Minnesota Energy Efficiency Potential Study: 2020–2029

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Definition of Acronyms

ACEEE	American Council for an Energy Efficient Economy
AMI	Advanced metering infrastructure
ASHP	Air source heat pump
BBTu	Billion British thermal units
C&I	Commercial and industrial
CARD	Conservation Applied Research and Development program
CEE	Center for Energy and Environment
CIP	Conservation Improvement Program
COMMERCE	Minnesota Department of Commerce
COU	Consumer-owned utility
CT	Combustion turbine
DER	Division of Energy Resources, Minnesota Department of Commerce
DOE	Department of Energy (U.S.)
Dth	Dekatherm
EISA	Energy Independence and Security Act of 2007
EERS	Energy efficiency resource standard
EM&V	Evaluation, measurement, and verification
EPA	Environmental Protection Agency (U.S.)
G&T	Generation and transmission
GWh	Gigawatt-hour
HVAC	Heating, ventilation, and air conditioning
IoT	Internet of Things
IOU	Investor-owned utility
KW	Kilowatt
kWh	Kilowatt-hour
LED	Light-emitting diode

MEEA	Midwest Energy Efficiency Alliance
MMBTu	Million British thermal units
MWh	Megawatt-hour
MPUC	Minnesota Public Utilities Commission
PUC	Public Utilities Commission
SMMPA	Southern Minnesota Municipal Power Agency
SCT	Societal Cost Test
T&D	Transmission and distribution
TRM	Minnesota Technical Reference Manual
UCT	Utility Cost Test

Executive Summary

Minnesota has a thirty-plus year history of leadership in energy efficiency policy and achievements. In order to continue to maximize the benefits of cost-effective energy efficiency resource acquisition by utilities, the project team, consisting of Center for Energy and Environment (CEE), Optimal Energy (Optimal) and Seventhwave, was commissioned to:

- Estimate statewide electric and natural gas energy efficiency and carbon-saving potential for 2020-2029;
- Produce data-driven and stakeholder-informed resources defining market segments, end uses, measures, and programs that could be targeted in the decade ahead to realize the state's cost-effective energy efficiency potential; and
- Engage stakeholders in order to help advance robust energy policies and energy efficiency programs in the state, and to inform future efficiency portfolio goals.

Overview of the Conservation Improvement Program

The Conservation Improvement Program (CIP) helps Minnesota households and businesses use electricity and natural gas more efficiently – conserving energy, reducing carbon dioxide emissions, and lessening the need for new utility infrastructure. CIP is funded by ratepayers and administered by electricity and natural gas utilities.

Minnesota policymakers have long recognized the promotion of energy efficiency as a cornerstone of the state's energy policy. CIP began in Minnesota in the 1980s to motivate utility spending on energy efficiency. The 2007 Next Generation Energy Act established Minnesota's energy efficiency resource standard, requiring utilities develop plans to achieve energy savings of 1.5% of average annual retail sales each year. Minnesota Statute 216B.241 outlines the statutory requirements for utility CIP programs that are designed to meet Minnesota's 1.5% energy savings goal. Currently, 140 of Minnesota's 213 electric and natural gas utilities are covered under Minnesota Statute 216b.241.

The Minnesota Department of Commerce, Division of Energy Resources oversees CIP to ensure that ratepayer dollars are used effectively in achieving the 1.5% energy savings goal and that energy savings are reported as accurately as possible. Minnesota utilities operate a wide array of residential, commercial, and industrial CIP programs targeted to both retrofits as well as new construction projects.

Typical utility programs for residential customers include:

- Energy audits, where a trained energy consultant examines a home and offers specific advice on energy improvements;
- Rebates on high-efficiency heating, cooling, and water-heating appliances; efficient lighting; and low-flow showerheads and faucet aerators; and
- Air-conditioner cycling programs, which allow the utility to manage its peak energy demand in return for discounted electric bills for participating customers.

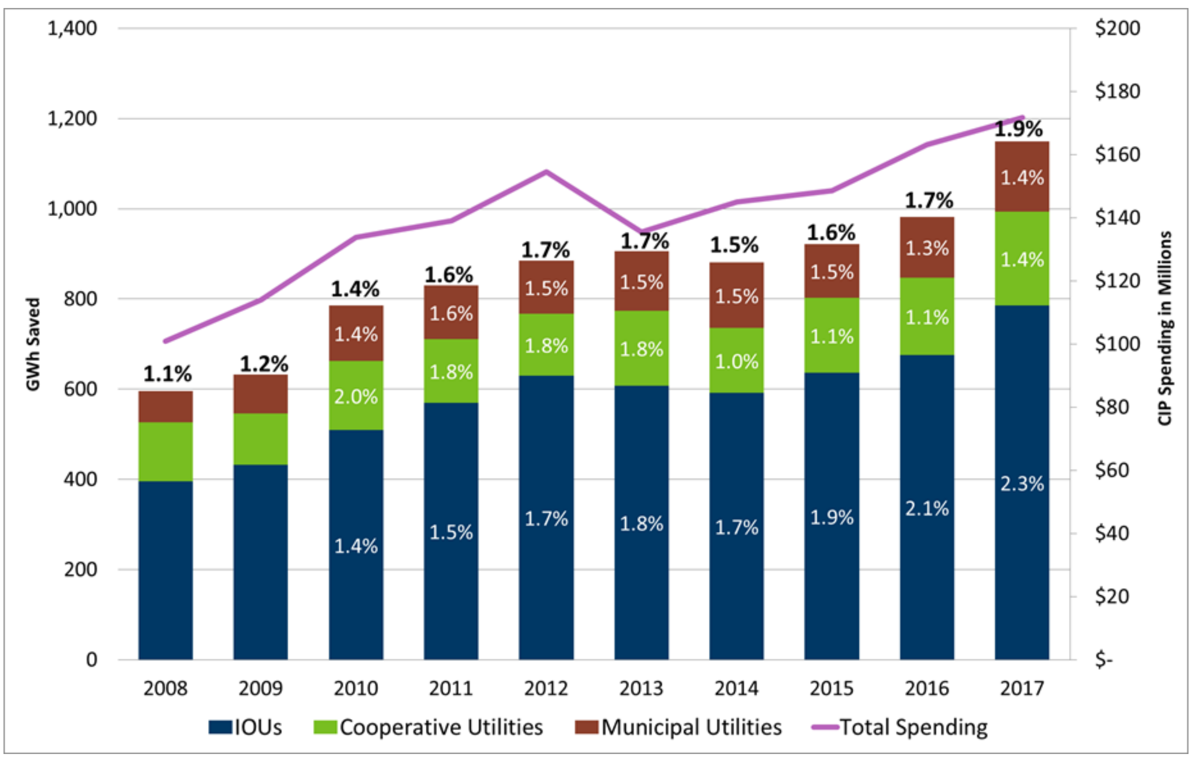
Typical utility programs for commercial or industrial customers include:

- Rebates for high-efficiency boilers, chillers, and rooftop units; high efficiency motors and drives; high-efficiency lighting and lighting control systems;
- Building recommissioning studies; and
- Manufacturing process improvements that reduce energy intensity and improve productivity.

Minnesota electric utilities, as a whole, have met or exceeded the 1.5% annual energy savings goal each year since 2011 (Figure ES-1). Minnesota gas utilities, overall, have met the 1% minimum, but only exceeded the 1.5% goal in 2017 (Figure ES-2). Both electric and natural gas utilities have seen a steady increase in achievements over the last decade.

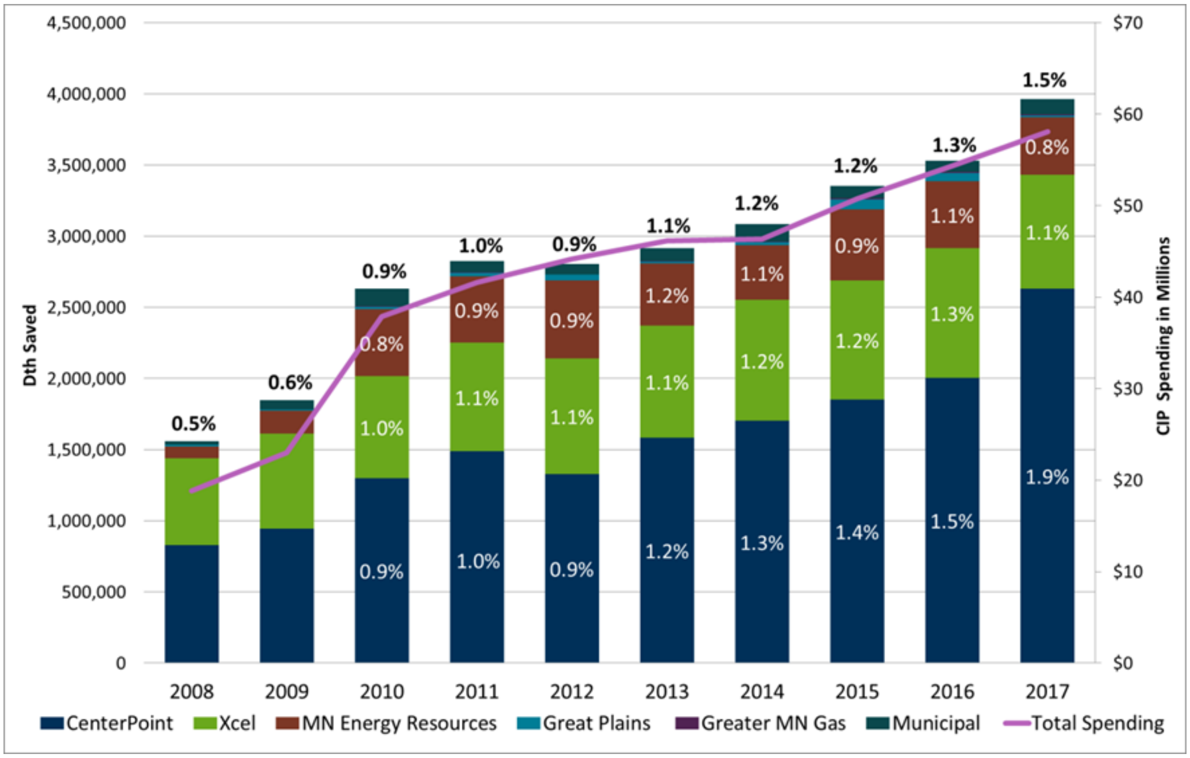
An independent review examining the economic impact of CIP found that every one dollar that is spent on CIP returns four dollars to the state's economy. This return on investment is created through job growth, economic surplus, lower utility costs, and environmental benefits. The analysis also found that CIP has resulted in aggregate net benefits to society from 2008 to 2013 of approximately $3.3 billion, with each program year providing net electric and natural gas benefits to society ranging from $315 million to $919 million.[1]

Figure ES-1. Historical energy efficiency spending and savings achievements of Minnesota electric utilities (in gigawatt-hours and as a percentage of total sales), 2008-2016.



[1] Minnesota Department of Commerce. *The Aggregate Economic Impact of the Conservation Improvement Program 2008-2013*. October 2015. Page 5 (http://mn.gov/commerce-stat/pdfs/card-report-aggregate-eco-impact-cip-2008-2013.pdf).

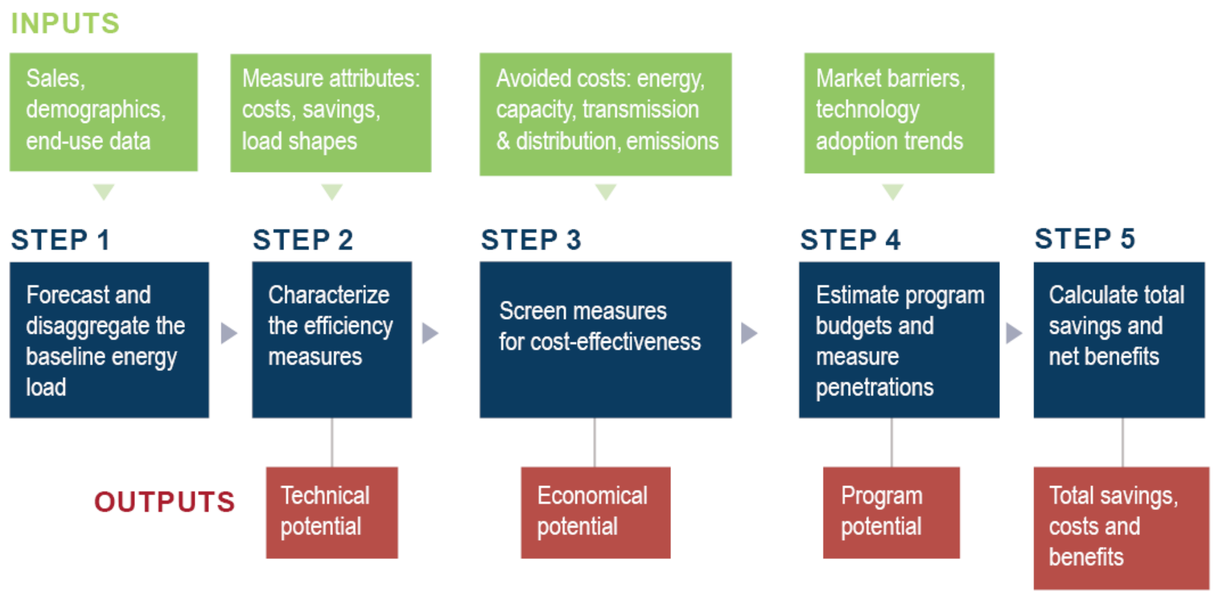
Figure ES-2. Historical energy efficiency spending and savings achievements of Minnesota natural gas utilities (in dekatherms and as a percentage of total sales), 2008-2016.



Project methodology

The modeling approach to estimating potential savings followed best practices for conducting energy efficiency potential studies, and involved the five steps referenced in Figure ES-3 (see Chapter 3 for a detailed explanation of each of these steps in the analysis). Separate models were created for seven different analysis regions of the state, and aggregated to sum statewide potential.

Figure ES-3. Modeling approach used for this study.



The model relies on a large number of assumptions about the energy savings and costs of energy efficiency measures, existing baselines of efficiency in Minnesota building stock, the impact of future codes and standards on savings, the avoided costs of energy saved, and other parameters. To develop these assumptions, the project team collected a large amount of data from existing sources, including past Conservation Applied Research and Development (CARD) program research projects, confidential cost data supplied by utilities, U.S. Department of Energy data sets, U.S. Census data, and other sources. In addition, the project team conducted 1,797 phone surveys of building owners, managers and contractors, and 136 on-site surveys of Minnesota residential and commercial buildings.

303 separate measures were included in the model, about 20% of which are not currently included in Minnesota's Technical Reference Manual (TRM).[2] Each measure was characterized for up to 16 separate building types, resulting in 3,378 separate measure permutations.

Cost-effectiveness screening was done at the measure level, and relied on utility-provided costs for six different peak and off-peak periods. The measure characterization included determining load shapes for

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2 The Department oversees development of the TRM, which is a list of CIP-eligible energy efficiency measures, associated technical assumptions, and energy-savings calculations for use by utilities in their CIP plans. Minnesota TRM Webpage: mn.gov/commerce/industries/energy/utilities/cip/technical-reference-manual/.

each measure according to the same periods, so that the model could capture the time-value of each energy efficiency measure.

In addition to total economic potential (i.e., the total potential if all possible measures were installed that meet cost-effectiveness criteria), two program scenarios were calculated:

- ***Maximum achievable potential:*** This is the subset of economic potential that is achievable considering market barriers, given the most aggressive program scenario possible. This study assumed financial incentives would cover 100% of the incremental cost of each measure, along with very aggressive marketing and program designs to achieve maximum market penetration of the measures.
- ***Program potential***: The program potential is a subset of the maximum achievable, given constraints in implementation. This study assumed that financial incentive levels are dropped to 50% of the incremental cost of each measure, which is a typical scenario used for planning purposes in Minnesota,[3] and a good benchmark for aggressive programs nationally. The project team still assumed aggressive marketing and program designs for this scenario.

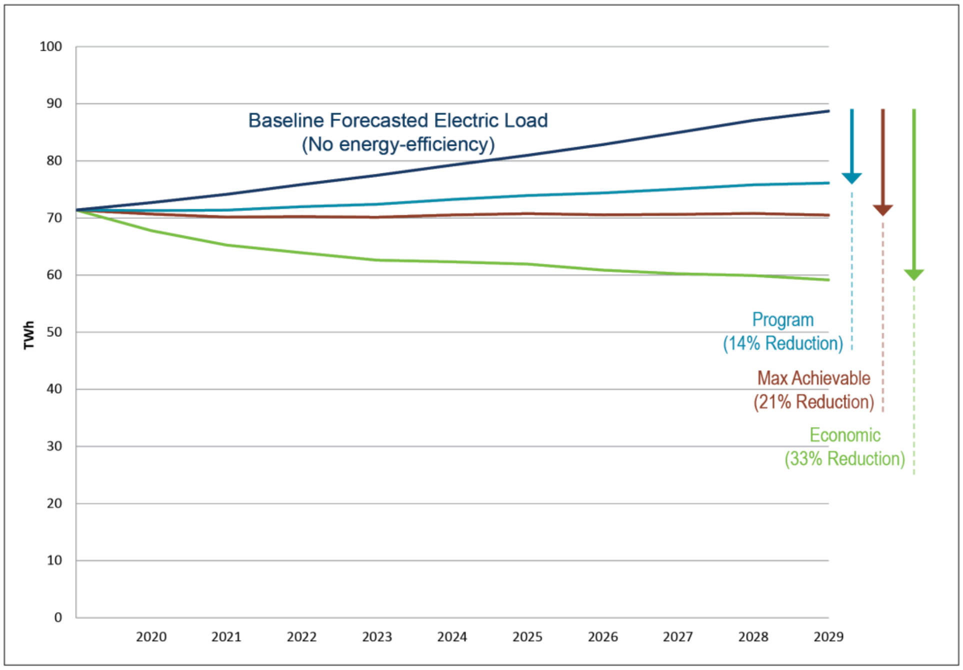
The outputs of this study represent the study team's best effort to identify statewide energy efficiency potential, if all utilities in the state employed the best practices in program implementation discussed in this report, and provided incentives at the levels specified in the two program scenarios for this study. While this study employed best practices for conducting energy efficiency potential studies and used the best data available to support the assumptions, there are limitations to this study, as there are in any potential study. We discuss some of the specific limitations in more depth at the end of chapter three.

[3] Xcel Energy, for example, typically will use a 50% incentive scenario when conducting their potential studies.

Results – electric utilities

Statewide, the study estimates the economic potential of energy efficiency could decrease forecasted electric load by 33%, and program potential could reduce load by 14% in 2029 (Figure ES-4).

Figure ES-4. Cumulative annual electric energy savings potential compared to forecasted load for economic, max achievable, and program scenarios.



The incremental annual program savings ranges from 1.4% to as high as 2.0%, with maximum achievable potential in the range of 2.0% to 2.9% (Table ES-1)[4]. Since the study assumes equal program success across utility territories, there is very little difference in potential between investor-owned utilities and consumer-owned utilities, which includes both cooperative and municipal utilities, with only slight variations due to differences in their overall customer mix.

[4] Consistent with how behavioral savings are counted by utilities now, the "average savings methodology" was applied to (only) residential behavioral measures. (For full discussion of this issue, see pg. 81-94, "Energy Efficiency Behavioral Programs: Literature Review, Benchmarking Analysis, and Evaluation Guidelines," Illume, et. al, a CARD project. Available at: http://mn.gov/commerce-stat/pdfs/card-report-energy-efficiency-behavorial-prog.pdf). The application of the average savings method lowered incremental potential about 10% a year. For comparison, the 10-year incremental average for the program scenario, without applying the average savings method, would be 2.0% for IOUs, 2.0% for cooperative utilities, and 1.9% for municipal utilities; for the maximum achievable scenario, savings would be 3.0% for IOUs, 2.8% for cooperative utilities, and 2.7% for municipal utilities.

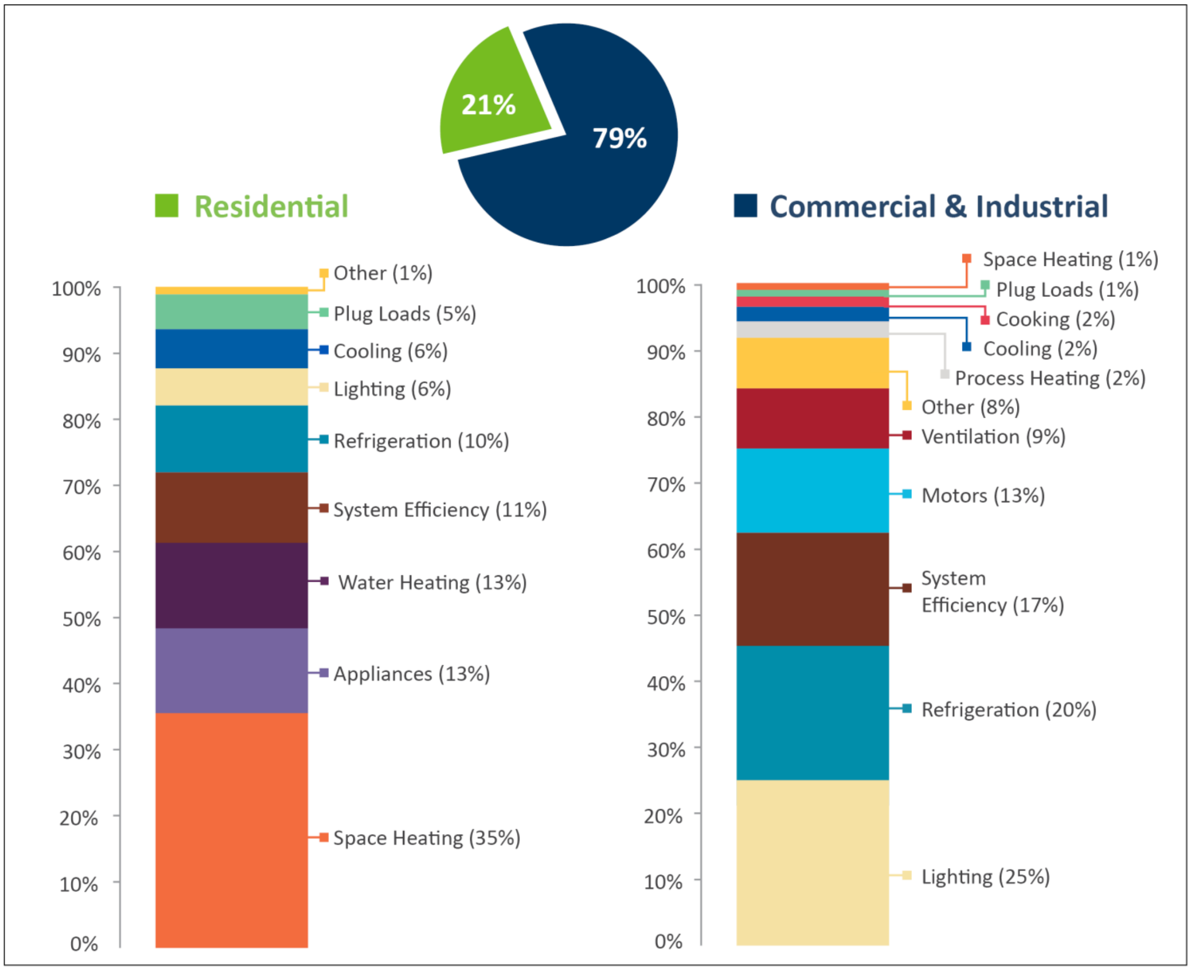
Table ES-1. Incremental annual electric energy savings from maximum achievable and program scenarios as a percentage of total sales.

	Investor-Owned Utilities		Cooperative Utilities		Municipal Utilities	
Year	Max achievable	Program	Max achievable	Program	Max achievable	Program
2020	2.6%	1.8%	2.4%	1.7%	2.4%	1.7%
2021	2.9%	2.0%	2.7%	1.9%	2.7%	1.9%
2022	2.4%	1.6%	2.0%	1.4%	2.3%	1.5%
2023	2.6%	1.8%	2.3%	1.6%	2.4%	1.7%
2024	2.8%	1.9%	2.4%	1.7%	2.5%	1.8%
2025	2.8%	1.9%	2.5%	1.7%	2.5%	1.8%
2026	2.8%	2.0%	2.4%	1.7%	2.6%	1.8%
2027	2.9%	2.0%	2.4%	1.7%	2.5%	1.8%
2028	2.9%	2.0%	2.4%	1.7%	2.5%	1.7%
2029	2.8%	1.9%	2.4%	1.7%	2.5%	1.7%
10-year average	**2.7%**	**1.9%**	**2.4%**	**1.7%**	**2.5%**	**1.7%**

Within end uses, space heating is responsible for nearly half of residential savings at the end of the study period, while lighting declines to a small fraction of total savings (Figure ES-5). Although only 17% of residential customers have electric space heating, these customers use substantial amounts of energy to heat their homes, and there is a large opportunity for energy savings in these homes. The single-largest measures driving these savings are air-source heat pumps, as discussed further below. Appliances are the next largest end use, in total (with space heating) accounting for over half of total residential potential.

In the commercial and industrial sector, lighting, refrigeration, and system energy account for approximately 60% of total program potential in 2029 (Figure ES-5). While lighting still remains the largest source of savings for the commercial and industrial sector, it declines from well over half of potential in most utilities' current portfolios, to just over 20% in 2029. System energy includes whole-building measures that address multiple end-uses, and includes savings from measures like integrated building design and advanced building controls.

Figure ES-5. Cumulative annual electric energy savings by end use in 2029 as a percentage of total savings for the residential and commercial & industrial sectors (program scenario).



Results – natural gas utilities

For natural gas, the study estimates the state could economically decrease forecasted sales by 33%, with program potential to reduce sales by about one-third of that, or 11%, by 2029 (Figure ES-6). The incremental annual natural gas savings over the study period increases from 0.7% in 2020, and levels off at 1.4% of annual sales around the middle of the decade for program potential. Maximum achievable potential starts at 1.2% and increases to 2.3% of annual sales over the study period (Table ES-2).

Figure ES-6. Cumulative annual natural gas energy savings potential compared to forecasted sales for economic, max achievable, and program scenarios.

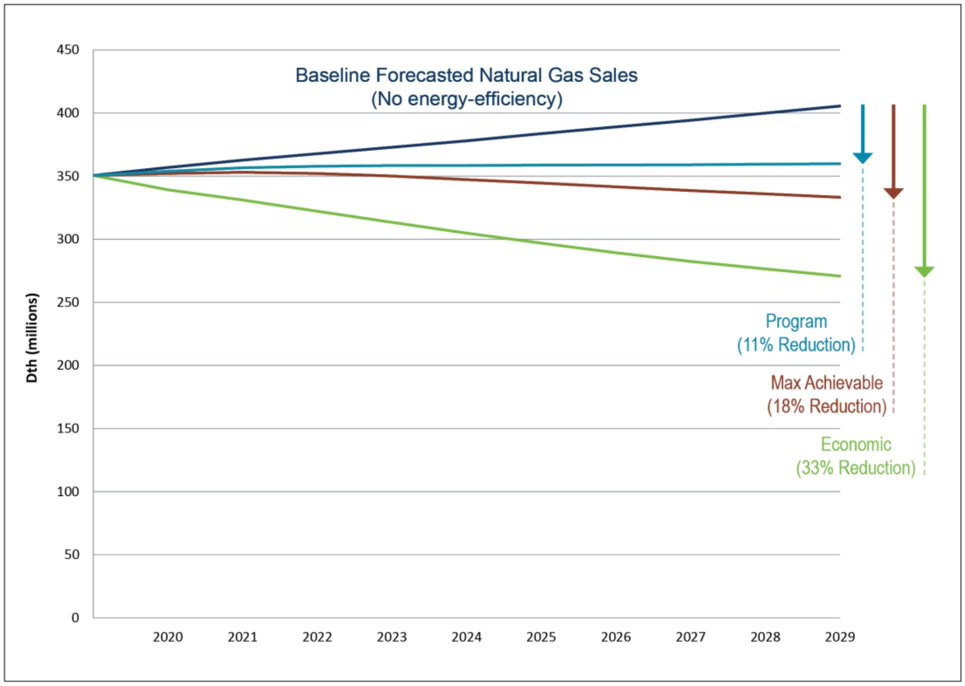
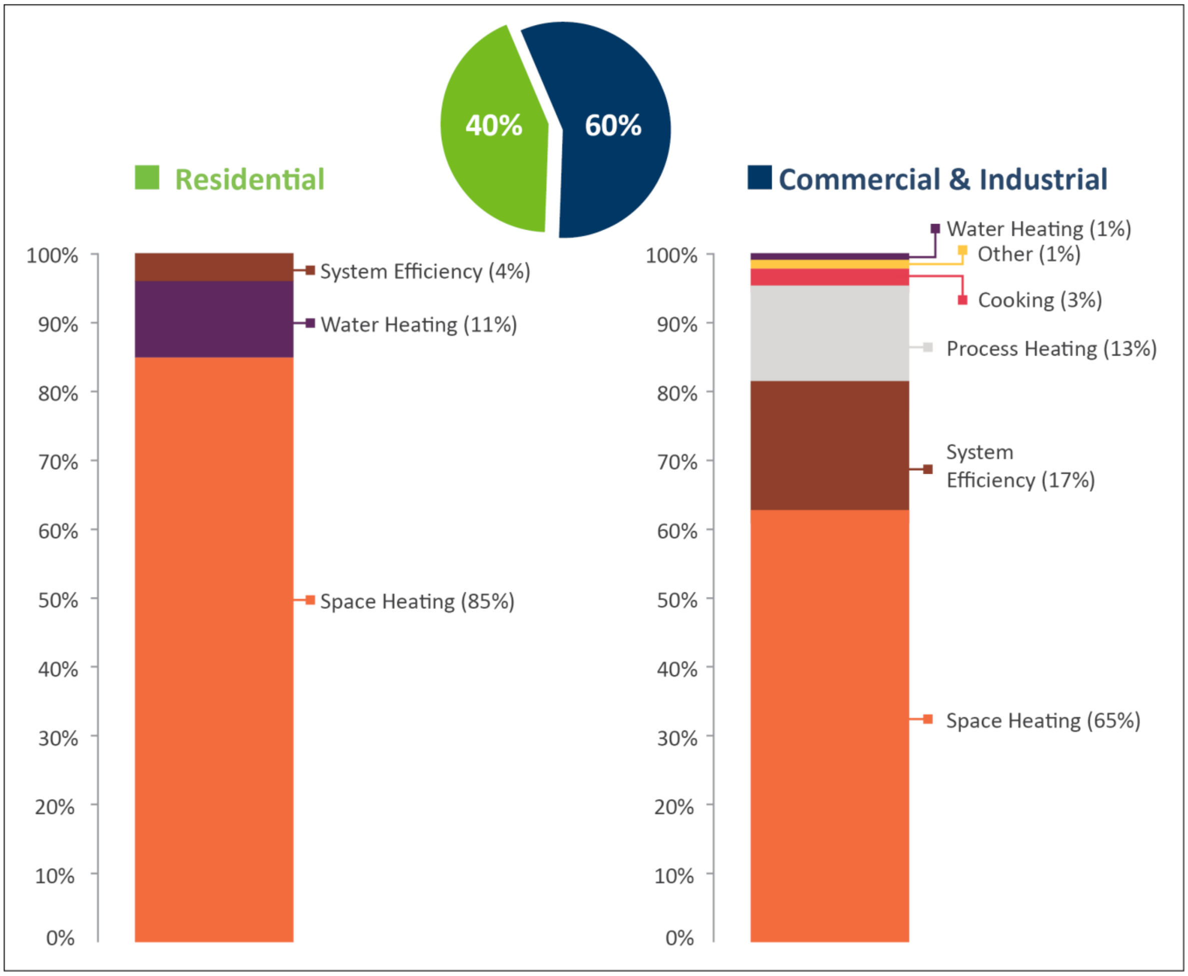


Table ES-2. Incremental annual natural gas energy savings from maximum achievable and program scenarios as a percentage of total sales.

	All utilities	
Year	**Max achievable**	**Program**
2020	1.2%	0.7%
2021	1.4%	0.9%
2022	1.7%	1.1%
2023	2.0%	1.2%
2024	2.2%	1.4%
2025	2.2%	1.4%
2026	2.2%	1.4%
2027	2.3%	1.4%
2028	2.3%	1.4%
2029	2.3%	1.5%
Average	**2.0%**	**1.2%**

Space heating dominates the end use potential for the residential sector as well as the commercial and industrial sectors (Figure ES-7).

Figure ES-7. Cumulative annual natural gas energy savings by end use in 2029 as a percentage of total savings for the residential and commercial & industrial sectors (program scenario).



Efficiency measures implemented in the program scenario would result in a cumulative annual reduction in carbon dioxide emissions in 2029 of 5.5 million tons for electric utilities, and 2.8 million tons for natural gas utilities.

Program findings and recommendations

The project team conducted a review of utility energy efficiency programs in Minnesota and nationally to make recommendations about program implementation that will be useful for utilities, regulators, and other stakeholders in designing and implementing programs for 2020 and beyond.

In reviewing current programs in Minnesota, the study team found that:

- Minnesota currently has some of the lowest-cost and best-performing conservation programs in the country;
- Utilities in Minnesota — both investor-owned utilities and consumer-owned utilities — have been proactive in designing and implementing comprehensive, effective and innovative program models;
- Smaller utilities (the majority of Minnesota utilities, by number) face additional challenges in implementing programs;
- Deep relationships with trade allies have helped utilities deliver programs;
- The most successful consumer-owned utility programs involve cooperation among utilities; and
- Some utilities have achieved enhanced performance through joint natural gas-electric programs.

Based on the technical work done for this study, the study team found that:

- Residential electric programs will need to transition from lighting to cold climate air source heat pumps in order to capture the largest potential of savings;
- Lighting declines in importance for the commercial and industrial sector, but still represents a large portion of total potential savings;
- Refrigeration is another large source of electric potential savings; and
- Space heating measures continue to dominate natural gas potential, with smart thermostats being the largest new source of potential savings.

In order to continue to achieve high savings in the future, the study team provides the following recommendations for utilities implementing CIP programs:

- Continue to test promising new approaches;
- Offer comprehensive program designs for larger and harder-to-reach customers;
- Develop upstream incentives and associated program support in selected markets;
- Incorporate operational savings into commercial and industrial programs;
- Employ segment-specific strategies to reach customers;
- Deepen trade ally engagement and training efforts;

- Incorporate advanced metering infrastructure (AMI)-enabled capabilities into programmatic strategies;
- Leverage interest by local governments in energy efficiency; and
- Improve coordination amount utilities through coordinating more closely on trade ally outreach and training, and working toward further coordinated implementation of programs.

Policy conclusions

The following policy conclusions represent the project team's effort to identify solutions that will help ensure Minnesota continues to maximize cost-effective energy efficiency resources into the next decade. Extensive stakeholder outreach was done for this study; the project team attempted to synthesize this outreach in crafting the conclusions, seeking common ground where possible. The project team also used relevant data from this study to inform the recommendations.

The recommendations are organized around three issue areas:

- Achievement of CIP goals;
- Regulatory oversight of CIP; and
- Incorporating demand-response and efficient fuel-switching into CIP.

The conclusions are summarized in Table ES-3, along with key stakeholder input and findings from this study.

Table ES-3. Summary of policy findings, stakeholder input, and study conclusions.

Topic Area	Relevant findings from potential study	Stakeholder input	Conclusions
Achievement of CIP goals	Meeting or exceeding, on average, the current CIP goal of 1.5% for electric utilities and the statutory minimum of 1.0% for gas utilities is achievable in the 2020-2029 timeframe. Achieving savings targets is likely to require increased but still cost-effective spending. The existing incentive structure has been effective at motivating investor-owned utilities to exceed their energy-savings goals.	Small consumer-owned utilities report facing additional challenges in implementing programs; thus, it may not be possible for them to achieve the same energy-savings level as the investor-owned utilities. More emphasis on lifetime savings is justified, but the first-year savings goal is still preferred as the main statutory CIP goal.	***The 1.5% savings goal can continue to be achieved using the existing flexibility to adjust goals when justified.*** Lifetime savings could be better measured and tracked through the annual reporting process, rather than a statutory change. Consider allowing consumer-owned utilities to report savings in a multi-year framework.
Regulatory oversight of CIP	CIP programs in the 2020s will need to expand into new end uses and technologies, increasing the complexity of regulatory issues. Results from Commerce-funded conservation applied research and development projects inform this potential study's estimates and pave the way for increased savings from new end uses.	The stakeholder survey shows mostly strong support for current Department regulation. Most stakeholders support a practical approach that minimizes confusion and provides regulatory clarity.	***Clarity on key regulatory topics could be accomplished through the creation of a CIP guide.*** Consider creating a formal advisory committee for CIP regulatory topics to increase transparency and avenues for stakeholder coordination on CIP implementation. Continue to have strong research and development to support future energy savings.
Incorporating demand-response & efficient fuel-switching into CIP	Demand-response programs will increasingly be needed for integrating carbon-free renewables onto the grid, and to balance high load with high-generation times. With appropriate safeguards, efficient fuel-switching could significantly increase overall efficiency, decrease emissions, and reduce costs for consumers.	There is strong electric utility support for incorporating demand-response and efficient fuel-switching into CIP. Public interest concerns were raised about investor-owned utilities receiving incentives for load-building activities. Public interest concerns were raised about demand-response and fuel-switching diluting or competing for limited capital with energy efficiency efforts. Both demand-response and fuel-switching programs are customer-facing programs, like CIP.	***Consider whether to incorporate "integrated demand-side management" into the CIP framework — with appropriate safeguards.*** In crafting specific policy for integrating demand-response and fuel-switching, safeguards should ensure end-use efficiency is not decreased; utility incentives for investor-owned utilities should be considered separately (demand-response) or not provided (fuel-switching).

Chapter 1: Introduction

Minnesota has a thirty-plus year history of leadership in energy efficiency policy and achievements. This has been the result of common sense state policy focusing on cost-effective prioritization of efficiency as a resource that has had broad support from utilities and other stakeholders. However, state efficiency leaders recognize some significant challenges ahead for utility-driven efficiency that will need to be addressed. In particular, lighting standards and other standards and codes will reduce the baseline for calculating savings, and current low-market energy costs are reducing potential avoided cost savings from energy efficiency.

To help inform this transition, the state has embarked upon an ambitious study, the goal of which is not only to assess the technical and economic potential for utility-funded efficiency in the years ahead, but to craft a program and policy approach that will help address some of the identified challenges.

Specifically, the ***objectives of this study*** are to:

- Estimate statewide electric and natural gas energy efficiency and carbon-saving potential for 2020-2029;
- Produce actionable resources about which market segments, end uses, measures, and programs should be targeted in the decade ahead to realize the state's cost-effective energy efficiency potential; and
- Engage stakeholders in order to help advance robust energy policies and energy efficiency programs in the state, and to inform future efficiency portfolio goals.

This report summarizes the results of this study, and is divided into the following chapters:

The ***Executive Summary*** in the preceding pages provides an overall summary of key findings, background, and recommendations.

Chapter 2: Background provides additional background information on the state's Conservation Improvement Program and other energy efficiency policies, and summarizes key findings from the stakeholder work that was done for this project.

Chapter 3: Methodology summarizes the methodology and data sources used for this study, along with some of the caveats and limitations of energy efficiency potential studies in general. Detailed information on the methodology is provided in Appendix A.

Chapter 4: Results presents the key results from the study, including technical, economic, and program potential.

Chapter 5: Program Findings and Recommendations provides findings and recommendations for future programs from a review of both Minnesota and national energy efficiency programs.

Chapter 6: Policy Conclusions presents the policy conclusions of the study team. These conclusions are significantly informed by the Advisory Committee and other stakeholder work conducted as part of the study.

A rich knowledge base of background information and data was developed for this study – including primary data collected from Minnesota building stock and input from stakeholders involved in energy efficiency policy and implementation. Much of this background material is presented in the appendices, listed below, which can be downloaded as separate reports.

Appendix A: Methodology and Data Sources provides more detail on the methodology and data sources used for this study, which is summarized in Chapter 3.

Appendix B: Detailed Model Results presents more detailed results from the potential study modeling for each of the seven analysis areas.

Appendix C: Energy Efficiency Measures describes the screening process used for selecting measures to include in the study, as summarized in Chapter 3.

Appendix D: Behavioral Measures and Approaches provides background on current practices, and describes the behavioral measures and approaches selected for inclusion in the study.

Appendix E: Load Management and Demand-Response provides background on the current state of load management and demand-response efforts, and describes the measures selected for the study.

Appendix F: Low-Income Sector Market Study provides an analysis of the low-income sector, with recommendations for utility low-income programs.

Appendix G: Rural Utility and Agriculture Sector Market Study provides an analysis of rural utility opportunities for energy efficiency, including the agricultural market sector.

Appendix H: Small Commercial Market Sector Study provides an analysis of energy efficiency opportunities in the small commercial sector.

Appendix I: Energy Efficiency Program Benchmarking Report presents the results of the program benchmarking research of Minnesota utilities and utilities in other states.

Appendix J: Residential Buildings Primary Data Collection Report presents the results of the primary data collection efforts in residential single-family homes, and how this was used in the modeling.

Appendix K: Commercial Large Buildings Primary Data Collection Report presents the results of the primary data collection in commercial large buildings, and how this was used in the modeling.

Appendix L: Trade Ally Survey Report presents the results of the primary data collection in commercial large buildings, and how this was used in the modeling.

Appendix M: Minnesota HVAC Sales Data Report presents a summary of the heating, ventilation, and air conditioner (HVAC) sales data that was purchased for this study.

Appendix N: Advisory Committee Membership and Policy Comments lists the Advisory Committee members for this project and contains the policy comments submitted for this project.

Appendix O: Review of Past Minnesota Energy Efficiency Potential Studies is an analysis of how past study estimates of potential compare to actual energy efficiency achievements in the years subsequent to the analysis.

Appendix P: Analysis of Workforce Impacts of Modeled Energy Efficiency Programs is an analysis of the likely workforce implications of future energy efficiency programs, which informs program recommendations related to trade allies, training organizations, and workforce partners.

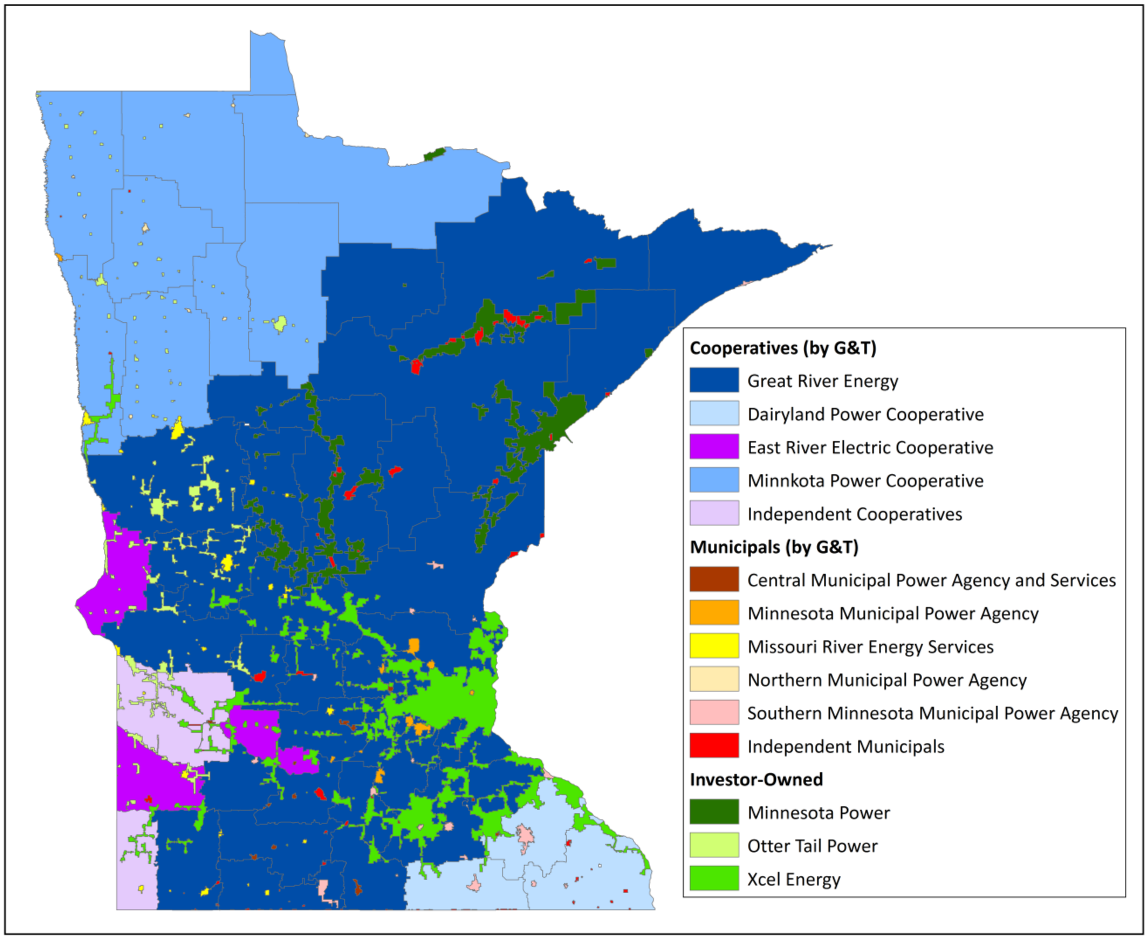
These documents, and others, are available on the project website: www.mncee.org/mnpotentialstudy.

Chapter 2: Background

Minnesota's energy utilities

Minnesota has a total of 176 electric utilities and 37 natural gas utilities.[5] Of the electric utilities, three are investor-owned utilities (IOUs), 47 are cooperatively-owned, and 126 are municipally-owned.

Figure 1. Minnesota electric utility territory map.



While cooperative and municipal electric utilities (together, "consumer-owned utilities," or COUs) serve the largest geographic territory of the state, the electric IOUs serve a majority of the state's population centers and commercial/industrial hubs (Figure 1). In 2016, 62% of the state's electric load was served by the IOUs, 23% by cooperative utilities, and 15% by municipal utilities.

[5] There are 19 municipal utilities and one investor-owned utility (Xcel Energy) in Minnesota that provide both electric and natural gas service. These combination utilities are counted separately in both the electric and natural gas totals.

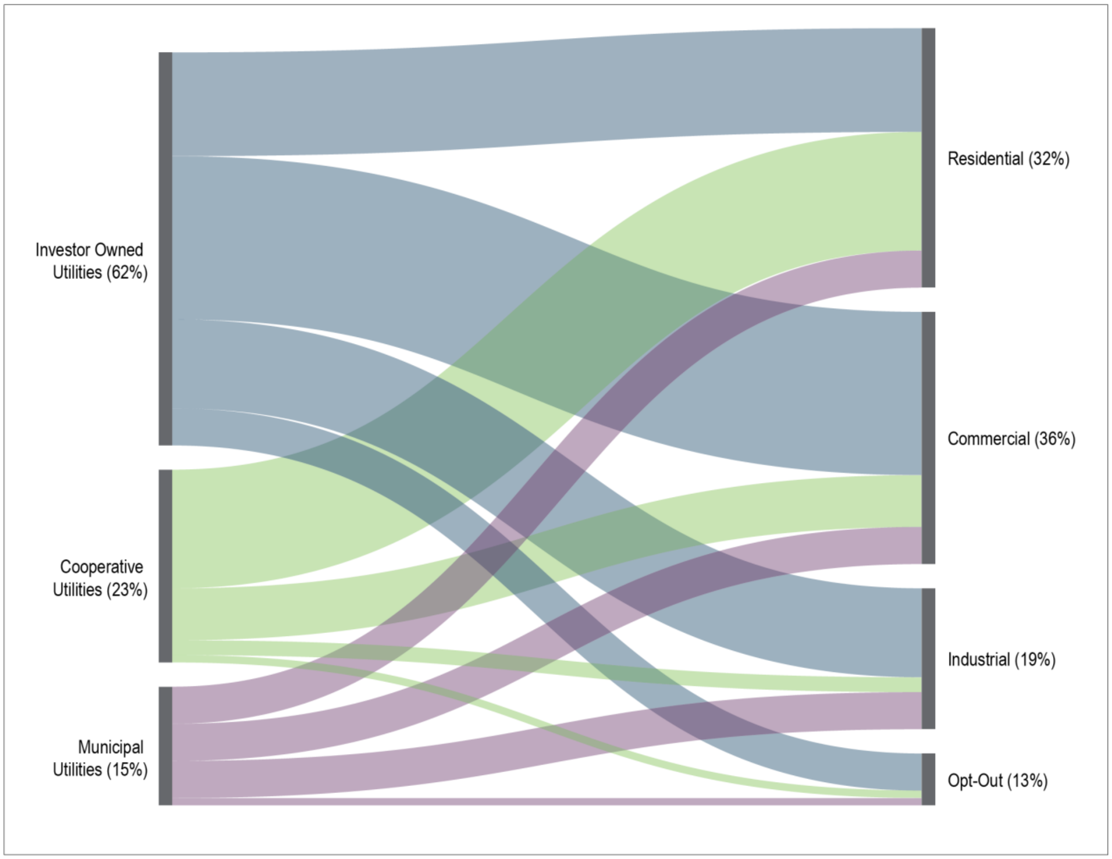
The majority of individual COUs aggregate their purchase and bulk transfer of energy among several generation and transmission (G&T) organizations (Table 1). These organizations themselves are member-based, and allow the COUs to realize efficiencies of scale in generating and transmitting power to their customers. There are two cooperative utilities and 24 municipal utilities that independently meet their generation and transmission needs, representing 0.5% and 2.3% of Minnesota's total energy load, respectively.

Table 1. Generation and transmission entities serving Minnesota consumer-owned utilities.

Generation and Transmission Organization	Number of Utility Members	Percent of total MN load served
Great River Energy	28	18.7%
Southern Minnesota Municipal Power Agency	18	4.3%
Missouri River Energy Services	24	4.0%
Minnesota Municipal Power Agency	12	2.8%
Minnkota Power Cooperative	8	2.0%
Dairyland Power Cooperative	3	1.8%
Central Municipal Power Agency / Services	12	0.7%
Northern Municipal Power Agency	21	0.6%
East River Electric Power Cooperative	3	0.5%
TOTAL:	**129**	**35.4%**

Generally, electric cooperative utilities tend to have a higher proportion of residential customers in their overall customer profile than electric municipal utilities and electric investor-owned utilities, which tend to be more equally balanced between residential, commercial, and industrial customers (Figure 2).

Figure 2. Minnesota electric utility loads by utility type and sector.[6]

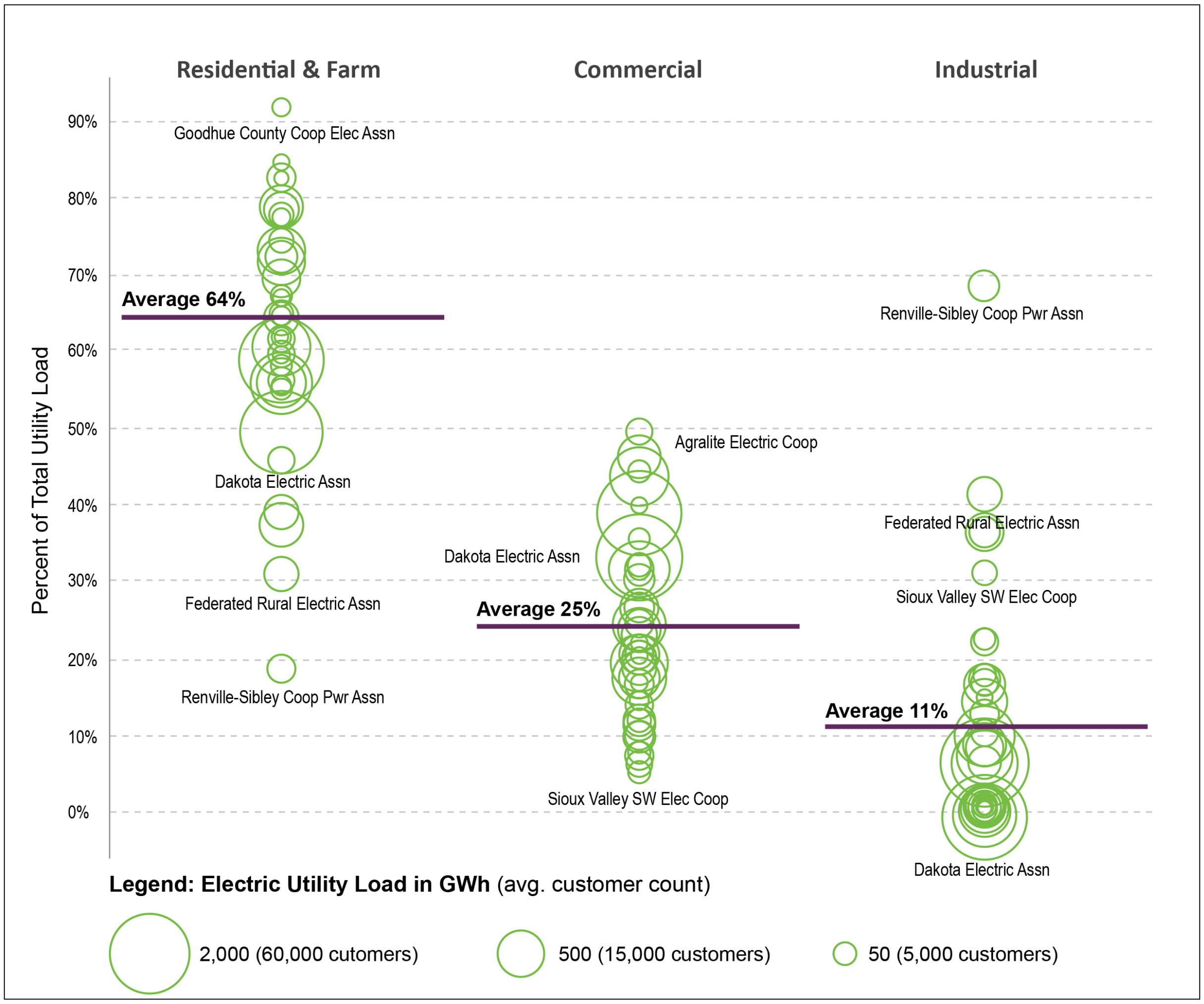


However, there is significant diversity of customer profile within each of the utility business types. Some municipal utilities serve only residential customers. Several electric cooperative utilities serve less than 10% of residential customers, and some investor-owned utilities serve as little as 12% of residential customers.[7] Figure 3 shows each cooperative electric utility in Minnesota and its particular mix of residential, commercial, and industrial loads.

[6] In 1999, the Minnesota Legislature authorized large customer facilities meeting certain criteria to opt-out from participating in and paying for CIP. Laws of Minnesota 1999, chapter 140.

[7] Utility "customer profiles" refer to the proportion of utility sales by customer type, based on 2016 Energy Information Administration data.

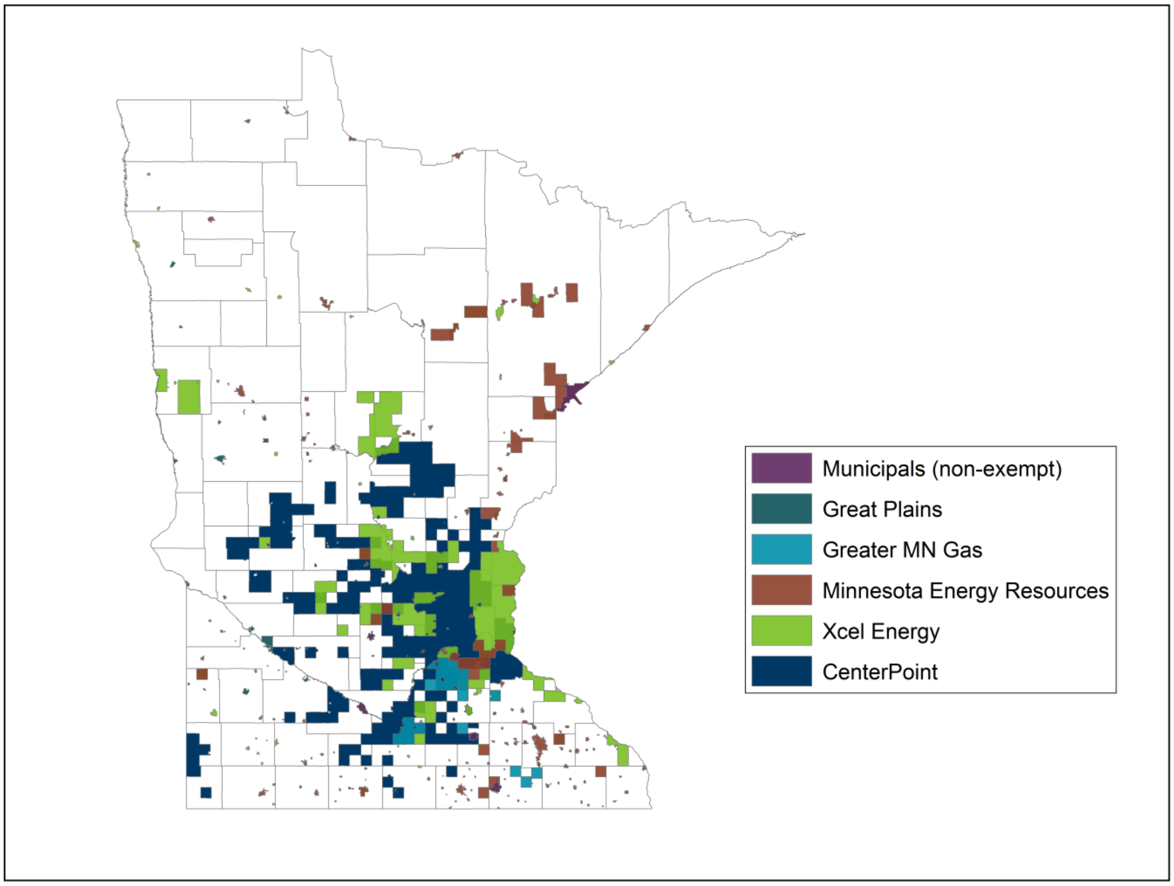
Figure 3. Distribution of electric energy loads by sector for Minnesota's cooperative utilities.



Minnesota has five IOU and 30 municipally-owned natural gas utilities (Figure 4). The IOUs served 94% of the state's natural gas sales; with the remaining 6% served primarily by municipal utilities (Figure 5). There is less variation among utilities in the proportion of residential, commercial, and industrial customers compared to the electric utilities. Approximately 66% of Minnesota residential households have natural gas service — 17% heating with electricity and 12% served by delivered fuels, primarily propane.[8]

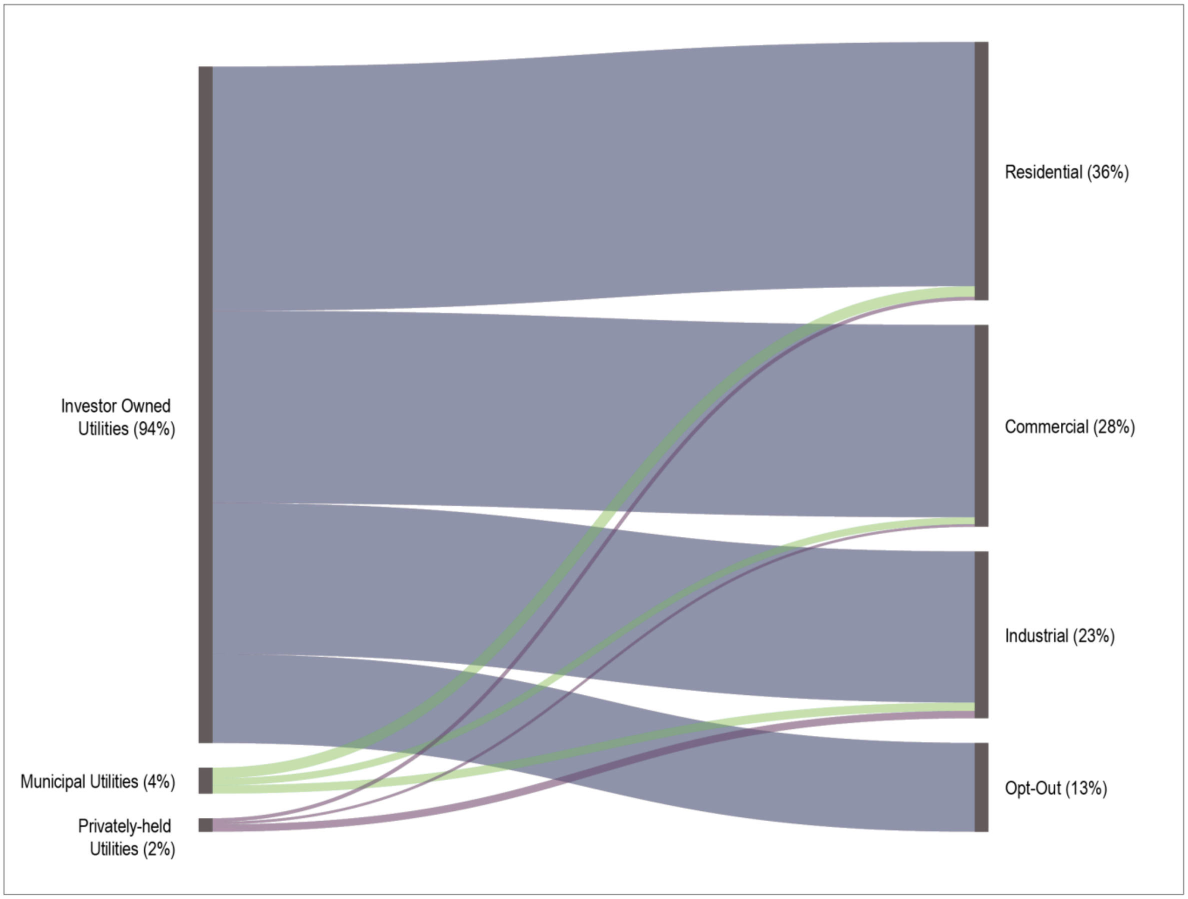
[8] American Community Survey, 2016. Note that among renter-occupied households, 35% heat their homes with electricity.

Figure 4. Minnesota natural gas utility territory map.[9]



[9] Natural gas utility service territories are considered trade secret. Figure 4 provides an approximation of Minnesota's natural gas service areas based on the municipalities and townships that natural gas utilities report that they serve.

Figure 5. Minnesota natural gas utility sales by utility type and sector.



The history of energy efficiency policy in Minnesota

Minnesota policymakers have long recognized the promotion of energy efficiency as a cornerstone of the state's energy policy. This is reflected in Minnesota statute, which states that "cost-effective energy savings are preferred over all other energy resources," and that "cost-effective energy savings should be procured systematically and aggressively."[10]

Minnesota has required utility-funded energy efficiency programs since the early 1980s. In 1983, the first Conservation Improvement Program (CIP) legislation was passed, requiring utilities with annual revenues over $50 million to operate an energy conservation program. In 1989, that requirement was expanded to all investor-owned utilities. Throughout the 1980s and 1990s, the Minnesota legislature

[10] See 2017 Minnesota Statutes, Section 216B.2401 (https://www.revisor.mn.gov/statutes/cite/216B.2401).

continued to build on the initial CIP legislation, passing additional utility energy conservation provisions, including:

- requiring utilities to spend a percentage of their gross revenues to help customers save energy;
- requiring utilities to have programs to help low-income customers reduce their energy use and save money on their bills; and
- allowing IOUs to collect financial incentives set by the Minnesota Public Utilities Commission to offset the impact of energy sales lost due to energy conservation.[11]

Since its inception, CIP has been constantly evolving to better capture and optimize the benefits of energy conservation and address market and technological changes. In addition to the policies noted above, many changes to the CIP statute have occurred over the years – the statute has been amended 36 times since it was enacted 38 years ago.[10]

Minnesota's energy efficiency efforts and achievements accelerated significantly in 2007, with the addition of an Energy Efficiency Resource Standard (EERS) of 1.5% of energy sales for both electric and natural gas utilities to CIP. The EERS, which was enacted in 2007 and took effect in 2010, remains in place today. Minnesota is one of the few states whose EERS applies to both IOUs and COUs.

Of the 213 utilities in Minnesota, 122 are under CIP requirements (79 municipal utilities, 35 distribution cooperatives, and eight investor-owned utilities).[12] About 13% of electric load and gas sales are exempt from paying for or participating in energy efficiency through CIP, under Minnesota's large customer opt-out provision.[13]

Historical CIP achievements

Since passage of the EERS in 2007, Minnesota utilities have increased their investments and achievements in CIP. Annual CIP energy savings and expenditures, for both natural gas and electric utilities, have been moving in an upward trend since that landmark legislation. CIP energy savings and expenditures reached a peak in 2017.[14] Total CIP electric energy savings in 2016 were equivalent to the

[11] The current financial incentive plan framework is based on a shared savings model. The shared savings model allows utilities to keep a portion of the net benefits generated by their energy conservation achievements each year, while sharing the vast majority of those benefits with their customers. The Department of Commerce, Division of Energy Resources. *Report on the Impacts of the 2010-2014 Shared Savings Demand-Side Management (DSM) Financial Incentive on Investor-Owned Utility Conservation.*

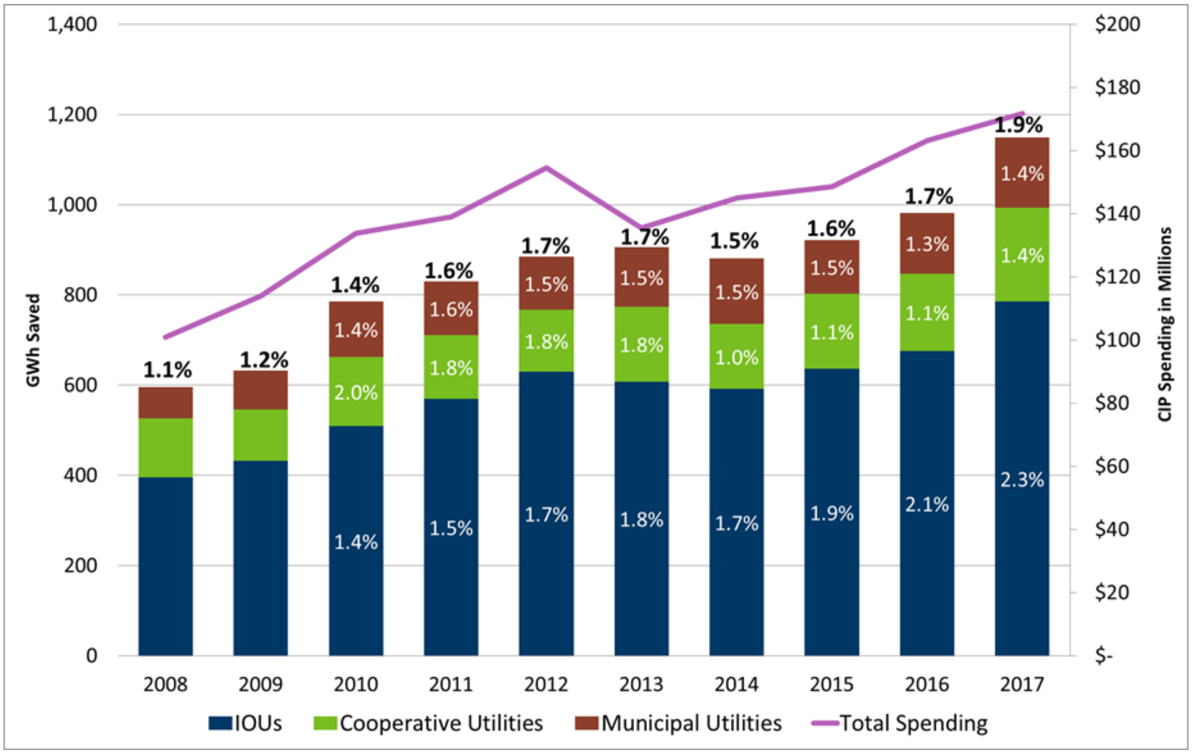
[12] Legislation passed in 2017 exempted municipal and electric cooperative utilities from the energy efficiency program requirements under Minnesota's CIP statute based upon a threshold of the number of cooperative members (for cooperative utilities) or the number of retail customers (for municipal utilities). Municipal natural gas utilities that fall below a minimum annual throughput threshold were already exempt from the CIP statute requirements. Minnesota Statute 216B.241.

[13] In 1999, the Minnesota Legislature authorized large customer facilities meeting certain criteria to opt-out from participating in and paying for CIP. Laws of Minnesota 1999, chapter 140.

[14] 2017 CIP achievement projections are based on CIP Status Report compliance filing data. The COU spending and savings data were compiled from Energy Savings Platform (ESP) reporting data on October 22, 2018.

annual energy usage of nearly 80,000 single-family homes.[15] Total CIP natural gas savings in 2016 were equivalent to the annual energy usage of nearly 18,000 single-family homes.[16]

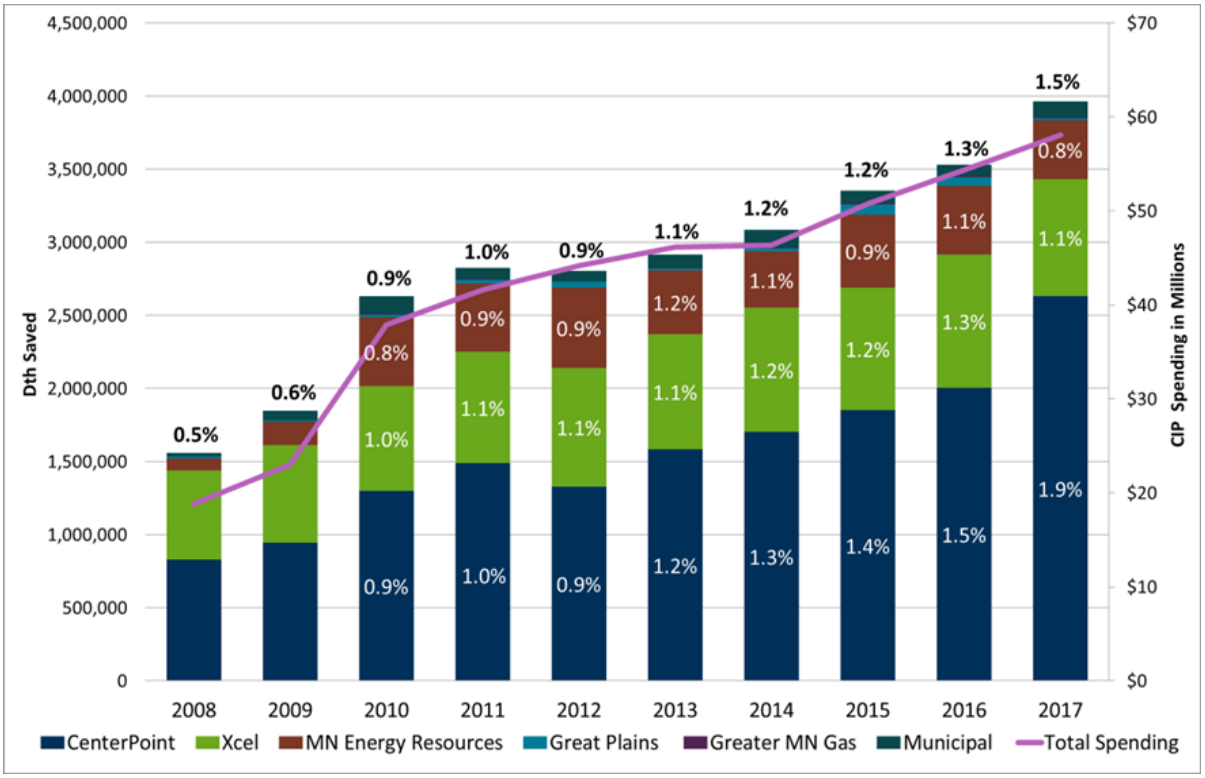
Figure 6. Historical energy efficiency spending and savings achievements of Minnesota electric utilities (in gigawatt-hours and as a percentage of total sales), 2008-2016.



[15] According to https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

[16] According to https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

Figure 7. Historical energy efficiency spending and savings achievements of Minnesota natural gas utilities (in dekatherms and as a percentage of total sales), 2008-2016. [17]



Regulatory oversight of CIP

Regulatory oversight for CIP activities, goals, and achievements has been provided by the Minnesota Department of Commerce ("the Department") or its predecessor, the Minnesota Department of Public Service, since the late 1980's.[18] Currently, utilities that are subject to the CIP statute file CIP plans with the Department, which oversees the review and approval process. Municipal and cooperative utilities file annual plans with the Department through the state's online platform. IOUs file their CIP plans, called "Triennial Plans," every three years, and are required to provide more information and analysis than municipal and cooperative utility annual plans. The IOUs' Triennial Plans include their expected

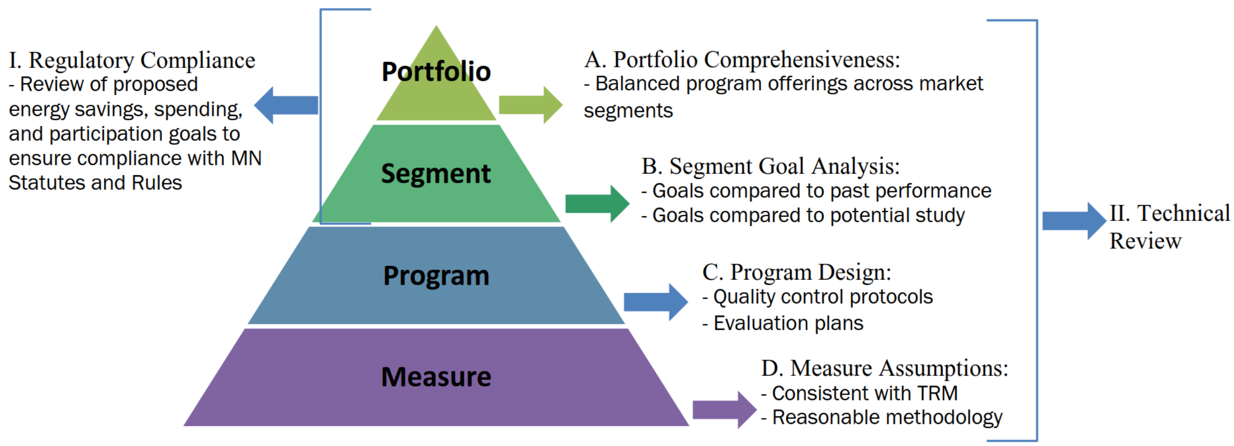
[17] The project team would add one caveat to the interpretation of Figure 7, which shows particularly high achievements in 2017. CenterPoint Energy's achievements in that year were unusually high, and driven by a particularly large custom rebate project that was responsible for over one-third of its total savings that year. CenterPoint reported nearly 40% of total savings coming from custom rebates in 2017 (six times higher than the previous year's achievements). Removing that single project would likely result in lower 2017 statewide savings than were achieved in the previous two years.

[18] State of Minnesota Department of Public Service. *Statement of Need and Reasonableness in the Matter of the proposed Amendments to Rules Governing Conservation Improvement Programs and Utility Renewable Resource Pilot Programs*, *Minn. Rules Chapter 7840, to be re-codified as Minn. Rules Parts 7690.0100 - 7690.1500.* November 22, 1989 (https://www.leg.state.mn.us/archive/sonar/SONAR-01563.pdf).

program portfolio activities, goals, budgets, estimated cost-effectiveness, energy savings calculations, and technical assumptions. The COUs report their expenditures and energy savings performance from the previous year, along with their budgets and energy savings goals, and updated program designs for the following year.

The Department conducts a regulatory and technical review of IOU proposed plans and may order modifications (Figure 8).[19] The Department may recommend changes to COU CIP plans, but generally does not mandate that the changes be made. Between Triennial Plan filings, IOUs may request permission for changes to their approved CIP portfolio, to add or remove activities, or change goals and budgets. Program modifications are subject to a similar review process as the CIP Triennial Plan filings.

Figure 8. Department of Commerce CIP technical and regulatory review for investor-owned utilities.



To ensure that reasonable calculations are used by the utilities to calculate their CIP performance, a key part of the Department staff's role is to establish approved technical assumptions that the utilities are required to use — including prescriptive measure algorithms in the Minnesota Technical Reference Manual (TRM)[20] to estimate energy savings, providing uniform natural gas cost-effectiveness inputs through the Inputs to BENCOST for Natural Gas CIPs document,[21] and standardizing the methodology for calculating transmission and distribution avoided costs.[22]

The Department oversees development of the TRM, which is a list of CIP-eligible energy efficiency measures, associated technical assumptions, and energy-savings calculations for use by utilities in their CIP plans. The Minnesota TRM is updated annually but receives a comprehensive review and rewrite

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[19] Per Minnesota Statutes § 216B.241, and Minnesota Rules, part 7690.0500.

[20] Minnesota TRM Webpage: mn.gov/commerce/industries/energy/utilities/cip/technical-reference-manual/.

[21] Inputs to BENCOST for Natural Gas 2017-2019 CIP, February 19, 2016. Docket no: 16-36. www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={C952168E-C6B2-4994-90DF-852677019F0E}&documentTitle=20162-118479-01.

[22] Deputy Commissioner's Decision – Avoided T&D Cost Study for Electric 2017-2019 CIP Triennial Plans, September 29. 2017. Docket no: 16-541. www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={E0B7CD5E-0000-C01B-B43D-58AB61CE562A}&documentTitle=20179-135899-01.

every three years, ahead of the CIP Triennial Plan filings. Utilities may also propose their own energy efficiency measures, technical assumptions, and energy savings calculations. However, these utility-proposed measures and technical assumptions receive additional scrutiny and review by the Department.

Each spring, the Department reviews and approves annual compliance reports for the IOUs called "Status Reports." The reports provide information about each utility's energy conservation program achievements, including participation, expenditures, energy savings, and cost-effectiveness.[23] The COUs file their annual achievements through the state's online saving reporting platform.[24]

The IOUs file a full accounting of their CIP expenses (including a request for approval of any financial incentives) with the Minnesota Public Utilities Commission for review and approval. Typically, CIP program costs and the CIP financial incentive are recovered within twelve months of being incurred through a rate rider.

Cost-effectiveness framework

The foundation of Minnesota's energy conservation framework is cost-effectiveness. Minnesota's CIP statute states that no utility is "required to make energy conservation investments to attain the energy-savings goals of this subdivision that are not cost-effective; even if the investment is necessary to attain the energy-savings goals."[25]

Tests for cost-effectiveness involve a calculation of the total benefits of achieved energy savings and the total costs to achieve those energy savings, in dollar terms. To determine whether or not the overall benefits exceed the costs of the energy conservation activity, the costs to capture energy savings are tested against the costs avoided by the energy savings. Results are reported in terms of the net present value dollars or as a ratio (i.e., benefits/costs). A project is considered cost-effective if the benefit-to-cost ratio is greater than one and the net present value of benefits (net benefits) is greater than zero.[26]

Cost-effectiveness of Minnesota's CIP is reported at the program, sector (i.e., residential, commercial, and industrial), and overall CIP portfolio level. The Department requires utilities to meet cost-effectiveness standards at the sector level. This approach "recognizes that individual programs are often linked together and not intended to operate in isolation; for example, energy audit projects are

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[23] Minnesota Rules: 7690.0550, Program Status Report. The IOUs publish these reports on the eDockets on-line filing system.

[24] Minnesota's online platform for filing CIP data is called the Energy Savings Platform (http://www.energyplatforms.com/MN.aspx).

[25] Minnesota Statutes 2018, section 216B.241, subdivision 1c, paragraph (f).

[26] For more background on the use of cost-effectiveness tests in energy efficiency portfolio planning, and more details of their calculation, see: California Public Utilities Commission: *California Standard Practice Manual: Economic Analysis of Demand-Side Management Programs and Projects.* 2001. And: Environmental Protection Agency. *Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers.* November, 2008 (https://www.epa.gov/sites/production/files/2017-06/documents/understanding_costeffectiveness_of_energy_efficiency_programs_best_practices_technical_methods_and_emerging_issues_for_policy-makers.pdf).

intended to identify conservation opportunities and drive participation in equipment rebate programs."[27]

The primary tests used to evaluate CIP program and portfolios are the societal test and the utility test.[28]

The utility cost-benefit test (UCT) (also called the "program administrator test") considers cost-effectiveness from the perspective of the utility that is paying for the energy conservation program. It compares the costs incurred by the utility to fund energy efficiency programs against the benefits of the avoided energy that the utility would have had to acquire had the energy not been saved (i.e., the avoided costs for generation, transmission, distribution, and capacity). Significantly, net benefits as calculated by the UCT are the basis for the calculation of utility incentives for the IOUs, under Minnesota's current incentive mechanism. Since participants' costs are not included in the UCT, all other things being equal, lower utility incentive payments will increase the utility cost-effectiveness of a CIP program. Thus, utilities seeking to maximize the UCT have an incentive to lower overall CIP incentives, while still motivating customers to choose the efficient option.

The societal cost-benefit test (SCT) considers the overall cost-effectiveness of energy efficiency to society. In addition to the costs the utility pays for energy efficiency, it also includes the costs that customers pay for efficiency measures (Figure 9).

On the benefits side, in addition to the avoided cost of saved energy, it also considers the environmental benefits from reduced air emissions as a result of using less energy. In contrast to the UCT, lowering the utility incentive costs has no impact on the SCT results, as lowering the utility incentive would increase the cost that the participant had to pay for a given CIP measure, resulting in no net change in cost-effectiveness.

Since the SCT is the primary test used by the Department in evaluating CIP portfolios, and is the broadest cost-effectiveness test, the SCT is used as the primary screen for cost-effectiveness in this study, as described further in Chapter 3.

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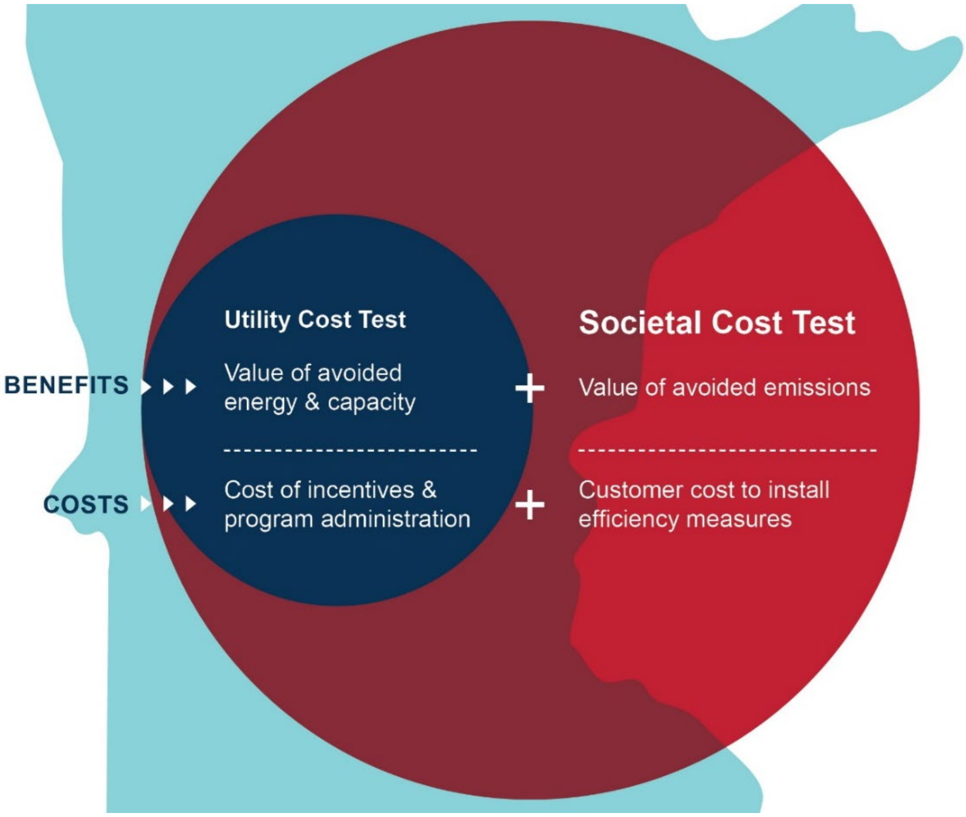
[27] Department of Commerce. *Proposed Decision CenterPoint Energy's 2017-2019 Natural Gas Conservation Improvement Program Triennial Plan Docket Nos. G008/CIP-16-119, G008/CIP-16-119.01, G008/CIP-16-119.02*. September 19, 2016.

[28] In addition to these two tests, the Department requires utilities to calculate two additional cost-effectiveness tests in preparing and reporting on their CIP plans: participant cost-benefit test and the ratepayer impact test. These tests assess costs and benefits for groupings of ratepayers within the utility and have narrower applications; they were not used for this study. Within the Venn diagram in Figure 9, these tests would be subcomponents of the utility cost test.

Figure 9. Comparison of societal and utility cost-benefit test inputs as used in Minnesota.



The Cadmus Group recently conducted a cost-effectiveness analysis of the CIP electric and natural gas program portfolios. Cadmus found that, based on the societal test, Minnesota's CIP resulted in aggregate net benefits to society from 2008 to 2013 of approximately $3.3 billion, with each program year providing net electric and natural gas benefits to society ranging from $315 million to $919 million.[29]

Long-term planning for energy efficiency

The CIP process described above is how utilities procure efficiency within the period of the Triennial Plans. Energy efficiency is also considered as a long-term resource for electric utilities by the Minnesota Public Utilities Commission (MPUC) in their review of utility Resource Plans. These plans extend out 15 years, and utilities are required to show how efficiency will help them meet their long-term resource needs. The MPUC has the authority to order utilities to pursue more energy efficiency if the record supports that. Any utility that plans to file for a Certificate of Need for a new generation resource is required to show that they are pursuing all cost-effective energy conservation prior to a certificate being

[29] Minnesota Department of Commerce. *The Aggregate Economic Impact of the Conservation Improvement Program 2008-2013.* October 2015. Page 5. http://mn.gov/commerce-stat/pdfs/card-report-aggregate-eco-impact-cip-2008-2013.pdf.

issued[30]. Many of the data inputs developed to support utility resource planning is used in utility efficiency programs (e.g., forecasts of future avoided costs to be used for calculating energy efficiency cost-effectiveness).

Stakeholder perspectives on the existing CIP framework

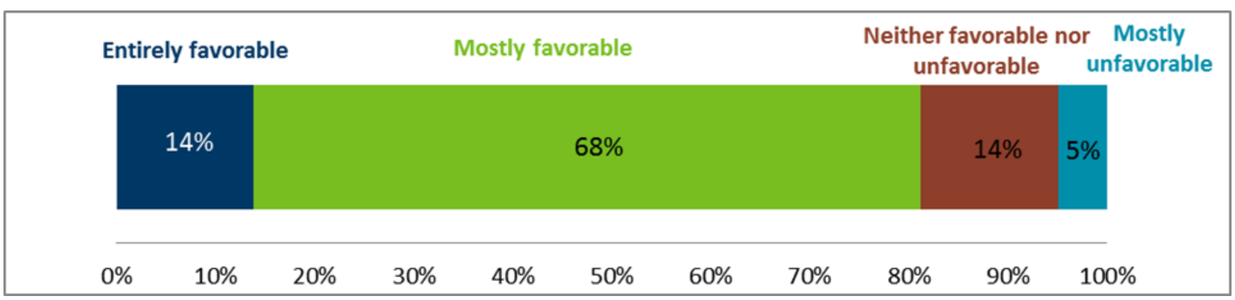
Utility, business, and public interest stakeholders have always played a large role in the planning and implementation of CIP in Minnesota, and their perspectives will continue to be important as regulators plan for the future of CIP. To help inform this study, the project team conducted a survey of nearly 40 stakeholders, which included utilities, business groups, consumer groups, and environmental groups (Table 2). Below are some of the survey's key findings. Additional stakeholder findings are discussed in Chapter 6 (Policy Conclusions).

Table 2. Stakeholders participating in survey.

Stakeholder sector	Number taking survey
Investor-owned utilities	9
Cooperative utilities	4
Municipal utilities	8
Business organizations	7
Consumer/government organizations	6
Clean energy organizations	4
Total:	**38**

Over 80% of stakeholders reported having a favorable experience with CIP, with a small minority reporting unfavorable experiences (Figure 10).

Figure 10. Stakeholder experiences with CIP.



According to one municipal utility stakeholder:

> *"We've had some good success stories with saving our commercial or industrial customers a significant amount of money and they're able to expand their operations because of savings we*

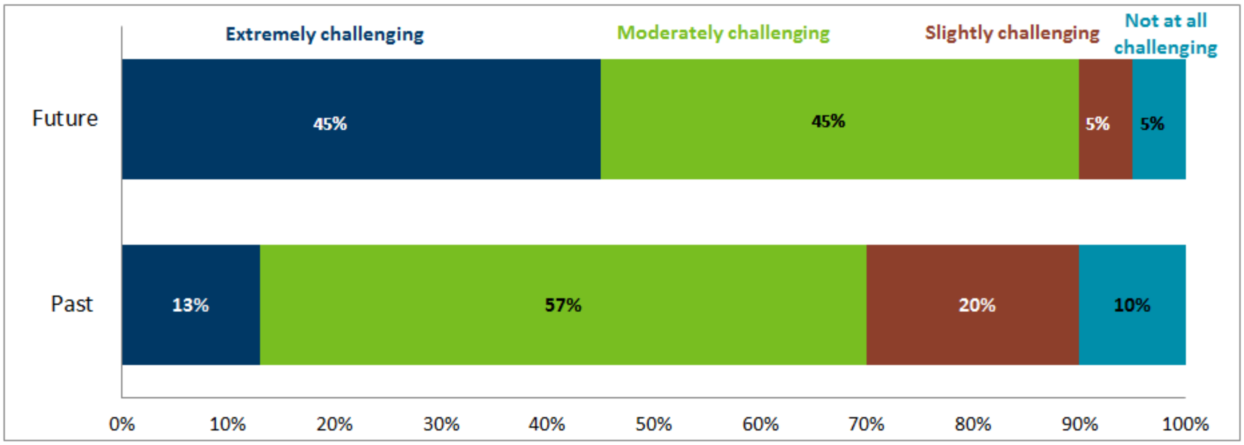
[30] 216B.2401 ENERGY SAVINGS POLICY GOAL: The legislature finds that energy savings are an energy resource, and that cost-effective energy savings are preferred over all other energy resources. https://www.revisor.mn.gov/statutes/cite/216B.2401.

found for them. I think it's a win-win. It helps build relationships with our customers and helps us defer systems expansions and helps keep rates down."

IOUs particularly cited the regulatory process as a positive experience for them; in particular the ability to make investments in energy efficiency with a high degree of confidence that they would receive cost-recovery and incentives from those investments.

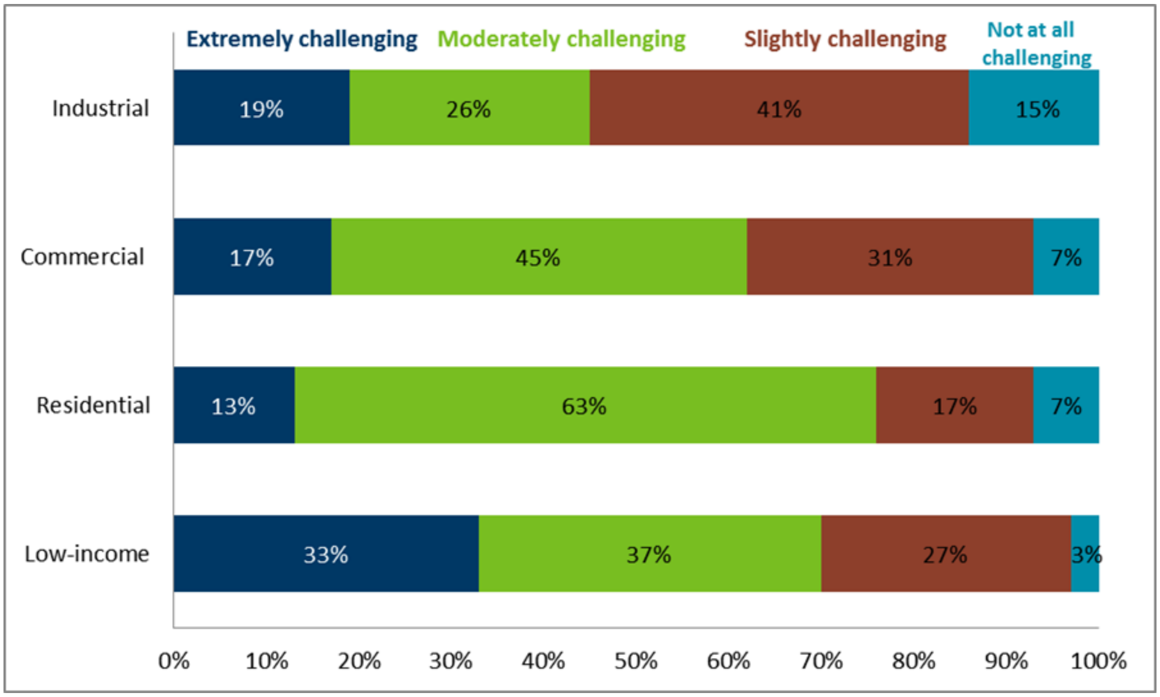
However, while stakeholders believe that it has been relatively easy to meet the state goals in recent years, most believe that it will become harder in the coming years (Figure 11).

Figure 11. Stakeholder perceptions of how challenging it is to meet CIP savings requirements now and in the future.



Stakeholders also report that they are most challenged with reaching residential customers – and in particular low-income residential customers (Figure 12).

Figure 12. Stakeholder perceptions of how challenging it is to reach customers with energy efficiency programs (by sector).



According to one stakeholder:

> *"I think sometimes low-income [customers] aren't in tune with utility programs and [we struggle with] how to get them educated with the programs. There may be language barriers in some communities; culture barriers, and I think just knowing who those customers are can be challenging."*

Greater emphasis on lifetime savings may be warranted

When asked which metric for energy efficiency was most important, stakeholders identified lifetime energy savings as the most important. Currently, the greatest emphasis is on first-year savings. A couple of quotes from stakeholders on this topic:

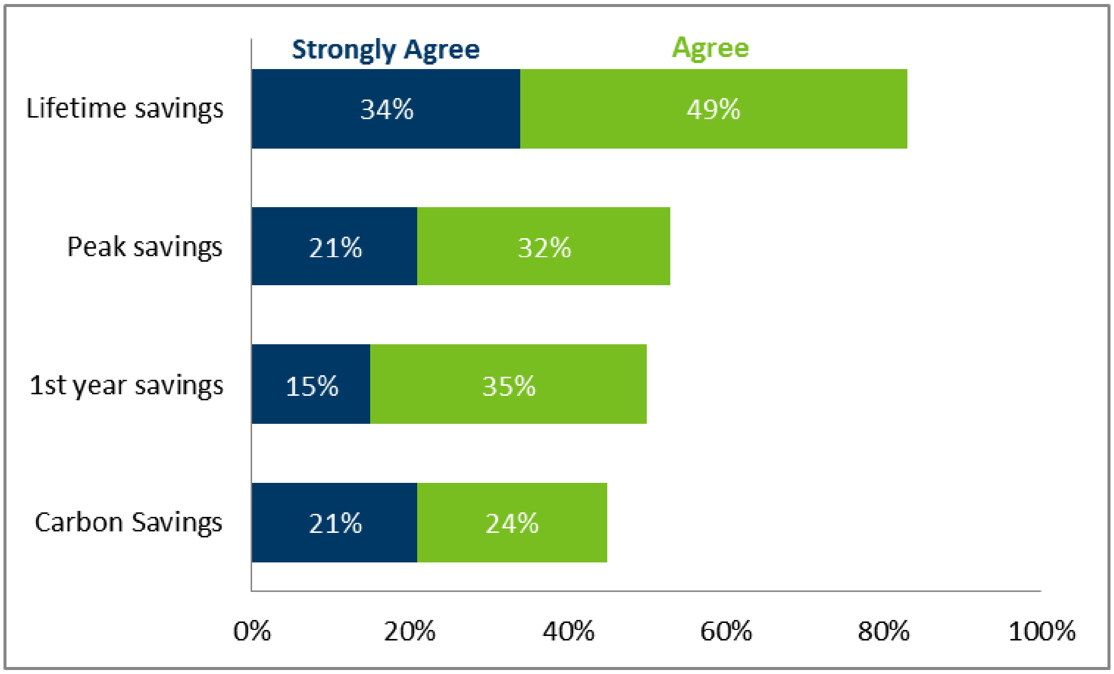
> *"One of the problems I've had with CIP is not being able to capture savings through the life cycle of the savings implemented. So I can only capture the first year, I don't get 2-3-4 years of savings out of it. I don't like the fact that I don't get multi-year savings out of a multi-year program."*

> *" … Some of the measures that could have long-term overall savings may be expensive upfront or have small year-by-year savings, so I think it's important to measure not just first-year savings."*

However, other stakeholders emphasized that first-year savings were more easily understood by the broader public:

> *"First-year savings are well known, well understood, and they're really important. Lifetime savings are good, but when you're encouraging first-year savings and encouraging cost-effectiveness, you're going to get lifetime savings. I also think first-year savings is an easier-to-understand goal. It's easier to explain to public stakeholders who don't understand this stuff, and that's really important."*

Figure 13. Stakeholder views of what metrics should be used to measure CIP success.



Chapter 3: Methodology

This chapter summarizes the methodology and key data sources employed in the calculations of energy efficiency potential. The scope of the study includes the calculation of economic and achievable utility-driven energy efficiency for Minnesota electric and natural gas utilities for the period 2020 to 2029. No calculation of fuel switching (e.g., from propane to electricity for space heating to increase overall fuel efficiency) was included in the analysis, although this issue is discussed further in Chapter 6.

A comprehensive description of the methodology and data sources is found in Appendix A. The methodology the project team used is consistent with national best practices for conducting potential studies. By its nature, estimating the potential for energy efficiency for more than a decade into the future involves a large number of technology and market assumptions. An effort was made to ensure the maximum amount of transparency in documenting these assumptions.

Types of potential calculated

Four levels of potential were calculated for this study, as described below and summarized in Figure 14.

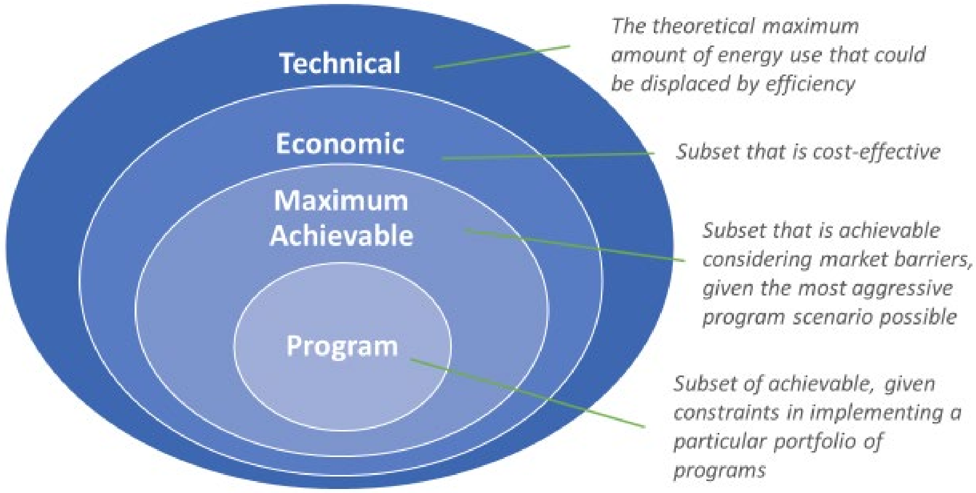
- ***Technical potential:*** Technical potential is a necessary step to assessing the full economic and achievable potential. It represents in theory the maximum amount of energy use that could be displaced by efficiency. However, as with virtually all studies, the modelling did not include many energy efficiency measures that are technically possible, but realistically are not practical or typically pursued because of cost or other reasons.[31] In this study, technical potential represents implementing all of the most aggressive energy efficiency measures that were identified for inclusion in the modeling (Step 2 in the following section).
- ***Economic potential***: This is the subset of the technical potential that is cost-effective, based on the societal cost test, as used in Minnesota. Most measures that did not pass the cost-effectiveness screen were removed from the analysis, but all cost-effective measures were assumed to be fully implemented regardless of market barriers.[32] This is described in Step 3 below.
- ***Maximum achievable potential:*** This is the subset of economic potential that is achievable considering market barriers, given the most aggressive program scenario possible. In this study, the project team assumed financial incentives would cover 100% of the incremental costs of each measure, along with very aggressive marketing and program designs to achieve maximum market penetration of the measures. The process for estimating measure penetrations and budgets is described in Step 4 below.

[31] Since it is known technically how to build super insulated buildings that have no heating loads; for example, true technical potential approaches 100% for some end uses and is not particularly useful to report.

[32] To avoid double counting, where there was more than one measure that could be used to address a specific efficiency opportunity, the project team assumed full penetration of the highest saving measure option.

- ***Program potential***: The program potential is a subset of the maximum achievable, given constraints in implementation. This study assumed that financial incentive levels are dropped to 50% of the incremental cost of the measure, which is a typical scenario used for planning purposes in Minnesota,[33] and a good benchmark for aggressive programs nationally. The project team still assumed aggressive marketing and program designs for this scenario.

Figure 14. Types of potential calculated for this study.



Primary data collection

This study used hundreds of data sources to develop inputs to the models, including past CARD studies, utility-provided data, residential audit data, secondary data from the northern Midwest region, U.S. Department of Energy studies, and others. Many of these sources are listed in the following section. In addition, the project team undertook additional data collection efforts to fill in some of the gaps of these other data sources. This included three components:

- Residential building phone and on-site surveys;
- Commercial large building phone and on-site surveys; and
- Energy efficiency contractor (trade ally) surveys.

In total, over 136 on-site surveys and 1,797 telephone surveys were completed (Table 3).

[33] Xcel Energy, for example, typically will use a 50% incentive scenario for planning purposes and for conducting their potential studies.

Table 3. Summary of primary data collection efforts.

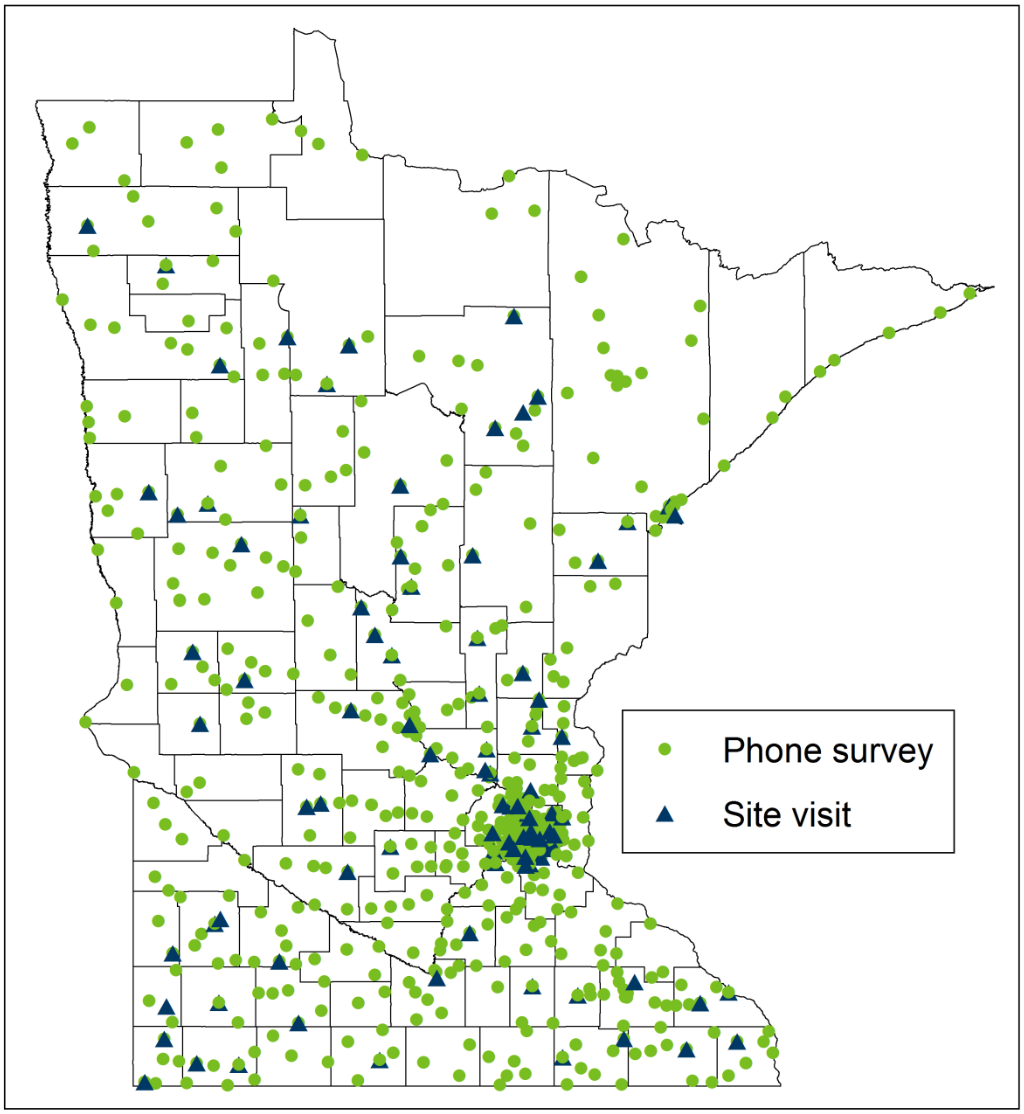
Sector	Phone surveys completed	On-site surveys completed
Residential building data collection	1,491	106
Large commercial building data collection	201	30
Total trade ally surveys (subtotals below)	105	-
HVAC contractors	*29*	-
New construction design professionals	*20*	-
Insulation contractors	*20*	-
Electricians	*26*	-
Plumbers	*10*	-
Total:	**1,797**	**136**

The data collection efforts were conducted throughout the state, with an emphasis on non-metro areas (Figure 15). While the project team did collect data in many different utility territories across the entire state, the sample sizes for different territories were not large enough to distinguish statistically significant differences among utility territories, or even the seven analysis regions in the state that were used for modeling.

In addition, the project team contracted with D+R International to purchase statewide data on HVAC sales.

In total, this primary data collection helped to inform key parameters of the study, such as the prevalence of measure opportunities and existing levels of measure saturation. The primary data collection effort is discussed more thoroughly in Appendices I, J, K, and L.

Figure 15. Map of statewide primary data collection sites.[34]



Analysis regions

To account for the diversity of utility types in Minnesota, as well as climate differences from the northern and southern parts of the state, the state was split into seven different analysis regions (Figure 16). A separate model was used for each region, and for the presentation of statewide potential, the results of these individual models were aggregated together. This gave the study team the ability to use separate assumptions and data for each of these analysis areas, rather than global assumptions for the state. For example, as discussed later in this chapter, different assumptions were used for the avoided

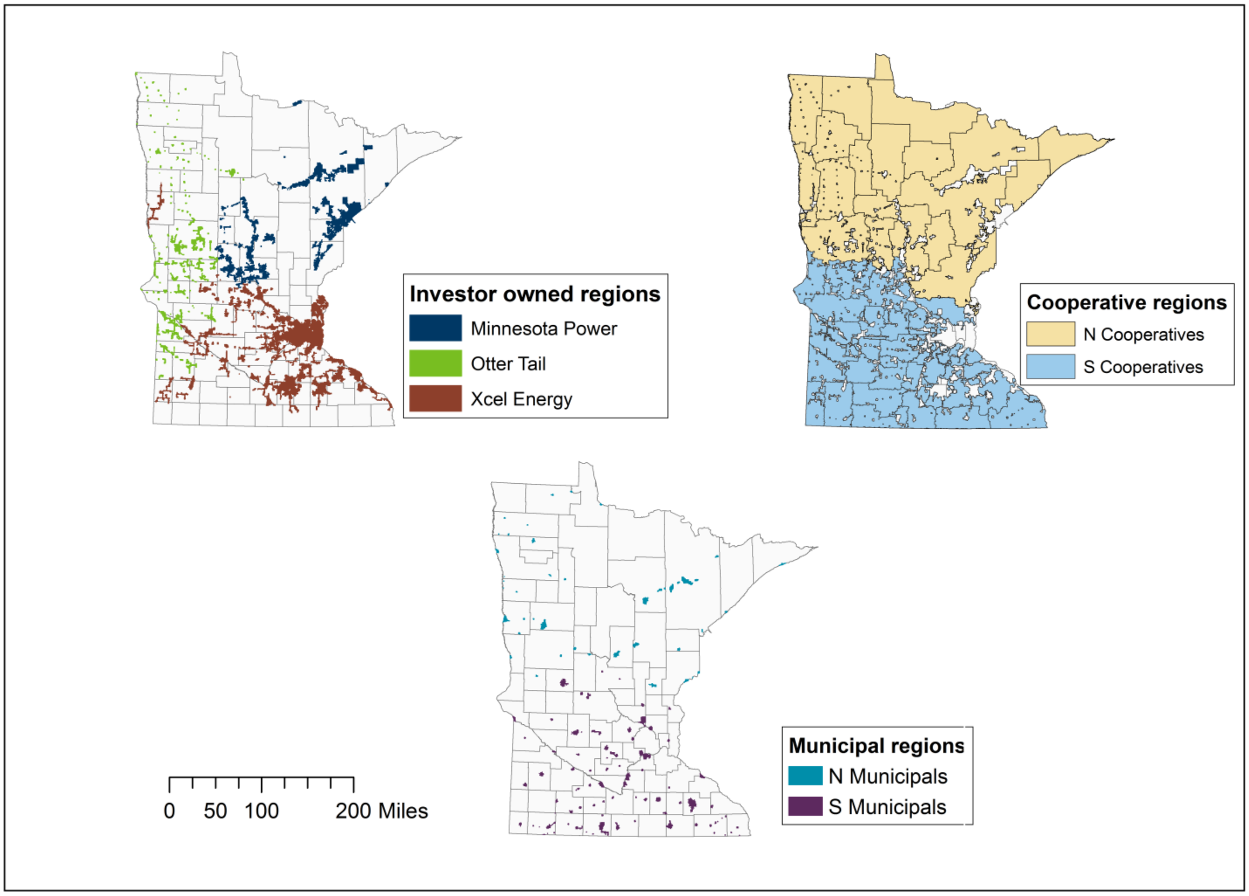
[34] Due to data privacy considerations, the points on this map represent primary data collection sites by zip code. Many zip codes had more than one phone survey or site visit, but are still represented by a single point.

cost of energy for each of the seven regions, to reflect utility-specific differences among IOUs, cooperative utilities, and municipal utilities.

The seven regions are based on the territories of electric utilities in the state as follows:

- Separate regions for the territories of each of the three electric IOUs (Xcel Energy, Minnesota Power, Otter Tail Power).
- A northern and southern model for groupings of cooperative utilities and municipal utilities respectively (four models total: northern cooperatives, southern cooperatives, northern municipals, and southern municipals).

Figure 16. Map of seven regions used for the analysis.



The model conducted an integrated analysis of both electric and natural gas potential, so the natural gas potential was also calculated for these same regions. While this did not allow for setting utility-specific parameters for the natural gas utilities, it did allow for the consideration of climate and other differences across a given utility's territory. For example, the model is able to account for climatic differences across Minnesota Energy Resources' territory, which spans from Worthington in the southern end of the state to International Falls in the northern end of the state. While the initial groupings were related to electric utility territories, the project team also disaggregated the gas potential in each model to develop the natural gas potential separately for the five IOUs (CenterPoint Energy, Xcel Energy gas, Minnesota Energy Resources, Great Plains Natural Gas, and Greater Minnesota

Gas), as well as groupings of northern municipal and southern municipal gas utilities. This process included disaggregation of gas potential in each electric territory by sector, building type, and end use to develop customized gas utility results. These results are reported in Appendix B.

Although some of the major model inputs were varied by analysis region, data and study limitations limited how many of the inputs the project team could make region-specific. Some of these major inputs are shown in Table 4, which are discussed further later in this chapter, and in Appendices A and B. The major differences between electric and natural gas utility territories, in terms of using statewide analysis versus region-specific inputs, include, but are not limited to, the use of region-specific avoided cost inputs for electric utilities and customized disaggregation of customer loads by sector, building type and end use, load forecasts, and weather impacts.[35]

Table 4. List of select model inputs, and whether they varied by analysis region or were statewide.

Region-specific inputs
Demographic and energy usage data by sector and building type[36]
Avoided electric energy and capacity costs (electric utilities only)
Impact of weather on gas and electric measure savings
Statewide inputs
Avoided natural gas energy and capacity costs (the same for all gas utilities)
Energy efficiency measures included in modeling
Existing measure saturation levels
Program budgets and incentive costs for modeled programs[37]
Market penetrations for modeled energy efficiency programs
Societal discount rate[38]

Steps in calculating potential

There are two general approaches commonly used to calculate energy efficiency potential: the "bottom-up" approach and the "top-down" approach. While both approaches use detailed measure level data inputs, a top-down approach applies those bottom-up measure data to actual applicable baseline loads, whereas a pure bottom-up approach assumes certain quantities of measures are adopted and does not link directly to actual baseline loads. The top-down approach was used for this study and involves five

[35] Typically the Department defines statewide avoided commodity costs that all natural gas utilities use for CIP purposes, while electric utilities use utility-specific avoided energy costs.

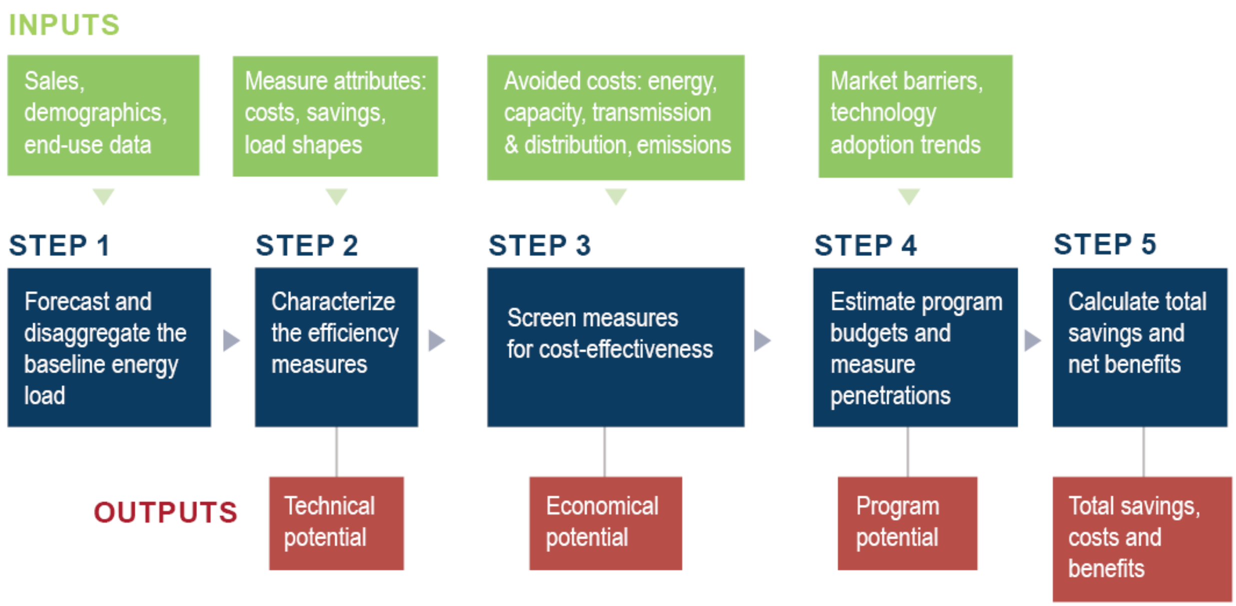
[36] This includes the proportion of energy consumed by 16 different building types and 14 (electric) or 6 (gas) different energy end uses (refer to Figure 18 for electric & Figure 19 for gas for a list of the building types and sectors). Other demographic information was also region-specific, such as the proportion of low-income customers.

[37] The budgets are modeled to scale with measure implementation, so costs vary based on the quantity of measures installed, but the program and incentive costs for a given measure do not vary by region.

[38] As discussed further in the below "Step 3" section, a rate of 2.55% was used for the societal discount rate, consistent with Department guidance.

major steps. The approach is illustrated in Figure 17, and described in more detail in Appendix A. Major data sources used for each of the steps are summarized at the end of this section in Table 7.

Figure 17. Modeling approach used for this study.



Step 1: Forecast and disaggregate the baseline energy load

Sales forecasts were obtained from publicly filed Integrated Resource Plans as well as directly from nine different utilities or utility associations. In the event a utility's forecast did not project to 2029, the project team extrapolated by assuming the sales grew by the same rate as the last five years of the forecast. When available, the team obtained forecasts separately for commercial, industrial, and residential. The known industrial opt-out loads were subtracted from the total sales figures, so all results reflect only the potential from non-opted out loads.

Since the forecasts were developed using econometric models, they implicitly include some impacts of future efficiency programs, along with past and future codes & standards trends. Therefore, the project team first adjusted the forecasts upward to remove the impacts of continued efficiency programs, based on historical levels of energy efficiency achievement. This helped ensure that the potential study reflects the full efficiency potential over and above a no-program scenario with only naturally occurring and known codes and standards impacts.

The study team then used a variety of data and methods to disaggregate total energy sales into 16 different building types (three residential, twelve commercial, and the industrial sector). For each of these building types, the energy load was further disaggregated into 19 separate end uses for electric utilities (Figure 18), and seven end uses for gas utilities (Figure 19). These building types and end-uses were used to classify the measures according to their applicability to different building types and end-uses, as discussed in the next section. This ensures that the potential of any given set of measures is limited by the total energy used in each relevant building sector and end use for those measures.

Figure 18. Statewide electric energy load by building type segments and end use.

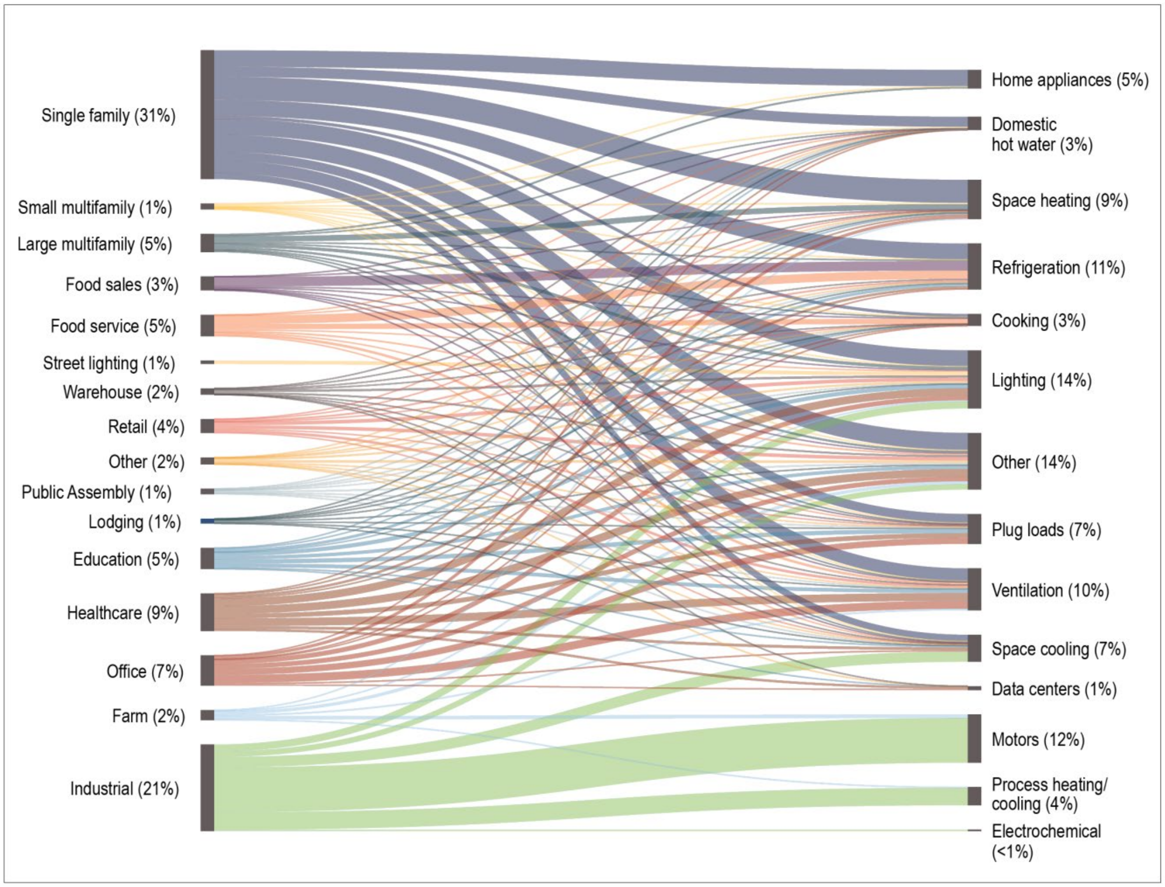
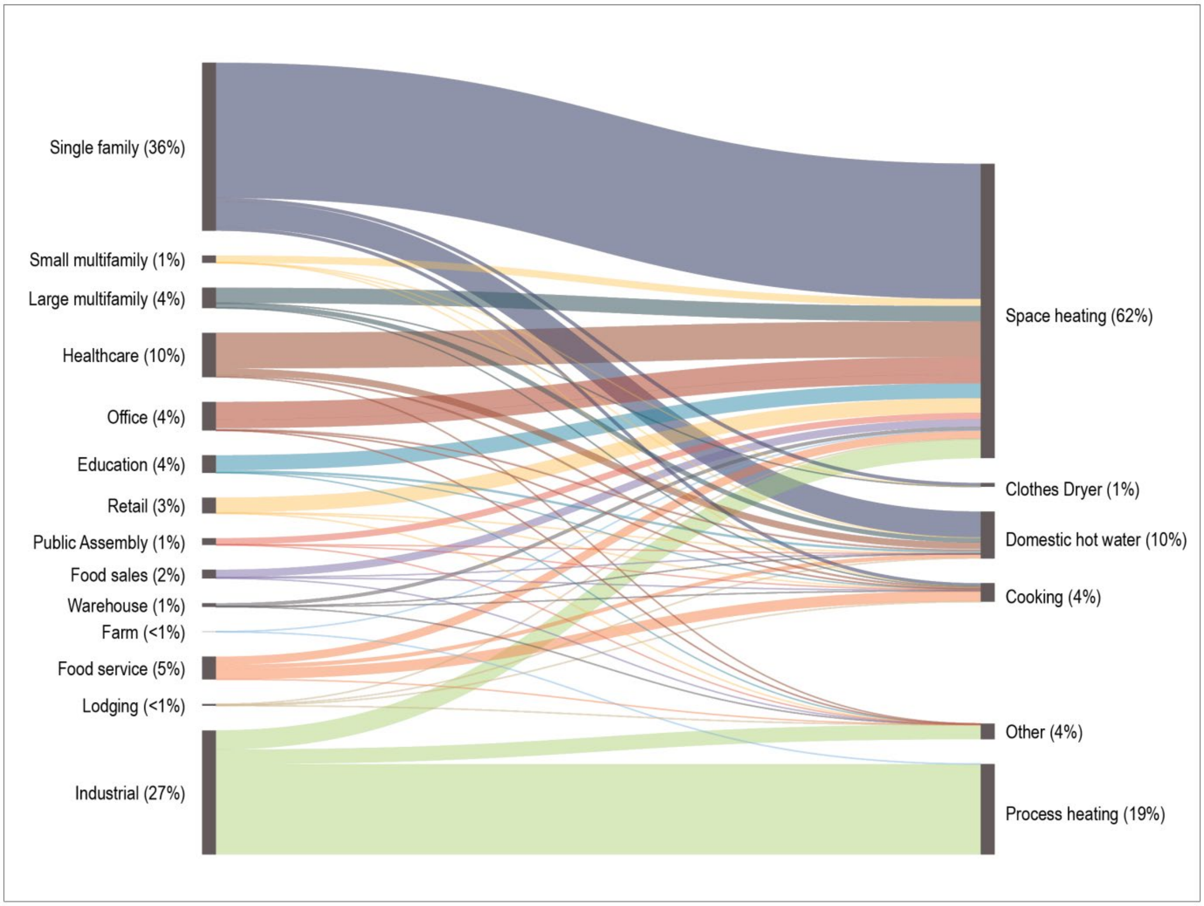


Figure 19. Statewide natural gas energy sales by sector, building type segments, and end use.



Step 2: Characterize the efficiency measures

The study team undertook an extensive investigation of measures to include for the study, described in Appendix C. Based on this review, a total of 303 measures were selected for inclusion in the study (Table 5); of these, 69 were gas-only technologies, 181 were electric-only, and 53 saved both gas and electricity. No fuel-switching measures were included. Each technology or practice was then analyzed individually by four market approaches as applicable (i.e., retrofit, replacement, renovation or new construction, as discussed below) and by the 16 individual building segments. In some cases, separate tiers of efficiency levels of a given technology were also analyzed as separate measures (e.g., "Tier 1" simple programmable thermostats and "Tier 3" smart thermostats). This resulted in modelling of a total of 3,378 individual measure permutations.

Table 5. Source of measures selected for the study.

Source of measure	Residential	Commercial/ Industrial	Total
Conventional (MN & other state's TRMs)	84	156	240
Emerging Tech Screening	18	18	36
Behavioral Program Screening	10	7	17
Demand-Response Screening[39]	5	5	10
Total	**117**	**186**	**303**

Once the measures were selected, measure-specific assumptions were defined for each measure, including:

- Energy savings from the baseline (including any baseline shifts over the study period);
- Annual energy and electric coincident peak demand savings (adjusted for differing climate regions where applicable);
- Incremental cost;
- Future O&M and capital replacement cost impacts;
- Lifetime;
- Existing efficiency measure penetration;
- Measure load shapes; and
- Applicability to specific building types and end uses.

Measures were also characterized according to which types of markets they could apply to:

Retrofit – This refers to measures that are non-time-discretionary. In other words, customers can adopt them at any point and they are not dependent on some other market activity to happen. This includes equipment that is replaced prior to the end of its useful life, such as the early replacement of an inefficient boiler with a more efficient version before the boiler fails or requires extensive repairs. It also includes new measure adoptions where the measure had not been there before, such as for many controls and building envelope measures. For most early replacement measures, the incremental cost reflects the entire equipment and labor cost of the retrofit, and the initial baseline energy usage is the existing measure or usage, which is often below current code and standard market practices.[40]

Replacement– This includes measures that are time dependent, including replace-on-failure or end-of-life, such as a boiler that is at the end of its useful life and is replaced with a more efficient version. Significantly, the incremental cost for replacement measures is the difference between a new inefficient baseline version and the efficient version. Likewise, the baseline for calculating energy savings is not the equipment that was replaced, but the inefficient, new version of the equipment, which is often set by current code or standards, or based on typical market practice. Also significant is that replacement, like new construction and renovation, are time-sensitive opportunities that can only be captured at the time of some other natural market event or investment. As a result, the magnitude of eligible opportunities is

[39] Per current CIP policy, demand-response measures were only included if they also had energy consumption savings.

[40] A baseline shift was generally applied at the point where it was expected that the average existing equipment would naturally be replaced with code level equipment.

more limited than with retrofit measures, and successfully intervening in the market at the appropriate time can be challenging.

New construction & renovation – This includes measures that are installed in new buildings, or those undergoing major renovation, that are above the applicable energy code. This can include, for example, a high-efficiency furnace. The baseline energy use is typically the currently applicable standard or code for the measure.

Step 3: Screen measures for cost-effectiveness

Measures were screened for cost-effectiveness using the societal cost-effectiveness test (SCT), which is the primary test used by the Department for assessing proposed utility programs (see discussion in Chapter 2). The SCT considers the full incremental cost of each measure, whether it is the utility or participant that pays for that cost. For behavioral measures, the estimated cost of running the program was used for screening the measures, since often the measure itself is zero cost. Note that for screening purposes, program administration costs are not included in the initial cost-effectiveness screening. This is because adding or deleting a single measure rarely has a substantial impact on administrative, EM&V, or other non-measure costs.

There are four primary sources of benefits from the measures: avoided energy costs, avoided generation, transmission and distribution capacity costs, and a monetized value for emissions reduction benefits. Shifts in capital replacement cycles were also quantified. The project team attempted to use avoided cost assumptions consistent with existing Department guidance and policy where possible. For example, one of the main assumptions was the use of the current Department-approved societal discount rate of 2.55%, which is the rate used to discount the future value of CIP energy savings and other benefits. Additional assumptions and details of the approach can be found in Appendix A.

Avoided energy costs

For electric utility systems, the value that efficiency brings in reducing energy usage varies with the time period (both the time of day and the season of the year) that the energy reduction occurs. It is generally more valuable to reduce energy during times of high-energy usage than at other times because utilities must draw on increasingly more expensive generation resources to meet the higher demand.

Therefore, the study's model separated avoided energy costs into six time periods, developed from hourly avoided energy costs from selected IOUs. The load shape curves for each measure were used to estimate energy savings during each period, and for peak demand impacts. The model used utility-specific avoided costs for all the IOUs. For the municipal utility regions the model used a weighted average of Southern Minnesota Municipal Power Agency's (SMMPA) and Central Minnesota Municipal Power Agency's (CMMPA) avoided cost data. For the cooperative utility regions the analysis used avoided costs provided by GRE. The time period definitions are shown below in Table 6, along with the average prices in those periods for the start of the study period for SMPPA; the only utility that provided non-trade-secret pricing data (from MISO). Appendix A provides more detail on the approach used to develop the costs for each region.

Table 6. Avoided cost period definitions and average costs for Southern Minnesota Municipal Power Agency (2020 projections).

Period	Period definition	% of total hours for year	Avg price in 2020 ($/MWh)
Summer on-peak	Jun-Aug: weekdays 9 a.m. – 10 p.m.	10%	$30
Summer off-peak	Jun-Aug: weekdays 10 p.m. – 9 a.m.	8%	$17
Winter on-peak	Nov-Mar: weekdays 8 a.m. – 10 p.m.	17%	$26
Winter off-peak	Nov-Mar: weekdays 10 p.m. – 8 a.m.	12%	$19
Shoulder on-peak	Apr-May & Sep-Oct: Weekdays 7 a.m. – 11 p.m. + All weekend days 9 a.m. – 11 p.m.	33%	$27
Shoulder off-peak	Apr-May & Sep-Oct: Weekdays 11 p.m. – 7 a.m. + All weekend days 11 p.m. – 9 a.m.	20%	$16

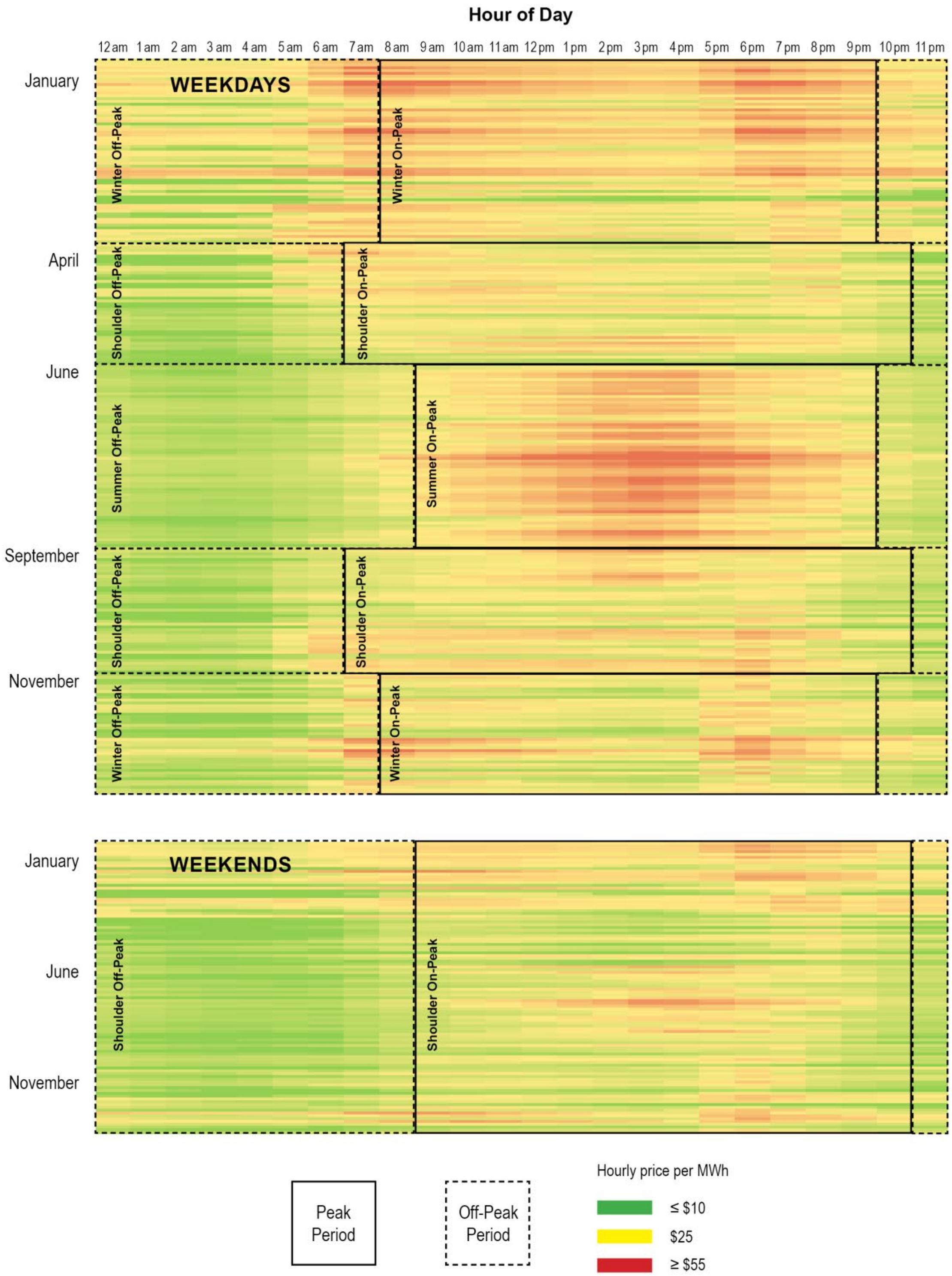
Figure 20 shows these periods superimposed on the (8760) hourly energy prices, for one year of one of the data sets used for the analysis.[41] The boxed areas in the figure represent the peak and off-peak times (summer, winter, and shoulder).

While Minnesota is primarily a summer peaking state (experiencing the highest hourly costs in summer months), northern parts of the state can be winter peaking, and other parts of the state can be close to being winter peaking, due to the high prevalence of electric space heating in some parts of the state. Although SMMPA is in the southern part of the state, you can a prominent price spike in the winter, as shown in Figure 20; although the peak hours are different compared to summer. Winter peaking occurs early the morning, and later in the evening, compared to summer peak periods primarily in the mid-afternoon.[42] Thus, the study's model attempts to capture the price differentials in the summer as well as winter peaks.

[41] Data set received from SMMPA, based on MISO projections of 2020 energy costs.

[42] The difference in hours between winter peaking and summer peaking demonstrated in Figure 20 is perhaps due to the primarily residential nature of winter peaking, compared to the higher commercial A/C load that play a greater role in driving the peak summer periods.

Figure 20. Hourly projected 2020 avoided electricity costs for Southern Minnesota Municipal Power Agency, overlaid with the peak and off-peak periods used for modeling.



For natural gas utilities, the project team used the Department-approved avoided energy and capacity costs for all utilities and regions.[43] The team escalated the avoided commodity costs by the Energy Information Administration's 2017 Annual Energy Outlook estimates of future wholesale natural gas commodity price increases. The 2020 estimated avoided commodity cost for gas is $4.85/Dth.

While avoided gas costs also vary by time period like electricity, the project team analyzed the recent daily commodity price changes and determined that applying daily or period specific costs and impacts at the measure level would yield very little difference in benefits in Minnesota. This likely reflects ample pipeline supply and storage facilities in Minnesota. Therefore, all measures and programs are screened based on annual average costs, consistent with current Department guidance.

Avoided generation capacity costs

For electric utilities, capacity avoided by energy efficiency has traditionally been based on the projected cost to build a new natural gas simple-cycle combustion turbine (CT) generation facility. The project team received utility-specific estimates of this cost from several utilities and used a single weighted-average capacity value of $61.50/kW-yr (2018$). This is based on the assumption that the cost to build a new CT will not likely vary significantly depending on which utility retains ownership, and that utilities can have wholesale transactions between them. Note that since this is a statewide study, the study's model implicitly assumes that there is an avoided capacity value for all the utilities included in this analysis, even though some individual utilities may not need to add capacity for the next decade or more.

Avoided transmission and distribution capacity costs

For the IOU electric utilities, the project team used utility-specific transmission and distribution (T&D), based on constant valuation costs from the most recent Department decision that establishes a consistent methodology statewide for T&D avoided cost estimation.[44] The team used a weighted average of the three IOUs results to represent the northern and southern municipal and cooperative utility models.

While the Department decision for gas utility avoided costs also quantifies peak avoided transmission (pipeline) capacity costs, the Department-approved methodology bundles the capacity costs into the commodity charge based on typical load shapes. The project team also included an additional local distribution system capacity costs based on the Department-approved values for CenterPoint and Minnesota Energy Resources, bundled into a single composite commodity charge.[45] The study, therefore, did not separately estimated gas peak-day impacts and benefits. The total T&D 2020 capacity cost translates into an annual average value of $1.29/Dth (2018$).

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[43] MN EDocket No. G999/CIP-16-36. The project team also relied on this decision for some additional global assumptions, such as inflation and discount rates.

[44] Minnesota Department of Commerce, Decision in Docket No. E999/CIP-16-541, September 29, 2017. Note that while the Decision calls for use of the discrete choice T&D cost estimations for the current 2017-2019 plan, the project team deemed these less appropriate than the constant valuation estimations for a longer term potential study.

[45] Both CenterPoint Energy and Minnesota Energy Resources provided identical distribution capacity cost estimates, so they were applied statewide.

Avoided emissions

The benefits of cleaner air because of avoided criteria pollutants[46] and carbon dioxide (CO_2) have long been included as a benefit in CIP. The project team updated the values used for these pollutants based on the latest MPUC ruling on externalities in the power generation sector, per guidance from the Department. Although not currently in the most recent Department guidance document, the Department expects to include these values in a future version of its guidance document.[47] These are the same values that are applied in Integrated Resource Planning proceedings before the MPUC.[48] The study's model used a single state-wide value[49] for calculating the emissions intensity in lbs/MWh, which resulted in a total value of $17.65/MWh for electric, and $1.84/Dth for gas (2018$). Of the total emissions factor, CO_2 represents 74% of the total impact for electric, and 84% of the impact for gas.

While emissions rates for electric can be expected to decline over the study period as the grid becomes increasingly powered by renewables, the project team did not attempt to model this in this study. The model could not easily accommodate this, and the team did not have good data on projected statewide emissions declines over the study period. Based on existing filed Integrated Resource Plans, the statewide CO_2 emissions rate is expected to decrease 12% from 2020 to 2029.[50]

Other than avoided emissions benefits, no other non-energy benefits were included in the modeling, even though water benefits and benefits from reduced maintenance are allowable under current CIP guidance, and used by some utilities in their calculation of net benefits.

Step 4: Estimate program budgets and measure penetrations

The project team defined two achievable scenarios — a "maximum achievable" scenario and a constrained "program potential" assuming 50% of the measure costs on average are covered by programs, with a 50% customer contribution. The maximum achievable scenario assumes that 100% of the incremental measure cost was covered by programs with no customer contribution. While in theory a program could provide even larger financial incentives, this is unlikely for numerous policy reasons and it is common practice to assume 100% cost coverage for maximum achievable potential scenarios. In practice, there are many reasons why rebating 100% of the measure cost may not be desirable, so the project team also analyzed a scenario that assumes 50% of the measure costs are covered by the program, which is more consistent with current Minnesota program planning.

For all achievable scenarios, the study did not model specific, detailed program designs. Rather, measures were bundled into appropriate broad program markets, which collectively cover all efficiency

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[46] Criterial pollutants in include sulfur dioxide (SO_2), particular matter less than 2.5 microns ($PM_{2.5}$), carbon monoxide (CO), oxides of nitrogen (NO_x), and lead (Pb).

[47] The last guidance document, for natural gas utilities, was released in 2016. Docket No. G999/CIP-16-36, "In the matter of Inputs to BENCOST for Natural Gas 2017-2019, Conservation Improvement Program," February 19, 2016.

[48] MPUC Docket No. 15-21, Xcel Energy 2015 Integrated Resource Planning Docket.

[49] MPUC Docket No. 14-643, Order Updating Environmental Cost Values. https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={5066BD60-0000-C71B-9B5B-305CF65BCAE1}&documentTitle=20181-138585-01.

[50] See Table 19 for projected statewide emissions rates, and footnote 61 for description of how this was calculated.

opportunities and do not include any double counting. For example, the study distinguished between new and existing buildings, between retrofit and market driven opportunities, and by particular market segments. The project team assumed well designed, marketed, and implemented programs, with optimal administrative and delivery frameworks to support success. The team recognizes that this implicitly assumes some coordination, or more likely, jointly delivered efforts spanning across utility territories and fuels to provide consistent market messages and benefits from appropriate economies of scale.[51]

In addition to financial incentives, there are administrative, marketing, technical support, and other costs to running programs. The project team estimated program budgets based on benchmarking typical ratios of measure-related to non-measure-related spending by Minnesota and other utilities.

The study's model projected annual penetration rates for each measure based on a market adoption model, which requires measure-specific awareness and willingness-to-adopt factors as inputs. The determination of individual measure awareness, willingness, and overall market penetration potential was informed by a review of Minnesota — and other national programs, other program literature and evaluations, and the levels of financial and non-financial barriers associated with each measure. The implicit participant cost-benefit is another factor used in the adoption model (e.g., the more cost-effective to the participant, the higher market adoption). This is discussed further in Appendix A.

Step 5: Calculate total savings and net benefits

The model applies all the inputs developed as discussed above (and in more detail in Appendix A), and performs year-by-year calculations to roll up all impacts, costs, and benefits; applying the appropriate penetrations to each set of measure and load inputs for all 3,278 measures. The model accounts for the rolling impact over time of building and equipment stock and associated load adjustments based on prior measures assumed to be adopted. It also accounts for measure interaction and mutual exclusivity with other measures.

[51] For example, the project team implicitly assumed that a small muni still has the maximum achievable because it could contract to deliver programs through third parties, or aggregate its programs with other smaller utilities to achieve scale.

Table 7. Summary of major data sources used for each step of potential study.

	1. Forecast sales & disaggregate energy load	2. Characterize the energy efficiency measures	3. Screen for cost-effectiveness	4. Estimate program budgets and measure penetrations
Utility-provided load forecasts from the IOUs and several municipal and cooperative utility aggregators	•			
Primary data collected for this study	•	•		•
Other available Minnesota studies, such as CARD-funded energy-use characterization studies	•	•		
Other available studies from outside Minnesota, with a preference for those in neighboring states	•	•		
U.S. Department of Energy, Energy Information Agency data on 2016 utility load	•			
Sales data by customer type reported by utilities to the State of Minnesota	•			
American Community Survey and other U.S. Census data for Minnesota	•			
Commercial Building Energy Consumption Survey (2015) (CBECS) for the Northern Midwest region, U.S. Energy Information Agency	•	•		
Residential Energy Consumption Survey (2015) (RECS) for the Northern Midwest region, U.S. Energy Information	•	•		
Manufacturing Energy Consumption Survey (2015) (MECS) U.S. Energy Information Agency	•			
Minnesota Technical Reference Manual, version 2.0		•		
Current and likely future codes & standards		•		•
Baseline and appliance saturation surveys		•		•
Utility-specific assumptions found in utility Triennial CIP plans		•		•
Utility-specific program evaluations or other data sources		•		•
Weather data		•		
Engineering analyses		•		
Utility-specific avoided energy costs for each hour of the year (if available)			•	
Department of Commerce assumptions for cost-effectiveness screening			•	
Utility-provided avoided capacity costs			•	
Historical CIP information on program achievements and budgets				•

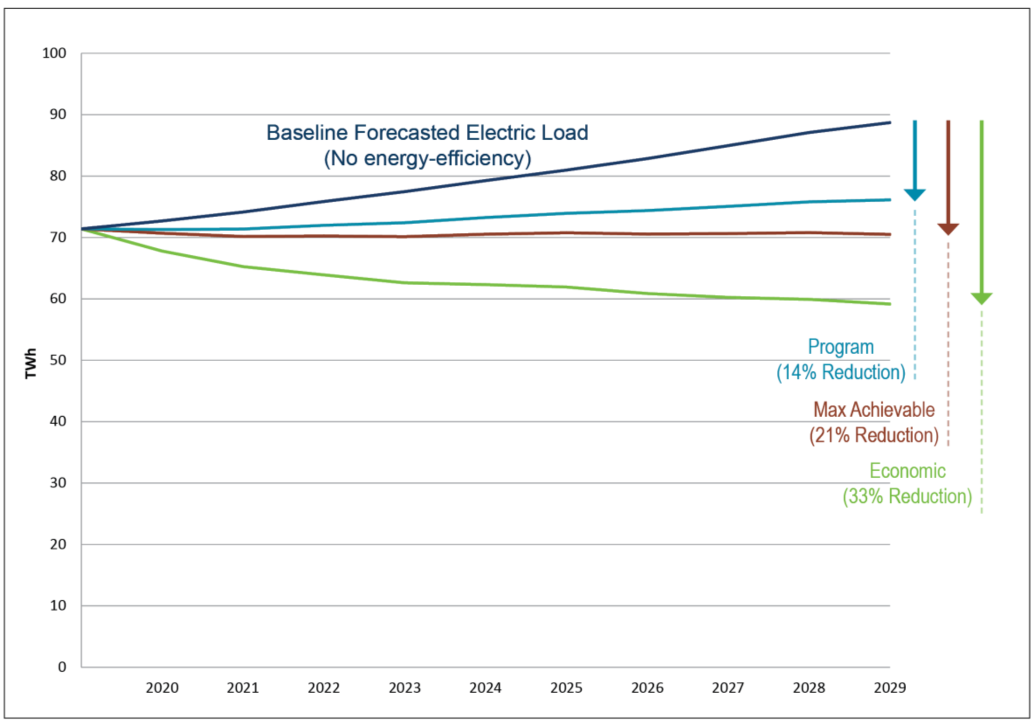
Chapter 4: Results

Below, modeling results are provided with a focus on the program potential.[52] Detailed results for each of the geographic regions modeled for the study are available in Appendix B.

Electric potential

Statewide, the study estimates that the state could economically decrease forecasted electric load by 33%, with program potential to reduce load by 14% in 2029 (Figure 21). In other words, the modeling suggests that the program scenario will be able to capture just under half of the total economic potential.

Figure 21. Cumulative annual electric energy savings potential compared to forecasted load for economic, max achievable, and program scenarios.



[52] Note that the project team does not present technical potential here, as it is more of a stepping stone to economic potential and not meaningful to readers in and of itself — as discussed in the methodology chapter, the *true* technical potential (not modeled here) would include wildly uneconomic measures that would result in a technical potential of saving energy that would approach 100%. In contrast, the model only included measures that had a possibility of being economic measures.

The incremental annual program savings ranges from around 1.5% in the initial part of the decade, leveling off at around 1.9% near the end of the decade, with maximum achievable potential in the range of 2.0% to 2.9% (Table 8).[53] There is a slight dip in achievements in 2022 because of the elimination of lighting savings due to lighting standards that go into effect in 2021,[54] which then rises as non-lighting measures start to take hold after 2022. Since the model assumed equal program success across utility territories, there is very little difference in potential between the IOUs and COUs, with the slight difference due to differences in their overall customer mix.

Note that the total of the incremental annual savings for 2020-2029 in Table 8 does not add up to the cumulative annual potential shown in Figure 21. This is because not all measures installed during that period have a lifetime that extends to 2029 (for example, behavioral measures have a one-year lifetime in the model), resulting in some measures not contributing to the cumulative efficiency potential in that year.

Table 8. Incremental annual electric energy savings from maximum achievable and program scenarios as a percentage of total sales.

	Investor-Owned Utilities		Cooperative Utilities		Municipal Utilities	
Year	Max achievable	Program	Max achievable	Program	Max achievable	Program
2020	2.6%	1.8%	2.4%	1.7%	2.4%	1.7%
2021	2.9%	2.0%	2.7%	1.9%	2.7%	1.9%
2022	2.4%	1.6%	2.0%	1.4%	2.3%	1.5%
2023	2.6%	1.8%	2.3%	1.6%	2.4%	1.7%
2024	2.8%	1.9%	2.4%	1.7%	2.5%	1.8%
2025	2.8%	1.9%	2.5%	1.7%	2.5%	1.8%
2026	2.8%	2.0%	2.4%	1.7%	2.6%	1.8%
2027	2.9%	2.0%	2.4%	1.7%	2.5%	1.8%
2028	2.9%	2.0%	2.4%	1.7%	2.5%	1.7%
2029	2.8%	1.9%	2.4%	1.7%	2.5%	1.7%
10-year average	**2.7%**	**1.9%**	**2.4%**	**1.7%**	**2.5%**	**1.7%**

[53] Consistent with how behavioral savings are counted by utilities now, the "average savings methodology" was applied to (only) residential behavioral measures. (For full discussion of this issue, see pg. 81-94, "Energy Efficiency Behavioral Programs: Literature Review, Benchmarking Analysis, and Evaluation Guidelines," Illume, et. al, a CARD project. Available at: http://mn.gov/commerce-stat/pdfs/card-report-energy-efficiency-behavorial-prog.pdf). The application of the average savings method lowered incremental potential about 10% a year. For comparison, the 10-year incremental average for the program scenario, without applying the average savings method, would be 2.0% for IOUs, 2.0% for cooperative utilities, and 1.9% for municipal utilities; for the maximum achievable scenario, savings would be 3.0% for IOUs, 2.8% for cooperative utilities, and 2.7% for municipal utilities.

[54] This is the EISA (Energy Independence and Security Act of 2007) standards. There is still some debate as to how much and how soon this would impact energy-efficiency programs, with some utilities planning for a more gradual phase-out, but the project team conservatively assumed no savings from screw-in bulbs after 2021 in this study's modeling.

Table 9. Incremental annual electric energy savings in gigawatt-hours from maximum achievable and program scenarios.

	Investor-Owned Utilities		Cooperative Utilities		Municipal Utilities	
Year	Max achievable	Program	Max achievable	Program	Max achievable	Program
2020	1,050	720	470	330	300	210
2021	1,190	820	550	390	360	250
2022	1,000	690	420	290	300	210
2023	1,100	750	480	340	330	230
2024	1,200	830	530	380	360	250
2025	1,230	850	560	390	370	260
2026	1,270	870	560	400	380	270
2027	1,320	910	580	410	390	270
2028	1,360	940	590	420	400	280
2029	1,300	890	600	420	410	280

Within the residential sector, the space heating end use is responsible for nearly 40% of residential cumulative savings at the end of the study period, while lighting declines to a small fraction of total savings (Figure 22). Although only 17% of residential customers have electric space heating, these customers use substantial amounts of energy to heat their homes, and there is a large opportunity for energy savings in these homes. The single-largest measures driving these savings are air source heat pumps (Figure 23).[55] Appliances are the next largest end use, in total (with space heating) accounting for over half of total potential.

Within the C&I sector, lighting, refrigeration, and system energy account for approximately 60% of total cumulative program potential savings in 2029 (Figure 22). While lighting still remains the largest source of savings for the commercial and industrial sector, it declines from well over half of potential in most utilities current portfolios, to just over 20% in 2029. System energy includes whole-building measures that address multiple end uses, and includes savings from measures like integrated building design and advanced building controls.

[55] The multifamily segment makes up 18 percent of the total space heating savings, and 16 percent of the total air-source heat pump savings.

Figure 22: Cumulative annual electric energy savings by end use in 2029 as a percentage of total savings for the residential and commercial & industrial sectors (program scenario).

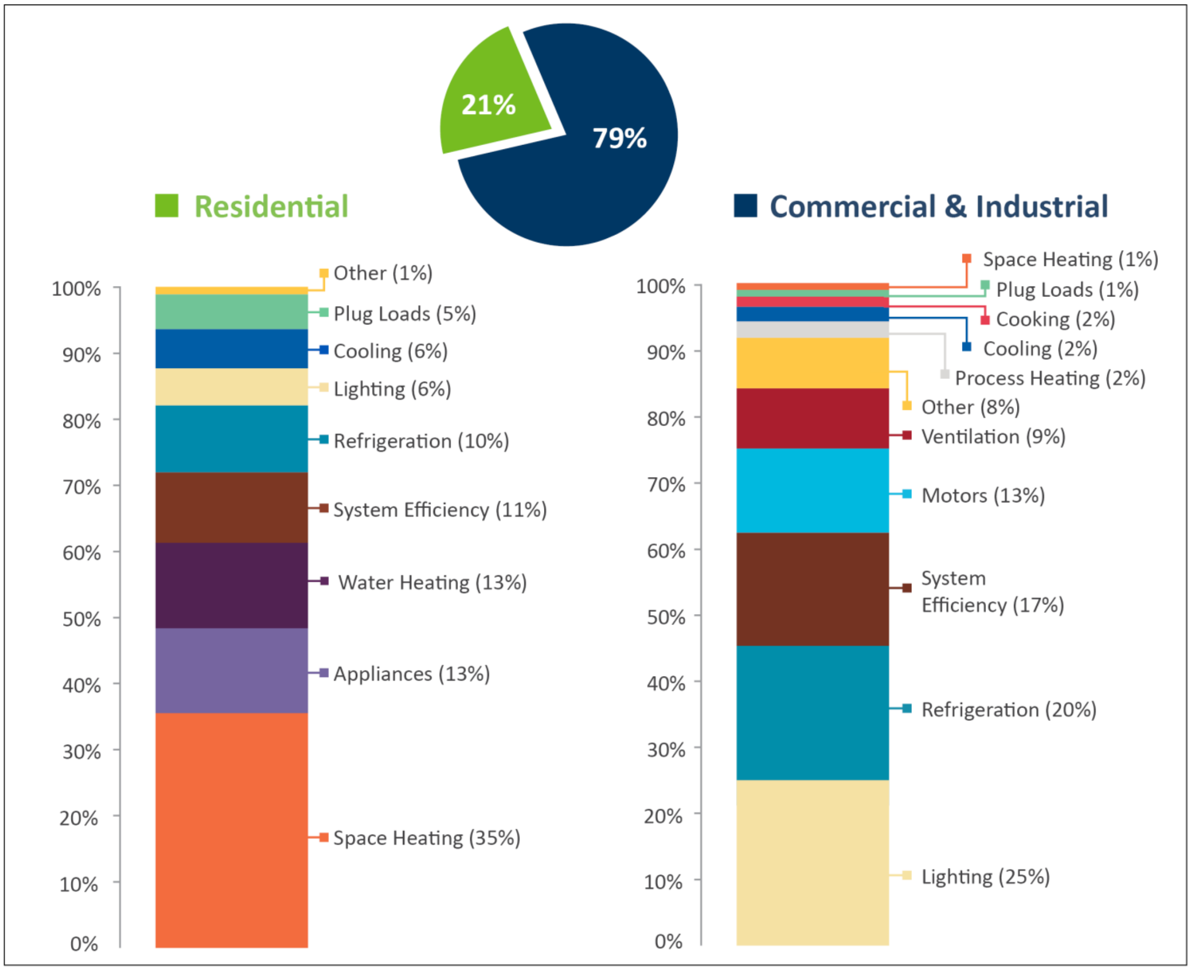


Figure 23. Breakout of measure types within residential electric space heating, 2029 cumulative annual savings, program scenario.

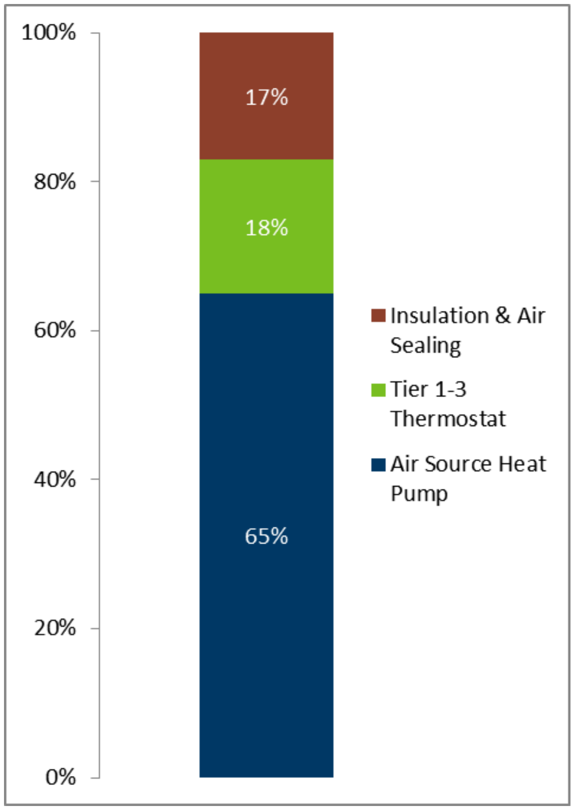


Figure 24 shows the potential organized by building type. Within the building types modeled for this study, industrial has the largest potential, followed by single-family and healthcare.

Figure 24. Cumulative annual electric energy savings in 2029 by building type segment, program scenario.

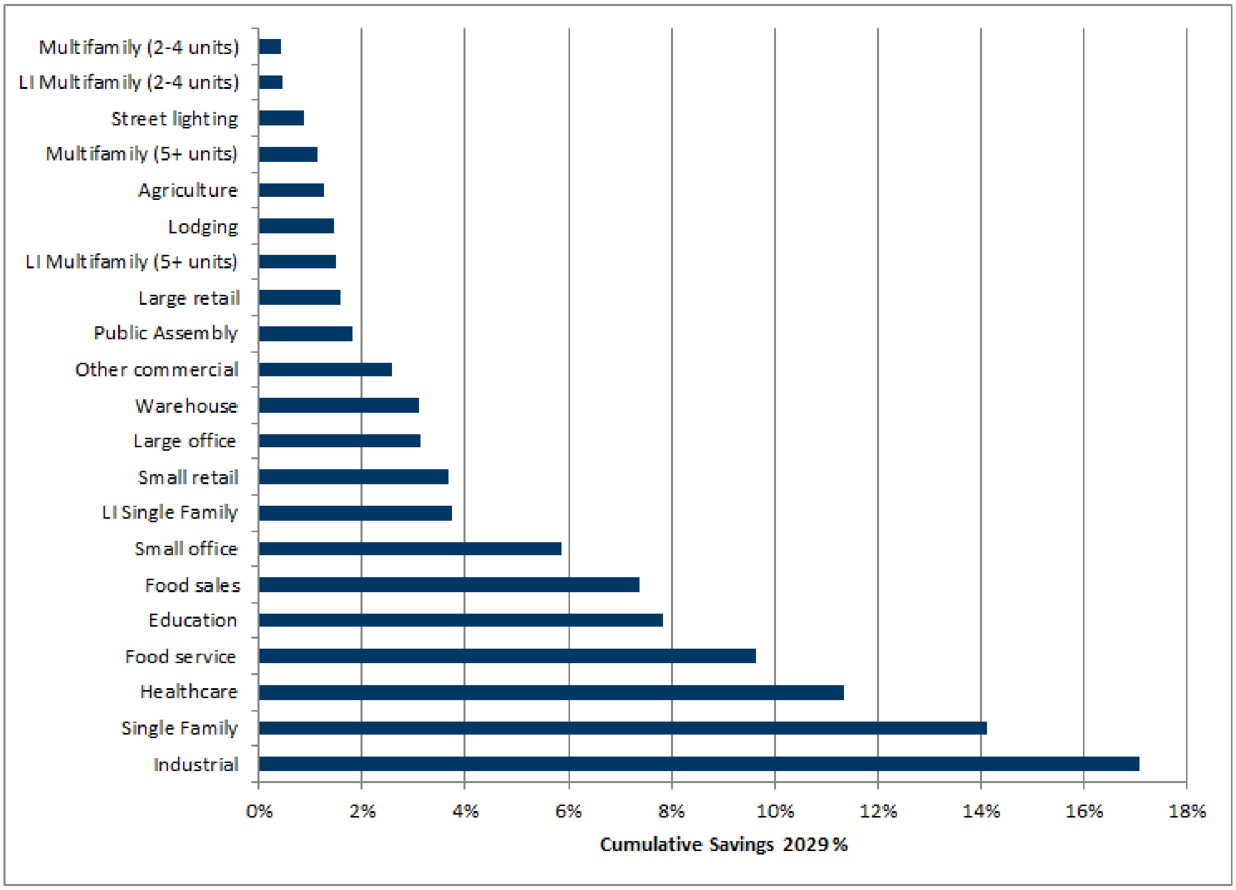


Table 10 and Table 11 present the top residential and commercial electric measures, respectively, each of which is described in the text below.

Table 10. Top residential electric measures, program scenario.

Residential measure name	Cumulative annual 2029 energy (MWh) savings	Percent of total residential energy savings potential
Cold climate ductless mini-split air source heat pump	356,000	13%
Tier 1-3 thermostat	258,000	10%
ES clothes washer	240,000	9%
Cold climate central air-source heat pump	230,000	9%
Home energy reports	227,000	9%
Fridge and freezer removal	159,000	6%
Advanced power strip	146,000	5%
Water heater insulation	142,000	6%
ES refrigerator & freezer	109,000	4%
Attic insulation & air sealing	109,000	4%

Cold climate ductless mini-split air source heat pump: This measure applies to Minnesota households that use electric resistance baseboards as their main heating source. This technology saves energy by transferring heat from outside the home to the inside via a vapor-compression cycle – the same technology used by refrigerators and air conditioners. Thus, by moving (and not creating) heat, these systems are able to produce more heat energy into the house than the energy required to run the heat pump, resulting in system efficiencies (energy output per unit of input energy, or the coefficient of performance) greater than 100%. Some of the rated efficiencies (under optimal conditions) are as high as 400% for new ASHPs. A backup heating source is typically needed for this technology when used for space heating, as their efficiencies are lowest at lower temperatures when the most heating output is needed. Recent advances in cold climate, high-efficiency versions of this technology allow useful heat energy to be extracted at temperatures of -10 degrees or lower. The project team assumes the existing electric baseboard heat remains and is used for back-up heat. Ductless mini-splits can be used for cooling as well, at efficiencies that are substantially greater than typical air conditioning systems; they have an outside unit, similar to a central air conditioner which connects to the inside with a “header” that supplies heating and cooling to a single room (Figure 26). Multiple units can be installed to heat or cool multiple, or all, rooms in a single house or apartment.

This technology is applicable to housing units that use electric baseboard. This includes most of the electrically heated multifamily units in the state, which are predominantly rental units. As typically the tenants, and not the building owner, pay the electric bills for these multifamily buildings, this creates an additional barrier (the “split incentive”) for programs promoting this technology. Thus, the adoption rates in the modeling are substantially lower for the multifamily sector than the single-family sector for this technology. As shown in Figure 25, the largest fraction of electrically heated homes is in the northwest part of the state.

Figure 25. Electric home heating percentages in Minnesota utility territories.

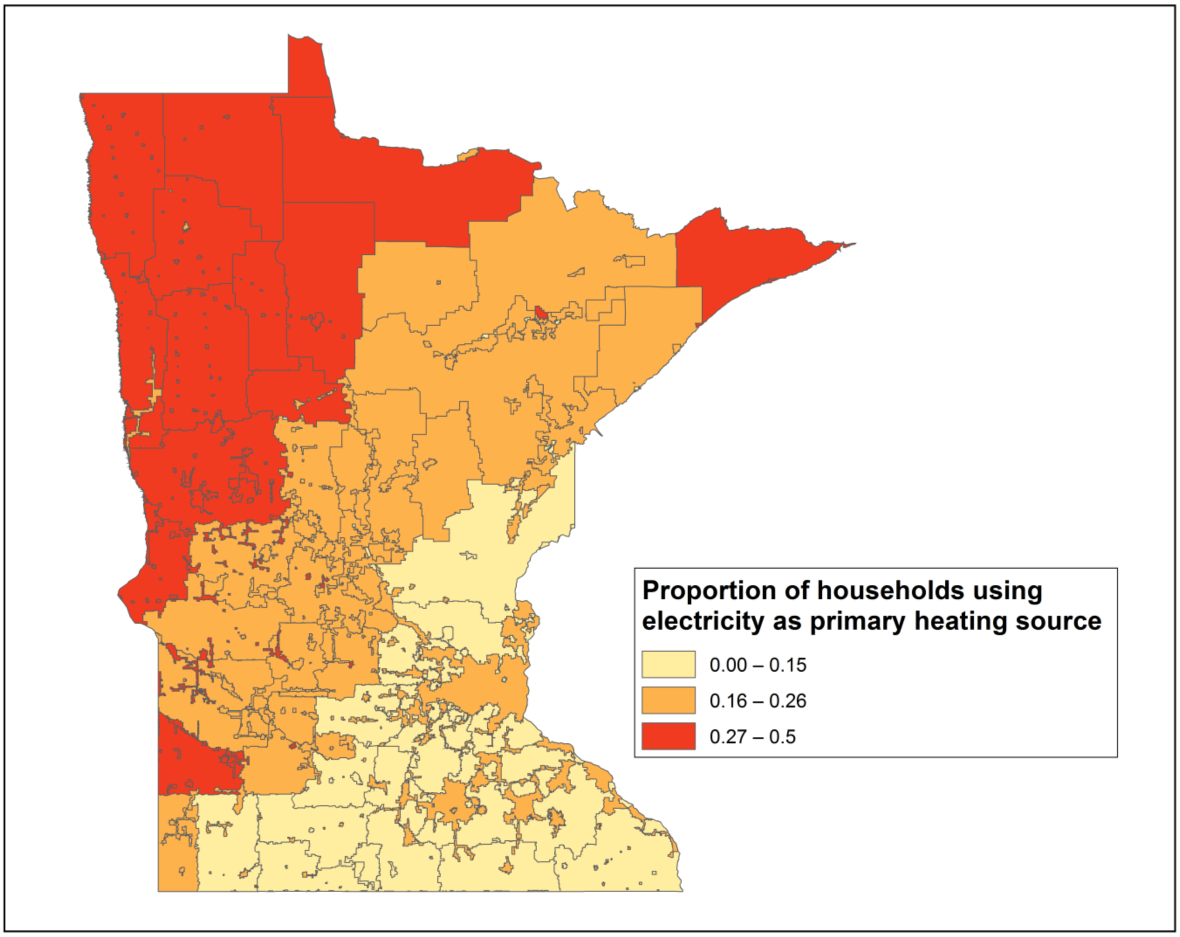
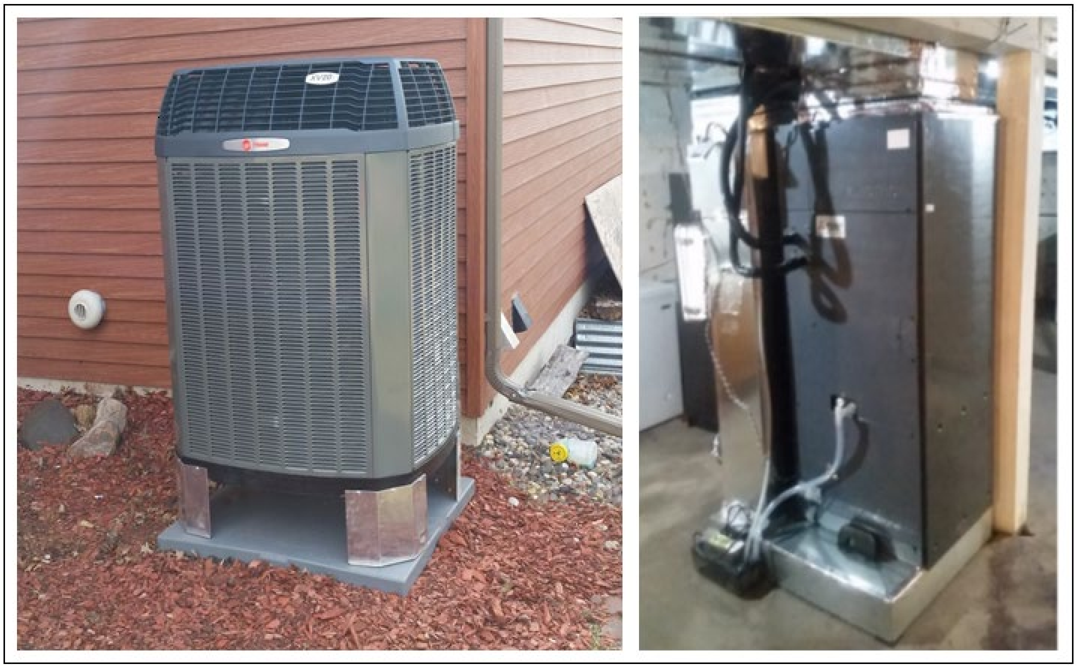


Figure 26. Example of installed cold climate ductless mini-split air-source heat pump.

Cold climate central air source heat pump: This measure is either replacing an electric furnace central heating system with an ASHP or a higher efficiency option when installing a baseline efficiency ASHP. ASHP's work similarly to a ductless mini-split heat pump system — but can heat the whole home with one system — similar to a forced air natural gas furnace (Figure 27). The home needs to have an existing duct system to implement this technology. Savings of over 50% are possible for this technology. A backup heating source is generally needed with a central air source heat pump. This technology can also efficiently cool homes as well, offering savings over typical central A/C systems.

Figure 27. Example of installed cold climate central air-source heat pump



Tier 1-3 thermostat: A tier 3 thermostat, or smart thermostat, is a Wi-Fi enabled thermostat that has analytical capabilities that 'learn' a customer's temperature preferences, can adjust temperature to weather forecasts, and adjust temperature when a person is out of the house. The customer can also save energy by scheduling temperature and setting or changing temperature while the customer is out of the home. A tier 2 thermostat is able to be controlled and scheduled through Wi-Fi devices but does not have analytical capabilities. A tier 1 thermostat is a programmable thermostat that cannot connect to the Internet.

ENERGY STAR clothes washer: An ENERGY STAR clothes washer uses less water and electricity than a baseline model. ENERGY STAR clothes washers typically have sensors to reduce water usage and increase spin times to reduce drying time.

Home energy reports: This is a behavioral measure targeting the highest 20% energy users with home energy reports. These reports describe the customer's energy usage and compare them to their 'neighbor's energy usage.' Numerous studies have shown that these reports save energy by motivating people to cut down their energy consumption through conservation or efficient product upgrades.

Fridge and freezer removal: A majority of homes in Minnesota use a secondary fridge or freezer; these units are usually older and often substantially less efficient than the home's main fridge or freezer. Thus, a large energy savings opportunity is realized when homeowners decide to retire their secondary fridge or freezer through a utility program. One concern brought up by advisory committee members with this type of program design is that participants could be 'free-riders,' meaning they were already planning to get rid of their old fridge and participated in the program because of the free recycling and rebate. Studies have shown that typical free ridership for these programs are around 50 – 70%. Utilities may need to design their programs to limit free ridership, or adjust baseline savings to account for free riders. The project team limited participation in the program scenario modeling but did not adjust baseline savings.

Attic insulation & air sealing: Adding insulation & air sealing in the attic greatly increases the efficiency of the home because the majority of heat energy lost in the home is through the attic, if poorly insulated. This measure saves both electric space heating and space cooling energy.

Advanced power strips: The advanced analytics built into the power strip achieve energy savings by powering off devices when they are not in use. For example, a cable box, television, gaming system, and a charger could all be automatically disconnected from the power source by the advanced power strip when the devices are not in use. This is achieved through electronic sensors that power down devices after a period of time. The Minnesota Technical Reference Manual shows that a tier 2 power strip has the potential to reduce plug load consumption by 30%.

Water heater insulation: This measure saves energy by installing an insulating water heater jacket over an existing electric water heater without adequate insulation. This saves energy by reducing the amount of hot water energy that is "lost" during water heater standby times

Energy Star refrigerator & freezer: Upgrading to an ENERGY STAR model refrigeration at the time of purchases can energy when compared to the federal minimum energy efficiency standard. ENERGY STAR models typically have better insulation to prevent heat loss and more efficient cooling evaporators.

Table 11: Top commercial electric measures, program scenario.

Measure name	Cumulative annual 2029 energy (MWh) savings	Percent of total commercial energy savings potential
Integrated Building Design	797,000	10%
Variable Speed Drive	789,000	10%
Improved Lighting Design	489,000	6%
Integrated Lighting Controls	482,000	6%
High-efficiency Small Walk-In	458,000	6%
Deep Energy Retrofit	318,000	4%
LED Tube Replacement Lamps	304,000	4%
Evaporator Fan Speed Controls	295,000	4%
ECM Fan Motors	292,000	4%
High-efficiency built-up refrigeration	260,000	3%

Variable speed drive: Variable speed drives are an energy efficient technology that save energy by reducing electric motor speeds to match system requirements. Variable speed drives are commonly used in HVAC and process load applications.

Integrated building design**:** Reflects comprehensive and optimized design of new buildings and large-scale renovations, addressing all end uses and interactions between them on a systems basis. Measures include improved air barrier performance, minimum IAQ performance, lighting controls, improved lighting power density, improved mechanical equipment efficiency, demand-controlled ventilation, and other measures. This measure is similar to Xcel Energy's Energy Design Assistance program.

Improved lighting design**:** Improved lighting, including switching from fluorescent to LED lighting, has historically been one of the most important utility run energy efficiency programs in terms of total energy savings. This measure includes the application of emerging lighting technology and design principles in new construction, including LEDs, daylighting, advanced lighting controls, and fixture layouts.

Integrated lighting controls: Installation of fixture integrated controls to adjust for scheduling, occupancy, varying lighting needs, daylight, and system maintenance. This saves energy by lowering the amount of time lights are on and/or the power draw of the fixture.

High-efficiency small walk-In: Refrigeration equipment for businesses such as grocery stores, convenience stores, and restaurants can account for as much as 60% of electricity consumption. This measure targets this end use with the installation of a high-efficiency small walk-in fridge or freezer, including economizers and evaporator fans (Figure 28).

Figure 28. Example of a high-efficiency commercial walk in refrigerator.

Deep energy retrofit: This is a bundle of measures that is intended to target buildings going under major renovations to add additional energy efficiency measures while the building is already undergoing significant capital improvement. These measures may include adding insulation, improving windows, adding lighting control system, or installing more efficient heating, ventilation, and air conditioning (HVAC) systems.

LED tube replacement lamps: This includes retrofits of fluorescent lamps with LED tubes. Linear fluorescent technology makes up a significant fraction of all commercial lighting energy use.

Evaporator fan speed controls: Replacement of an existing, working standard-efficiency shaded-pole evaporator fan motor in refrigerated/freezer display cases or walk-in coolers with a high-efficiency electronically commutated motor (ECM) and controls to minimize operation.

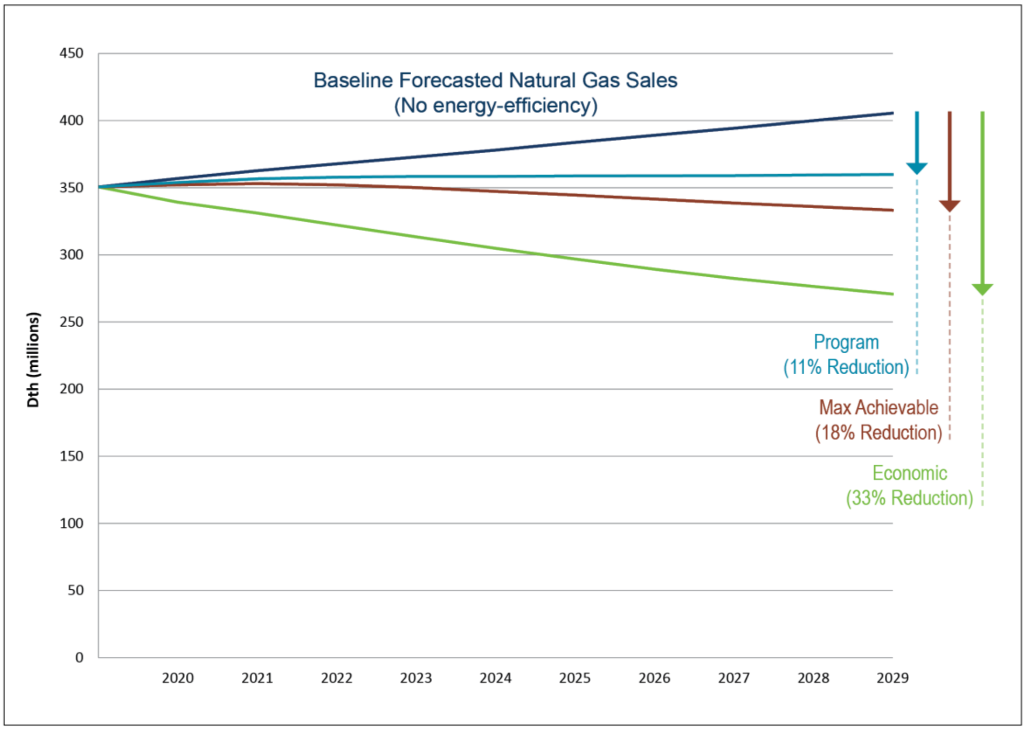
ECM fan motor: An electronically commutated motor (ECM) fan motor is applied within fan-powered terminal boxes, fan coils, and HVAC supply fans on small unitary equipment. ECM motors are more efficient than standard motors because fan speed can be adjusted according to demand (note the project team assumes ECMs are now baseline efficiency for residential furnaces).

High-efficiency built-up refrigeration: This is a bundle of measures that apply to large refrigeration systems for grocery stores and refrigerated warehouses. It includes high-efficiency compressors, better design and controls, high-efficiency motors and variable frequency drives to improve the efficiency of the entire refrigeration system.

Natural gas potential

For natural gas, the study estimates the state could economically decrease forecasted loads by 33%, with program potential to reduce load by 11% in 2029 (Figure 29). Thus, the modeling estimates that about one-third of total economic potential could be captured in the program scenario.

Figure 29. Cumulative annual natural gas energy savings potential compared to forecasted sales for economic, max achievable, and program scenarios.



The incremental annual natural gas savings increases from 0.7% in 2020, and levels off at 1.4% of annual sales around the middle of the decade for program potential (Table 12). Maximum achievable potential starts at 1.2% and increases to 2.3% of annual savings over the study period.[56]

[56] As with electric potential, and consistent with how behavioral savings are counted by utilities now, the "average savings methodology" was applied to residential behavioral measures. This lowered incremental potential about 10% a year. For comparison, without this adjustment, the un-adjusted 10-year average annual incremental savings would be 1.3 percent for the program scenario, and 2.1 percent for the maximum achievable scenario.

Table 12. Incremental annual natural gas energy savings from maximum achievable and program scenarios as a percentage of total sales.

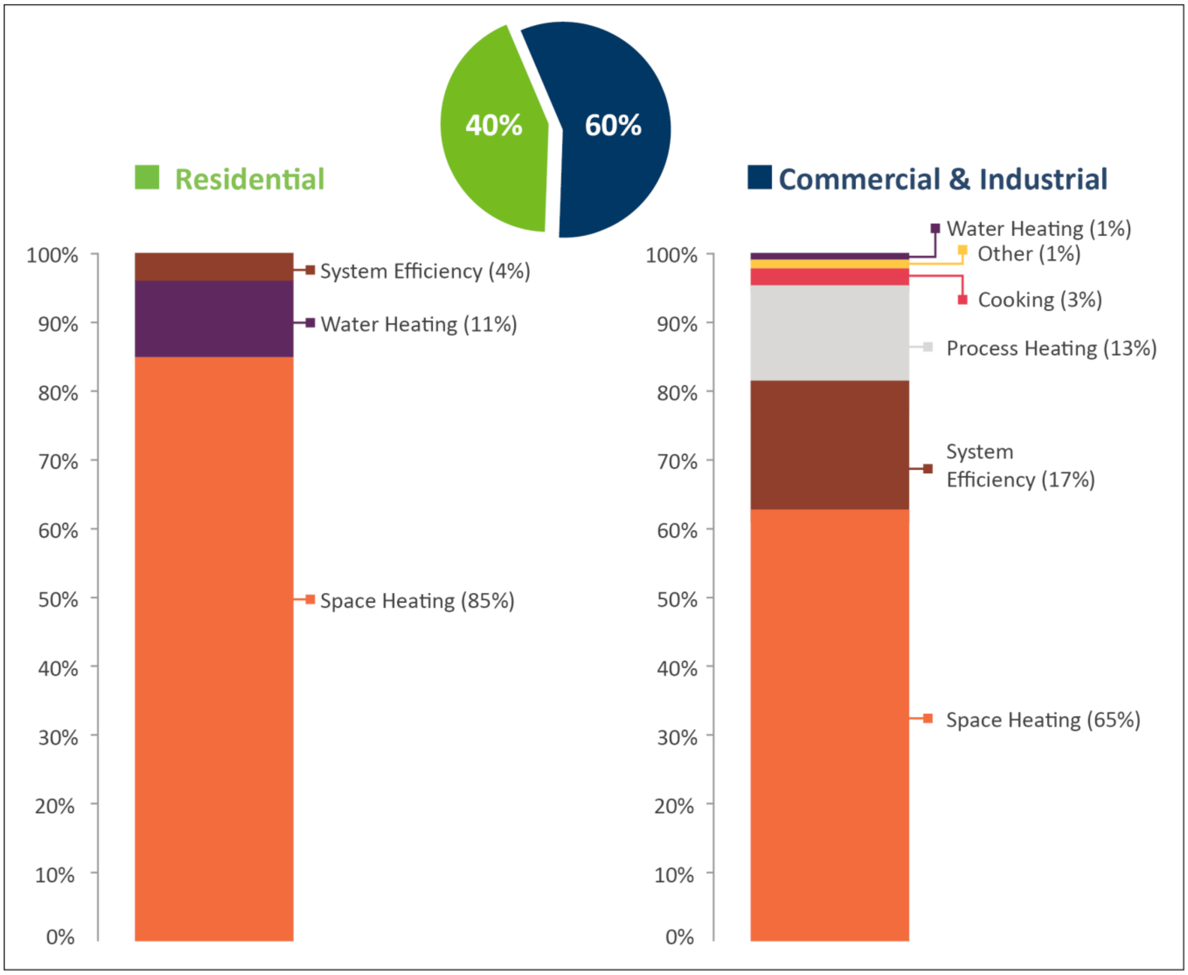
	All utilities	
Year	Max achievable	Program
2020	1.2%	0.7%
2021	1.4%	0.9%
2022	1.7%	1.1%
2023	2.0%	1.2%
2024	2.2%	1.4%
2025	2.2%	1.4%
2026	2.2%	1.4%
2027	2.3%	1.4%
2028	2.3%	1.4%
2029	2.3%	1.5%
Average	**2.0%**	**1.2%**

Table 13. Incremental annual natural gas energy savings from maximum achievable and program scenarios in thousands of dekatherms.

	All utilities	
Year	Max achievable	Program
2020	4,200	2,700
2021	5,100	3,300
2022	6,300	4,000
2023	7,300	4,600
2024	8,300	5,200
2025	8,500	5,400
2026	8,700	5,500
2027	8,900	5,600
2028	9,200	5,800
2029	9,500	5,900

Space heating dominates the end use potential for the residential as well as the commercial and industrial sectors (Figure 30). While the commercial/industrial sector still represents the majority of potential savings, the residential sector is nearly as important, representing 40% of total savings (well above the residential portion of total natural gas sales).

Figure 30. Cumulative annual natural gas energy savings by end use in 2029 as a percentage of total savings for the residential and commercial & industrial sectors (program scenario).



Reflecting the importance of the residential sector, single family represents the single largest source potential – over 30% – among the building types modeled for this study, followed by industrial and healthcare (Figure 31).[57]

[57] Note that for single family and small multifamily the study treats low-income and non-low-income separately.

Figure 31. Cumulative annual natural gas energy savings in 2029 by segment as a percentage of total natural gas energy savings, program scenario.

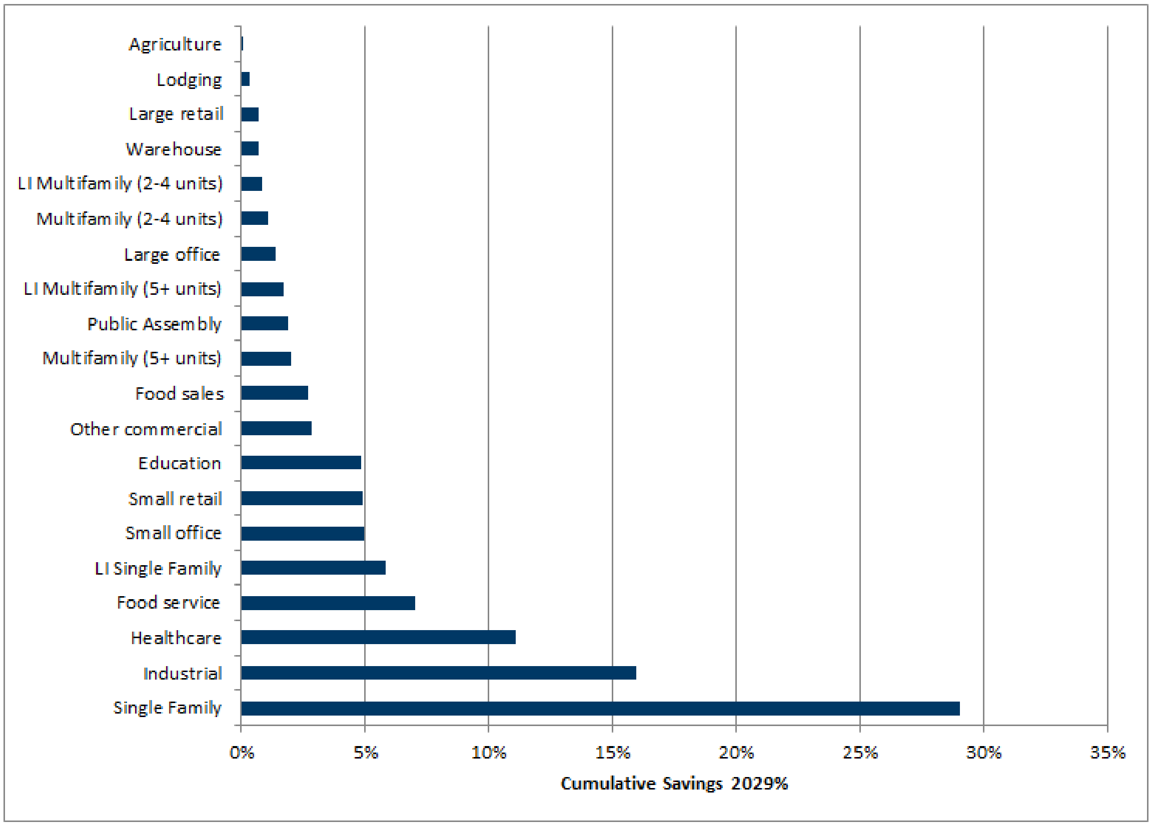


Table 14 and Table 15 present the top residential and commercial natural gas measures, respectively, each of which is described in the text below.

Table 14: Top residential natural gas measures, program scenario.

Measure Name	Cumulative 2029 energy savings (Dth, thousands)	Percent of total residential energy savings potential
Condensing furnace	5,200	28%
Tier 1-3 thermostat	4,600	25%
Attic insulation & air sealing	2,300	12%
Boiler	1,900	10%
Aerosol envelope sealing	1,100	6%
Tankless water heater	750	4%
Wall insulation	520	3%
Home energy reports	500	3%
Storage water heater	470	3%
Electronic ignition hearth	450	2%

Tier 1-3 thermostat: A tier 3 thermostat is a Wi-Fi enabled thermostat that has analytical capabilities that 'learn' a customer's temperature preferences, can adjust temp to weather forecasts, and can automatically adjust temp when one is out of the house.

Condensing furnace: This system saves energy by installing a condensing furnace instead of a non-condensing system. Condensing systems capture the latent heat of water vapor in the flue gases, increasing the overall efficiency of the heating system.

Attic insulation & air sealing: Adding insulation & air sealing in the attic greatly increases the efficiency of the home because the majority of heat energy lost in the home is through the attic, if poorly insulated. This measure saves both natural gas heating and space cooling energy.

Condensing Boiler: This measure is a more efficient hydronic boiler — it works similarly to a condensing furnace that allows more heat energy to be utilized because it condenses water vaper in the flue gases, releasing and capturing heat that would otherwise be lost.

Aerosol envelope sealing: This is a new construction/emerging technology measure where the innovative aerosol envelope sealing is used in the construction process that allows the builder to develop an air tight seal inside the house by effectively sealing many hard to reach areas (like electrical outlets) with relative ease (Figure 32). This saves energy by reducing the amount of air infiltration inside the home, thus, when the house is heating, less energy is lost through the home's envelope. This is the only emerging technology for gas savings in the list of top measures.

Figure 32. Example of aerosol sealing in a new construction application

Tankless Water Heater: An instant water heater is more efficient than storage water heaters, mainly because instant water heaters only use heat water when it is needed (Figure 33). This is more efficient than a storage water heater because there is less energy lost in the tank during standby times when hot water is not needed.

Figure 33. Example of a tankless water heater

Home energy reports: This is a behavioral measure targeting the highest 20% energy users with home energy reports. These reports describe the customer's energy usage and compares them to their 'neighbor's energy usage.' Numerous studies have shown that these reports save energy by motivating people to cut down their energy consumption through conservation or efficient product upgrades.

Storage gas water heater: A more efficient storage water heater is able to save some gas energy by having better insulation, heat traps, and an efficient combustion system to use gas more efficiently than a baseline model.

Wall insulation: This measure involves filling wall cavities with insulation in older homes with little or no wall insulation.

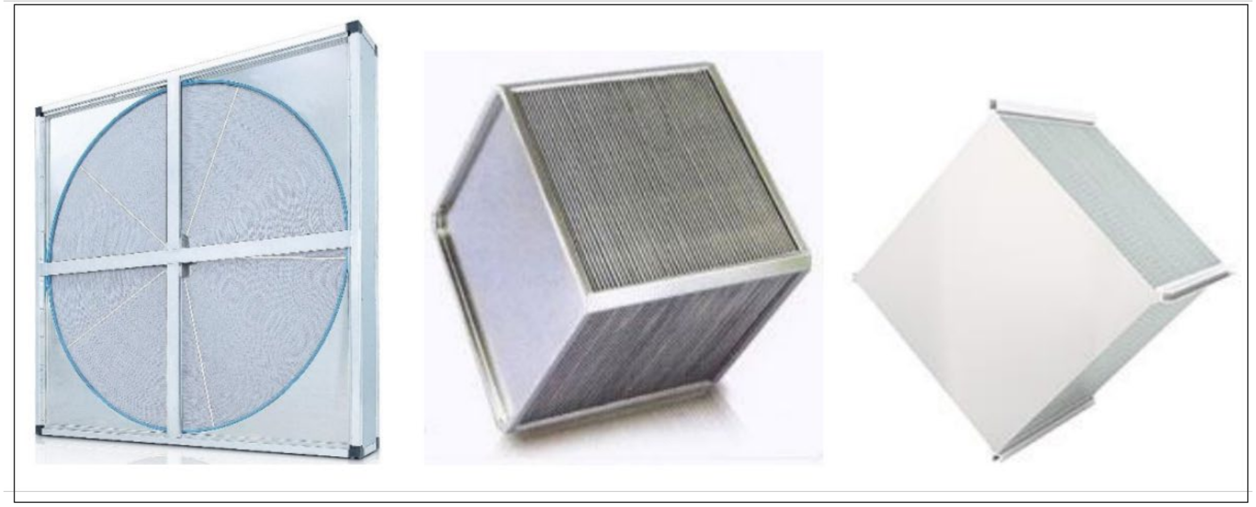
Electronic ignition hearth: This measure includes replacement of an existing hearth/artificial fireplace using a standing pilot with a unit using electronic ignition. This ensures that the pilot light is on only when the fireplace is on, compared to the standard pilot light that is on all the time.

Table 15: Top commercial natural gas measures, program scenario.

Measure Name	Cumulative 2029 energy savings potential (Dth, thousands)	Percent of total commercial energy savings potential
Energy recovery ventilator	3,600	16%
Demand control ventilation	2,900	13%
Boilers	2,600	12%
Condensing furnaces	2,500	11%
Smart thermostat	2,000	9%
Integrated building design	1,600	7%
Kitchen DCV	1,400	6%
Condensing RTUs	1,000	4%
Deep energy retrofit	900	4%
Commissioning	700	3%

Energy recovery ventilator: Energy recovery ventilators are able to save both heating and cooling energy when installed in commercial buildings. They save energy by preheating/precooling incoming air from outside of the building by utilizing the already heated/cooled outgoing air (Figure 34). By preheating/precooling the cold/warm air with the inside air, less energy is required to maintain an appropriate indoor temperature.

Figure 34. Example of three common types of energy recovery ventilators.



Demand control ventilation: This measure saves energy by adjusting the amount of ventilation that is required in a commercial building by analyzing the indoor air quality.

Boilers: Installing an energy efficient boiler saves a significant amount of gas that goes toward space heating or process heat. New condensing boilers are able to achieve efficiencies of over 95%, older boilers typically have efficiencies below 80% (Figure 35). Commercial boilers typically last over 20 years meaning the savings from installing condensing commercial boilers persist for a long time.

Figure 35. Example of a condensing boiler in a commercial application.

Condensing furnaces: This is a commercial version of the residential measure. Many small commercial buildings (e.g. convenience stores, restaurants, and small businesses) use residential-type furnaces for their heating needs.

Smart thermostat: A tier 3 thermostat is a Wi-Fi enabled thermostat that also has analytical capabilities that 'learn' a customer's temperature preferences, can adjust temp to weather forecasts, and adjust temp when the building is not in use. These can save significant amounts of energy by setting back the temperature when the commercial building is not in use.

Integrated building design: Reflects comprehensive, optimized design of new buildings addressing all end uses and interactions between them on a systems basis. Measures include, but are not limited to, improved air barrier performance, minimum IAQ performance, improved mechanical equipment efficiency, and demand-controlled ventilation.

Kitchen demand-control ventilation: Demand-control ventilation for kitchen applications is able to save large amounts of energy because the sensors in this technology automatically adjust fan speed in response to cooking demand in the kitchen. Typically baseline equipment runs all day at full load regardless of the need.

Condensing RTUs: Condensing roof-top units (RTUs) are an emerging technology that has the potential to reduce heating energy in many commercial applications. Condensing RTUs are similar to residential condensing heating equipment, but have much higher heating capacities and typically incorporate condensate treatment systems.

Deep energy retrofit: This applies to commercial spaces that are undergoing a substantial remodel, when major equipment is being replaced anyway, allowing deeper savings to be achieved.

Commissioning: Whole-building commissioning of new buildings ensures optimized design, installation, and operation of systems.

Program costs and net benefits

Overall, the model calculated the annual budgets for each year to range from $205 - $380 million per year for electric, and $102 - $241 million per year for gas for the program scenario (Table 16). The costs of the maximum achievable scenario are more than double the costs of the program scenario (Table 17).

Table 16. Estimated annual statewide budgets and incremental savings, program scenario.

	Electric			Natural gas		
Year	Budget (millions)	Incremental savings	Lifetime cost ($/kWh)	Budget (millions)	Incremental savings	Lifetime cost ($/Dth)
2020	$205	1.70%	$0.017	$102	0.70%	$2.70
2021	$237	2.00%	$0.017	$124	0.90%	$2.70
2022	$250	1.60%	$0.017	$150	1.10%	$2.70
2023	$282	1.70%	$0.017	$177	1.20%	$2.70
2024	$315	1.80%	$0.017	$206	1.40%	$2.80
2025	$329	1.80%	$0.017	$214	1.40%	$2.80
2026	$346	1.90%	$0.017	$220	1.40%	$2.90
2027	$363	1.90%	$0.017	$225	1.40%	$2.90
2028	$380	1.90%	$0.017	$234	1.40%	$2.90
2029	$379	1.80%	$0.017	$241	1.50%	$2.90

Table 17. Estimated annual statewide budgets and savings, maximum achievable scenario.

	Electric			Natural gas		
Year	Budget (millions)	Incremental savings	Lifetime cost ($/kWh)	Budget (millions)	Incremental savings	Lifetime cost ($/Dth)
2020	$521	2.40%	$0.020	$303	1.10%	$4.20
2021	$603	2.80%	$0.021	$370	1.40%	$4.30
2022	$643	2.20%	$0.026	$450	1.70%	$4.30
2023	$728	2.40%	$0.027	$537	1.90%	$4.40
2024	$808	2.60%	$0.027	$625	2.10%	$4.60
2025	$840	2.60%	$0.027	$651	2.10%	$4.60
2026	$875	2.60%	$0.027	$669	2.10%	$4.60
2027	$906	2.60%	$0.027	$683	2.10%	$4.60
2028	$934	2.60%	$0.027	$713	2.20%	$4.60
2029	$917	2.50%	$0.027	$734	2.20%	$4.60

The project team would note that even the program scenario budgets are significantly higher than current budgets, even for similar amounts of savings. For instance, in 2017 the statewide spending on electric energy efficiency was approximately $160 million, to achieve a savings level of 1.9%. In the model, statewide electric energy savings of 1.7% is achieved in 2020 at a cost of $205 million, which is about 20% higher than the actual spending in 2017.

For example, in 2017 Xcel Energy averaged spending of approximately 34% of measured incremental costs on rebates, whereas the project team assumes spending of 50% of incremental costs in the program scenario. The program assumption of 50% incentive costs is consistent with what Xcel Energy and other utilities use for planning purposes, even while they have historically met or exceeded their savings goals at less than their planning target. Thus, there is reason to believe that for the level of savings projected in the program scenario, utilities' actual spending could be significantly lower than projected by the model. However, that is not to say that some level of increased spending won't be necessary compared to historical levels — the modeling suggests this will be the case, with total costs per kWh and per Dth rising over the study period.

A limitation of the modeling approach is that it can only use a single discount rate for calculating both societal and utility net benefits for a given model run. Gas and electric programs are also modeled as combined programs, and thus the net benefits are also calculated as a combined value for both gas and electric. As the project team used the societal test for the economic screening, we also used the societal discount rate for calculating net utility benefits, presented in Table 18. The team notes that a forthcoming Conservation Applied Research and Development (CARD) project reviewing Minnesota cost-benefit tests has recommended that the Department change the discount rate to the utility test to the societal discount rate, and thus, according this CARD project, this project's approach is reasonable.

However, current Department guidance directs utilities to use the weighted average cost of capital (WACC) for the utility test discount rate. Therefore, the project team conducted a sensitivity analysis to calculate the net utility benefits using the WACC discount rate,[58] while still conducting economic screening using the societal test discount rate. The impact of the higher discount rate decreases cumulative 2029 utility net benefits in the program scenario from $9.0 billion to $4.0 billion (Table 18).

Table 18. Cumulative 2020-2029 net benefits for maximum achievable and program scenarios.

	Societal cost test		Utility cost test (societal discount rate)		Utility cost test (WACC rate)	
	Max achievable	Program	Max achievable	Program	Max achievable	Program
Total net benefits (millions)	$14,500	$10,100	$8,000	$9,000	$1,700	$4,000
Benefit-cost ratio	2.1	2.2	1.6	2.8	1.2	2.2

Although the study's model used the SCT as the primary screen for determining cost-effectiveness, we did examine the impact of screening measures for cost-effectiveness using the utility cost test at the higher discount rate as well. If measures were screened out that did not pass the utility cost test using the WACC, this would lower overall potential by 0% for electric and 2% for natural gas for the program scenario. For the maximum achievable scenario, eliminating measures that did not pass the utility cost test using the WACC would reduce savings more dramatically – by 21% for electric, and 32% for natural gas.

Note that the level of savings reduction reported does not imply that this entire level of savings is not achievable if measures were to be screened according to the utility cost test using the WACC as a discount rate. While the scenarios modeled only a 50% incentive (program) or a 100% incentive (maximum achievable) for all measures in a given scenario, measure incentives for individual measures could be calibrated so that they would pass the utility cost test; i.e., a portfolio could have incentives set lower than 100%, for that portion of measures that were not cost-effective at 100% incentives, and have all measures be cost-effective for both the utility cost test and the societal cost test. Savings in this case would be higher than the program level, but lower than the maximum achievable level.[59]

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[58] This study's analysis used a nominal discount rate of 7.3%, which approximates the weighted average of the IOUs reported weighted average cost of capital.

[59] As described in Chapter 2, the utility cost test only includes the cost of the incentive in the denominator, not the total cost of the measure. Thus, a given measure will increase in cost-effectiveness as the incentive is lowered. Given this fact, the technical interpretation of the results of this sensitivity are: For electric utilities, 79% of the total savings in the maximum achievable scenario is still cost-effective if screened at the measure level using the utility cost test (with the WACC as the discount rate), while 21% of the savings reported is cost-effective at a lower incentive than 100%. For gas utilities, 68% of the total savings in the maximum achievable level is cost-effective using the utility test (with the WACC as the discount rate), while 32% of the savings is cost-effective at a lower incentive than 100%. For the savings that is not cost-effective at the 100% incentive level, lowering the incentive level will to some extent also lower participation (because less people will participate the lower the incentive), and thus total savings.

The modeled program scenarios will have a substantial impact on CO_2 emissions reductions. Statewide, the study projects a cumulative annual decrease in carbon dioxide equivalent emissions (CO_2e) of 5.5 million tons from electric utilities (Table 19), and 2.8 million tons from natural gas utilities in 2029 (Table 20).

Table 19. Carbon dioxide emission reductions (tons CO_2e) from electric utility savings for maximum achievable and program scenarios.[60]

		Max achievable		Program	
Year	Emissions factor (tons CO_2e/MWh[61])	Incremental annual CO_2 decrease	Cumulative annual CO_2 decrease	Incremental annual CO_2 decrease	Cumulative annual CO_2 decrease
2020	0.494	992,500	992,500	692,500	692,500
2021	0.479	1,094,300	1,913,200	764,000	1,330,100
2022	0.479	919,000	2,683,600	637,000	1,858,200
2023	0.457	966,000	3,346,700	670,300	2,314,320
2024	0.457	1,053,500	3,990,900	733,000	2,754,600
2025	0.457	1,082,800	4,665,400	754,400	3,215,500
2026	0.439	1,073,400	5,390,800	747,900	3,718,900
2027	0.439	1,110,100	6,286,800	774,000	4,342,900
2028	0.439	1,141,400	7,158,900	795,800	4,949,700
2029	0.439	1,127,800	7,989,800	787,400	5,528,600

[60] Total avoided carbon dioxide equivalent emissions (CO_2e) over the course of the study period is a sum of the annual "Cumulative annual CO_2 decrease" column. The total emissions reduction from electric efficiency savings is 44,418,600 tons CO_2e for the max achievable scenario and 30,705,320 tons CO_2e for the program scenario.

[61] This is a statewide emissions factor, calculated for future years based on utilities' Integrated Resource Plans if available, and extrapolated for the rest of the state. Note that individual utilities' emission factors may vary considerably from this statewide average, especially in future years. The emissions factors were calculated as described for the "Existing Resource Plan" scenario in this paper: Jennifer Edwards, et.al, "Brrrrr…! The Outlook for Beneficial Electrification in Heating Dominant Climates," ACEEE Summer Study, 2018. Available at: https://www.mncee.org/MNCEE/media/PDFs/Brrrrr%E2%80%A6!-The-Outlook-for-Beneficial-Electrification-in-Heating-Dominant-Climates.pdf

Table 20. Carbon dioxide emission reductions (tons CO_2e) from natural gas utility savings for maximum achievable and program scenarios.[62]

		Max achievable		Program	
Year	Emissions factor (tons CO_2/1,000 Dth)	Incremental annual CO_2 decrease	Cumulative annual CO_2 decrease	Incremental annual CO_2 decrease	Cumulative annual CO_2 decrease
2020	60.5	287,800	287,800	180,500	180,500
2021	60.5	344,700	579,800	217,200	367,300
2022	60.5	418,000	944,600	264,200	600,600
2023	60.5	477,900	1,374,900	301,500	874,900
2024	60.5	536,700	1,867,400	337,500	1,187,500
2025	60.5	554,000	2,369,300	347,100	1,504,700
2026	60.5	568,600	2,872,200	355,000	1,822,000
2027	60.5	582,400	3,369,800	362,800	2,135,000
2028	60.5	605,800	3,866,800	376,100	2,447,200
2029	60.5	622,900	4,372,200	385,500	2,763,400

Segment analysis

The project team conducted a more detailed look at two hard-to-reach segments: low-income, small businesses, and the customers of small COU utilities. This section presents some of this study's key findings, with the full reports found in Appendices F, G, and H.

Low-income segment

For the purposes of the study, the project team defines "low-income" as households with income at or below 200% of the Federal Poverty Guideline (FPG).[63] By this definition, there are roughly half a million low-income households in Minnesota, representing almost one in four households in the state. Note that while this definition is used by the U.S. Department of Energy (DOE) Weatherization Assistance Program and a number of utility Conservation Improvement Programs (CIP), other metrics are also used, particularly for determining eligibility of multifamily properties.

The housing type mix of low-income households is fundamentally different from that of the non-low-income population in the state. While nearly nine out of ten non-low-income households resides in a

[62] Total avoided carbon dioxide equivalent emissions (CO_2e) over the course of the study period is a sum of the annual "Cumulative annual CO_2 decrease" column. The total emissions reduction from natural gas efficiency savings is 21,904,800 tons CO_2e for the max achievable scenario and 13,883,100 tons CO_2e for the program scenario.

[63] The 2018 Federal Poverty Guideline is $12,140 in annual income for the first household member, plus $4,320 for each additional member. This analysis is based on Census survey data for 2011 through 2015, and uses the FPG for each survey year.

single-family home, about a third of low-income households live in a multifamily building (Table 21). Looked at another way, only about one in five residents of a single-family home is low-income, but roughly half of apartment dwellers can be classified as such. This makes multifamily energy efficiency improvements an important consideration for programs targeting this population. This basic demographic fact is noted in a recent set of evaluation reports examining utility low-income CIP programs prepared by APPRISE, Inc., and this report examines the issue in more detail in Appendix F.[64]

Table 21. Housing mix for low-income and non-low-income households in Minnesota.

Type of home	Low-Income	Non-Low-Income
Single-family	57%	85%
Multifamily (2-4 units)	8%	3%
Multifamily (5+ units)	35%	12%
Total	**100%**	**100%**
Source: Census American Community Survey (2011-2015).		

Low-income households are also more likely to heat their home with expensive fuels such as electricity. This is partly a reflection of the fact that these households are more likely to be apartment dwellers, where electric heat is more common, but the difference between low-income and non-low-income households persists to some extent even within housing type (Table 22).

Moreover, low-income households are more likely to reside in older homes than are non-low-income households. A useful dividing line is 1980, because most homes built prior to the 1980s were not subject to energy codes and are more likely to be under-insulated or leaky.[65] More low-income households reside in pre-1980s housing stock than do non-low-income households.

Table 22. Heating fuel by housing type and household income level.

Heating fuel	Overall		Single-family		Multifamily	
	Low-Income	Non-Low-Income	Low-Income	Non-Low-Income	Low-Income	Non-Low-Income
Natural gas	55%	70%	61%	72%	48%	58%
Electricity	26%	14%	13%	10%	43%	34%
Other	19%	16%	26%	18%	9%	8%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Source: Census American Community Survey (2011-2015).						

Since low-income households have less disposable income for energy efficient upgrades, there are some aspects of low-income households, and housing stock, where there are more remaining opportunities

[64] See "Low Income CIP Evaluation Study: Summary Report," prepared by APPRISE, Inc. for the Minnesota Department of Commerce, Division of Energy Resources, December 31, 2017. Available at: http://mn.gov/commerce-stat/pdfs/card-low-income-cip-evaluation.pdf. Four additional detailed reports can be found via the CARD Research Project Search Engine (https://mn.gov/commerce/industries/energy/utilities/cip/card-grant-search/)

[65] The first energy conservation code in Minnesota came into effect in 1976.

for energy efficiency improvements than the general population. For example, the single-family survey conducted for the study revealed that the saturation of programmable thermostats in low-income households is less than that of non-low-income households (by about 14 percentage points — 56% vs. 70%). Similarly, data from the State's low-income weatherization program suggests that even after controlling for home age, low-income households have more opportunities for shell measures such as insulation and air sealing. These differences are incorporated into the modeling.

Notably, about half of the achievable electric potential for low-income customers of municipal utilities — and a third of the natural gas potential — is the multifamily segment. The APPRISE study noted that while Minnesota's investor-owned utilities have made efforts to address the low-income multifamily segment, municipal utilities largely have not done so. The analysis here suggests that there is untapped savings potential among low-income multifamily properties in municipal-utility service territories. Unsurprisingly, the models show little low-income potential in the multifamily segment for cooperative electric utilities, which tend to be dominated by single-family housing.

Space heating measures dominate the low-income savings potential for both electricity and natural gas. This is not surprising for natural gas, where most consumption is in fact for this end use. For electricity, it reflects the significant savings that can be achieved from offsetting or eliminating resistance electric heat with heat pumps, particularly opportunities for using ductless heat pumps to offset baseboard resistance electric heat in multifamily buildings.

The modeling estimates suggest that programs targeting low-income households have the potential to achieve cost-effective first-year savings of 1.4 percent of annual electric sales and 1.3 percent of natural gas utility sales for low-income households under the program scenario (Table 23 and Table 24). This represents 24 percent of the total achievable electricity savings potential in the residential sector and 21 percent of the total residential potential for natural gas.

Table 23. Statewide electric energy efficiency potential by low-income housing type.

Low-income customer segment	Projected mean annual 2020-2029 Sales (GWh)	Incremental energy efficiency potential*	
		(GWh)	% of segment sales
Single-family	4,735	68	1.4%
Small multifamily (2-4 units)	556	7	1.2%
Large multifamily (5+ units)	1,788	23	1.3%
Total	**7,080**	**98**	**1.4%**

*Mean of first-year savings potential for 2020-2029 under the 50% Incentive Scenario.

Table 24. Statewide natural gas energy efficiency potential by low-income housing type.

Low-income customer segment	Projected mean annual 2020-2029 sales (Dth, thousands)	Incremental energy-efficiency potential*	
		(Dth, thousands)	% of segment sales
Single-family	21,454	287	1.3%
Small multifamily (2-4 units)	2,638	39	1.5%
Large multifamily (5+ units)	6,410	81	1.3%
Total	**30,502**	**407**	**1.3%**

*Mean of first-year savings potential for 2020-2029 under the 50% Incentive scenario.

Small business segment

According to the U.S. Census Bureau's 2013 County Business Patterns (CBP), there are roughly 138,000 small businesses in Minnesota, accounting for 94% of all businesses in the state and employing over one million people. The majority of small businesses in Minnesota employ fewer than five people and only one-tenth employ 20 or more.

The results from the modeling suggests that programs targeting three business segments in the small commercial sector (small office, retail, and food service) have the potential to achieve cost-effective annual incremental savings of 2.6% percent annual electric utility sales for small commercial businesses (Table 25) and 2.0% of natural gas sales (Table 26). This represents 31% of the total achievable electricity savings potential in the commercial sector and 39% of the total commercial potential for natural gas.

Table 25. Statewide electric program potential by small commercial segment.

Small commercial business segment	Projected mean annual 2020-2029 sales (GWh)	Incremental achievable program potential*	
		(GWh)	% of segment sales
Office	3,831	78	2.0%
Retail	1,918	49	2.6%
Food Service	3,993	127	3.2%
Total	**9,742**	**254**	**2.6%**

*Mean of first-year savings potential for 2020-2029 under the 50% Incentive scenario.

Table 26. Statewide natural gas program potential by small commercial segment.

Small commercial business segment	Projected mean annual 2020-2029 sales (Dth, thousands)	Incremental achievable program potential*	
		(Dth, thousands)	% of segment sales
Office	10,715	230	2.2%
Retail	10,424	228	2.2%
Food Service	18,662	331	1.8%
Total	**39,801**	**788**	**2.0%**

Small consumer-owned utilities

Small consumer-owned utilities face unique opportunities and challenges in achieving energy efficiency goals. For this section, and Appendix G which is dedicated to this topic, the project team focuses on electric cooperatives with fewer than 50 customers per square mile and municipal electric utilities with fewer than 10,000 customers. This includes all but three of Minnesota's 47 electric cooperatives, and 119 of 124 municipal electric utilities in the state.[66] Combined, these utilities account for about a quarter of statewide electricity sales. Legislation enacted in 2017 exempts 18 smaller cooperatives and 51 municipal electric utilities from CIP requirements. These utilities are included in a few results reported here, but omit them from most of the analysis results.

Rural electric cooperatives

Minnesota's 44 rural electric cooperatives serve an astonishing 87% of Minnesota's land area, yet account for only 18% of electricity sales. While "rural cooperative" may bring to mind farms, most of the electricity sold by rural cooperatives is actually for homes (including farm residences) and businesses.

Nearly all homes in rural cooperative service areas are single-family structures, including about half of Minnesota's 80,000 manufactured homes. Notably, almost 30% of homes served by rural cooperatives in the northern half of the state are seasonal properties that are not typically occupied year-round. Since rural residences served by cooperatives are typically outside natural-gas service areas, residential customers of rural cooperatives are about twice as likely as the state as a whole to have electric heat or an electric water heater. Similarly, these homes also have a much higher prevalence of deliverable heating fuels such as propane. And, as might be expected, the saturation of air conditioning is lower among northern cooperatives.

Rural cooperatives have significantly fewer industrial customers and somewhat less commercial load than other utilities. On the other hand, more than 80% of the electricity used for farm operations in the

[66] Excluded electric cooperatives are: Dakota Electric, Connexus Energy and Wright-Hennepin Electric Cooperative. Excluded municipal electric utilities are Rochester, Moorhead, Shakopee, Austin and Owatonna.

state is sold through rural electric cooperatives — though the project team estimates that these sales still account for only about 11% of rural cooperative sales on average.[67]

Farm electricity consumption can be divided into various livestock operations, crop production, and irrigation. These are not uniformly distributed among rural cooperatives; some cooperatives are much heavier in some types of farms than others. For example, dairy farms account for as little as zero and as much as 60% of total farm-operation load among Minnesota's 44 rural cooperatives. The energy efficiency models take these regional differences into account.

The 44 rural electric cooperatives account for 17% of the achievable statewide electric potential under the program scenario. Only 17% of this potential is attributable to the 18 CIP-exempt rural cooperatives, while 83% is in the service areas of the 26 rural cooperatives with CIP requirements. This report confines the remainder of the discussion to rural cooperatives with CIP requirements, but relative results are substantially the same if CIP-exempt utilities are also included.

The models project an average annual achievable energy efficiency potential of 1.6% of electricity sales among the cooperatives with CIP requirements (Table 27). At the end of the 10-year analysis period (2029), the models estimate 13% savings from achievable program activity over the period — with 41% of this attributable to the Residential sector, 49% to the Commercial sector, and 10% to the Industrial sector.

Table 27. Energy efficiency for rural electric cooperatives with CIP requirement, by sector.

Sector	Projected mean annual 2020-2029 Sales (GWh)	Incremental energy efficiency potential*	
		(GWh)	% of sector sales
Residential	7,026	100.7	1.4%
Commercial	4,414	90.3	2.0%
Industrial	1,250	17.7	1.4%
Total	**12,691**	**208.8**	**1.6%**
*Mean of first-year savings potential for 2020-2029 under the program scenario.			

While nearly all agricultural potential is in the form of retrofits to existing equipment, more than a third of the estimated potential for non-farm commercial customers — and a fifth of the residential-sector potential — is estimated to be associated with new construction and/or renovation activities (a result that largely mirrors the statewide proportions for achievable potential in these markets). Since most rural areas are not seeing significant growth, this potential is mainly associated with renovation of existing homes and businesses.

Residential customers of rural cooperatives overwhelmingly live in single-family homes, so it is no surprise that 95% of the achievable potential in this sector lies within this housing type. Offsetting electric resistance heat with central and ductless heat pump dominates the measures in the residential sector, accounting for a third of the estimated achievable potential in 2029.

[67] "Farm" sales reported by utilities are considerably higher, because these generally include farm residences, which are accounted for separately here.

In the commercial sector, achievable potential is more evenly distributed among businesses, though unsurprisingly, there is little potential for savings in large offices and retail establishments. As noted above, renovation measures lead the list of measures in this segment.

Farm opportunities are led by variable-speed drives, lighting measures, and measures associated with dairy farms.

Small municipal utilities

The most notable aspect of small municipal utilities is that they tend to have a proportionately higher industrial load. On average, almost 40% of electricity sales by small municipal utilities goes to industrial customers, though a third have no industrial load at all, while a few sell nearly 80% of their electricity to industrial customers. The median small municipal utility with industrial load has only 10 industrial customers, though a few have more than 200.

Homes served by small municipal utilities tend to mirror the statewide composition of Minnesota housing, with a mix of single-family and multifamily dwellings. Similarly, the distribution of commercial businesses served by these utilities resembles that of the state as a whole, with the exception of fewer large commercial properties found in larger urban areas.

The 119 small municipal utilities in the state account for 12% of the achievable statewide electric program potential. Only 10% of this potential is attributable to the 51 CIP-exempt municipal utilities, while 90% is in the service areas of the 73 small municipal utilities with CIP requirements. The remainder of the discussion omits CIP-exempt municipal utilities.

The models suggest that small municipal utilities have average annual achievable energy efficiency potential of 1.7% of electricity sales, with the residential and industrial sectors showing about 1.3% incremental potential and the commercial sector showing 2.6% (Table 28). At the end of the 10-year analysis period (2029), the models estimate 15% savings from achievable program activity over the period — with 17% of this attributable to the Residential sector, 50% to the Commercial sector, and 33% to the Industrial sector.

Table 28. Energy efficiency for small municipal utilities with CIP requirements, by sector.

Sector	Projected mean annual 2020-2029 Sales (GWh)	Incremental energy efficiency potential*	
		(GWh)	% of sector sales
Residential	2,789	36.1	1.3%
Commercial	2,760	73.0	2.6%
Industrial	3,607	46.8	1.3%
Total	9,156	155.9	1.7%

*Mean of first-year savings potential for 2020-2029 under the program scenario.

Challenges faced by rural cooperatives and small municipal utilities

The primary challenge for rural cooperatives and small municipal utilities to make energy efficiency inroads is one of scale. The average rural cooperative has electricity sales that are less than 10% of the sales of Otter Tail Power, which is the smallest investor-owned electric utility that implements CIP activities in the state. Small municipal utilities have even fewer sales, averaging only 2% of Otter Tail Power's load. For the most part, these smaller utilities lack adequate staffing and other resources for implementing CIP programs, and any fixed costs associated with operating CIP programs must be spread across a much smaller base.

The scale issue is addressed somewhat through joint programs, through power marketing membership organizations. Minnesota has four cooperative-utility membership organizations and six municipal power pools, collectively involving 41 of 48 rural cooperatives and 70 of 118 small municipal electric utilities (in additional to three cooperatives in the Twin Cities area and three larger municipal utilities that have been excluded here). Most of these organizations coordinate umbrella efficiency programs for their members. This pooling of resources can help smaller utilities achieve CIP energy efficiency goals, though these efforts are sometimes complicated by the fact that some of the organizations have membership that spans across multiple states. Two of these organizations, Great River Energy and the Southern Minnesota Municipal Power Agency, have achievable potential that meets or exceeds that of the investor-owned utilities. However, the scale of the remaining cooperative and municipal utilities falls short of that of the smallest investor-owned electric utility in the state (Otter Tail Power). Moreover, 19 municipal utilities with CIP requirements are not members of any power-pool association.

Another scale challenge that rural cooperatives and small municipals face is marshaling the expertise needed to address energy efficiency opportunities for a small number of large customers with unique characteristics. For rural cooperatives, this issue largely manifests itself in the form of larger livestock operations. For example, the project team estimates that about 90% of the electricity used for raising turkeys in Minnesota is associated with a few hundred farms scattered across about a dozen rural cooperatives in the state, few of which have more than 15 farms. It is hard to envision serious efforts to incentivize turkey farm energy savings under such circumstances in the absence of some sort of collaborative cross-utility effort. Similar issues arise with industrial customers of small municipal utilities.

Tool to estimate individual utility potential

As part of the study scope, the project team is developing a tool that will allow the user to view estimated potential for individual utilities or groups of utilities, as well as for individual customer segments and measures.[68] This will allow users to produce more customized outputs of the data than is possible to present in this report.

This tool is not meant to provide accurate estimates of potential from any given utility. This would not be a reasonable expectation, given the inherent limitations of the number of statewide or region-wide (and not utility-specific) assumptions that were used for this model. However, it will reflect utility-specific differences in customer composition, climate and sector-level sales – and this alone can be

[68] This tool will be available a month or so after the release of this report, and will be made available on the project website: www.mncee.org/mnpotentialstudy

helpful in understanding the types of programmatic strategies or measures that might be pursued in an individual utilities' territory, or what scale might be achieved from joint programmatic approaches across multiple utilities' territory.

Limitations in modeling

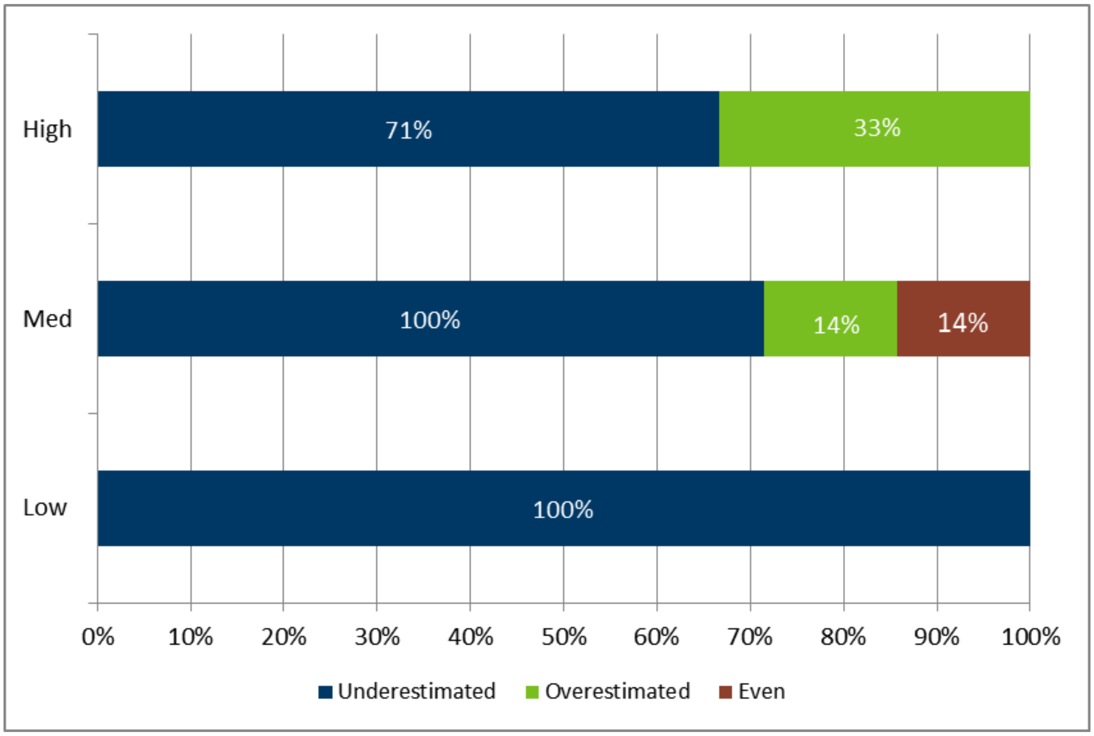
While this study employed best practices for conducting energy efficiency potential studies and used the best data available to support the assumptions, it is worth discussing the limitations of this, or any, potential study. There have been many studies suggesting that most potential studies underestimate actual achievable potential. For example, a recent meta-analysis of 55 potential studies across all regions of the United States indicates average maximum achievable savings of about 1.5% per year, despite numerous jurisdictions currently exceeding these levels.[69] In fact, the American Council for an Energy-Efficient Economy (ACEEE) did not find a single study that indicated levels being consistently achieved in some New England states were possible. Some of the key drawbacks include:

- It is impossible to include all potential opportunities, and many customized and site-specific solutions often account for a large portion of actual efficiency opportunities;
- Studies tend to model business as usual based on the types of programs and savings activity already occurring. As a result, because virtually no jurisdiction truly pursues all cost-effective efficiency with no budget limitations, this calibrates studies to much lower levels being modeled as achievable; and
- The longer the study period, the lower the annual efficiency potential is generally assumed, and the less certain the study becomes. This is both because practitioners will spread out whatever potential is quantified over the entire time frame, and because they tend to focus on current opportunities and underestimate ongoing technology advancement — which, historically, has always reduced costs, improved performance, and expanded efficiency opportunities. For example, while many jurisdictions have aggressively invested in efficiency programs for 25 years, they have found that levels of efficiency potential (as a share of load forecasts) have remained relatively stable. In short, technology advancement can often keep up with natural and program efficiency improvements.

The project team analyzed 12 recent Minnesota potential studies (both statewide, and for individual utilities) to compare the potential reported in those studies to the actual energy savings achieved by Minnesota utility companies. Many of the potential studies analyzed had a number of scenarios calculated (e.g., 100% incentive, 50% incentive, business as usual, etc.). Typically, the high scenarios corresponding to the project team's maximum achievable potential scenario — the low and medium scenarios correspond to the project team's program achievable scenario. Overall, the study's analysis found that 84% of scenarios in these potential studies underestimated potential when compared to actual energy savings achievements by Minnesota utilities. Furthermore, all of the low scenarios underestimated the actual amount of potential achieved. Appendix O has more details on the analysis, including citations for the 12 potential studies that were analyzed.

[69] Max Neubauer, et. al, "Cracking the TEAPOT: Technical, Economic, and Achievable Potential Studies," ACEEE, 2014. Available at: https://aceee.org/research-report/u1407.

Figure 36. Comparison of past Minnesota studies of energy efficiency potential under various scenarios, compared to actual utility achievements after the potential study was completed.



Below is more detail on some of the specific issues.

The further out in time, the less accurate the projections are. The project team used the best available data to calibrate the model to the 2020 start date, and to make projections and forecasts about the future. As with all forecasting, however, the farther out in the future you model, the greater the level of uncertainty and potential error.

The adoption of individual technologies and overall program participation could happen much faster, or slower, than predicted by the model. Unlike the market-driven measures, which are tied to an event like replace-on-fail or major renovation, retrofits can happen at any time. Therefore, the rate of adoption tends to be driven not only by what is achievable, but also significantly by the level of effort and resources devoted to capturing the efficiency. Since the study period is 10 years, the project team chose to spread out retrofit adoptions over that time period, with some ramp up in early years, and then relative stable levels of effort. This is also true for the economic potential, where the model assumed 10% of the eligible opportunities are captured each year. While many studies simply assume 100% capture of retrofit measures immediately when modeling technical and economic potential, the project team believes that spreading this activity out over the study period more closely aligns with real-world efforts and makes comparisons between economic and achievable scenarios more useful. Many measures can be adopted as either retrofits or market-driven opportunities. An assumption that all customers adopt all cost-effective retrofit measures in the first year will remove all future opportunities for additional efficiency through market-driven programs at the time of natural turnover. This is because everything is assumed to have already been replaced with efficient equipment.

In terms of overall penetration forecasts, this is inherently uncertain, as is true with all future projections. While the project team used the best available data, experience and knowledge of past trends has shown that measure adoptions vary significantly (either higher or lower) than past projections.

It is likely this study has not included technologies and programmatic strategies that could have a major impact on future energy efficiency. It is hard to predict the unknowns. However, vast sums of money are going into the research and development of clean energy technologies today, and it is virtually certain that there will be new technologies (or that technologies that the team determined are not cost-effective) that will be the new LEDs of the future. Ten years ago, no energy efficiency potential study that the project team is aware of included the amount of penetration that LEDs currently have in the market. Historically, improvements in technologies and programmatic strategies have more than offset the increasing baselines over time from rising codes and standards, along with natural efficiency adoption. The team has yet to see a situation where we are approaching physical limits on efficiency improvements in most end uses.

This study makes projections for gross energy savings but does not adjust for the natural adoption of energy efficiency, which is already accounted for in the sales forecasts used to derive the potential. The natural adoption of energy efficiency is what would occur in the absence of utility-funded efficiency programs. Two terms that are used in the industry related to this concept are "gross savings," which is the total of utility-caused and naturally occurring energy savings, and the "net-to-gross" ratio, which is the ratio of net utility-caused savings to total savings. The project team estimated the current net-to-gross ratio in Minnesota, based on program evaluation studies conducted by Xcel Energy, and found it to be very close to the national average of about 85% (that is, 85% of the total gross savings claimed through utility programs can be attributed to utility programs). This suggests that the vast majority of savings claimed by utility-run programs currently are attributable to those programs and is a testament to good program design.

As markets are transformed by utility-funded efficiency programs, utilities have stopped giving incentives. The project team was careful in the selection of measures to choose technologies for which the markets are not yet transformed and adjust savings for those measures that might be transformed during the study period. For example, this study assumes that the market for LED screw-in bulbs will be totally transformed by 2021 in the study's model, regardless of what may happen with national lighting standards. However, the markets for some of the technologies modeled in the study may become transformed more quickly than predicted here.

A related issue is that the spillover effect is also not considered in the modeling. Spillover refers to when customers are influenced by the utility to purchase the efficient equipment, but do not submit paperwork. For some measures, utilities may be causing savings, but not all of those savings are being claimed by utilities. Note, that this is one reason the project team recommends midstream program models; they typically have a much higher rate of rebate adoption by customers.

Not all utilities in Minnesota can be expected to achieve the high program penetration assumed here without changes to how they run programs. In particular, the most aggressive programs require more sophisticated program designs, as discussed in chapter 6. These program designs target particular niche markets or require specialized capabilities to implement, which can be hard to do in a relatively small market. For example, programs that target refrigeration loads in small businesses through a combination of direct install measures, specialized technical assistance, and targeted prescriptive rebates have proven to be successful in many utility territories. However, if a small utility only has one grocery store and two gas stations that might benefit from such a program, it is hard to justify the costs to create such a program. Some level of aggregation or sharing of program models, among smaller COUs will likely be necessary in order to achieve the savings predicted here.

The model assumes that market barriers and technology adoption curves are uniform statewide, which could overstate or understate potential for utilities where this is not true. This is related to limitation listed above. The project team did not have sufficient data resolution to support different assumptions for different analysis regions of the state or different utilities on penetration levels of efficiency measures.

Fuel switching measures were not included in the study scope, and no heating efficiency measures were included for customers that heat with delivered fuel. Delivered fuel companies are not subject to CIP requirements, and measures that result in fuel switching are not allowed within CIP, with certain exceptions. Thus, the potential presented here will underestimate total potential if fuel switching measures were to be included. In particular, cold climate air source heat pumps would likely be a cost-effective measure for customers on delivered fuels and could represent a large potential — for example, in rural areas where a high fraction of residential customers heat with delivered fuels. The Department is launching a stakeholder group to discuss fuel switching issues.

Chapter 5: Program Findings and Recommendations

The Center for Energy and Environment project team conducted a review of utility energy efficiency programs in Minnesota and nationally, to inform inputs used in the model for the program scenarios, and to make recommendations about program implementation that will be useful for utilities, regulators and other stakeholders in designing and implementing programs for 2020 and beyond.

This study used the following data sources in making these findings and recommendations:

- Interviews with representatives of nine Minnesota utilities or groups of utilities;
- Review of survey responses from 38 Minnesota stakeholders;
- Review of public Minnesota utility filings and trade-secret, utility-provided data;
- A literature review of best practices in program design; and
- Consultation with three national organization (E Source, ACEEE and NAM) on non-Minnesota best practice programs.[70]

In addition, the project team conducted a more in-depth study of three difficult-to-serve segments: low-income, small business, and small utilities/agricultural (Appendices F, G and H). This project's trade ally survey (Appendix L) also helped to inform these recommendations.

Further background on research conducted for the Programs Chapter is found in Appendix I.

Current programs in Minnesota

This section summarizes the project team's findings on current program implementation in Minnesota.

Minnesota currently has some of the lowest cost and best performing programs in the country

Nationally, Minnesota has long been a top-achieving state for energy efficiency program achievements. The American Council for an Energy-Efficient Economy (ACEEE) compiles rankings of top states annually, and Minnesota has long been the leading Midwestern state, and consistently in the top 10 nationally. Minnesota ranks the highest in the nation for natural gas efficiency achievements.[71]

Furthermore, compared to other top-performing states, Minnesota acquires efficiency at the lowest cost (Table 29). Part of the reason for this can be attributed to Minnesota's slightly lower energy costs

[70] All three organizations worked under contract to CEE. E Source provided information on best practice programs based on their experience following and supporting utilities across the U.S., with benchmarked program metrics. The American Council for an Energy-Efficient Economy (ACEEE) provided customized information on best practice programs from around the U.S. across utility types and customer sectors, in addition to a number of publicly available papers documenting high-performing programs. Newcomb Anderson McCormick (NAM) provided information and insight on California best practice programs.

[71] Minnesota averaged 1.4% net natural gas savings in 2016 – one of only five states in the country to achieve higher than 1.0% savings (Berg 2017).

compared to costal states. Based on interviews with Minnesota stakeholders, the project team would also attribute this to the practical nature of implementers in Minnesota. Virtually every practitioner that the team talked to cited the creation of customer value through their programs as a primary motivation for their work, and the importance of spending utility dollars wisely.

Table 29: Cost of efficiency for top-ranking states (2016 net incremental savings).[72]

State	ACEEE Ranking	Electric spending ($/kWh)	Gas spending ($/therm)
Massachusetts	1	$0.34	$7.39
California	2	$0.35	$6.02
Rhode Island	3	$0.37	$5.89
Vermont	4	$0.39	$3.68
Oregon	5	$0.29	$3.56
Connecticut	6	$0.43	$6.17
Washington	7	$0.21	$3.83
New York	7	$0.27	$5.12
Minnesota	9	$0.19	$1.76
Maryland	10	$0.33	$9.88

Utilities in Minnesota – both IOUs and COUs – have been proactive in designing and implementing comprehensive, effective, and innovative program models.

In addition to high achievements, Minnesota utilities have also been recognized for their innovative and comprehensive programs. Although not a comprehensive list, Table 30 lists 19 national awards that Minnesota utilities have received for the CIP programs they run.

[72] Note that this is presented in dollars per kWh or therm of first-year savings, not lifetime savings – the lifetime savings would be a much lower cost than presented in this table. For example, the average lifetime of Xcel Energy's measures are over 10 years – at $0.19/kWh of first-year savings, this would be less than 2 cents/kWh of lifetime savings. Table derived from tables in: Berg, A., S. Nowak, M. Kelly, S. Vaidyanatha, M. Showmaker, A. Chittum, M. DiMascio and H. DeLucia. 2017. The 2017 State Energy Efficiency Scorecard. Washington, DC: American Council for an Energy-Efficient Economy (http://aceee.org/sites/default/files/publications/researchreports/u1710.pdf).

Table 30: Minnesota CIP programs winning national awards.

Utility or utility association	Program name (& organization giving award)	Year
Otter Tail Power	House Therapy for Low-Income Homes (E Source)	2018
SMMPA	ENERGY STAR Partner of the Year (U.S. EPA/DOE)	2016
Xcel Energy	Computer Efficiency Program (MEEA)	2013
Xcel Energy & CenterPoint Energy	Home Energy Squad (ACEEE)	2013
Austin Utilities, Owatonna Public Utilities, Rochester Public Utilities, & MN Energy Resources	Energy Efficient Cities (ACEEE)	2013
CenterPoint Energy	Foodservice Program (ACEEE)	2013
CenterPoint Energy	Custom Rebate Program (ACEEE)	2008 & 2013
Xcel Energy	Self-Direct Custom Efficiency (ACEEE)	2008 &2013
Xcel Energy	One-Stop Efficiency Shop (ACEEE)	2008 & 2013
Xcel Energy	ENERGY STAR Partner of the Year - Sustained Excellence (U.S. EPA/DOE)	2010, 2011 & 2012
SMMPA	ENERGY STAR Award for Excellence in ENERGY STAR Promotion (U.S. EPA/DOE)	2010
Xcel Energy	Lighting Efficiency (ACEEE)	2008
Xcel Energy	Energy Design Assistance - Custom Consulting (ACEEE)	2008
Rochester Public Utilities	Commercial Programs' Communication Plan (MEEA)	2008
CenterPoint Energy	Non-Profit Affordable Housing Project (ACEEE)	2008
Great River Energy	ENERGY STAR National Product Campaign Award (U.S. EPA/DOE	2004
Minnesota Power	ENERGY STAR Excellence in Energy Efficiency and Environmental Education (U.S. DOE)	2004
SMMPA	ENERGY STAR Award for National Campaign Promotion (U.S. EPA/DOE)	2004
SMMPA	ENERGY STAR Award for Leadership in Energy Efficiency (U.S. EPA/DOE)	2003

Minnesota utilities, including cooperative and municipal utilities, were also some of the first in the nation to pilot residential behavior programs.

Smaller utilities face additional challenges in implementing programs

Smaller utilities, predominately in rural areas of the state, have additional program implementation challenges due to lack of scale. This makes it difficult to find both qualified implementers and qualified contractors to install efficient equipment. According to one utility stakeholder interviewed for this project:

> *"As you get out into rural Minnesota, there's quite a bit less density. That density does have an impact on how aggressive you might be able to be. It doesn't really afford you to look at doing*

door-to-door programs, and it also limits the number of alternative providers. Not necessarily cooperative providers, but other providers of energy efficiency services, which we all rely on to deliver the programs. When you get into very rural areas, there's a challenging business proposition for some of the third-party providers to be able to deliver services at a level that is cost-effective for our membership."

In addition, it is harder for smaller utilities to achieve scale in implementing their programs, which can be particularly challenging for upstream program designs (discussed more below) or other more sophisticated program approaches that reach specific market segments. Smaller utilities may be able to overcome this shortcoming by aggregating their programs with other utilities (also discussed further below).

Deep relationships with trade allies have helped utilities deliver programs

Many of the utilities the project team interviewed stressed the importance of their relationships with energy efficiency contractors, widely referred to as "trade allies" by efficiency program administrators. These trade allies include HVAC, electricians, architecture and engineering firms, and others that install energy efficiency equipment. These contractors have immense influence on the efficiency choices their customers make, and most utilities are proactive in working closely with them. A well-educated and trained workforce of trade contractors is critical to the success of utility programs. The larger utilities often have multiple staff that are assigned specifically to managing these relationships, and they conduct active communications campaigns, trainings, and events to keep their trade allies educated and engaged.

It is also a symbiotic relationship. Utility incentives and awareness-building of energy efficiency create business opportunities for contractors and help employ thousands of workers across the state.

The survey of trade allies (Appendix L) shows that a high percentage of contractors across the state report that they currently work with their utilities, although non-metro contractors are slightly less likely to do so (Table 31). The contractors that were interviewed generally find utility programs easy to participate in. A very high percentage also report that utility programs have helped their business, with the exception of new construction trade allies (architects and residential home builders).[73] Overall, a majority of contractors would find value in additional utility-provided training and information, although lighting and HVAC contractors were less likely to find that valuable (Table 32).

[73] The project team interprets this to mean that rarely, if ever, do new construction trade allies see a building built due to the presence of utility incentives (which is to be expected); whereas for electrical contractors, utility incentives get more people to retrofit their lighting than would occur without utility incentives.

Table 31: Trade allies surveyed, by location and utility interaction.

	Count	Percent that reported worked with utility
Metro	56	84%
Non-metro	49	71%

Table 32: Trade ally feedback on utility programs.

	Plumbing Contractors	Electrical Contractors	HVAC Contractors	Insulation Contractors	Residential Home Builders	Architects
Worked with utility programs in the past	90%	100%	100%	85%	80%	80%
Utility programs are easy to participate in	80%	92%	93%	60%	40%	40%
Utility programs have helped business	60%	77%	90%	60%	30%	40%
Utilities should provide additional rebates to increase participation	60%	12%	65%	25%	70%	20%
Utilities should provide additional training and info to increase participation	50%	23%	35%	50%	80%	50%

The most successful COU programs involve cooperation among utilities

As discussed above, rural and smaller utilities face challenges in implementing programs due to lack of scale and other issues. Many of these utilities have been able to overcome, or partially overcome, these challenges by aggregating their programs together. The most common aggregation approach is for the generation and transmission (G&T) provider to run programs on behalf of, or in partnership with, their distribution cooperative and/or municipal utilities. However, other approaches have been successful. All of the G&Ts are involved with helping their members implement programs to a greater or lesser extent. Some of them serve more as a decentralized resource to individual utilities that implement their own programs, while others take a more active and engaged role in implementing programs, including providing staffing for on-site work with individual customers.

A few examples of aggregation in Minnesota include:

- ***Great River Energy*** (GRE), the G&T for the majority of cooperatives in Minnesota, uses a decentralized approach in aggregating programs. They design programs and marketing materials for their members, including an efficiency program guidebook, but rarely get involved in running individual programs. The individual cooperatives tailor the program designs and incentive levels to their needs, and generally run their own programs.
- ***Minnkota Power Cooperative***, the G&T for eight northern cooperatives in Minnesota. In addition to aggregating programs for their distribution cooperative utilities, they do so for a

number of municipal utilities which have solicited their services. Minnkota not only does the marketing and promotion, but coordinates with third-party service providers to run tailored programs on behalf of their members.

- The ***Southern Minnesota Municipal Power Agency*** (SMMPA) has developed, marketed, implemented, and reported CIP programs for their members for many years. SMMPA has three technical staff that work directly with businesses in their 15 smaller member cities. SMMPA's three largest members (Rochester, Austin, and Owatonna) have internal staff to do the majority of their own marketing, program implementation, and CIP reporting. However, SMMPA works with their largest members on program design, implementation, and marketing to ensure consistency in program offerings, and to share best practices.
- ***Missouri River Energy Services*** (MRES) is G&T for 24 municipal utilities in Minnesota, and coordinates energy efficiency program implementation for their members. They package their energy efficiency program under the "Bright Energy Solutions" brand.

While there are many examples of individual COUs achieving high performance, the project team found that in general, the most impact occurred when multiple utilities were working together and pooling resources. Committed and talented utility staff were responsible for superior performance as well.

Some utilities have achieved enhanced performance through joint natural gas-electric programs

Operating joint gas and electric programs when there are opportunities for both gas and electric savings measures can achieve efficiencies in program implementation, as well as decreased confusion from customers. In recent years, Xcel Energy and CenterPoint Energy have increasingly run joint programs, such as their Multifamily Buildings Efficiency Program. This program has been popular with multifamily building owners, because it offers a comprehensive energy assessment for their total energy needs, and includes in-unit direct installs of both gas and electric savings measures in a single appointment. This saves them time and hassle, and can reach deeper savings than would otherwise be the case, as it would be far less cost-effective to set up separate appointments for installing electric measures and gas measure. Given the limited attention that most facility managers have for energy issues, a fragmented approach would likely reach fewer customers.

Outside of municipal gas utilities (where they are likely to be the electric provider as well), it is not common for municipal electric utilities to run joint gas electric programs, although there are a few examples of utilities that do cooperate with their gas provider (e.g., Rochester Public Utilities, Worthington Public Utilities, and Kasson Utilities).

Insights from potential modeling

This section outlines insights for programs from the potential study's modeling.

Residential electric programs will need to transition from lighting to ASHPs as the largest source of savings

For electric utilities, residential programs will need to undergo a major transition away from lighting and toward non-lighting technologies — in particular, air source heat pumps (AHSPs). There are two general types of ASHPs that were modeled for the potential study: ducted (which distributes heat and cooling throughout the home through central ductwork) and ductless, referred to as ductless mini-splits. This study assumes from the modeling that the market for all LED screw-in bulbs will be transformed by 2021, which is the vast majority of residential lighting.[74] Currently, residential lighting makes up 70% or more of residential savings, so this will be a large transition.

As there was no fuel switching modeled for this study, all of the savings from customer adoption of air source heat pumps is from the 17% of residential customers in Minnesota that heat primarily with electric heat. The savings are large from this segment of customers because their usage of electricity is very high, and there is so much energy to be saved. These customers have electric loads that are roughly double customers who heat with other sources of energy. An efficient ASHP serving heating loads for an entire single-family home can save over 9,000 kWh, or roughly $1,000, per year in heating costs versus heating with electric heat. Note that many utilities offer off-peak thermal storage rates, where customers can get a cheaper electric rate if they use special thermal storage resistance heating units. For these customers, the economics of switching to an ASHP will be less attractive.

Minnesota has about 353,000 total households with electric resistance heat; the majority (201,000) are multifamily, with about 153,000 single-family households on electric resistance heat.[75] However, the proportion of single-family homes and multifamily homes that are electric varies significantly by utility type (Table 33). Of the multifamily units, almost all are rental units, with the majority (53%) being low-income. Each of these segments will require a different approach. While there is a strong economic incentive for single-family owner-occupied homes to adopt ASHPs to reduce their energy bills, the owners of multifamily rental buildings where the tenant pays the bills (as is almost always the case for electrically heated multifamily) are particularly hard to address with CIP programs because of the split incentive. Larger incentives and other strategies may be required to achieve a foothold in the multifamily segment. As a large proportion of electrically heated multifamily units are low-income, coordination with federally funded weatherization programs may be another opportunity to address this segment.

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[74] The project team notes that there is some uncertainty over whether "specialty bulbs," which are arguably not covered by the federal EISA standards, will truly be transformed by 2021, so there is a possibility that there may be some residential lighting savings from these bulbs in the years after 2021; but for the modeling purposes, the team assumes all savings from specialty bulbs goes away in 2021.

[75] Still, the overall load of single-family homes with electric heat is larger than the total multifamily homes with electric heat, because the average multifamily home has a significantly lower heating load than the average single-family home.

Table 33. Proportion of homes with electric resistance heating, by utility analysis region.

	Percent of homes with electric resistance heating					
Utility region	**Single family**	**Small multifamily**[76]	**Large multifamily**	**All homes**	**Portion low-income**[77]	**Total ASHP program savings potential (GWh)**
Xcel Energy	4%	19%	39%	13%	44%	130
MN Power	9%	31%	51%	16%	45%	30
Otter Tail Power	19%	45%	67%	28%	41%	30
N Municipals	10%	30%	59%	22%	50%	30
S Municipals	3%	35%	49%	13%	52%	40
N Cooperatives	19%	52%	61%	21%	29%	160
S Cooperatives	11%	35%	44%	14%	31%	170
Statewide total	**9%**	**25%**	**42%**	**15%**	**40%**	**590**

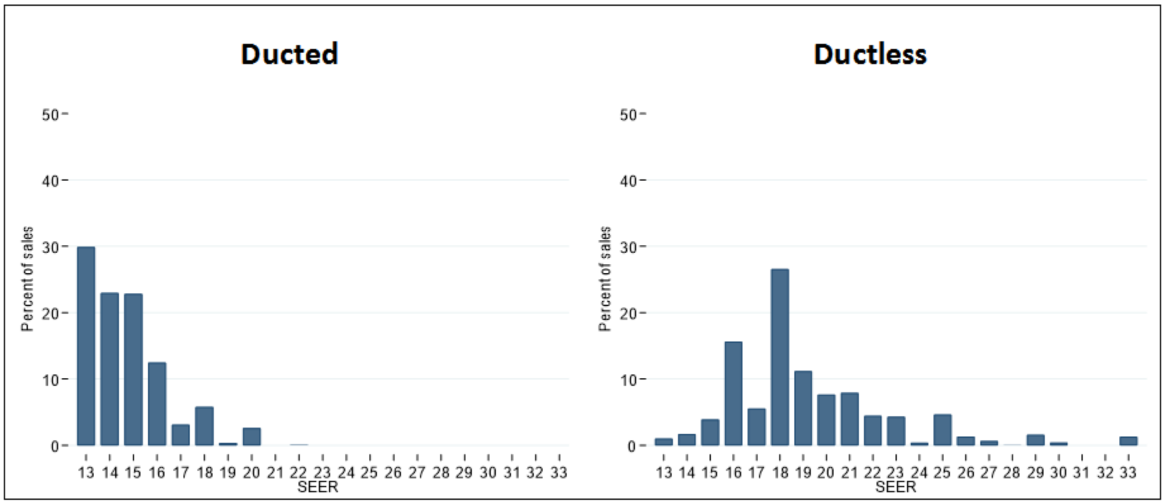
In designing effective ASHP programs, research suggests several features will be important in maximizing savings from these programs:

1. ***Utility programs can help push people to the most efficient ASHP option, which will increase space heating as well as A/C savings***. ASHP's are capable of achieving high efficiencies in both space heating as well as air conditioning, but current market data shows that consumers are not currently selecting the highest efficiency option. While the technology exists today to achieve efficiencies of over 22 SEER for ducted and approaching 30 SEER for ductless, the highest efficiency models represent only a fraction of sales currently (Figure 37).

[76] Small multifamily is defined as 2-4 units; large multifamily is 5 or more units.

[77] That is, the portion (of the total homes with electric heat) that are low-income; thus, 40% of electrically-heated homes in Minnesota are low-income.

Figure 37: Efficiencies of air-source heat pumps sold in Minnesota (2013-2016) for ducted and ductless types.[78]



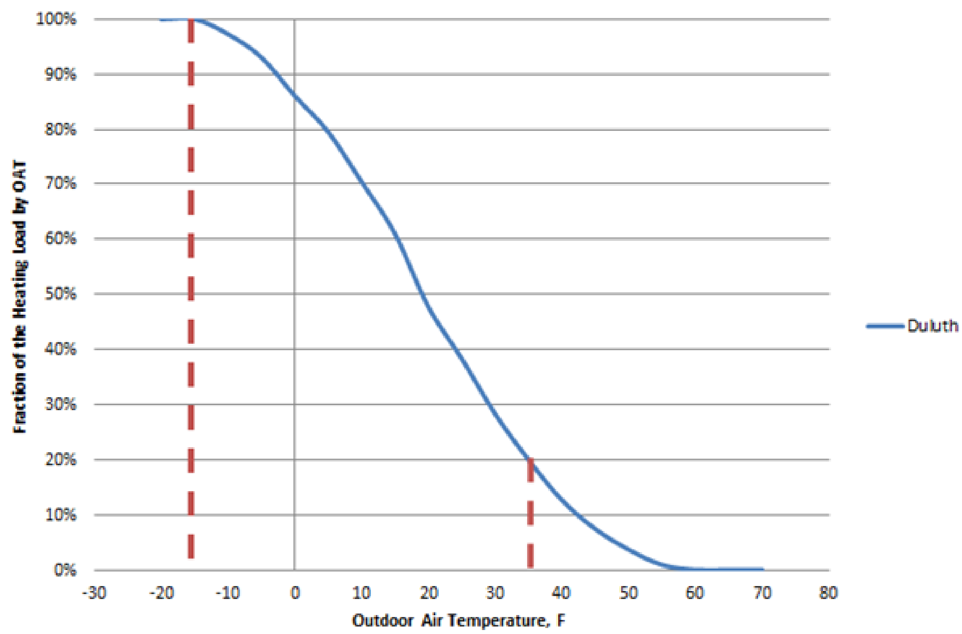
2. ***Building envelope measures can be pursued concurrently with ASHP retrofits, which can further increase savings.*** Completing building envelope measures (attic insulation, air sealing, and wall insulation) concurrently with ASHP installation can decrease the size and cost of ASHP equipment, and result in additional savings.

3. ***Contractor training and quality control are crucial for achieving the full energy-savings potential of ASHPs.*** Field research in Minnesota has shown that contractor installation of ASHPs is frequently sub-optimal, and that utility intervention can help to dramatically increase the realized efficiency of ASHP systems. The largest source of error identified is in setting overly conservative default setpoints.

   For example, Figure 38 below demonstrates the importance of correctly setting the backup heat setpoints when installing a cold climate ASHP. If the setpoints are set at 35 degrees (i.e., the ASHP does not heat below 35 degrees, and the backup heating source meets all heating needs), only a maximum of 20% of the heating load can be met by the ASHP. However, the rated capacity of newer cold climate heat pumps reach down to -20 degrees, and while they operate at lower coefficients of performance at these lower temperatures, they can still provide an energy savings benefit in weather conditions far below zero degrees.

[78] From data collected for this study. See Appendix L for a full description of the data sources.

Figure 38. Fraction of heating load by outdoor air temperature for Duluth, MN.



Lighting declines in importance for the C&I sector, but still represents a large portion of total savings

The C&I sector is impacted by the transformation of the LED screw-in market, but there is still a lot of potential from other lighting types and lighting controls, representing about 20% of the total C&I cumulative potential in 2029. The study's model shows that several LED fixture types will be important in capturing this efficiency, including high-bay, troffers, tube replacement, and exterior lighting.

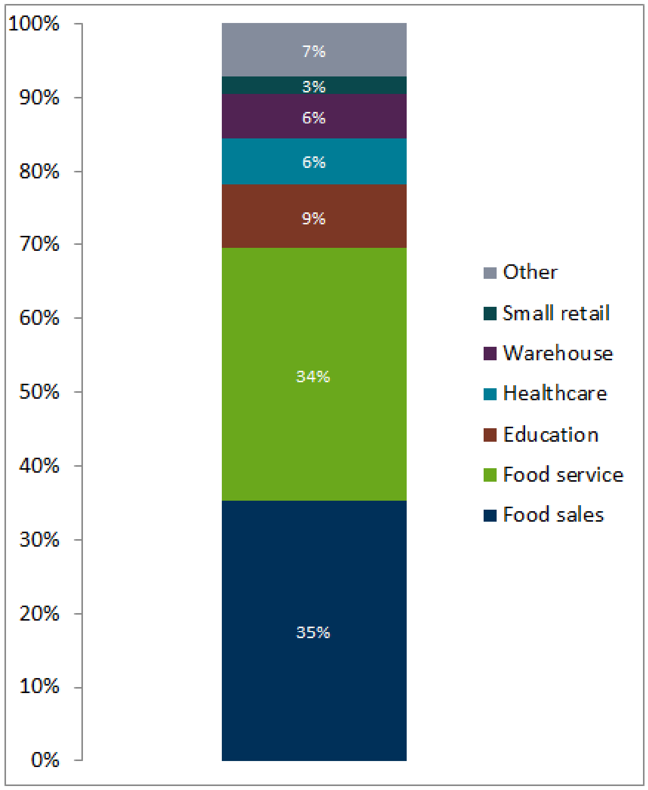
Another important aspect of lighting savings is controls for lighting, such as sensor-based and/or Power Over Ethernet (PoE) enabled controls. Lighting controls, although they are controlling more efficient fixtures, represent over 20% of the lighting savings and will be important for utility lighting programs to promote.

While this study's modeling shows that lighting in the C&I sector will continue to be a steady opportunity through the entire study period, it is possible that the market will be transformed more quickly, resulting in higher savings in the early years of the study, and less in the latter half of the study period as the market becomes transformed.

Refrigeration is another large source of electric potential

Refrigeration represents about one-fifth of the total 2029 cumulative potential. Nearly 90% of this potential is in the commercial/industrial sector, and of this, nearly two-thirds is concentrated in the food sales and food services segment (Figure 39). The food sales segment includes grocery stores, food markets, gas stations, and convenience stores. The food service segment includes fast food and other restaurants and cafeterias, bars, catering services or reception halls, and coffee, bagel, doughnut and ice cream shops. Programs will need to effectively target these segments with refrigeration measures to reach the overall electric potential.

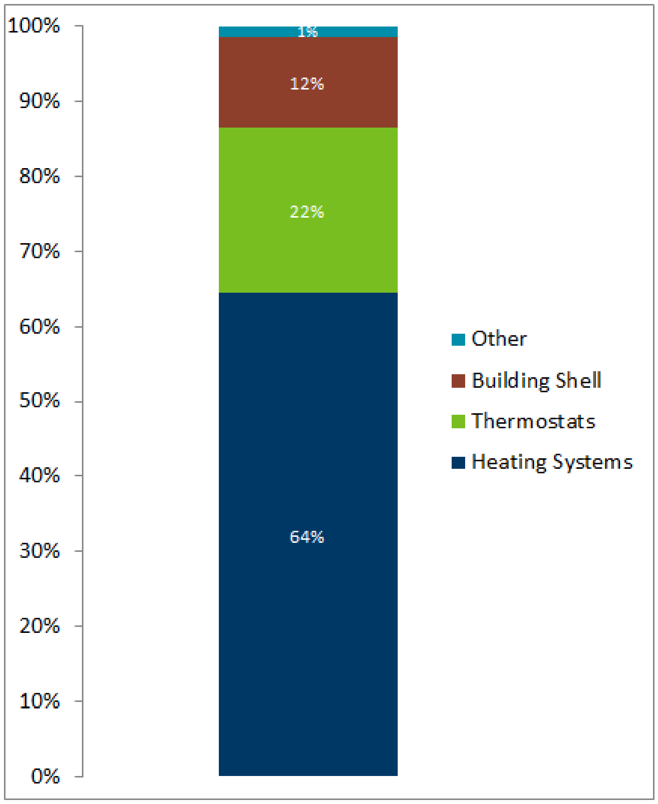
Figure 39. Refrigeration end use electric energy savings potential by building segment (cumulative 2029 program potential).



Space heating measures continue to dominate natural gas potential, with smart thermostats as the largest new source of potential

The space heating end use represents over two-thirds of total natural gas potential, as shown in Chapter 4. Within this end use, improving the heating system efficiency is the largest single group of measures (Figure 40). Although programmable thermostats are not new to gas portfolios, the improved savings potential of smart thermostats results in that technology being the second-most important opportunity for energy savings, followed by building shell measures and industrial space heating measures. Not only are smart thermostats a large source of natural gas savings, but they also provide substantial electric benefits for those spaces with cooling.

Figure 40. Breakout of measure types within residential natural gas space heating, 2029 cumulative annual savings, program scenario.



Among building shell measures, advanced air sealing in new construction is the largest source of new potential that is not currently in the market, representing 4% of overall space heating savings potential.

Best practice recommendations for utilities

This section presents the project team's recommendations for utilities in Minnesota, as well as the regulators who oversee utility program investment, for the continued improvement of CIP program implementation in 2020 and beyond. The study's modeling assumed the adoption of all of these best practices to achieve the market penetration assumed in the program and maximum achievable scenarios.

As the previous section has shown, there is much exemplary work that is happening with current CIP programs, which can be built upon to create successful programs in 2020 and beyond. While the measures pursued and the programmatic strategies used to implement them will need to change, the process of this change will be less a transformation and more an evolution of CIP that builds upon the solid foundation of current practices. Consequently, this study's recommendations are aimed at what the project team believes are good focus areas for that evolution.

1. Continue to test promising new approaches

In the review of Minnesota and national programs, the team found Minnesota utilities to have been a test-bed of innovative program and technology approaches for over a decade. This includes IOUs, but Minnesota is unique in the participation levels of a large number of cooperative and municipal utilities as well.

For example, a handful of Minnesota municipal and IOU utilities were among the first in the nation ten years ago to pilot what were then cutting-edge residential behavioral programs run by OPOWER, which provided monthly feedback reports for their customers. Shortly afterwards, several cooperative utilities started a behavioral program run by Minnesota software company Accelerated Innovations, that provided even more frequent feedback of smart meter usage data to their customers via a mobile app or web interface.

It was in Minnesota that a cost-effective method of inserting wall insulation into older homes, called the "dense pack" method, was invented in Minnesota as part of low-income weatherization efforts, and was eventually incorporated into weatherization programs across the country.

Minnesota recently funded research on air source heat pump application in cold climate settings, which was the basis for this study's finding of large potential from this technology in the coming years.

Continued investment in testing out and evaluating new approaches will be essential to developing the new sources of efficiency that we do not know about currently, but could be transformational in future years. Capturing more energy efficiency is a very technology-forward endeavor, and Minnesota will need to continue to be at the forefront of testing and evaluating this technology to be able to fully capture its potential.

2. Offer comprehensive program designs for larger and harder-to-reach customers

Comprehensive program designs work with customers to identify energy savings opportunities that they might not have been aware of, and help provide implementation support to make it easy for them to implement energy efficiency actions. These programs have been proven successful in getting savings beyond lighting for large customers, and in reaching small business customers that traditionally are hard to get to participate in CIP offerings. For example, Minnesota Energy Resource's C/I Turn Key Program offers a wide range of technical audit and project management services in order to achieve savings from some of their largest customers.

One type of comprehensive program design that has recently seen a lot of buzz is called "strategic energy management." Generally employed for large industrial customers (but also increasingly for large commercial customers), strategic energy management is defined as:

> *… a holistic approach to managing energy use in order to continuously improve energy performance, by achieving persistent energy and cost savings over the long term. It focuses on business practice change from senior management through the shop floor, affecting organizational culture to reduce energy waste and improve energy intensity. [Strategic energy*

management] emphasizes equipping and enabling plant management and staff to impact energy consumption through behavioral and operational change.[79]

Strategic energy management often involves pursuing operational savings, or using existing equipment more efficiently, as well as traditional capital projects that replace existing equipment with more efficient versions. Thus, appropriate measurement and verification approaches are necessary for this program approach. Although they don't generally call it "strategic energy management," utilities in Minnesota have been implementing this concept for their largest customers.[80] It has proven to be an effective method, especially for getting savings beyond lighting. It is, however, initially a very labor-intensive approach, but SEM typically continues to provide significant and very low-cost program savings for about 5-6 years. A key of SEM is that it includes development of a customer-specific M&V approach and tool that will allow for utility tracking and claiming large savings in real time, somewhat similar to current efforts being explored around M&V 2.0. While so far SEM has seen its greatest application among only the very largest of commercial and industrial customers, there are substantial opportunities among somewhat smaller customers as well.

Utilizing the concepts of strategic energy management is not limited to the big utilities either. One implementer working for smaller utilities in Minnesota talked about working with industrial customers using strategic energy management concepts:

> *"Most industrial customers are interested in saving energy, but limited by time. You can build these relationships with industrial customers that are long-term [and] ongoing [by] interacting with them on a regular basis. We set up teams bringing in people from across teams, accounting, engineering, and now you got a team that's out there pushing hard for doing energy efficiency projects."*

The challenge for utilities going forward will be to incorporate some of the insights from strategic energy management and similar approaches, and to cost-effectively apply them to smaller customers. They will need to develop solutions for the other 99% that have a significantly smaller load than the top 1% that are the target of current strategic energy management programs today.

3. Develop upstream incentives and associated program support in selected markets

Upstream programs target incentives to manufacturers, distributors, or contractors rather than to individual customers. This can provide greater market penetration, is often easier for the customer (since they don't have to fill out rebate forms), and have cost efficiencies in program delivery. Minnesota utilities currently have upstream and midstream programs for lighting and other products. However, increasingly these programs are spreading beyond lighting to HVAC and other sectors, with appliances being a crucial one for electric utilities with a high faction of residential load.

Upstream programs can be a difficult model for individual smaller utilities to do without coordinating with nearby utilities, or even statewide, since their territories may not intersect well with a given

[79] From "Strategic Energy Management Minimum Elements," Consortium for Energy Efficiency, 2014.

[80] For example, Xcel Energy has two programs that could be considered strategic energy management: its Process Efficiency program for large industrial customers, and its Commercial Efficiency program for very large commercial customers.

distributor's territory. Utilities may also be reluctant to participate in these types of programs because they get little to no recognition from their customers when they participate in the program. This is due to the transaction (since it occurs upstream of the customer) often being invisible to the customer.

A national upstream effort was started recently for appliances, called the ENERGY STAR Retail Products Platform (ESRPP). The ESRPP, coordinated by the U.S. Environmental Protection Agency, allows participants to leverage each other's resources. This helps to avoid duplication of effort and redundancy across neighboring service territories, and to streamline operations. The focus is providing retailers with incentives from utilities, along with other energy efficiency program sponsors, to change their inventories to sell increasing numbers of ENERGY STAR certified products. Xcel Energy was an early participant in this effort, and savings from this effort are part of its CIP portfolio.

This effort could make sense for more utilities in Minnesota to join, pool their efforts, and cost-effectively address the residential sector. Pursuing upstream incentives are likely necessary for utilities to capture the full potential from this end use, particularly for residential appliances and smart thermostats. However, cooperative-owned utilities might have a harder time justifying this expense to their customer-members versus something they can more directly explain.

4. Incorporate operational savings into commercial and industrial programs

Operational savings is also called "intelligent efficiency"[81] or "systems efficiency." It involves moving beyond individual equipment efficiency and improving the equipment operations to only use as much energy as is needed for occupant comfort and other outputs. Much of this potential for capturing savings from improving the efficiency of the overall system is enabled by new technologies. Efficiency from the "Internet of Things" (IoT) is largely operational savings as well, achieved from using sensors and controls to optimize existing HVAC equipment, motors, fans, burners, and more. This is a large area of savings in this study for utilities with load in the commercial sector.

Building recommissioning is an example of a current utility program offering that is common in Minnesota that achieves operational savings for building owners. Within the commercial/institutional building segment, new program models are emerging as well, which focus on more continuous commissioning approaches. The approach, much like recommissioning 20 years ago, has not been perfected yet, but it is a good area for pilots and innovation.

5. Employ segment-specific strategies to reach customers

Energy efficiency programs rarely cite mass market approaches, such as buying radio ads, as being sufficient for people to enroll in programs. However, they often report the failure of mass-market approaches in increasing program sign-up rates by decision-makers, particularly for business customers. In the commercial sector in particular, segment-specific strategies, often based on relationship building, are a proven engagement method. An example of a segment-specific approach is working with specialized trade allies, like small-business refrigeration service contractors (a trusted source of information on refrigeration upgrades by many convenience store owners), to effectively reach the convenience store market and reduce energy waste from refrigeration end use.

[81] See Rogers, Ethan and E. Junga, "Intelligent Efficiency Technology and Market Assessment," American Council for an Energy-Efficient Economy, Washington D.C., 2017. https://aceee.org/topics/intelligent-efficiency.

The best programs employ these types of segment-specific strategies because market dynamics related to energy efficiency can vary dramatically from one segment (e.g., education) to another (e.g., retail). One might be most receptive to efficiency measures only when they have financing for broader initiatives, but will invest in long-payback items, while another might invest immediately, but only in items with less than a five-year payback. Each segment requires a different approach for the optimally successful program portfolio. This requires market research — from studies, personally knowing the market actors (often the best approach), or from some other source. Data analytics, on the energy usage patterns of customers, can be a good source of segmentation data. The research then determines the best segment-specific approach to use.

6. Deepen trade ally engagement and training efforts

Further developing trade ally relationships can be an important strategy to bring overall program costs down. Trade allies already have a sales force to sell energy efficiency to the market, and they can provide great leverage in implementing efficiency programs.

Training is another area where utilities have played a greater role in recent years. How a piece of equipment gets installed is often as important as the choice of equipment for realizing the full savings potential from retrofits, and in new construction. This is especially true of newer types of equipment that contractors are not as familiar with, which increasingly represents where the savings potential exists. Air source heat pumps, for example, commonly are not installed with the correct setpoints that would maximize the energy and cost savings for the customer. This is because contractors are unfamiliar with the technology and want to minimize potential call-backs. Utility training can play a role in helping their customers to get the full energy savings from the equipment they are helping to pay the customer to install.

Utilities playing a role in contractor training has had some success in Minnesota. Prior to utilities requiring certification of insulation contractors, virtually no contractors were certified in the proper techniques for air sealing and insulating existing attic and wall spaces. However, utilities started to require this certification, and partially compensated employers for the training and expense of getting certified. A majority of insulation contractors in the state are now certified, and the workforce for efficiency in Minnesota has advanced.

One concern faced by both trade allies and utilities in Minnesota is a workforce shortage, particularly in the skilled trades involved in installing energy efficient equipment. Contractors struggle to find enough qualified applicants to fill open positions, which limits their productivity and has the potential to limit their ability to meet customer demand for efficiency services. Both utilities and trade allies could engage with the state workforce development system, funded through the Department of Employment and Economic Development (DEED) and administered at the local and regional level, to help address workforce challenges. Particular attention is needed on supporting small and mid-size businesses in adjusting their practices to more effectively attract and retain qualified workers, and in providing quality on-the-job training to both entry-level and skilled new hires. A variety of services and supports are available to employers through the workforce system to help them find and implement effective solutions that will enable them to support expansion of energy efficiency in Minnesota.

Table 34 shows the mixture of jobs that can be expected to be supported, meaning retained or created, by total efficiency spending during the study period (2020-2029) under the program scenario. It is important to note that during the study period there will be a large wave of retirements taking place in the energy efficiency sector, so while the jobs supported may not be new, a significant proportion of them will be filled by new workers. The calculation of these jobs numbers is fully explained in Appendix P.

Table 34. Expected workforce supported by total CIP spending over the course of the study period (program scenario).

Direct job type	Expected job-years[82]	% of total job-years
HVAC technicians	10,500	21%
Electricians	5,100	10%
Insulation installers	2,200	5%
Mechanical engineers	2,100	4%
Architects	2,000	4%
Plumbers, pipefitters	1,800	4%
Retail salespersons	1,400	3%
Weatherization technicians	1,100	2%
Stationary engineers and boiler operators	700	2%
Other	3,500	7%
Total direct job-years	30,400	62%
Indirect job-years (*Not listed above)	18,900	38%
TOTAL JOB-YEARS	**49,300**	**100%**

7. Incorporate AMI-enabled capabilities into programmatic strategies

Advanced Metering Infrastructure (AMI) includes smart meters and all the accompanying infrastructure that enables two-way communication between customers and their utility through the customer's billing meter. It opens up new possibilities for engagement by customers in their energy usage. Rather than receiving billing information once a month, customers can now receive usage information on a nearly instantaneous basis. This information and the engagement opportunity can be leveraged by energy efficiency programs.

Currently, Minnesota as a whole has a relatively low level of AMI adoption. Minnesota cooperatives are ahead of other utilities in AMI adoption, and most of them are also taking advantage of opportunities to engage customers in energy efficiency. For example, many of the cooperatives with AMI provide their customers with the "MyMeter" service and behavioral program.[83] This provides a web and mobile phone application dashboard for customers to track their energy usage in intervals of one hour or less.

8. Leverage interest by local governments in energy efficiency

Local governments are increasingly interested in how they can improve their overall energy efficiency, and that of their residents and businesses. The Minnesota GreenStep Cities, a voluntary program for cities interested in enacting sustainability actions, reports that 122 cities in Minnesota currently

[82] A job-year represents a single job retained or created for one year. A single job maintained over the course of the ten year study period is equivalent to ten job-years.

[83] The MyMeter platform is run by St. Paul-based software company Accelerated Innovations.

participate in the program.[84] All of these cities, and more, are interested in doing what they can to promote energy efficiency, and could potentially partner with utility programs.

Several utilities in Minnesota have undertaken efforts to leverage city interest in energy efficiency. Xcel Energy, through its Partners in Energy offering, provides extensive support for local governments in developing and implementing a local energy action plan.[85] Some of the implementation efforts that local governments can help with are:

- Cross-marketing of utility energy efficiency programs. For example, cities can market efficiency on their water bills sent to customers;
- Funding for completing energy efficiency upgrades. Several metro area cities offer bonus incentives for homeowners and businesses to complete upgrades, and tie their incentive to the utility incentive; and
- Community efforts can help recruit and mobilize "trusted messengers" for energy efficiency campaigns, and increase the penetration and effectiveness of utility marketing efforts.

Utilities have only just begun to explore the possibilities of how to leverage this opportunity, and should continue to develop partnerships in this area.

Recommendations for coordination among utilities

In addition to the program and portfolio recommendations above, the project team also suggests the following strategies to enhance coordination among utilities. Some of this can be accomplished by individual utilities working together, while other strategies may need the state or another actor to play a lead or facilitating role.

1. Coordinate more closely on trade ally outreach and training

Unsurprisingly, the trade ally survey indicated that trades contractors are an important component of the success of CIP programs. It also indicated several areas of improvement for utilities in better engaging them, including education and training. Trade allies are not recommending some key technologies to their customers because they are not familiar enough with them.[86] This is a common chicken-and-egg program with emerging energy efficiency technologies, and is a strong argument for coordinated, utility-funded efforts to overcome this barrier. Since many contractors work across utility territories, this is a good area for utility cooperation.

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[84] See: MN Green Step Cities website (https://greenstep.pca.state.mn.us)

[85] See: Xcel Energy's Partners in Energy website (https://www.xcelenergy.com/working_with_us/municipalities/partners_in_energy)

[86] For example, many plumbing contractors in the survey reported concerns about the performance and feasibility of tankless water heaters and do not actively promote them, even though utilities provide incentives for this technology.

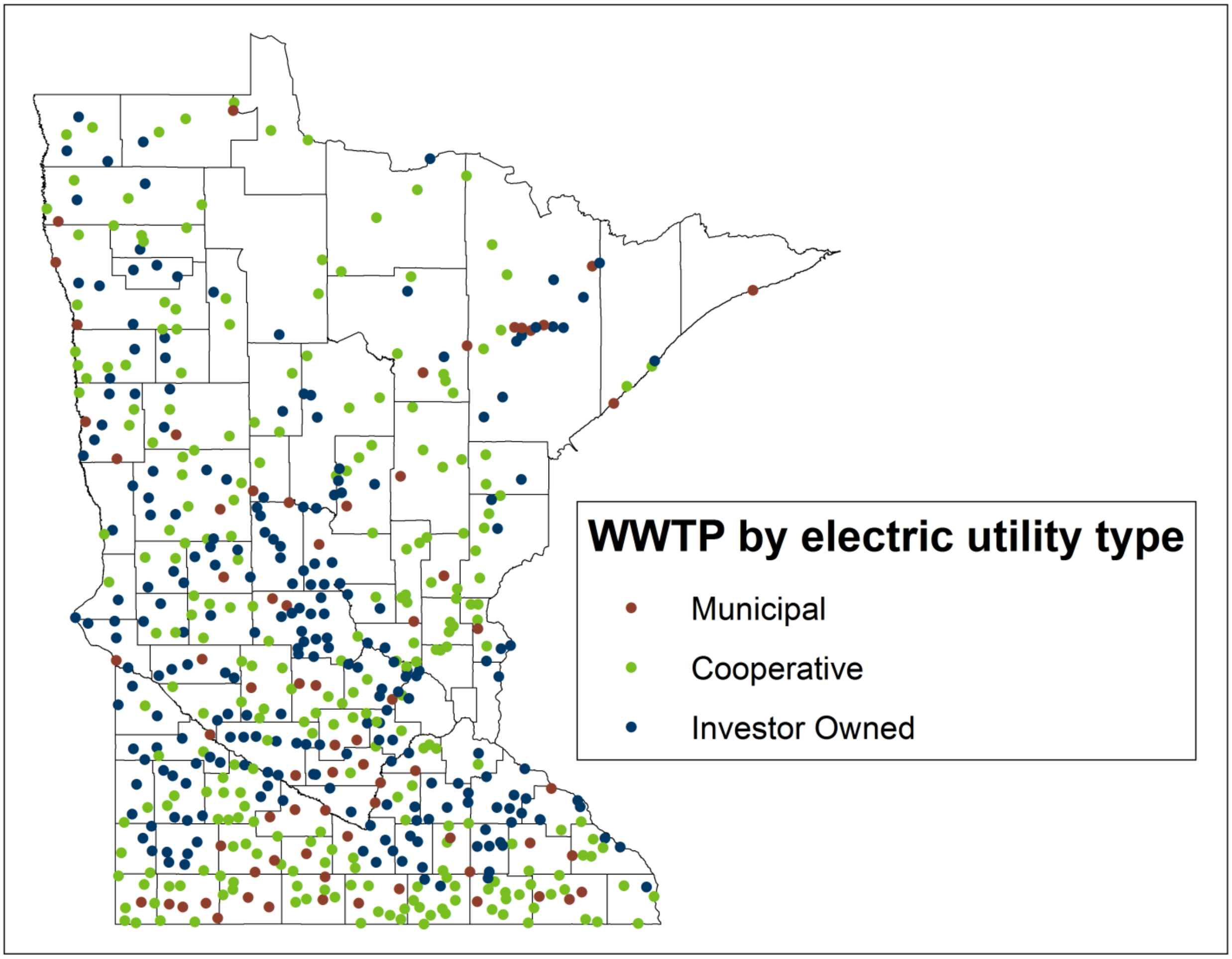
Utilities can play a key role in bringing new technologies to existing training programs preparing workers for energy efficiency jobs. They can also work with technical colleges to develop customized training classes for groups of contractors, to teach new skills or technologies to incumbent workers. Both approaches would benefit from close collaboration with the state workforce development system and other workforce partners to facilitate identification of transferrable skills and abilities to inform curriculum design, and of available funding streams to support training.

2. Work further toward coordinated and/or joint implementation of programs

The project team's research suggests that coordinated approaches to program implementation can result in enhanced program results. Some types of program designs are also more easily or economically accomplished at scale — some apply to specialized business segments that an individual utility may have only a few or even one instance of in their service territory. This is not enough to build a program around, but when combined with other utility service territories, can make sense to address the segment in a holistic fashion.

For example, the Minnesota Technical Assistance Program (MnTAP) at the University of Minnesota has a current CARD grant to look at operational savings through wastewater treatment plants (WWTP). They are using a cohort model, where many facilities join together to commit to savings, along with sharing best practices. It relies on a critical mass of participation and is not suitable for addressing a single facility at a time. Having multiple facilities participate concurrently is critical for the program design to be successful. In total, Minnesota has 211 WWTPs that would be good candidates for targeting operational savings (Figure 41). Of this total, 74 are located in utilities with only one wastewater treatment plant. This may be a good opportunity for an "opt-in" program model, where interested utilities could opt into the program. This may be enough to get a critical mass sufficient for the program to be successful.

Figure 41. Location of non-metro wastewater treatment plants by electric utility type



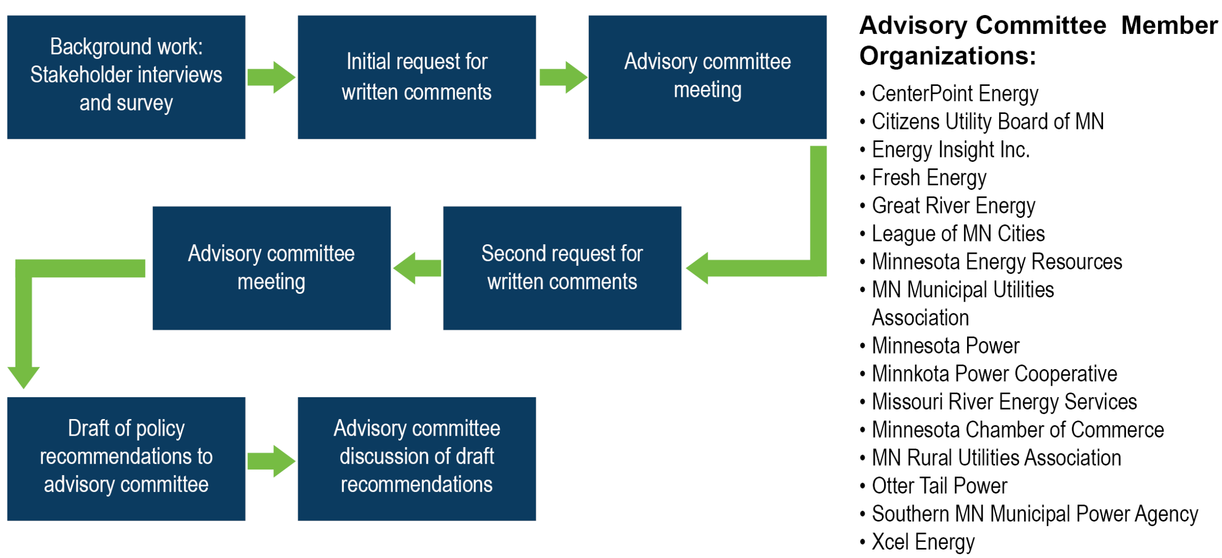
Chapter 6: Policy Conclusions by Topic Area

The following chapter represents the project team's effort to inform Conservation Improvement Program (CIP) discussions and ensure Minnesota continues to maximize cost-effective energy efficiency resources into the next decade. For three important issue areas, this chapter discusses the study's findings, summarizes the stakeholder input received, and presents conclusions for consideration by policymakers.

This study's stakeholder outreach process (Figure 42) began with individual interviews and a survey to broadly understand how stakeholders perceive CIP and what topics related to CIP are of most importance to them (see Chapter 2 for key survey results).

A project advisory committee, composed of 13 CIP stakeholders representing utilities, clean energy organizations, consumer advocacy organizations, and businesses provided input on the policy topic areas — including two rounds of written comments (see Appendix N for list of committee members and submitted comments).

Figure 42. Process for gathering stakeholder input into policy discussion and organizations represented on the advisory committee.



The three topic areas discussed were: 1) achievement of CIP goals; 2) regulatory oversight of CIP; and 3) the integration of efficient fuel-switching and demand-response programs in CIP, summarized in Table 35.

Table 35. Summary of policy findings, stakeholder input, and study conclusions.

Topic Area	Relevant findings from potential study	Stakeholder input	Conclusions
Achievement of CIP goals	Meeting or exceeding, on average, the current CIP goal of 1.5% for electric utilities and the statutory minimum of 1.0% for gas utilities is achievable in the 2020-2029 timeframe. Achieving savings targets is likely to require increased but still cost-effective spending. The existing incentive structure has been effective at motivating investor-owned utilities to exceed their energy- savings goals.	Small consumer-owned utilities report facing additional challenges in implementing programs; thus, it may not be possible for them to achieve the same energy-savings level as the investor-owned utilities. More emphasis on lifetime savings is justified, but the first-year savings goal is still preferred as the main statutory CIP goal.	***The 1.5% savings goal can continue to be achieved using the existing flexibility to adjust goals when justified.*** Lifetime savings could be better measured and tracked through the annual reporting process, rather than a statutory change. Consider allowing consumer-owned utilities to report savings in a multi-year framework.
Regulatory oversight of CIP	CIP programs in the 2020s will need to expand into new end uses and technologies, increasing the complexity of regulatory issues. Results from Commerce-funded conservation applied research and development projects inform this potential study's estimates and pave the way for increased savings from new end uses.	The stakeholder survey shows mostly strong support for current Department regulation. Most stakeholders support a practical approach that minimizes confusion and provides regulatory clarity.	***Clarity on key regulatory topics could be accomplished through the creation of a CIP guide.*** Consider creating a formal advisory committee for CIP regulatory topics to increase transparency and avenues for stakeholder coordination on CIP implementation. Continue to have strong research and development to support future energy savings.
Incorporating demand-response & efficient fuel-switching into CIP	Demand-response programs will increasingly be needed for integrating carbon-free renewables onto the grid, and to balance high load with high-generation times. With appropriate safeguards, efficient fuel-switching could significantly increase overall efficiency, decrease emissions, and reduce costs for consumers.	There is strong electric utility support for incorporating demand-response and efficient fuel-switching into CIP. Public interest concerns were raised about investor-owned utilities receiving incentives for load-building activities. Public interest concerns were raised about demand-response and fuel-switching diluting or competing for limited capital with energy efficiency efforts. Both demand-response and fuel-switching programs are customer-facing programs, like CIP.	***Consider whether to incorporate "integrated demand-side management" into the CIP framework — with appropriate safeguards.*** In crafting specific policy for integrating demand-response and fuel-switching, safeguards should ensure end-use efficiency is not decreased; utility incentives for investor-owned utilities should be considered separately (demand-response) or not provided (fuel-switching).

Topic Area 1: Achievement of Conservation Improvement Program (CIP) goals

One of the main objectives of this study was to estimate the potential for utility-funded energy efficiency in the next decade. This is relevant to determining if the current CIP goals in the statute are achievable for the next decade.

The CIP statute sets a 1.5% annual energy savings target for utilities of all utility types:

> *Each individual utility and association shall have an annual energy-savings goal equivalent to 1.5 percent of gross annual retail energy sales unless modified by the commissioner under paragraph (d). The savings goals must be calculated based on the most recent three-year weather-normalized average. A utility or association may elect to carry forward energy savings in excess of 1.5 percent for a year to the succeeding three calendar years, except that savings from electric utility infrastructure projects allowed under paragraph (d) may be carried forward for five years. A particular energy savings can be used only for one year's goal.*[87]

The statute also allows electric utility infrastructure and combined heat and power projects to count toward the 1.5% goal, but sets a 1% minimum energy-savings requirement from traditional end-use energy conservation activities for those utilities subject to CIP:

> *A utility or association may include in its energy conservation plan energy savings from electric utility infrastructure projects approved by the commission under section 216B.1636 or waste heat recovery converted into electricity projects that may count as energy savings in addition to a minimum energy-savings goal of at least one percent for energy conservation improvements.*[88]

The statute also recognizes the important differences between utilities by allowing the Commissioner of the Minnesota Department of Commerce to adjust a utility's annual energy-savings target, "based on its historical conservation investment experience, customer class makeup, load growth, a conservation potential study, or other factors the commissioner determines warrants an adjustment."[89] The CIP statute precludes the Commissioner from setting "an annual energy-savings goal of less than one percent of gross annual retail energy sales from energy conservation improvements" for the investor-owned utilities (IOUs), but does not restrict the ability of the Commissioner to adjust the CIP goal to less than 1% for the consumer-owned utilities (COUs).[90]

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[87] MN Stat 2018, section 216B.241, subd. 1c, paragraph (b).

[88] MN Stat 2018, section 216B.241, subd. 1c, paragraph (d).

[89] MN Stat 2018, section 216B.241, subd. 1c, paragraph (d).

[90] MN Stat 2018, section 216B.241 subd. 1c, paragraph (d).

Achievement of CIP Goals: Relevant findings

Meeting or exceeding, on average, the current CIP goal of 1.5% (electric utilities) or the statutory minimum of 1.0% (gas utilities) is achievable in the 2020-2029 timeframe.

The results of this study indicate that, overall, Minnesota's electric utilities should be able to continue to meet or exceed their annual 1.5% energy efficiency resource goal in the next decade (Table 36). It also found that while it will be more difficult for gas utilities to meet or exceed the 1.5% goal (Table 36), as they have only done so once in the past decade, they should be able to meet or exceed the 1% minimum requirement, as has been accomplished in the recent past.

Table 36. Summary of projected average incremental annual savings and budgets, 2020-2029.

	Electric utilities		Natural gas utilities	
	Max achievable	Program	Max achievable	Program
Average incremental annual savings	2.60%	1.80%	2.20%	1.30%
Average annual budget (millions)	$777	$309	$573	$189

Achieving savings targets is likely to require increased, but still cost-effective, spending.

Modeling completed for this study indicates that meeting or exceeding the CIP targets could come at a higher cost than in the past. Lighting (in particular LEDs) has been a great boon in recent years for achieving low-cost efficiency gains for electric utilities. However, achievement of savings goals in the future will require expansion to new end uses beyond lighting and, for gas utilities, reaching harder-to-reach customers. The modeling suggests that savings targets can still be cost effectively achieved, but energy efficiency portfolios may not be as cost effective as they have been in the past.

Many of the strategies for achieving savings in the future work better at scale, and smaller COUs — unless they coordinate and aggregate their individual efforts more closely — could have difficulty achieving savings targets.

The existing incentive structure has been effective at motivating investor-owned utilities (IOUs) to exceed statutory minimum goals.

As discussed in Chapter 2, the IOUs receive incentives for meeting or exceeding their CIP goals, based on the share of net benefits their CIP programs create. While selling less energy is not a natural business model for utilities, these incentives have helped to make it in their business interest to pursue CIP vigorously, even beyond the statutory minimum. Electric IOUs have surpassed their statutory minimum goals in six of the eight years that the statute has been in effect — in some cases, significantly exceeding the 1.5% goal. As an example, Otter Tail Power achieved 3.0% savings in 2017. This suggests that the incentives structure that is part of the CIP framework has been effective at motivating utilities to pursue cost-effective CIP programs that go beyond the statutory minimum.

Achievement of CIP Goals: Stakeholder feedback

Small consumer-owned utilities (COUs) report facing additional challenges in implementing programs; thus it may not be possible for them to achieve the same energy-savings level as the investor-owned utilities (IOUs).

Throughout the CIP policy stakeholder process, a number of stakeholders discussed challenges in meeting CIP energy savings goals due to unique utility characteristics. This was particularly true for Minnesota's small COUs.

The Southern Minnesota Municipal Power Agency (SMMPA), which provides wholesale electric service and CIP programming to a number of municipal utilities with diverse and sometimes challenging customer profiles, explained how the current energy savings goal paradigm falls short for some utilities:

> *"[E]xpecting each individual utility to achieve 1.5 [percent] savings every year may not be a realistic expectation… Utilities with high load growth and utilities with no load growth all have the same CIP savings goal – 1.5 percent – which seems unfair. It would be helpful if issues like this could somehow be factored into setting the CIP goal. The Department currently provides some flexibility to utilities by allowing aggregation and carry-forward savings provisions. But not all utilities have an opportunity to aggregate, and the carry-forward term is rather short compared to the average lifetime of the energy savings. Allowing for some additional flexibility by allowing utilities to adjust CIP targets based on statewide potential studies (a), or by the type and proportion of customers they serve (b), seems reasonable."*[91]

Banding several utilities together for tracking, reporting, and achieving energy savings is a strategy that many cooperative and municipal utilities employ to manage the cost and difficulty of capturing the cost-effective efficiency potential available to them. Aggregation of CIP services allows costs and expertise to be shared and spread among more utilities and customers. Extending aggregation to more COUs that are currently not aggregated could reduce the cost, regulatory burden, and administrative burden of achieving the annual CIP target.

[91] Southern Minnesota Municipal Power Agency, Response to Second Request for Written Comments, Page 1, Question 4.

More emphasis on lifetime savings is justified, but the first-year savings goal is still preferred as the main statutory CIP goal.

Minnesota expresses CIP goals in terms of "first-year savings" goals, or the sum of the annual incremental savings from all the energy efficiency measures that are installed in that year. However, many of these measures last for 10 years or more, and measuring CIP by its first-year impact could understate the long-term impact of energy efficiency. Also, a focus on first-year savings can overemphasize the importance of short-lived measures, as these are given equal weight to longer-lived measures in CIP.[92]

Many CIP stakeholders suggested that lifetime energy savings should play a greater role in CIP. Eighty-three percent of respondents to the CIP stakeholder survey said that they agree or strongly agree that lifetime savings should be used to measure CIP success (See Figure 13 in Chapter 2).

Stakeholders noted two specific benefits of using lifetime energy savings as a measure of CIP achievements. First, lifetime energy savings are more representative of the resource value of energy savings than first-year energy savings.

As explained by the American Council for an Energy-Efficient Economy (ACEEE),

> *"While it is important to assure annual incremental progress (as opposed to simply setting a long-term goal to hit some time in the future), there is now widespread recognition in the industry that in order for energy efficiency to be a true utility system resource, it must have a lasting and cumulative impact on the utility system."*[93]

In written comments, Great River Energy (GRE), an electric cooperative owned by its 28 member cooperatives, stated that:

> *"First-year savings is an understandable metric, but it does not reflect the true lifetime impacts of the efficiency improvements. Cumulative savings that highlight the total savings that have been realized through ongoing programmatic efforts seem to best reflect the energy efficiency resource impacting a utility's operations. A benchmark that incorporates cumulative savings from energy efficiency is an indicator of a utility's "good faith effort" toward the promotion of*

[92] Although notably, current DER guidance is for behavioral measures to use the "Average Savings Method" for reporting first-year savings for these programs, which is a more conservative way to report savings from behavioral programs, compared to other states. For full discussion of this issue, and other approaches, see pg. 81-94, "Energy Efficiency Behavioral Programs: Literature Review, Benchmarking Analysis, and Evaluation Guidelines," Illume, et. al, a CARD project. Available at: http://mn.gov/commerce-stat/pdfs/card-report-energy-efficiency-behavorial-prog.pdf.

[93] American Council for an Energy-Efficient Economy, response to Second Request for Written Comments, Page 3, Question 3.

energy efficiency and allows a more forgiving lens of evaluation vis-à-vis a first-year savings approach that would seemingly punish utilities for not making the goal every year."[94]

Similarly, the Southern Minnesota Municipal Power Agency (SMMPA), a wholesale joint action agency created by its 18 member municipal utilities stated that, "SMMPA has long believed that incremental/first-year savings do not reflect the true lifetime savings impacts and carbon impacts from DSM."[95]

Another benefit of using lifetime savings as a main metric for the success of CIP is that first-year energy savings are not always indicative of a utility's long-term program performance. Some other states have moved away from first-year goals to metrics like "cumulative persistent energy savings," which is the metric that the state of Illinois uses to account for lifetime savings.[96] This type of goal accounts for the lifetime savings of energy efficiency and provides a long-range view of utility performance. It is also less susceptible to the annual ups and downs from natural fluctuations in customer participation. These annual fluctuations can be particularly relevant for smaller utilities, for which one or two large projects determine whether the utility meets annual first-year energy saving goals.

Despite the many stakeholders who support a greater emphasis on lifetime energy savings in CIP, other stakeholders stated that the existing first-year energy savings CIP goals were working well and saw no need for a statutory change. Also, Minnesota's IOUs currently factor the lifetime value of energy savings into the calculation of their financial incentive, so it is a very important metric already for them. As CenterPoint Energy stated, the current CIP goal framework works well, "if utilities continue to receive a financial incentive that is based on net benefits achieved by CIP."[97]

Though first-year savings do not capture the full value of energy conservation, it is a simple metric that is relatively easy to calculate, track, and report. SMMPA noted the complexities involved in moving to a lifetime savings goal and said that, "[E]ven some of our member utilities fail to consider lifetime benefits simply because the current CIP goals only focus on first-year savings."[98] CenterPoint Energy discussed the additional challenge for utilities in incorporating policy changes into program plans, stating, "The

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[94] Great River Energy, Response to First Request of Written Comments, Page 5, Question 6.

[95] Southern Minnesota Municipal Power Agency, Response to First Request for Written Comments, Page 2, Question 6.

[96] In 2016, Illinois passed the "Future Energy Jobs Bill" which enacted new energy efficiency goals, including that the largest utility, Commonwealth Edison, attain 21.5% "cumulative annual persisting savings" by 2030. See: http://www.ilga.gov/legislation/publicacts/99/PDF/099-0906.pdf.

Also, note that this study reports the "cumulative annual 2029 savings," which is identical in concept to how Illinois changed their statute, and represents the total impact of CIP from measures installed in 2029, as well as other measures that still have a "life" in 2029, and are continuing to save energy even though they were installed in previous years.

[97] CenterPoint Energy, Response to Second Request for Written Comments, Page 3, Question 3.

[98] Southern Minnesota Municipal Power Agency, Response to First Request for Written Comments, Page 2, Question 6.

transition between one goal framework and another can be disruptive to programs and planning as stakeholders adapt to the new framework."[99]

In the end, most stakeholders agreed that while lifetime savings as a CIP metric had its merits; changing the statute to a lifetime savings metric would be complicated, and not likely worth the effort. Outside of a statutory change, there may be simpler ways to emphasize the lifetime savings of CIP. Better tracking and reporting of lifetime savings, without a statutory change to CIP, was one of the stakeholder suggestions.

In addition, some of the COUs suggested that the annual savings goal could be a multi-year goal, rather than a single-year target each year. This could help to solve the issues that some smaller utilities have with annual fluctuations in achievements, without having to change to a lifetime savings framework. SMMPA noted the value of this more long-range view of utility performance:

> *"Instead of having an annual savings goal, maybe a longer term (5, 10, or 15-year) savings goal makes more sense. Doing that would also eliminate the need for the messy/unfair carry-forward savings policy that utilities currently operate under, and eliminate the stigma of being "non-compliant" for not achieving the savings goal every year (even though you may actually exceed 1.5 percent on average)."*[100]

Achievement of CIP goals: Conclusions

The 1.5% savings goal can continue to be achieved, and the existing flexibility of the statute can be used to adjust individual utility goals when justified.

The current CIP annual energy-savings target of 1.5% of gross annual retail energy sales could be retained, and the flexibility inherent in the CIP statute utilized to adjust that target to fit the circumstances of any particular cooperative or electric or natural gas utility. The Department already uses the existing flexibility for natural gas utilities that have achievements of less than 1.5%, and this could continue to be utilized in the 2020-2029 framework.

This study's modeling indicates that even higher achievements, beyond 1.5%, may be possible, although this would likely come at a higher cost. Past history suggests that IOUs in particular could exceed the statutory minimum if financial incentives continue to be in place to encourage investment in all cost-effective energy efficiency.

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[99] CenterPoint Energy, Response to First Request for Written Comments, Page 3, Question 6.

[100] Southern Minnesota Municipal Power Agency, Response to First Request for Written Comments, Page 2, Question 5.

Lifetime savings could be better measured and tracked through the annual reporting process, rather than a statutory change.

Although stakeholders did not support changing the statute away from the first-year savings framework, most agreed that a greater emphasis on lifetime savings was justified, and could help ensure CIP is focused on long-term impact and resource acquisition.

Currently, there is no consistent reporting of lifetime impacts by utilities, so it is hard to even know what the lifetime impacts of CIP are. A logical starting point is to start tracking this impact. The Department could require IOUs to consistently report lifetime savings by program, so that they and other stakeholders could start to track the impact CIP programs have not only on first-year savings, but also lifetime savings. Since utilities already internally track this information (some include this data in their CIP filings already), it should not be difficult. This information will be useful over time in understanding which programs have the greatest impact on long-term resource acquisition, and what the total impact is, over a period of time, of CIP. This information does not consistently exist for IOUs currently.

While COUs report according to the Department's online tool, which can already calculate lifetime savings by program, this tool reportedly is not consistent with the Minnesota Technical Reference Manual (TRM) lifetime assumptions. This inconsistency could be corrected in the next iteration of the tool, so that COUs can more accurately report lifetime savings.

Consider allowing consumer-owned utilities (COUs) to report savings in a multi-year framework.

Allowing COUs to meet a multi-year savings goal, rather than a fixed annual goal of 1.5% per year, might be helpful for these utilities. This could still be expressed as first-year savings, but could help smooth out years where they were under the goal, and years when they were over the goal. For example, instead of a 1.5% goal in each of the next five years, an individual utility could have a goal to reach 7.5% savings over the five-year period.

Topic Area 2: Regulatory oversight of CIP

In addition to recommending program changes, the project team also considered how the Department's oversight of CIP may need to expand in response to the future challenges of CIP.

Regulatory oversight: Relevant findings

Conservation improvement programs in the 2020s will need to expand into new end uses and technologies, increasing the complexity of regulatory issues.

In its role overseeing CIP, the Minnesota Department of Commerce (Department) must review utility technical assumptions for reasonableness, which is particularly important for the IOUs, since those assumptions can drive incentives that they receive for meeting or exceeding CIP goals. The modeling has shown that CIP programs will need to increasingly reach new end uses like space heating and refrigeration, incorporate new technologies such as smart thermostats, and use enhanced programmatic strategies including strategic energy management.

Some of these technologies do not have a long track record of savings, and nuances of program implementation could impact savings. For example, different thermostat models, or installation methods, could affect the level of savings that is actually achieved from smart thermostats. These technologies and methods, while currently being used in CIP, may become a bigger part of CIP savings over time.

Enhanced programmatic strategies likewise might call for different methods to validate energy savings. For instance, those strategies employing smart meters data may require new, data-intensive savings validation methods.

For all of these reasons, the project team expects the Department's review of CIP programs in the 2020s to become more complex, compared to recent years.

Past Department Conservation Applied Research and Development (CARD) projects have helped to inform potential study estimates, and paved the way for increased savings from new end uses.

The Conservation Applied Research and Development (CARD) program is overseen by the Department, and is intended to help identify new technologies and programmatic approaches for CIP programs. This potential study was funded by CARD, as well as numerous other research projects that informed the inputs into this study.

For example, one of the major findings of this report is that cold-climate air source heat pumps (ASHPs) are a major new source of savings for CIP in the future. The technical inputs that the study team used were informed by a CARD-funded project that field tested new cold-climate ASHPs, and verified the heating load that could be achieved in Minnesota's climate. As CIP programs are very technology-forward, and traditional CIP programs such as lighting will need to be replaced, it appears that continuing research of this type will be important in order to pave the way for increased savings from new end uses.

Regulatory Oversight: Stakeholder input

Stakeholder survey shows mostly strong support for current Department regulation.

This study's stakeholder survey showed that over 80% of stakeholders reported having a favorable experience with CIP, with a small minority reporting unfavorable experiences (Figure 10, Chapter 2). This was confirmed by individual interviews, where most utilities and other stakeholders reported they found the regulatory approach of the Department to work well for them.[101]

Most stakeholders support a practical approach that minimizes confusion and provides regulatory clarity.

Individual conversations with stakeholders also emphasized their value on practicality, and getting things done in a 'common-sense' manner.

For example, Minnesota regulators do not require a "net-to-gross" calculation for savings (see discussion on page 89 for net-to-gross issues), which, in states that do this, tends to increase the regulatory burden of efficiency programs, to the benefit of having increased confidence in net savings values. However, from the study team's work reviewing utility portfolios, utilities do tend to manage their programs to minimize "free riders" — or participants that would have participated anyway without any incentives.[102] The issue of net-to-gross is important for utility-attributed savings, and yet lots of time, funding, and regulatory filings can be spent on the topic without much of a change in result. Most stakeholders supported the practical approach taken in Minnesota of dealing with net-to-gross issues

[101] COUs were more likely than other stakeholders to express dissatisfaction with the CIP regulatory process, which stemmed both from some of the increased challenges they face (see Chapters 4 and 5 for more discussion of this) and a greater likelihood to believe that CIP regulation is unnecessary for COUs.

[102] Especially for the smaller utilities, this policy of minimal spending on program evaluation is a practical reality. One can envision millions of dollars being spent on evaluation if every utility in the state separately did intensive program evaluations of all of their programs, and especially for small utilities, this could become a substantial portion of their overall program expenses. The study team's experience in talking with both large and small utility program managers (including and especially COUs), is that they do express concern that lighting or other programs may face too much free-ridership in the future, and thus dilute the value of the dollars they spend on CIP programs. The two main ways of managing the freeridership issue, without doing net-to-gross evaluations are: 1) utilize good program design, and/or eliminate programs that have high free-ridership issues; 2) adjust the savings level for programs with high freeridership, so that the utility claims a blend of the savings from program-influenced participants and free riders. Both methods are reportedly used by Minnesota utilities.

with good program design, or adjusting the baseline of measures to account for free ridership, rather than extensive evaluation and regulatory filings.[103]

Stakeholders also indicated that increased regulatory clarity would be helpful on some topics. For example, stakeholders repeatedly noted the important role that they expect operational savings to play in future CIP portfolios. In the CIP stakeholder survey, 73% of respondents stated that behavioral and operational savings should have greater emphasis in CIP.[104] Minnesota Power stated in response to the second request for written comments:

> *"This type of program offering [operational savings] has significant potential that could be pursued if there were 1) a more clearly established method for incentivizing non-asset driven investments and 2) published criteria for calculating associated (influenced) energy savings. With such a path in place, these activities could be more specifically and explicitly incorporated into CIP programs and more customers could benefit from these efforts."*

Stakeholders also pointed to savings from codes and standards as another area for regulatory clarity. More generally, stakeholders noted that there is no single place for looking up CIP regulatory policy; it is scattered across multiple dockets spanning 20 years. Looking up a given policy in these dockets can be time-consuming and tedious.

Regulatory oversight of CIP: Conclusions

Clarity on key regulatory topics could be increased through the creation of a CIP guide.

The stakeholder discussion above, and in Appendix N, suggests a few areas where utilities may be able to expand current program offerings with increased regulatory clarity. In addition, it is sometimes hard for utilities to find existing CIP regulatory guidance, as it is not gathered together in one location. One solution would be for the Department to create a CIP guide, to increase clarity on key regulatory topics. Other states, such as Illinois, have done similar guidebooks that have been well-received.[105] Recognizing

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[103] Note that when considering efficiency programs from the societal perspective (as was done for this report, by using the societal cost test to screen measures), the issue of net-to-gross is less important. This is because the viewpoint is whether society as a whole benefits from a particular energy efficiency measure, regardless of whether the participant or the utility was the "cause" of installing that particular measure. The net-to-gross issue is more important from the utility perspective, and for the utility cost test, as only the utility investment is considered, not the participant's contribution.

[104] Although, through written comments, stakeholders noted the distinct and important difference between behavioral and operational savings. Xcel Energy stated, "Operational savings involve activities that optimize existing systems without installing new equipment, such as programming or adjusting settings. These savings persist long after the action has been taken." Xcel goes on to say, "In contrast, behavioral programs require longer-term intervention in order to create some level of persistence, if it persists at all (See Appendix N).

[105] See "Illinois Energy Efficiency Policy Manual Version 1.1, A Manual Guiding the Operation of Illinois Energy Efficiency Programs," Available at: http://ilsagfiles.org/SAG_files/Subcommittees/IL_EE_Policy_Manual_Subcommittee/2017_Revision/IL_EE_Policy_Manual_Version_1.1_5-5-17_FINAL.pdf.

that it could take time to create such a document all at once, there may be other methods to achieve increased regulatory clarity.

Consider creating a formal advisory committee for CIP regulatory policy to increase transparency and avenues for stakeholder coordination on CIP implementation.

The Department has a strong history of actively engaging stakeholders in decision-making, as the stakeholder outreach conducted for this project demonstrates. The Department could consider formalizing this stakeholder involvement by establishing a standing advisory committee of CIP stakeholders. The purpose of this body would be to provide input to the Department of Commerce on CIP regulatory policy issues. Doing so would allow the Department to engage the advisory committee as needed to proactively consider regulatory policy issues and obtain stakeholder guidance.

Continue to have strong research and development to support future energy savings.

CIP programs are very technology-forward, and a strong, coordinated Minnesota-specific research and development agenda is crucial for optimal performance of these programs. It would be beneficial to utilities and their customers for the Department to continue to focus the CARD program on new technologies and new approaches in order to generate savings well into the future.

Topic Area 3: Incorporating demand-response and efficient fuel-switching into CIP

Demand-response is shifting load from a period of high demand to a period of low demand (Appendix E provides a thorough discussion of different types of programs and technologies for accomplishing this). For IOUs, demand-response is allowed within CIP only if the demand-response program also saves energy. This limitation leaves out a large number of demand-response strategies that could benefit customers (see Appendix E).

The study team defines efficient fuel-switching as projects that result in converting a customer from use of one fuel to the use of another, lead to a net increase of the use of electric energy or natural gas, and result in an overall net decrease in energy consumption on a fuel-neutral basis. Fuel-switching is currently not allowed in CIP, except in limited circumstances for low-income customers with delivered fuels or customers of non-CIP regulated natural gas utilities.[106] In recent years, many organizations have made the case for programs to encourage fuel-switching in cases where it has clear energy efficiency, cost-reduction, and emissions benefits; particularly for electric utilities.[107] Natural gas utilities, and other energy providers, have urged more caution in approaching the fuel-switching issue.[108]

Cost-recovery and regulatory oversight treatment, similar to that of CIP, could motivate utilities to pursue these demand-side management activities further; this may result in additional benefits to Minnesota utility customers. Additionally, demand-response and efficient fuel-switching (both customer-facing activities that act on customer energy end uses) provides opportunities for synergy when pursued in coordination with energy conservation — increasing net benefits for utility customers, an approach known as "integrated demand-side management."

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[106] CIP Policy Guidelines: Energy Savings from Delivered Fuels, Minnesota Division of Energy Resources, August 3, 2012. Available at: http://mn.gov/commerce-stat/pdfs/conserve-prog-delivered-fuels.pdf.

[107] See, for example: David Farnsworth, et. al, "Beneficial Electrification: Ensuring Electrification in the Public Interest," Regulatory Assistance Project, 2018. Available at: https://www.raponline.org/knowledge-center/beneficial-electrification-ensuring-electrification-public-interest/.

[108] See "Implications of Policy-Driven Residential Electrification," American Gas Association, prepared by ICF, 2018. Available at: https://www.aga.org/globalassets/research--insights/reports/AGA_Study_On_Residential_Electrification.

Incorporating demand-response and efficient fuel-switching: Relevant findings

Demand-response programs will increasingly be needed for integrating carbon-free renewables onto the grid and to balance high load with high-generation times.

Some of the energy pricing forecasts suggest there will increasingly be times of the year that the marginal cost of energy is very low or zero.[109] This is due to increasing penetrations of wind and other intermittent resources on the grid. Demand-response programs can help to balance these resources, and shift load from times of high-cost and high-emissions, to times of lower cost and lower emissions. Thus, demand-response can play a role in enabling more carbon-free generation on the grid, and lowering overall carbon levels in the state.

With appropriate safeguards, efficient fuel-switching could significantly increase overall efficiency, decrease emissions, and reduce costs for consumers.

While a comprehensive evaluation of potential savings through efficient fuel-switching was beyond the scope of this study, other research and data collected for this study suggest that efficient fuel-switching could result in further energy savings for Minnesotans. One potential use-case of efficient fuel-switching was examined by using data on the 278,000 single-family propane households in Minnesota and data on cold-climate air-source heat pumps (ASHP)s. When replacing propane with ASHPs, initial findings show that existing propane customers could cost effectively install air source heat pumps while maintaining propane furnaces as back-up heat, and save the equivalent of 2,600 GWh per year in heating fuel.[110] This represents 3.6% of all projected retail electricity sales in 2020. This would result in reduced emissions and customer heating costs as well as reduced energy consumption.[111]

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[109] While most of the utility-provided pricing forecasts used for this study are not publicly available, some utilities have released information demonstrating increased hours of the year with low costs, presumably driven by increased renewables penetration. See: Xcel Energy Modification Request, June 6, 2018, Docket No. E,G002/CIP-16-115: 2017-2019 Minnesota Electric and Natural Gas Conservation Improvement Program.

[110] AHSP annual savings (9,372 kWh/yr) is estimated from a field study of savings in a propane house, in Ben Schoenbauer, "Cold-Climate Air-Source Heat Pump," Conservation Applied Research and Development grant, 2017. The house that the field study was conducted in had a design heating load of 32,000 btu/hr at -11F and a balance point of 60F. This results in a heating load in line with RECS 2009 data for the Midwest. See: https://www.cards.commerce.state.mn.us/CARDS/security/search.do?documentId=%7B339B1EA5-AA5C-422E-AEC5-CA58A8EE10CA%7D.

[111] This is for MN statewide projected grid emissions and other assumptions as documented in: Jennifer Edwards et. al, "Brrrrr…! The Outlook for Beneficial Electrification in Heating Dominant Climates," ACEEE Summer Study 2018. Available at: https://www.mncee.org/MNCEE/media/PDFs/Brrrrr%E2%80%A6!-The-Outlook-for-Beneficial-Electrification-in-Heating-Dominant-Climates.pdf.

Incorporating demand-response and efficient fuel-switching: Stakeholder input

There is strong electric utility support for incorporating demand-response and efficient fuel-switching into CIP.

Throughout the policy stakeholder process, numerous stakeholders discussed the benefits of demand response and efficient fuel-switching, and noted the importance of both activities. Some stakeholders felt strongly that demand-response and fuel-switching that reduces energy consumption should be included in CIP. They noted that both demand-response and efficient fuel-switching can, under certain circumstances, provide customer, utility system, and environmental benefits; similar to energy conservation. Eighty-two percent of respondents in the CIP stakeholder survey stated that demand-response should be allowed in CIP, and 65% of respondents thought that electrification (a type of fuel-switching) should be allowed in CIP.

Otter Tail Power, for example, explained:

> *"Otter Tail believes it is imperative to include the benefits of demand-response (DR), carbon reduction, and electrification in CIP. As stated in previous comments, Otter Tail supports including any program in CIP which provides net benefits to customers by saving energy, shifting energy usage to low-cost periods, reducing carbon emissions, or reducing overall fuel consumption."*[112]

Still other stakeholders indicated that CIP should remain separate from demand-response and electrification. CenterPoint Energy stated,

> *"[I]n CenterPoint Energy's view, the purpose of CIP is and should remain energy efficiency. Existing statute already allows for load management which reduces overall energy consumption to be included within CIP. Load management efforts which do not reduce energy consumption should not be paid for using funds collected from customers for energy efficiency programs. Encouragement of measures that further goals other than energy efficiency should not come at the expense of energy efficiency."*[113]

Given the seemingly stark difference in opinion on this matter, the study team engaged further with stakeholders to understand the reasons underlying stakeholder's strong opinions on this topic. Through that engagement, the team determined that stakeholders have different interpretations of what it means to include demand-response or electrification "in CIP." The team found that CIP means different things to different stakeholders. From one perspective, CIP is a utility regulatory structure overseen by the Department of Commerce, rather than the Minnesota Public Utilities Commission. From another, it

[112] Otter Tail Power Company, Response to Second Request for Written Comment, Page 2, Question 2.

[113] CenterPoint Energy, Response to Second Request for Written Comments, Page 2, Question 2.

is a cost-recovery mechanism for a set of customer-facing utility programs. From a third, CIP ensures that utilities are actively seeking to reduce customer's energy consumption through policies designed to overcome the disincentives of energy conservation to the traditional utility business model. Through this deeper understanding of how stakeholders think of CIP, the team determined that there was less conflict of opinion than previously thought and that both demand-response and efficient fuel-switching may have a place in CIP.

Public interest concerns were raised about investor-owned utilities (IOUs) receiving incentives for load-building activities.

Stakeholders pointed out that energy efficiency, demand-response, and efficient fuel-switching all have different impacts on the utility business model and policies must reflect those differences. For example, there is a fundamental disincentive for a utility to implement energy efficiency programs that decrease its sales. This same disincentive does not apply to demand-response programs (although, a utility may face different disincentives for demand-response), and clearly does not apply to load-building — which is inherently in the economic interest of energy utilities.

Public interest concerns were raised about demand-response and efficient fuel-switching diluting or competing for limited capital with energy efficiency efforts.

Many stakeholders indicated that they would not want efforts to pursue demand-response or efficient fuel-switching to offset or replace energy conservation activities. The American Council for an Energy-Efficient Economy (ACEEE) stated in written comments:

> *"Demand-response itself may be an appropriate objective for the state, but it should not be pursued at the expense of achieving energy savings (i.e., DR should not take CIP funds, and DR goals should not detract from energy savings goals). To the extent that Minnesota wants to encourage demand-response, a parallel set of goals and associated incentives could very well be set up and applied, but should not detract from CIP energy-savings goals and incentives."*[114]

Both demand-response and efficient fuel-switching programs are customer-facing programs, like CIP.

Stakeholders also see the potential for synergies in the implementation of energy conservation programs, demand-response activities, and efficient load building efforts. At the same time, they caution against separate, duplicative efforts at the program level for those particular types of programs where a combined approach would make sense. As Fresh Energy stated in written comments:

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[114] American Council for and Energy-Efficiency Economy, Response to First Request for Written Comments, Page 2, Question 3.

"CIP currently provides utilities with a powerful customer engagement structure to deliver energy savings and provide some education on energy use. Creating a new but similar structure focused on demand-response may be duplicative and create confusion if it competes with CIP outreach for customer attention. In addition, if the utility is approaching a customer about demand-response there may be opportunities to implement significant energy savings as well, which would be lost if two siloed programs are operating simultaneously. Therefore, it may be more efficient to house demand-response efforts under this framework within CIP but establish separate goals and incentives."[115]

Often technologies that are being promoted for energy efficiency and fuel-switching are the same. For example, according to this study's modelling results, the single largest electric energy efficiency opportunity in the residential sector is air source heat pumps for customers that heat with electricity. Similarly, this same technology offers potential energy savings from efficient fuel-switching as well.

Incorporating demand-response and efficient fuel-switching into CIP: Conclusions

Consider whether to incorporate "integrated demand-side management" into CIP framework – with appropriate safeguards.

Utility programs could be encouraged to facilitate cost-effective, efficient fuel-switching improvements and demand-response as a matter of state policy, through a framework similar to CIP, with distinct goals, cost-recovery, and appropriate incentives. As discussed above, the business model impacts of CIP, demand-response, and fuel-switching are distinct and different. Therefore, different incentive structures are required for demand-response activities, and no incentive is required for efficient fuel-switching.

Opportunities at the program level for coordinating services to customers for energy efficiency, demand-response, and efficient fuel-switching should be evaluated for incorporation into CIP. These programs could benefit from a coordinated regulatory oversight framework. Where such coordination of program elements is appropriate, this could provide multiple benefits for utility customers.

If pursued, it would be important to develop separate goals, metrics, and criteria for each of the three activities. Similarly, any utility performance incentives should be structured uniquely for each activity and based upon the impact on the utility business model. The project team further recommends that decision makers and stakeholders undertake a robust exploration of the potential overlap between energy efficiency, demand-response, and efficient fuel-switching. This will help in developing clear criteria for how and under what policy mechanism to assign costs and credit benefits for specific activities and achievements.

[115] Fresh Energy, Response to Second Request for Written Comments, Page 2, Question 2.

The Department's review of fuel-switching through a CIP docket[116] and stakeholder process, which it plans to kick-off in the coming months, should provide a strong foundation for this discussion.

[116] Docket Number CIP-18-402.