. **Note**: Also referred to as the Utility Cost Test, Electric System Test, or Gas System Test.
	Other Test(s) considered (if applicable)	TRC	**Source**: DEEP 2012, pp 19-20.
	Level at which Test(s) is applied	Program	**Source:** CT G.S. §16-245m (d)(1).
	Other level(s) at which Test(s) is applied (if applicable)	n/a	
	Discount rate used in Test(s)	Cost of Capital	**Source**: Connecticut Utilities 2011, pp 331. **Note**: Each CT utilities' after-tax cost of capital is weighted by utility, and the weighted average cost of capital is used by all utilities. The average is compared to 7%, and the higher value is used. The current rate is 7.43% for electric programs. The inflation rate of 2 percent based on the 2011 AESC.
	Study period over which Test(s) is applied	Measure Life	**Source**: Connecticut Utilities 2011, p 323.
Avoided Costs Included in Primary Cost-Effectiveness Test	Capacity Costs	Yes	**Source**: Connecticut Utilities 2011, pp 320-322. **Note**: Values from Synapse 2011.
	Energy Costs	Yes	**Source**: Connecticut Utilities 2011, pp 320-324. **Note**: Values from Synapse 2011.
	T&D Costs	Yes	**Source**: Connecticut Utilities 2011, pp 320-323, 326-328. **Note**: Values from independent consultant quantifications.
	Environmental Compliance	Yes	**Source**: Connecticut Utilities 2011, pp 320-322, 329. **Note**: Values from Synapse 2011.
	Price Suppression	Yes	**Source**: Connecticut Utilities 2011, pp 320-322, 327-328. **Note**: Values from Synapse 2011.
	Line Loss Costs	Yes	**Source**: Connecticut Utilities 2011, pp 320-322, 327-328; Personal Communication with CT DEEP Staff. **Note**: Values from Synapse 2011.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Test(s)?	Yes	
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	No	
	Low-Income	Yes - Qualitative	**Source**: CT DPUC 1999; CT DPUC 2010. **Note**: Low-income programs that do not pass the cost-effectiveness test are still approved due to additional benefits that accrue to low-income customers.
	Equipment	No	
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Table A.3: Illinois

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		Diverse program offerings to customers	**Source:** 220 ILCS 5/8-103, § 8-103(f)(5). **Note**: "The utility shall demonstrate that its overall portfolio of energy efficiency and demand-response measures... represent a diverse cross-section of opportunities for customers of all rate classes to participate in the programs."
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Total Resource Cost Test	**Source:** 220 ILCS 5/8-103,§103(a). **Note**: "cost-effective" means that the measures satisfy the total resource cost test.
	Other Test(s) considered (if applicable)	PAC	**Source:** 220 ILCS 5/16-111.5B(a)(3)(D); ComEd 2013b, p 26. **Note:** Show that "the new or expanded cost-effective energy efficiency programs or measures would lead to a reduction in the overall cost of electric service."
	Level at which Test(s) is applied	Portfolio or Program	**Source**: 220 ILCS 5/8-103,§103(a); 5/16-111.5B. **Note**: Section 8-103 programs are required to screen at the portfolio level. IPA programs are required to screen at the program level.
	Other level(s) at which Test(s) is applied (if applicable)	Portfolio, Program, Measure	**Source**: ICC 2010, p 30; Personal Communication with ICC Staff. **Note**: The Commission finds that evaluating cost-effectiveness on a portfolio level is necessary to ensure that Ameren not be penalized for planning assumptions that turn out to be inaccurate. The Commission concludes it is appropriate to apply the TRC test at the portfolio level, but Ameren Illinois and the DCEO should be allowed to apply it at the measure or program level if they so choose.
	Discount rate used in Test(s)	WACC	**Source:** Ameren 2013b, Testimony of Andrew Cottrell, p 10; Exh. 1.1, App. D, Vol. 3, p 2-23. **Note:** Ameren Illinois used the corporate weighted average cost of capital. Ameren's nominal discount rate is 7% with an inflation rate of 2.92%, for a real discount rate of 3.93%.
	Study period over which Test(s) is applied	Measure Life	**Source**: 20 ILCS 3855/1-10. **Note**: "The benefit-cost ratio is the ratio of the net present value of the total benefits of the program to the net present value of the total costs as calculated over the lifetime of the measures."
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** Ameren 2013b, pp 26-27.
	Energy Costs	Yes	**Source:** Ameren 2013b, pp 25-26.
	T&D Costs	Yes	**Source:** Ameren 2013b, pp 27-29.
	Environmental Compliance	Yes	**Source:** 20 ILCS 3855/1-10. **Note**: In calculating avoided costs of power and energy that an electric utility would otherwise have had to acquire, reasonable estimates shall be included of financial costs likely to be imposed by future regulations and legislation on emissions of greenhouse gases.
	Price Suppression	No	**Source:** See ICC 2012, p 270.
	Line Loss Costs	Yes	**Source:** Ameren 2013b, Testimony of Andrew Cottrell, pp 9-10; Exh. 1.1, App. D, Vol. 3, p 2-23. **Note**: Each avoided cost is adjusted upwards in the TRC calculation by the appropriate line loss factor. Ameren uses an electric delivery losses factor of 6.7% and a natural gas delivery losses factor of 0.0085%.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source:** 20 ILCS 3855/1-10. **Note**: A total resource cost test compares the sum of avoided electric utility costs, representing the benefits that accrue to the system and the participant in the delivery of those efficiency measures, as well as other quantifiable societal benefits, including avoided natural gas utility costs.
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	Yes - Quantified	**Source:** 20 ILCS 3855/1-10; Ameren 2013b, pp 24-25. **Note**: Natural gas and water.
	Low-Income	Yes - Qualitative	**Source:** 220 ILCS 5/8-103,§103(a). **Note**: Low-income measures shall not be required to meet the total resource cost test.
	Equipment	No	
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Table A.4: Massachusetts

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		All available cost-effective energy efficiency	**Source:** MA G.L. c. 25.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Total Resource Cost Test	**Source:** MA DPU 2013a, Guidelines § 3.4.3.
	Other Test(s) considered (if applicable)	n/a	
	Level at which Test(s) is applied	Program level	**Source:** MA DPU 2013a, Guideline § 3.4.3.1. **Notes:** Hard-to-measure EE programs are screened at the customer sector level. MA EE Guidelines, § 3.4.3.2.
	Other level(s) at which Test(s) is applied (if applicable)	n/a	
	Discount rate used in Test(s)	10 year Treasury Note	**Source:** MA DPU 2013a, Guideline § 3.4.6. **Note:** "A discount rate that is equal to a twelve-month average of the historic yields from the ten-year United States Treasury note, using the previous calendar year to determine the twelve-month average." In the 2013-2015 plans, the nominal discount rate was 2.78% and the real discount rate was 0.55%.
	Study period over which Test(s) is applied	Measure Life	25 years.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(a)(i). **Note:** Values from Synapse 2011.
	Energy Costs	Yes	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(a)(ii). **Note:** Values from Synapse 2011.
	T&D Costs	Yes	**Source:** MA DPU 2013a, Guidelines § 3.4.4.1(a)(iii), (iv). **Note:** Values developed individually by Program Administrators.
	Environmental Compliance	Yes	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(a)(v). **Notes:** "Reasonably projected to be incurred in the future." Values from Synapse 2011.
	Price Suppression	Yes	**Source:** MA DPU 2013a, Guidelines § 3.4.4.1(a)(vi), (vii). **Notes:** Both capacity and energy price suppression. Values from Synapse 2011.
	Line Loss Costs	Yes	**Note:** Values from Synapse 2011.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source:** MA DPU 2013a, Guidelines § 3.4.4.1(a)(viii), (b)(ii). **Note:** Each OPI is explicitly quantified.
	Program Administrator or Utility OPIs	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(a)(viii). **Note:** Each OPI is explicitly quantified.
	Participant or Customer OPIs:		**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii). **Note:** Each OPI is explicitly quantified.
	Resource	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(i). **Notes:** Includes natural gas, oil, propane, wood, kerosene, water, other. Each OPI is explicitly quantified.
	Low-Income	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii)(D). **Notes:** Includes all benefits associated with providing energy efficiency services to Low-Income Customers. Each OPI is explicitly quantified.
	Equipment	Yes - Quantified	**Source:** MA DPU 2013a, Guidelines § 3.4.4.1(b)(ii)(A), (B). **Notes:** Includes reduced costs for operation and maintenance associated with efficient equipment or practices, the value of longer equipment replacement cycles and/or productivity improvements associated with efficient equipment. Each OPI is explicitly quantified.
	Comfort	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii). **Note:** Each OPI is explicitly quantified.
	Health & Safety	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii)(C). **Notes:** Includes reduced environmental and safety costs, such as those for changes in a waste stream or disposal of lamp ballasts or ozone-depleting chemicals. Each OPI is explicitly quantified.
	Property Value	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii). **Note:** Each OPI is explicitly quantified.
	Utility Related	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii). **Notes:** Includes reductions in all costs to the electric distribution company associated with reduced customer arrearages and reduced service terminations and reconnections. Each OPI is explicitly quantified.
	Societal OPIs	No	**Source:** MA DPU 2013b, pp 105-106. **Note:** The MA DPU explicitly directed the removal of certain societal OPIs from TRC test.

Table A.5: Minnesota

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		Achieve annual savings goal of 1.5% of sales	**Source:** MN Statute 216B.241, Subp. 1c; Personal Communication with MN DER Staff.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Societal Cost Test	**Source:** MN Rules 7690.1200, Subp. 1(c); MN DOC 2011, p 7. **Note**: Although Minnesota Rules require utilities to file cost-effectiveness results from all four perspectives, DER focuses on the Societal test as it measures the ratio of overall benefits and costs to society of energy conservation improvements.
	Other Test(s) considered (if applicable)	PAC, Participant Cost, TRC, RIM	**Source:** MN Rules 7690.1200, Subp. 1(c); MN Rules 7690.0550, Subp. E; Personal Communication with MN DER Staff. **Note**: a utility should provide information on the cost-effectiveness of its programs, as calculated from the utility, participant, ratepayer, and societal perspectives.
	Level at which Test(s) is applied	Segment (essentially Sector)	**Source:** MN DER 2012, pp 9-10. **Note**: In April 2012, the DER announced a policy for 2013-2015 CIP plans that requires portfolios to be cost-effective at the segment level, rather than the program level. Segments include business; residential; low-income; planning; research, evaluations and pilots; renewable energy; and assessments.
	Other level(s) at which Test(s) is applied (if applicable)	Portfolio, Program, Measure	**Source:** Personal Communication with MN DER Staff. **Note:** The MN DER reviews cost-effectiveness results at the portfolio and program levels, and sometimes at the measure level.
	Discount rate used in Test(s)	Social Discount Rate, WACC	**Source:** MN DER Staff 2012, Inputs 11-13; Xcel 2012a, p 481. **Note**: The Societal Discount Rate is based on the US Treasury's 20-year constant maturity rate, which was 2.67% as of January 3, 2012. The Utility Discount Rate is a utility's weighted cost of capital approved in the utility's most recent rate case. Xcel Energy's WACC was 7.04% in the utility's 2010 rate case. For the Societal Cost test, residential programs use the societal discount rate, and commercial programs use the utility discount rate. The Participant Test uses the societal discount rate, and the PAC test uses the utility discount rate.
	Study period over which Test(s) is applied	15 years	**Source:** MN DER Staff 2012, Input 20; Personal Communication with MN DER Staff. **Note**: The Project Life is the expected lifetime of a particular energy conservation measure, expressed in number of years. The measure life is capped at 15 years.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** Xcel 2012a, p 478; Xcel 2012b. **Note:** Avoided Generation included in Avoided Revenue Requirements.
	Energy Costs	Yes	**Source:** Xcel 2012a, p 478; Xcel 2012b. **Note:** Avoided Marginal Energy included in Avoided Revenue Requirements; Bill Reduction included in Participant Benefits.
	T&D Costs	Yes	**Source:** Xcel 2012a, p 478; Xcel 2012b. **Note:** Avoided T&D included in Avoided Revenue Requirements.
	Environmental Compliance	Yes	**Source:** Xcel 2012a, p 478; MN PUC 2013. **Note:** Avoided Environmental Externality included in Avoided Revenue Requirements.
	Price Suppression	No	
	Line Loss Costs	Yes	**Source:** Personal Communication with MN DER Staff. **Note:** Typically the utility will provide line loss values. If not, the MN DER will assume 8%.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source:** Xcel 2012a, p 478.
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	No	
	Low-Income	Yes - Qualitative	**Source:** MN DER 2012, p 10. **Note:** Due to their unique purpose and the spending requirement for low-income projects, the Commissioner has not required low-income programs to pass the Societal Cost test in previous triennials.
	Equipment	No	
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Table A.6: New York

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
	Primary Policy Driver	Maximize cost-effectiveness given limited funding	**Source:** NY PSC 2008.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Total Resource Cost Test	**Source:** NY PSC 2008, App. 3.
	Other Test(s) considered (if applicable)	n/a	**Source:** Personal Communication with NY DPS Staff; ConEdison 2013. **Notes:** A couples of times in recent years rate impact assessments were considered as part of energy efficiency screening.
	Level at which Test(s) is applied	Measure Level	**Source**: Personal Communication with NY DPS Staff; NY PSC 2011a, p 10. **Note:** Measures are pre-screened for cost-effectiveness.
	Other level(s) at which Test(s) is applied (if applicable)	Project, Program	**Source**: Personal Communication with NY DPS Staff; NY PSC 2011a, p 10. **Note:** Project level screenings are conducted and are not provided to the DPS staff but are subject to audit. New programs are often screened at the program level, but the results do not impact the DPS's determination.
	Discount rate used in Test(s)	Utility Weighted Debt/Equity Cost of Capital	**Source:** NYSERDA 2011, p 8-8; Personal Communication with NY DPS Staff. **Notes:** Currently 5.5% real, 7.72% nominal.
	Study period over which Test(s) is applied	Measure Life	**Source**: NYSERDA 2011, p 8-8; NYDPS; NY PSC 2011b. **Notes:** Estimated mean measure lifetime.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** NY PSC 2009a, pp 33-38. **Notes:** Generation is based on FERC price-setting and NYISO market values, with projections based on need date.
	Energy Costs	Yes	**Source**: NY PSC 2009a, pp 33-38. **Notes:** Baseline year historic NYISO LBMPs with projections based on MAPS simulations.
	T&D Costs	Yes	**Source:** NY PSC 2009a, pp 33-38. **Notes**: Values established by tariff studies. Avoided transmission costs embedded in avoided energy costs.
	Environmental Compliance	Yes	**Source:** NY PSC 2008. **Notes:** credit for avoided CO2 emissions at $15/ton
	Price Suppression	No	
	Line Loss Costs	Yes	**Source:** NY PSC 2009a, App. 2. **Note:** Divide marginal costs by 0.928 or multiply the savings by (1+7.76%). Avoided transmission line loss costs embedded in avoided energy costs.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Cost-Effectiveness Test(s)	Are OPIs included in Test(s)?	Yes	**Source:** NY PSC 2008; Personal Communication with NY DPS Staff. **Note:** The DPS provides guidelines for program administrators to report various OPIs qualitatively. In practice, only CO2 and low income benefits have been incorporated into screening practices.
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	Yes - Quantified	**Source:** Personal Communication with NY DPS Staff. **Notes:** Includes water and other fuels. Can be modeled as a reduced O&M cost as subtracted from measure costs.
	Low-Income Only	Yes - Qualitative	**Source:** NY PSC 2010, pp 64-65. **Note:** Co-benefits considered as part of qualitative analysis, including effect on low-income customers. At least one low-income program was approved despite a TRC ratio less than 1.0.
	Equipment	Yes - Qualitative	**Source:** Personal Communication with NY DPS Staff. **Notes:** Flexibility for O&M savings.
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Table A.7: Oregon

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		All-Cost Effective Measures	**Source:** Sixth Northwest Power Plan, p 6; Personal Communication with ETO Staff. **Note:** "Cost-effective energy efficiency should be developed aggressively and consistently for the foreseeable future. The Council's plan demonstrates that cost-effective efficiency improvements could on average meet 85 percent of the region's load growth over the next 20 years."
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Total Resource Cost Test	**Source:** OR PUC 1994. **Note:** The docket calls for an amended application of the TRC as it only examines benefits direct to the utility and ratepayers.
	Other Test(s) considered (if applicable)	PAC	**Source:** ETO Methodology 2011.
	Primary Level at which Test(s) is applied	Program	**Source:** OR PUC 1994.
	Other level(s) at which Test(s) is applied (if applicable)	Measure	**Source:** OR PUC 1994.
	Discount rate used in Test(s)	Risk-adjusted cost of capital	**Source:** Personal Communication with ETO Staff. **Note:** Risk-adjusted cost of capital, as established by Utility IRPs and accepted/allowed by the PUC. As of 2009, it was 5.2%.
	Study period over which Test(s) is applied	Measure Life	**Source:** Personal Communication with ETO Staff.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** ETO Methodology 2011.
	Energy Costs	Yes	**Source:** ETO Methodology 2011, p 2.
	T&D Costs	Yes	**Source:** ETO Methodology 2011.
	Environmental Compliance	Yes	**Source:** Personal Communication with ETO Staff. **Note:** Avoided environmental compliance costs are embedded in market predictions. For instance, carbon regulation risk is assumed to be included in price forecasts utilized by utilities.
	Price Suppression	No	**Source:** Personal Communication with ETO Staff.
	Line Loss Costs	Yes	**Source:** ETO Methodology 2011.
	Reduced Risk	Yes	**Source:** Fifth Northwest Power Plan 2005; ETO Methodology 2011. **Note:** 10% credit for energy efficiency that acts as a "catch-all" for other avoided costs that aren't quantifiable. Specifically, this credit recognizes the benefits of conservation in addressing risk and uncertainty.
	Other Avoided Costs	Yes	**Source:** ETO Methodology 2011. **Note:** A range of risk avoidance values are applied from $5/MWh for discretionary programs to $10/MWh for lost opportunity programs. A 10% credit for energy efficiency that acts as a "catch-all" for other avoided costs that aren't quantifiable.
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** 10% credit for energy efficiency that acts as a "catch-all" for other avoided costs that aren't quantifiable.
	Program Administrator or Utility OPIs	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Participant or Customer OPIs:		
	Resource	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Low-Income	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Equipment	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Comfort	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Health & Safety	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Property Value	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Utility Related	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Societal OPIs	No	**Source:** Personal Communication with ETO Staff. **Note:** PUC only accounts for benefits to participants and the utility system.

Table A.8: Vermont

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		Least cost planning including environmental costs	**Source:** 30 VSA § 218c
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Societal Cost Test	**Source:** VT PSB 1990a, Section V.14.
	Other Test(s) considered (if applicable)	PAC, TRC	**Source:** Personal Communication with VT PSD Staff. **Note:** Efficiency programs are required to meet the Program Administrator test in order for the utility to receive a performance incentive. Further, 25% of the utility's performance incentive is based on the Total Resource Benefits achieved.
	Level at which Test(s) is applied	Portfolio	**Source:** Efficiency Vermont 2011, pp 3-5. **Note:** The decisive "test" under each perspective is the size of the net benefits, rather than the benefit/cost ratio.
	Other level(s) at which Test(s) is applied (if applicable)	Program, Project, Measure	**Source:** Efficiency Vermont 2011, pp 3-5. **Note:** Because cost-effectiveness of the portfolio is the primary objective, cost-effectiveness of any one component of the portfolio is secondary. The relative importance of cost-effectiveness of each component is hierarchical: (i) measure-level cost-effectiveness is subordinate to project-level cost-effectiveness; (ii) Individual measure- and project-level cost-effectiveness are subordinate to program cost-effectiveness; and (iii) Individual program cost-effectiveness is subordinate to overall portfolio cost-effectiveness.
	Discount rate used in Test(s)	Societal Discount Rate	**Source:** VT PSB 2012a, p 21. **Note:** Discount rate is 3% (real dollars), which is revisited as part of the biennial EEU avoided-cost proceedings.
	Study period over which Test(s) is applied	Measure Life	**Source:** Efficiency Vermont 2011, p 4; Personal Communication with VEIC and VT PSD Staff. **Note**: Cost-effectiveness is assessed over the near term (3 years or less) and longer term (3-20 years). However, 30 years is the maximum number of years allowed in the screening analysis, and there have been instances of even longer measures lives.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** VT PSB 2011. **Note:** Values from Synapse 2011.
	Energy Costs	Yes	**Source:** VT PSB 2011. **Note:** Values from Synapse 2011.
	T&D Costs	Yes	**Source:** VT PSB 2012b. **Note:** T&D working group established by VT Public Service Board.
	Environmental Compliance	Yes	**Source:** VT PSB 2011. **Notes:** Environmental compliance and "externality" values from Synapse's 2011 AESC Study are used for the Societal Cost Test. Externality values not used for TRB or PA tests.
	Price Suppression	No	**Source:** Volz, James, et al. **Notes:** Memo denies the use of price suppression effects for Vermont.
	Line Loss Costs	Yes	**Source:** Personal Communication with VEIC.
	Reduced Risk	Yes	**Source:** VT PSB 2012a, p 23. **Note:** Costs of efficiency measures are decreased by 10%, which will be revisited in the next biennial EEU avoided-cost proceeding.
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source:** VT PSB 2012a, p 26. **Note:** A 15% adder is applied to energy benefits.
	Program Administrator or Utility OPIs	Yes - 15% Adder	**Note:** Included in the 15% adder.
	Participant or Customer OPIs:		
	Resource	Yes - 15% Adder	**Source:** VT PSB 2012a. **Note:** Water and fuel savings and benefits are directly calculated, separate from the 15% adder.
	Low-Income	Yes - Additional 15% Adder	**Source:** VT PSB 2012a, p 33. **Note:** An additional 15% adder is applied to the energy benefits of the low-income sector.
	Equipment	Yes - 15% Adder	**Source:** VT PSB 2012a. **Note:** Changes in O&M expenses by measure are directly calculated, separate from the 15% adder.
	Comfort	Yes - 15% Adder	**Note:** Included in the 15% adder.
	Health & Safety	Yes - 15% Adder	**Note:** Included in the 15% adder.
	Property Value	Yes - 15% Adder	**Note:** Included in the 15% adder.
	Utility Related	Yes - 15% Adder	**Note:** Included in the 15% adder.
	Societal OPIs	Yes - 15% Adder	**Source:** VT PSB 2011. **Note**: Included in the 15% adder.

Table A.9: Wisconsin

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		All cost-effectiveness energy efficiency up to funding cap	**Source:** Personal Communication with WI PSC Staff.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Modified Total Resource Cost Test	**Source:** Cadmus 2012, p 48; WI PSC 2010. **Note**: The TRC is used because it is "consistent with the Commission's focus on energy use and peak demand reduction." Michigan refers to its primary cost-effectiveness test as the modified TRC to distinguish it from the expanded TRC test, which is also used in cost-effectiveness screening.
	Other Test(s) considered (if applicable)	PAC, Expanded TRC	**Source:** WI PSC 2010. **Note**: "the modified TRC test does not provide useful guidance for appropriate program design, so the Commission finds it reasonable to require that programs must pass the Utility/Administrator test in order to ensure that the benefits ratepayers receive from these programs exceed the programs' costs." "The Commission recognizes that other non-economic externalities are also significant, so the Expanded test must also be applied at the portfolio level."
	Level at which Test(s) is applied	Portfolio	**Source:** WI PSC 2010, pp 7-8.
	Other level(s) at which Test(s) is applied (if applicable)	Measure, Program	**Source:** WI PSC 2010, p 7; Personal Communication with WI PSC Staff.
	Discount rate used in Test(s)	Low-Risk	**Source**: Cadmus 2012, p 49; WI PSC 2010. **Note**: The low-risk discount rate represents the public sector cost of borrowing. It also provides an appropriate balance between the benefits of current ratepayers and benefits of future ratepayers. It is current set at 2% by the MI PSC.
	Study period over which Test(s) is applied	Measure Life	**Source:** Personal Communication with WI PSC staff.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** Cadmus 2012, p 48; WI PSC 2010. **Note:** Avoided capacity costs based on the cost of a new peaking plant.
	Energy Costs	Yes	**Source:** Cadmus 2012, p 48; WI PSC 2010. **Note**: Avoided energy costs are based on the most recent three-year historical average of locational marginal prices.
	T&D Costs	No	**Source:** Cadmus 2012; Personal Communication with WI PSC Staff. **Note**: It is included in the line losses calculation, but significantly undervalued.
	Environmental Compliance	Yes	**Source**: Cadmus 2012, p 49. **Note**: Emissions Benefits for CO2, NOx, and SOx. A levelized carbon value of $30/ton is reasonable.
	Price Suppression	No	**Source:** Personal Communication with WI PSC Staff.
	Line Loss Costs	Yes	**Source:** Cadmus 2012, p 49; WI PSC 2010. **Note:** Line loss factor of 8%.
	Reduced Risk	No	**Source:** Personal Communication with WI PSC Staff.
	Other Avoided Costs	No	**Source:** Personal Communication with WI PSC Staff.
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source:** WI PSC 2010. **Note**: Only gas benefits are included in the modified TRC. No other OPIs are included in the modified TRC test, although the expanded TRC test does included additional OPIs.
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	Yes	**Source:** Cadmus 2012, App. I. **Note**: Includes gas benefits only.
	Low-Income	No	
	Equipment	No	
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Appendix B – Best Practices on Select Issues

Introduction

As a fundamental principle, the costs and benefits included in a state's energy efficiency screening test should be consistent with the state's policy objectives, because these objectives provide guidance on the value that a state might place on energy resources. The list of relevant policy objectives to use for efficiency screening may be unique to each state. Some of the key policy objectives that have been established in states include, for example, reduce costs to electric customers, achieve all cost-effective energy efficiency, reduce market barriers to energy efficiency, promote economic development, and reduce environmental impacts.

The public policy goals in each state have a large impact on the states' decisions with regard to cost-effectiveness screening details. For example, Vermont has an explicitly stated goal of reducing the cost of electricity generation, including environmental costs, and therefore has chosen to use the Societal Cost test. These different policy objectives apparently explain some of the key differences between the cost-effectiveness practices across states.

There are certain key energy efficiency screening practices that may be appropriate for all states, or that may be appropriate for all those states that have chosen to utilize a particular test. The following best practices are based on the premise that sound screening practices should (a) generally meet the state's energy policy goals, (b) use a screening test that is consistent with the state's energy policy goals, (c) apply the chosen screening test in a way that is internally consistent, (d) use methodologies that are consistent with the perspective of the chosen test, and (e) account for all the costs and benefits that are relevant to the chosen test.

Other Program Impacts

It is best practice to include OPIs in cost-effectiveness tests for which the relevant costs and benefits are applicable. If any one test includes some of the costs (or benefits) from one perspective, but excludes some of the costs (or benefits) from that same perspective, then the test results may be skewed; i.e., they may not provide an accurate indication of cost-effectiveness from that perspective. (Synapse 2012b; Neme and Kushler 2010).

Therefore, if a state has chosen to use the TRC test as the primary screening test, then it would be more internally consistent for the state's cost-effectiveness analysis to include utility- and participant-perspective OPIs. The TRC test includes all the costs to program participants, and therefore it should also include all the benefits to program participants in order to maintain internal consistency. Otherwise the test results may be inherently skewed against energy efficiency. (RAP 2013, pp 13-14).

For similar reasons, if a state has chosen to use the Societal Cost test as the primary screening test, then it should include utility-, participant-, and societal-perspective OPIs.

If a state chooses not to account for OPIs, then the state would benefit from using the PAC test, as the test results would be more internally consistent. Otherwise, if a state uses the TRC or Societal Cost test without including OPIs, then the state may undervalue energy efficiency, which may result in customers paying higher costs than necessary for energy services.

Ideally, states should establish quantitative, monetary values for all relevant OPIs. There are, however, several challenges and uncertainties associated with developing monetary estimates of some OPIs. Some of the OPIs may be unique to certain customer types, and some of the OPIs may depend upon the unique preferences or conditions of different customers. Under even the best of circumstances it is difficult to ensure that all relevant OPIs are accounted for, and that their magnitudes are properly assessed. These challenges can be one of the biggest barriers that hinder states' willingness and ability to account for OPIs.

Given the large number of OPIs, and the difficulty in measuring and accounting for all of them, it may be helpful for regulators to prioritize the impacts to identify those that are most likely to affect the outcome of the energy efficiency cost-effectiveness screening. For example,

- Utility-perspective OPIs are generally considered to be small relative to other OPIs. However, some studies have identified significant benefits associated with reduced shutoffs and reconnects, as well as bad debt write offs and carrying costs on arrearages. In addition, utility-perspective OPIs can be significantly larger for low-income customers, particularly in states where low-income customers are offered discounted rates or shutoff protection provisions that can sometimes result in large arrearages.
- Participant-perspective OPIs have been found to be particularly significant and thus have important implications for screening efficiency resources with the TRC test. While there is a wide range of potential participant-perspective OPIs, the ones that are used most frequently in energy efficiency screening can be categorized as follows: resource benefits (e.g., water or other fuel savings), low-income benefits; equipment operations and maintenance costs; health and safety; comfort; property value; and utility related benefits.
- Many of these participant-perspective OPIs are particularly large for low-income customers, because of the conditions of their dwellings, the other demands on their limited resources, and other hardships they may face. In addition, low-income energy efficiency programs are often less cost-effective than other efficiency programs because the customers are harder to reach and the barriers are more difficult to overcome. Consequently, regulators frequently place a higher priority on the participant-perspective OPIs that apply to low-income efficiency programs.
- Societal-perspective OPIs can be quite large and also can be challenging to develop quantitative estimates for. The reduction of greenhouse gases from the electricity industry is frequently considered among the more significant societal benefits, and there are studies available to provide guidance as to their magnitude (see Synapse 2013). The economic development benefits of energy efficiency resources are also considered to be significant, and there are studies available to provide guidance as to their magnitude (see ENE 2009).

It is important to avoid giving greater priority to those impacts that are readily measurable and quantifiable simply because they are easier to obtain. The utility-perspective OPIs tend to be relatively easy to quantify, but they also tend to be low in value. Conversely, some participant-perspective NEIs can be difficult to quantify, but are expected to be quite large.

States that do not currently have estimates of quantitative monetary values for OPIs could take the following steps to develop such estimates:

1. Identify all of the OPIs that are likely to have a significant impact on the costs and benefits of the energy efficiency programs, based upon the energy efficiency programs offered, and the screening test used, in the state.
2. Develop quantitative estimates for all OPIs that can be readily quantified. At a minimum, this could include the other fuel and resource savings, because these savings can be relatively easily quantified using forecasts of the prices for those fuels.
3. Develop some methodology for addressing those OPIs that are not quantified, e.g., by using an adder to the benefits as a proxy for the OPIs. For example, if the state does not develop quantitative estimates for the low-income NEBs, then at a minimum these benefits could be addressed through some proxy approach.[13]
4. Undertake independent analyses to develop the best state-specific OPI estimates possible. The money required for this type of research could come from program administrator's evaluation, monitoring and verification budgets.

While it may be difficult to quantify or otherwise prioritize values for OPIs when applying the Societal Cost test or the TRC test, using the best estimates available is a significant improvement over using no estimates at all. Again, states that are unwilling or unable to account for a reasonable range of OPIs would benefit from using the PAC test to screen efficiency resources instead of the TRC test.

Price Suppression Effects

Energy efficiency resources provide benefits through wholesale market price suppression effects in regions with competitive wholesale electric markets. Even a small reduction in a market clearing price can result in significant cost reductions across the entire market. The price suppression effects act as a benefit because it represents a reduction in costs to wholesale electric customers, which are passed on to retail electric customers. Therefore, cost-effectiveness results from the PAC test, the TRC test, and the Societal Cost test would be more accurate if they included benefits associated with price suppression.

Some states do not account for the price suppression effects on the grounds that these effects will dissipate over time as the wholesale electricity market naturally adjusts to the new level of demand on the system. While it is true that the wholesale electricity market will naturally adjust in this way, it will take several years to do so. During that time there will be a real reduction in wholesale electricity market prices as a result of the energy efficiency savings, and those reductions will represent real

[13] One way to determine an adder to apply to program benefits is to review the benefits used in neighboring states that quantify OPIs. For example, in Massachusetts, the non-resource benefits on a statewide basis make up approximately 17% of total benefits in 2013. Another way to account for OPIs without knowing the exact value of the benefits is to allow programs to be implemented even if they do not have a benefit-cost ratio greater than 1.0, with the understanding that there are benefits that would make the program cost-effective if they could be quantified more easily.

savings to electricity customers. Cost-effectiveness test results would better account for all energy efficiency resource benefits if states ensured that estimates of the price suppression effect account for the dissipation of this effect, rather than simply excluding the price suppression effect altogether.

It is sometimes argued that the price suppression effect should not be considered a benefit to energy efficiency programs because it is a "transfer payment" from generators to electricity customers. As such, the benefit to electricity customers is equally offset by a cost to the generators. While it is true that the effect results in reduced profits to generators, this does not mean that the reduced profits should be netted out against the reduced cost to customers. Profits are not considered a transfer payment. Instead, they are a part of the cost of a resource; in the same way that the cost of capital, which includes an element of profit, is typically considered a part of the cost of a supply-side resource. The reduction in generator profits is simply the equivalent of a reduction in cost for the resource. Therefore, cost-effectiveness results from the PAC test, the TRC test, and the Societal Cost test may better account for all energy efficiency resource benefits by including benefits from the price suppression effect.

Reduced Risk

Most states do not recognize that energy efficiency may reduce risks on the utility system associated with supply-side resources. States could consider explicitly accounting for the risk benefits of energy efficiency, given the potential value of reduced risk and the many ways that energy efficiency can reduce utility system risks.[14] There are three types of risks related to utility system resource planning: financial risk, project risk and portfolio risk.

<u>Financial risk</u> refers to the risk associated with the funding (i.e., the cost of capital) used to invest in the supply-side or demand-side resource. When an energy efficiency program administrator uses a system benefit charge, or some other fully-reconciling charge, to fund energy efficiency there is a very low financial risk (i.e., low cost of capital) to the utility or the program administrator. In these cases, energy efficiency resources have a lower financial risk than supply-side resources.

<u>Project risk</u> refers to the risks associated with planning, constructing and operating the resource, or, project. Efficiency resources are typically much less risky than supply-side resources that have risks associated with construction costs, fuel price volatility, swings in electricity demands, market volatility and other market risks (Ceres 2012). While energy efficiency resources have project risks of their own, these tend to be significantly lower than those associated with supply-side resources, particularly for those states that have been operating efficiency programs for a sufficient period of time to establish stable programs and develop enough historical data to be able to make reasonable predictions of program participation and results. Therefore, energy efficiency resources typically have lower overall project risk than supply-side resources.

[14] See, for example, Ceres 2012, which includes a detailed discussion of risks associated with electricity resources, and explains why energy efficiency has lower risks than all other electricity resources.

Portfolio risk refers to the risk experienced by an investor from the total portfolio of investments, projects, or resources. Different combinations of investments, projects or resources will result in different types of risks for the investor. One common practice for reducing portfolio risk is to diversify investments. Energy efficiency can help diversify a utility system resource mix. Therefore, energy efficiency resources can generally help reduce portfolio risk.

Risk benefits can be accounted for in several ways when screening energy efficiency resources (RAP 2013, pp 41-42). For example:

- A risk adder can be applied to the energy efficiency benefits, as a proxy for the risk benefits. This approach is used by Vermont and Washington DC.
- The discount rate can be selected, or adjusted, to account for the risk benefits of energy efficiency. Several states in our survey apparently use this approach.
- In states that use integrated resource planning (IRP) to determine the appropriate level of energy efficiency resources to implement, risk assessment modeling techniques can be used to assess risks associated with different resources and resource portfolios.

The choice of discount rate (addressed in the next section) is likely the best way to reflect the risk benefits of energy efficiency for a state. The discount rate is likely the best approach to addressing *financial* risks, because the discount rate is intended to account for the time value of money. The discount rate is also better suited to reflect *project* risk and *planning* risk than a proxy benefits adder. A proxy adder for risk benefits simply increases the avoided costs equally across all years, while a risk-adjusted discount rate will affect the value of costs and benefits over time commensurate with the risks associated with time.

While a proxy adder for risk benefits is a reasonable way to approximate the risk benefits of energy efficiency, the choice of discount rate provides a better option for accounting for risk. This option is discussed in more detail in the following section.

It is important to ensure that risk benefits are neither undervalued nor double-counted. For this reason, when states apply risk benefit adders and/or risk-adjusted discount rates they should consider explicitly identifying the extent to which each mechanism is meant to address financial risk, project risk, portfolio risk, or some combination of these risks.

Discount Rate

Discount rates are commonly used to compare future streams of costs in a consistent way, by estimating the present value of the costs and expressing them in a common reference year. The choice of discount rate will have a significant impact on the present value of costs and benefits; relatively high discount rates will significantly reduce the value of costs and benefits in the later years of the study period, while relatively low discount rates will reduce that value by much less. A discount rate of zero means that costs and benefits in future years are valued as much as costs and benefits today. The choice of discount rates is especially important for energy efficiency resources, whose costs are typically incurred in early years while benefits are experienced in later years. (RAP 2013, p 19).

Discount rates are used to account for two concepts: the time value of money and the riskiness of the investment (Synapse 2012b).[15] The time value of money is captured in the cost of capital that an investor uses to finance an investment; and the cost of capital is one of the key determinants of the discount rate. The riskiness of an investment is an indication of the project risk and or portfolio risk; and those investments that are expected to have a low project risk or portfolio risk can be discounted using a relatively low discount rate to reflect that risk.

It is best practice that the discount rate used for efficiency screening reflect the relatively low financial risk of the energy efficiency programs. Energy efficiency programs financed by a system benefits charge, or a similar fully-reconciling charge, would provide cost-effectiveness test results that are more internally consistent if states used a low-risk discount rate to reflect the low financial risk of the funding source. A low-risk discount rate could, for example, be based on a general indicator of low-risk investments, such as US Treasury bonds.

Also, when screening energy efficiency resources states could consider using risk-adjusted discount rates to reflect the low project and portfolio risks associated with energy efficiency. This would mean reducing the discount rates, to a level below the discount rate that is chosen solely on the basis of the cost of capital. Therefore, a state that uses a system benefits charge, or similarly reconciling charge, could start with a low-risk discount rate based on the cost of capital, and then adjust it downward to reflect the project and portfolio risk reduction benefits.

In some cases, a state will choose a discount rate based on the cost-effectiveness test. For example, in Vermont and Washington DC the societal discount rate is chosen because the state has chosen to use the Societal Cost test to screen energy efficiency. While there is sound logic in applying a societal discount rate when using the Societal Cost test, it is not entirely clear what the societal discount rate represents in these cases. First, there is a range of discount rates that could be used to reflect society's perspective. Second, it is not clear to what extent this choice of discount rate is intended to account for reduced financial, project and/or portfolio risk.

Finally, it is important to note that the choice of discount rate is essentially a policy decision. In addition to the considerations described above, states could consider choosing a discount rate that is informed by the weight the regulators wish to give to the future benefits of energy efficiency programs. At a minimum, each state's cost-effectiveness test results would be more internally consistent if the state explicitly identified what objectives it is trying to achieve with its choice of discount rate, and ensured that the choice of discount rate is consistent with these objectives.

[15] Discount rates can also be used to account for inflation. In this report, we refer to "real" discount rates, which should be applied to "real" or "constant" dollars.

Appendix E: Options for Establishing Energy Efficiency Targets in Michigan: 2016 - 2020

Prepared by Optimal Energy

Integrated Energy Resources

Options for Establishing Energy Efficiency Targets in Michigan: 2016-2020

Prepared for

Michigan Public Service Commission

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INTRODUCTION

In Michigan and many other jurisdictions, policymakers set numerical energy efficiency performance goals for utilities and non-utility program administrators. Those goals are established to achieve a number of public policy objectives such as adaptability, reliability, affordability, and environmental protection. There are several different approaches and assumptions that can be used to determine appropriate energy savings targets. The purpose of this study is to use some of these different approaches to develop a set of options from which Michigan can select to set energy efficiency goals after 2015. The report also describes additional considerations and opportunities that may affect the level of savings that could be achieved in the State. These considerations include demand targets and integrated demand response programs, expanded savings potential from promising technologies, and cost-effectiveness test selection.

The options presented in this report quantify energy savings targets and program budgets based on results of a recently completed potential study by GDS Associates. Potential studies are often used as a tool to inform the goal-setting process by measuring the potential for efficiency resources and opportunities for savings in a geographic area. The GDS study provides energy efficiency potential estimates in Michigan based on several scenarios that use different assumptions such as program incentive levels and the tests used to assess cost-effectiveness. As policymakers in Michigan make decisions about its energy future, they should consider which scenario provides the best framework for establishing efficiency targets and associated budgets to meet the State's policy objectives.

The tables below summarize the goal-setting options that are quantified and discussed in the "Options for Energy Savings Targets" section of this report.

Table 1. Summary of Efficiency Savings Target Options 2016-2020

	Cost Effective-ness Test	Lifecycle or First -year Savings	Annual or Cumulative Goals	Incentive Level	Budget Constrain (Y/N)	Ramp Up (Y/N)
Option 1 Budget Constrained						
Option 1A 1st Yr.	UCT	First Year	Either	50%	Yes	No
Option 1B Adjusted	UCT	Lifecycle	Either	50%	Yes	No
Option 1C Lifecycle	UCT	Lifecycle	Either	50%	Yes	No
Option 2 Base Achievable UCT						
Option 2A 1st Yr.	UCT	First Year	Either	50%	No	Yes
Option 2B Adjusted	UCT	Lifecycle	Either	50%	No	Yes
Option 2C Lifecycle	UCT	Lifecycle	Either	50%	No	Yes
Option 3 Base Achievable TRC						
Option 3A 1st Yr.	TRC	First Year	Either	50%	No	Yes
Option 3B Adjusted	TRC	Lifecycle	Either	50%	No	Yes
Option 3C Lifecycle	TRC	Lifecycle	Either	50%	No	Yes
Option 4 Max Achievable						
Option 4A 1st Yr.	TRC	First Year	Either	100%	No	Yes
Option 4B Adjusted	TRC	Lifecycle	Either	100%	No	Yes
Option 4C Lifecycle	TRC	Lifecycle	Either	100%	No	Yes

Table 2. Summary of Numerical Efficiency Savings Target Options 2016-2020

Option	UCT Constrained		UCT Base		TRC Base		TRC Max	
	1A & 1B	1C	2A & 2B	2C	3A & 3B	3C	4A& 4B	4C
	1st Year & 1st Year Adjusted	Lifecycle	1st Year & 1st Year Adjusted	Lifecycle	1st Year & 1st Year Adjusted	Lifecycle	1st Year & 1st Year Adjusted	Lifecycle
Annual % MWh Savings Ramp- up	**2016:** 0.7% **2017:** 0.7% **2018:** 0.7% **2019:** 0.7% **2020:** 0.7%	**2016:** 7.6% **2017:** 7.6% **2018:** 7.6% **2019:** 7.6% **2020:** 7.6%	**2016:** 1.3% **2017:** 1.6% **2018:** 1.9% **2019:** 2.1% **2020:** 2.1%	**2016:** 12.8% **2017:** 15.6% **2018:** 18.4% **2019:** 21.0% **2020:** 21.0%	**2016:** 1.3% **2017:** 1.6% **2018:** 1.8% **2019:** 2.0% **2020:** 2.0%	**2016:** 12.3% **2017:** 14.6% **2018:** 16.8% **2019:** 19.0% **2020:** 19.0%	**2016:** 1.4% **2017:** 1.8% **2018:** 2.2% **2019:** 2.5% **2020:** 2.5%	**2016:** 13.6% **2017:** 17.2% **2018:** 20.8% **2019:** 24.4% **2020:** 24.4%
Annual % MW Savings Ramp-up	**2016:** 0.7% **2017:** 0.7% **2018:** 0.7% **2019:** 0.7% **2020:** 0.7%	**2016:** 7.4% **2017:** 7.4% **2018:** 7.4% **2019:** 7.4% **2020:** 7.4%	**2016:** 1.3% **2017:** 1.6% **2018:** 1.9% **2019:** 2.2% **2020:** 2.2%	**2016:** 12.8% **2017:** 15.6% **2018:** 18.4% **2019:** 21.0% **2020:** 21.0%	**2016:** 1.3% **2017:** 1.6% **2018:** 1.9% **2019:** 2.1% **2020:** 2.1%	**2016:** 12.4% **2017:** 14.8% **2018:** 17.2% **2019:** 19.4% **2020:** 19.4%	**2016:** 1.5% **2017:** 1.9% **2018:** 2.3% **2019:** 2.7% **2020:** 2.7%	**2016:** 13.9% **2017:** 17.8% **2018:** 21.7% **2019:** 25.4% **2020:** 25.4%
Annual % MMBtu Savings Ramp-up	**2016:** 0.6% **2017:** 0.6% **2018:** 0.6% **2019:** 0.6% **2020:** 0.6%	**2016:** 7.8% **2017:** 7.8% **2018:** 7.8% **2019:** 7.8% **2020:** 7.8%	**2016:** 1.0% **2017:** 1.2% **2018:** 1.4% **2019:** 1.6% **2020:** 1.6%	**2016:** 10.4% **2017:** 13.3% **2018:** 16.2% **2019:** 19.0% **2020:** 19.0%	**2016:** 0.9% **2017:** 1.1% **2018:** 1.2% **2019:** 1.3% **2020:** 1.3%	**2016:** 9.2% **2017:** 10.9% **2018:** 12.6% **2019:** 14.3% **2020:** 14.3%	**2016:** 0.9% **2017:** 1.1% **2018:** 1.3% **2019:** 1.5% **2020:** 1.5%	**2016:** 9.8% **2017:** 12.1% **2018:** 14.4% **2019:** 16.7% **2020:** 16.7%
Cumulative % MWh Savings	3.7%	38.2%	9.0%	88.8%	8.7%	81.7%	10.4%	100.4%
Cumulative % MW Savings	3.7%	37.2%	9.2%	86.0%	9.0%	83.2%	11.1%	104.2%
Cumulative % MMBtu Savings	3.2%	39.0%	6.8%	77.9%	5.8%	61.3%	6.3%	69.7%
Measure Life Goal (yrs., e=electric, g=gas)	1A: NA 1B: 10 (e) 12 (g)	NA	2A: N/A 2B: 10 (e) 12 (g)	NA	3A: NA 3B: 10 (e) 11 (g)	NA	4A: NA 4B: 10 (e) 11 (g)	NA
Annual Program Budget ($ million)	$279		$765		$474		$1,100	
Cumulative Program Budget ($ million)	$1,394		$3,825		$2,370		$5,498	
% of Utility Revenue	2.0%		5.5%		3.4%		7.9%	

HISTORY OF ENERGY EFFICIENCY TARGET SETTING

In 2008, following a 13 year period in which few utility sponsored efficiency programs were implemented, the Michigan legislature established an Energy Efficiency Resource Standard (EERS) by passing Act 295. The EERS sets increasing energy saving goals and requires gas and electric utilities to provide Energy Optimization (EO) programs to customers as approved by the Michigan Public Service Commission. Efficiency programs are administered by utilities as well as through the state-selected third party administrator, Efficiency United.

Act 295 specifies the annual incremental energy savings targets utilities must achieve from 2009-2015. For electric utilities, savings goals ramp up from 0.3% savings in 2009 to 0.5% in 2010, 0.75% in 2011, and 1.0% in each year from 2012 to 2015. Natural gas utilities must achieve 0.10% savings in 2009, 0.25% in 2010, 0.50% in 2011, and 0.75% in each year from 2012 to 2015. Saving goals are set based on first-year energy savings relative to the prior year total retail sales. Savings goals after 2015 will be determined by the Michigan legislature.

Regulated utilities can recover costs for efficiency programs through Commission-approved Energy Optimization surcharges. To do so, they must demonstrate that costs pass the Utility Resource Cost Test, also referred to as the Utility Cost Test (UCT), and are reasonable and prudent. Utilities are currently limited in the amount they can spend on efficiency programs. For 2012 and beyond, Section 89 of PA 295 indicates that utilities may spend no more than 2% of total retail sales revenues for the purpose of meeting optimization performance standards.

Michigan utilities exceeded the incremental targets laid out in Act 295 each year from 2009 to 2011.[1] In 2011, utilities achieved a combined average of 125% of their energy savings targets. Statewide program savings totaled more than one million megawatt hours (MWh) of electricity and more than 3.8 million cubic feet (Mcf) of natural gas. These electric and gas savings are enough to power 1.5 million and 40,000 homes for a year respectively. Total efficiency program expenditures of $246 million will result in at least $936 million lifecycle savings to customers.[2] This translates into customers benefits of $4.07 for every dollar spent on Energy Optimization programs in 2012.[3] Ultimately, the EO program benefits will decrease future costs of service to all gas and electric customers regardless of their participation in the EO program.

GDS POTENTIAL STUDY

Overview of Results from the GDS Potential Study

In 2013, the MPSC, Consumers Energy, and DTE commissioned GDS Associates to assess the potential to reduce electric and natural gas consumption as well as peak demand through the implementation of energy efficiency technologies and practices in the State. Completed in November of this year, the study assesses energy efficiency potential in Michigan from 2014 through 2023. The study presents potential estimates for technical, economic, and three

1 Michigan Public Service Commission, "2012 Report on the Implementation of P.A. 295 Utility Energy Optimization Programs." November 30, 2012. http://www.michigan.gov/documents/mpsc/2012_EO_Report_404891_7.pdf

2 Michigan Public Service Commission Staff, personal correspondence.

3 Michigan Public Service Commission Staff, personal correspondence

achievable scenarios (two base achievable scenarios and an achievable budget constrained scenario). Two scenarios assessed the economic potential; one using the Total Resource Cost test (TRC) and one using the Utility Cost Test (UCT). The base potential savings was also estimated under two scenarios; one using the Total Resource Cost test (TRC) and one using the Utility Cost Test (UCT). The UCT is used for the budget constrained achievable scenario.

Tables 1-1 and 1-2 from the GDS potential study indicate that significant energy efficiency resources could be included in Michigan's energy resource mix over the next 10 years. For example, the cumulative achievable electricity savings based on UCT screening in 2023 is 15.0% of forecast electric sales and 13.4% of forecast natural gas sales. The budget constrained achievable potential, based on the current program spending cap, represents significantly less savings, though still indicates that additional cost-effective savings can be achieved in Michigan over the next several years. GDS further breaks out energy savings potential by sector, indicating that savings can be achieved among each of the primary customer groups. Between 2014 and 2018, for example, residential and commercial sectors provide the greatest potential for electric savings. Under the base achievable scenarios, residential and commercial saving are roughly twice as much as the industrial potential savings. Under the constrained achievable scenario, the residential sector provides the greatest opportunity for savings at 4.3% by 2018, with the commercial and industrial sectors providing 3.1% and 2.3% savings respectively.

Table 3. Summary of GDS Potential Electric Energy Savings for 2018[4]

End Use	Technical Potential	Economic Potential (UCT)	Economic Potential (TRC)	Achievable Potential (UCT)	Achievable Potential (TRC)	Constrained Achievable (UCT)
Electric Sales MWh						
Savings % - Residential	45.8%	41.3%	39.8%	10.7%	10.5%	4.3%
Savings % - Commercial	48.5%	44.9%	37.4%	12.2%	10.5%	3.1%
Savings % - Industrial	27.0%	21.0%	19.3%	4.9%	4.5%	2.3%
Savings % - Total	**40.7%**	**36.1%**	**32.4%**	**9.4%**	**8.6%**	**3.2%**
Savings MWh - Residential	15,481,730	13,967,946	13,466,463	3,622,394	3,549,596	1,465,036
Savings MWh - Commercial	18,525,217	17,186,647	14,282,862	4,651,994	4,004,548	1,188,821
Savings MWh - Industrial	9,180,717	7,133,458	6,568,017	1,674,490	1,537,639	785,903
Savings MWh - Total	**43,187,664**	**38,288,051**	**34,317,341**	**9,948,878**	**9,091,783**	**3,439,760**

4 Included as Table 1-1 from GDS Associates, Inc. "Michigan Electric and Natural Gas Energy Efficiency Potential Study, Final Report." November 5, 2013.

End Use	Technical Potential	Economic Potential (UCT)	Economic Potential (TRC)	Achievable Potential (UCT)	Achievable Potential (TRC)	Constrained Achievable (UCT)
Electric Demand MW						
Savings % - Residential	42.7%	38.9%	41.0%	8.4%	8.9%	3.4%
Savings % - Commercial	53.8%	49.9%	42.3%	12.2%	10.6%	3.1%
Savings % - Industrial	40.6%	30.8%	27.4%	6.7%	6.3%	3.1%
Savings % - Total	**47.0%**	**42.1%**	**39.2%**	**9.7%**	**9.2%**	**3.2%**
Savings MW - Residential	4,274	3,895	4,106	839	892	340
Savings MW - Commercial	5,715	5,300	4,496	1,292	1,127	334
Savings MW - Industrial	1,790	1,360	1210	296	278.5	138
Savings MW - Total	**11,779**	**10,555**	**9,812**	**2,426**	**2,298**	**812**
Natural Gas Sales MMBtu						
Savings % - Residential	45.9%	34.8%	19.4%	9.4%	7.1%	3.8%
Savings % - Commercial	34.6%	29.8%	24.2%	6.1%	5.4%	3.1%
Savings % - Industrial	16.1%	13.0%	12.1%	2.7%	2.5%	0.7%
Savings % - Total	**35.2%**	**27.8%**	**18.8%**	**6.8%**	**5.5%**	**2.8%**
Savings MMBtu - Residential	136,706,666	103,587,007	57,885,592	27,930,065	21,296,093	11,332,060
Savings MMBtu - Commercial	58,904,392	50,760,002	41,188,176	10,382,936	9,274,379	5,309,780
Savings MMBtu - Industrial	26,183,022	21,190,526	19,611,597	4,451,220	3,986,192	1,070,312
Savings MMBtu - Total	**221,794,080**	**175,537,535**	**118,685,365**	**42,764,221**	**34,556,665**	**17,712,153**

Table 4. Summary of GDS Potential Electric Energy Savings for 2023[5]

End Use	Technical Potential	Economic Potential (UCT)	Economic Potential (TRC)	Achievable Potential (UCT)	Achievable Potential (TRC)	Constrained Achievable (UCT)
Electric Sales MWh						
Savings % - Residential	39.7%	35.2%	33.7%	14.7%	14.3%	5.9%
Savings % - Commercial	48.0%	44.5%	37.0%	20.8%	17.6%	6.0%
Savings % - Industrial	26.4%	20.5%	18.9%	8.9%	8.1%	5.0%
Savings % - Total	**38.4%**	**33.8%**	**30.1%**	**15.0%**	**13.5%**	**5.7%**
Savings MWh - Residential	13,697,929	12,146,247	11,644,006	5,070,834	4,946,942	2,044,561
Savings MWh - Commercial	18,601,147	17,251,862	14,344,326	8,057,699	6,835,102	2,326,054
Savings MWh - Industrial	9,180,717	7,133,458	6,568,017	3,087,742	2,816,429	1,735,830
Savings MWh - Total	**41,479,793**	**36,531,567**	**32,556,350**	**16,216,275**	**14,598,473**	**6,106,445**
Electric Demand MW						
Savings % - Residential	40.5%	36.7%	38.9%	13.1%	14.1%	5.3%
Savings % - Commercial	53.2%	49.3%	41.9%	22.6%	19.7%	6.8%
Savings % - Industrial	39.7%	30.2%	26.9%	12.7%	12.0%	7.4%
Savings % - Total	**45.7%**	**40.9%**	**38.0%**	**17.0%**	**16.1%**	**6.3%**
Savings MW - Residential	4,138	3,758	3,980	1,338	1,447	540
Savings MW - Commercial	5,741	5,325	4,519	2,433	2,128	737
Savings MW - Industrial	1,790	1,360	1210	571	539.2	335
Savings MW - Total	**11,669**	**10,442**	**9,709**	**4,342**	**4,114**	**1,613**

5 Included as Table 1-2 from GDS Associates, Inc. "Michigan Electric and Natural Gas Energy Efficiency Potential Study, Final Report." November 5, 2013.

END USE	TECHNICAL POTENTIAL	ECONOMIC POTENTIAL (UCT)	ECONOMIC POTENTIAL (TRC)	ACHIEVABLE POTENTIAL (UCT)	ACHIEVABLE POTENTIAL (TRC)	CONSTRAINED ACHIEVABLE (UCT)
Natural Gas Sales MMBtu						
Savings % - Residential	51.0%	38.9%	22.1%	18.9%	14.0%	7.7%
Savings % - Commercial	34.9%	30.1%	24.4%	12.3%	11.0%	6.3%
Savings % - Industrial	17.1%	13.8%	12.8%	4.4%	3.9%	1.3%
Savings % - Total	**37.9%**	**30.1%**	**20.4%**	**13.4%**	**10.6%**	**5.7%**
Savings MMBtu - Residential	143,271,591	109,298,652	62,091,152	53,178,705	39,326,470	21,495,414
Savings MMBtu - Commercial	59,047,573	50,950,115	41,298,436	20,766,093	18,548,759	10,743,415
Savings MMBtu - Industrial	26,183,022	21,190,526	19,611,597	6,677,438	6,013,211	2,038,818
Savings MMBtu - Total	**228,502,186**	**181,439,293**	**123,001,185**	**80,622,236**	**63,888,440**	**34,277,647**

The five and ten-year budget and acquisition cost estimates associated with GDS's achievable potential scenarios for electric and natural gas energy efficiency savings are shown in Table 5 below.

Table 5. Budgets for GDS Achievable Potential Scenarios (Electric and Natural Gas)[6]

ALL SECTORS COMBINED	5 - YEAR EE BUDGET	10-YEAR EE BUDGET
Achievable UCT	$3,901,363,759	$7,525,943,114
Achievable TRC	$2,377,472,684	$4,680,432,660
Constrained UCT	$1,367,298,803	$2,806,853,228

Although higher budget levels are associated with scenarios that offer higher levels of savings, the net benefits associated with those scenarios are also greater. The tables below present benefit-cost results of the three achievable scenarios included in the GDS potential study.

[6] Included as Table 1-5 from GDS Associates, Inc. "Michigan Electric and Natural Gas Energy Efficiency Potential Study, Final Report." November 5, 2013.

Table 6. Benefit-Cost Ratios for Achievable Potential Scenarios (2014-2018)[7]

Achievable Potential Scenarios	NPV $ Benefits	NPV $ Costs	Benefit/Cost Ratio	Net Benefits
Achievable UCT	$8,819,456,909	$3,452,121,731	2.55	$5,367,335,178
Achievable TRC	$9,090,916,601	$3,542,860,326	2.57	$5,548,056,275
Constrained UCT	$3,134,114,985	$1,212,231,599	2.59	$1,921,883,386

Table 7. Benefit-Cost Ratios for Achievable Potential Scenarios (2019-2023)[8]

Achievable Potential Scenarios	NPV $ Benefits	NPV $ Costs	Benefit/Cost Ratio	Net Benefits
Achievable UCT	$15,854,685,097	$5,807,771,171	2.73	$10,046,913,925
Achievable TRC	$16,434,033,885	$6,063,428,268	2.71	$10,370,605,616
Constrained UCT	$5,996,092,253	$2,145,524,086	2.79	$3,850,568,167

Use of the GDS Potential Estimates in this Report

For the purposes of this report, we use the three achievable potential estimates in the GDS study to quantify target setting options Achievable potential estimates represent the amount of efficiency that can realistically be reached given customer acceptance, considerations for energy efficiency measures, non-measure costs of delivering programs, and the capability of programs and administrators to ramp up program activity over time. Achievable potential can further be broken down into "maximum" or "program" achievable. Maximum (max) achievable potential assumes the most aggressive program scenario possible in which customers receive the entire incremental cost of more efficient equipment. Program potential, however, represents estimates of efficiency potential given specific program designs and funding levels.

The GDS achievable potential study estimates used for this report are based on program potential. These program potential estimates include a budget constrained achievable scenario, base achievable scenario using the Total Resource Cost Test (TRC), and a base achievable scenario using the Utility Cost Test (UCT). The budget constrained achievable scenario uses the UCT to assess cost-effectiveness and assumes a spending cap of 2% of utility revenues, as is currently specified in Michigan state law. The base achievable scenarios resulted in funding requirements and thus spending caps on efficiency programs greater than 2% of utility revenue.

The differences in results between the two base achievable potential scenarios are due to differences in cost-effectiveness screening from the Utility Cost Test compared to the Total Resource Cost Test. Section 73(2) of PA 295 requires utilities in Michigan to use the Utility System Resource Cost Test, also referred to as the Utility Cost Test, to determine the cost-

7 Included as Table 1-9 from GDS Associates, Inc. "Michigan Electric and Natural Gas Energy Efficiency Potential Study, Final Report." November 5, 2013.

8 Included as Table 1-10 from GDS Associates, Inc. "Michigan Electric and Natural Gas Energy Efficiency Potential Study, Final Report." November 5, 2013.

effectiveness of their efficiency program portfolios of programs.[9] The UCT looks at cost-effectiveness from the utility perspective and compares the total cost to the utility of administering and delivering the program to the avoided costs of generation, transmission and distribution costs as a result of the program. The TRC, on the other hand, accounts for the total costs and benefits to society and assesses cost-effectiveness from the perspective of all utility customers as well as program administrators.

This report also includes a goal-setting option based on a max achievable potential scenario that was funded and commissioned by the Natural Resources Defense Council (NRDC) and does not appear in the potential study. The max achievable scenario represents the energy savings that would be feasible assuming incentive levels at 100% of the incremental cost of efficiency measures over the cost of the baseline measure. In contrast, the achievable scenarios presented in the GDS study assume incentive levels at 50% of the incremental cost. Therefore, the max achievable scenario represents the upper bounds of energy savings that would be feasible in Michigan. The TRC is used to assess cost-effectiveness for the max achievable scenario.

The GDS study analyzes potential savings beginning in 2014; however, our five-year analysis period begins in 2016 because PA 295 Sec. 97 requires the Commission to review Energy Optimization standards for the period beginning in 2016 and make recommendations for the continuation, expansion or reduction of such standards. For our analysis, Optimal Energy obtained potential results from GDS specific to the 2016-2020 timeframe, which are presented in Appendix A of this report.

Michigan's current energy savings targets specify annual incremental goals. Although GDS results were presented for each year of the study timeframe, those savings represent cumulative annual values. Cumulative savings represent 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 savings do not always equal the sum of all prior year incremental values because savings from measures with short effective useful lives drop off over time. Although this difference is relatively small, GDS provided Optimal with annual incremental potential data for the purposes of this report. The target options presented in this way are consistent with the way Michigan's current goals are defined.

The incremental savings potential provided by GDS fluctuates up and down slightly between years. Rather than present savings targets that do the same, annual goals listed in this report are based on the arithmetic average of the total incremental savings over the five-year period. Furthermore, because Michigan sets targets as an aggregate of all sectors, the targets presented in this report refer to total energy savings rather than sector-specific savings goals.

The purpose of this report is not to scrutinize the results claimed in the GDS analysis, but rather to present options based on the results of the study that could be considered in setting

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9 The USRCT is also referred to as the Program Administrator Costs Test, Utility Resource Cost Test (URTC), or Utility Cost Test.

Michigan savings goals. The GDS study was conducted with significant input from stakeholders having a wide range of interests, including the Commission, utilities, and environmental organizations.

OPTIONS FOR ENERGY SAVINGS TARGETS

As discussed in the previous section, the achievable efficiency potential estimates from GDS Associates are used to develop and present four concrete options for utility savings targets and funding caps for years 2016-2020. In addition to the primary options derived from the GDS potential scenarios, we analyze sub-options by calculating goals based on first-year savings, first-year adjusted savings, and lifecycle savings.

Sub-options

The sub-options for quantifying savings goals are based upon: (1) energy savings in the first-year of the expected useful life of measures; (2) normalized first-year savings (adjusted to reflect measure life); and (3) simple lifecycle savings.

Savings longevity is an important element affecting the value of efficiency investments.[10] Some efficiency programs produce savings that are relatively short-lived, either because they rely on behavioral change that does not persist for long periods of time absent continued or additional efficiency program support, or because they promote measures that do not last very long before they wear out and need to be replaced. Examples of the latter are programs that promote the sale, purchase and/or installation of compact fluorescent lamps (CFLs), low flow showerheads and other hot water conservation measures, advanced or "smart" power strips, and steam traps. Other programs produce savings that are much longer-lived because they focus on measures that are either permanent (e.g. the orientation of a new building) or have very long lives (e.g. building insulation, HVAC equipment, and some appliances).

Lifecycle Savings

In Michigan and many other places, savings goals are currently expressed as the quantity of savings that efficiency measures will produce just in the first year they are implemented. This method of savings calculation encourages utilities to maximize first-year savings rather than maximizing lifetime savings or the value of the benefits provided over the entire lives of the efficiency measures. For example, suppose a utility is deciding whether to promote an efficiency measure that saves 20 therms of gas for just one year and costs $10 (i.e. $0.50 per unit of first-year savings and $0.50 per unit of lifecycle savings) or a measure that saves 100 therms per year for 20 years and costs $200 (i.e. $2.00 per unit of first year savings and $0.10 per unit of lifecycle savings). If the utility's goals are set in terms of first-year savings, it is more likely to invest in the first measure even though the second measure provides five times as much value over its life.[11]

There are several different ways to set savings goals that maximize overall benefits of efficiency programs. Many of these methods were discussed in Optimal's September 2013

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[10] Longevity of savings is also closely related to other policy objectives, such as minimizing emissions of air pollutants.

[11] The factor of five is calculated without any discounting of future benefits. However, even if future benefits were discounted using a 5% real annual discount rate, the second measure would be far preferable, providing more than three times the lifetime benefits.

report to the Michigan Public Service Commission titled, "Alternative Michigan Energy Savings Goals to Promote Longer Term Savings and Address Small Utility Challenges."[12] One such method would be to articulate goals in terms of lifecycle savings rather than first-year savings. Under a lifetime savings goal, a program administrator's performance would be measured relative to the total savings they produce over the estimated life of the efficiency measures installed through their programs. For example, if a furnace saves 100 therms of gas per year for 20 years, then the lifetime savings for that measure would be 2,000 therms. We refer to this approach in the goal-setting options below as "lifecycle."

A second method builds off of first-year savings to express savings goals while establishing an average measure life expectation and related total savings adjustment factor that is applied at the portfolio level, along with the first-year savings target. For example, if the goal was to achieve first year savings of 100,000 MWh with an average life of 10 years, and the program administrator achieved only 90,000 MWh but with an average life of 12 years, the savings achieved would be increased by 20% (i.e. a multiplier of 12 divided by the expected 10) and the goal would have been exceeded (108,000 MWh after adjustment). Conversely, if 110,000 MWh of first year savings was achieved but with an average measure life of only 8 years, a 20% penalty (i.e. a multiplier of 8 divided by the expected 10) would be applied to the savings and the goal would not have been met (88,000 MWh after adjustment). The lifecycle adjustment method could also be made on a measure-by-measure basis. However, determining the particular algorithm used to normalize first-year savings would best be left to the Michigan Public Service Commission to develop with utilities. We refer to this approach in the goal-setting options below as "adjusted first-year savings."

Cumulative Savings

Although many jurisdictions set targets as annual incremental values, other states use cumulative savings reduction over a multiple year period. Cumulative targets specify the total amount of savings to be achieved up through a certain timeframe, typically three to five years. For example, Pennsylvania set a cumulative savings target of 3% from 2009 to 2013.[13] A cumulative target provides more flexibility between years and allows any combination of annual savings as long as the total savings goal is achieved over the specified period of time. For example, a utility with a five-year, 3% savings goal could achieve 0.6% savings each year during the five-year period or 0.1% in the first four years and 2.6% in the last year and still meet the savings requirement.

This option might be particularly useful for small utilities, which may require greater flexibility to meet energy savings targets. Small utility programs may have a small number of large projects that have an especially large impact on goal achievement in any given year. Because small utilities cannot ensure similar participation of these large customers each year,

12 Optimal Energy and Energy Futures Group, "Alternative Michigan Energy Savings Goals to Promote Longer Term Savings and Address Small Utility Challenges." September 12, 2013. http://www.dleg.state.mi.us/mpsc/electric/workgroups/progdesign/final_phase1_report.pdf

13 Pennsylvania Public Utility Code, Section 2806.1, Title 66.

cumulative goals allow for some smoothing and averaging of program impacts over time. One potential drawback to cumulative targets is that it is difficult to fully reconcile goals achievements annually for purposes of cost recovery and awarding of any performance incentives. However, mechanisms can be used to provide partial payments with future true-ups, if cumulative goals are pursued.

Five-year cumulative savings are presented in the "Options for Energy Savings Targets" section should Michigan wish to consider taking this goal-setting approach. Michigan could choose to apply savings at the annual or cumulative level for any of the goal-setting options discussed.

OPTION 1: BUDGET CONSTRAINED TARGETS

A. First-Year Savings

Option 1A presents annual energy and capacity targets and funding levels for 2016 through 2020 based on the budget constrained scenario analyzed in the GDS potential study. These targets assume future Energy Optimization funding caps equivalent to 2% of a utility's retail revenue, which is the level currently established in Act 295. Annual incremental energy savings are based on first-year savings. Economic analysis (benefit/cost tests) for the budget constrained option is based on the Utility Cost Test.

Results of the budget constrained potential analysis suggest that a cumulative five-year energy savings goal of 3.7% of electric sales would be achievable by 2020. To reach this cumulative total, utilities would be required to save 0.7% of annual sales each year between 2016 and 2020. Demand potential suggests that 5-year cumulative savings of 3.7% would be achievable based on annual demand forecast at 0.7% savings per year. Natural gas potential is slightly lower with a cumulative 5-year energy savings goal of 3.2%. To achieve this goal, utilities would be required to save 0.6% of annual gas forecast each year. These savings goals are listed in the table below. Please note that the cumulative totals do not appear to equal the sum of the annual values due to rounding.

Table 8. First-Year Energy Optimization Targets Based on UCT Constrained Screening

	2016	2017	2018	2019	2020	Cumulative 5-Year Total
Annual Energy Savings for 2016 to 2020						
% of Annual MWh Forecast	0.7%	0.7%	0.7%	0.7%	0.7%	3.7%
Annual Demand Savings Goals for 2016 to 2020						
% of Annual MW Forecast	0.7%	0.7%	0.7%	0.7%	0.7%	3.7%
Annual Gas Savings for 2016 to 2020						
% of Annual MMBtu Forecast	0.6%	0.6%	0.6%	0.6%	0.6%	3.2%

Assuming a budget cap of 2% of annual revenue, statewide efficiency program spending would be set at approximately $1.4 billion over a five-year period, with an annual budget of $279 million in efficiency program spending per year.

Table 9. Energy Optimization Program Budgets Based on UCT Constrained Screening

	2016	2017	2018	2019	2020	Cumulative 5-Year Total
Total Program Costs ($ millions)	$279	$279	$279	$279	$279	$1,394
% of Revenue	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%

B. Adjusted First-Year Savings

As described above, efficiency goals in Michigan are currently established using first-year savings, i.e. savings from efficiency measures are only counted in the first year they are implemented regardless of the length of time those measures continue to save energy. A sub-option using the GDS budget constrained scenario would be to factor measure lifetime into achieved savings calculations to determine whether efficiency targets have been met. The budget and savings targets themselves would be the same as those described under Option 1A. However, Option 1B includes a savings multiplier, based on a target average measure life that would be applied to the actual savings.

The Michigan Public Service Commission is currently using a lifecycle savings multiplier to calculate savings for a limited number of utilities. However, the use of this approach could be expanded to additional utilities.

Table 10 provides examples of adjusted savings calculations based on 2016 energy savings goals. The savings multiplier value is equal to the actual efficiency program portfolio average measure life divided by the target measure life. For a utility whose portfolio average measure life equals the target average measure life, adjusted savings will equal actual savings. If a utility's portfolio average measure life was greater than the target average measure life, actual savings would be adjusted upward using the savings multiplier. In this case, a utility's adjusted savings may meet the savings goal even if their actual first-year savings are lower than the specified annual goal. Conversely, savings from a portfolio with a lower average measure life than the target would be adjusted downward using the savings multiplier In this case, a utility's adjusted savings may fail to meet the savings goal even if their actual first-year savings are equal to or greater than the specified goal.

Based on data from the GDS potential study, the average electric measure life for the UTC constrained scenario is 10 years and the average gas measure life is 12 years. An average measure life of 10 years for electrics savings is used in the table below for illustrative purposes. A measure life adjustment factor could also be applied at the program or measure level because measure life data for specific measures is available through the Michigan Energy Measures Database (MEMD).

Again, the budget and savings targets under Option 1B would be the same as those described under Option 1A.

Table 10. Example Electric Measure Life Multiplier Savings Calculations

	1st Year Savings Goal (MWh)	Actual First Year Savings (MWh)	Average Measure Life Goal (yrs.)	Actual Measure Life (yrs.)	Multiplier (Actual Measure Life/Goal Life)	Adjusted Savings (MWh)
Example 1	790,000	790,000	10	10	1.0	790,000
Example 2	790,000	690,000	10	12	1.2	828,000
Example 3	790,000	890,000	10	8	0.8	712,000

C. Lifecycle Savings

As an alternative to using a first-year adjustment factor to account for lifecycle benefits, Michigan could also set goals that use actual lifecycle savings. Using this approach, goals would still be set as a percent of sales or forecast, but would appear to be greater by a factor of about 10 than the current goals. This is due to the fact that they include the cumulative annual savings that accrue from measures throughout the expected useful life of each measure.

Under a lifecycle savings approach, program budgets would remain the same as those listed in Option 1A. Lifecycle goals are based on lifecycle savings results from GDS potential study and are presented in the table below. Please note that the cumulative totals do not appear to equal the sum of the annual values due to rounding.

Table 11. Lifecycle Energy Optimization Targets Based on UCT Constrained Screening

	2016	2017	2018	2019	2020
Lifecycle Energy Savings for 2016 to 2020					
% of Annual MWh Forecast	7.6%	7.6%	7.6%	7.6%	7.6%
Lifecycle Savings Goals for 2016 to 2020					
% of Annual MW Forecast	7.4%	7.4%	7.4%	7.4%	7.4%
Lifecycle Gas Savings for 2016 to 2020					
% of Annual MMBtu Forecast	7.8%	7.8%	7.8%	7.8%	7.8%

Cumulative Savings Goals

As previously mentioned, some jurisdictions have chosen to set cumulative savings targets over a period of time rather than setting annual incremental goals. Cumulative savings targets provide PAs with greater year-to-year flexibility as long as they are able to meet the total goal over the five-year period. Cumulative targets could be used for either first-year, first-year adjusted, or lifecycle savings goals. Budget and savings targets themselves would be the same as those described under Option 1A. The table below presents potential cumulative goals that could be set based on the GDS UCT budget constrained potential results under the first-year saving option.

Table 12. First-Year Cumulative Energy Optimization Targets Based on UCT Constrained Screening

5-year Cumulative Savings (2016-2020)	
% of Annual MWh Forecast	3.7%
% of Annual MW Forecast	3.7%
% of Annual MMBtu Forecast	3.2%

OPTION 2: BASE ACHIEVABLE TARGETS (UCT)

A. First-Year Savings

This option presents quantified annual energy and capacity targets and funding levels for 2016 through 2020 based on the UCT base achievable scenario analyzed in the GDS potential study. Annual incremental energy savings are based on first-year savings and cost-effectiveness is based on the UCT screening with a rate of market adoption driven by a 50% rebate level, on average. Results of the UCT base achievable potential analysis are listed in Table 13.

Under Michigan's current energy saving goals, targets slowly increase over a period of years before leveling off at 1.0% annual electric savings and 0.75% annual gas savings. A ramp-up period allows utilities time to fully develop program delivery infrastructure and raise awareness about programs to customers. Because savings targets under this scenario are higher than those under Michigan's current savings trajectory, a ramp-up period would allow utilities to gradually achieve higher levels of saving over time. Annual energy savings targets using a ramp-up approach are presented in the table below. Savings goals increase incrementally each year using the current savings goals as a starting point until they reach the average annual percent savings based on the GDS potential estimate. Although this goal-setting approach would allow time for PAs to build program capacity, it would also result in lower cumulative savings over the 5-year period than suggested in the potential study scenario results.

Table 13.First-Year Energy Optimization Targets Based on UCT Base Achievable Screening

	2016	2017	2018	2019	2020	Cumulative 5-Year Total
Annual Energy Savings for 2016 to 2020						
% of Annual MWh Forecast	1.3%	1.6%	1.9%	2.1%	2.1%	9.0%
Annual Demand Savings Goals for 2016 to 2020						
% of Annual MW Forecast	1.3%	1.6%	1.9%	2.2%	2.2%	9.2%
Annual Gas Savings for 2016 to 2020						
% of Annual MMBtu Forecast	1.0%	1.2%	1.4%	1.6%	1.6%	6.8%

Using the estimated costs developed by GDS, the budget cap would be set at 5.5% of annual retail revenue under the UCT base achievable potential scenario. Budgets are based on the costs required to meet cost-effective savings potential and are listed in Table 14 below.

Table 14. Energy Optimization Program Budgets Based on UCT Base Achievable Screening

	2016	2017	2018	2019	2020	Cumulative 5-Year Total
Total Program Costs ($ millions)	$765	$765	$765	$765	$765	$3,825
% of Revenue	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%

B. Adjusted First-Year Savings

This sub-option uses the same methodology for lifecycle adjustment factors as detailed in Option 1B. The budget and savings targets themselves would be the same as those described under Option 2A and a target measure lives of 10 and 12 years for the electric and gas portfolios would apply.

C. Lifecycle Savings

As an alternative to using a first-year adjustment factor to account for lifecycle benefits, Michigan could also set goals that use actual lifecycle savings. Lifecycle goals based on lifecycle savings from the GDS potential study are presented in the table below. Annual lifecycle energy savings targets use a ramp-up approach and goals increase annually until they reach the average annual percent savings based on the GDS potential estimate.

Table 15. Lifecycle Energy Optimization Targets Based on UCT Base Achievable Screening

	2016	2017	2018	2019	2020
Lifecycle Energy Savings for 2016 to 2020					
% of Annual MWh Forecast	12.8%	15.6%	18.4%	21.0%	21.0%
Lifecycle Savings Goals for 2016 to 2020					
% of Annual MW Forecast	12.5%	15.0%	17.5%	20.5%	20.5%
Lifecycle Gas Savings for 2016 to 2020					
% of Annual MMBtu Forecast	10.4%	13.3%	16.2%	19.0%	19.0%

Cumulative Savings Goals

The table below presents cumulative goals that could be set based on the GDS UCT potential results under the first-year saving option. Budget and savings targets themselves would be the same as those described under Option 2A.

Table 16. First-Year Cumulative Savings Targets Based on UCT Base Achievable Screening

5-year Cumulative Savings (2016-2020)	
% of Annual MWh Forecast	9.0%
% of Annual MW Forecast	9.2%
% of Annual MMBtu Forecast	6.8%

OPTION 3: BASE ACHIEVABLE TARGETS (TRC)

A. First-Year Savings

This option presents quantified annual energy and capacity targets and funding levels for 2016 through 2020 based on the TRC base achievable scenario analyzed in the GDS potential study. Annual incremental energy savings are based on first-year savings and cost-effectiveness is based on the TRC screening with a rate of market adoption driven by a 50% rebate level, on average. The GDS estimated TRC potential is slightly less than that based on the UCT. This is because the UCT approach allows the utilities to pursue some measures that do not pass the TRC, but can still be promoted in a way that passes the UCT so long as incentives are lower than 100% of the measure cost. Savings goals ramp-up annually until they reach the annual average percent savings based on GDS results. Savings goals for the TRC base achievable scenario are listed in the table below.

Table 17. First-Year Energy Optimization Targets Based on TRC Base Achievable Screening

	2016	2017	2018	2019	2020	Cumulative 5-Year Total
Annual Energy Savings for 2016 to 2020						
% of Annual MWh Forecast	**1.3%**	**1.6%**	**1.8%**	**2.0%**	**2.0%**	**8.7%**
Annual Demand Savings Goals for 2016 to 2020						
% of Annual MW Forecast	**1.3%**	**1.6%**	**1.9%**	**2.1%**	**2.1%**	**9.0%**
Annual Gas Savings for 2016 to 2020						
% of Annual MMBtu Forecast	**0.9%**	**1.1%**	**1.2%**	**1.3%**	**1.3%**	**5.8%**

Using the estimated costs developed by GDS, annual budget caps under the TRC base achievable potential scenario would be greater than the 2% of revenue that is the current limit and would be set at 3.4% of annual revenue. Budgets are based on the costs required to meet cost-effective savings potential and are listed in Table 18.

Table 18. Energy Optimization Program Budgets Based on TRC Base Achievable Screening

	2016	2017	2018	2019	2020	Cumulative 5-Year Total
Total Program Costs	**$474**	**$474**	**$474**	**$474**	**$474**	**$2,370**
% of Revenue	**3.4%**	**3.4%**	**3.4%**	**3.4%**	**3.4%**	**3.4%**

B. Adjusted First-Year Savings

This sub-option uses the same methodology for lifecycle adjustment factors as detailed in Option 1B. The budget and savings targets themselves would be the same as those described under Option 3A and a target measure lives of 10 and 11 years for the electric and gas portfolios would apply.

C. Lifecycle Savings

Lifecycle goals are based on the lifecycle results from the GDS potential study and are presented in the table below. Under a lifecycle savings approach, program budgets would remain the same as those listed in Option 3A. Annual lifecycle energy savings targets use a ramp-up approach and goals increase annually until they reach the average annual percent savings based on the GDS potential estimate.

Table 19. Lifecycle Energy Optimization Targets Based on TRC Base Achievable Screening

	2016	2017	2018	2019	2020
Lifecycle Energy Savings for 2016 to 2020					
% of Annual MWh Forecast	12.3%	14.6 %	16.8%	19.0%	19.0%
Lifecycle Savings Goals for 2016 to 2020					
% of Annual MW Forecast	12.4%	14.8%	17.2%	19.4%	19.4%
Lifecycle Gas Savings for 2016 to 2020					
% of Annual MMBtu Forecast	9.2%	10.9%	12.6%	14.3%	14.3%

Cumulative Savings Goals

The table below presents cumulative goals that could be set based on the GDS TRC potential results under the first-year saving option. Budget and savings targets themselves would be the same as those described under Option 3A.

Table 20. First-Year Cumulative Savings Targets Based on TRC Base Achievable Screening

5-year Cumulative Savings (2016-2020)	
% of Annual MWh Forecast	8.7%
% of Annual MW Forecast	9.0%
% of Annual MMBtu Forecast	5.8%

OPTION 4: MAX ACHIEVABLE TARGETS (TRC)

A. First-Year Savings

This option presents quantified annual energy and capacity targets and funding levels for 2016 through 2020, based on the max achievable scenario analyzed by GDS. The analysis of this scenario was funded by the Natural Resources Defense Council (NRDC) and does not appear in the potential study. Annual incremental energy savings are based on first-year savings and cost-effectiveness is based on the TRC screening with a rate of market adoption driven by a 100% rebate level. Savings goals ramp-up annually until they reach the annual average percent savings based on GDS results. Savings goals based on the TRC max achievable potential analysis are presented in the table below.

Table 21. First-Year Energy Optimization Targets Based on TRC Max Achievable Screening

	2016	2017	2018	2019	2020	Cumulative 5-Year Total
Annual Energy Savings for 2016 to 2020						
% of Annual MWh Forecast	1.4%	1.8%	2.2%	2.5%	2.5%	10.4%
Annual Demand Savings Goals for 2016 to 2020						
% of Annual MW Forecast	1.5%	1.9%	2.3%	2.7%	2.7%	11.1%
Annual Gas Savings for 2016 to 2020						
% of Annual MMBtu Forecast	0.9%	1.1%	1.3%	1.5%	1.5%	6.3%

Under the TRC max achievable scenario, there are no budget caps that limit efficiency program spending. Using the estimated costs developed by GDS, achieving this level of savings would require 7.9% of annual retail revenue. Budgets are based on the costs required to meet the cost-effective savings potential and are listed in Table 22.

Table 22. Energy Optimization Program Budgets Based on TRC Max Achievable Screening

	2016	2017	2018	2019	2020	Cumulative 5-Year Total
Total Program Costs	$1,100	$1,100	$1,100	$1,100	$1,100	$5,498
% of Revenue	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%

B. Adjusted First-Year Savings

This sub-option uses the same methodology for life cycle adjustment factors as detailed in Option 1B. The budget and savings targets themselves would be the same as those described under Option 4A and a target measure lives of 10 and 11 years for the electric and gas portfolios would apply.

C. Lifecycle Savings

Lifecycle goals are based on lifecycle results from the GDS potential study and are presented in the table below. Under a lifecycle savings approach, program budgets would remain the same as those listed in Option 4A. Annual lifecycle energy savings targets use a ramp-up approach and goals increase annually until they reach the average annual percent savings based on the GDS potential estimate.

Table 23. Lifecycle Energy Optimization Targets Based on TRC Max Achievable Screening

	2016	2017	2018	2019	2020
Lifecycle Energy Savings for 2016 to 2020					
% of Annual MWh Forecast	**13.6%**	**17.2%**	**20.8%**	**24.4%**	**24.4%**
Lifecycle Savings Goals for 2016 to 2020					
% of Annual MW Forecast	**13.9%**	**17.8%**	**21.7%**	**25.4%**	**25.4%**
Lifecycle Gas Savings for 2016 to 2020					
% of Annual MMBtu Forecast	**9.8%**	**12.1%**	**14.4%**	**16.7%**	**16.7%**

Cumulative Savings Goals

The table below presents cumulative goals based that could be set based on the GDS TRC max achievable potential results. Budget and savings targets themselves would be the same as those described under Option 4A.

Table 24. First-Year Cumulative Energy Optimization Targets Based on TRC Max Achievable Screening

5-year Cumulative Savings (2016-2020)	
% of Annual MWh Forecast	10.4%
% of Annual MW Forecast	11.1%
% of Annual MMBtu Forecast	6.3%

COMPARISON WITH OTHER STATES

Potential Studies

To assess the most reasonable option for setting efficiency targets in Michigan, it may be useful to examine potential and actual savings in other jurisdictions. A report written by the Energy Center of Wisconsin and ACEEE in 2009 compiled results of existing potential studies completed for the Midwestern region.[14] Achievable savings are presented on an annual basis representing the energy savings per year as a percent of annual sales. The review suggests that achievable potential for all sectors ranged from 0.4 to 1.8% of annual savings with a median value of 1.1%. The table below presents result of these studies.

14 Energy Center of Wisconsin and ACEEE, "A Review and Analysis of Existing Studies of the Energy Efficiency Resource Potential in the Midwest." August 2009.

Table 25. Midwestern Potential Study Achievable Potential Estimates, All Sectors

State	Study Year	Author	Study Period	# of Years	Electric Achievable Potential (% savings/year)	Gas Achievable Potential (% savings/year)
Midwestern Studies Reviewed						
Illinois	2003	MEEA	Not Specified			0.6%
Indiana	2007	Summit Blue and WECC	2008-2027	20		0.6%
Iowa (Municipal)	2009	Energy Center of WI, et al.	2008-2018	11	1.2%	1.8%
Kansas	2008	Summit Blue	2008-2028	21	1.1%	1.5%
Midwest	2006	MEEA	2006-2025	20		1.3%
Minnesota	2009	Navigant	2009-2019	11		1.6%
Wisconsin	2009	Energy Center of WI, et al.	2008-2018	11	1.6%	1.0%
Wisconsin	2005	Energy Center of WI, et al.	2006-2015	10	0.8%	0.4%
Ontario	2005	ICF	2006-2025	20	0.7%	

The authors were quick to point out that differences in potential study methodologies, vintage and quality of the data, types of potential, markets included, and other differences make it difficult to draw strong conclusions from these studies. Additionally, given the limited number of studies completed in the Midwest, the authors drew on 14 additional studies from northeastern, southern, and western states as a point of comparison. When including these additional studies, the authors found achievable potential ranged from 0.3 to 4.0% of annual savings with a mean value of 1.5% and a median of 1.2%. While slightly larger, the authors suggest that these results are relatively similar to Midwestern studies.

Although the authors indicate that it may be tempting to assume these numbers represent the maximum achievable potential estimates, they point out that they believe these potential studies to be conservative estimates. The authors cite a paper by Goldstein (2008) as well as their own experience to explain their reasoning.[15] Among other things, they suggest that conservatism is built into key assumptions for these potential studies. Where there is uncertainty of input estimates, the studies rely on estimates at the low end of the range of possible values.

Many of the studies included in the report represent regionally similar jurisdictions, but the majority of the studies reviewed are more than five years old. Therefore, it may also be useful to consider results from more recent studies from other regions. In the introduction of the Michigan potential study, GDS provides a table comparing the achievable potential in several

[15] Goldstein, "Extreme Efficiency: How Far Can We Go if We Really Need To?" Proceedings from the ACEEE Summer Study on Energy Efficiency in Buildings. 2008.

recent potential studies complied in states throughout the United States. Results of these studies are shown in Table 3-1 of the GDS report. Annual achievable potential from these studies ranges from 0.6 to 2.9% of annual retail sales. The average achievable potential from this group of studies is 1.7% and the median value is 1.6%, indicating that the more recent studies, though relatively similar, estimate slightly greater achievable potential than the Midwestern studies. Although these potential studies provide points of comparison to the GDS potential study, it is important to keep in mind that they may vary in the way they treat key assumptions and inputs. For example, many of the studies listed in the table below represent the maximum achievable potential, which assumes incentives at 100% of incremental cost rather than 50% as assumed in the GDS potential study.

Table 26. Results of Recent Energy Efficiency Potential Studies in the US[16]

State	Study Year	Author	Study Period	# of Years	Cumulative Achievable Potential	Annual Achievable Potential[17]
Missouri	2011	ACEEE (1)	2011-2020	10	6.4%	0.6%
District of Columbia	2013	GDS (2)	2014-2023	10	29%	2.9%
New Hampshire	2009	GDS (3)	2009-2018	10	20.5%	2.1%
Rhode Island	2008	KEMA (4)	2009-2018	10	9.0%	0.9%
Vermont	2011	GDS/Cadmus (5)	2012-2021	10	14.3%	1.4%
New York City	2010	Global Energy Partners (6)	2011-2018	8	15%	1.5%
USA	2009	McKinsey & Company (7)	2011-2020	10	23.0%	2.3%
Pennsylvania	2012	Statewide Evaluator (8)	2013-2023	10	17.3%	1.7%
Note 1: The ACEEE energy efficiency potential study builds on several energy efficiency potential studies conducted in Missouri from 2008 through 2011 and analyzes a specific suite of energy efficiency policies and programs.						
Note 2: The July 2013 District of Columbia potential study evaluated the maximum achievable potential scenario where incentives equaled 100% of measure incremental costs.						
Note 3: The 2009 New Hampshire potential study figure presented here is maximum achievable potential. Maximum Achievable potential is defined in this study as the maximum penetration of an efficient measure that would be adopted absent consideration of cost or customer behavior.						
Note 4: This 2010 KEMA report titled "Opportunity for Energy Efficiency That Is Cheaper Than Supply In Rhode Island" examined technical, economic and achievable potential for electric energy efficiency savings. Here is the definition of achievable potential used in that report: "Achievable program potential refers to the amount of cost-effective savings that are estimated to occur in response to a specific funded set of program activities. Achievable potential reflects *net* savings — in other words incremental savings over and above those projected to occur naturally from future changes in codes and standards or from other market activities outside of National Grid's efficiency program interventions and efforts. Achievable potential is estimated at the program level – namely groups						

[16] Included as Table 3-1 from GDS Associates, Inc. "Michigan Electric and Natural Gas Energy Efficiency Potential Study, Final Report." November 5, 2013.

[17] Annual percentages were calculated by dividing the cumulative savings potential by the study period.

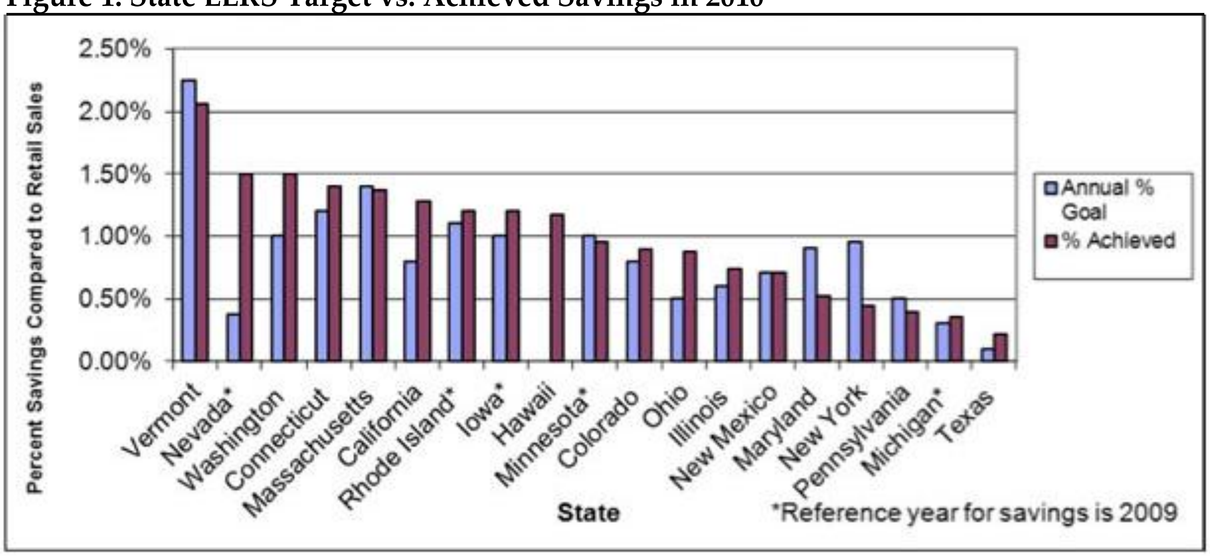
State	Study Year	Author	Study Period	# of Years	Cumulative Achievable Potential	Annual Achievable Potential[17]
of measures are bundled into program offerings						
Note 5: The 2011 Vermont study figure presented here is maximum achievable potential. Achievable potential in this study is defined as the amount of energy use that 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 efficiency equipment).						
Note 6: The 2010 New York City potential study figure provided here is maximum achievable potential.						
Note 7: The 2009 McKinsey & Company potential study only includes energy efficiency measures that can be hard-wired and excludes the impacts of all behavior-based programs.						
Note 8: The 2012 Pennsylvania potential study figure provided here is maximum achievable potential.						

Savings Targets and Achievement

A 2011 ACEEE report indicates that twenty-four states in the U.S. have implemented Energy Efficiency Resource Standards that specify long-term (3 or more years), binding energy savings goals.[18] An additional three states have set nonbinding goals. The report further suggests that most states that have had EERS policies in place for more than two years are meeting or are close to meeting energy saving goals. Only three states are achieving less than 80% of their goals.

Figure 1 below from the report indicates that although Michigan had exceeded its 2009 EERS target, the goal was comparatively low when considering other state EERS goals and achievement.

Figure 1. State EERS Target vs. Achieved Savings in 2010[19]



18 Sciortino, et al., "Energy Efficiency Resource Standards: A Progress Report on State Experience." ACEEE Report Number U112. June 2011.

19 This graph appears as "Figure 3: State EERS Target vs. Achieved Savings in 2010" in Sciortino, et al., "Energy Efficiency Resource Standards: A Progress Report on State Experience." ACEEE Report Number U112. June 2011.

The chart indicates that only one state had an energy savings target over 2% of annual retail sales to be achieved by 2010; however, several states have set targets to achieve annual savings of 2% or higher since 2010. For example, Massachusetts' annual electric savings goals ramp up from 2.5 to 2.6% from 2013-2015. Several Midwestern states have also set energy savings goals at the 2% level in the next several years. The State of Illinois' EERS, which began at 0.2% of annual electric sales in 2008, ramps up to 2.0% of annual sales by 2015.[20] Indiana energy savings goals increase to 1.1% in 2014 and 2% in 2019, and utilities in Ohio must save 2% savings by 2018 following a ramp-up period starting in 2010. [21]

In the potential study, GDS also presents findings from a 2012 report by the American Council for an Energy Efficient Economy (ACEEE) indicating that in 2011, 11 states spent greater than 2% of electric sales revenue according to self-reports.[22] GDS's analysis of actual energy efficiency savings data for 2010 and 2011 from the US Energy Information Administration (EIA) also indicates that the top twenty utilities saved over 2% of annual kWh sales in 2010 with their energy efficiency programs, and 3.8% of annual kWh sales in 2011. These results indicate the savings level possible with full-scale and aggressive implementation of programs.

[20] Illinois General Assembly, Illinois Compiled Statues, "220 ILCS 5/8-103." Accessed November 17, 2013. http://www.ilga.gov/legislation/ilcs/fulltext.asp?DocName=022000050K8-103

[21] ACEEE, "State Energy Efficiency Policy Database, Indiana Utility Policies." Accessed November 17, 2013. http://aceee.org/sector/state-policy/indiana; General Assembly of the State of Ohio, "Senate Bill 221." Accessed November 17, 2013. http://www.legislature.state.oh.us/BillText127/127_SB_221_EN_N.pdf

[22] American Council for an Energy Efficient Economy, "The 2010 State Energy Efficiency Scorecard", Report #E107, October 2010.

ADDITIONAL TARGET SETTING CONSIDERATIONS

DEMAND CONSIDERATIONS

Demand Targets

Whereas the term "energy" used with regard to efficiency savings refers to the total amount of energy consumed, demand (often expressed in megawatts) refers to the rate at which energy is consumed. Both energy and demand savings help to limit the need for additional generation resources. Reducing demand also helps to improve electric system reliability by limiting the frequency with which systems are strained to maximum capacity. Although efficiency measures often lead to both energy and demand savings, peak savings often are not the primary focus of efficiency programs.[23] The same is currently true in Michigan where targets are set solely based on energy savings.

Several states, however, have adopted peak demand reduction targets in addition to energy savings targets. For example, Ohio Senate Bill 221 requires utilities to reduce energy use by 22% by 2025 while reducing peak demand by 1% in 2009 and an additional 0.75% annually through 2018.[24] Maryland, Pennsylvania, and Texas have also adopted demand savings goals. These goals ensure that utilities consider both energy and demand savings in the design of DSM programs.

Although Michigan has only set energy savings targets in the past, it could consider including demand savings targets as part of the new goal-setting process. Setting demand targets in addition to energy targets could encourage more balanced portfolios that maximize the overall benefits of both energy and demand savings while effectively reducing the future costs of service to customers. The "Options for Energy Savings Targets" section of this report provides both energy and demand targets based on the GDS achievable potential scenarios analyzed should Michigan wish to set demand targets.

Integrated Demand Response and Energy Optimization Programs

In addition to the peak demand savings achievable through energy efficiency measures, many jurisdictions achieve peak demand savings by implementing Demand Response (DR) programs. Energy efficiency refers to "permanent changes to electricity usage through installation of or replacement with more efficient end-use devices or more effective operation of existing devices that reduce the quantity of energy needed to perform a desired function or

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23 York, Kushler, and Witte, "Examining the Peak Demand Impacts of Energy Efficiency: A Review of Program Experience and Industry Practices." 2007.

24 Goldman et al., Ernest Orlando Lawrence Berkley National Laboratory, "Coordination of Energy Efficiency and Demand Response." A Resource of the National Action Plan for Energy Efficiency. January 2010.

service."[25] Demand response, on the other hand, refers to "changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized."[26]

Efficiency and DR programs are often implemented separately with different goals in mind. However, the benefits of these two types of programs also overlap with efficiency leading to reduced demand and demand response enabling additional energy savings. York et al (2005) identified several of the potential synergies between efficiency and demand response.[27]

- Energy efficiency can reduce demand permanently, at peak and non-peak times
- Peak-demand reductions can help identify inefficient and non-essential energy uses that could be reduced at other times, resulting in broader energy and demand savings
- Technologies that can enable DR also can be used effectively to manage energy use year-round
- Experience from DR activities can lead to greater awareness of energy savings opportunities through improved energy efficiency
- Customers who participate in DR programs may be prime candidates for participating in other types of DSM programs such as energy efficiency (and vice versa)
- Program marketing could be more effective at communicating with customers about their energy use by addressing integrated approaches to energy management

Many of these synergies were echoed in a report by Goldman et al. (2010), which suggested that integration of efficiency and demand response programs could result in cost efficiencies and more rational allocation of resources for customers and providers. The report indicates that the majority of customers do not understand the difference between energy efficiency and demand response and would be open to managing energy use in an integrated way.[28] This coordinated effort could in turn lead to increased demand response participation and greater energy and demand savings. Ultimately, "customer and utility smart grid investments in communications, monitoring, analytics, and control technologies will blur many of the distinctions between energy efficiency and demand response and help realize the benefits of this integration."[29]

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25 Goldman, et al. (2010).

26 U.S. Department of Energy, "Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them. 2006" As cited in Goldman et al. (2010).

27 York and Kushler, "Exploring the Relationship Between Demand Response and Energy Efficiency: A Review of Experience and Discussion of Key Issues." ACEE Report Number U052. 2005.

28 Goldman et al. (2010).

29 *Ibid.*

The report further describes potential strategies for integrating energy efficiency and demand response at the customer level. One strategy would be to combine efficiency and demand response program offerings rather than offering them separately. Program marketing and education could also package and promote efficiency and demand response opportunities in the absence of combined program offerings. Education efforts could address both concepts together. Although less relevant to the discussion at hand, the report also describes market-driven coordinated services through private firms and building codes and appliance efficiency standards as additional ways to coordinate energy efficiency and demand response. Additional coordination strategies other than at the customer level include coordinated resource planning processes, funding efficiency and demand response programs from a single budget and training program staff in both energy efficiency and demand response.

Several different types of DR programs are commonly implemented and could be considered in Michigan. These programs fall into two primary categories: load response and price response.[30] Under load response programs, customers receive a financial incentive for agreeing to reduce demand at the request of a utility during peak load events. These programs often involve the use of control and communications technologies to allow the customer to reduce demand by turning off, cycling, or modulating certain equipment or appliances. Price response programs on the other hand, provide customers with incentives to change their demand through differentiated pricing structures or other economic incentives to change their demand. For example, under time-of-use pricing, large commercial and industrial customers are offered different rates for on and off peak energy use (peak may be hourly or seasonal). Under real-time pricing, customer rates vary hourly, daily and seasonally based on actual or projected market rates.

Additional opportunities exist that would allow customers to engage in demand response programs and access information. These opportunities include consumption data web portals and smart phone applications and other smart enabling devices. Simplifying the process of tracking and managing energy use and providing rebates for smart enabling devices would likely provide greater opportunities for customer participation in DR programs.

Numerous technologies can be used to enable energy efficiency and demand response. For example, programmable thermostats are frequently implemented as energy efficiency measures. Customers can save energy by adjusting heating or air-conditioning times based on a pre-set schedule. Programmable communicating thermostats (PCTs) could provide the same energy savings benefits while also enabling customers to participate in demand response programs that curtail load during peak seasons and hours. PCTs provide two-way communication between the utility and the customer and enables customers to set thermostats to adjust the temperature of their buildings when the utility signals a peak load event. Similarly, smart appliances receive a signal from the utility company during times of peak electrical usage and are programmed to avoid energy usage or operate on a lower wattage during these times. With both technologies, customers can override these settings if needed. Many energy efficiency

30 York and Kushler, "Exploring the Relationship Between Demand Response and Energy Efficiency: A Review of Experience and Discussion of Key Issues." ACEE Report Number U052. 2005.

programs already promote efficient appliances that use less energy than standard appliances. Promoting efficient and smart appliances in an integrated fashion would save customers energy while also allowing them to participate in demand response programs.

Energy Management Systems (EMS) also enable demand response while improving building energy efficiency. EMS refers to electronic devices that communicate with and control multiple appliances and equipment from a central location. Simplified and improved day-to-day facility operations and monitoring capabilities can result in multiple opportunities for energy savings. Utilities can also send price and peak demand signals to EMSs and stop or reduce non-critical energy uses through an automated process.

In Michigan, energy efficiency programs could be used to leverage demand response programs thus providing enhanced cost-of-service benefits to customers, as opposed to traditional stand-alone DR, which is more expensive and may provide more limited energy and environmental benefits. The demand targets included in this report represent demand savings only from Energy Optimization programs and savings. Savings from demand response integration would provide additional demand savings opportunities beyond EO program demand goals. Integrated demand response resources could be captured by allowing flexibility for the commission to expand demand targets on a utility by utility basis.

Providing integrated DR and efficiency programs may require increased administrative and funding resources. However, in recent years, several pilot programs have been completed to test various smart grid technologies in real world conditions. For example, Consumers Energy is currently conducting a SmartStreet™ pilot program.[31] The program installed smart meters at participating homes and businesses in the Grand Rapids area. These customers will have their electric usage information available to them through a web site or in-home display, allowing them to monitor their energy usage over various periods of time. It may be possible to leverage programs already being piloted and funded to incorporate DR with EO programs.

EXPANDED SAVINGS OPPORTUNITIES

Although the GDS potential study helps to inform the level of energy savings Michigan can seek to achieve in the coming years, results of the study represent a lower bound of the achievable energy efficiency in the state. The study excluded the efficiency potential of several technologies that could provide additional opportunities for energy savings. These technologies include combined heat and power systems (CHP), geothermal heat pumps, fuel switching and on-site solar. The following sections describe these technologies and their applications. In addition to providing additional energy saving potential, these technologies help to reduce costs to customers as well as greenhouse gas emissions. Michigan may wish to consider encouraging and enabling the use of these technologies in energy optimization program offers to achieve greater energy savings.

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31 Michigan Public Service Commission Department of Licensing and Regulatory Affairs, "Smart Grid, Michigan Activity." Accessed November 17, 2013. http://www.michigan.gov/mpsc/0,4639,7-159-56137-257108--,00.html.

Geothermal Heat Pumps

Geothermal heat pumps (GHP) use a heat exchanger to extract heat from a building and transfer it to the ground for cooling in the summer and take heat from the ground and transfer it to a building for heating in the winter.[32] Because ground temperatures remain relatively constant throughout the year, it provides a reservoir of heat energy that can be used more efficiently than outdoor air. To provide domestic hot water, residential systems often include desuperheaters that deliver excess heat from the geothermal heat pump's compressor to a hot water tank.[33] Although geothermal heat pumps only provide hot water when the system is running, some manufacturers have started offering "full demand" systems with a separate heat exchanger that allows the geothermal heat pump to provide hot water year round. This results in very high efficiencies, both for space heating and cooling and makes the technology a prime candidate for efficiency programs.

There are four main types of geothermal heat pumps: horizontal, vertical, pond/lake, and open loop.[34] The appropriate option largely depends on site and climate conditions. The first three types are closed loop systems. Horizontal systems are largely used in residential new construction with sufficient available land. Vertical systems are primarily used in larger commercial applications with limited land or shallow soil. Pond/lake systems require an on-site body of water with pipes that run underground from the building to the water. Open-loop systems circulate water from a well or surface body of water through the heat pump and returns the water to its source. This type of system requires a sufficient supply of clean water and the ability to meet groundwater discharge codes and regulations.

GHP can be used for both commercial and residential applications. Commercial systems typically include loops that connect multiple packaged heat pumps and a single ground source water loop.[35] The capacity of these units is typically between 1 and 10 tons of cooling, and they can be used in an array of multiple units to meet a large demand.

By taking advantage of the consistency of ground temperatures and the much higher thermal mass of soil and groundwater compared to air, geothermal heat pump systems are much more energy efficient than other systems. GHP can reduce energy use by 25-50% in comparison with standard options.[36] Additionally, they provide significant peak electric reductions during cooling periods when the cost of energy is most expensive. Geothermal heat

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32 U.S. Department of Energy, "Guide to Geothermal Heat Pumps." Accessed November 17, 2013. http://energy.gov/sites/prod/files/guide_to_geothermal_heat_pumps.pdf

33 U.S. Department of Energy, Geothermal Technologies Office, "Geothermal Heat Pumps." Accessed November 17, 2013. http://www1.eere.energy.gov/geothermal/heatpumps.html

34 U.S. Department of Energy, "Guide to Geothermal Heat Pumps." Accessed November 17, 2013. http://energy.gov/sites/prod/files/guide_to_geothermal_heat_pumps.pdf

35 U.S. Department of Energy, Federal Energy Management Program, "New and Underutilized Technology: Commercial Ground Source Heat Pumps." Accessed November 17, 2013. https://www1.eere.energy.gov/femp/technologies/eut_comm_gshp.html

36 *Ibid.*

pumps present a particularly good opportunity for new buildings or replacing an HVAC system in a building undergoing significant renovation. While installing a geothermal heat pump is more expensive upfront that air source heat pumps, and other conventional heating systems, the payback period from energy savings is typically 5 to 10 years.[37]

Geothermal heat pumps provide an opportunity for energy savings in many jurisdictions. For example, a 2010 study by the Oak Ridge National Laboratory suggest that significant potential national benefits exist from retrofitting all space heating and cooling and water heating systems in existing U.S. single-family homes with geothermal heat pump systems. [38] These potential benefits include 4.3 quadrillion (quad) British thermal units (Btu) in primary energy savings, which represents a 14.1% reduction in primary energy consumption as well as a 48.2% reduction in energy costs, equaling savings of $52.2 billion in energy expenditures. Some states such as Connecticut and Maryland offer rebates to commercial and residential customers for installing geothermal heat pumps. Michigan may also wish to include geothermal heat pumps in their EO program offerings and count savings toward the State's resource standards in order to harness additional energy savings opportunities.

One option to allow for expanded geothermal heat pump implementation would be to allow the use of the Total Resource Cost Test (TRC) with GHP cost-effectiveness screening. The current approach in Michigan requires efficiency measures to pass the Utility Cost Test (UCT) at the portfolio level. Although this is a reasonable screening method for most electric and gas utility efficiency resources, it may undervalue benefits from GHP and other fuel switching measures. GHP can offer significant electric energy and peak demand savings by improving the efficiency with which cooling loads are met. However, if a customer with oil or propane heating installs a GHP there will likely also be significant primary Btu savings from these unregulated fuels, which are not accounted for in the UCT. It is possible that an electric utility incentive designed only to pass the UCT might not be sufficient to encourage widespread adoption of GHP. To achieve greater savings through the promotion of GHP, Michigan could allow this resource to be included as an EO program measure whenever it passes TRC screening.

Combined Heat and Power

An opportunity for future energy savings in Michigan that is not currently recognized is the use of combined heat and power technologies (CHP). CHP is a type of distributed generation, which uses small-scale technologies to generate electricity near customer facilities.[39] CHP produces both electricity and heat from a single fuel source and uses both sources of energy in an integrated system. The heat generated from the system is recovered as useful energy for

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37 U.S. Department of Energy, "Guide to Geothermal Heat Pumps." Accessed November 17, 2013. http://energy.gov/sites/prod/files/guide_to_geothermal_heat_pumps.pdf

38 Oak Ridge National Laboratory, "Assessment of National Benefits from Retrofitting existing Single-Family Homes with Ground Source Heat Pump Systems." June 2010.

39 U.S. Environmental Protection Agency Combined Heat and Power Partnership, "Catalog of CHP Technologies." December 2008.

nearby heating, cooling, water heating, or industrial processes. Additionally, CHP systems reduce transmission and distribution losses that occur when electricity is used from central power plants because electricity is generated on site. For these reasons, CHP systems are more efficient than electric or thermal-only systems. Improved efficiency from CHP also reduces environmental impacts by limiting pollution and GHG emissions from power plants.[40] CHP can offer potential reliability benefits since dispersed systems are less vulnerable to disruption than centralized power plants.

CHP systems can be used for numerous applications in the commercial, industrial, and residential sectors. Markets such as industry and manufacturing, food processing, hospitals, and multifamily housing complexes, among others may especially benefit from CHP opportunities.[41] It is estimated that CHP systems produce nearly 8% of electric power in the United States.[42] Currently, Michigan has 3.1 GW of existing CHP capacity with an additional estimate technical potential of 2.3 GW and 2.1 GW within the industrial and commercial sectors respectively.[43]

The U.S. EPA Combined Heat and Power Partnership identifies five primary CHP technologies: gas turbines, reciprocating engines, steam turbines, micro turbines, and fuel cells.[44] Gas turbines or reciprocating engine systems as well as steam turbines are the most commonly used CHP systems configurations. Gas turbines and reciprocating engine systems produce electricity by burning fuel, often natural or biogas, and recover waste heat from the combustion system. The heat is then converted into useful thermal energy such as steam or hot water. These systems are most common among larger industrial or commercial uses that require large amounts of heat and electricity.

A steam turbine does not convert fuel to electricity directly, but requires a separate heat source. Fuel is burned in a boiler and high pressure steam runs the turbine and generator. Steam turbines can operate using a range of fuels. The energy is transferred from the boiler to the turbine through high pressure steam that in turn powers the turbine and generator. Steam turbines are often used for industrial processing with readily available waste fuels, such as the paper industry.

Micro-turbines are small systems that burn gas or liquid fuels to create high-speed rotation that turns an electrical generator.[45] Waste heat is used for thermal energy to produce hot water for space heating and other thermal energy uses. Primary applications may include, "financial services, data processing, telecommunications, restaurant, multifamily residential buildings,

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40 CHP Association, "Benefits." Accessed November 11, 2013. http://chpassociation.org/benefits/.

41 CHP Association, "Uses of CHP." Accessed November 11, 2013. http://chpassociation.org/uses-of-chp/.

42 CHP Installation Database developed by ICF International for Oak Ridge National Laboratory and the U.S. DOE; 2012. Available at http://www.eea-inc.com/chpdata/index.html.

43 *Ibid*.

44 U.S. Environmental Protection Agency Combined Heat and Power Partnership, "Catalog of CHP Technologies." December 2008.

45 ICF Energy And Environmental Analysis, Prepared for the U.S. EPA Combined Heat and Power Partnership Program, "Technology Characterization: Microturbines."December 2008.

lodging, retail, office building, and other commercial sectors."[46] In CHP applications, fuel cells generate direct current electricity through an electrochemical process as well as heat that can be used to generate steam. Fuel cell CHP is mainly used in the commercial/institutional sectors by colleges and universities, hospitals, nursing homes, and hotels whose buildings have high coincident electric and hot water and space heating demand. Fuel cells currently have limited cost-effective applications; however, future technological advances should increase the market for this technology.

Some states have taken steps to allow and utilize CHP as eligible efficiency resources in their efficiency programs. For example, Ohio Senate Bill 315, enacted in 2012, allows new CHP technologies to apply towards reaching Ohio's energy efficiency resource standard.[47] The Public Utility Commission of Ohio is also engaged in a pilot project with the U.S. Department of Energy to reduce regulatory and educational barriers to the development of CHP in Ohio and elsewhere.[48] Although the current legislation in Michigan does not necessarily prevent the inclusion of CHP in Energy Optimization programs, Michigan may wish to consider adopting policies and regulations that encourage and specifically reference the use of CHP as an energy resource. Additional CHP resources could be captured by allowing flexibility for the commission to expand demand targets on a utility by utility basis.

A described in reference to geothermal heat pumps, implementing the use of the TRC at the measure level to screen CHP could help to access this additional resource. In this case, the TRC provides a check against promotion of non-cost-effective CHP where it may pass the UCT for electric but result in a poor application that actually increases total primary energy usage.

Fuel Switching

Fuel Switching refers to replacing the use of inefficient fuels with less expensive, cleaner alternatives such as natural gas. In addition to upgrading equipment, fuel switching provides a way to reduce energy use and customer costs. Fuel switching may be cost-effective for a number of end uses including space heating and cooling, refrigeration, clothes drying, and water heating. For example, an electric domestic hot water heater might be replaced with a gas heater. Changing to a ground source heat pump as described above from an oil or propane fired heating system provides another example of fuel switching. Similarly, CHP can be viewed as a fuel switching measure by reducing electricity usage but increasing usage of a fossil or biomass fuel to produce the electricity.

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46 *Ibid.*

47 The Public Utilities Commission of Ohio, "Combined Heat and Power in Ohio. Accessed November 12, 2013. http://www.puco.ohio.gov/puco/index.cfm/industry-information/industry-topics/combined-heat-and-power-in-ohio/

48 Add Website, http://www.puco.ohio.gov/puco/index.cfm/industry-information/industry-topics/combined-heat-and-power-in-ohio/ See more at: http://www.puco.ohio.gov/puco/index.cfm/industry-information/industry-topics/combined-heat-and-power-in-ohio/#sthash.uuXUlp7n.dpuf

Fuel-switching can also be applicable to the commercial, industrial, and residential sectors. Although the cost-effectiveness of the fuel switching may depend on the end use and application, fuel switching is increasingly being recognized as eligible demand-side management measures in various jurisdictions. For example, in Western Washington State, Puget Sound Energy provides residential customers up to $3,500 to switch their home and water heating systems to natural gas.[49] Michigan could choose to encourage utilities to make fuel switching measures available to customers through EO programs as an additional savings opportunity. A described in reference to geothermal heat pumps, and CHP, implementing the use of the TRC at the measure level to screen fuel switching measures could help to access this additional resource

On-Site Solar

In addition to expanded energy efficiency options, on-site solar technologies could provide an additional energy resource in Michigan. Solar energy is considered a renewable energy source because it does not rely on finite resources such as fossil fuels to generate power. Rather, solar photovoltaic technologies collect sunlight and convert it to electricity. There are two primary categories of on-site solar technologies: solar photovoltaic (PV) and solar thermal. The latter provides thermal energy directly that can be used to offset another energy source such as gas or oil traditionally used to produce thermal energy. Both solar PV and solar thermal technologies can be used on commercial and industrial as well as residential sites.

Photovoltaic (PV) solar power is one of the most well-known and fastest growing types of renewable energy.[50] PV panels have long been used to provide power in remote locations such as off-grid homes, weather towers, buoys, and satellites. Solar cells are made of semi-conductors; direct current (DC) electricity flows through them when sunlight hits them. Most panels are made up of many cells connected in series, each of which adds a small amount of voltage. The panels are then wired together in series strings. If shade falls on any of the cells in the series, output is severely degraded for that string. Consequently, it is extremely important that PV systems are installed where they will not be shaded during hours of peak sunshine, between about 9 AM and 4 PM. Some installations use microinverters or other power control electronics so that shading only affects shaded panels, not the whole string. Microinverters also allow for more precise monitoring and optimization.

PV systems range vastly in scale, and can be designed to match virtually any load, with available space and capital being the major constraints. Tiny solar cells power watches and calculators while ever larger utility installations are being built and expanded, a few of which have capacities over 70 MWDC. Solar panels can be installed at a fixed angle, optimized for

49 Puget Sound Energy, "Converting to Natural Gas: Fuel Conversion Rebate." Accessed November 17, 2013. http://pse.com/savingsandenergycenter/ForHomes/Pages/Converting-to-Natural-Gas.aspx

50 The On-Site Solar section of the report was adapted from "Appendix B: Renewable Energy Technology and Market Overview," which appeared in Optimal Energy's 2011 report, "Statewide Energy Efficiency and Renewable Energy Potential for New York State," prepared for the New York Power Authority. Content for this appendix was developed by the Vermont Energy Investment Corporation.

annual output on roofs or the ground, mounted vertically or at an angle on south facing walls, or can be installed on the ground on pole-mounted trackers that move around one or two axes to follow the sun through the day. Dual axis trackers produce more electricity than fixed panels and have a flatter daily output curve, operating near peak output for longer. Increased energy output from trackers must be balanced against higher installation and maintenance costs due to the additional framing and moving parts. Trackers also need an open location to take advantage of their generating capability in the morning and evening. The increased cost at large scale is typically somewhat less than the increased output. The higher output (MWh) per installed capacity (MW) allows a smaller capacity system to be installed, sometimes making a tracking system cheaper than a comparable fixed system.

Solar energy is also used to heat water for residential needs and space heating and process needs in commercial and industrial facilities. The basic idea behind a solar water heating system is to expose part of the domestic hot water system to the sun. The system generally involves water or coolant cycling between black collectors exposed to the sun where it collects solar energy, and tanks where the solar energy is stored. These tanks either provide needed hot water directly, or preheat the water supply to reduce the amount of energy required from a standard water heating system.

Residential and commercial solar water heating systems are designed to deliver a portion of the total hot water demand and reduce a building's overall consumption of gas or electricity. A solar hot water s system is typically sized to meet one half to two thirds of the annual solar hot water load of a building. Solar water heating (SWH) systems typically consist of a liquid-based collector array, freeze-protection strategy, pumping and control system, heat exchanger and solar heated storage tank system. Systems also include interface piping and valves to connect to the backup water heating system, usually a conventional water heater. In retrofit applications, the existing water heater is often used as the backup.

Unlike solar PV panels, if a portion of the solar thermal panel or array is shaded, output is only degraded proportional to the shading. Although it is still important that SWH systems are installed where they will not be shaded during hours of peak sunshine, this allows for greater degree of flexibility in system designs and siting. Given the long lifespan of the panels, the underlying roof should not be scheduled for replacement within about 30 years. The roof also needs to be strong enough to support the additional weight. The single largest limiting factor to SWH installations is the requirement for onsite use of the heated water, which dictates both the maximum capacity of the system, as well as the need to limit longer distance piping requirements.

Just as utilities could seek to integrate demand response into energy optimization projects, they could also integrate the use of solar technologies with energy efficiency projects. This integration of on-site solar would help to maximize energy savings by taking advantage of an additional resource that has not been effectively procured through the Michigan's renewable energy standard where the primary focus is grid-scale renewable energy. There are currently limited cases of integration of on-site solar resources with Energy Optimization programs. Expanded integration of on-site solar resources in utility efficiency programs could provide utilities with added flexibility towards meeting savings goals as well as enable higher levels of energy savings than the levels identified in the GDS potential study.

COST-EFFECTIVENESS TESTS

Defining cost-effectiveness is an important aspect of setting energy efficiency savings goals. The California Standard Practice for Cost-Benefit Analysis and Conservation and Load Management Programs describes five primary cost effectiveness tests used to assess the costs and benefits of energy efficiency investments. Although all five tests compare costs and benefits of efficiency program, the tests determine total lifecycle net benefits from the perspective of different stakeholders. As mentioned above, Section 73(2) of PA 295 requires utilities in Michigan to use the Utility Cost Test to determine the cost-effectiveness of their efficiency program portfolios.[51] This cost-effectiveness test takes the perspective of the Program Administrator and compares the PA's costs of implementing the program to the costs of supply-side resource costs.

Of the 45 jurisdictions nationwide in which rate-payer funded efficiency programs operate, 5 states (12% of those that operate efficiency programs) recognize the UCT as the primary cost-effectiveness test used for efficiency program screening.[52] A positive UCT value suggests that efficiency program investments can meet load growth at a lower-cost than new generation resources and wholesale energy purchases. Because the UCT only considers costs to the utility and not customer efficiency measure implementation costs, it is typically the easiest cost-effectiveness test to pass.[53]

Although Michigan currently recognizes the UCT, the most commonly used cost-effectiveness test is the Total Resource Cost Test. The TRC is the primary test recognized in 29 states, or 71% of the states that implement efficiency programs.[54] The TRC takes a broader perspective than the UCT and includes the costs and benefits from efficiency programs to the economy in a region as a whole. The TRC determines whether the total costs of energy in the service area will decrease by comparing PA, participating customer, and nonparticipating customer costs to utility resource savings. It is used by states who want to include benefits to the utilities and its customers as well as other constituents. A positive TRC value indicates that

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51 The USRCT is also referred to as the Program Administrator Costs Test, Utility Resource Cost Test (URTC), or Utility Cost Test (UTC).

52 Kushler, Nowak, & Witte., "A National Survey of State Policies and Practices for the Evaluation of Ratepayer Funded Energy Efficiency Programs." ACEEE Report Number U122. February 2012.

53 National Action Plan for Energy Efficiency, "Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers." November 2008. http://www.epa.gov/cleanenergy/documents/suca/cost-effectiveness.pdf

54 Kushler, Nowak, & Witte. (2012, February).

the associated energy efficiency investments will result in a decrease in the total cost of energy services for an average customer.[55]

Differences between the UCT and TRC are usually the result of differences in costs. The TRC includes both the costs of incentives paid by utilities as well as the cost of the efficiency measure to participants. Because incentives are usually lower than the incremental cost of an efficiency measure, the TRC may be more difficult to pass than the UCT. Should Michigan decide that using the TRC most appropriately measure costs and benefits to meet its policy objectives, energy savings potential would differ as presented in the GDS potential study and affect the target savings levels that should be set. The state could also maintain the use of the UCT for portfolio level screening, but allow the use of the TRC on a measure-by-measure basis. This would be relevant to combined heat and power, geothermal heat pumps, and fuel switching measures as discussed in the "Expanded Opportunities Section" of this report.

[55] Daykin, Aiona, & Hedman, the Cadmus Group, "Whose Perspective? The Impact of the Utility cost Test." Accessed November 17, 2013. http://www.cadmusgroup.com/wp-content/uploads/2012/11/TRC_UCT-Paper_12DEC11.pdf

CONCLUSION

The recent potential study completed by GDS Associates indicates that a significant amount of energy efficiency potential exists in Michigan. As Michigan policymakers contemplate savings goals after 2015, it has several options for setting new targets based on GDS's results. This report quantifies four primary options with three sub-options each that could be used to set new savings goals in Michigan. The budgets associated with each option are also discussed.

In summary, our analysis presents a variety of options based on the following considerations in selecting how to set savings goals:

- whether the budget cap of 2% of revenues should be maintained for the new goal cycle
- whether savings should be assessed based on a first-year, adjusted first-year, or lifecycle savings perspective
- whether the UCT or TRC is the most appropriate cost-effectiveness test to screen energy savings opportunities.

In addition to these factors, we believe that Michigan policymakers should consider whether annual or cumulative savings goals would be preferable.

There are a number of additional considerations that relate to the current goal-setting process as well as future opportunities. Although Michigan currently sets savings targets for energy savings, it does not include demand savings goals. Setting demand targets would encourage more balanced EO portfolios and potentially that achieve additional benefits. Integrating Demand Response and adding explicit DR goals in addition to the energy and demand goals may present a particularly good opportunity to maximize both energy and demand savings.

Additionally, the GDS potential study excluded the efficiency potential of several technologies that could provide additional opportunities for energy savings. These technologies include combined heat and power systems (CHP), geothermal heat pumps, fuel switching and on-site solar. Encouraging and allowing the use of these technologies could help Michigan to maximize energy savings and increase future savings targets.

APPENDICES

APPENDIX A: GDS POTENTIAL RESULTS FOR YEARS 2016-2020

2016-2020 UCT Budget Constrained Achievable Potential Screening

First Year Savings

Table 27. Incremental Annual MWh Savings for 2016 to 2020 (UCT Budget Constrained)

	2016	2017	2018	2019	2020
Residential	359,314	363,897	367,189	368,439	368,497
Commercial	259,398	268,564	259,458	268,158	300,484
Industrial	164,649	178,112	218,205	99,906	100,924
Total	783,361	810,573	844,852	736,503	769,905
Total Forecast MWh	104,590,711	105,273,676	106,061,980	106,400,745	106,899,856
Savings as % of MWh Forecast	0.7%	0.8%	0.8%	0.7%	0.7%

Table 28. Incremental Annual MW Savings for 2016 to 2020 (UCT Budget Constrained)

	2016	2017	2018	2019	2020
Residential	77	79	79	80	80
Commercial	65	67	77	79	122
Industrial	28	30	37	17	17
Total	171	176	194	176	219
Total Forecast MW	24,907	24,963	25,050	25,149	25,221
Savings as % of MW Forecast	0.7%	0.7%	0.8%	0.7%	0.9%

Table 29. Incremental Annual MMBtu Savings for 2016 to 2020 (UCT Budget Constrained)

	2016	2017	2018	2019	2020
Residential	2,640,435	2,685,031	2,704,570	2,718,919	2,746,164
Commercial	1,053,404	1,070,378	1,087,611	1,105,136	1,122,937
Industrial	228,322	237,053	264,558	279,545	332,810
Total	3,922,161	3,992,462	4,056,738	4,103,600	4,201,911
Total Forecast MMBtu	647,332,377	639,321,127	630,604,773	624,000,158	618,540,331
Savings as % of MMBtu Forecast	0.6%	0.6%	0.6%	0.7%	0.7%

Lifecycle Savings

Table 30. Incremental Annual Lifecycle MWh Savings for 2016 to 2020 (UCT Budget Constrained)

	2016	2017	2018	2019	2020
Residential	3,008,011	3,068,569	3,124,767	3,167,380	3,190,689
Commercial	2,901,490	2,955,133	2,759,924	2,808,457	2,755,039
Industrial	1,869,500	1,927,090	2,172,594	2,231,202	2,469,117
Total	7,779,002	7,950,791	8,057,285	8,207,039	8,414,846

Table 31. Incremental Annual Lifecycle MW Savings for 2016 to 2020 (UCT Budget Constrained)

	2016	2017	2018	2019	2020
Residential	790	806	817	826	832
Commercial	611	622	672	683	845
Industrial	281	290	384	396	469
Total	1,682	1,718	1,873	1,905	2,146

Table 32. Incremental Annual Lifecycle MMBtu Savings for 2016 to 2020 (UCT Budget Constrained)

	2016	2017	2018	2019	2020
Residential	31,072,416	31,281,687	31,496,935	31,629,211	31,909,952
Commercial	14,040,901	14,267,153	14,496,830	14,730,432	14,967,691
Industrial	3,122,163	3,161,154	3,272,738	3,314,815	3,502,766
Total	48,235,480	48,709,995	49,266,503	49,674,458	50,380,410

2016-2020 UCT Base Achievable Potential Screening

First Year Savings

Table 33. Incremental Annual MWh Savings for 2016 to 2020 (UCT Base Achievable)

	2016	2017	2018	2019	2020
Residential	900,710	916,642	923,336	924,539	918,915
Commercial	1,092,286	1,112,083	853,792	869,887	881,805
Industrial	379,759	401,481	354,084	377,501	368,833
Total	2,372,756	2,430,206	2,131,212	2,171,927	2,169,553
Total Forecast MWh	104,590,711	105,273,676	106,061,980	106,400,745	106,899,856
Savings as % of MWh Forecast	2.3%	2.3%	2.0%	2.0%	2.0%

Table 34. Incremental Annual MW Savings for 2016 to 2020 (UCT Base Achievable)

	2016	2017	2018	2019	2020
Residential	194	198	199	200	199
Commercial	274	277	254	256	357
Industrial	62	66	58	62	60
Total	530	541	511	518	617
Total Forecast MW	24,907	24,963	25,050	25,149	25,221
Savings as % of MW Forecast	2.1%	2.2%	2.0%	2.1%	2.4%

Table 35. Incremental Annual MMBtu Savings for 2016 to 2020 (UCT Base Achievable)

	2016	2017	2018	2019	2020
Residential	6,624,679	6,770,016	6,809,113	6,831,487	6,857,218
Commercial	2,076,631	2,076,631	2,076,631	2,076,631	2,076,631
Industrial	1,288,925	1,288,925	839,368	839,368	644,745
Total	9,990,236	10,135,573	9,725,112	9,747,487	9,578,595
Total Forecast MMBtu	647,332,377	639,321,127	630,604,773	624,000,158	618,540,331
Savings as % of MMBtu Forecast	1.5%	1.6%	1.5%	1.6%	1.5%

Lifecycle Savings

Table 36. Incremental Annual Lifecycle MWh Savings for 2016 to 2020 (UCT Base Achievable)

	2016	2017	2018	2019	2020
Residential	7,540,330	7,729,595	7,857,553	7,948,032	7,956,571
Commercial	12,217,747	12,236,765	9,082,013	9,110,457	8,084,991
Industrial	4,760,883	4,782,454	3,943,619	3,970,349	3,577,757
Total	24,518,959	24,748,814	20,883,185	21,028,838	19,619,319

Table 37. Incremental Annual Lifecycle MW Savings for 2016 to 2020 (UCT Base Achievable)

	2016	2017	2018	2019	2020
Residential	1,981	2,030	2,055	2,072	2,075
Commercial	2,573	2,575	2,212	2,216	2,479
Industrial	715	719	664	668	678
Total	5,268	5,324	4,931	4,956	5,233

Table 38. Incremental Annual Lifecycle MMBtu Savings for 2016 to 2020 (UCT Base Achievable)

	2016	2017	2018	2019	2020
Residential	77,890,758	78,797,250	79,202,343	79,368,437	79,573,334
Commercial	27,679,427	27,679,427	27,679,427	27,679,427	27,679,427
Industrial	18,685,446	18,685,446	11,097,230	11,097,230	7,363,430
Total	124,255,631	125,162,123	117,979,001	118,145,094	114,616,191

2016-2020 TRC Base Achievable Potential Screening

First Year Savings

Table 39. Incremental Annual MWh Savings for 2016 to 2020 (TRC Base Achievable)

	2016	2017	2018	2019	2020
Residential	889,740	905,050	911,840	912,958	907,203
Commercial	963,915	983,646	734,921	751,016	767,718
Industrial	346,179	367,940	328,332	351,733	355,533
Total	2,199,833	2,256,636	1,975,093	2,015,707	2,030,454
Total Forecast MWh	104,590,711	105,273,676	106,061,980	106,400,745	106,899,856
Savings as % of MWh Forecast	2.1%	2.1%	1.9%	1.9%	1.9%

Table 40. Incremental Annual MW Savings for 2016 to 2020 (TRC Base Achievable)

	2016	2017	2018	2019	2020
Residential	206	210	212	212	212
Commercial	241	244	224	226	329
Industrial	58	62	55	59	60
Total	505	516	491	498	601
Total Forecast MW	24,907	24,963	25,050	25,149	25,221
Savings as % of MW Forecast	2.0%	2.1%	2.0%	2.0%	2.4%

Table 41. Incremental Annual MMBtu Savings for 2016 to 2020 (TRC Base Achievable)

	2016	2017	2018	2019	2020
Residential	5,371,459	5,495,197	5,519,601	5,531,936	5,548,969
Commercial	1,854,876	1,854,876	1,854,876	1,854,876	1,854,876
Industrial	1,156,011	1,156,011	779,935	779,935	672,227
Total	8,382,346	8,506,084	8,154,412	8,166,747	8,076,072
Total Forecast MMBtu	647,332,377	639,321,127	630,604,773	624,000,158	618,540,331
Savings as % of Annual MMBtu Forecast	1.3%	1.3%	1.3%	1.3%	1.3%

Lifecycle Savings

Table 42. Incremental Annual Lifecycle MWh Savings for 2016 to 2020 (TRC Base Achievable)

	2016	2017	2018	2019	2020
Residential	7,464,865	7,659,032	7,789,720	7,879,447	7,886,249
Commercial	10,495,135	10,513,365	7,532,747	7,561,191	6,622,793
Industrial	4,316,204	4,337,965	3,613,585	3,640,267	3,387,182
Total	22,276,205	22,510,362	18,936,052	19,080,905	17,896,224

Table 43. Incremental Annual Lifecycle MW Savings for 2016 to 2020 (TRC Base Achievable)

	2016	2017	2018	2019	2020
Residential	2,189	2,245	2,274	2,293	2,297
Commercial	2,090	2,092	1,782	1,785	2,075
Industrial	670	674	625	628	645
Total	4,950	5,012	4,681	4,706	5,017

Table 44. Incremental Annual Lifecycle MMBtu Savings for 2016 to 2020 (TRC Base Achievable)

	2016	2017	2018	2019	2020
Residential	53,348,540	54,038,939	54,214,825	54,225,634	54,296,888
Commercial	24,173,495	24,173,495	24,173,495	24,173,495	24,173,495
Industrial	16,851,084	16,851,084	10,192,126	10,192,126	7,151,605
Total	94,373,119	95,063,518	88,580,446	88,591,255	85,621,988

2016-2020 TRC Max Achievable Potential Screening

First Year Savings

Table 45. Incremental Annual MWh Savings for 2016 to 2020 (TRC Max Achievable)

	2016	2017	2018	2019	2020
Residential	1,204,704	1,202,843	1,207,580	1,204,863	1,199,621
Commercial	1,175,765	1,198,285	897,423	927,658	945,977
Industrial	415,452	441,940	395,394	426,851	422,356
Total	2,795,921	2,843,069	2,500,396	2,559,372	2,567,953
Total Forecast MWh	104,590,711	105,273,676	106,061,980	106,400,745	106,899,856
Savings as % of MWh Forecast	2.7%	2.7%	2.4%	2.4%	2.4%

Table 46. Incremental Annual MW Savings for 2016 to 2020 (TRC Max Achievable)

	2016	2017	2018	2019	2020
Residential	292	292	294	294	294
Commercial	298	301	276	280	408
Industrial	69	73	65	71	70
Total	658	666	635	645	771
Total Forecast MW	24,907	24,963	25,050	25,149	25,221
Savings as % of MW Forecast	2.6%	2.7%	2.5%	2.6%	3.1%

Table 47. Incremental Annual MMBtu Savings for 2016 to 2020 (TRC Max Achievable)

	2016	2017	2018	2019	2020
Residential	5,915,778	5,940,042	5,976,826	5,998,199	6,016,324
Commercial	2,368,462	2,368,462	2,368,462	2,368,462	2,368,462
Industrial	1,490,212	1,490,212	997,789	997,789	845,558
Total	9,774,451	9,798,716	9,343,077	9,364,450	9,230,343
Total Forecast MMBtu	647,332,377	639,321,127	630,604,773	624,000,158	618,540,331
Savings as % of Annual MMBtu Forecast	1.5%	1.5%	1.5%	1.5%	1.5%

Lifecycle Savings

Table 48. Incremental Annual Lifecycle MWh Savings for 2016 to 2020 (TRC Max Achievable)

	2016	2017	2018	2019	2020
Residential	10,654,007	10,719,994	10,830,316	10,887,486	10,932,554
Commercial	12,755,475	12,776,178	9,149,145	9,217,197	8,063,740
Industrial	5,129,766	5,156,107	4,294,876	4,336,245	3,939,499
Total	28,539,248	28,652,279	24,274,337	24,440,928	22,935,794

Table 49. Incremental Annual Lifecycle MW Savings for 2016 to 2020 (TRC Max Achievable)

	2016	2017	2018	2019	2020
Residential	3,166	3,185	3,220	3,235	3,246
Commercial	2,559	2,562	2,170	2,179	2,537
Industrial	783	788	728	734	752
Total	6,508	6,534	6,118	6,148	6,535

Table 50. Incremental Annual Lifecycle MMBtu Savings for 2016 to 2020 (TRC Max Achievable)

	2016	2017	2018	2019	2020
Residential	58,176,856	58,320,011	58,669,281	58,775,556	58,813,501
Commercial	31,015,466	31,015,466	31,015,466	31,015,466	31,015,466
Industrial	22,253,255	22,253,255	13,495,424	13,495,424	9,454,526
Total	111,445,577	111,588,731	103,180,171	103,286,446	99,283,493