Optimal ENERGY Integrated Energy Resources

Options for Establishing Energy Efficiency Targets in Michigan: 2016-2020

Prepared for

Michigan Public Service Commission

MICHIGAN PUBLIC SERVICE COMMISSION

by

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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

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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,

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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.

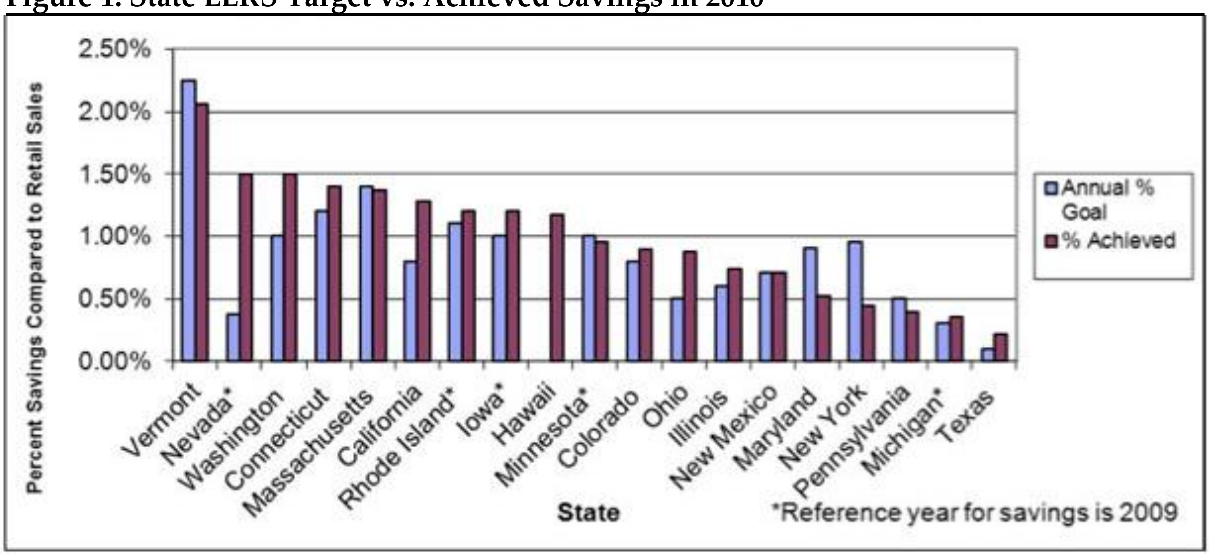
State	Study Year	Author	Study Period	# of Years	Cumulative Achievable Potential	Annual Achievable Potential[17]
of measures are bundled into program offerings						
Note 5: The 2011 Vermont study figure presented here is maximum achievable potential. Achievable potential in this study is defined as the 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

[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