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MINNESOTA'S 2025 ENERGY ACTION PLAN

STAKEHOLDER-DRIVEN STRATEGIES FOR SUCCESS

REPORT PREPARED FOR MINNESOTA DEPARTMENT OF COMMERCE AND THE MINNESOTA LEGISLATIVE ENERGY COMMISSION

SUBMITTED BY ROCKY MOUNTAIN INSTITUTE BASED ON INPUT FROM THE 2025 STAKEHOLDER ADVISORY COMMITTEE

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About Rocky Mountain Institute

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. In 2014, RMI merged with Carbon War Room (CWR), whose business-led market interventions advance a low-carbon economy. The combined organization has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing.

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GLOSSARY OF TERMS

- **Advanced biofuels** –renewable fuels other than ethanol derived from cornstarch, wood, agricultural residues, organic wastes, and other renewable biomass, and achieve a 50 percent GHG emissions reduction requirement
- **Advanced metering infrastructure (AMI)** – an integrated system of smart meters, communications networks, and data management systems that allows communication between customers and utilities
- **Alternative fuel vehicles (AFVs)** – vehicles that are powered by fuels other than petroleum, including battery electric, hybrid gas and electric, natural gas, biofuels, and hydrogen fuel cells
- **Anaerobic digestion** – a series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen; by-product is combustible biogas, which can be used to generate electricity or heat, or can be processed into renewable natural gas and transportation fuels
- **Benchmarking and disclosure** – voluntary or mandated programs in which a building's energy use is measured and, in the case of disclosure, shared publicly in some manner
- **Biobased chemicals** – chemicals derived from forestry, agricultural, and organic waste materials, rather than petroleum
- **Biofuels** – energy sources derived from agricultural materials, forestry materials, and other biomass resources
- **Clean energy** – low-emission energy sources, including renewables and, in some cases, natural gas and nuclear energy
- **Combined heat and power (CHP)** – cogeneration of useful thermal and electrical energy
- **Demand response** – a mechanism by which customers are compensated by the utility for shedding or shifting their load during times of peak energy demand
- **Distributed energy resources (DERs)** – smaller-scale, decentralized power sources and/or conversion equipment, including renewable energy, energy efficiency, demand response, and energy storage technologies
- **Electric vehicles (EVs)** – vehicles that are powered by an electric powertrain
- **Energy efficiency** – measures that target consumer behavior, technology, or processes to either reduce energy consumption, or use less energy on a per-unit basis to provide the same service
- **Fossil fuels** – hydrocarbon deposits formed by the decomposition of prehistoric organisms; includes coal, natural gas, and petroleum
- **Greenhouse gases (GHGs)** –gases that contribute to the greenhouse effect by absorbing infrared radiation, including carbon dioxide, methane, and chlorofluorocarbons
- **Grid modernization** – upgrades to the electrical grid infrastructure that support reliability, operations, customer engagement, and the integration of distributed energy resources with improved communication and other supporting technology
- **Renewable energy** – Energy from sources that can be renewed within a reasonable amount of time, including solar, wind, hydro, tidal, geothermal, and biomass
- **Retrocommissioning** – a process for evaluating, adjusting, and/or replacing a building's equipment, lighting, and control systems to reach optimal performance based on its design
- **Smart inverter** – device that converts direct current to alternating current, and has bidirectional communication abilities, digital architecture, and software infrastructure for grid support functions
- **Thermal grid** – a heating and/or cooling distribution system network
- **Time-based rates** – electricity rates that are based on the time at which energy is consumed to account for system demand
- **Utility green power programs** – programs offered by electric and natural gas utilities for customers to purchase clean energy from sources separate from the utility's standard resource mix.

Acronyms

- B3: Buildings, Benchmarks and Beyond: Minnesota's sustainable building program
- CEE: Center for Energy and Environment
- CERTs: Clean Energy Resource Teams
- CIP: Conservation Improvement Program
- COMM: Minnesota Department of Commerce
- CSBR: Center for Sustainable Building Research
- CSEO: Climate Solutions and Economic Opportunities
- DEED: Minnesota Department of Employment and Economic Development
- DLI: Minnesota Department of Labor and Industry
- DNR: Minnesota Department of Natural Resources
- DOE: United States Department of Energy
- EQB: Minnesota Environmental Quality Board
- GPI: Great Plains Institute
- ICE: Internal Combustion Engine
- MDA: Minnesota Department of Agriculture
- MnTAP: Minnesota Technical Assistance Program
- MPCA: Minnesota Pollution Control Agency
- MRITS: Minnesota Renewable Energy Integration and Transmission Study
- PUC: Minnesota Public Utilities Commission
- RES: Renewable Electricity Standard
- SB 2030: Sustainable Buildings 2030 standard
- USDA: United States Department of Agriculture

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1. EXECUTIVE SUMMARY

The 2025 Energy Action Plan lays out a path forward for Minnesota to help advance a clean, reliable, resilient, and affordable energy system for Minnesota. Funded through a U.S. Department of Energy grant, the 2025 Energy Action Plan focuses on near-term, cross-sector strategies that add value to Minnesota's dynamic energy landscape. While the scope of these strategies is wide, the Action Plan is not intended to be a comprehensive energy plan for the state; it centers on consensus-driven strategies with traction to move forward.

A changing energy landscape

Minnesota is facing a rapidly changing energy landscape that offers opportunities in the near term to make progress toward clean energy while boosting the state economy. Several trends indicate a changing outlook for the state's energy landscape:

- Vehicle technology is becoming more efficient, with vehicles that run on electricity[1] and other alternative fuels gaining market share.[2]
- The century-old energy production paradigm is quickly shifting. Clean energy resources are becoming cost-competitive with conventional energy resources[3] and are becoming more appealing to consumers.[4]
- Technology to allow the efficient use of energy is evolving quickly,[5] and data to support energy efficiency investments is becoming increasingly accessible to utilities and consumers.[6]
- Minnesota's agricultural businesses and other industries continue to advance local energy resources and drive progress toward leadership in the clean energy economy.[7]
- All the while, local governments and tribal nations in Minnesota, like others around the country, are increasingly advancing community-scale solutions to climate and energy challenges.[8]

These developments, coupled with federal environmental regulations, state policies, and state goals, can help Minnesota move toward a clean energy future. The current momentum has Minnesota poised to strengthen its leadership in the Midwest and the rest of the nation. Taking advantage of these opportunities over the next ten years will be pivotal in determining the state's energy future. By acting now, Minnesota can position itself as a competitive player in a $200 billion national clean energy market and a $1.4 trillion global clean energy market.[9]

The 2025 Energy Action Plan identifies paths forward

The Energy Action Plan identifies strategies with traction to move forward and capture opportunities that can strengthen Minnesota's clean energy leadership. The Action Plan tells the story of Minnesota's current energy landscape and identifies priority strategies with actionable steps to advance these strategies over the next ten years. This report also includes indicators that can be used to track and communicate the impacts of the Action Plan in the future.

Strategies were selected through a rigorous stakeholder engagement process. The Stakeholder Advisory Committee[10] provided input in the development of technologies, strategies, and baseline and outcome indicators, and the committee steered the development of the 2025 Energy Action Plan through three meetings held between July and December 2015.

Stakeholders selected strategies based on a set of common criteria:

- The strategy or technology's **potential impact to support Minnesota's current goals** (outlined in Table ES1 below) related to energy, climate and air quality, and environmental justice
- The potential for the 2025 Energy Action Plan project to **significantly advance progress toward clean energy** on a particular strategy in the context of related projects in Minnesota
- Anticipated **benefits relative to costs**
- **Commitment** by stakeholders or other champions to advancing the strategy and ability to leverage additional resources
- Potential to provide benefits **across economic sectors**, and
- **Ten-year timeframe** for implementation.

FIGURE ES1: HIGHLIGHTED MINNESOTA CLEAN ENERGY POLICIES AND CURRENT STATUS

Area	Goal/Requirement	Status
Total Energy Consumption and GHG Emissions		
Conservation Improvement Program (M.S. 216B.241)	Energy savings of 1.5 percent of gross annual retail sales for all electric and natural gas utilities	On track – Utilities are meeting their energy efficiency goals[11]
Per Capita Fossil Fuel Use (M.S. 216C.05)	Reduce by 15 percent by 2015	On track – 14 percent reduction from 2005–13[12]
Renewable Energy Goal, total energy (M.S. 216C.05)	Derive 25 percent of total energy used in the state from renewable resources by 2025	Caution – Minnesota obtained 13 percent of its energy from renewable resources in 2013[13]
Greenhouse Gas Emissions Reduction (M.S. 216H.02)	Reduce state greenhouse gas emissions 15 percent below 2005 base levels by 2015, 30 percent by 2025, and 80 percent by 2050	Not on track – According to a recent MPCA analysis, Minnesota is not on track to meet 2015 or 2025 goals[14]
Renewable Electricity		
Renewable Electricity Standard (M.S. 216B.1691)	Derive 25 percent of retail electricity sold in the state from renewable resources by 2025; 30 percent for Xcel Energy by 2020	On track – Utilities retired Renewable Energy Credits (RECs) representing 14.8 percent of 2014 total retail sales in Minnesota.[15] Utilities are planning for renewable generation to meet or exceed future RES milestones[16]
Solar Electricity Standard (M.S. 216B.1691)	Generate 1.5 percent of public utility retail electricity sales from solar energy by 2020. Goal: Generate 10 percent of all retail electricity sales from solar energy by 2030.	On track – Utilities are planning for solar generation to meet or exceed the 1.5 percent standard
Biofuel Content		
Gasoline - Petroleum Replacement Goal (M.S. 239.7911)	30 percent renewable fuels in total gasoline sold or offered by 2025	Caution – The ethanol content in 2015 total gasoline sales was 10.3 percent[17]
Gasoline - Biofuel Content Mandate (M.S. 239.791)	10 percent ethanol or other approved biofuel in all gasoline fuel sold or offered	On Track – The ethanol content in 2015 total gasoline sales was 10.3 percent[18]
Diesel - Biodiesel Content Mandate (M.S. 297.77)	20 percent biodiesel in all diesel fuel sold or offered by 2018	Caution – The biodiesel content in 2015 total diesel sales was 7.4 percent.[19] Minnesota's existing capacity can provide 55 percent of the biodiesel required to meet its target[20,21]

Abundant near-term opportunities

Importantly, most strategies in this Action Plan do not require an act of Congress or additional legislation to be successful; strategies can be advanced immediately, either individually or in tandem. Within each strategy, cross-sector opportunities and related initiatives are identified. Dedicated leadership will be critical to the success of the Action Plan. Each strategy has a defined champion and key participants to move it forward over the next ten years.

Ultimately, the 2025 Energy Action Plan seeks to help Minnesota prepare for a changing energy landscape and take full advantage of the opportunities available today. The Action Plan aims to assist Minnesota in fulfilling—and in some cases, even exceeding—its energy policies and goals, and in so doing, advance a clean, efficient energy system for all Minnesotans. The strategies fall into five categories, which are summarized below:

- Transportation
- Energy supply and grid modernization
- Efficient buildings and integrated energy systems
- Industrial and agricultural processes
- Local planning and action

Transportation

In 2014, Minnesotans spent $11 billion on transportation fuels,[22] the majority of which were imported from out of state. The opportunity to keep transportation fuel dollars in the state and increase the sector's clean energy footprint is significant. Stakeholders' recommendations for the transportation sector fall into two key categories: electric vehicles and alternative fuel vehicles.

Electric vehicles (EVs) offer reduced fuel and operations and maintenance costs, as well as decreased air pollution, and are becoming more cost-effective. Stakeholders recommended the following strategies related to EVs:

- **Increasing adoption of personal electric vehicles** through bulk discount arrangements, incentives for new EV purchases, and expanded workplace charging
- **Encouraging electric vehicles in fleets** by creating a bulk purchase arrangement and convening an EV procurement workshop for fleet managers
- **Promoting electric buses** by validating lifecycle cost studies and demonstrating electric buses on urban and suburban transit routes

Alternative fuel vehicles (AFVs) are also an attractive transportation option. AFVs can bolster the state economy, since their fuel sources can be produced in Minnesota. Their carbon emissions are lower than conventional vehicles, and they offer longer ranges than electric vehicles. Stakeholders recommended:

- **Increasing adoption of heavy-duty alternative-fuel vehicles** that use natural gas, including natural gas produced locally from anaerobic digestion, as a fuel source

Energy supply and grid modernization

Electricity generation in Minnesota accounts for 29 percent of total energy use in the state, with 44 percent of the energy used to produce electricity coming from coal.[23] Minnesota has abundant wind and solar resources, and in 2015, 21 percent of the state's electricity came from renewable energy.[24]

In order to promote local resources and keep additional energy dollars in the state, Minnesota can effectively integrate additional clean energy resources onto the grid, and establish pricing signals that more accurately capture the cost of electricity generation. Stakeholders' recommendations for the energy supply sector fall into two key categories: grid modernization, and pricing and tariff structures.

Modernizing the grid will enable more two-way flows of electricity, information, and value, to allow for the expansion of large-scale, variable renewable energy sources and to unlock opportunities for energy efficiency. Stakeholders identified the following strategies to modernize the grid:

- **Deploying advanced metering infrastructure (AMI)** to allow for collection of more granular information and to enable communication between the utility and the customer
- **Enabling smart inverter functionality** to allow utilities to better integrate increasing levels of solar power, and potentially other distributed energy resources, with the grid
- **Integrating energy storage and demand response** to reduce peak power demands, lower customer costs, and enable additional renewable energy penetration

Updated pricing and tariffs can better reflect the grid-level costs of consumption, and can empower customers with choices, allowing them to reduce their energy bills and reduce costs for the entire energy system. Stakeholders identified the following strategies related to pricing and tariffs:

- **Adopting time-based rates** to more accurately capture the cost of electricity generation and reduce overall costs to the grid by avoiding investment in peaking capacity
- **Expanding and improving utility green power options** to meet increasing customer demand for renewable electricity and renewable natural gas

Efficient buildings and integrated energy systems

Residential and commercial buildings account for two-thirds of the state's electricity use and more than half of natural gas delivered in Minnesota.[25] Minnesota has demonstrated national leadership and progress toward an energy efficient building stock already,[26] which has set the stage for even more substantial energy savings.

New buildings present an excellent opportunity to design for optimal energy performance right from the start. Stakeholders recommended the following strategies related to new buildings:

- **Adopting SB 2030 as an optional stretch code** for new buildings, additions, and major renovations

Existing buildings will continue to play a key part in the energy equation over the next decade. Stakeholders recommended the following strategies related to existing buildings:

- **Enhancing energy data access** through a standardized data protocol in order to unlock energy savings
- **Increasing adoption of commercial-building energy-benchmarking and disclosure programs** by expanding access to B3 Benchmarking and working with local governments and tribal nations
- **Improving buildings operations** through retrocommissioning and ongoing commissioning, building operator training, and advanced buildings controls
- **Promoting behavioral energy efficiency strategies** to capture cost-effective energy reductions and sustain savings over time

Integrated energy systems offer the opportunity to optimize energy use across buildings. Strategies to advance integrated energy systems include:

- **Identifying opportunities for thermal energy grids** and integrating existing thermal grids with district energy systems
- **Supporting combined heat and power (CHP) development** by advancing the recommendations from the Minnesota Department of Commerce's 2015 CHP Action Plan

Industrial and agricultural processes

Minnesota's industrial and agricultural sectors contribute significantly to the state's economy, and account for 34 percent of the state's energy use. Minnesota has been a national leader in bioenergy development,[27] and

industries have begun making progress toward increased energy productivity.[28] Still, there remain significant opportunities for Minnesota's agricultural and industrial sectors to continue Minnesota's economic growth through bioenergy, energy productivity, and clean energy development.

Promoting bioenergy allows Minnesota to build upon its existing bioenergy resources and leadership to create low-carbon fuels for a variety of uses. Stakeholders identified the following strategies to promote bioenergy:

- **Commercializing advanced biofuels and biobased chemicals** through supply chain mapping, addressing feedstock supply and infrastructure, and identifying and addressing permitting barriers
- **Capturing organic feedstocks through anaerobic digestion** by resetting the conversation on anaerobic digestion, incorporating anaerobic digestion into the state's solid waste hierarchy, and establishing a public-private partnership to demonstrate an anaerobic digestion project incorporating biogas

Reducing wasted energy and promoting clean energy focus in Minnesota's industries can lower energy costs, improve competitiveness, and benefit the state's economy. Stakeholders identified the following strategies to promote energy efficiency and clean energy:

- **Promoting industrial and agricultural efficiency practices** by sharing state and federal programs to improve energy productivity, and strengthening peer networks to share best practices on energy management
- **Coordinating and promoting the clean energy industry** to coalesce Minnesota's energy and business community around the state's competitive strengths in clean energy

Local planning and action

Leading local governments and tribal nations in Minnesota are demonstrating that it is possible to make progress toward a cleaner, more resilient energy system at the local level, for example through voluntary participation in challenges around best practices.[29] Understanding that many changes start at the local level, stakeholders identified strategies to **advance local energy planning** and **pursue near-term actions** at the local level.

- **Advance local energy planning** by developing resources and tools to assist local governments and tribal nations in their energy-related planning
- **Pursue near-term actions at the local level** that can help local governments and tribal nations make progress toward clean energy in the near term.

Additional opportunities

The strategies in this Energy Action Plan were selected based on common criteria, among them, potential to drive progress in the state in the near-term. However, stakeholders identified many more strategies that did not meet all the selection criteria, but will likely be relevant in shaping Minnesota's energy system. These additional opportunities are listed below and outlined further in the full report.

- Autonomous electric vehicles
- Vehicle miles traveled (VMT)-based pricing
- An expanded Renewable Electricity Standard (RES)[30]
- Expanded incentives for distributed energy resources (DERs)
- Geothermal energy
- Distributed generation

Cross-sector opportunities

All of the strategies in this Action Plan have important relationships with strategies in other sectors. Notably, local governments and tribal nations have a key role to play in driving and executing community-level action to

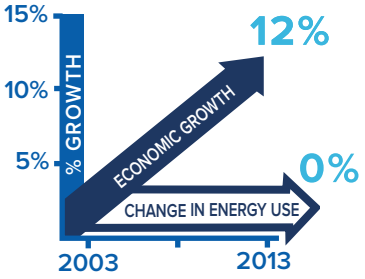
make progress in each of those sectors. This report has laid out where these cross-sector opportunities may be most important, in order to let stakeholders focused on one particular opportunity know where their actions may influence or depend on the actions of others.

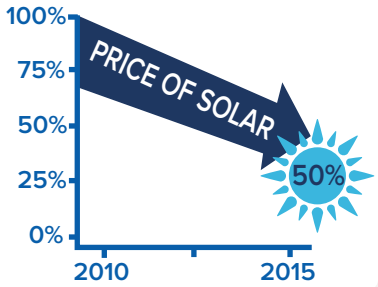
Capturing the momentum

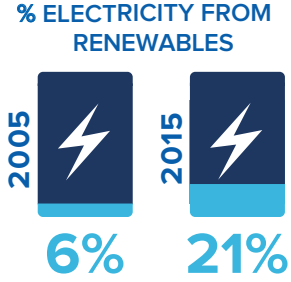
This Energy Action Plan identifies strategies to capture the large opportunity Minnesota has to make progress toward existing goals, develop a competitive advantage in the clean energy industry, and advance Minnesota's leadership in the region and the nation. As state- and national-level clean energy trends accelerate, the report identifies how Minnesota can act now to capitalize on its ongoing clean energy initiatives, leverage local renewable natural resources, drive growth in an important sector of the state economy and advance a clean, reliable, resilient and affordable energy system for all Minnesotans.

MINNESOTA'S 2025 ENERGY ACTION PLAN

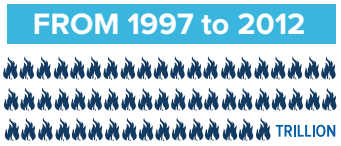
1 THE ENERGY LANDSCAPE IS RAPIDLY CHANGING







2 MOMENTUM TOWARD CLEAN ENERGY IS ALREADY BUILDING



MINNESOTANS HAVE SAVED OVER 56 TRILLION BTUs OF ELECTRICITY & NATURAL GAS

3 ACTION PLAN STRATEGIES ACCELERATE GROWTH IN 5 AREAS

TRANSPORTATION
Electric vehicles and alternative-fuel vehicles

ENERGY SUPPLY & GRID MODERNIZATION
Smart meters and smart inverters, storage, updated pricing and programs

EFFICIENT BUILDINGS & INTEGRATED ENERGY SYSTEMS
Low-energy design, efficient operations, thermal energy integration

INDUSTRIAL & AGRICULTURAL PROCESSES
Advanced biofuels, business leadership on energy

LOCAL PLANNING & ACTION Coordinated energy and resilience planning, adopting best practices

4 STAKEHOLDERS WHO WILL CONTRIBUTE TO CAPTURING THIS VALUE

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[30] *Minnesota Renewable Energy Integration and Transmission Study,* prepared by GE Energy Consulting for the Minnesota Department of Commerce, 2014, http://mn.gov/commerce/industries/energy/distributed-energy/mrits.jsp

2. INTRODUCTION

For decades, Minnesota has been on the leading edge of energy efficiency and renewable energy policy. Today, Minnesota is well positioned to expand its leadership in the Midwest and, increasingly, the rest of the nation. The 2025 Energy Action Plan lays out a path to enable the state to meet the state's renewable energy and energy efficiency goals, while strengthening the state's economy.

Funded through a U.S. Department of Energy grant, the 2025 Energy Action Plan outlines actionable steps, developed through a consensus process by stakeholders[i], for priority strategies and technologies over the next ten years. The Action Plan includes indicators that illustrate Minnesota's current energy landscape, and can be used to track and communicate the impacts of the Action Plan. Ultimately, the Action Plan aims to help advance clean and affordable energy for all Minnesotans.

Today, Minnesota is well positioned to expand its clean energy leadership in the Midwest and, increasingly, the rest of the nation.

Purpose statement

The purpose of the 2025 Energy Action Plan is to develop indicators and action plans to significantly advance a number of strategies and technologies for clean, efficient energy in Minnesota between now and 2025. Building upon related efforts, the Energy Action Plan will develop recommended next steps to leverage near-term opportunities to increase clean, affordable, reliable, and resilient energy in the state.

Intended audience and scope

The intended audience of the 2025 Energy Action Plan includes the Legislative Energy Commission, the Minnesota Department of Commerce, local government, utilities, business leaders, nonprofit professionals, university and academic professionals, and the broader Minnesota public.

The 2025 Energy Action Plan focuses on near-term, cross-sector strategies that add value to Minnesota's dynamic energy landscape. While the scope of these strategies is wide, this is not intended to be a comprehensive energy plan for the state. The 2025 Energy Action Plan contains recommended strategies under five categories:

- Transportation
- Energy supply and grid modernization
- Efficient buildings and integrated energy systems
- Industrial and agricultural processes
- Local planning and action

Project team

The Stakeholder Advisory Committee steered the development of the 2025 Energy Action Plan through three meetings held between July and December 2015 and through additional engagement outside of these meetings. The Committee ultimately selected the strategies and the baseline and outcome indicators. See the front matter for a list of committee members and additional participants.

[i] See the acknowledgements section for a list of Stakeholder Advisory Committee Members.

The Minnesota Department of Commerce and the Legislative Energy Commission provided high-level guidance to assure that the project meets guidelines for DOE funding.

The following consultants conducted analysis and research to support the deliberations of the Stakeholder Advisory Committee: Great Plains Institute (committee facilitation, stakeholder engagement); LHB, Inc. (metrics and indicators); and Rocky Mountain Institute (analysis and report development).

Additional project guidance and contributions came from Energy Systems Consulting, the Minnesota Environmental Quality Board, the Minnesota Pollution Control Agency, and the U.S. Department of Energy.

Additional stakeholder engagement and research methods

The project team reached additional stakeholders through the Metro and Greater Minnesota Clean Energy Resource Teams (CERTs) meetings, a presentation to the Minnesota Solar Energy Industry Association (SEIA), a food processors' workshop, and the Great Plains Institute's Energy Innovation Celebration Collaboratory. In addition, the project team conducted over twenty interviews with stakeholder advisory committee members, observers, and other relevant stakeholders, and reviewed relevant literature and Minnesota-specific studies.

Criteria for strategy selection

The Stakeholder Advisory Committee and project team selected strategies for inclusion in the 2025 Energy Action Plan based on common criteria:

- The strategy or technology's potential **impact to support Minnesota's current goals** related to energy, climate and air quality, and environmental justice
- The potential for the 2025 Energy Action Plan Project to **significantly advance progress toward clean energy** on a particular strategy in the context of related projects in Minnesota
- Anticipated **benefits relative to costs**
- **Commitment** by stakeholders or other champions to advancing the strategy and ability to leverage additional resources
- Potential to provide **benefits across economic sectors**
- **A timeframe of ten years or less** for implementation

3. MINNESOTA'S ENERGY LANDSCAPE

Section summary

In this section, we describe Minnesota's energy landscape, including trends in energy supply and consumption across sectors, and historic and projected greenhouse gas emissions.

- Minnesota has no indigenous fossil fuel supply and imports its fossil fuels, which represents 72 percent of the state's total energy supply [31,32]
- Even so, renewable energy makes up an increasing share of the state's energy mix, with 21 percent of *electricity* coming from renewables in 2015[33]
- While the state's greenhouse gas emissions decreased slightly from 2012 to 2015, total emissions are expected to exceed the state's goals for 2015 and 2025 levels[34]

What is shaping Minnesota's energy future?

A variety of factors are contributing to a changing energy landscape in Minnesota and throughout the country, including:

- **Market trends** toward cleaner, cost-competitive energy technologies and increased demand for customer choice[35]
- **Federal legislation and regulations** that are incentivizing renewable energy production and limiting emissions[36,37]
- **State policies and goals** that encourage energy efficiency, clean energy development, and reduced carbon emissions

Opportunities for further progress

While Minnesota has made great progress toward meeting its energy goals, there are opportunities for further progress toward a clean, affordable, reliable, and resilient energy system. Stakeholders identified five key categories of opportunity for Minnesota to pursue:

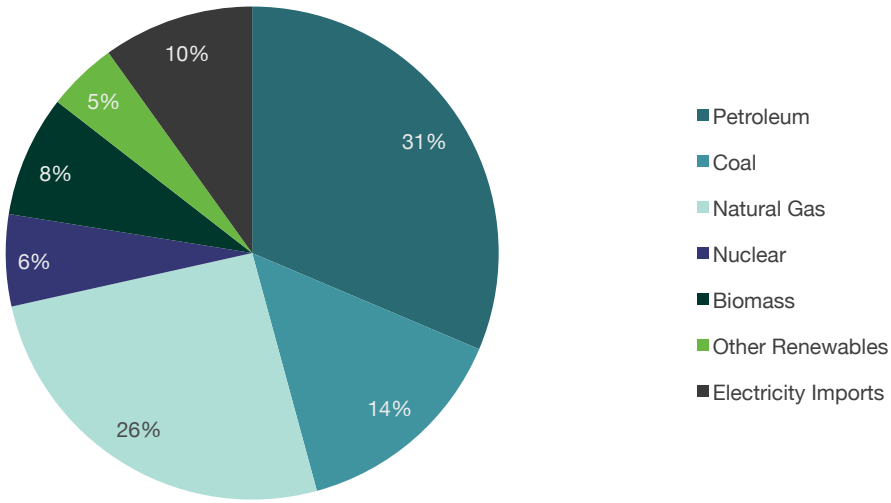
- Transportation
- Energy supply and grid modernization
- Efficient buildings and integrated energy systems
- Industrial and agricultural processes
- Local planning and action

This section concludes with guidelines for how to read and use this Energy Action Plan.

Energy supply

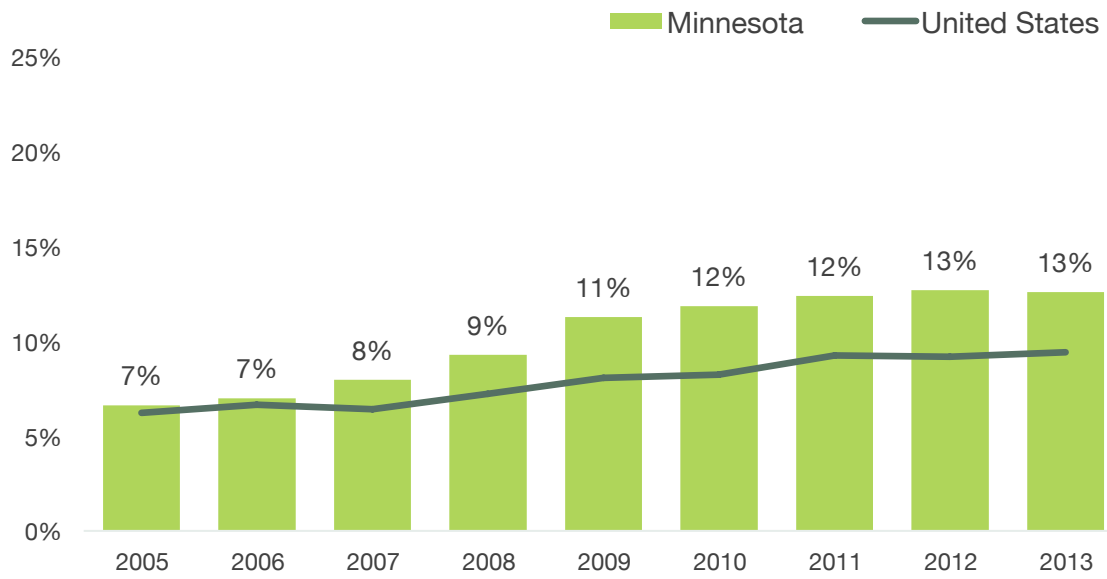
Minnesota has no indigenous fossil fuel reserves to supply its energy needs; the state imports its fossil fuel supply, which represents 72 percent of the state's total energy supply (see Figure 1 below).[38] However, Minnesota has an abundant supply of wind, solar, and biobased energy. In 2013, Minnesota ranked fourth in the nation in ethanol production capacity.[39] In addition, Minnesota ranks among the top ten states in electricity generation from wind,[40] and renewable resources continue to make up an increasing share of the state's energy supply (see Figure 2 below).[41]

FIGURE 1: MINNESOTA ENERGY SUPPLY BY SOURCE, 2013



Source: U.S. Energy Information Administration, "Table CT1. Total End-Use Energy Consumption Estimates, 1960–2013, Minnesota."

FIGURE 2: RENEWABLES AS A PERCENT OF MINNESOTA'S TOTAL ENERGY SUPPLY, 2005–2013



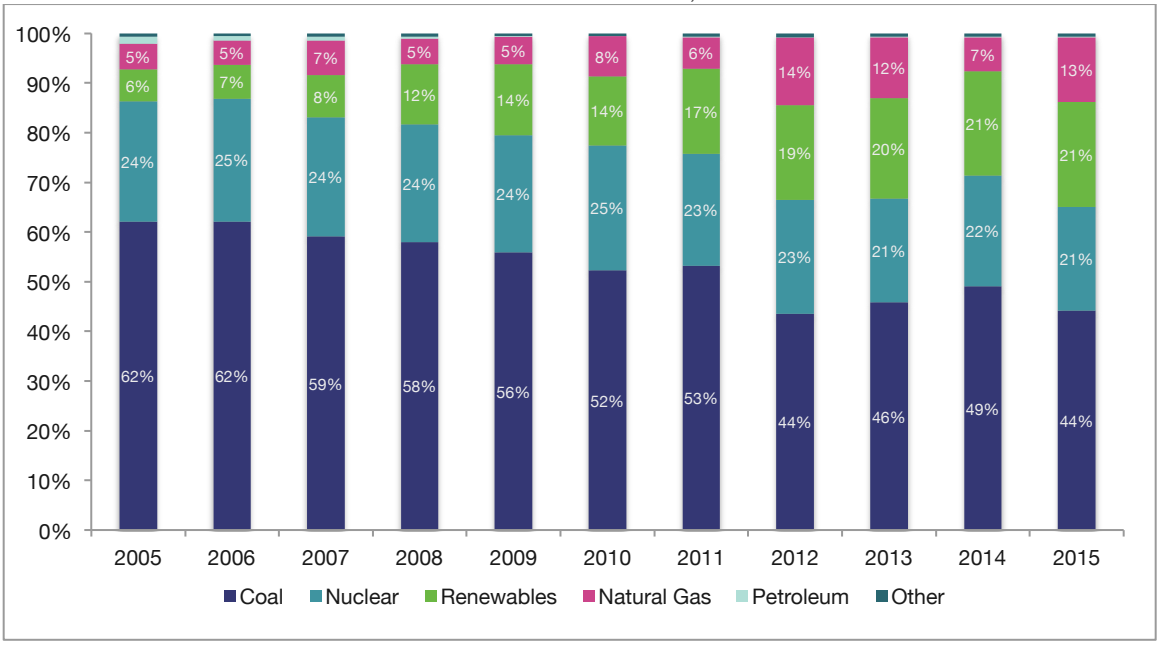
Source: U.S. Energy Information Administration, "Table CT1. Total End-Use Energy Consumption Estimates, 1960–2013, Minnesota."

Electricity Supply

Within the electricity sector, renewables make up a large and growing share of total energy used to produce electricity, accounting for 21 percent of annual generation in Minnesota in 2015.[42] [43] In addition to electricity generated in-state, electricity imports from neighboring states and Canada account for approximately 26 percent of the electricity used in the state.[44]

In 2015, renewable resources made up 21% of Minnesota's electricity generation.

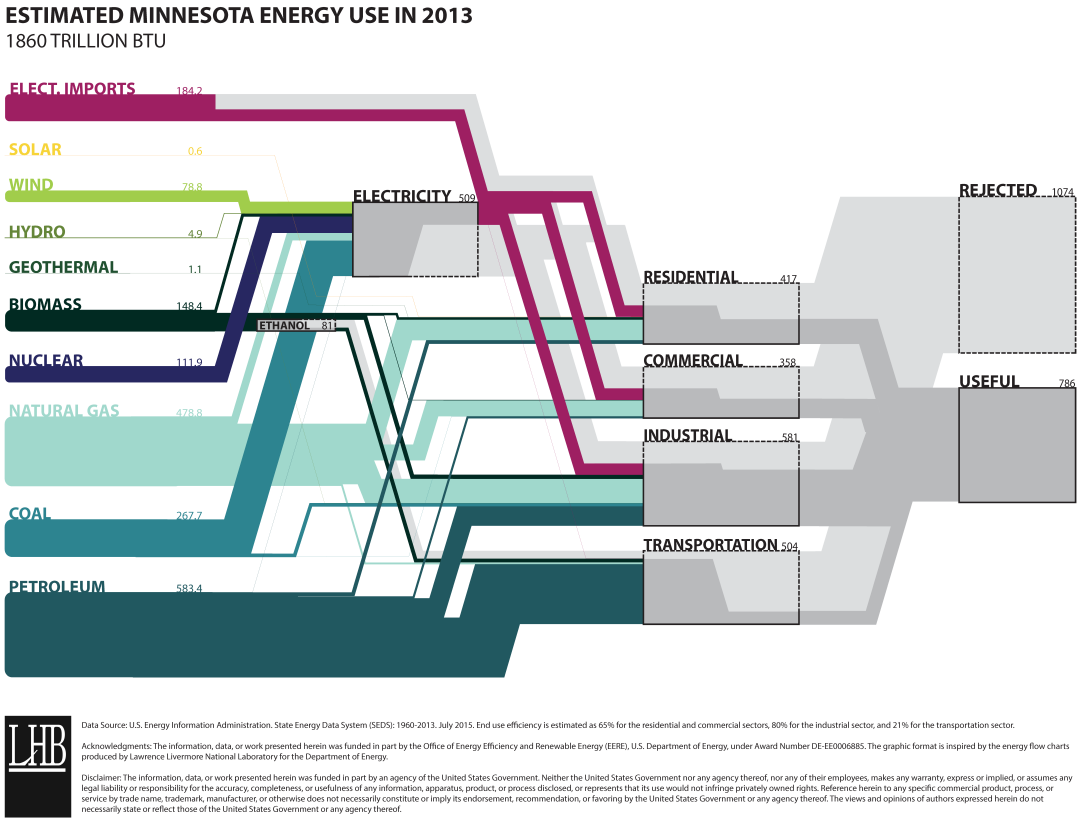
FIGURE 3: MINNESOTA ELECTRICITY NET GENERATION BY SOURCE, 2005–2015



Source: U.S. Energy Information Administration "Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923), 1990-2014" and "Electric Power Monthly with data for December 2015, Net Generation by State by Type of Producer by Energy Source," U.S. Energy Information Administration.

Figure 4, below, illustrates Minnesota's energy use and shows how energy flows from primary fuel sources, through energy use by sector, to losses due to system inefficiencies. Notably, more than half of the energy that is produced in the state is wasted due to system inefficiencies, rendering only 42.3 percent of the energy produced useful.

FIGURE 4: ESTIMATED MINNESOTA ENERGY USE IN 2013, BY SOURCE AND SECTOR

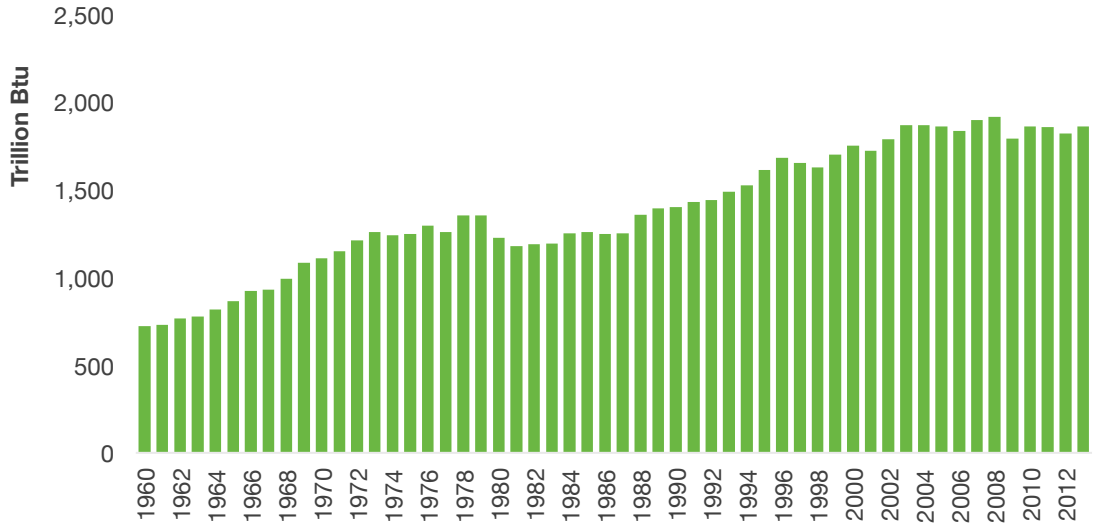


Source: Data from U.S. Energy Information Administration State Energy Data System (SEDS). Graphic produced by LHB with inspiration from Lawrence Livermore National Laboratory's Energy Flow Charts.

Energy consumption

Following an increase in overall energy use from 1960–2005, Minnesota's total energy consumption for industrial, commercial, residential, and transportation use has remained relatively flat in recent years (see Figure 5), despite a six percent increase in population. The most notable drop in consumption occurred between 2008 and 2009, which may be partly attributed to the financial recession.

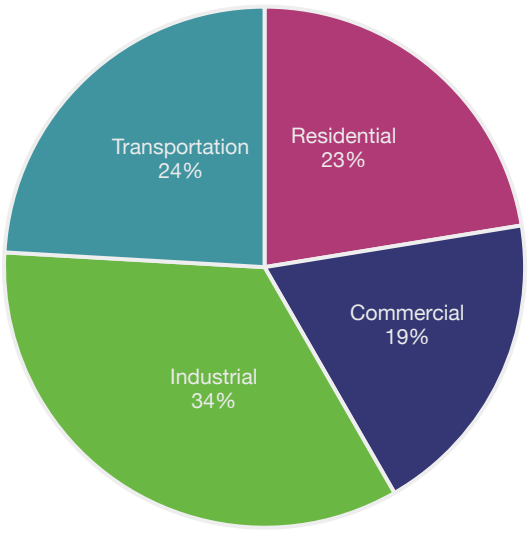
FIGURE 5: TOTAL MINNESOTA ENERGY CONSUMPTION, 1960–2013



Source: U.S. Energy Information Agency: Primary Energy Consumption Estimates, 1960–2013, Minnesota

In 2013, the industrial sector led the state's energy consumption by sector, followed by the transportation, residential, and commercial sectors, all at relatively similar levels of consumption (see Figure 6 below).

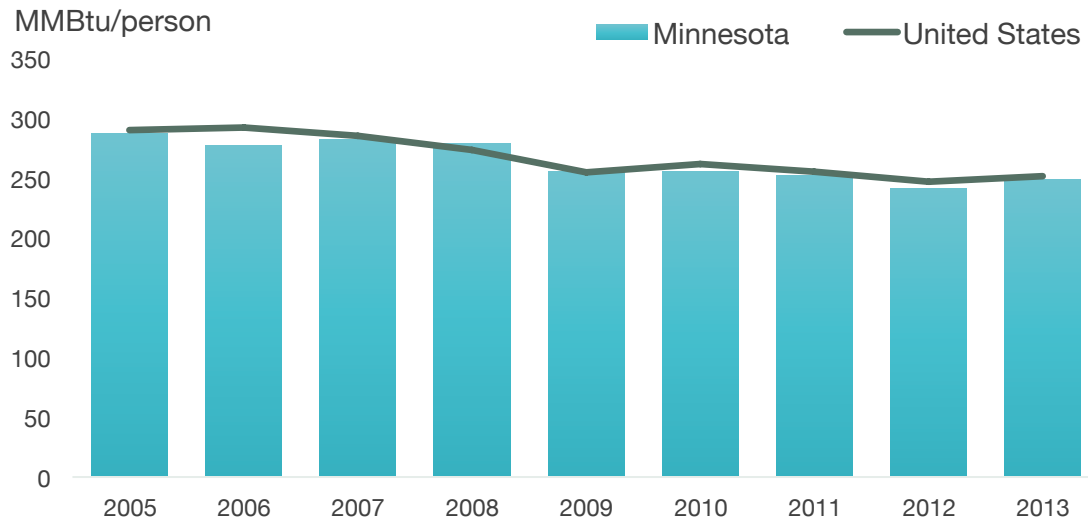
FIGURE 6: MINNESOTA SOURCE ENERGY USE BY SECTOR, 2013



Source: U.S. Energy Information Administration. "Tables CT4-CT7, 1960–2013, Minnesota."

Minnesota's per capita energy consumption ranks 18th nationally,[45] despite having the third-coldest winters in the U.S.[46] From 2005 to 2013, per capita energy use declined by 5.5 percent.[47] From 2005 to 2013, Minnesota's per capita fossil fuel use declined by 13.5 percent and today remains slightly lower than the national average (see Figure 7 below).

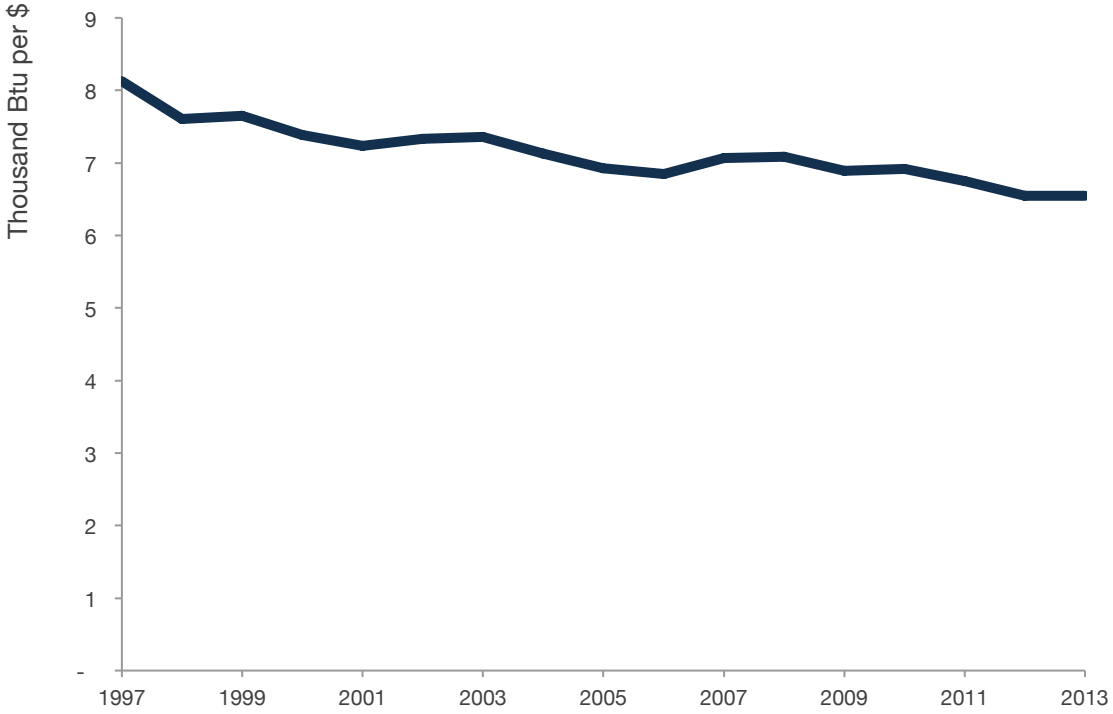
FIGURE 7: MINNESOTA FOSSIL FUEL USE PER CAPITA, 2005–2013



Source: U.S. Energy Information Administration, "Table CT1. Total End-Use Energy Consumption Estimates, 1960–2013, Minnesota" and US Census population estimates

Minnesota's energy intensity (i.e., the energy required to produce one dollar of gross state product) has been declining in the last two decades. Since 2003, gross state product has increased by 12 percent, while overall energy use has remained flat.

FIGURE 8: MINNESOTA ENERGY INTENSITY, 1997–2013



Source: U.S. Energy Information Administration, Table CT2. Primary Energy Consumption Estimates, 1960–2013, Minnesota; and Federal Reserve Bank of St. Louis, Real Total Gross Domestic Product for Minnesota, 1997–2013

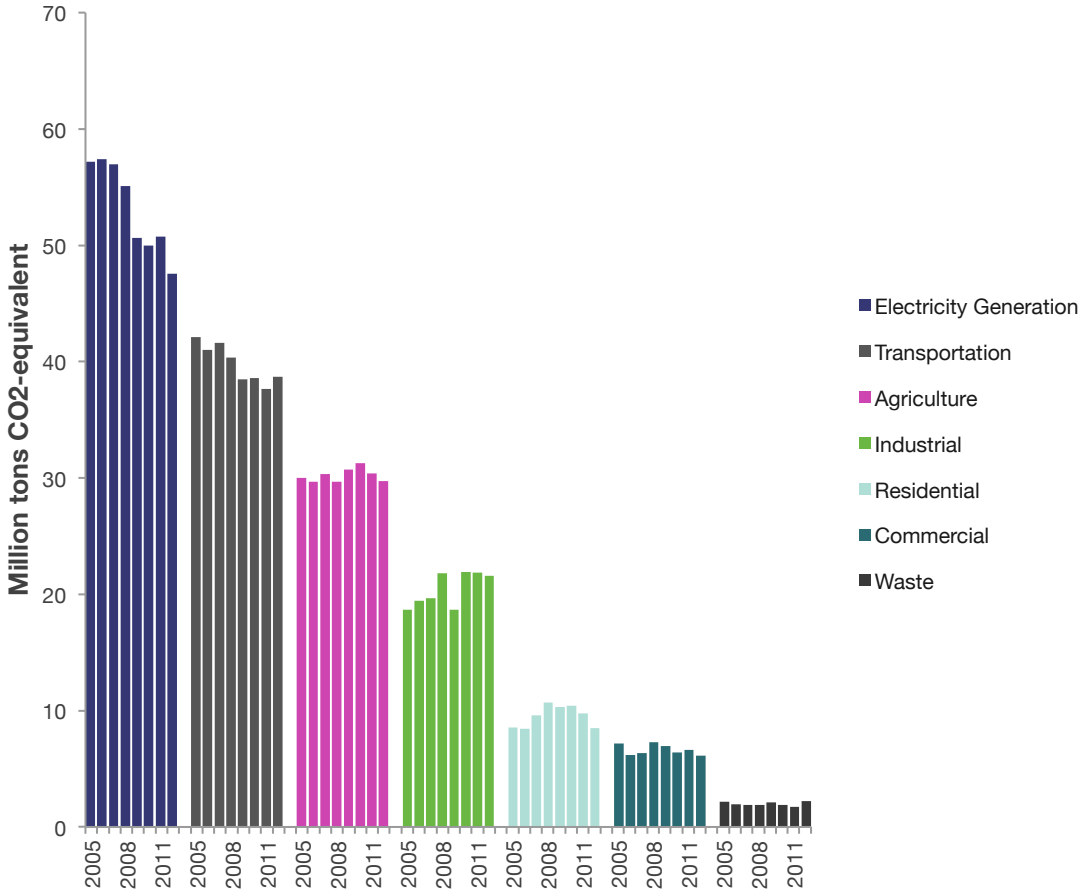
Greenhouse gas emissions

In 2012, energy-related activity accounted for 79 percent of the state's emissions, agriculture for 19 percent and waste for 1 percent. [ii,48] From 2005 to 2012, Minnesota's greenhouse gas emissions declined by 7 percent, primarily due to the 17 percent decrease in emissions from the electricity sector over the same time period.

If Minnesota continues on its current trajectory, the state will fall short of its greenhouse gas reduction goals and overall renewable energy goals.

[ii] In 2012, electricity generation accounted for 30.8% of the state's emissions, followed by transportation at 25.0%, agriculture at 19.3%, industry at 14.0%, residential at 5.5%, commercial at 4.0%, and waste at 1.4%.

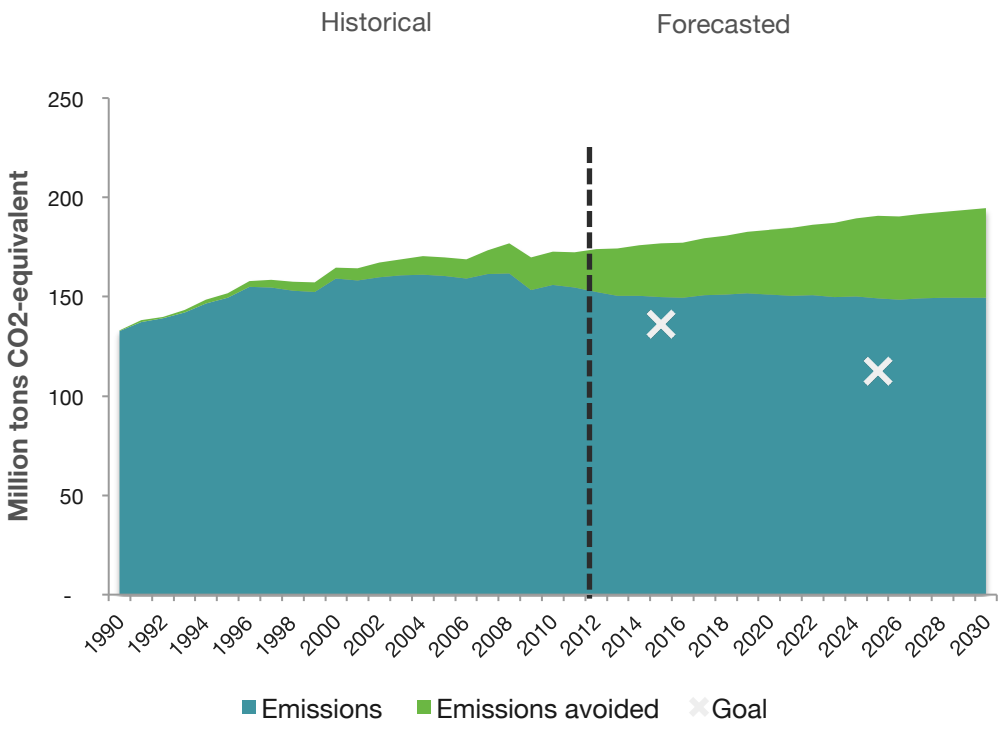
FIGURE 9: MINNESOTA GREENHOUSE GAS EMISSION TRENDS BY SECTOR, 2005–2012



Source: Minnesota Pollution Control Agency

Based on the latest assessment from the Minnesota Pollution Control Agency (MPCA), Minnesota's total emissions are anticipated to decrease slightly from 2012 to 2025 (see Figure 10 below). However, the state's emissions are anticipated to exceed the state's goals for 2015 and 2025 emissions levels.

FIGURE 10: MINNESOTA FORECASTED GREENHOUSE GAS EMISSIONS AND STATE GOALS



Source: Minnesota Pollution Control Agency

What is shaping Minnesota's energy future?

A variety of national policies, state policies and goals, and market trends are shaping Minnesota's energy future.

National policy and market trends

The national energy landscape is undeniably and rapidly changing. On both the supply and demand sides, cleaner energy sources are becoming more economical and demand is growing. At the same time, federal regulation is changing the economics of conventional energy production, prompting a shift toward cleaner resources.

On the supply side, renewable energy resources are becoming increasingly cost-competitive with fossil fuels (see Table 1 below[iii]), even as low natural gas prices have broadened the use of that fuel significantly[49] and helped decrease carbon emissions from the power sector in recent years.[50]

TABLE 1: UNSUBSIDIZED LEVELIZED COST OF ENERGY (LCOE) COMPARISON

Energy Source	**LCOE ($/MWh)**
Wind	$32–77
Solar PV—Utility Scale	$50–70
Gas Combined Cycle	$52–78
Coal	$65–150
Solar PV—Community Scale	$78–136
Biomass Direct	$82–110
Nuclear	$97–136
Solar PV – Rooftop, Commercial / Industrial	$109–193
Gas Peaking	$165–218
Solar PV – Rooftop, Residential	$184–300

Source: Lazard, 2015[51]

Federal legislation and regulations are further shaping the market for renewable energy. In December of 2015, Congress voted to extend the 30 percent investment tax credit (ITC) for solar PV and the Production Tax Credit (PTC) for wind energy. The bill also extends a tax credit for biodiesel and biodiesel mixtures and the tax credit for small agribusiness producers, making investments in biofuels, wind, and solar more favorable.[52]

Concurrently, a number of federal regulations, most notably the Mercury and Toxic Air Standards (MATS),[53] are making the operation of old coal-fired power plants less economical and accelerating plant retirement.[54] In addition, the EPA's Clean Power Plan, which aims to reduce carbon emissions from the power sector 32 percent below 2005 levels by 2030, is expected to have a significant impact on coal generation. Though at the time of press, the Supreme Court had issued a stay on implementation of the Clean Power Plan, many states, including Minnesota, are on track to comply with the regulation.[55,56] Going forward, the status of the Clean Power Plan is uncertain: it could be changed or struck down by the courts, Congress, or a new presidential administration. Finally, federal fuel-economy standards are reducing dependence on foreign oil.[57]

These federal regulations and legislation, coupled with trends in the energy sector's supply and demand sides, are contributing to a rapidly changing energy landscape in which clean energy is becoming competitive with conventional energy resources.

[iii] Lazard's levelized cost of energy estimates the cost of energy generated on a dollar per MWh basis, over the lifetime of the investment. This calculation does not take into account federal tax subsidies, social and environmental externalities, integration or reliability considerations, or the impact of the EPA's Clean Power Plan on the cost of generation.

Minnesota energy policy landscape

For decades, Minnesota has been a leader in energy innovation, beginning with its Conservation Improvement Program Statute in 1980, through its Renewable Energy Standards in 2007, and community solar gardens today. In addition to these pioneering policies, Minnesota has also introduced ambitious policy goals. This section details the energy policy landscape in Minnesota.

Energy efficiency

In the early 1980s, Minnesota enacted its **Conservation Improvement Program** (CIP), and utilities invested hundreds of millions of dollars to improve energy efficiency.

For decades, Minnesota has been a leader in energy efficiency and renewable energy policy, from its Conservation Improvement Program, to its Renewable Energy Standard, to its community solar gardens.

In 2007, Minnesota amended the **Conservation Improvement Program** statute (M.S. 216B.241), adding an energy savings requirement to the existing spending goal. The Conservation Improvement Program Statute establishes a goal for Minnesota's electric and natural gas utilities to achieve energy savings equal to 1.5 percent of sales each year, effectively doubling the amount of energy saved by Minnesota utilities.[58] A recent evaluation of the **Shared Savings Demand-Side Management (DSM) Financial Incentive** mechanism finds that, from 2010 to 2014, Minnesota electric investor-owned utilities saved roughly 37 billion lifetime kWh. Over the same time period, natural gas investor-owned utilities saved roughly 145 million lifetime thousand cubic feet (Mcf) of natural gas. Even when accounting for the cost of Minnesota's financial incentives, electric and natural gas utilities' CIP investments have resulted in $2.1 billion in net benefits to the state.[59]

In 2011, Minnesota Governor Dayton issued Executive Order 11-12, **Energy Standards for Public Buildings**, which requires a 20 percent reduction in energy use in state-owned buildings. Each state agency must track building energy use within B3 Benchmarking software, set site-specific energy goals, and report progress annually. B3 Benchmarking tracks energy use in nearly 8,000 buildings and has identified easily achievable savings of over 3 million MMBTU annually. As part of EO 11-12, Minnesota committed to the U.S. Department of Energy Better Building Challenge (BBC). The BBC commits Minnesota to a 20 percent reduction in energy use by 2020. As of 2014, Minnesota State buildings had reduced energy use by five percent. Minnesota highlighted the Guaranteed Energy Savings Program (GESP) as the implementation model for state agency energy reduction.

The **Guaranteed Energy Savings Program** (GESP) (M.S. 16C.144) is a procurement and financing mechanism that assists state agencies, local units of government, school districts, and institutions of higher education with the development, implementation, and ongoing measurement & verification of energy efficiency and/or renewable energy projects. Participants gain access to technical assistance from the Minnesota Department of Commerce, prequalified Energy Services Companies, Master Contract, selection and procurement documents, and GESP staff oversight for each phase of the project that can last up to 25 years. The intent of the program is to maximize job creation and operational cost savings through investment in public facilities.

The **Local Energy Efficiency Program** (LEEP) and the **Energy Savings Partnership** (M.S. 216C.42–216C.43) help local units of government and school districts identify, study, implement, and finance energy efficiency and recommissioning projects. LEEP helps participants to identify site-specific goals, find high-quality firms to perform an investment grade audit, and gain access to low-interest lease-purchase financing. Participants gain access to the Minnesota Department of Commerce technical assistance through each stage of the process.

The **RevItUp Loan Program** administered by the Department of Commerce annually solicits request for proposals (RFPs) from units of local government seeking low-cost, long-term capital to finance community energy efficiency and renewable energy-system projects that are financed via energy savings and/or projected revenues created by the systems. [60]

The **Buildings, Benchmarks, and Beyond (B3)** suite of tools (funded and administered by the Minnesota Departments of Commerce and Administration) was developed to help make buildings more energy efficient and sustainable. The B3 programs have been developed for and are required on State-funded projects in Minnesota; however, they can be applied to any project. The *B3 Guidelines* and the *Sustainable Building (SB) 2030 Energy Standard* can be applied to new and renovated buildings during design. *B3 Benchmarking*, *B3 Energy Efficient Operations* and the *B3 Post Occupancy Evaluation (POE)* tools can be used to evaluate and improve existing buildings.[61]

Sustainable Buildings 2030 (SB 2030) (M.S. 216B.241) is an energy performance requirement for all state-bonded buildings that receive General Obligation (GO) Bonds. Energy standards for new buildings require an increasing reduction of carbon-producing fuel, from 60 percent in 2010 to 100 percent in 2030. These targets are halved for renovations of existing buildings.[62] To date, the SB 2030 requirements have saved an estimated 534,000 MMBTU annually in avoided energy consumption, 58,000 tons annual estimated avoided CO_2e, and $8.3 million in estimated annual energy savings.

Energy and electricity supply

Minnesota revised its 2001 voluntary renewable-energy objective to create a **Renewable Electricity Standard** in 2007 (M.S. 216B.1691), requiring more than 25 percent of retail electricity sales be renewable by 2025, with a higher standard and accelerated timeline for Xcel.[63] In 2013, Minnesota passed H.F. 729, which requires that 1.5 percent of public utilities' retail electricity sales come from solar energy. Further, the bill set a statewide goal of generating 10 percent of retail electric sales from solar energy by 2030.[64]

The Minnesota Public Utilities Commission (PUC) and the Minnesota Department of Commerce track utility compliance with the RES through the Midwest Renewable Energy Tracking System (M-RETS). In 2015, the PUC found that all utilities that are subject to RES requirements met the 12 percent Renewable Electricity Standards for 2012 and 2013 (18 percent for Xcel Energy), and had plans to meet the standards for the 2014 to 2016 reporting period.[65] In fact, recent Department analyses indicate that Minnesota utilities are well positioned to comply, and potentially exceed the RES.[66,67]

TABLE 2: MINNESOTA RENEWABLE ELECTRICITY STANDARD REQUIREMENTS

Utility	Percent Renewable (+ solar standard)	Year
Xcel Energy	31.5 percent (including 1.5 percent from solar)	2020
Other investor-owned utilities	26.5 percent (including 1.5 percent from solar by 2020)	2025
Municipal and cooperative utilities	25 percent	2025

Source: DSIRE[68]

Minnesota has also established overall greenhouse gas emission reduction goals. The **Next Generation Energy Act** of 2007 calls for cutting the state's greenhouse gas emissions to 15 percent below 2005 base levels by 2015, 30 percent below by 2025 and 80 percent below by 2050. Based on the latest assessment from Minnesota Pollution Control Agency, Minnesota will not meet these goals without significant additional reduction efforts.

In terms of cleaner fuels, the **Petroleum Replacement Promotion** establishes a goal that biofuels comprise an increasing portion of total gasoline sold or offered for sale in this state by each specified year, reaching at least 30 percent by 2025.[69] In addition, the **Biofuel Content Mandate**

(M.S. § 239.791) **and the Biodiesel Content Mandate** (M.S. § 239.77) establish a minimum biofuel content for all gasoline and all diesel fuel sold in the state.

Minnesota has a number of policies and incentives related to renewable energy production and solar production in particular. The **Made in Minnesota Solar Incentive Program** (M.S. 216C.411-.416) offers $15 million per year for incentives for Minnesota-made solar PV and solar thermal.[70] The state's utilities also offer solar incentives, including the **SolarSense** (Minnesota Power) rebate, and the **Solar*Rewards** (Xcel Energy) program providing $5 million per year in performance-based incentives for solar installations.

Minnesota is one of only 14 states to offer community solar gardens, with at least 250 MW expected to be developed by the end of 2016.

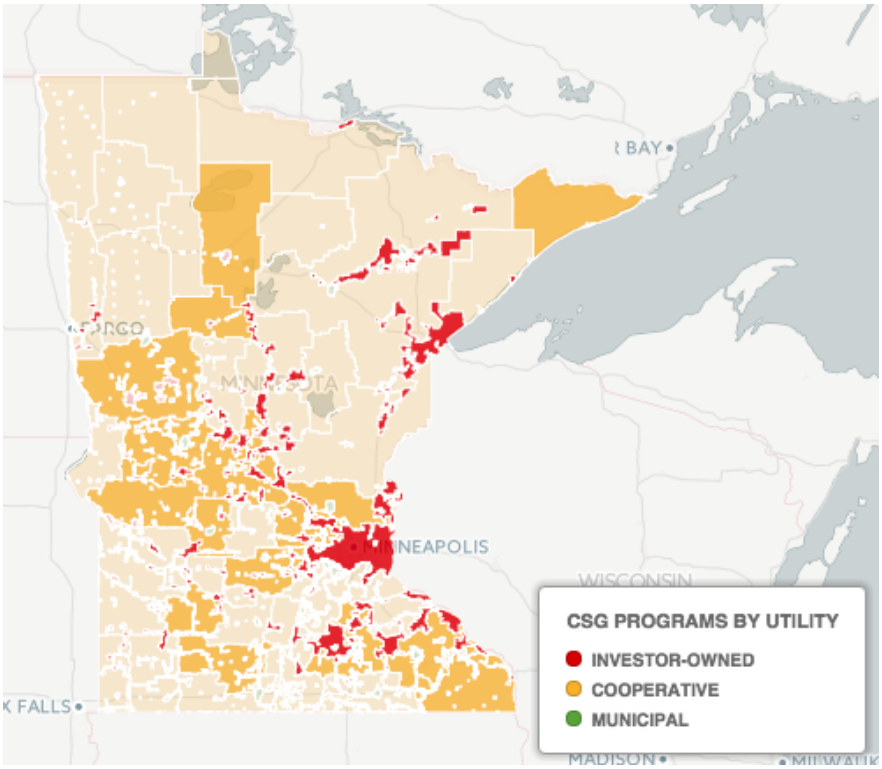
In 2013, Minnesota became one of only 14 states and the District of Columbia to offer community solar to utility customers. The state-mandated **community solar** program (M.S. 216B.1641) allows customers to access clean energy without putting solar panels on their roofs; customers simply subscribe to a community solar installation. Xcel Energy is required by this law to offer a community solar program; 17 additional utilities voluntarily offer community solar.[71] There is no cap on the number or total capacity of community solar gardens in Xcel's program, and the utility expects that 250 MW or more of over 900 MW of applications for community solar will be developed by the end of 2016.[72,73]

In 2014, Minnesota became the first state to adopt a **Value of Solar Tariff methodology**, a rate-design policy that gives customers with solar installations credit for the energy their PV systems produce. Unlike net metering, under the value of solar tariff (VOST), customers are not compensated for solar PV production at the standard retail rate. The VOST includes factors such as avoided generation and transmission capacity, fuel cost, transmission and distribution line losses, and environmental cost. To date, no utilities in Minnesota have opted for the VOST in lieu of net metering.

Several additional initiatives are addressing the changing energy landscape and utility regulation in Minnesota:

- The **e21 Initiative** aims to develop a more customer-centric and sustainable framework for utility regulation, better aligning utility revenue with public policy goals, changing customer expectations, and the changing technology landscape. Convened by Great Plains Institute, Center for Energy and Environment, Energy Systems Consulting Services, George Washington University Law School, Xcel Energy, and Minnesota Power, e21 is in its second phase and is gaining national attention.[74]
- The Minnesota Public Utilities Commission **Grid Modernization Proceeding**[75] is addressing the need for an integrated, dynamic, and efficient grid, with an emphasis on distribution planning.
- The Minnesota Department of Commerce directed the **Minnesota Renewable Energy Integration and Transmission Study (MRITS),**[76] which focused on the reliability impacts and associated transmission costs of increased levels of wind and solar generation and found that the addition of wind and solar (variable renewable) generation to supply 40 percent of Minnesota's annual electric retail sales can be reliably accommodated by the electric power system with modest infrastructure investment.

FIGURE 11: MAP OF MINNESOTA UTILITY TERRITORIES OFFERING COMMUNITY SOLAR, AS OF MARCH 2016



Source: Clean Energy Resource Teams

Looking ahead

Minnesota's energy landscape is certainly changing, due to national and state policies, changing customer preferences, and technology development. Recent developments, such as Xcel Energy's proposal to close two large coal units early, illustrate a changing energy paradigm. Due to acceleration in technical innovation and the expanding influence of world energy markets, the number of variables facing the energy industry has increased dramatically over recent years. The Climate Solutions and Economic Opportunities (CSEO) initiative, an interagency collaboration led by the Environmental Quality Board, demonstrates a range of possible scenarios for Minnesota's energy future. CSEO's modeling illustrates that Minnesota may fall short of meeting core state climate goals, but a number of additional pathways to achieve greenhouse gas reductions exist.

Opportunities for further progress

While Minnesota has made great progress toward meeting its energy goals, there is opportunity for further progress. The stakeholder engagement process that drove the creation of this Energy Action Plan led to the identification of many strategies with the potential to significantly advance clean energy and leverage opportunities for a clean, affordable, reliable, and resilient energy system.

To highlight pathways for making progress toward these goals, this action plan outlines strategies in five general categories:

- Transportation
- Energy supply and grid modernization
- Efficient buildings and thermal energy
- Industrial and agricultural processes
- Local planning and action

Four of these categories represent discrete energy-intensive sectors of the Minnesota economy. Action in these sectors is possible at both the state and local levels, and strategies discussed in these sections highlight roles for a wide range of actors. The fifth section is focused on the specific ways in which local jurisdictions (cities and communities) and tribal nations can take meaningful action.

Guidelines to strategy structure

Each of the five chapters of this Energy Action Plan contains a number of distinct **Strategies**. Each strategy, while consisting of a number of specific recommendations, is, as a whole, meant to address a specific near-term opportunity for Minnesota to make further progress in meeting its clean energy goals. The strategies included in this document are recognized as having high potential for impact and near-term opportunities for action.

Each strategy includes a collection of **Actions,** discrete recommendations that together will lead to the strategy's success. These are concrete steps, each with identified **Champions** and/or **Key Participants**, that can be undertaken in the near term and whose progress can be measured. Champions are those that can drive the actions to successful completion, while key participants are those that are needed to engage in the process but may not play the primary leadership role. The list of Champions and Key Participants for each strategy is not comprehensive, but includes those organizations identified by stakeholders.
Each strategy also notes a number of **Success Factors**. Success factors are criteria that must be true for the strategy to be successful. Ensuring that these success factors are in place may take extra effort beyond the identified actions. We note these success factors in order to flag potential areas for further exploration, and to highlight important considerations for strategy success that champions and participants can track in their efforts.

Indicators of Strategy Success can track progress toward success in each strategy**.** Where available, we note the source of existing baseline data that can be used to construct these indicators. However, these data are often not readily available. In these cases, we note the key indicators that champions and stakeholders should track in order to demonstrate progress.

Given the increasingly interconnected nature of energy sectors and jurisdictions, each strategy also notes **Cross-Sector Opportunities and Synergies** where the content of one strategy may influence or depend on another strategy in this document. Highlighting these relationships can help stakeholders "connect the dots" and get a sense of complementary activities and opportunities in the state. Table 3 lists the strategies contained in this report and indicates the breadth of each strategy's cross-sector opportunities.

Each strategy in this Action Plan already has significant momentum behind it in Minnesota and, in many cases, at the national level. We highlight **Ongoing Minnesota Initiatives** and **Other Resources** for each strategy to note activities and resources that champions, stakeholders, and observers can use to gather more information about best practices, context, and lessons learned in the topic area covered by each strategy.

TABLE 3: STRATEGIES AND CROSS-SECTOR OPPORTUNITIES

			Cross-sector opportunities				
Sector	Strategy	Purpose	Transportation	Energy Supply and Grid Modernization	Efficient Buildings and Integrated Energy Systems	Industrial and Agricultural Processes	Local Planning and Action
Transportation	Increase adoption of personal electric vehicles	Electric vehicles offer reduce emissions and lower operating costs compared to conventional vehicles		■	■		
	Electrify buses	Electric buses offer increased fuel efficiency and reduced air emissions		■			■
	Electrify fleets	Electric vehicles in high-mileage fleets offer increased economic benefits		■			■
	Increase adoption of alternative-fuel heavy-duty vehicles	Heavy-duty vehicles powered by renewable natural gas offer emissions savings				■	
Energy Supply & Grid Modernization	Deploy advanced metering infrastructure (AMI)	AMI allows for two-way communication between customer meters and the utility	■	■	■		
	Enable smart-inverter functionality	Smart inverters allow utilities to better integrate solar power with the grid		■	■		
	Integrate energy storage and demand response	Storage and demand response can reduce peak power demands and customer costs	■	■	■		
	Adopt time-based rates	Time-based rates send a signal to customers to shift consumption during peak times	■	■	■		
	Expand and improve utility green energy options	Expanded utility offerings can meet customer demand for green energy	■				■

TABLE 3 (CONTINUED): STRATEGIES AND CROSS-SECTOR OPPORTUNITIES.

			Cross-sector opportunities				
Sector	Strategy	Purpose	Transportation	Energy Supply and Grid Modernization	Efficient Buildings and Integrated Energy Systems	Industrial and Agricultural Processes	Local Planning and Action
Efficient Buildings and Integrated Energy Systems	Adopt SB 2030 as an optional stretch code	Zero-energy and low-energy options reduce energy use in buildings		■	■		■
	Enhance energy data access	Access to standardized energy data allows customers to make informed decisions about their energy use		■	■		■
	Increase adoption of commercial-building energy benchmarking and disclosure programs	Benchmarking and disclosure programs can enable energy savings in existing buildings		■	■		■
	Improve building operations to capture energy efficiency opportunities	Building operators ensure that buildings perform efficiently and as designed		■	■	■	
	Promote behavioral energy efficiency strategies	Nonfinancial motivators can lead to energy savings			■		■
	Identify opportunities for thermal energy grids	District energy can be expanded to existing networks to increase efficiency			■		■
	Support combined heat and power (CHP)	CHP can increase energy efficiency by integrating electrical and thermal energy			■	■	■

TABLE 3 (CONTINUED): STRATEGIES AND CROSS-SECTOR OPPORTUNITIES.

			Cross-sector opportunities				
Sector	Strategy	Purpose	Transportation	Energy Supply and Grid Modernization	Efficient Buildings and Integrated Energy Systems	Industrial and Agricultural Processes	Local Planning and Action
Industrial and Agricultural Processes	Commercialize advanced biofuels and biobased chemicals	Leverage agriculture and forestry sectors to produce biofuels and biobased chemicals	■		■	■	
	Capture organic feedstocks through anaerobic digestion	Anaerobic digestion uses waste material to produce renewable natural gas, heat, and electricity	■	■	■	■	
	Promote industrial efficiency practices	Industrial facilities can take advantage of opportunities to increase efficiency and save money		■		■	
	Coordinate and promote the clean energy industry	Increase coordination and communication across the clean energy industry to maximize economic development		■	■	■	■
Local Planning and Action	Advance energy planning at the local level	Third parties can support local governments to plan for energy efficiency and renewables	■		■	■	
	Pursue near-term actions at the local level	Local governments can leverage their unique authority to advance clean energy	■		■	■	

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4. STAKEHOLDER-IDENTIFIED STRATEGIES

A. TRANSPORTATION

Section summary

The transportation sector accounts for more than 28 percent of the state's primary energy use and 25 percent of the state's greenhouse gas emissions.[77,78] The transportation sector also accounts for well over 50 percent of Minnesotans' energy spending.[79] In 2014, Minnesotans spent $11 billion on transportation fuels, the vast majority of which are imported from out of state.[80]

The opportunity to reduce the cost of transportation and increase the sector's clean energy footprint is significant. Stakeholders' recommendations for the transportation sector fall into two key categories: electric vehicles and alternative fuel vehicles.

Electric vehicles

Electric vehicles (EVs) are quickly becoming a desirable option for consumers, due to rapid advances in technology and declines in cost. Compared with conventional vehicles, EVs offer reduced fuel and operations and maintenance costs, as well as decreased air pollution. Stakeholders recommended several actions related to electric vehicles:

- **Increase adoption of personal electric vehicles** through bulk discount arrangements, incentives for new EV purchases, and expanded workplace charging
- **Electrify fleet vehicles** by creating a bulk purchase arrangement and convening an EV-procurement workshop for fleet managers
- **Electrify buses** through validating lifecycle-cost studies and demonstrating electric buses on urban and suburban transit routes

Alternative fuel vehicles

Alternative fuel vehicles (AFVs)—which run on energy sources other than petroleum—are also an attractive transportation option. AFVs can bolster the state economy because their fuel sources can be produced in Minnesota. Further, their carbon emissions are lower than conventional vehicles, and they offer longer ranges than electric vehicles. Stakeholders recommended that Minnesota:

- **Increase adoption of heavy-duty alternative-fuel vehicles** using natural gas, including renewable natural gas produced locally from anaerobic digestion, as a fuel source.

Energy profile

The transportation sector is a major source of energy use, greenhouse gas emissions, and energy-related costs in Minnesota. The transportation sector accounted for 28 percent of the state's energy use and for 25 percent of the state's greenhouse gas emissions in 2012, and for over 50 percent of Minnesotans' spending on energy in 2013.[81,82,83] Between 2005 and 2012, transportation-sector greenhouse gas emissions declined by eight percent, which can be attributed to higher fuel efficiency, according to the Minnesota Pollution Control Agency (MPCA).[84] Looking ahead over the next decade, MPCA projects transportation sector emissions to remain roughly stable.[85]

In 2014, Minnesotans spent $11 billion on transportation fuel, which is imported from out of state. Adopting electric vehicles and alternative fuel vehicles will allow Minnesota to keep more energy dollars in the state.

In 2014, Minnesota's system of roads carried approximately 57 billion vehicle miles of travel (VMT), with an annual per capita VMT of roughly 11,000 miles (see Table 4 below). According to a 2013 US Department of Transportation survey, 78 percent of Minnesota commuters report driving alone to work, roughly nine percent report carpooling and three percent report using transit.

TABLE 4: MEANS OF TRANSPORTATION TO WORK, MINNESOTA 2013, U.S. DEPARTMENT OF TRANSPORTATION[86]

Means of Transportation to Work	Number	Percent of Total
Drive alone	2,136,394	78.1%
Carpool	237,894	8.7%
Transit	94,172	3.4%
Bicycle	20,803	0.8%
Walked	79,106	2.9%
Other means (including taxi)	22,648	0.8%
Worked at home	145,028	5.3%
Total	2,736,045	100.0%

Minnesotans spent over $11 billion in 2014 on transportation fuels, including gasoline and diesel,[87] which are imported from out of state. Minnesota has increasingly become a leader in biofuel production from local resources and related policymaking. The state requires that motor gasoline sold in the state be at least a ten percent blended ethanol mixture; further, the state's biodiesel mandate requires that diesel fuel sold in the state contain at least ten percent biodiesel from April through September, and at least five percent in the remaining months.[88] Finally, Minnesota's Petroleum Replacement Goal aims to have biofuel comprise at least 30 percent of total gasoline sold or offered for sale in the state by 2025.[89] The Minnesota Department of Agriculture has concluded that the ethanol industry contributes five billion dollars in total economic output and more than 12,600 jobs, and in 2012, Minnesota ranked fifth nationally in ethanol production.[90]

Summary of opportunities

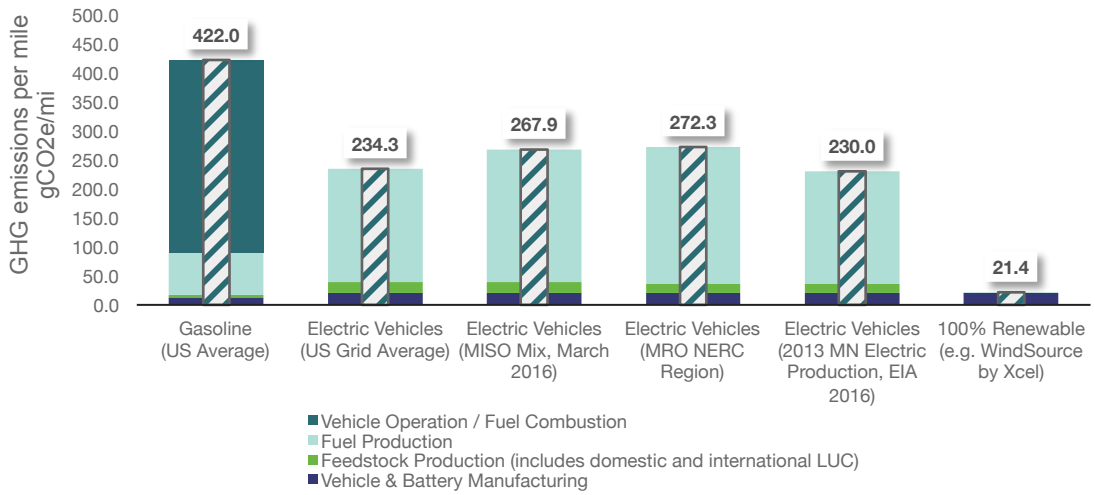
The stakeholder advisory committee has identified the following opportunities to expand and accelerate clean energy and reduce the economic cost of transportation in Minnesota. These opportunities fall into two major categories: electric vehicles (EVs) and alternative fuel vehicles (AFVs).

Electric vehicles

Electric vehicles—which are propelled by electric motors alone or in combination with small combustion engines—are quickly becoming a viable choice for consumers due to rapid advances in technology and cost declines. Electric vehicles hold several advantages over conventional internal combustion engine (ICE) vehicles, including lower operating and maintenance costs. These two factors led the Edison Electric Institute to conclude that, although the upfront cost of an EV is often higher than that of a conventional car, the lifetime cost can be far lower.[91] In addition, EVs have no tailpipe emissions; EVs that are charged with electricity from zero-emission generators cause no air pollution.

Electric vehicles that are charged using fossil fuel-based electricity still cause emissions. However, several factors indicate that the emissions caused by EVs in Minnesota are likely less than those of ICE vehicles. First, over half of Minnesota EV drivers in a recent survey reported that they took service under a renewable energy-sourced electricity rate, such as Xcel's Windsource®, offsetting their short-run emissions,[92] and Great River Energy offers renewable electricity for EVs at no added cost when EV owners sign up for an off-peak EV rate. These programs provide a market signal for additional renewable capacity that can offset emissions from power used to charge customer EVs. Second, the grid as whole is getting cleaner, with an announced proposal to retire a major coal-fired power plant in Minnesota and continued growth in renewables,[93] meaning that the emissions intensity of EVs purchased today is likely to continue declining.
Figure 12 illustrates the emissions impact on a per-mile basis of an ICE vehicle versus an EV.[94] Electric vehicles emit less CO_2 per mile than traditional vehicles, even when accounting for the additional CO_2 emissions inherent in manufacturing EVs,[95] which would reduce the savings shown in the chart below by only two to five percent.

FIGURE 12: COMPARISON OF WELL-TO-WHEEL LIFECYCLE GHG EMISSIONS BY VEHICLE TYPE, PER MILE



Source: GREET 2015 Lifecycle GHG Model default results, Argonne National Laboratory. Figure authored by GPI, March 2016

However, EVs do present some challenges. Most electric vehicles have limited range compared to ICEs; "range anxiety" is a common concern among those considering an EV purchase, charging infrastructure is not yet ubiquitous, and charging times can be much longer than those for refueling a liquid-fueled vehicle. While refueling is a common concern among those considering an EV purchase, EV owners can mitigate range anxiety with trip planning tools. Fortunately, battery technology is rapidly evolving, costs are declining up to 14 percent

per year, and charging technology is improving.[96] At least three car models are announced for 2017–18 that will have more than 200 miles of range and cost under $40,000. These advances, combined with changes to the grid, indicate that the future of electric vehicles looks bright over the next decade,.

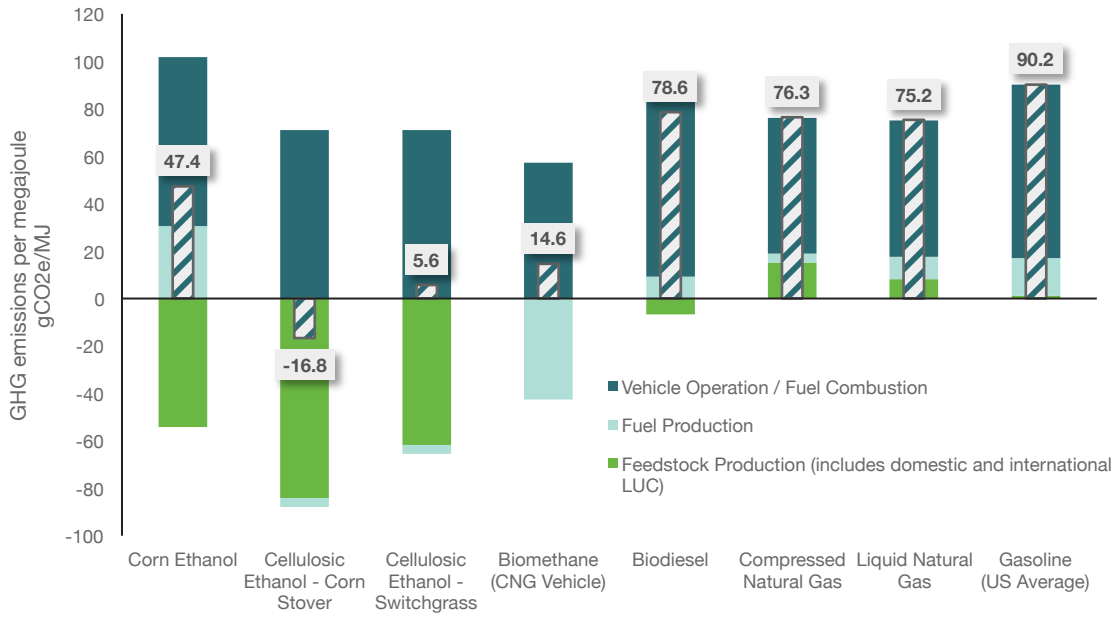
This section identifies opportunities to accelerate adoption of personally owned EVs, EVs for fleets, and electric buses.

Alternative fuel vehicles

Alternative fuel vehicles (AFVs) are vehicles that run on energy sources other than petroleum, including biodiesel, electric and hybrid-electric sources, ethanol, hydrogen, and natural gas. This section discusses opportunities to increase the use of AFVs that are heavy-duty vehicles.

Alternative fuel vehicles have several advantages over conventional vehicles. First, fueling with these resources can bolster the state economy, as these resources can be produced locally. Second, their carbon emissions are often less than those of conventional gasoline- or diesel-fueled vehicles, especially if they are fueled by renewable fuels like biobased compressed natural gas (CNG) or biodiesel. The chart below shows the carbon benefits associated with some common options for alternative fuels.

FIGURE 13: COMPARISON OF WELL-TO-WHEEL LIFECYCLE GHG EMISSIONS BY TRANSPORTATION FUEL TYPE, PER MEGAJOULE



Source: GREET 2015 Lifecycle GHG Model default results, Argonne National Laboratory. Figure authored by GPI, Feb 2016.

The stakeholder advisory committee focused on actions to increase AFV adoption specifically for heavy-duty vehicles fueled by biofuels and natural gas, including renewable natural gas.

A1. Increase adoption of personal electric vehicles

Strategy overview

Single-occupant vehicles currently account for the vast majority of vehicle miles traveled in Minnesota, and are likely to continue to do so in the 2025 timeframe. As a result, widespread adoption of personally owned EVs has the potential to drive significant emissions savings, especially outside of metropolitan areas, where personally-owned vehicles are an important means of serving the needs of a dispersed population.

New advances in cost and range mean that EVs are viable and cost-effective choices for an increasing number of drivers. Across the country, state and local governments are taking action to help their constituents make the switch. This strategy outlines steps to drive expanded adoption of personal EVs in Minnesota.
Specific actions for strategy implementation are:

1. **Coordinate a bulk discount program or public awareness campaign.**
   Dealerships and manufacturers could work with state and/or local government's help to reduce the upfront cost of EVs by setting up a bulk discount program that offered EVs at a reduced rate for local buyers. This program would help increase sales volume for the dealerships and manufacturers by providing marketing for many potential buyers, allowing a lower per-vehicle unit price to still make financial sense for sellers.

   To execute this deal, state or local government entities could issue a request for proposals to vehicle manufacturers or dealerships asking them to come forward with favorable pricing on EVs. All partners may participate in marketing efforts and heavily promote the offer during a set time period.

   Champions/ Key Participants:
   - Drive Electric Minnesota
   - Local and state government
   - Manufacturers
   - Dealerships
   - Marketing partners, including electric utilities and NGOs

2. **Develop state, local, and other incentives for purchasers of new EVs.**
   At least a dozen states have introduced state-level tax credits and other incentives for EV purchasers. Combined with the federal tax rebate available for new EVs—between $2,500 and up to $7,500[97]—these incentives have been shown to drive EV adoption in the states where they are introduced.[98] State government or agencies, local governments, and private companies could introduce one or more incentives, including:

   - Tax credits
   - High occupancy-vehicle lane access
   - Charging-equipment financing, including at workplaces
   - Preferential parking
   - Reduced fees at state parks, etc.

   These incentives would improve the value proposition for drivers to choose an EV. State and local governments should consider the costs of these measures with respect to their benefits in driving adoption of EVs.

   Champions/ Key Participants:
   - Drive Electric Minnesota
   - State and/or local governments

3. **Increase access to workplace charging stations**.
   Due to the battery range limits of many current EV models, a lack of workplace charging access has been identified as a major barrier for drivers to choose an EV over a conventional vehicle. To accelerate adoption, employers can work with utilities and service providers to investigate funding opportunities and prioritize charging equipment deployment.

   Champions/ Key Participants:
   - PlugIn Connect

- Individual workplaces
- Electric utilities

Success factors:

1. **Drivers understand the benefits of owning an EV as compared to another vehicle**. Car purchasers take into account fuel savings and maintenance costs when evaluating options; consumer education can help broadcast these benefits.
2. **"Range anxiety" concerns are mitigated.** A variety of strategies can help address range anxiety, including expanded charging-network access with compatibility for the majority of vehicle types, technology advances (e.g., upcoming, lower-cost, 200-mile range EV models), and education about actual range needs versus perceived needs.

Indicators of strategy success:

1. Number of electric vehicles registered (or percentage of total)
2. Growth rate in electric vehicle sales (percent increase from 2015 to 2025)
3. Electric vehicle miles traveled (VMT) in Minnesota (as percent of total VMT)

Cross-sector opportunities and synergies:

1. **Green power options** let EV owners opt to charge their vehicles with green power.
2. **Time-varying electricity pricing** could incent owners to charge EVs during off-peak hours, further improving the economic case and lowering grid costs.
3. With the development of favorable market mechanisms, large numbers of EVs can collectively serve as an **energy storage and/or demand response resource** to improve grid operations.

Ongoing Minnesota initiatives:

1. Drive Electric Minnesota worked with Nissan North America and Kline Nissan in Maplewood to create a bulk discount program. During the month of March 2016, customers were able to purchase or lease a 2016 Nissan Leaf for approximately 40 percent less than the suggested retail price.[99]
2. The electric vehicle charging tariff requires public utilities to offer a tariff to customers who purchase electricity to charge their electric vehicles, which must contain either a time-of-day or off-peak rate, and the option to purchase electricity from the utility's current energy mix or entirely from new renewable resources.[100]
3. Plug-In Electric Vehicle Charging Rate Reduction – several Minnesota utilities offer a discounted rate for electricity used to charge EVs during off-peak times and/or provide EV drivers with 100 percent renewable energy, including Dakota Electric, Connexus Energy, and Great River Energy.[101,102,103]
4. Drive Electric Minnesota's Zero Emission Charging Challenge aims to power all public charging stations with Windsource® or solar-generated electricity.[104]
5. Minnesota has a well-developed public charging infrastructure, with 494 public EV-charging outlets (including 283 Level 2 charging outlets) as of March 2016, according to the U.S. Department of Energy Alternative Fuels Data Center.[105]

Other related resources:

1. Recent bulk discount programs in Colorado have been successful in driving sales of electric vehicles including the Nissan LEAF and the BMW i3.[106,107]

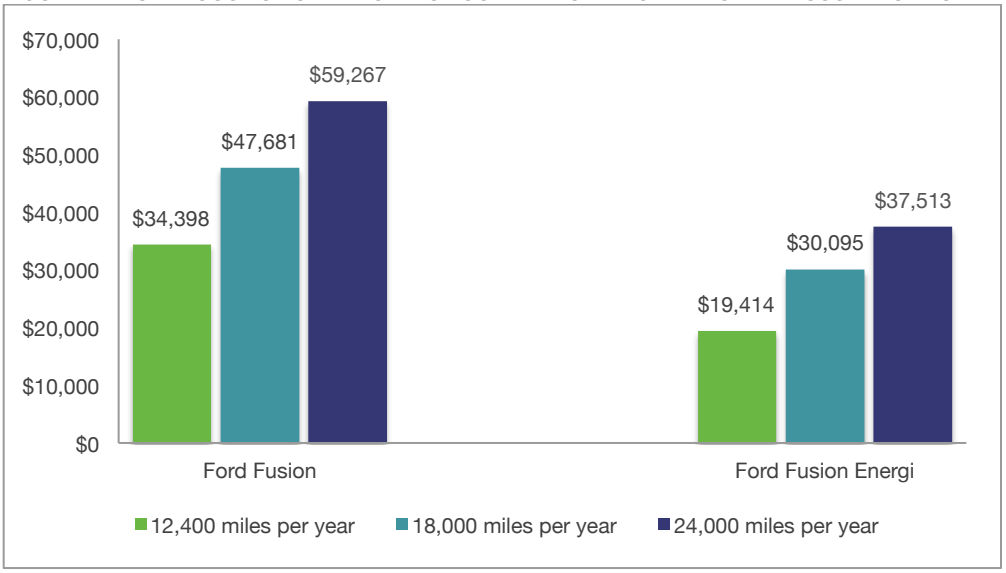
A2. Electrify fleet vehicles

Strategy overview

Light duty vehicle (LDV) fleets, defined as all non-personal LDVs, account for approximately five percent of VMT nationwide,[108] with a similar share likely present in Minnesota. Fleet owners and operators are good leverage points for increasing EV adoption because a single decision can affect multiple vehicles. However, fleet

operators tend to choose cars with a balance of low purchase price and low total cost of ownership, which has commonly resulted in fleets composed of standard gasoline-fueled sedans. But with more electric vehicles entering the market, it is increasingly feasible for the lowest-cost option to be an EV for certain use cases. High utilization rates, for instance, mean EVs' low operating costs can overcome a purchase price premium (see Figure 14 below). Predictable and consistent driving patterns mean it is easy to choose the right vehicle (e.g., a short-range EV) that matches the needs of a particular fleet; and central parking infrastructure common to fleets allows for consolidated charging infrastructure.

FIGURE 14: TOTAL COST OF OWNERSHIP OF CONVENTIONAL ICE VEHICLE VERSUS ELECTRIC VEHICLE BY ANNUAL MILEAGE



Source: Prepared by GPI using data from Edison Electric Institute, "Electrification: Utility Fleets Leading the Charge," June, 2014.

As a result of these potential benefits, some fleet owners and operators across the country are evaluating and choosing EVs. This strategy lays out the steps for fleet decision-makers in Minnesota to evaluate EVs and increase adoption.

Specific actions for strategy implementation

1. **Increase EV purchasing in public and private fleets, where cost-effective.**
   Some fleets, especially those with high-mileage vehicles like taxis, are likely to see an immediate financial gain from switching to EVs. Other fleets, such as those with low-mileage vehicles or vehicles driven for long distances at a time, may not see as compelling a financial case to invest in EVs at current vehicle prices and with current ranges. In both cases, in may be possible to further improve the economics of EVs by setting up a bulk purchasing arrangement, potentially in coordination with the state, to help reduce the upfront cost of EVs.

   Champions/Key Participants:
   - Drive Electric Minnesota
   - Minnesota Department of Administration

2. **Convene workshop on EV procurement.**
   The workshop would focus on best practices for increasing EVs in fleets. Attendees could include private and public sector fleet managers, fleet service providers, as well as representatives from fleets

with EVs from across the county. Workshop participants may develop clear commitments and next steps for the group to further evaluate, test, and ultimately roll out EVs where cost-effective.

Champions/Key Participants:

- Minnesota Pollution Control Agency could help convene workshop and, with partner Great Plains Institute via GreenStep Cities, could help include local governments in the workshop

Success factors

1. **A financial case exists for EVs in a fleet context.** Despite additional upfront costs, electric vehicles can be less expensive on a lifecycle basis than conventional vehicles due to lower fuel costs, reduced operations and maintenance costs, and longer lifecycles. With current vehicle prices, this may only apply to a small portion of fleets. However, as EV purchase prices decline, it is likely that more fleets will include EVs.
2. **Major operational challenges are overcome.** Concerns including range limitations, charging time, etc. are important to the operation of fleet vehicles, and can be overcome to enable large-scale adoption.

Indicators of strategy success

1. Electric vehicle miles in Minnesota (percent of total fleet miles)
2. Petroleum saved (barrels of oil equivalent)
3. Cost savings due to energy savings and operational savings (dollars)

Cross-sector opportunities and synergies

1. **Green power options** allow EV fleets to charge with renewable energy.
2. **Time-varying electricity pricing** could incent fleet operators to charge EVs during off-peak hours at a discounted rate.
3. Large numbers of EVs can be used for **energy storage and/or demand response** to improve grid operations.

Ongoing Minnesota initiatives

1. A number of fleets in private companies, local governments, state agencies, and colleges/universities currently use electric vehicles.[109]
2. During the 2015 legislative session, Minnesota Statute 16C.135, Purchase of Fuel and Vehicles by State Agencies, Subdivision 3 was amended, removing the requirement for fleet vehicles to be "reasonably available at similar costs to other vehicles." Subdivision 3 now reads:

   > ...When purchasing a motor vehicle for the central motor pool or for use by an agency, the commissioner or the agency shall purchase a motor vehicle that is capable of being powered by cleaner fuels, or a motor vehicle powered by electricity or by a combination of electricity and liquid fuel, if the total life-cycle cost of ownership is less than or comparable to that of other vehicles and if the vehicle is capable of carrying out the purpose for which it is purchased.[110]

   This enables EV purchases in public fleets by allowing a lifecycle cost comparison instead of a simple upfront cost comparison.

Other related resources

1. DOE's *Plug-In Electric Vehicle Handbook for Fleet Managers* guides users through EV technology and charging infrastructure, and provides information about EV procurement.[111]
2. Edison Electric Institute's 2014 report, "Transportation Electrification: Utility fleets leading the charge" outlines the rationale for utility support for EVs in general and, in particular, for electrification of utility fleets.[112]
3. State fleets can get compliance credits for the Energy Policy Act by choosing EVs.[113]

A3. Electrify buses

Strategy overview

Buses carry three percent of total Minnesota commuters to work, and the environmental impacts of these trips, including criteria air pollutants, are concentrated in urban areas. Electric buses have potential to limit both local air pollution and GHG emissions. Electric buses are close to cost-competitive today, and with further deployment, Minnesota can demonstrate leadership among states and help bring the costs down for future rollout.

Given the momentum and the likely benefits of pursuing broader adoption of electrified buses in Minnesota, stakeholders have identified this strategy as a near-term priority for further action.

Specific actions for strategy implementation

1. **Validate lifecycle cost studies/estimates for electric buses.**
   Third-party validation of transit agencies' and manufacturers' lifecycle cost studies or estimates could verify the costs and benefits of electric buses compared to conventional diesel buses. The costs and benefits considered may include:

   Costs:
   - Capital cost premium
   - Charging infrastructure
   - Battery replacement
   - Electricity costs, including demand charges as appropriate
   - Auxiliary heating costs (e.g., reduced wintertime range, diesel heater costs)

   Benefits:
   - Avoided fuel purchases
   - Avoided maintenance costs
   - Reduced emissions (including local criteria air pollutants)

   Champions/Key Participants:
   - Metro Transit
   - Duluth Transit Authority

2. **Demonstrate electric buses on different types of transit routes in Minnesota.**
   Demonstration projects allow riders to become more familiar with electric bus technology and for transit agencies to test them. Routes for electric buses could include both suburban and urban routes, in order to test applicability (including charging-infrastructure requirements) across these different use cases.

   Champions/ Key Participants:
   - Metro Transit
   - Duluth Transit Authority
   - Transit authorities
   - Electric utilities

Success factors

1. **A compelling financial case exists for electric buses**. Despite additional upfront costs, electric buses are expected to be less expensive on a lifecycle basis than conventional diesel buses, due to lower fuel costs, reduced operations and maintenance costs, and longer lifecycles.

2. **Bus operators demonstrate that operational issues can be overcome.** Demonstration projects allow operators and riders to become familiar with the technology and show that there are no major operational challenges that cannot be overcome with planning.

3. **Transit agencies are committed to adopting electric buses.** Ultimately, after demonstrating that electric buses are financially viable and operationally viable, commitments from transit agencies are made to purchase electric buses.

Indicators of strategy success

1. Number of electric buses, or percentage of fleet
2. Number of Minnesota transit authorities/cities/counties with electric bus programs
3. Electric bus miles traveled (percent of total bus miles traveled)
4. Petroleum saved (barrels of oil equivalent)
5. Cost savings due to energy savings and operational savings (in dollars)

Cross-sector opportunities and synergies

1. **Green power options**, including programs for electric vehicle charging. Transit authorities may opt to charge their vehicles with green power and could secure a favorable rate, given the high load.
2. **Time-varying electricity pricing** could incent fleet operators to charge EVs during off-peak hours and further improve the economic case.
3. Large numbers of EVs can be used for **energy storage and/or demand response** to improve grid operations.

Ongoing Minnesota initiatives

1. In February 2015, Duluth was awarded a Federal Transit Administration (FTA) grant of $6.3 million for six battery-electric buses and two fast-charging stations. $1.1 million in local funding supplemented the FTA grant. Proterra Manufacturing in Greenville, SC is currently manufacturing the buses.[114]
2. Metro Transit held demonstrations of electric buses in April and May of 2015.[115]
3. Metro Transit has applied for federal funding to procure additional EV buses to demonstrate them on a few routes.

Other related resources

1. The Antelope Valley Transit Authority in California announced, in 2016, its commitment to become the first 100 percent electric bus fleet in the U.S. within two years.[116]
2. The Chicago Transit Authority is expanding its current electric bus pilot program.[117]
3. Transit agencies in cold-weather European cities including Copenhagen and Helsinki are currently demonstrating electric buses.[118,119]
4. The US DOE's Alternative Fuels Data Center compiles information on multiple policies and programs from across the nation that federal, state, and local jurisdictions are using to promote adoption of alternative fuel vehicles, including electric buses.[120]

A4. Increase adoption of alternative-fuel heavy-duty vehicles

Strategy overview

Even with recent advances in technology and cost, electric vehicles may not be appropriate for some drivers. In particular, drivers with needs for long range and/or heavier duty vehicles may not find a suitable or cost-effective EV option. In these cases, alternative fuels, including compressed natural gas (CNG) and/or liquid natural gas (LNG), are levers for reduced emissions.

In particular, natural gas produced from biobased sources and then compressed for vehicle use, known as biobased CNG or renewable natural gas (RNG), has significant emissions-savings potential. Increasing adoption of biobased CNG-powered vehicles can also help build the market for Minnesota industries that provide these

fuels (see, for example, the recommendations in the Industry & Agriculture chapter of this report).

Given the relevance to Minnesota drivers and industries, stakeholders have identified this strategy as an important lever to reduce emissions from vehicles whose duty cycle could not easily be met by an electric alternative.

Specific actions for strategy implementation

1. **Promote natural gas sourced from anaerobic digestion in heavy-duty vehicles.** Anaerobic digestion to produce biobased CNG is a large, untapped resource in Minnesota, and would provide a low-carbon fuel option for heavy-duty vehicles. Biobased CNG can be produced within Minnesota from local resources, offering the potential for economic development and keeping energy expenditures within the state economy.

   Champions/Key Participants:
   - Metropolitan Council
     - Fleet partners
   - Counties involved in municipal solid waste-based anaerobic digestion projects
   - Agriculture processors
   - CenterPoint Energy

Success factors

1. **Refueling infrastructure is in place.** Heavy-duty vehicles have reliable access to CNG/LNG refueling stations without an excessive burden on their routing or duty cycle.

Indicators of strategy success

1. Number of CNG-powered (including biobased CNG) vehicle sales and fueling stations built
2. MMbtus of CNG (including biobased CNG) produced and used in vehicles.

Cross-sector opportunities and synergies

1. Increased production of renewable natural gas from organic feedstocks using **anaerobic digestion** offer a supply for passenger, heavy-duty, and fleet vehicles.
2. Implementation of a voluntary pilot program for natural gas **green pricing** programs can help to facilitate renewable natural gas to market.

Ongoing Minnesota initiatives

1. Minnesota has 15 existing CNG fueling stations as of March 2016.[121]

Other related resources

1. Energy Vision prepared a report on community actions that can promote renewable natural gas for vehicle fuel.[122]

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B. ENERGY SUPPLY AND GRID MODERNIZATION

Section summary

Retail electric and gas utilities supply the majority of end-use energy to customers in Minnesota. Electricity generation in Minnesota accounts for 29 percent of total energy use in the state, and natural gas used in buildings and industrial facilities accounts for an additional 23 percent. Minnesota also has abundant, renewable resources; in fact, 17 percent of the state's electricity already comes from wind, and solar resources are also plentiful in Minnesota, with the industry poised for additional growth. [123]

In order to accelerate clean energy development and keep energy dollars in the state, Minnesota must be able to effectively integrate additional clean energy resources onto the grid, and to establish pricing signals that more accurately capture the cost of electricity generation. Stakeholders' recommendations for the energy supply sector fall into two key categories: grid modernization, and pricing and tariff structures.

Grid modernization

Today's grid is designed for a one-way flow of electricity, information, and value. However, the costs of distributed energy resources are declining and the capabilities of advanced control technologies are evolving. Modernizing the grid will enable more two-way flows of electricity, information, and value, and will allow for the expansion of large-scale, variable renewable energy sources. Stakeholders identified the following strategies to modernize the grid:

- **Deploy advanced metering infrastructure (AMI)** to allow for communication between the utility and the customer
- **Enable smart inverter functionality** to allow utilities to better integrate increasing levels of solar power with the grid
- **Integrate energy storage and demand response** to reduce peak power demands, lower customer costs, and enable additional renewable energy penetration

Pricing and tariffs

Most utilities charge customers for their total energy consumption each month, without taking into account the energy source, the cost to produce that energy during a particular time of day or year, or the location of the demand. Updated retail pricing can better reflect the grid-level costs of consumption, and can empower customers with choices, allowing them to reduce their energy bills and reduce costs for the entire energy system.

Stakeholders identified the following strategies related to pricing and tariffs:

- **Adopt time-based rates** to more accurately capture the cost of electricity generation and reduce overall costs to the grid by avoiding investment in peaking capacity
- **Expand and improve utility green energy options** to meet increasing customer demand for renewable electricity and renewable natural gas

This section covers strategies to shift energy supplied to Minnesota customers, including electricity and natural gas, toward cleaner energy resources, as well as to streamline the delivery of electricity to best integrate distributed energy resources.

Energy profile

Electric and natural gas utilities in Minnesota supply the majority of energy to end-use sectors. The largest two electric utilities (Xcel Energy and Minnesota Power) account for almost 60 percent of total electricity retail sales in the state, but there are over 170 other electric utilities and over 35 natural gas utilities that serve retail customers.[124] The power plants that generate electricity are owned by an array of utilities, independent power producers, private businesses and institutions, and communities; there are more than 140 large power plant owners in all,[125] not counting small, distributed resources like rooftop PV.

Wind accounts for 17 percent of Minnesota's electricity generation. A modernized grid and updated energy pricing and tariffs can facilitate further renewable energy adoption.

Electricity generation in Minnesota accounts for 29 percent of total energy use in the state, with 44 percent of the energy used to produce electricity coming from coal.[126] Due to efficiency losses associated with burning fuels to create electricity, thermal power plants lose as heat 67 percent of the primary energy in their fuel.[127] Electricity generation also makes up roughly 30 percent of Minnesota's GHG emissions, so supplying electricity with low-carbon sources is providing a near-term solution for reducing GHG emissions to the level required by state law. Natural gas used in the industrial, residential, and commercial sectors accounts for nearly as much (23 percent) of Minnesota's total energy use (see Figure 4).

Minnesota has abundant wind resources, and is among the top tier of states in wind generation, with 17 percent of the state's electricity being generated by wind in 2015.[128] Other renewable resources, including biobased natural gas, make up a much smaller portion of the state's generation mix, but the renewable energy sector is poised for diversification and growth; for example, Minnesota has also been a recent leader in policies promoting solar PV adoption.

Summary of opportunities

The strategies outlined in this section have been identified by stakeholders as key levers to ensure that the transition brought on by the rapidly improving cost-effectiveness of clean energy resources can be managed at low cost and while maintaining or improving the reliability and resiliency that Minnesotans enjoy from the grid today. The strategies fall into two major categories: grid modernization, and pricing and tariff structures.

- **Grid modernization:** A transition to clean energy resources can be aided by targeted upgrades to grid infrastructure to support the integration of distributed energy resources (DERs), including renewable generation resources (e.g., solar photovoltaic [PV] systems) and other technologies (e.g., smart inverters, load control technologies, energy storage). Today's grid is largely designed for one-way flow of electricity, information, and value; with the declining costs and evolving capabilities of DERs and advanced control technologies, targeted grid upgrades will be beneficial for seamlessly enabling more two-way flows. These upgrades will also help DERs to integrate with central infrastructure, including a likely expanded level of large-scale variable renewable generating resources (e.g., wind farms).

  Strategies in this category focus on several upgrades to grid infrastructure:
  - Rolling out advanced meters to provide visibility and communications at more points on the grid
  - Adopting smart inverters to provide enhanced visibility and control for distributed PV resources
  - Integrating energy storage and demand response technologies to add flexibility to the grid, reducing costs and allowing integration of more renewable resources

- **Pricing and tariffs:** Most Minnesota electric utilities (like most utilities in other states) typically charge customers based on total kilowatt-hour consumption per month, with no accounting for what the energy source is or what the cost to produce that energy is, which can vary dramatically based on the time of day, season, and location. Updated retail pricing can better reflect the real grid-level costs of consumption at different times of day, location, or from different sources (e.g., wind power), empowering customers with choices and allowing them to reduce their bills as well as reducing costs for the system as a whole.

  Strategies in this category focus on several pricing changes to better reflect the timing and source of purchased electricity:
  - Time-varying rates that reflect the changing costs of generating electricity across different times of day, location, and seasons
  - Green tariffs that allow customers to purchase renewable energy through their utility

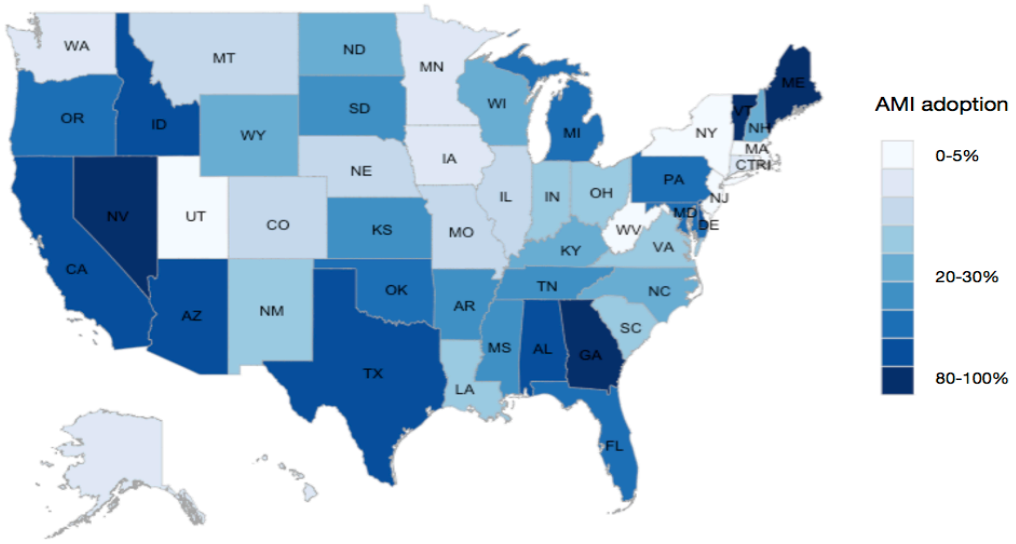
B1: Deploy advanced metering infrastructure (AMI)

Strategy overview

Electricity meters are the interface between utilities and customers. However, even as an increasing share of modern life becomes more data-rich and connected, the way in which we measure electricity use looks much the same as it has for the last century. Most meters in Minnesota only record total energy used on a daily or even monthly basis, and offer no capability for two-way communications between utility operators and the meter.

To address these limitations, utilities in many states have adopted a newer technology known as advanced metering infrastructure (AMI), or "smart meters." Nationwide, there were more than 50 million smart meters deployed to utility customers as of mid-2014, or 36 percent of the total number of meters. However, in Minnesota, only 12 percent of customers were connected to AMI as of 2014 (see Figure 15).

FIGURE 15: AMI ADOPTION BY STATE, 2014



Source: U.S. Energy Information Administration, Form 861

Specific actions for strategy implementation

1. **Assess possible benefits of AMI when considering deployment.**
   Depending on the technology selected, AMI can provide many sources of benefit for customers and the grid. Utilities, as the entities responsible for deploying and maintaining AMI, may take the lead in assessing these benefits for their particular systems, including:

   - *Support for conservation voltage reduction (CVR) and volt-var optimization (VVO) programs.*[iv] AMI supports the use of these tools that a utility can use to optimize the flow of power over the grid, helping to reduce energy consumption and peak demand.[129]
   - *Reduced truck rolls and outage duration.* Utilities frequently have to send workers to investigate grid issues and manually connect or disconnect equipment. AMI allows utilities to do many of these tasks remotely, reducing the number of worker trips to the field (i.e., "truck rolls") and reducing the duration of outages.
   - *Improved system visibility for planning and operations.* AMI allows utility operators to monitor aspects of the grid, leading to potential savings for both infrastructure planning as well as operational efficiencies. This includes worker safety improvements and visibility for recovery after outages.
   - *Cost savings through pricing and payment programs.* AMI facilitates the adoption of time-varying and other advanced rates, which can lead to cost reductions for both customers and the utility through reduced peak demand and lower consumption.

   Champions/Key participants:
   - Minnesota Power has already achieved 31 percent rollout of AMI meters in its territory. The utility can share its lessons learned with other stakeholders to more fully elaborate the value of AMI in the state.
   - Great River Energy helps their member utilities to increase value of AMI following deployment – at least 10 member utilities had rolled out AMI to a significant number of customers as of 2014.[130] In particular, Minnesota Valley Electric Cooperative has full AMI deployment, and can share lessons learned in evaluating costs and benefits.
   - Xcel Energy indicated in its October 2015 grid modernization filing that it will likely be pursuing AMI cost recovery in a subsequent filing.
   - Center for Energy and Environment (CEE) provides analysis, engagement and education on AMI opportunities and value proposition to end-users and utilities.
   - The Minnesota Public Utilities Commission reviews the costs and benefits of AMI for rate recovery and inclusion in grid modernization and integrated resource plans.

2. **Consider costs of AMI deployment when considering adoption.**
   Rolling out AMI at scale comes with many costs, which are considered when performing a cost-benefit analysis for a broad deployment. Costs to consider include:

   - *Meter capital costs*. Direct utility capital investment in AMI-connected meters can be substantial. Due to increased functionality, these devices may come at a premium compared to other options. In addition, the replacement frequency may be higher for AMI-connected meters than traditional meters.
   - *Supporting infrastructure costs.* AMI systems comprise more than just the meters themselves; they also rely on a network to enable communication between the utility and meters in the field,

[iv] These programs adjust voltage within the distribution system to reduce both peak demand and total energy usage, while maintaining customer voltage within limits to avoid damaging equipment. For more information see for instance, https://www.smartgrid.gov/files/Distribution_System_Energy_Efficiency_17Nov11.pdf

as well as utility-side, "back end" infrastructure and software (including meter data management systems) to support the communication and metering functionality and fully utilize the new capabilities of AMI. These systems add incremental costs to AMI system rollouts.
- *Ongoing operating expenses.* Maintaining the information technology systems necessary to realize value from AMI deployment requires ongoing expenses that are incremental to costs from legacy systems.

Champions/Key participants:
- Minnesota Power has already achieved 31 percent rollout of AMI meters in its territory. The utility can share its lessons learned with other stakeholders to more fully elaborate the costs of AMI in the state.
- Xcel Energy indicated in its October 2015 grid modernization filing that it will likely be pursuing AMI cost recovery in a subsequent filing.
- Great River Energy member utilities (e.g., Minnesota Valley Electric Cooperative) can share lessons learned in evaluating costs and benefits.
- CEE provides analysis, engagement and education on AMI opportunities and value proposition to end-users and utilities.
- The Minnesota Public Utilities Commission reviews the costs and benefits of AMI for rate recovery and inclusion in grid modernization and integrated resource plans.

3. **Analyze the value of deploying AMI across different geographies.**
Utilities can assess the benefits of deploying AMI in a targeted manner against the economies of scale associated with pursuing service territory-wide rollout. Phased adoption approaches can be used to target early deployment to areas with the highest immediate value, and/or or the highest potential to realize certain benefits of AMI deployment. For example, utilities could choose to target initial AMI adoption in areas with forecast demand growth, or with high adoption of distributed energy resources such as solar PV or electric vehicles, in order to leverage the benefits of AMI for those specific use cases and inform the business case for broader adoption.

Champions/Key Participants:
- Great River Energy member utilities (e.g., Minnesota Valley Electric Cooperative) can share lessons learned in phased rollout of AMI.
- Minnesota Power has already achieved 31 percent rollout of AMI meters in its territory. The utility can share its lessons learned with other stakeholders to more fully elaborate the value of AMI in the state.
- Xcel Energy
- CEE provides analysis, engagement and education on AMI opportunities and value proposition to end-users and utilities.
- The Minnesota Public Utilities Commission reviews the costs and benefits of AMI for rate recovery and inclusion in grid modernization and integrated resource plans.

4. **Pilot leading-edge AMI technology and pursue best practices.**
AMI systems have evolved over the years since the initial deployment of these systems, and are likely to continue to do so. Utilities may stay abreast of changes in technology costs and capabilities, as well as best practices in realizing AMI benefits gleaned from other utility deployments (e.g., through the U.S. Department of Energy's Smart Grid Investment Grant reporting, expected to continue through 2016).

Champions/Key Participants:
- Minnesota Power has already achieved 31 percent rollout of AMI meters in its territory. The integration of technology, tools, and information were at the heart of Minnesota Power's Time-of-Day Pilot. This is an evolving area with plenty of opportunities and challenges. The utility can share its lessons learned with other stakeholders to identify best practices.

- Great River Energy helps their member utilities to increase value of AMI following deployment.
- Xcel Energy
- CEE provides analysis, engagement and education on AMI opportunities and value proposition to end-users and utilities.
- The Minnesota Public Utilities Commission reviews the costs and benefits of AMI for rate recovery and inclusion in grid modernization and integrated resource plans.

Success factors

1. **Alignment on cost-benefit framework for AMI.** It is important to ensure that all stakeholders are aligned in their understanding of the costs and benefits of AMI. Consumer advocates, utilities, environmental interests, and other stakeholders can agree on the appropriate cost-benefit analysis framework to inform AMI investment plan.
2. **All benefits of AMI are captured.** Utilities may focus not just on operational savings of deploying AMI (e.g., reduced truck rolls), but also explicitly leverage AMI investment to support customer benefits including time-varying rates, granular customer consumption data access, and integration of distributed energy resources. Utilities can also consider the benefits of expanding customer offerings and/or potentially allowing new businesses and other third parties to use AMI data and/or functionality in non-utility product offerings.
3. **Secure data and information transfer are in place.** Without utility-side software and other infrastructure to allow for data analysis, processing, and reporting, AMI data is much less actionable. Utilities could consider prioritizing this functionality in AMI deployments. In addition, utilities could consider ensuring that software applications for AMI data, both utility- and customer-facing, are standardized to the extent possible to avoid duplicative spending. Steps can be taken to investigate if these systems are secure in order to ensure that customer data remains private. Further, data transfer capacity can be enabled through dedicated radio frequency bandwidth.

Indicators of strategy success

1. AMI adoption, statewide and per-utility (number of meters, percent rollout)[131]
2. Cost of deployment, statewide and per-utility
3. Reported benefits from programs that leverage AMI in dollars saved, statewide and per-utility

Cross-sector opportunities and synergies

1. AMI can facilitate **energy data access** to drive building energy efficiency and provide data to help optimize grid infrastructure upgrades. The interval data offered by AMI, as well as the near-real time availability of data from AMI-enabled Home Area Networks to customers, can be leveraged by customers, utilities, and/or third party service providers to identify high-value efficiency or conservation opportunities and opportunities for infrastructure savings.
2. AMI can allow utilities additional flexibility in **demand response** and other customer product program design and implementation. AMI facilitates both the granular data needed to inform program design, as well as a communication pathway that can be used to control loads during demand response events.
3. AMI can support **time-varying rate programs** to encourage energy efficiency and peak demand reduction. An AMI system allows a utility to track customer energy consumption at an hourly or even 15-minute level, allowing the implementation of time-varying rates that can more accurately align customer pricing with utility cost structures.
4. AMI can aid utilities in planning for the increasing number of **electric vehicles** (EVs) on the grid, and may facilitate scheduling or direct control of EV charging to minimize adverse grid impacts.

Ongoing Minnesota initiatives

1. The Minnesota PUC has an ongoing grid modernization proceeding (docket 15-556) that is considering issues around AMI deployment, among other topics.[132]

Other related resources

1. The US Department of Energy's Smart Grid portal contains information on tools and applications for AMI deployment.[133]
2. The Smart Grid Investment Grant program contains information on 99 smart grid projects, including AMI deployment, totaling $8 billion in investment.[134]
3. The DOE's Consumer Behavior Studies report the outcomes from DOE-funded AMI deployment relating to peak reduction and other behavioral responses.[135]

B2: Enable smart inverter functionality

Strategy overview

Inverters convert the power produced by solar photovoltaic (PV) panels into a form that can be used both by customers' homes, in the case of rooftop panels, as well as the broader grid. As adoption levels of distributed PV grow, standard inverters are increasingly seen as inadequate because they offer limited capability to support grid conditions (e.g., voltage) at customer locations.

Advanced inverters, also called "smart inverters," add the ability to respond intelligently to grid signals when necessary; for example, they have "ride through" capabilities that can accommodate short-duration grid outages that would disable standard inverters, while still limiting risks to utility worker safety. States around the country have put forth requirements for smart inverters as PV adoption grows.[136] Noting the benefits of smart inverters even at low PV adoption levels, and that Minnesota has policy goals that lead to higher adoption of distributed PV, stakeholders identified increasing smart inverter adoption as a near-term strategy to gather data and proactively mitigate any PV integration issues.

Specific actions for strategy implementation

1. **Convene workgroup to evaluate pathways for smart inverters in Minnesota.**
   The workgroup can review UL and Institute of Electrical and Electronics Engineers (IEEE) progress on developing standards for advanced inverter functions and consider pathways for implementing advanced inverter functionality in Minnesota. Attendees may include representatives from utilities, the solar industry, state government, and regulators. Possible options to drive smart inverter adoption include taking steps to require smart inverters in interconnection agreements under certain conditions.

   Champions/Key Participants:
   - Minnesota Department of Commerce
   - Minnesota Public Utilities Commission
   - Xcel Energy
   - Great River Energy
   - Minnesota Power
   - Minnesota Solar Energy Industry Association
   - Solar PV developers

2. **Pilot smart inverter functionality.**
   Although the capabilities of smart inverters are well understood, extensive experience in other states shows that it is still necessary for grid operators to gain comfort with using them in an operational context. Utilities can test the value of smart inverters in combination with other demand and supply-side DERs, e.g., storage or demand response. Distribution feeders with near-term avoided cost potential from smart inverters could be prioritized for deployment.

   Champions/Key Participants:
   - Xcel Energy is piloting smart inverter functionality in Minnesota and Colorado.

- Great River Energy is exploring opportunities to further its understanding and involvement with distributed generation technologies, including smart inverters.
- Minnesota Power is currently looking at the relationship of production metering, net metering, and inverter functionality to evaluate the necessary and prudent investments in this space.
- CEE provides analysis, engagement and education on opportunities and value proposition to end-users and utilities.

Success factors

1. **Lessons learned from other states' smart inverter rollouts are used to inform Minnesota's process.** The process of driving adoption of smart inverters in other states (e.g., California) and the development of IEEE 1547 standards are of particular relevance to Minnesota.
2. **Standards or requirements provide a consistent signal for utilities and/or installers to choose and install technologies.** A disjointed or inconsistent set of standards would slow growth of both solar PV and smart inverter functionality.
3. **Cost-based objections to smart inverters are mitigated.** Stakeholders are aligned on the cost-benefit analysis of smart inverters, including the potential long-run value of smart inverters and the low incremental cost of including smart inverters at time of system installation.

Indicators of strategy success

1. Smart inverter adoption (number of inverters, percent rollout), statewide and per-utility for new systems meeting certain criteria.
2. Reported benefits from programs that leverage smart inverters in dollars saved, statewide and per utility.
3. Utility-reported hosting capacity (i.e., the capacity of PV that can be accommodated on a feeder or on the system) increases due to smart inverter adoption.

Cross-sector opportunities and synergies

1. Inverters have been integrated into customer-side energy management systems to allow building-level energy monitoring and facilitate energy efficiency through **improved building performance,** as well as allow for **energy storage** and **demand response** opportunities.

Ongoing Minnesota initiatives

1. The Minnesota Public Utilities Commission has an ongoing grid modernization proceeding (docket 15-556) that is considering issues around smart inverter deployment, among other topics.

Other related resources

1. Electric Power Research Institute & Solar Electric Power Association. "Rolling Out Smart Inverters," 2015.[137] This paper highlights lessons learned from leading utilities and states in rolling out large-scale adoption of smart inverters.
2. The National Renewable Energy Lab and the Solar Electric Power Association published a paper in 2015 with industry perspectives on advanced inverters in the US.[138]

Selected types of energy storage:

Batteries store energy chemically to directly provide electricity when discharging

Thermal storage systems store thermal energy in order to shift the timing of electricity use from one time to another.

Pumped hydro facilities store energy by pumping water uphill, then generating electricity later by letting it pass through turbines as it falls.

Flywheels store energy as spinning mass, which can be slowed using a generator to produce electricity.

B3: Integrate energy storage and demand response

Strategy overview

Electricity is unlike most commodities in that supply and demand must be balanced at all times. As a result, the grid has significant power plant capacity that is only used a small number of hours each year when demand

spikes. Peak demand has increased more rapidly than average demand over the past ten years in many areas of the country, including the Midwest.[139] If this peak demand is met with additional power plant capacity, the system becomes both less efficient and more expensive, thereby increasing costs to utilities and customers.

Battery storage, which can alleviate this issue, has until recently been prohibitively expensive. However, costs are quickly decreasing, prompting some utilities to speculate that building batteries to meet peak demand may soon be cheaper than building additional traditional peak power plants.[140] Similarly, demand-response capabilities have improved dramatically in recent years, with costs that are often much lower than traditional power plants.[141] Demand response (or DR) refers to providing a mechanism to encourage customers to change their energy demand in response to grid signals (including pricing), for example, to use less energy during peak demand hours.

There is significant national momentum in both storage and DR, and Minnesota utilities are already deploying both solutions. This strategy outlines near-term steps to capture the benefits of these emerging grid resources.

Specific actions for strategy implementation

1. **Explore opportunities for federal funding and partnerships to integrate energy storage and demand response into grid operations.**
   With the growing national momentum to integrate storage and demand response, there are emerging opportunities to pursue federal funding and/or other partnership opportunities for demonstration projects. Demonstration projects can help quantify the value proposition for these technologies, beyond what Minnesota utilities have already demonstrated.

   Champions/Key Participants:
   - Minnesota Energy Storage Alliance, led by University of Minnesota Energy Transition Lab, can develop partnerships for response to funding opportunities.
   - Energy Storage Technology Advancement Partnership (ESTAP) is a collaboration of Sandia National Laboratory and Clean Energy State Alliance (CESA) that facilitates technical assistance and cofunding partnerships between states and the U.S. Department of Energy.
   - Xcel Energy, in its October 2015 Grid Modernization filing, proposed a solar and battery storage project in Belle Plaine, MN. Xcel has deployed other battery storage pilot projects in Minnesota and Colorado.
   - Great River Energy is exploring opportunities to further its understanding and involvement with distributed energy resources, including demand response and energy storage.
   - CEE provides analysis, engagement and education on opportunities and value proposition to end-users and utilities. CEE administers the Energy Intelligence demand response CIP program for Xcel Energy.
   - Minnesota Department of Commerce contracted for analyses of Energy Storage and Microgrids in 2013, and reviews the costs and benefits of demand response for inclusion in utility Conservation Improvement Programs.
   - Minnesota Public Utilities Commission reviews the costs and benefits of energy storage and demand response for inclusion in utility Grid Modernization and Integrated Resource Plans.

2. **Investigate energy storage and demand response participation in wholesale markets.**
   Storage and demand response have many different value streams associated with them. For example, both resources can provide benefits in the following categories:
   - Benefits to individual customers or groups of customers: lowering bills; providing increased reliability
   - Benefits to local utilities: lowering peak demands; avoiding investment in traditional grid infrastructure.
   - Benefits to the broader grid: allowing higher use of least-cost resources (including wind and solar PV); smoothing demand profiles.

Champions/Key Participants:

- MISO develops policies and procedures for energy storage and demand response participation in wholesale markets.
- Minnesota Energy Storage Alliance, led by University of Minnesota Energy Transition Lab, provides input to MISO on energy storage market rules.
- Great River Energy is evaluating how demand response and storage fit into wholesale markets.
- CEE provides analysis, engagement, and education on opportunities and value proposition to end-users and utilities.
- Great Plains Institute
- Sandia/CESA Energy Storage Technology Advancement Partnership (ESTAP)
- Xcel Energy
- Minnesota Department of Commerce, State Energy Office reviews the costs and benefits of energy storage and demand response for inclusion in utility Conservation Improvement Programs. The Department's regulatory unit analyzes ratepayer impact of storage and demand response participation in wholesale markets.
- The Minnesota Public Utilities Commission reviews the costs and benefits of energy storage and demand response for inclusion in utility Grid Modernization and Integrated Resource Plans.

Success factors

1. **Storage and DR projects capture multiple value streams.** Storage, at today's prices, may not make economic sense if it only provides a single service to customers, utilities, or the grid. The overall value of projects will increase if they are designed to provide multiple benefits, for example, deferring generation and/or distribution infrastructure, smoothing power prices and/or renewable output, demand charge savings for utilities and customers, and back up power.
2. **Thermal energy storage is considered a viable form of storage or DR.** The storage potential of thermal loads in homes and businesses, such as water heaters, is already being successfully leveraged by Minnesota utilities to provide benefits, such as using lower-priced nighttime energy, at low cost. Utility deployment of advanced distribution management systems may unlock additional capability for thermal storage to provide grid interactive services to support power quality.

Indicators of strategy success

1. Number and capacity (MW and MWh) of energy storage and demand response resources by type in Minnesota
2. Number and capacity (MW and MWh) of energy storage and demand response resources participating in MISO market
3. Value of savings compared to traditional built capacity solutions ($ per year)

Cross-sector opportunities and synergies

1. Potential for combination with **smart inverter** functionality to provide similar or complementary services.
2. **Time-based rates** can help incent storage and DR by increasing the customer benefits of having flexible load.
3. **Electric vehicle** charging can act as a form of energy storage and/or demand response, allowing vehicles to schedule and/or modulate their charging behavior and reduce costs on the grid.
4. **Improved building operations** are a key component of a successful demand response strategy.
5. **Advanced Metering Infrastructure** can support enhanced demand response and energy storage functions.

Ongoing Minnesota initiatives

1. Xcel Belle Plaine Battery Storage proposal in Grid Modernization filing (docket 15-962)[142]
2. In July 2015, the Energy Transition Lab at University of Minnesota hosted the first Energy Storage Summit, where national and local experts investigated the market drivers affecting energy storage in Minnesota. The Energy Storage 101 document from the summit is a reference handbook, and additional

resources, videos and presentations, and opportunities for stakeholder engagement are available online.[143]

3. Center for Energy and Environment has proposed a project for the 2016 Legislative-Citizen Commission on Minnesota Resources funding for a Geotargeted Distributed Clean Energy Initiative in partnership with Xcel energy. The project will determine the potential for geographically targeted clean, distributed energy resources to defer utility infrastructure investments.[144]
4. Strategen Consulting and Electric Power Resource Institute's White Paper "Analysis of Utility-Managed, On-Site Energy Storage in Minnesota" investigates the potential costs and benefits of customer-sited, grid-connected electrical energy storage technology.[145]
5. The Legislative Energy Commission's November 2015 meeting on energy storage included presentations from industry experts.[146]
6. The Microgrid Institute's white paper, "Minnesota Microgrids: Barriers, Opportunities, and Pathways Toward Energy Assurance," identifies regulatory barriers and opportunities for microgrid development in Minnesota.[147]
7. Xcel RDF supported Research and Demonstration Project: Luverne Sodium Sulfur Battery Energy Storage Project.[148]
8. The Natural Resources Research Institute has completed two studies of energy storage opportunities in Minnesota.[149]
9. Honeywell, with extensive operations in Minnesota, has partnered with demand response providers to help customers save money while reducing peak grid demand through use of communicating thermostats.[150]
10. Minnesota Valley Electric Cooperative is in the process of implementing a next-generation demand response system, including traditional direct load control, behavioral, and smart thermostat programs.

Other related resources

1. The January 2016 MISO Energy Storage Workshop presentation provides current technologies and market rules for energy storage.[151]
2. On January 25, 2016, the U.S. Supreme Court ruled in favor of FERC order 745, which calls for demand response to be compensated like other generators in wholesale energy markets.[152]
3. Rocky Mountain Institute's 2015 report, *The Economics of Battery Energy Storage* highlights the potential for multiple value streams from storage investments.[153]

B4: Adopt time-based rates

Strategy overview

Most electricity customers pay retail electric rates that are the same no matter when energy is consumed, even though the prices that utilities pay for wholesale electricity vary widely. Wholesale prices tend to peak on hot summer days and cold winter days, and it is increasingly common for utilities to offer retail prices that reflect these market patterns. This sends economic signals to customers to reduce consumption when power costs the most.

Time-based pricing can be beneficial both for customers as well as for the grid as a whole. Studies have estimated at least $3 billion per year in potential savings across the United States from wide adoption of time-varying rates.[154] Nearly seven million utility customers nationally are already served by time-varying rates, including over 11,000 customers in Minnesota, mostly commercial and industrial customers.[155] This strategy outlines steps for implementing this type of rate for mass-market (i.e., small commercial and residential) customers in Minnesota.

Specific actions for strategy implementation

1. **Develop and pilot new time-based rates for different customer groups.**
   These rates could be designed to lower the costs of the grid (e.g., by avoiding investment in peaking capacity), while balancing against customer needs and limited capabilities to shift demand in time. For

example, rates may consider the needs of certain customer groups, such as large industrial users and low-income customers that are unable to easily shift their demand.

Champions/Key Participants:

- Great Plains Institute and partners convene a working group (e21) that is examining rate design options for Minnesota.
- Minnesota Power initiated a time-of-day rate pilot project in 2014 using AMI. The annual compliance filing was submitted on March 25, 2016 under Docket 12-233 with some rate modifications proposed for further piloting. Minnesota Power is in the process of final evaluation and reporting under the terms of the DOE grant.
- Center for Energy and Environment (CEE)
- Minnesota Public Utilities Commission has an open proceeding investigating alternative rate design options for Xcel Energy in Docket No. 15-662.

2. **Drive customer adoption of new rates through education and enabling technology.**
To realize maximum benefits from time-varying rates, customers need to be sufficiently educated to not only understand the new rates, but to be knowledgeable about actions they can take in response to the new rates. New technologies or other services made available to customers can help them to take action to shift their energy use and save money on bills.

   Rates can be designed to take advantage of customer capabilities and preferences. For example, residential customers are responsive to both behavioral (i.e., notifications via text message during peak periods)[156] and technological (i.e., automatic thermostat setbacks)[157] time-varying pricing programs, allowing a utility and/or another service provider flexibility in designing and executing these rates.

   Enabling technology comes in multiple forms, each with its pros and cons. Clear objectives for the new rates and the anticipated outcomes may be important as options for enabling technology are considered. Also, a path for timely advancement of pilots is helpful to ensure applied learning and understanding of customer adoption rates, actions, and impacts. Importantly, there may be correlation to conservation programs from an energy-savings perspective.

   Champions/Key Participants:

   - Great Plains Institute and partners convene a working group (e21) that is examining rate design options for Minnesota.
   - Minnesota Power initiated a time-of-day rate pilot project in 2014 using AMI infrastructure and is in the process of evaluation and reporting.
   - Center for Energy and Environment (CEE)
   - Utilities

Success factors

1. **Utility metering and billing systems have functionality to handle time-based rates**. Time-varying rates can be facilitated with AMI to improve customer understanding their energy use and cost, but less-complex time-based rates may be supported by existing infrastructure (e.g., automated meter reading [AMR]).
2. **Benefits of time-varying rate programs must be analyzed and communicated to customers**. Customers must be provided with information on strategies to shift their load to reduce costs and/or technologies to automate these shifts.
3. **Time-varying rates reflect wholesale price signals**. It is undesirable to have mixed signals for shifting consumption to different times of day; this may occur, for example, if a local utility has different peak periods during which it wishes to reduce consumption than the regional peaks reflected in the wholesale market. Peak time periods may thus vary by utility.
4. Objectives for the new rates and the anticipated outcomes must be made clear as options are considered.

Indicators of strategy success

1. Number of customers on time-based rates[158]
2. Change in customer load profile in response to time-based rates (percent peak reduction)
3. Change in system load factor over time, defined as average load divided by peak load

Cross-sector opportunities and synergies

1. Time-based rates can alter incentives for **building efficiency** programs (e.g., by incentivizing energy conservation measures that reduce peak-period demand).
2. Time-based rates can be used to promote charging **electric vehicles** at low-cost times that would not add to peak demand.
3. Time-based rates can unlock additional value from **AMI deployment.**
4. Time-based rates can improve the business case for **energy storage and demand response.**

Ongoing Minnesota initiatives

1. Minnesota Power initiated a time-of-day rate pilot project in 2014 using AMI infrastructure and is in the process of evaluation and reporting.[159]
2. The Minnesota Department of Commerce's "Report on Alternative Rate Design Options" describes "alternative rate designs that result in rates that promote energy conservation, reduce peak demand, and/or send more accurate, useful price signals to customers."[160]
3. The e21 Initiative continues work around rate design reforms.[161]
4. The e21 Initiative Phase 1 Report recommendations identified the opportunity for Time-Based Rates in Minnesota.[162]
5. Center for Energy and Environment promotes education and outreach surrounding time-based rates.[163]
6. The Minnesota Public Utilities Commission has an open proceeding investigating alternative rate design for Xcel Energy in Docket No. 15-662.

Other related resources

1. The Brattle Group's paper, "The Power of 5 Percent," highlights the national opportunity to achieve significant savings though peak demand reduction.[164]
2. The Brattle Group's paper, "Arcturus: International Evidence on Dynamic Pricing," provides a meta-review of international time-varying pricing programs that suggests significant peak reduction benefits.[165]
3. Rocky Mountain Institute's May 2016 report *A Review of Alternative Rate Designs* lays out challenges of existing rate design and the opportunities available with time-based rates.[166]

B5. Expand and improve utility green energy options

Strategy overview

Electric and gas utilities generally offer customers a single product: kilowatt-hours or therms of gas, on demand, with no differentiation for the source of that energy. However, there is an increasing demand across many customer classes to be able to buy energy with "green" attributes, for example, electricity produced by a wind turbine, or natural gas generated through anaerobic digestion. Institutions and corporations, including several large Minnesota-based businesses (Target, 3M and others),[167] increasingly seek to power their facilities with green energy in order to meet internal goals for sustainability and energy cost stability.

Utilities across the country, including some in Minnesota, are offering tariffs (i.e., pricing agreements) that allow for customers to choose renewable supply. Even though it is impossible to track an individual kWh on the grid and difficult to physically deliver and/or track renewably generated natural gas through existing infrastructure, financial means (e.g., renewable energy credits, or RECs) can be used to track and allocate the production and consumption of renewable energy. In addition to satisfying customer demand for green energy, these tariffs can also be an opportunity for driving incremental growth in renewables beyond utility- or state-level mandates.

While utilities already offer some green energy tariffs, not all customer needs are met by existing options, including cost performance and additionality. This strategy outlines steps to expand utility-sponsored green energy programs in Minnesota, in order to satisfy increasing demand for green energy from Minnesota businesses and households and promote renewable energy investment.

Specific actions for strategy implementation

1. **Develop and pilot green power options to fit customers' needs.**
   Electric utilities may expand current green power offerings and create new ones to meet expanding customer needs. Specific customer needs should be addressed, including cost performance (i.e., cost-effective green energy programs, including those with fixed-price attributes) and additionality (meaning that the purchase of green energy must be linked to new renewable energy project construction).

   Champions/Key Participants:

   - Great Plains Institute and partners convene a working group (e21) that is examining green power options for Minnesota customers.
   - Xcel Energy offers Windsource® and has developed Renewable*Connect, currently pending Public Utilities Commission review.
   - Minnesota Power's WindSense program expires at the end of 2016, and the utility is looking at replacement options.
   - Great River Energy was the first Minnesota utility to offer green pricing programs and has continued to develop a variety of green power products including Wellspring wind, Wellspring solar, and Revolt for electric vehicles.

2. **Educate customers about available programs**.
   Utilities can better market their green energy pricing programs to educate the customers about the benefits of enrolling. This education may also include information for comparison with other options for meeting renewable energy demand, such as on-site installation (e.g., rooftop PV) and community solar gardens. State agencies and organizations can inform Minnesotans about programs available to them.

   Champions/ Key Participants:
   - Clean Energy Resource Teams (CERTs)
   - Minnesota Pollution Control Agency
   - Minnesota Department of Commerce
   - Minnesota utilities

3. **Consider offering a voluntary green pricing pilot program for renewable natural gas.**
   A complement to renewable natural gas integration into the existing natural gas distribution system is a system for tracking and retiring renewable natural gas credits. This type of system would mirror the tracking systems already in place for renewable electricity. Tracking renewable natural gas credits could be an added function of current renewable electricity credit tracking systems.

   Champions/Key Participants:
   - Minnesota Department of Commerce
   - Great Plains Institute
   - Midwest Renewable Energy Tracking System
   - Minnesota utilities
   - Metropolitan Council

Success factors

1. **Programs offered meet the needs of different customer groups.** Key customer groups include corporate customers as well as mass-market groups. Specifically, many large corporate buyers have

signed onto the Corporate Renewable Energy Buyers' Principles,[168] which emphasize criteria for successful tariffs, including choice, cost-competitiveness, fixed price contracts, and additionality.

2. **Utility programs offer appropriate price signals to consumers.** Price signals should reflect the costs and benefits of procuring renewable resources and programs should be designed to ensure fairness of rates and reasonable costs for all customers.

Indicators of strategy success

1. Customer participation rate (percent of eligible customers)
2. MWh or mmBTU renewable energy delivered through programs

Cross-sector opportunities and synergies

1. Renewable natural gas offerings can help power **alternative fuel vehicles**.
2. Green power programs used for **electric vehicles** can provide low-carbon energy for transportation.
3. **Anaerobic digestion** can provide renewable natural gas to be sold through green energy programs.

Ongoing Minnesota initiatives

1. The DOE maintains a list of green power programs available from Minnesota utilities.[169]
2. Xcel submitted a new green tariff proposal in November 2015, in docket 15-985, allowing customers to access renewable energy at a premium to base rates, but with long-term price guarantees.[170]
3. The e21 Initiative Phase 1 Report recommendations identified the opportunity for Green Tariffs in Minnesota.[171]
4. In October 2015, the Minnesota Department of Commerce, Division of Energy Resources held a webinar entitled, "Emerging Trends in Utility Green Power Products." The video and slides provide a market overview and highlight specific utility programs and green tariff offerings.[172,173]
5. Environmental Initiative connects businesses with resources to support sustainability through a variety of programs such as the Minnesota Sustainable Growth Coalition, a collection of companies, organizations, and individual leaders aiming to advance a circular economy that promotes a healthy environment and sustainable growth.

Other related resources

1. World Resources Institute's report, "Emerging Green Tariffs in US Regulated Electricity Markets," discusses electricity customers' desires for renewable energy, not only to access Renewable Energy Certifications, but also long-term, fixed-price structures.[174]
2. The "Corporate Renewable Energy Buyers Principles," published by World Wildlife Fund for Nature and World Resources Institute, communicate the renewable energy products that a number of large corporate buyers would like to purchase.[175]
3. World Resources Institute's working paper, "Above and Beyond: Green Tariff Design for Traditional Utilities," argues that traditional utilities are positioned to offer renewable energy services with greater flexibility and lower transaction costs than third parties.[176]
4. The report, Power Forward 2.0: How American Companies Are Setting Clean Energy Targets and Capturing Greater Business Value, investigates how Fortune 500 companies are leading in capturing business value by reducing emissions and using cleaner forms of energy.[177]

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C. EFFICIENT BUILDINGS AND INTEGRATED ENERGY SYSTEMS

Section summary

Residential and commercial buildings account for two-thirds of the Minnesota's electricity use and more than half of natural gas delivered in the state.[178] Minnesota has demonstrated national leadership and progress toward an energy efficient building stock,[179] which has set the stage for even more energy savings. This section outlines strategies to increase efficiency in new buildings and existing buildings, and through integrated energy systems.

New buildings

It is easier to design buildings to be energy efficient right from the start than to upgrade them later. Given the building-stock turnover rate in Minnesota, new buildings present an excellent opportunity to design for optimal energy performance from the start. Strategies to improve new building energy performance include:

- **Adopting SB 2030 as an optional stretch code** for new buildings, additions, and major renovations.

Existing buildings

Nevertheless, given the building-stock turnover rate in Minnesota, existing buildings will play a key part in the energy equation over the next decade. Strategies for existing buildings are varied and include:

- **Enhancing energy data access** through a standardized data protocol in order to unlock energy savings
- **Increasing the adoption of commercial energy benchmarking and disclosure programs** by educating local governments and tribal nations about the benefits and available software tools
- **Improving buildings operations** through retrocommissioning and ongoing commissioning, building operator training, and advanced buildings controls
- **Promoting behavioral energy efficiency strategies** to capture cost-effective energy reductions and sustain savings over time.

Integrated energy systems

Finally, there are opportunities to optimize energy use beyond the individual building level, and to create cost-effective, highly efficient energy systems across buildings. Strategies for integrated energy systems involve:

- **Identifying opportunities for thermal energy grids** and integrating existing thermal grids with district energy systems
- **Supporting combined heat and power (CHP) development** by advancing the recommendations from the Department of Commerce's 2015 CHP Action Plan

Energy profile

Residential and commercial buildings account for two-thirds of the state's electricity consumption and over half of the natural gas delivered in Minnesota.[180] Making these buildings more efficient is a major opportunity to reduce the energy and greenhouse-gas intensity of the state.

This section covers strategies to help design, retrofit, and operate buildings and their energy supply systems more efficiently, through design standards for new buildings, expanded programs for existing buildings, and optimization of thermal energy systems for individual buildings, as well as communities.

Minnesota has already demonstrated national leadership and substantial progress toward an energy efficient building stock. In 2015, the American Council for an Energy Efficient Economy (ACEEE) ranked Minnesota tenth nationally for its energy efficiency programs and policies.[181] With the State's recent adoption of the 2012 International Energy Conservation Code (IECC), the state has set the stage for improvements in energy efficiency over time.[182]

Buildings account for over 40 percent of all energy use in Minnesota. Ensuring that new buildings are highly energy efficient and that existing buildings are performing well is crucial to Minnesota's energy equation.

The current building energy landscape sets the stage for additional energy saving opportunities. New buildings can be held to increasingly ambitious energy codes. Owners and operators of existing buildings can take advantage of expanded access to data and advanced building system controls in order to identify and act on savings opportunities. Buildings are the end-points of a modernizing and interconnected electricity grid, and buildings are the major individual constituents of a local community's energy footprint; there is a tremendous opportunity to dovetail building efficiency improvements with grid modernization and local government action in order to further drive energy savings.

Summary of opportunities

The strategies outlined in this section have been identified as key near-term levers to improve upon Minnesota's leadership in building energy efficiency. The strategies fall into three major categories: efficiency in new building design and construction; efficiency in existing buildings through retrofits and improved operation; and opportunities for integrated supply of electricity and thermal energy.

New buildings, additions, and major renovations

Due to the up-front opportunities to optimize site selection, building design, and material and equipment specifications based on energy efficiency goals, the thoughtful design of new buildings, additions, and major renovations is a cost-effective way to reduce building energy use and optimize performance. Because of building stock turnover, new buildings are expected to account for a large share of Minnesota's total energy use over the time horizon of existing policies and goals.

The strategy outlined in this section would make it easier to apply aggressive building energy codes to an increasing share of buildings in the state, ensuring that new additions to the building stock are as efficient as possible.

Existing buildings

Addressing energy use in existing buildings is another important lever to reduce sector energy use. Minnesota's existing energy efficiency programs address building envelope efficiency, heating and cooling systems, and plug loads. However, there is room to expand the breadth and depth of energy-efficient practices and programs.

The strategies in this section address the rapidly growing opportunities for building operators and occupants to understand their energy use through data access and benchmarking, and to use that information to better manage their energy consumption through building system operations and behavior change.

Integrated energy systems

The strategies in the previous two categories can drive energy efficiency at the single-building and single-fuel levels. However, there are many opportunities to drive additional energy savings by integrating district heating and cooling systems and capturing and reusing waste heat.

Strategies in this section lay out actions to identify and take advantage of opportunities to meet the thermal needs of multiple buildings together, and to combine the provision of electricity and thermal energy with combined heat and power (CHP) facilities.

C1. Adopt SB 2030 as a stretch code that can be adopted by local jurisdictions

Strategy overview:

New buildings, additions, and major renovations represent a large opportunity for energy and CO_2 savings in Minnesota over the coming decades. One opportunity to capture these savings is to implement a stretch code for energy performance that can be adopted at the local level. Currently, commercial and residential construction is required to meet the 2015 Minnesota Energy Code, which is based on the 2012 International Energy Conservation Code.[183] Additionally, state-bonded buildings are required to meet performance-based energy standards established through the State's Sustainable Buildings 2030 (SB 2030) program. SB 2030 is based on the Architecture 2030 program, and is supported by state and utility funding and a local project team.[184] This program sets energy targets for new and renovated buildings that increase over time, resulting in net-zero energy building design in 2030.

By expanding SB 2030's scope beyond state-bonded buildings and encouraging local jurisdictions to adopt it as an optional stretch code—in other words, a voluntary building energy code that exceeds energy reduction requirements—for new buildings, additions, and major renovations, implementing this strategy will result in significant energy savings in a greater variety and number of buildings. In its analysis of the climate and economic impacts of using a phased approach to expand the application of SB 2030 to all commercial and residential buildings, the Climate Solutions and Economic Opportunities (CSEO) process has identified a 9.3 million tonnes of CO_2-equivalent per year savings opportunity in 2030, with an estimated net present value of $2 billion from 2015 to 2030.[185] Given the scale of the energy savings opportunity highlighted by CSEO, stakeholders have identified the strategy of enabling local jurisdictions to adopt SB 2030 within their local building code as a promising near-term action.

Specific Actions for Strategy Implementation:

1. **Initiate Department of Labor and Industry (DLI) rulemaking**.
An administrative action by the Department of Labor and Industry (DLI) to add SB 2030 as an Appendix option to the MN State Building Code would allow local jurisdictions in Minnesota to elect to enforce SB 2030 standards to achieve energy and climate goals.

   SB 2030 can either be added as a stand-alone appendix, or integrated into a broader set of sustainability standards. Building upon DLI interest in the International Green Construction Code (IgCC) 2015, the new rulemaking could propose including the IgCC 2015 as an appendix to the Minnesota State Code, with the modification of an SB 2030 "overlay" to set building-specific limits on energy use. Specifically, replacing IgCC Table 612.1 with the SB 2030 Energy Standard Tool would allow the appendix code to base energy use intensity targets on individual building-specific characteristics. This would address the issue that, as a design-based code targeted at a limited number of building types, the IgCC 2015 does not account for atypical usage patterns or mixed-use building types.

   This proposed appendix code would be optional and would not necessarily be adopted by jurisdictions immediately. The recommendation described in the CSEO report suggests phasing compliance requirements over time to ensure that the requirements do not outpace the availability of training and development of resources. CSEO proposes the following, in this order:

   - Expanding the SB 2030 requirement to include state-licensed buildings
   - Implementing assistance and/or incentive programs for voluntary adoption of SB 2030 by the public and private sectors
   - Making SB 2030 available as an appendix to the state building code for local jurisdictions to adopt voluntarily (which is the focus of this action)
   - Making SB 2030 mandatory for all new construction and major renovations[186]

   Champions/Key Participants:

   - Minnesota Department of Labor and Industry implements changes to the state building code.
   - Minnesota Departments of Commerce and Administration provide funding and administration for the SB 2030 program.
   - Center for Sustainable Building Research leads the SB 2030 consultant team.
   - LHB assists with project management for the SB 2030 consultant team.
   - The Weidt Group developed and maintains the SB 2030 Energy Standard Tool.
   - Center for Energy and Environment (CEE) verifies SB 2030 compliance for state-bonded projects and provides support for code officials.
   - Fresh Energy supports policy development to promote energy efficiency.
   - Utilities

2. **Educate local government staff and building officials about the appendix building code.**
If the appendix code were added by DLI, it would be up to local jurisdictions to adopt it. Education and outreach to local jurisdictions would be necessary to ensure that they are informed about the appendix code and that they fully understand the benefits and costs when deciding whether or not to implement it.

   Champions/Key Participants:

   - Minnesota Pollution Control Agency and Great Plains Institute, via GreenStep Cities, can provide support to local building officials in their decision making process on whether and how to adopt the appendix code.

- Minnesota Departments of Commerce and Administration provide technical resources for SB 2030 through a team made up of the Center for Sustainable Building Research, LHB, The Weidt Group, CEE, and Herzog Wheeler & Associates.
- Minnesota Department of Labor and Industry provides training to building officials on changes to the state building code.

3. **Train architects, engineers, and contractors to design and construct buildings that meet SB 2030.** As local jurisdictions begin to adopt the appendix code, it is critical that architects, engineers, and contractors are able to effectively design and construct buildings that meet the standards of the code. Training for these actors is an important step in achieving the success of this strategy, and can build on the existing SB 2030 Training Series offered each year.

   Champions/Key Participants:
   - Minnesota Departments of Commerce and Administration provide funding for the current SB 2030 Training Series.
   - Center for Sustainable Building Research coordinates and conducts SB 2030 training workshops.
   - The Weidt Group provides resources for SB 2030 training.
   - LHB provides resources for SB 2030 training.
   - Local trade associations: American Institute of Architects (AIA), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Building Owners and Managers Association (BOMA), Builders Association of the Twin Cities (BATC), and US Green Building Council (USGBC) support continuing education opportunities.
   - Utilities

Success factors

1. **The SB 2030 Energy Standard Tool addresses a greater variety of building types.** The SB 2030 Energy Standard Tool incorporates a building's space type and use patterns to calculate building-specific energy use intensity targets. The tool currently encompasses 17 different buildings types, but it does not support single-family residences or certain specialized building types. By switching from a model based on 17 building types to one based on 45 space asset types, future iterations of the tool will be increasingly customizable, enabling users to build an SB 2030 Energy Standard from nearly any combination of uses. In addition to this planned evolution of the tool, support will be needed for the continued addition of specialized-space asset types.
2. **Distributed energy resources at the building scale are cost effective.** Approaching zero-energy buildings will require an increased use of on-site renewable energy resources, demand response, and load management.
3. **Local jurisdictions have the expertise and capacity required to verify compliance with performance-based energy codes.** Unlike standard building codes, ensuring compliance with SB 2030 and similar performance-based energy codes requires understanding of whole-building energy simulation and metered energy data. Verifying compliance also requires access to an energy data-reporting platform, such as B3 Benchmarking.
4. **Other potential opportunities for adopting SB 2030 as an appendix code have been identified.** Both stakeholders and the CSEO process have identified additional potential opportunities to address, including: cost effectiveness of SB 2030 buildings, market acceptance of SBSB 2030, availability of technology to meet performance requirements, interaction with existing conservation Improvement programs, and accountability within policy enforcement.

Indicators of strategy success

1. Number and square feet of SB 2030 buildings[187]
2. Annual energy saved by SB 2030 buildings[188]

3. Number of local jurisdictions that have adopted SB 2030 into their building code

Cross-sector opportunities and synergies

1. Improved **energy data access** is required for verifying compliance, because SB 2030 is a performance-based standard and thus relies on energy use data during building operations.
2. **Local governments** can choose to adopt SB 2030 as their building energy code.
3. Approaching net zero energy buildings will require an increased use of on-site renewable energy resources, **enhanced building controls, demand response**, and load management.

Ongoing Minnesota initiatives

1. The CSEO process, as noted above, proposes a "SB 2030/Zero Energy Transition/Codes" strategy, upon which this recommendation is based.[189]
2. In the City of Saint Paul, entities that receive tax incentives or abatement are required to participate in the SB 2030 program.[190]
3. Maplewood has adopted a Green Construction code for all new city-funded buildings.[191]

Other related resources

1. Architecture 2030
2. Department of Energy's Zero Energy Ready Home
3. Conservation Applied Research and Development (CARD), Clean Energy Resource Teams (CERTs), and Sustainable Buildings 2030 (SB 2030), 2016 Report, MN Department of Commerce annual report to the legislature includes energy savings results from the SB 2030 program.
4. The B3: Buildings, Benchmarking, and Beyond website includes tools and resources to help meet the SB 2030 standard.
5. The Microgrid Institute's white paper, "Minnesota Microgrids: Barriers, Opportunities, and Pathways Toward Energy Assurance," identifies regulatory barriers and opportunities for microgrid development in Minnesota.[192]

C2. Enhance energy data access

Strategy overview

Timely access to energy data is essential for identifying potential energy and cost savings. Traditionally, customers have had limited access to their energy usage data through their monthly utility bills. For customers with multiple sites served by different utilities, tracking energy usage data becomes a challenge when data is provided in different formats. Fortunately, energy data is becoming increasingly reliable and easily accessible, allowing customers and third-party providers to unlock significant savings.

There are a number of emerging energy data-access standards, and Green Button is one such standard gaining traction. Today, with Green Button data standards, 60 million households and businesses can access their energy usage data from their utilities .[193,194] Companies and utilities across the country, including Xcel Energy, offer Green Button to customers. This strategy explores the potential for this new standard to be applied more broadly in Minnesota.

Green Button Data Standard

Green Button is the product of multiple utilities responding to a challenge from the White House in 2011 to provide customers with better access to their energy data. The more than 50 utilities nationwide that have adopted these standards implement a common XML data format in a way that is easy for customers to download.

Green Button has two levels of access: Download My Data allows an individual customer to download their own data from a web portal, while Connect My Data allows a customer to authorize a third party to download and analyze usage data on a customer's behalf. Connect My Data can also be used to provide community-level energy data access and help local governments and tribal nations assess their energy use.

Specific actions for strategy implementation

1. **Evaluate the potential for standardized customer data access, automated data transfer, and standardized community data access.** A broad group of interested parties can work together to facilitate peer-to-peer learning from implementation of standardized platforms for personal energy data access, automated data transfer, and community energy data access programs.

   Champions/Key Participants:
   - Minnesota Department of Commerce reviews potential for inclusion as a CIP measure
   - Xcel Energy has implemented Green Button, automated data transfer into Energy Star Portfolio Manager and B3 Benchmarking, and standardized community energy data access.
   - CenterPoint Energy
   - Minnesota Valley Electric Cooperative
   - Minnesota Power included a customer portal as part of its Consumer Behavior Study Plan and is in the process of evaluating next steps for these types of features.
   - The Weidt Group
   - Center for Energy and Environment (CEE)
   - US Green Building Council – MN Chapter
   - Fresh Energy
   - Metropolitan Council
   - MN Public Utilities Commission
   - Electric and gas utilities
   - LHB Architects

2. **Determine a process for widespread adoption of standardized energy data access.** Following successful implementation of standardized platforms for energy data access and automated data transfer by early adopters, involved parties can use lessons learned and best practices (including for both value creation as well as implementation cost reduction) to design a broader rollout plan for other Minnesota utilities using a standardized data platform, and including consideration of individual as well as community-level energy data access. This plan will take into account different situations and needs of individual utilities.

   Champions/Key Participants:
   - Minnesota Department of Commerce
   - The Weidt Group
   - Great Plains Institute
   - LHB
   - Electric and gas utilities
   - Center for Energy and Environment
   - Fresh Energy
   - Metropolitan Council
   - Minnesota Public Utilities Commission

Success factors

1. **Protection and standards for data privacy must be clear.** This strategy will rely on the open Public Utilities Commission Energy Data Access/Data Privacy proceeding (docket 12-1344) for a ruling on the level of aggregation and other measures needed to protect the privacy of energy usage data at the community and multi-tenant building scales.
2. **Utility billing system has functionality to work with data reporting standard.** There is some risk that implementation costs for utilities may be very high if existing billing systems are incompatible with the agreed-upon standard for data reporting. Utilities may assess whether the standard for data access is supported by utility back-end systems prior to large investment in particular solutions.

3. **Outreach and education** can help stakeholders understand options and resources for data access, and application of data access tools, once they are available.
4. **Automated data transfer is in place.** To unlock the full potential of energy data access to impact energy efficiency will require automated data transfer into benchmarking platforms such as B3 Benchmarking and Energy Star™ Portfolio Manager. Green Button Connect My Data is one option to enable automated data transfer, but utilities can also set up automated data transfer through other means.

Indicators of strategy success

1. Number of Minnesota utilities offering Green Button Download My Data, Green Button Connect My Data, automated data transfer into Energy Star™ Portfolio Manager, automated data transfer into B3 Benchmarking, or similar platform.
2. Number of Minnesota utilities offering community-level energy data

Cross-sector opportunities and synergies

1. **Advanced metering infrastructure (AMI)** is necessary to collect interval electricity consumption data, and thus critical to be able to process and make it available to customers. Advanced metering can be used not only to monitor energy consumption, but also to help businesses (particularly industrial stakeholders) increase process efficiency beyond energy savings and demand reduction.
2. Easy access to energy use data facilitates **benchmarking** of building energy use**.**
3. Energy data access allows for tracking effectiveness of **behavioral strategies** as well as other community-level, **local actions** to support energy efficiency.

Ongoing Minnesota initiatives

1. This strategy will rely on the open Public Utilities Commission Customer Data Privacy proceeding (docket 12-1344) for a ruling on who can access energy usage data.[195]
2. Xcel Energy provides Green Button Download My Data functionality to its customers, allowing them to access daily electricity consumption data. Xcel's implementation does not provide access to demand data (i.e., peak kilowatt consumption for commercial customers, which drives a substantial portion of these customers' bills) or more granular interval data that would be supported by AMI.
3. Xcel offers a Benchmarking Portal for automatic energy data transfer to Energy Star Portfolio Manager as part of a CIP pilot.[196]
4. B3 Benchmarking is developing a method to automatically transfer energy data for Xcel customers into B3 Benchmarking platform.[197]
5. Xcel offers Community Energy Reports to all interested communities in their service territories to support community energy planning. These reports contain information on energy consumption and associated emissions, and participation in renewable, demand response, and energy efficiency programs.[198]
6. A number of Minnesota utilities use a web-based service provided by MyMeter (based in Saint Paul) for customer data access, enhanced customer engagement, load management, prepay solutions, and outage management notification.

Other related resources

1. A study called "Energy Consumption Data: The Key to Improved Energy Efficiency," conducted by two University of Minnesota professors, demonstrates the range of state and federal efforts supporting data access.[199]
2. "Integrating Benchmarking into Utility Conservation Improvement Programs to Capture Greater Energy Savings," prepared by The Weidt Group for the Minnesota Department of Commerce, highlights different means of energy data access in Minnesota and the related benefits of using the data in benchmarking programs.[200]
3. Mission:Data's study, "The EmPOWERED Consumer: How Consumer Access to Energy Data can Help Solve our Biggest Energy Challenge," features case studies from three states on energy savings achieved due to enhanced energy data access.[201]

C3. Increase adoption of commercial building energy benchmarking and disclosure programs

Strategy Overview

With proper access to data, motivated commercial building owners and operators can track and analyze their own energy use data, identify savings opportunities, and verify actual savings. However, making energy data available does not ensure that it will be used to drive energy savings, or even that building owners have enough information to prioritize energy reduction strategies. This is where benchmarking programs come into play. Benchmarking programs require that energy use be tracked and compared against similar buildings, or benchmarked, which can help prioritize cost-effective upgrades. Additional savings can be unlocked through disclosure programs, which can take different forms. Program administrators may anonymize and aggregate building energy data, rank building performance, and/or disclose individual building-level data through a report or online database. Benchmarking and disclosure programs can help enable cities and states to meet building energy efficiency targets.

Nationwide, benchmarking and disclosure programs have been proven to drive energy savings. 36,000 buildings using Portfolio Manager showed average savings of 2.4 percent. At the local scale, Minnesota State Colleges and Universities (MnSCU) has seen an 8.5 percent energy savings associated with disclosing campus energy use on a public website. This strategy outlines the means for broadening participation in benchmarking and disclosure programs in Minnesota.

Stakeholders have identified benchmarking and disclosing building energy use data as a near-term, high-value lever that can identify areas for improvement in existing buildings, help ensure that new buildings are operating as predicted, and measure the impact and persistence of actions taken, whether energy efficiency retrofits or behavior modification strategies.

Specific actions for strategy implementation

1. **Expand access to B3 Benchmarking to encourage voluntary benchmarking.**
   B3 Benchmarking is an online program that allows buildings to compare their energy use with a code-based benchmark, identify areas of improvement, and quantify the cost savings. B3 Benchmarking is available at no cost for Minnesota public buildings, and its use is required for buildings participating in the State's SB 2030 program.

   Extending access to and training on B3 Benchmarking beyond public buildings would enable building owners and operators to more deeply understand their building energy performance and opportunities for savings. Additionally, this would create the framework for a comprehensive database of building energy use in Minnesota that could be leveraged to develop targeted energy efficiency programs and track progress.

   Champions/Key Participants:
   - Center for Sustainable Building Research can facilitate the expanded use of B3 Benchmarking.
   - The Weidt Group can facilitate the expanded use of B3 Benchmarking.
   - LHB can facilitate the expanded use of B3 Benchmarking.
   - Department of Commerce cancan review the costs and benefits of increasing funding to expand B3 Benchmarking access for voluntary private sector use.
   - Utilities

2. **Work collaboratively with local governments and tribal nations to encourage voluntary benchmarking programs.**
   Local governments and tribal nations may be interested in leveraging voluntary benchmarking to achieve energy savings in commercial buildings and lay the groundwork for deeper energy savings across the community. To provide maximum benefit, collaborative efforts should focus on how local governments

and tribal nations can engage local businesses in benchmarking through lease requirements, competitions, and incentive programs. By empowering interested cities, counties, and tribal nations to pass on training to commercial building owners, this strategy can encourage voluntary participation in energy benchmarking.

Champions/Key Participants:

- Center for Sustainable Research can provide support, resources and planning for community energy and resilience planning.
- US Green Building Council-Minnesota can coordinate efforts to expand voluntary adoption of benchmarking programs.
- CEE provides community engagement and education on benchmarking, energy competitions, and other tools and resources.
- Great Plains Institute can provide education on the importance of building energy benchmarking.
- Clean Energy Resource Teams (CERTs) can provide city and tribal staff with training on benchmarking tools.
- Minnesota Pollution Control Agency and Great Plains Institute via GreenStep Cities can provide funding to support city and tribal staff training for local businesses.
- Utilities can further encourage benchmarking through CIP and offer bonus incentives for customers who take action.

3. **Promote adoption of energy benchmarking and disclosure ordinances.**
After achieving broad, voluntary use of benchmarking tools by local groups and building owners, a follow-up step will promote adoption of benchmarking and disclosure ordinances or voluntary programs. Requiring building owners to publicly disclose their energy use (without compromising privacy or competitive positioning) can prompt building owners and operators to become more aware of their energy use and allow them to compare their energy use with similar buildings, encouraging friendly competition to reduce energy expenses. Commercial building energy disclosure ordinances in Minnesota cities and tribal communities can unlock additional energy savings by ensuring that these jurisdictions have the data and analytical tools, such as B3 Benchmarking, necessary to identify low-performing buildings and target them for upgrades.

   By first piloting in a few local jurisdictions, benchmarking and disclosure ordinances can establish a strong baseline of energy use for participating buildings, and lay the foundation for future benchmarking and disclosure programs for large commercial buildings.

   Champions/Key Participants:

   - Minnesota Pollution Control Agency and Great Plains Institute via GreenStep Cities can provide technical assistance to communities interested in adoption of energy disclosure programs.
   - Center for Energy and Environment (CEE) can communicate lessons learned from the implementation of the City of Minneapolis' commercial building rating and disclosure ordinance.

4. **Support actions to save energy based on benchmarked and/or disclosed energy data.** Train building owners, operators, and funding providers to leverage benchmarked data to target investment in areas of greatest savings potential. Connect building owners with existing resources for operational and behavioral energy efficiency strategies and related funding opportunities.

   Champions/Key Participants:

   - MN Department of Commerce has several programs, including the Guaranteed Energy Savings Program (GESP), to provide support to public entities in acting on savings opportunities identified by benchmarking and disclosure activities.
   - Clean Energy Resource Teams (CERTs) can connect building owners and operators with resources for efficiency strategies and related funding opportunities.
   - USGBC-MN is currently seeking funding to provide in-person training to building operators.

- Utilities

Success factors

1. **Communities, tribal nations, and building owners understand the importance of building energy benchmarking and disclosure programs** and champion their adoption.
2. **Building owners have access to at least one building benchmarking program** and related training materials at low or no cost.
3. **Data entry into benchmarking programs requires minimal time and effort**. One way of achieving this is by promoting automated data transfer from utilities. Xcel Energy is piloting this through both Portfolio Manager and B3 Benchmarking.
4. **Building operators understand how to use benchmarking data to reduce energy use.**
5. **Benchmarking programs are well integrated with other, existing efforts** (e.g., utility programs) in order to avoid customer confusion and/or energy saving backsliding.

Indicators of strategy success

1. Number and square footage of Minnesota buildings in B3 Benchmarking and/or Energy Star™ Portfolio Manager
2. Potential energy savings identified by B3 Benchmarking
3. Number of communities/tribal nations that have instituted commercial building energy disclosure ordinances

Cross-sector opportunities and synergies

1. **Data access** is required in order to participate in benchmarking and disclosure programs.
2. **Advanced metering infrastructure (AMI)** facilitates automatic tracking of interval data.
3. **Local governments and tribal nations** can take action to require benchmarking and/or disclosure from buildings within their jurisdiction.

Ongoing Minnesota initiatives

1. Under the State of Minnesota's B3 Benchmarking program, over 8,000 public buildings track their energy use and compare their performance to a code-based benchmark.[202]
2. The City of Minneapolis commercial building rating and disclosure ordinance 47.190 requires commercial buildings above 50,000 square feet to report their energy use to the City.[203]
3. The Minnesota Energy Star® Challenge provides participating building owners with free education and assistance regarding benchmarking, energy reduction strategies, and financing.[204]
4. 12-1344 Energy Data Access/Data Privacy docket
5. Minneapolis is partnering with Xcel on the Department of Energy's Better Buildings Initiative Energy Data Accelerator to facilitate better access to energy usage data. (ACEEE)
6. This strategy does not address data ownership or privacy, instead deferring to the open PUC Customer Data Privacy proceeding (docket 12-1344) for a ruling on who can access energy usage data.[205]
7. Minneapolis is partnering with Xcel on the Department of Energy's Better Buildings Initiative Energy Data Accelerator to facilitate better access to energy usage data.[206][207]
8. Xcel offers a Benchmarking Portal for automatic energy data transfer to Energy Star Portfolio Manager as part of a CIP pilot.[208]

Other related resources

1. The Building Energy Asset Score is a nationally used tool to benchmark energy efficiency, provided by the Department of Energy.[209]
2. Integrating Benchmarking into Utility Conservation Improvement Programs to Capture Greater Energy Savings, prepared by Weidt Group for Minnesota Department of Commerce, August 2014

C4. Improve building operations to capture energy efficiency opportunities

Strategy overview

Even when buildings are designed to be energy efficient, many do not operate to their full efficiency potential, leaving 10 to 20 percent of available energy savings on the table, according to industry studies.[210] This strategy identifies how building owners and operators can ensure that buildings operate to optimize energy efficiency.

First and foremost, building operators are critically important in ensuring that buildings are operating as efficiently as designed. However, a large percentage of the building operator workforce in Minnesota is expected to retire in the coming decade. This presents both a challenge and an opportunity to ensure that new building operators are well trained and able to take full advantage of technology innovation.

Second, it is critical to ensure that existing buildings continue to operate correctly over time through retrocommissioning and ongoing commissioning. These approaches involve verifying that building systems are functioning at their highest efficiency and making operational and maintenance improvements in existing buildings to ensure performance. Several notable projects in Minnesota have achieved significant savings using these approaches.[v] Resources for retrocommissioning and ongoing commissioning should be widely available to commercial building owners and operators through utility and state programs.

Finally, new building controls are emerging that can aid building owners and operators in capturing greater energy savings. Technology developers, utilities, and building owners and operators can partner to implement enhanced building controls.

Specific actions for strategy implementation

1. **Promote existing building operators with training and resources.**
   High quality building operator training programs can provide access to tools and best practices for operating buildings efficiently. Utilities, existing building operators, unions, and commercial building owners can partner with training programs, to ensure that all building operators, and particularly new operators, are sufficiently trained in efficient operations and maintenance.
   Champions/Key Participants:
   - Midwest Energy Efficiency Alliance offers training and partners with utilities who sponsor tuition rebates for customers that successfully complete Building Operator Certification ® (BOC) training; participating utilities include:
     - Minnesota Power,
     - Minnesota Energy Resources,
     - Austin Utilities,
     - Owatonna Public Utilities,
     - Rochester Public Utilities,
     - Otter Tail Power Company, and
     - Missouri River Energy Services.
   - Seventhwave offers in-person and online training on energy efficient best practices for a range of building types and equipment.
   - ASHRAE offers a variety of in-person and online professional development courses targeted toward enhanced building operation.
   - US Green Building Council, MN Chapter lists ongoing training opportunities for members.
   - Center for Sustainable Building Research and Herzog/Wheeler

The Building Operator Certification® (BOC) Program through the Midwest Energy Efficiency Alliance is a nationally recognized program that trains building operators in efficient operations and preventative maintenance. BOC® has certified 11,000 building operators nationwide and over 600 building operators in Minnesota, with potential for growth in the state.

[v] See, for example, a case study for the Minnesota History Center.

2. **Ensure that retrocommissioning and ongoing commissioning resources are available.** Retrocommissioning and ongoing commissioning are processes to ensure that existing buildings perform the way they were intended to. These processes can reveal, for example, that thermostats or sensors are not calibrated correctly, or that equipment is left on when it should not be. Studies show that retrocommissioning can result in up to 15 percent energy savings, with a payback period of 0.2 to 2.1 years.[211,212,213]

   To access these savings broadly in Minnesota, it is necessary to improve outreach to commercial building owners and operators on available resources.

   Champions/Key Participants:
   - The Minnesota Department of Commerce has several programs, including the Guaranteed Energy Savings Program (GESP), RevItUp, and LEEP, to provide support for efficiency measures including building commissioning.
   - Center for Sustainable Building Research and Herzog Wheeler & Associates can continue developing the B3/SB 2030 Energy Efficient Operations Manual (B3 EEOM), a web-based ongoing commissioning tool.
   - Commercial building owners and associations can share information with members about building commissioning resources.
   - Electric and gas utilities may provide rebates and other program resources for building commissioning as part of their conservation improvement programs.

3. **Encourage cost-effective adoption of enhanced building controls.** Building controls are becoming increasingly automated and intelligent. For example, sensors can detect occupancy in rooms and adjust the temperature and lighting accordingly, connected thermostats can adjust indoor temperature based on weather conditions,[214] and advanced controls can dim lights to balance available natural lighting.[215] Other new technologies offer the opportunity to incorporate utility signals such as demand charges into building operations.

   To encourage adoption, key stakeholders can develop partnerships and pilots to improve understanding of available technologies, applications, and potential savings**.** Federal resources and funding opportunities can enhance partnerships, pilots, and implementation.

   Champions / Key Participants:
   - Honeywell
   - Siemens
   - Great River Energy
   - Xcel
   - Minnesota Power
   - Energy Design Conference (hosted & facilitated by Minnesota Power)
   - University of Minnesota
   - Minnesota Technical Assistance Partnership (MnTAP)
   - Clean Energy Resource Teams (CERTs)
   - U.S. Department of Energy

Success factors

1. **Building operator training programs are available** and attractive for operators to enroll in.
2. **Commissioning tools and building control technologies meet the needs of building operators.** These tools can provide energy savings value without unduly burdening other operational practices.

Indicators of strategy success

1. Enrollment in building operator training programs
2. Square footage touched by retro-/ongoing commissioning
3. Energy usage savings reported from controls upgrades

Cross-sector opportunities and synergies

1. Building operator training is an important component for using **building energy benchmarking** to identify energy savings strategies.
2. Enhanced building controls could be a component of grid modernization, specifically for integration of **demand response** and response to **time-based rates.**
3. There is potential for an industry-led organization to improve **Coordination and Promotion of Clean Energy Industry** around enhanced building controls to support Minnesota leadership in this area.

Ongoing Minnesota initiatives

1. The Minnesota Department of Commerce provides a number of technical assistance and financing programs to support public entities in implementing energy efficiency and renewable energy projects. Programs include the Guaranteed Energy Savings Program, the Local Energy Efficiency Program, Energy Savings Partnership, the Public Entity Energy Audit and Renewable Energy Feasibility Study Loan Program, and Rev It Up.[216]
2. SB 2030 Energy Efficient Operations is a web-based application that facilitates ongoing commissioning by identifying building-specific tasks and assigning responsibility and timing for task completion. The application is currently in the pilot stage for state-funded buildings.[217]
3. Minnesota Training Plan for Building Designers and Operators, completed by CSBR and Herzog/Wheeler for MN Department of Commerce, October 2010.

C5. Promote behavioral energy efficiency strategies

Strategy overview

Historically, energy efficiency programs have focused on financial incentives for capital investments to achieve energy reductions, with varying results. Increasingly, though, behavior-based strategies are being used to achieve energy conservation. Behavior-based energy efficiency strategies draw from social-science insights to inspire consumers to modify their actions.[218] Utilities and third-party providers can send personalized, targeted messages through multiple channels to encourage energy conservation, saving between one and three percent of energy use for residential customers.

Stakeholders identified behavioral energy efficiency strategies as a near-term opportunity for Minnesota to help sustain savings and enhance the effectiveness of existing utility efficiency programs involving commercial and residential customers.

Specific actions for strategy implementation

1. **Expand use of behavioral strategies to drive energy reductions.** Behavioral strategies are often underutilized in energy efficiency programs. Techniques like priming, framing, and fostering new social norms can change the way customers think about and consume energy.

   Champions/Key Participants:
   - Minnesota Department of Commerce
   - Center for Energy and Environment (CEE)
   - Ecolibrium3
   - Clean Energy Resource Teams (CERTs) can support education about energy reduction through behavioral strategies.
   - Utilities

2. **Introduce intra- and inter-city energy competitions.**
   Competitions within and across cities can channel consumers to existing energy efficiency programs and resources**.** These competitions can integrate social-science insights into behavioral program design Such insights include framing energy choices in nonmonetary terms (e.g., "similar home" comparisons), including commitment and goal setting, and "gamifying" energy use. Such competitions could be added as a best practice for GreenStep Cities, which could then help to provide behavioral strategy tips and give recognition to those cities that have made significant progress.

   Champions/Key Participants:
   - Minnesota Department of Commerce
   - Center for Energy and Environment (CEE)
   - Minnesota Pollution Control Agency and Great Plains Institute via GreenStep Cities
   - Ecolibrium3
   - Clean Energy Resource Teams (CERTs)
   - Utilities, including Minnesota Power

Success factors

1. **Energy use data is available at an appropriate aggregation level** in order to allow for assessment of progress in intra- and inter-city competitions.
2. **Local governments understand the benefits** of behaviorally based energy challenges.

Indicators of strategy success

1. Number of Minnesota utility energy efficiency programs using behavioral methods.[219]
2. Number of cities and utilities that have committed to implementing energy challenges

Cross-sector opportunities and synergies

1. Improved **energy data access**, such as through Green Button and community-level energy data access, will facilitate tracking the impact of behavioral strategies.
2. Behavioral strategies can enhance effectiveness of **Local Government Action**.
3. Intra- and inter-city competitions can pave the way for a statewide competition, as outlined in the **Local Action** strategy.

Ongoing Minnesota initiatives

1. ILLUME Advising's report for the Minnesota Department of Commerce, "Statewide Commercial Behavioral Segmentation and Potential Study," assesses the technical potential of behavior change among small and medium businesses. The report is expected to be released in 2017.
2. ILLUME Advising's forthcoming report for the Minnesota Department of Commerce, "Energy Efficiency Behavioral Programs: Literature Review, Benchmarking Analysis, and Evaluation Guidelines," identifies Conservation Improvement Programs that use behavioral techniques and estimates their savings.[220]
3. Xcel's Partners in Energy Community Program is a two-year collaboration between Xcel and selected communities to develop and implement custom energy action plans.[221]
4. Schools for Energy Efficiency is a program for K-12 schools to save energy through user behavior provides strategies for efficient operations, energy awareness materials for staff and students, training, and utility tracking for immediate and sustainable savings.[222]
5. Minnesota Energy Star Challenge provides participating building owners with free education and assistance regarding benchmarking, energy reduction strategies, and financing.[223]
6. Minnesota Valley Electric Cooperative's Beat the Peak Energy Challenge is a reward program for reducing electricity use during peak times.[224]
7. Duluth is participating in the Georgetown University Energy Prize, a national program where communities compete to raise the bar on energy efficiency.[225] It is a collaborative effort involving the city, nonprofit organizations, and the gas and electric utilities (Minnesota Power and Comfort Systems).

8. CARD Behavioral Workshops: Illume Advising, on behalf of the MN Department of Commerce, is hosting semi-annual stakeholder workshops between 2015–2017 to discuss all aspects of behavioral programming.
9. The Department of Military Affairs (DMA) implemented an energy competition between its 63 armories across the state with a goal of three percent energy reduction and a $10,000 facility improvement prize annually for the armory with the largest percentage reduction.[226] DMA used B3 Benchmarking to track progress within the competition.
10. The MN Department of Commerce's Clean Energy Community Award (CECA), launched in 2016, provides recognition to communities that have implemented programs, policies, and technologies that encourage energy efficiency, conservation, and renewable energy generation.

Other related resources

1. SEE Action provides an overview of behavior-based approaches to saving energy.[227]
2. MINDSPACE Behavioural Economics, established by the United Kingdom's Institute for Government and the Cabinet Office, provides insights into how behavior change can influence public policy outcomes.[228]

3. Tools of Change offers case studies, webinars, workshops and other resources related to community-based social marketing. [229]
4. The Fostering Sustainable Behavior website offers articles, case studies, and forums related to community-based social marketing.[230]

C6. Identify opportunities for thermal energy grids

Strategy overview

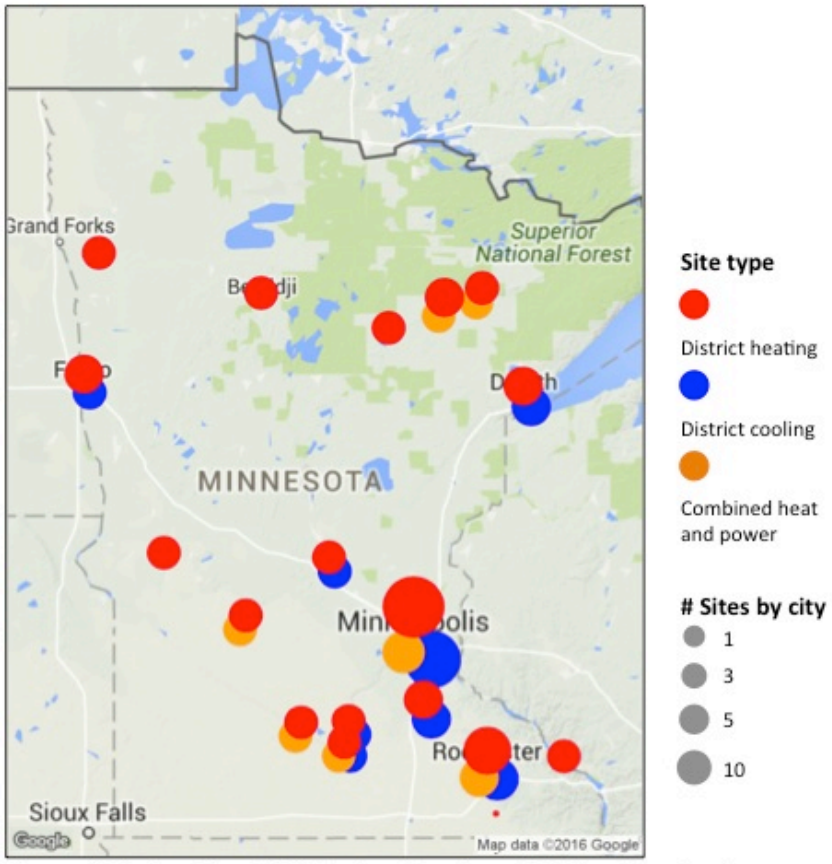
Thermal energy grids, also referred to as district energy, are a significant opportunity for energy savings that have been underappreciated due to perceived complexity. District energy involves producing steam, hot water, or chilled water at a central plant, which is then piped underground to individual buildings for heating, hot water heating, or air conditioning. This reduces the need for individual heating or cooling systems, and increases energy efficiency. In the long-term, district energy is one of the most cost-effective ways to achieve energy efficiency on a broad scale,[231] and can result in 30 to 50 percent greenhouse gas emissions reductions, according to the United Nations Environment Programme (UNEP).[232] Minnesota is already a leader in district energy with significant opportunity to expand existing networks. In particular, Minnesota can leverage nascent thermal grids and waste heat to integrate energy systems and improve energy efficiency.

Specific actions for strategy implementation

1. **Identify locations of existing thermal grids.** Many local decision-makers and planners are unaware of existing thermal grids and how they could be integrated into district energy systems. Identifying existing thermal grids would allow local governments to take into account opportunities to expand district energy systems or update related infrastructure when maintenance is required. Figure 16 on the following page illustrates what champions and key participants may build upon as they identify existing thermal grids.

   Champions/Key Participants:
   - Metropolitan Council
   - Ever-Green Energy
   - International District Energy Association
   - Ecolibrium3
   - Minnesota Pollution Control Agency and Great Plains Institute via GreenStep Cities

FIGURE 16: SELECTED UNIVERSITY, HOSPITAL, AND MUNICIPAL THERMAL ENERGY PROJECTS IN MINNESOTA BY CITY, AS OF JANUARY 2016



Sources: Site location data provided by Ever-Green Energy, January 2016. Map data courtesy of Google Maps. Map authored by Rocky Mountain Institute using ggmap: http://journal.r-project.org/archive/2013-1/kahle-wickham.pdf

2. **Analyze and map opportunities for waste heat.** In addition to district heat, district cooling and thermal storage improve system efficiency and can be effective load balancing tools to reduce costs from peak energy use.

   Champions/Key Participants:
   - Metropolitan Council
   - Ever-Green Energy
   - International District Energy Association
   - Minnesota Department of Commerce
   - Hospitals, colleges, universities, and businesses
   - Minnesota Pollution Control Agency and Great Plains Institute via GreenStep Cities can help encourage mapping as a best practice.
3. **Work with local governments and tribal nations to identify opportunities for district energy when planning for other community systems and infrastructure.** District energy opportunities can be considered more often in early infrastructure planning, because development is most cost effective in combination with planned road, sewer, or other infrastructure projects. When new infrastructure projects are starting, state resources can help local governments and tribal nations identify opportunities to incorporate district energy.

Champions/Key Participants:

- Metropolitan Council
- Ever-Green Energy
- Center for Energy and Environment (CEE) provides analysis, engagement and education on thermal grid opportunities, including work in Duluth, Rochester, and Arden Hills.
- International District Energy Association
- Hospitals, colleges, universities, and businesses
- Minnesota Pollution Control Agency and Great Plains Institute via GreenStep Cities – can help encourage district energy as a best practice

Success factors

1. **Waste heat from all sources is considered for use where available**, such as from sewer mains and wastewater treatment.

Indicators of strategy success

1. Number of district heating and cooling systems
2. Square feet of building space served by district heating and cooling

Cross-sector opportunities and synergies

1. Incorporate energy into **local government planning** and regulatory frameworks.
2. Support **combined heat and power (CHP).**
3. Provide a market for renewable natural gas produced by **anaerobic digestion**.

Ongoing Minnesota initiatives

1. The City of St. Paul was named as a champion city for district energy in the United Nations Environment Programme's District Energy in Cities report.[233]
2. Duluth Energy Systems is planning for district heating system upgrades that include system expansion to access further opportunities for efficiency.[234]
3. Rochester Destination Medical Center (DMC) Partners are considering options for a future district energy system to serve the expanded load of the DMC, along with strong energy efficiency measures. A report, "Destination Medical Center: Sustainable Energy Options," conducted by the Center for Energy and Environment lays out a path for DMC buildings to strive for zero net carbon emissions.[235,236,237]
4. Rice Creek Commons is a planned mixed-use development in Ramsey County that is striving to be the largest net zero energy redevelopment in the state. The proposed energy framework includes thermal energy recovery from the water treatment plant on site, an 8 MW solar installation, and efficient, all-electric residential neighborhoods.[238,239]
5. The University Avenue Innovation District, also known as the Prospect North Partnership, is a planned development along the Green Line Corridor between Minneapolis and St. Paul. Prospect North Partnership plans to include a district energy system and a shared hot and cold water system.[240]
6. Ford's former Twin Cities Assembly Plant in St. Paul will be redeveloped as a mixed-use neighborhood beginning in 2018, with aspirations of being entirely carbon neutral. Plans for the redevelopment's energy include a new district energy system.[241]
7. The design for the new Minnesota United soccer stadium includes a district heating system similar to TCF Bank Stadium or Target Field.[242]

Other related resources

1. Midwest DOE CHP Technical Assistance Partnership provides technical assistance resources on district heating and cooling with CHP.[243]
2. ICF's report, *CHP: Enabling Resilient Energy Infrastructure for Critical Facilities*, prepared for Oak Ridge National Laboratory, describes how CHP can be designed an used for energy reliability, and how local and state policies can promote CHP in critical infrastructure.[244]

3. The International Energy Agency - District Heating and Cooling site serves as a hub on international district energy research.[245]

C7. Support combined heat and power (CHP)

Strategy overview

Combined heat and power (CHP) systems are well established in Minnesota with the potential for additional capacity in the coming years. CHP systems generate electricity and useful thermal energy simultaneously within one integrated system. Conventional power generation rejects thermal energy as waste heat, but because CHP systems are able to reuse this thermal energy, their efficiency levels are much higher, up to 80 percent efficient.[246] Currently in Minnesota, there is 962 MW of CHP capacity installed. The full technical potential of CHP is estimated to be 3,049 MW, of which 984 MW are assumed to have a payback period of ten years or less.[247] Stakeholders emphasized the need to capture the energy savings from CHP across multiple sectors, including opportunities for building efficiency, industrial efficiency, and community thermal grids. Over the last two years, the Minnesota Department of Commerce has been conducting a robust effort to examine opportunities for increasing the deployment of CHP in Minnesota. As a result of a stakeholder engagement process, technical research studies, and evaluation of resource potential, a Minnesota CHP Action Plan was published in October 2015. The CHP Action Plan provides a roadmap for specific actions that will be undertaken in the next several years to improve the policy, regulatory, and technical environment in order to take advantage of CHP implementation opportunities.

The Department of Commerce CHP Action Plan highlights specific action items, based on recommendations from a rigorous stakeholder engagement process and the department's studies on CHP potential in Minnesota. The 2025 stakeholder advisory committee recommended further advancing the six priority areas outlined below.

Specific actions for strategy implementation

1. **Establish CHP energy savings attribution model and project evaluation criteria** to determine how CHP projects could be evaluated within CIP. Such a model would provide a fair, accurate, and comprehensive assessment and valuation of CHP projects within the Conservation Improvement Program (CIP). Any savings model within CIP should have as a guiding principle the idea that each energy provider (both natural gas and electricity) should receive value (in the form of claimable CIP energy savings that are included in their financial incentive determinations) from working jointly to facilitate and encourage CHP projects. Finalizing this model will take a considerable amount of time, but stakeholders can begin to develop the model during 2016 in order to inform utilities' 2017–2019 CIP Triennial Plan filings and individual project proposals. Ultimately, at the conclusion of this activity, the attribution model and project evaluation criteria would be formalized by Commerce issuing an Order pursuant to Minnesota Rules Chapter 7690.

   Champions/ Key Participants:
   - Minnesota Department of Commerce
   - Conservation Improvement Program (CIP) Technical Reference Manual Advisory Committee

2. **Map CHP opportunities at wastewater treatment facilities and public facilities.**
   CHP in Minnesota has significant potential, but a more granular analysis would help identify specific projects that could be implemented. Mapping CHP opportunities at public facilities and wastewater treatment facilities would be most helpful in determining viable projects. Stakeholders would collaborate with the Department of Energy on the following activities: planning potential projects, developing partnerships, conducting energy efficiency assessments, facilitating site investment, identifying opportunities for renewable energy, creating an implementation model, and disseminating results.

   Champions/ Key Participants:
   - Minnesota Technical Assistance Partnership (MnTAP)

- Energy Resources Center (ERC)
- Minnesota Department of Commerce

3. **Expand education and training resources on the Department of Commerce website.** Despite CHP's promising outlook in Minnesota, many key stakeholders remain unaware of its potential for energy and cost savings. Further, many consider developing CHP projects to be complicated and uncertain, thereby discouraging new projects. Finally, the workforce and training resource currently available are insufficient to meet growing demand. Therefore, the Department of Commerce will continue to disseminate information about CHP opportunities through its website, webinars, and workshops. Commerce will also provide assistance for determining project feasibility, as well as resources for project evaluation and project financing.

   Champions/Key Participants:
   - Minnesota Department of Commerce
   - Energy Resources Center (ERC)
   - Great Plains Institute
   - Fresh Energy

4. **Leverage existing financing programs applicable to CHP.** While The Minnesota Department of Commerce explores ways to expand financing options for CHP projects, organizations outside of The Minnesota Department of Commerce can explore CHP financing and ownership issues, synthesize existing resources, and recommend how best to address gaps and barriers.

   Champions/Key Participants:
   - Minnesota Department of Commerce
   - Saint Paul Port Authority

5. **Examine electric utility infrastructure policy**.
   CHP systems are not easily categorized as either a supply-side or demand-side efficiency resource, since CHP systems address whole-system efficiency improvements. Because these systems are not easily categorized, this makes project financing difficult. Therefore, stakeholders recommended categorizing CHP as supply-side conservation resources under the electric utility infrastructure (EUI) investments within CIP. The Minnesota Department of Commerce is exploring if and how CHP could qualify as supply-side resources under EUI statutory language, and possible implications for demand-side resources.

   Champions/Key Participants:
   - Minnesota Department of Commerce
   - GDS Associates
   - Electric utilities

6. **Continue discussion of standby rates through Public Utility Commission's generic proceeding.** A recent study from Energy Resources Center indicated that current standby rates are an economic barrier to investment in CHP and other distributed resources. [248] Utilities in Minnesota charge standby rates to customers with on-site generation systems such as CHP. Standby tariffs are designed to recover utility costs to provide standby service during events such as planned maintenance or an unscheduled outage of the on-site generator.[249]

   Energy Resources Center estimated that the potential for new CHP capacity with a payback period of less than ten years would increase from 779 MW to 1116 MW if these barriers were eliminated. The stakeholders participating in the CHP action plan process recommended implementing transparent and

unbundled pricing for standby rates. Commerce identified a Public Utilities Commission generic proceeding as an avenue to address standby rates. [250]

Champions/Key Participants:

- CHP stakeholders

Success factors

1. **Access to qualified operation and maintenance technicians** is necessary to service projects.
2. **Readily available case studies or examples of successful CHP projects** in different sectors to inspire pursuit of new projects.

Indicators of strategy success

1. Net fuel savings (Btu) and dollar savings from CHP projects
2. Number of new CHP installations and added capacity[vi]

Cross-sector opportunities and synergies

1. Waste-heat capture and CHP integration at **advanced biofuel and biobased chemical** production facilities.
2. Biogas from **anaerobic digestion** as a fuel source for CHP projects.
3. CHP as a strategy to increase **industrial energy efficiency.** Development opportunities in northern Minnesota for harvesting heat for secondary use in the mining, pulp/paper, and timber industries.

Ongoing Minnesota initiatives

1. The Minnesota Department of Commerce CHP Stakeholder Engagement website tracks and disseminates information on implementation activities of the final CHP action plan.[251,252]
2. MN Technical Assistance Partnership at the University of Minnesota works with Minnesota businesses to develop and implement industry-specific solutions to prevent pollution, maximize efficient use of resources, and reduce energy use and costs.[253]
3. In 2015, the Minnesota Public Utilities Commission opened a generic proceeding on standby service tariffs (docket 15-115).[254]

Other related resources

1. The Department of Energy's CHP Deployment Group serves as the center for CHP technical assistance at the DOE. Headquarter operations tracks CHP installs, works on CHP policies, develops targeting material materials, and implements other central operations.[255]
2. The Department of Energy, Midwest CHP Technical Assistance Partnership provides a wide variety of technical assistance resources and is a second arm of the DOE CHP deployment group.[256]
3. State and Local Energy Efficiency Action (SEE Action) Network's "Guide to the Successful Implementation of State Combined Heat and Power Policies," discusses CHP policies and successful implementation cases.[257]
4. The Department of Energy's Combined Heat and Power Installation Database identifies CHP installations in Minnesota and other states.[258]

[vi] Measure against DOC commissioned CHP potential study, which estimated 984 MW of new economical (payback < 10 y) CHP capacity.

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D: INDUSTRIAL AND AGRICULTURAL PROCESSES

Section summary

The industrial and agricultural sectors account for a large portion of the state's economic output as well as its energy use. These sectors consume 34 percent of the state's total energy[259]—more than the residential, commercial, or transportation sectors. This energy is used to drive a major economic engine, with agriculture accounting for 22 percent of the gross state product.[260]

Minnesota businesses have made significant progress in addressing the energy intensity of industrial and agricultural processes, with companies realizing significant energy savings both independently and with the help of state programs. In addition, Minnesota has been a national leader in bioenergy development, with more than 1.1 billion gallons of corn ethanol production capacity[261] and 63 million gallons of biodiesel production capacity.[262]

Still, significant opportunities remain for Minnesota industries to achieve cost savings through energy productivity, and continue Minnesota's economic growth through bioenergy and additional clean energy technologies.

Promoting bioenergy

Minnesota can build upon its bioenergy resources to create low-carbon fuels for a variety of uses. Stakeholders identified the following strategies to promote bioenergy:

- **Commercialize advanced biofuels and biobased chemicals** through supply chain mapping, addressing feedstock supply and infrastructure, and identifying and addressing permitting barriers.
- **Capture organic feedstocks through anaerobic digestion** by resetting the conversation on anaerobic digestion, incorporating anaerobic digestion into the state's solid waste hierarchy, and establishing a public-private partnership to demonstrate an anaerobic digestion project incorporating biogas.

Reducing wasted energy and promoting clean energy focus in industry

Minnesota's industries can lower their energy costs and improve competitiveness by pursuing energy efficient processes. Further, they can contribute to the state's economy by helping to grow the clean energy industry. Stakeholders identified the following strategies to promote energy efficiency and clean energy:

- **Promote industrial and agricultural efficiency practices** by sharing state and federal programs to improve energy productivity in industrial and agricultural processes, and strengthening peer networks to share best practices on energy management.
- **Coordinate and promote the clean energy industry** to coalesce Minnesota's energy and business community around the state's competitive strengths in clean energy.

This section outlines strategies to both reduce energy waste from industrial and agricultural processes, and leverage these sectors' potential to drive economic growth and clean energy progress in the state more broadly.

Energy profile

Minnesota's industrial and agricultural sectors[vii] account for a large portion of energy use in Minnesota and also a major portion of the state's economic output. In 2013, the Minnesota industrial sector, as defined by the U.S. Energy Information Agency, consumed 34 percent of total energy in the state, more than the residential, commercial, or transportation sectors.[263] This energy is used to drive a major economic engine, accounting for 22 percent of gross state product.[264] In particular, agriculture is a key state industry, helping Minnesota rank fourth nationally in total agricultural cash receipts.[265]

Minnesota has made significant progress in reducing the energy intensity of its industrial sector, as well as steering the economic engines of industry and agriculture toward supplying and supporting clean energy. A 2015 study on the economic impact of the state's Conservation Improvement Program (CIP) found that every dollar invested in CIP provides $4 to $4.30 in energy savings, environmental benefits, and new economic activity.[266] Another state-funded program, the Minnesota Technical Assistance Program, assisted 56 Minnesota companies in 2015 to achieve 2.3 million kWh and 238,000 therms of energy savings.[267] In addition, many companies are implementing energy efficiency measures on their own or through federal incentives and technical assistance programs.

Minnesota is a national leader in bioenergy development, with an ethanol production capacity of 1.1 billion gallons. Agriculture and industry leaders can continue to create competitive edge for Minnesota in the clean energy industry.

Investments in energy efficiency improve the economy in two ways: (1) spending on energy efficiency projects supports jobs and business for contractors and suppliers directly involved in the projects, and (2) the money that consumers save from lower utility bills can be spent on other goods and services.[268] Minnesota's agricultural industry has been a leader in bioenergy development, with 21 corn ethanol plants with 1.1 billion gallons of production capacity[269] and 33 biodiesel plants with 63 million gallons of biodiesel production capacity[270]. Furthermore, clean energy has a growing role in the state's economy, with sector workers in 2013 earning over $1 billion in wages and salary, an increase of nearly 80 percent from the year 2000.[271]

Summary of opportunities

There are significant opportunities to further drive cost savings from energy efficiency, and encourage economic growth from continued development of energy businesses in Minnesota. This section highlights opportunities in the following two categories, each with two strategies:

Promote bioenergy in the agricultural sector

The agricultural sector can build upon its important role in both Minnesota's economy and its clean energy future by capturing the opportunity to produce bioenergy resources that can be used as low-carbon fuels in a variety of end uses. This category consists of the following strategies:

- **Commercialize advanced biofuels and biobased chemicals.** Minnesota has a strong history in the biofuel industry and is poised for increased development of both advanced biofuels and biobased chemicals over the coming decade. Advanced biofuels are renewable fuels other than ethanol derived from cornstarch, wood, agricultural residues,

[vii] Here we use the EIA definition of industry to include mining, manufacturing, construction, agriculture, forestry, quarrying, fishing, and hunting (NAICS 11, 21, 23, and 31-33). GDP and energy use data shown here correspond to these NAICS codes.

and organic wastes, or other renewable biomass, and achieves a 50 percent GHG emissions reduction requirement. Biobased chemicals are derived from forestry, agricultural, or organic waste materials, offering alternatives to petroleum-based fuels and chemicals. The resources to produce biobased chemicals are abundant in Minnesota. Further, these products are increasingly becoming cost-competitive with conventional fossil fuels.

- **Capture organic feedstocks through anaerobic digestion.** Anaerobic digestion is a huge, untapped resource in Minnesota. To date, most anaerobic digestion projects in Minnesota have focused on electricity. However, there is a growing opportunity to use the biogas as an industrial-process heating fuel or as a substitute for natural gas transportation fuel.

Reducing wasted energy and promoting clean energy focus in industry

The industrial sector in Minnesota can lower its costs and improve its competitiveness by pursuing energy efficiency, and directly contribute to growth and development in the state by focusing on contributing to the clean energy economy. This category consists of the following strategies:

- **Promote industrial and agricultural efficiency practices.** Minnesota has existing programs to promote energy efficiency practices for industrial and agricultural facilities, and practitioners have made great strides in improving efficiency at many sites in the state. However, there is an opportunity to take further advantage of state and federal programs and adopt best practices through peer exchange to further scale and expand efficiency resources in this sector.
- **Coordinate and promote the clean energy industry.** Minnesota has made significant progress in expanding the clean energy sector of its economy, with large growth in employment and clean energy investment over many years. There is an opportunity to build upon this success by bringing together clean energy industry stakeholders in a group to promote this sector's growth and retain Minnesota's leadership among states. An industry-led organization focused on coordinating efforts and communication across all clean energy sectors could help coalesce competitive strengths in Minnesota's clean energy and business community and maximize economic development across the state.

D1. Commercialize advanced biofuels and biobased chemicals

Strategy overview

Minnesota has the opportunity to expand its already strong biobased industry by taking advantage of new value-added opportunities for the agricultural and forestry sectors to produce advanced biofuels and biobased chemicals.

Specific actions for strategy implementation

1. **Conduct a supply/value chain mapping study for the variety of biobased chemicals and fuels that can be produced in Minnesota.**
   Although state and local assessments of biomass-based feedstock availability and cost have been done in the past, Minnesota's biobased market would benefit from a more current, comprehensive assessment of the feedstocks available for advanced biofuels and biobased chemicals in Minnesota. Stakeholders also identified a need to match feedstocks with the associated, specific end products that could be produced from these resources. Mapping the current available feedstocks and associated end products will aid in assessing the economic potential for increased production of biobased fuels and chemicals in Minnesota. Additionally, this would let potential developers and investors recognize the scale of the opportunity and bring visibility to high-potential projects.

   Champions/Key Participants:
   - Bioeconomy Coalition of Minnesota; membership includes Minnesota Power, Great River Energy, Minnesota Farmers Union, Minnesota Corn Growers Association, Green Biologics, NatureWorks, and Potlach

- University of Minnesota, Department of Bioproducts and Biosystems Engineering
- Natural Resources Research Institute
- Agricultural Utilization Research Institute
- Minnesota Department of Agriculture
- Minnesota Department of Natural Resources
- Iron Range Resources & Rehabilitation Board
- Minnesota Department of Employment and Economic Development

2. **Address forestry feedstock supply and infrastructure.**
Significant feedstocks are available from forests in Minnesota to produce advanced biofuels and biobased chemicals. However, limited markets and costs of further developing those markets present a barrier to their economic competiveness. New practices may be necessary to streamline the process of bringing privately owned forest fiber to market. For example, increasing access to forestry feedstocks may require efforts to better utilize the Sustainable Forest Incentive Act (SFIA), which incents private forest landowners to maintain their forest lands as contiguous, undeveloped working forest lands. A principal barrier to nonindustrial private forest (NIPF) land harvest has been demand (and price) being too low to attract material to market, and limited investment by the public and private sectors in working with private landowners.

   Enhancing access to forestry feedstocks will also require efforts to support the Private Forest Management (PFM) System Framework that unites the Department of Natural Resources (DNR), Soil and Water Conservation Districts (SWCDs), private forest consultants, Board of Soil and Water Resources (BWSR), counties, and other private forest stakeholders in achieving Minnesota's PFM goals, in distributing responsibilities and in addressing private forest data collection and registration needs. Success of the PFM System Framework will require baseline budgeting to fulfill the data input needs necessary to predict the availability and location of forest fiber on private lands.

   Finally, addressing forest feedstock supply logistics will also require working to maintain and potentially enhance Minnesota's logging base; supporting the Minnesota Logger Education Program (MLEP) in efforts educate and train loggers on sustainable biomass harvesting as a means to expedite their participation in the development of increasingly diverse forest product markets.

   Champions/Key Participants:
   - DNR Forestry, which is leading the new Private Forest Management Strategy (a collaboration of Minnesota counties, DNR, BWSR, SWCD, and private consultants) to maintain momentum and achieve the goals outlined here

3. **Address agricultural feedstock supply and infrastructure.**
Similar to the concerns over forestry feedstocks, additional work is necessary to address feedstock concerns, supply, and infrastructure for agricultural biomass. Unlike the steps needed to address forestry feedstock supply, the actions to address agricultural feedstock supply are less clear at this time, and doing so will require a process that brings relevant stakeholders together to address key barriers and concerns on biomass sourcing.

   A stakeholder engagement process could examine current research on energy and environmental impacts for removing a portion of agricultural residues from existing cropping systems, discuss strategies for increasing cover cropping and perennial vegetation as a potential source of biomass, develop near-term and long-term strategies for biomass aggregation and supply chain constraints, and identify federal and state sources of funding that could be leveraged to help support biomass establishment and aggregation. This process should conclude with clear opportunities identified and recommended actions to harness these resources.

4. **Champions/Key Participants:**
    - Bioeconomy Coalition of Minnesota, organized and staffed by the Great Plains Institute
    - Minnesota Department of Agriculture manages incentive programs for advanced biofuel and biobased chemical production, in addition to several other complementary programs and initiatives.
    - Board of Soil and Water Resources (BSWR) administers several conservation and landowner management programs.

5. **Secure funding for and complete a renewable jet fuel/renewable diesel supply chain feasibility study**.
   Renewable jet fuel and diesel may be an economically attractive market for Minnesota companies to enter. To evaluate the potential to produce biobased renewable jet fuel in Minnesota, developers must identify the available feedstocks, infrastructure, customers, suppliers, and site selection factors in the state and assess strategies for putting in place the necessary elements of success.

   Champions/Key Participants:
    - Wenck Associates
    - Commercial Aviation Alternative Fuels Initiative (CAAFI)

6. **Identify and address barriers to permitting projects.**
   Project permitting for biobased fuel and chemical production facilities can be a barrier to initiating production. Project developers can work together with state assistance programs to streamline these processes and ensure that project permitting can occur in an efficient manner.

   Champions/Key Participants:
    - Minnesota Business First Stop[272] streamlines the development process for complex business startups, expansions, or relocations that involve finance, licensing, permitting, and regulatory issues that overlap multiple state agencies.

Success factors

1. **Biofuel distribution infrastructure (e.g., refueling) is available**. Distribution infrastructure is necessary to meet consumer demand and allow consumption of a greater percentage of fuel produced in state.
2. **Distribution barriers arising from geographically dispersed feedstocks and fuel production facilities are overcome.** The physical separation of feedstocks and production facilities can introduce cost barriers to biofuel or biochemical production, which may need to be mitigated to make an economic case for biofuels.
3. **Market access for advanced biofuels and biobased chemicals are supported by state policies**. It is likely necessary for policies to support both "market push," including production facility investment, and "demand pull," for example a state-level preferred procurement policy for biobased products.
4. **Companies have funding opportunities and access to capital needed to commercialize new processes or to site large facilities.** This was identified in the Minnesota Clean Energy Industry Roundtables and Summit in 2014, convened by multiple state agencies to identify highest priorities for continued growth and development of the clean energy economy.

Indicators of strategy success

1. Gallons produced (liquid advanced biofuels)
2. MMbtus produced (gaseous advanced biofuel such as bio-compressed natural gas)
3. Renewable Information Numbers (RINs) generated in Minnesota (liquid and gaseous advanced biofuels under EPA Renewable Fuel Standard)
4. Pounds produced (biobased chemicals)

Cross-sector opportunities and synergies

1. Renewable fuels as a strategy for increasing **alternative fuel vehicle** options
2. A more robust advanced biofuel market can help commercialize **anaerobic digestion** projects that would clean and upgrade produced biogas as a source of transportation fuel.
3. Industrial facilities for biofuel or biochemical production can capture waste heat for **combined heat and power, thermal energy grids,** or other integrated systems.
4. To improve **coordination and promotion of the clean energy industry,** an industry-led organization could coordinate communication across the wide range of biomass-based energy and chemical interests and provide marketing assistance to advertise Minnesota-sourced biofuels and biobased chemicals to attract biobased production and feedstock development companies to the state.

Ongoing Minnesota initiatives

1. Central Lakes College performs biofuel and biomass energy crop production research.[273]
2. The Chemical Extractives Laboratory at the Natural Resources Research Institute performs research into methods for extracting valuable organic materials from industry byproducts.[274]
3. The University of Minnesota has several energy cropping research activities and initiatives, including:
    a. Forever Green[275]
    b. Green Lands Blue Waters[276]
    c. Green Prairie Alliance[277]
4. The Agricultural Utilization Research Institute leads an initiative around agbioscience leadership in Minnesota[278] and provides a catalog of bioenergy resources in the state.[279]
5. The Bioeconomy Coalition of Minnesota advocates for project implementation and policy to support a growing, innovative, prosperous bioeconomy in Minnesota.[280]
6. Several early adopter companies and projects have been leading in this space in Minnesota, including:
    a. NatureWorks, a Minnetonka company that manufactures biopolymers.[281]
    b. Central MN Renewables, a Little Falls company that manufactures renewable chemicals.[282]
    c. Gevo, a Luverne company that produces renewable isobutanol and ethanol.[283]
7. In October 2015, the Minnesota Department of Agriculture (MDA) was awarded $8 million from the U.S. Department of Agriculture's Biofuel Infrastructure Partnership that will be matched with $6.11 million from MDA and in-kind contributions from in-state partners.[284] This new investment will assist with the installation or retrofit of about 620 pumps for ethanol-blended gasoline and related equipment at approximately 165 retail stations.[285]
8. In 2015, the Minnesota legislature put in place a new financing mechanism to assist with the commercial deployment of advanced biofuels and biobased chemicals. Eligible projects have until 2025 to come online and access state financing.[286]
9. The Minnesota Department of Agriculture has an Agricultural Growth, Research and Innovation (AGRI) program.[287]
10. The Iron Range Resources and Rehabilitation Board is involved with activities around forestry products in Northeastern Minnesota.[288]
11. Agriculture Research, Education, Extension, and Technology Transfer Grant Program, MN Statute 41A.14, is meant to "provide investments that will most efficiently achieve long-term agricultural productivity increases through improved infrastructure, vision, and accountability."[289]
12. The Minnesota Department of Employment and Economic Development actively markets Minnesota to attract new investment and project development for advanced biofuels and biobased chemicals. DEED also offers incentives and financing mechanisms to enable Minnesota business development.

Other related resources

1. The Department of Energy, Bioenergy Technology Office establishes partnerships to demonstrate advanced biofuel technologies.[290]

2. The United States Department of Agriculture, Rural Development focuses on economic development for rural areas, including biofuel-focused programs.[291]
3. The Energy Transition Lab (UMN) and Bureau of Business and Economic Research (UMD) have completed an economic analysis of proposed bioenergy and solar energy projects in Duluth and the Arrowhead region (released in May 2016).

D2. Capture organic feedstocks through anaerobic digestion

Strategy overview

Anaerobic digestion (AD) captures methane and carbon dioxide (biogas) as organic material decomposes in an oxygen-free, heated environment. Biogas can be collected and burned directly as a source of electricity and/or heat or can be scrubbed of carbon dioxide to produce renewable natural gas, which can be compressed to provide a source of transportation fuel in vehicles designed or converted to run on natural gas.

Anaerobic digestion has been an effective organic waste and wastewater management tool in wastewater treatment facilities for a number of years. As with biogas produced from closed landfills, large wastewater treatment plants produce the volume of biogas often needed to make power generation financially attractive.

Although sometimes driven in part by a need to meet water quality discharge standards, using biogas to replace natural gas for processing heat has proven cost-effective for a number of food processing facilities in the state[292] [293]. However, for small on-farm biogas-to-electricity projects, the cost of cleaning biogas as needed for use in generators coupled with the comparatively low price paid by electric utilities for their power has limited adoption. The following actions align with the need to make widespread use of biogas more cost-effective. They focus on the potential for producing biogas with anaerobic digestion of organic waste feedstocks, including crop residues, manure, food processing residues, and municipal solid waste, to unlock the significant potential for AD with biogas recovery in Minnesota.

Specific actions for strategy implementation

1. **Expand the conversation on anaerobic digestion opportunities among state agencies, financiers, and potential and existing project owners.**
   Most anaerobic digestion activity in Minnesota has focused on feedstocks from dairy manure or biosolids in wastewater. End uses have focused on biogas for electricity generation and process heating fuel at food processing plants. Since these have been the dominant development models for these projects to date, there are misconceptions about the variety of organics available from multiple feedstocks and biogas utilization options available in the state. There is a need to develop the full value proposition for promoting anaerobic digestion projects, including:

   - Educating stakeholders on the scale of the resource in the state from multiple feedstock sources available to maximize gas production
   - Documenting and educating the public about the economic impact on jobs and investment, in addition to the environmental benefits of AD
   - Quantifying the market premium available for using biogas as a transportation fuel (bioCNG).
   - Developing a set of success stories/case studies on anaerobic digestion at the municipal, agricultural, and industrial scales; correlate out-of-state examples to in-state opportunities that provide examples of economically successful implementation so the technology and the market achieve long-term financial and technical success
   - Engaging project financiers in a dialogue to identify what needs to be in place to help enable project investment. A dialogue will need to occur for three different common project configurations: food and agriculture, landfills, and wastewater treatment facilities, each with different financing limitations

Champions/Key Participants:

- Wenck Associates
- Minnesota Department of Agriculture
- Bioeconomy Coalition of Minnesota
- Metropolitan Council
- Solid Waste Management Coordinating Board

2. **Incorporate anaerobic digestion into the Minnesota solid waste hierarchy.**
   Minnesota uses a waste management hierarchy to guide waste management decisions with the lowest environmental impact. Counties, which are primarily responsible for directing solid waste management activities, receive state block grants, but they can be only used for activities outlined in the waste management hierarchy. Anaerobic digestion, which uses biosolids "waste" to make a transportable, renewable fuel (different from combustion of MSW), is not included in the hierarchy and as a result can limit the potential of anaerobic digestion projects focused on treating the organic portion of municipal solid waste. To address this, counties can take several actions, e.g., develop recycling strategies that comply with increased state requirements for landfill diversion by separating organics from recycling.

   Champions/Key Participants:
   - MPCA

3. **Establish a public-private partnership to demonstrate a replicable regional AD project with biogas utilization other than electricity generation**.
   This project could partner with an alternative vehicle strategy in order to demonstrate a market opportunity for biobased compressed natural gas. This would provide a new market for AD projects, and make available a low-emissions source of energy for alternative fuel vehicles. Money from a public investment, specifically a grant fund, could go to achieving goals necessary for the industry to succeed without the grant fund.

   Champions/Key Participants:
   - The Minnesota Department of Agriculture may have a natural role as the program administrator.
   - Technology providers and project developers
   - Solid Waste Management Coordinating Board

Success factors

1. Information on types and amounts of potential organic feedstocks for AD processing is more widely available in order to enable developers to identify project sites.
2. Cost reductions for AD projects at food and agriculture operations must be explored and achieved in order to drive down payback periods and increase adoption.
3. A stable and reliable source of organic feedstocks is necessary for AD projects to operate most efficiently.

Indicators of strategy success

1. Annual MMbtus of biogas produced and converted for useful energy
2. Annual wet tons of organic material treated in AD
3. Private and public investment dollars for individual projects

Cross-sector opportunities and synergies

1. Biobased compressed natural gas is a potential fuel source for **alternative fuel vehicles.**
2. Biogas can be a primary fuel source for **combined heat and power** and **thermal grid** projects.
3. Biogas-to-electricity projects may provide an opportunity for biogas to be used as transportation "fuel" for **alternative fuel vehicles** and qualify to generate RINs.

4. A voluntary **utility green pricing program** for renewable natural gas by natural gas utilities could help scale up anaerobic digestion projects.

Ongoing Minnesota initiatives

1. The Agricultural Utilization Resource Institute focuses on fostering "long-term economic benefit for Minnesota through value-added agricultural products," and is involved with several biobased fuel initiatives.
2. The CSEO process examined establishing a renewable thermal goal and a renewable thermal incentive fund.[294] Biogas would be an eligible source of renewable thermal energy.

Other related resources

1. The U.S. DOE, USDA, and EPA are coordinating action on a Biogas Opportunities Roadmap, with related progress reports for identified implementation actions.[295]

D3. Promote industrial and agricultural efficiency practices

Strategy overview

Although major improvements have been made at many industrial and agricultural facilities to increase energy efficiency, there are additional opportunities for focused actions aimed at improving the energy productivity of industrial and agricultural operations. For example, the U.S. Department of Energy estimated in a 2015 report to Congress that increasing the adoption rate of energy efficient technologies and practices in the industrial sector could reduce energy consumption by 15 to 32 percent by 2025, but that many barriers exist that prevent these opportunities from being captured.[296] In addition, a 2013 report completed for the USDA showed that the agricultural community stands to benefit significantly from energy efficiency, but a key barrier to program participation is low awareness among energy efficiency program managers of resources from the USDA available to assist with energy efficiency measures. [297]

This strategy highlights resources and approaches to help Minnesota industrial and agricultural facilities take advantage of available programs, benefit from best practices that have been documented across the country, and realize greater energy savings.

Specific actions for strategy implementation

1. **Promote local and site specific, state, and federal programs as a resource for industrial and agricultural sectors to improve energy productivity.**
   Programs include:

   - Local and site specific
   - State
     - Conservation Improvement Program (CIP)
     - Conservation Applied Research and Development (CARD)
     - RevItUp
     - Minnesota Technical Assistance Program (MnTAP)
   - Federal
     - Superior Energy Performance - a tool for companies to implement energy management systems with third-party verified savings
     - Better Plants - partners join the program and commit to a 25 percent improvement in energy intensity over 10 years across all facilities
     - Industrial Assessment Centers (IACs) - engineering universities across the country that provide no-cost assessments to small- and medium-sized manufacturers. Minnesota does not currently have an IAC, but Iowa State serves manufacturers

- U.S. Department of Agriculture, Rural Energy for America Program - provides guaranteed loan financing and grant funding to agricultural producers and rural small businesses to make energy efficiency improvements or install renewable energy systems

Champions/Key Participants:

- Minnesota Department of Commerce reviews the costs and benefits of commercial and industrial efficiency programs for inclusion in utility Conservation Improvement Programs (CIP), provides funding through the Conservation Applied Research and Development (CARD) program, and provides technical assistance through the Rev-It-Up program.
- DOE Advanced Manufacturing Office
- Iowa State Industrial Assessment Center provides no-cost energy assessments to small- and medium-sized manufacturers
- Electric and gas utilities offer commercial and industrial efficiency programs as a part of their state-approved conservation programs.
- Minnesota Technical Assistance Program (MnTAP) (pending additional funding) works with Minnesota businesses to develop and implement industry-specific solutions to reduce energy use and costs through on-site technical assistance with engineering staff and student interns.
- Minnesota Chamber of Commerce, through the MN Energy Smart program, helps Minnesota businesses find ways to save energy and connect to financial incentives. The program is funded through state-approved utility conservation programs.
- CEE administers a variety of small business efficiency programs funded through state-approved utility conservation programs.
- Enterprise Minnesota assists manufacturers to improve process and operational efficiency.
- Saint Paul Port Authority administers the Trillion BTU loan program and PACE to finance energy efficiency projects.
- Environmental Initiative offers sustainability best-practice exchange at its Business & Environment Series events.
- Clean Energy Resource Teams (CERTs) leads outreach initiatives such as "Milk the Savings" dairy energy efficiency program and "Gobbling up Savings" for LED lighting in turkey barns.
- USDA Minnesota Rural Development Office

2. **Work with industrial, agricultural, and trade associations to incorporate energy efficiency best management practices and program resources into communications materials and services offered.**
   Industrial and agricultural facilities that have made significant progress in improving energy efficiency in their operations can share their lessons learned through a facilitated network of motivated companies. This may be especially important for small to mid-sized facilities such as food processors.

   Champions/Key Participants:

   - Minnesota Department of Commerce reviews the costs and benefits of commercial and industrial efficiency programs for inclusion in utility Conservation Improvement Programs (CIP) and provides funding through the Conservation Applied Research and Development (CARD) program.
   - DOE Advanced Manufacturing Office
   - Iowa State Industrial Assessment Center provides no-cost energy assessments to small- and medium-sized manufacturers.
   - Minnesota Technical Assistance Program (MnTAP) (pending additional funding) works with Minnesota businesses to develop and implement industry-specific solutions to reduce energy use and costs through on-site technical assistance with engineering staff and student interns.
   - Minnesota Chamber of Commerce, through the MN Energy Smart program, helps Minnesota businesses find ways to save energy and connect to financial incentives. The program is funded through state-approved utility conservation programs.

- CEE administers a variety of small business efficiency programs funded through state-approved utility conservation programs.
- Enterprise Minnesota assists manufacturers to improve process and operational efficiency.
- Saint Paul Port Authority administers the Trillion BTU loan program and PACE to finance energy efficiency projects.
- Environmental Initiative offers sustainability best-practice exchange at their Business & Environment Series events.
- Clean Energy Resource Teams (CERTs) helps people connect with energy resources in seven Minnesota regions. Each region has a team, a coordinator, and a steering committee. The regional teams are diverse—business owners, farmers, members of environmental groups, local utility representatives, local government staff and elected leaders, and academics.
- USDA Minnesota Rural Development Office

Success factors

1. Solutions and resources are available for a wide variety of industrial and agricultural sectors. Broad applicability of resources will help maximize the scale of savings.
2. Energy managers are connected with resources. Resources such as technical experts, utility programs, information on available technology, and data will allow managers to take action.

Indicators of strategy success

1. Energy saved (kWh and dekatherms)
2. Net cost savings
3. Number of sites participating in Department of Energy's Better Plants program

Cross-sector opportunities and synergies

1. Pursuing energy efficiency at industrial facilities also provides an opportunity for facility managers to leverage the same equipment (e.g., controls technology) to enable **demand response**, potentially improving the economic case for the investment.
2. Industrial energy efficiency practices and DOE technical support resources can be used for wastewater and other large commercial and institutional facilities, and to improve the economic case for **advanced biofuel or biobased chemical** production facilities.
3. DOE technical resources and programs can be resources for **local governments** to use in planning studies and business outreach.

Ongoing Minnesota initiatives

1. Utility Incentives for commercial and industrial customer efficiency: Minnesota electric utilities and natural gas utilities are required to invest at least 1.5 percent and 0.5 percent of their gross operating revenues, respectively, on Conservation Improvement Programs (CIP) each year.
2. Minnesota Technical Assistance Program at the University of Minnesota works with Minnesota businesses to develop and implement industry-specific solutions to prevent pollution, maximize efficient use of resources, and reduce energy use and costs through on-site technical assistance with engineering staff and student interns.[298]
3. The MN Energy Smart program, from the Minnesota Chamber of Commerce, helps Minnesota businesses find ways to save energy and connect to financial incentives. The program is funded through state-approved utility conservation programs.
4. CEE administers a variety of small business efficiency programs funded through state-approved utility conservation programs.
5. Enterprise Minnesota assists manufacturers to improve process and operational efficiency.
6. Saint Paul Port Authority administers the Trillion BTU loan program and PACE to finance energy efficiency projects.
7. Environmental Initiative offers sustainability best-practice exchange at their Business & Environment Series events.

Other related resources

1. The U.S. DOE provides many energy efficiency resources[299], including:
    a. eGuide[300], an online tool for developing Strategic Energy Management (SEM) plans
    b. The Superior Energy Performance (SEP) Industrial Ratepayer-funded Program Accelerator Toolkit[301] provides sample program design, cost effectiveness considerations, and other resources to promote the inclusion of SEP into efficiency programs.
    c. Industrial Assessment Center resources[302]
    d. DOE also provides various other tools for industrials[303].
2. Institute for Industrial Productivity works to accelerate the uptake of industrial energy efficiency practices by partnering with industry and government.

D4. Coordinate and promote the clean energy industry

Strategy overview

Stakeholders in the advisory committee identified an opportunity to align efforts to grow Minnesota's clean energy industry. The need to facilitate on-going promotion and communication across clean energy industry value chain businesses in Minnesota's clean energy economy was independently identified as a priority by the energy efficiency, solar, wind, biomass, and smart grid industry sectors.[viii]

An industry-led organization focused on coordinating efforts and communication across all clean energy sectors could help coalesce competitive strengths in Minnesota's clean energy and business community and maximize economic development across the state.

Specific actions for strategy implementation

1. **Identify initial leadership team, board members, and funding sources, and commence initial organizational work.**
   The leadership team's immediate objectives should include:
    - Using the best available information to determine Minnesota's competitive strength in different advanced energy sectors
    - Interview local corporations: What is their vision and strategy for the clean energy space? What is the appropriate scope and positioning for a clean energy business organization?
    - Board members should commit to the initial setup and goals of the organization and help to raise seed money. This initial funding can come from many sources, including grants, and does not need to be extensive to enable initial operation.

   Key initial activities may include:
    - Identify other states and communities that have established industry-funded clean energy cluster organizations.
        - Determine benefits obtained, including: attracting funding to the community; coordinating research across the private, public, and nonprofit sectors; and preparation to take advantage of new business opportunities as they arise.
        - Determine best practices to help coalesce competitive strengths in Minnesota's clean energy and business community and maximize economic development across the state.
    - Identify existing programs and organizations that could be leveraged to accelerate development of Minnesota's clean energy economy.

[viii] Per Minnesota Clean Energy Industry Roundtables and Summit convened by multiple state agencies for the clean energy industry: http://www.lec.leg.mn/2014/RelatedStateActivities.pdf

- Develop asset map and contacts.
- Perform gap analysis.
- Define scope and budget needed for the new organization to provide "gap" deliverables.
- Develop coordination plan with partners.

Champions/Key Participants:

- Clean energy firms in Minnesota

2. **Build the basic elements of a business plan to guide the organization and its efforts, with essential staff.**
   Key steps for this action include:
   - Identify a potential executive director to hire.
   - Identify initial collaborating organizations and companies and socialize the effort with them as initial potential "sponsors."
   - Establish clear leadership consensus on mission, goals, and strategy, including broader goals such as education and workforce development.
   - Define a clear competitive differentiator; clearly articulate what the organization is and is not.
   - Identify where Minnesota accelerates a current industry or fosters a new one.
   - Engage with likely partners (state, universities, labs, businesses, economic development organizations, etc.).
   - Build upon core regional strengths.
   - Measure success metrics annually.
   - Identify and nurture ongoing funding partners.
   - Define the decision-making process.

   Champion/Key Participants:

   - 2100 Advisors
   - Clean energy firms in Minnesota

Success factors

1. The right stakeholders must be involved. This includes private sector and public sector leadership.
2. The organizational business model must be sustainable. Membership and other revenues must cover the costs of running the group.

Indicators of strategy success

1. Funding attracted/matched for state advanced energy companies
2. Clean energy projects created
3. Number of industry partners
4. Energy saved by projects created through the organization
5. GHG and criteria air pollutants reduced by projects created through the organization

Cross-sector opportunities and synergies

1. The organization could facilitate and help scale business-led growth in grid modernization, building efficiency, and advanced biofuels and biobased chemicals.

Ongoing Minnesota initiatives

1. Environmental Initiative connects businesses with resources to support sustainability through a variety of programs, such as the Minnesota Sustainable Growth Coalition, a collection of companies, organizations, and individual leaders aiming to advance a circular economy that promotes a healthy environment and sustainable growth.
2. Clean Energy Economy Minnesota, sponsored by the McKnight Foundation, is an existing clean energy-focused business group.[304]

3. Blue Green Alliance works to identify job-creating opportunities from environmentally sustainable business practices.
4. Clean Energy Industry Sector Roundtables The Minnesota Departments of Commerce, Employment and Economic Development, and Agriculture, along with the Environmental Quality Board, convened a series of Clean Energy Industry Sector Roundtables in 2014 to identify actions that industry considered the highest priority for their continued growth and development.

Other related resources

1. Other state- or regionally-focused clean energy business organizations and/or events include:
    - The Northeast Clean Energy Council[305]
    - University of North Carolina Institute for the Environment Clean Tech Summit[306]
    - The Colorado Cleantech Industries Association (CCIA)[307]
        - The CCIA commissioned the Colorado Cleantech Action Plan[308] to help the organization map out the opportunity to catalyze cleantech in Colorado.
        - The CCIA's Energy Fellows Institute[309] focuses on developing a workforce for clean energy, aiming to "educate experienced entrepreneurs and executives in industry sectors of the advanced energy and cleantech ecosystems."
    - The Los Angeles Clean-Tech Incubator[310]
    - NextEnergy in Michigan[311]

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E. LOCAL PLANNING AND ACTION

Section summary

Leading local governments and tribal nations can illuminate the path ahead for clean energy across Minnesota. These entities have the ability to shape many aspects of the local energy system and have a variety of policy tools at their disposal right now that can shape clean energy development within their jurisdictions.

In this section, we outline two strategies for local leadership in building a cleaner, more resilient energy system: **advancing local energy planning** and **pursuing near-term actions at the local level**.

Advance local energy planning. Actions include energy data collection and analysis and integrating energy and resilience planning into comprehensive planning and other planning efforts.

Pursue near-term actions at the local level. Actions include adopting best practices, addressing energy development in local ordinances, creating predictable permitting for distributed generation, publicizing existing programs, and engaging communities in a statewide energy challenge.

Energy profile

Understanding that much of energy planning, policy, and action occur at the local level, this section focuses on what can be done across energy sectors in local communities. Communities vary significantly in their contribution to the state's total energy use, but each has a meaningful role to play in influencing energy use within its borders. Local governments and tribal nations have the ability to shape many aspects of the future energy system within their boundaries, and thus in aggregate across the entire state. They have unique sets of policy and planning tools through which they can inspire public participation and private sector action, and in so doing, shape their energy future.

Summary of opportunities

The stakeholder advisory committee identified the following strategies to allow local communities to plan thoughtfully for the future energy landscape and capitalize on opportunities over the next decade. The strategies fall into two major categories: advancing local energy planning and capitalizing upon near-term energy actions at the local level.

Advancing local energy planning

Local governments and tribal nations have the ability to shape many aspects of the local energy system, but many communities need support to plan appropriately for a complex, changing energy landscape. For example, the community-level energy data that is essential to making informed decisions has historically only been collected sporadically, and only for large cities. Further, frameworks for integrating energy into comprehensive plans and other technical resources are also needed.

Communities and tribal nations across Minnesota are showing that a clean energy future is not only possible, but that it is steadily taking root.

Pursuing near-term actions at the local level

This strategy focuses on actions local governments and tribal nations can take to seize upon near-term opportunities. By adopting best practices and implementing near-term actions, local governments and tribal nations can save money and reduce environmental impacts and can support their residents and businesses in doing the same.

E1. Advance local energy planning

Strategy overview

By providing support to local governments and tribal nations in their energy-related planning activities, state- and local-level actors can help ensure that local economic development goes hand-in-hand with energy cost savings.

This strategy covers methods of advancing local energy planning through the development of resources and tools. Actions include identifying baseline energy use in the community, setting goals accordingly, and planning for the future.

Specific actions for strategy implementation

1. **Collect, analyze, and report community-scale data on energy use and associated greenhouse gas emissions**. A baseline analysis identifies each community's major sources of energy use and greenhouse gas emissions, thereby helping planners make informed decisions about where to focus reduction efforts. This type of baseline analysis has already been conducted for more than 27 Minnesota cities through the Regional Indicators Initiative and independent collaborations between local

governments and technical consultants. Expanding these efforts to cities, townships, counties, and tribal nations across the state would be invaluable to informing decision-making at the local, regional, and statewide scales. Ideally, energy costs would be incorporated into the analyses, enabling planners to identify potential economic savings associated with energy efficient practices. In addition to collecting past energy data to establish a baseline, the continued collection of data is critical to measure progress over time.

Champions/Key Participants:

- LHB, as leaders of the Regional Indicators Initiative, can coordinate development of an automated online database to collect and report community scale data.
- Minnesota Pollution Control Agency and Great Plains Institute can help coordinate data collection efforts with GreenStep Cities' metrics-driven Step 4 program.
- Metropolitan Council can assist in data collection and publication for the metropolitan area.
- Minnesota Department of Commerce can assist in expanding data collection and publication efforts to include the entire state.
- Utilities will be relied upon to provide community level energy data.

2. **Support the integration of energy and resilience planning into the upcoming comprehensive plan updates for local governments within the seven-county Metropolitan Council area.** Cities, townships, and counties within the seven-county metropolitan region are currently preparing updates to their comprehensive plans, as required by the Metropolitan Land Planning Act. These updates are due December 31, 2018. Although comprehensive energy planning is not a required element of these plans, this update provides an opportunity for local governments to add value by planning their energy future.

   This action includes the development of resources and tools to assist in this process, such as case studies of successful energy plans, calculators to determine potential reduction impacts of specific energy strategies, and energy planning templates that can be directly incorporated into comprehensive plans. To ensure usefulness and ease of use, local government stakeholders should be engaged in the development of these tools.

   In addition to the development of resources and tools, this action includes education and outreach to communicate the value of energy and resilience planning and to provide training and technical assistance to local governments. This action should extend beyond the current comprehensive planning timeframe, as the tools, resources, processes, and expertise developed within the next ten years will set the stage for greater adoption of energy and resilience planning in the next round of comprehensive plan updates.

   Champions/Key Participants:

   - The Metropolitan Council provides resources and tools through its online Local Planning Handbook, hosts workshops and events, and provides in-person technical assistance in the comprehensive planning process.
   - The Minnesota Local Government Energy Planning Team (made up of the Department of Commerce, LHB, Great Plains Institute, Energy Transition Lab, and Center for Science, Technology, and Environmental Policy) are funded by the Department of Energy to work with local government partners to develop, pilot, and disseminate energy planning resources and tools.
   - Interagency Climate Adaptation Team is a group of state agencies working to adapt to a changing climate and manage its risks by developing strategies and measures for a more resilient state.

3. **Support energy and resilience planning in Greater Minnesota.** Building off of the resources and tools mentioned in the action above, champions and key participants would engage local governments and

tribal nations to tailor energy and resilience planning tools to suit their local authority, regulatory processes, and specific needs and goals.

Champions/Key Participants:

- Minnesota Pollution Control Agency and Great Plains Institute via GreenStep Cities
- Xcel Energy's Partners in Energy (PiE) Program
- Utilities
- Climate Smart Municipalities, University of Minnesota

4. **Identify opportunities to integrate energy planning into planning for other community systems and infrastructure.** State agencies, local governments, campuses, and other stakeholders will need to collaborate to identify common triggers for performing energy upgrades and determine the most effective way to integrate energy planning into other community planning processes. One example of integrated energy planning is recognizing that replacing sewer infrastructure provides an opportunity to simultaneously install or upgrade district energy infrastructure. Communities that demonstrate integrated energy planning could be rewarded by being scored higher on state grant applications for infrastructure improvements.

   Champions/Key Participants:

   - Environmental Quality Board (EQB) would facilitate connections across state government to promote alignment of state technical resources and programs.
   - District Energy St. Paul
   - University of Minnesota

5. **Develop energy and climate goals and action plans at a community level.** Using baseline energy data and the resources and tools described above, communities may choose to develop goals and action plans separately from their formal comprehensive plans. To assist in the implementation of action plans, nonprofits and state agencies can collaborate with tribal nations and local governments to identify funding and/or partnership opportunities and reach out when resources are available to support their energy projects.

   Champions/Key Participants:

   - Center for Energy and Environment (CEE)
   - Xcel Energy's Partners in Energy (PiE) Program
   - Minnesota Pollution Control Agency and Great Plains Institute via GreenStep Cities
   - Clean Energy Resource Teams (CERTs) partner with communities across the state to connect communities with resources to implement energy conservation and clean energy projects.
   - Local governments
   - Utilities

Success factors

1. **Community-level energy data is available statewide** for use in energy planning. This will require collaboration with investor-owned utilities, municipal utilities, and co-ops in order to gather consistent and complete data.
2. **Processes cultivate community leaders** and empower them with information and resources. Local leaders are key to achieving success.
3. **Local governments and tribal nations are invested in improving their energy future** and have resources available to support continued progress. Local environmental commissions and/or paid sustainability coordinators help to maintain clean energy development as a priority. Additionally, paid regional coordinators help provide additional resources.

4. **Planning processes are transparent and collaborative**, and lead to a shared vision for the community's energy future.

5. **Community members are engaged throughout planning processes**, including: business leaders, large energy consumers, neighborhood groups, and historically underrepresented groups. These and other community members are engaged early and often through public forums or workshops, a formal citizen advisory commission, or in an ad hoc fashion.
6. **Third-party advisors, nonprofits, and state agencies build local capacity** for addressing climate and energy opportunities.
7. **Climate and energy strategies are tailored** to meet the unique circumstances of different city types, and shared among peer cities.
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FIGURE 17: KEY ELEMENTS OF COMMUNITY ENERGY PLANNING.

ELEMENTS OF COMMUNITY ENERGY PLANNING	EXAMPLE ACTIVITIES
IDENTIFY AND BRING TOGETHER KEY LEADERS	• Assemble a small group of individuals with a shared interest in advancing a community energy action plan • Secure the support of a few key leaders, seek third-party consultants, and collect their input
BUILD A SHARED UNDERSTANDING OF THE GOALS	• Organize a collaborative workshop for key stakeholders to coalesce around a vision, strategies, goals, and next steps
BASELINING: INVENTORY CURRENT ENERGY USE AND INITIATIVES	• Understand current energy use, energy expenditures and associated greenhouse gas emissions, and investment and job opportunities • Map related initiatives in order to leverage and to build upon success
PRIORITIZE STRATEGIES AND TACTICS	• Select strategies and tactics to achieve the community's goals for its energy future
DEVELOP A PLAN THAT CAN MOBILIZE THE COMMUNITY	• Establish a plan that will empower the community to achieve the envisioned energy future and solicit community feedback
SEEK COMMITMENTS TO THE PLAN	• Adopt a plan via appropriate avenues (e.g., city-council vote, business commitments, county-commission vote, or another appropriate avenue) • Execute strategy and tactics within the specified timeframe
MEASURE PROGRESS AND SHARE RESULTS	• Monitor progress and periodically release results to the community and other interested parties

Source: Rocky Mountain Institute, *Community Energy Resource Guide*, 2015

Indicators of strategy success

1. Number of communities that have baseline energy data available
2. Number of communities that have adopted energy and/or climate goals
3. Number of communities that have developed energy and/or climate action plans
4. Annual reduction in community-level energy use

Cross-sector opportunities and synergies

1. Local governments and tribal nations rely on community-scale **energy data access** to establish a baseline and track progress.

2. Progress in **CHP and integrated energy systems** can be spurred by local planning.

Local planners can harness **benchmarking and disclosure** programs to promote energy efficiency.

Ongoing Minnesota initiatives

1. The Regional Indicators Initiative has collected seven years of baseline energy and greenhouse gas emission data for 27 Minnesota cities, representing a third of the state's population. Through the Minnesota Local Government Energy Planning Project (see below), the Regional Indicators Initiative team is funded to develop an automated online database to facilitate the expanded and continued collection of this data.[312]
2. The Metropolitan Council, along with third-party consultants, will be providing education and training workshops to address how cities can voluntarily integrate energy and resiliency planning into their comprehensive plans.[313]
3. The Minnesota Local Government Energy Planning Project will create resources to assist metro area cities to integrate energy planning into their comprehensive plans. Resources to be developed include: case studies of energy strategies implemented by exemplar cities, a wedge diagram tool for energy and greenhouse gas reduction planning with an associated menu of feasible city actions, and energy planning templates for use in the 2040 comprehensive planning process.
4. GreenStep Cities Best Practices, specifically Best Practice #29: "Climate Adaptation and Community Resilience: Plan and prepare for extreme weather, adapt to changing climatic conditions, and foster stronger community connectedness and social and economic vitality."[314]
5. Xcel's Community Energy Reports, which include data on community-level energy consumption and greenhouse gas emissions, will be available June 1, 2016, for many Minnesota cities and counties.[315]
6. Xcel's Partners in Energy Community Program is a two-year collaboration between Xcel and selected communities to develop and implement custom energy action plans.
7. The open Minnesota Public Utilities Commission docket 12-1344 addresses data privacy issues related to community-scale data access.[316]
8. The Serendipity Grant Program of the University of Minnesota has funded a project team of public, private, and nonprofit partners to make progress "Toward a Statewide Energy Data Repository" to collect energy data at the community scale.[317]
9. New York has developed a nationally replicable Utility Energy Data Registry, a repository for standardized community energy data voluntarily provided by electric and gas utilities. Minnesota is partnering with the New York State Energy Research and Development Authority (NYSERDA) on a funding proposal to test how this system could be expanded to Minnesota and other states.

Other related resources

1. The Metropolitan Council's Local Planning Handbook assists communities in updating their comprehensive plans and includes specific resources on resilience planning and energy infrastructure.[318]
2. The Minnesota Climate Change Vulnerability Assessment, conducted by the Minnesota Department of Health, quantifies population vulnerabilities to climate hazards.[319]
3. The U.S. Department of Energy's Cities Leading through Energy Analysis and Planning (Cities-LEAP) project offers standardized, local energy data and analysis to help cities integrate strategic energy analysis into decision-making. Cities-LEAP is currently in beta form.[320]
4. The U.S. Department of Energy's "Guide to Community Energy Strategic Planning" provides a process for strategic energy planning at the local level.[321]
5. Rocky Mountain Institute's "Community Energy Resource Guide" offers practical guidance and leading-edge examples of communities shaping their energy futures.[322]

E2. Pursue near-term actions at the local level

Strategy overview

Complementing the energy planning strategy, this strategy encompasses local actions that can be taken in the near term to advance a clean energy future. Local governments and tribal nations have a variety of policy tools at their disposal that can shape clean energy development.

Local governments and tribal nations can take clean energy development into account in their zoning requirements, ordinances, and permitting processes. Further, local governments and tribal nations can lead by example, adopting voluntary best practices and reducing the energy impact of their own operations. Finally, local governments and tribal nations are well positioned to communicate existing opportunities to community members and local businesses. Independent of state or federal policy developments, local governments and tribal nations can capitalize on many opportunities in the near term to advance a clean energy future.

Specific actions for strategy implementation

1. **Adopt energy-related GreenStep Cities best practices**. GreenStep Cities offers a variety of best-practice actions related to improving energy efficiency, increasing renewable energy use, and decreasing greenhouse gas emissions. Minnesota cities and tribes can identify best practices through the program's website and take action based on the needs and goals of their community.

   Champions/Key Participants:
   - Minnesota Pollution Control Agency and Great Plains Institute via GreenStep Cities Partnership

2. **Explicitly address energy development in zoning ordinances, building codes, and permitting requirements.** Local entities can prioritize clean energy objectives within their regulatory frameworks by eliminating regulatory barriers to clean energy development, strengthening energy efficiency requirements within their building codes, and incentivizing clean energy in a way that balances and protects competing development or resources. Examples of incentives include the following:

   - **Property Assessed Clean Energy (PACE) financing** for renewable energy and energy efficiency projects
   - Additional **density and height allowances** in exchange for clean energy enhancements
   - Increased unit counts **without additional parking requirements** in exchange for clean energy enhancements
   - **Accelerated permitting** for clean energy projects

   This strategy also supports the Efficient Buildings and Integrated Energy Systems strategy of adopting SB 2030 as a stretch building energy code for new construction, additions, and major renovations. After SB 2030 is incorporated as an appendix in Minnesota's building code, local entities should be encouraged to adopt it for buildings within their jurisdictions, and associated training should be provided. Even without statewide code adoption as an appendix, local governments can reduce the energy used by newly constructed and renovated buildings by requiring projects that receive financial support from the city to meet SB 2030.

   Champions/Key Participants:
   - Great Plains Institute
   - Minnesota Department of Commerce
   - Minnesota Pollution Control Agency

3. **Create a transparent and predictable permitting process for distributed generation.** Communities can be poised to advance distributed generation by having clear permitting, inspection, and interconnection standards. Designed appropriately, these standards can accelerate projects and reduce unnecessary costs for consumers. A study by Lawrence Berkeley National Lab suggests that streamlining the permitting process could reduce development time by a month and decrease the price of a residential solar system by $1,000 or more.[323]

   Champions/Key Participants:
   - Great Plains Institute

- Metropolitan Council
- Minnesota Department of Labor and Industry

4. **Publicize existing renewable energy and energy efficiency financing options and related programs to market segments that have not been sufficiently involved**. Local governments can play an important role in marketing state and utility programs related to energy efficiency and renewable energy. In particular, marketing should target mid-sized businesses, which are relatively large users at the local level, but have not historically been engaged in these programs to the same extent as larger businesses.

   Champions/Key Participants:
   - Clean Energy Resource Teams (CERTs)
   - Minnesota Department of Commerce
   - Utilities

5. **Engage communities in a statewide city energy challenge**.
   A statewide city energy challenge would serve as a catalyst to increase adoption of proven energy efficiency strategies and spur innovative new approaches. In addition to expanding use of existing energy efficiency programs and promoting behavioral energy efficiency strategies for residents and businesses, this action would raise public consciousness and support for informed energy planning at the city level. To be most effective, this challenge should provide participating cities with access to education, technical resources, and grant funding opportunities.

   Champions/Key Participants:
   - The Minnesota Department of Commerce's Clean Energy Community Award (CECA), launched in 2016, provides recognition to communities that have implemented programs, policies, and technologies that encourage energy efficiency, conservation, and renewable energy generation.
   - Great Plains Institute
   - Clean Energy Resource Teams (CERTs)
   - U.S. Green Building Council-Minnesota (USGBC-MN**)**
   - Center for Energy and Environment (CEE)
   - Xcel Partners in Energy
   - Ecolibrium 3
   - Minnesota Power

Success factors

1. **Local government staff is equipped with sufficient resources to take action.**
2. **Local energy or environmental commissions are established** to advise city council and/or citizen groups to guide clean energy improvements.

Indicators of strategy success

1. Number of cities taking actions through the GreenStep Cities program
2. Percentage reduction in community-wide energy use per capita
3. Reduced energy bills for residents, businesses, and local government operations
4. Reduced percentage of households living in energy poverty

Cross-sector opportunities and synergies

1. **Benchmarking programs** can allow local governments and tribal nations to assess progress toward goals.
2. If the Efficient Buildings strategy is successful, local governments will be able to **adopt SB 2030 as their building energy code**.
3. Local governments can take action to promote **thermal grids** in their communities.

Ongoing Minnesota initiatives

1. The Climate Solutions and Economic Opportunities (CSEO) initiative is an interagency collaboration led by the Environmental Initiative that models a range of possible policy scenarios impacting Minnesota's energy future.[324]
2. Eighteen utilities in Minnesota offer community solar programs, as mandated by a state law for Xcel Energy (M.S. 216B.1641) in 2013. Community solar allows customers to power their homes with solar energy without putting solar panels on their roofs.[325]
3. Clean Energy Resource Teams (CERTs) partner with communities across the state to connect communities with resources to implement energy conservation and clean energy projects.[326]
4. Fresh Energy's Solar for All program seeks to ensure all Minnesotans have access to clean energy options as the solar market continues to grow in the state.[327]
5. The Minnesota Department of Commerce provides a number of technical assistance and financing programs to support public entities in implementing energy efficiency and renewable energy projects. Programs include the Guaranteed Energy Savings Program; the Local Energy Efficiency Program, Energy Savings Partnership; the Public Entity Energy Audit and Renewable Energy Feasibility Study Loan Program; and Rev It Up.[328]

Other related resources

1. Several Minnesota state agencies provide data, technical assistance, and funding, including the Minnesota Pollution Control Agency, the Department of Commerce, and the Department of Natural Resources.[329] [330] [331]
2. Grow Solar's Local Government Solar Toolkit for Minnesota offers guidance on comprehensive planning, zoning, and permitting to enable solar development. Grow Solar also offers technical assistance in solar energy.[332] [333]
3. The Minnesota Department of Labor and Industry offers a number of solar PV resources, including electrical licensing, permits, inspection fees, and codes.[334]
4. Optony's Solar Road Map offers customized, interactive information on local solar markets, and tools for local governments, residents, businesses, electric utilities, and industry professionals.[335]
5. The North Carolina Clean Technology Center's DSIRE® database catalogues state incentives for renewables and efficiency.[336]
6. The Minnesota Department of Commerce website will have state-based and government-funded programs, broken by sector (e.g., industrial, residential).

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5. ADDITIONAL OPPORTUNITIES

The strategies presented in this report focus by design on cross-sector opportunities for action. Each strategy was included because of its near-term potential to drive progress in the state. However, stakeholders identified many more strategies as potentially important and impactful steps for Minnesota to consider as part of the development of this report. They are not included as strategies in the preceding sections because they do not meet one or more of the criteria for strategy selection described in the Introduction (e.g., lack of a present-day champion or other reasons). We list them here, by section, in order to reflect the work of the stakeholder advisory committee on these important future opportunities.

Transportation

- **Autonomous electric vehicles** were identified by stakeholders as a mid-term opportunity to reduce costs and emissions associated with personal transportation. These vehicles, already being piloted by leading companies (e.g., Google, Tesla), would in many cases have high annual mileage, allowing for significant emissions reductions for each car on the road and lower per-mile costs of travel.

- **Vehicle miles traveled (VMT)-based insurance pricing and taxation** was discussed in stakeholder meetings as one approach to limit emissions from transportation and improve congestion. In addition, as vehicles become more efficient and/or increasingly run on electricity or other alternative fuels, the revenue from gasoline and diesel sales tax diminishes, leading to a gap in budget for state agencies that maintain roads.

Energy supply and grid modernization

- **An expanded Renewable Electricity Standard (RES)** was suggested by stakeholders as a lever to increase the amount of renewable energy on the grid. Studies have shown that a higher RES is technically feasible for the Minnesota electricity system.[337]

- **Expanded incentives for distributed energy resources (DERs)** were discussed at several stakeholder meetings. These resources, including solar PV systems, will be an important part of the future energy mix and are growing in popularity in Minnesota.

Efficient buildings and integrated energy systems

- **Geothermal energy** may be an important energy resource for Minnesota, including ground-source heat pumps to more efficiently provide thermal energy to buildings.

- **Distributed generation** at building sites is a key part of the low-energy building standard (Strategy C1) discussed in this document, and stakeholders discussed several other strategies to advance distributed generation in the state.

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6. CONCLUSIONS

The Minnesota 2025 Energy Action Plan describes the current energy system in the State of Minnesota, highlights progress that the state has made toward its current goals, and suggests how even more can be achieved. The report highlights 22 strategies to capture near-term opportunities to make further progress toward existing goals and further advance clean energy, economic growth, and leadership in the state. Minnesota is an established leader in clean energy and the strategies captured in this report can empower Minnesotans to enjoy a cleaner, more affordable, more reliable, and more resilient energy system within ten years, while keeping more energy dollars in the state.

The strategies described in this report are the result of extensive stakeholder discussions aimed at identifying near-term opportunities to help reach clean energy and economic goals in Minnesota. These opportunities represent actionable first steps toward reaching a clean, affordable, reliable, and resilient energy future for the state. Each opportunity has a champion that is already taking steps to move toward this outcome in Minnesota, but the opportunities can best be grasped by the collective action of Minnesotans of all walks of life, in the private and public sectors, and at all levels of government.

Importantly, these opportunities are highly interrelated. Actions in the electricity, transportation, buildings, industrial, and agricultural sectors all have important relationships. In addition, local governments and tribal nations have a key role to play in driving and executing community-level action to make progress in each of those sectors. This report identifies where these cross-sector opportunities may be most important, in order to let stakeholders focused on one particular opportunity understand how their actions may influence or depend on the actions of others. None of these opportunities are relevant to every Minnesotan, but every Minnesotan will find many of opportunities that are meaningful and valuable.

As state- and national-level clean energy trends accelerate, Minnesota can take action immediately to take advantage of its existing clean energy progress and leadership, leverage locally-sourced renewable natural resources, and drive growth in an increasingly important sector of the state economy. The stakeholder recommendations in this document can serve as a guide to taking the next steps toward capturing this value.