ENERGY POLICY AND CONSERVATION QUADRENNIAL REPORT 2016

Submitted in Compliance with Minnesota Statute § 216C.18

COMMERCE DEPARTMENT

DIVISION OF ENERGY RESOURCES

Table of Contents

List of Figures

List of Tables

INTRODUCTION

In accordance with Minnesota Statutes section 216C.18, the Minnesota Department of Commerce (Department) issues a State Energy Policy and Conservation Report. Informally referred to as the "Quadrennial" or "Quad Report," it identifies major emerging trends and issues in Minnesota's energy supply, consumption, conservation, and costs.

The following statutes provide the powers and responsibilities assigned to the Commissioner of Commerce over the production, distribution, and sale of energy in the state. Primary statutes include:

216A and 216B	Public Natural Gas and Electric Power
Utilities 216C	Energy Planning and Energy Conservation
216E	Electric Power Facility Permits
216F	Wind Energy Conversion Systems
216G	Routing of Certain Pipelines

The Department serves as the lead entity to coordinate cooperation, resources, and information between state agencies that have responsibilities for matters relating to energy and represents the public interest to maintain affordable, reliable energy. In general, the Department is charged to:

- Evaluate electric and gas utilities' rate increase requests and evaluate utility plans to add new power generation, power lines, or natural gas distribution pipelines;
- Serve as an advocate for the public interest at the Minnesota Public Utilities Commission to assure that utilities provide reliable, cost-effective, and environmentally sound service to ratepayers;
- Assure that utilities achieve Minnesota's Renewable Electricity Standard in a cost-effective manner;
- Assure that utility energy conservation programs are cost-effective and help Minnesota consumers achieve energy savings through energy efficiency;
- Administer the federal Weatherization Assistance Program to help low-income families make their homes more energy efficient, and administer the Low Income Home Energy Assistance Program to help low- and fixed-income Minnesotans with their winter energy bills;
- Provide specific energy information to consumers and businesses about how to save energy through conservation and efficiency improvements and provide technical assistance on options to access renewable energy resources;
- Provide technical assistance to businesses seeking to commercialize emerging technologies, and site or expand clean energy facilities in the state; and
- Monitor liquid fuel supplies (petroleum, biofuels).

The critical role that energy plays in the economic, environmental, and social vitality of Minnesota is demonstrated on a daily basis such that the Department is dedicated to ensure that:

- Minnesota has a reliable energy system into the future;
- The state's energy system meets Minnesota's economic needs;

- Minnesota's energy costs are reasonably priced;
- The environmental impacts of the energy produced and consumed in the state are minimized; and
- The state meets laws and goals established by the legislature.

Consequently, the Department's primary focus is to assure the state's current and long-term energy reliability, including the long-term adequacy of supply, security, quality, and sufficiency of the electricity transmission grid and its local distribution system, as well as for natural gas and petroleum products sold in the state.

In 2014, Minnesota's total expenditures for fossil fuels—coal, natural gas and petroleum—were $18.4 billion[1]. Since Minnesota has no natural deposits of fossil fuels they must be imported. Because energy conservation and a diversified energy supply and generation mix have shown that they improve energy security and stimulate economic vitality in the state, renewable energy and energy efficiency remain key components of that focus.

While the Department focuses on the long-term adequacy of supply, security, quality, and sufficiency of energy used in Minnesota, it also works with other state agencies to ensure that the energy needs for the system as a whole are balanced with local economic development and other community goals.

This Energy Policy and Conservation Quadrennial report identifies status, trends, and issues in Minnesota's energy supply, consumption, conservation, and costs for electric power, natural gas, and transportation fuels in the state.

[1] Based on U.S. EIA data; see further details on fossil fuel expenditures in Appendix B.

ELECTRICITY

Minnesota's economy depends on reliable, reasonably priced, environmentally sensitive electric service. Consumers of all types—residential, commercial, industrial—have come to expect and rely on electric utilities to provide a high level of reliability and quality of service. As such, the reliability and quality of electric service in Minnesota is among the top priorities of the Department.

A key to understanding the difficulty of maintaining the reliability of the electric system is that electricity, unlike natural gas and petroleum, cannot yet be stored cost-effectively. Thus, at any given moment, there must be enough electric generation and transmission capacity available to meet the needs of all consumers. Large-scale storage of electricity is currently not cost competitive, given low energy prices throughout the Midwest, although this is expected to change as storage technology costs continue to fall.

The assessment of reliability discussed in this chapter consists of four sections:

- The long-term adequacy of electric supplies to serve Minnesotans;[2]
- The changing fuel mix of the electric generating plants used to serve Minnesotans;
- The transmission system, often referred to as the transmission "grid" or the "bulk power" system; and
- The distribution system—the part of the electricity delivery system that connects end-use customers with their utility's transmission system.

A. Resource Adequacy

National—According to the Annual Energy Outlook 2016 (AEO16),[3] the projected electricity generation fuel mix is expected to significantly change over the next 25 years with generation from coal decreasing and generation from natural gas and renewables increasing. Major drivers of change include aging coal facilities, decreases in costs of natural gas, deregulated electric generation in eastern states combined with increased financial risks of investing in large generation facilities, and environmental regulations, such as the U.S. Environmental Protection Agency's (EPA) Clean Power Plan (CPP), which, if instituted, will require states to reduce carbon dioxide (CO_2) emissions from existing fossil fuel generators. The current relatively slow growth in demand for generation from central power stations is expected to continue, driven by energy efficiencies gained through technological advances and the desire by both large and small consumers for more locally owned electric generation resulting in increases in behind-the-meter, on-site generation. The U.S. Energy Information Administration (EIA) forecasts that national demand for electricity will increase by 0.3 percent in the residential sector, by 0.8 percent in the commercial sector, by 1.1 percent in the industrial sector, and by 6.7 percent in the transportation sector, with an overall increase of 0.7

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[2] Note that energy conservation, discussed below, also plays an important role in ensuring that electricity production is adequate to meet consumers' needs.

[3] U.S. Energy Information Administration, Annual Energy Outlook 2016.

percent, by 2040.[4]

Regional—Minnesota's utilities are members of the Midwest Reliability Organization (MRO).[5] MRO is a nonprofit organization that works to ensure the reliability and security of the bulk power system in the north central region of North America. MRO is a member of North American Electric Reliability Corporation (NERC), which collects the studies done by the regional entities to evaluate the reliability of the interconnected grid as a whole. The generation fuel source mix is made up of fossil/coal, hydroelectric, gas, oil, nuclear, and wind, biomass, and other types of renewable energy technologies.

This diverse generation mix keeps our power system reliable and economical. The MRO replaced the Mid-Continent Area Power Pool (MAPP) as a reliability organization within NERC in January 2005.[6]

The MRO region has a peak demand occurring in the summer season. The MRO summer peak demand is expected to increase at an average rate of 0.85 percent per year during 2016-2025.[7] The MRO summer reserve margin during the 2016-2025 period is predicted to tighten within this same period, going from 16.28 percent in 2016 to 11.08 percent in 2025, leading to a projected dependency on the use of load modifying resources such as behind-the-meter, or distributed generation (DG) and demand response.

State—Energy conservation and demand-side management programs are important resources in Minnesota. Conservation and demand-side management not only help manage load growth but are the cheapest and most environmentally friendly way to meet the demand. Nevertheless, the Department expects that the need to replace aging fossil fuel generation will surpass the contribution of conservation and demand-side management towards balancing supply and demand in a cost-effective manner. In recent years, regulated utilities' Integrated Resource Plans (IRP) have generally indicated a need for additional resources to meet Minnesota's projected demand for electricity and to replace retiring coal-fueled and other generating plants.[8] Analyses done in the IRP process consider energy conservation and demand-side management resources integrally in both the assessment of forecasted demand and in the selection of potential resources to meet an identified need. Consistent with the nation and region, new generation and transmission facilities will continue to be needed as generating units are retired and demand for electricity in the state continues to grow. Electric utilities engage in resource planning to determine the combination of conservation measures, power plants, and transmission lines that most economically meet the projected demand.

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[4] U.S. Energy Information Administration, Annual Energy Outlook 2016, Table A-2 in appendix A-3.

[5] *The MRO region covers all or portions of Iowa, Illinois, Minnesota, Montana, Nebraska, North Dakota, South Dakota, Wisconsin, and the Canadian provinces of Manitoba and Saskatchewan.*

[6] *MAPP continues to exist as a regional transmission group with a Transmission Planning Committee (TPC), a Reliability Planning and Coordination Committee (RPCC), and a Tariff Services Committee (TSC).*

[7] *NERC 2015 Long Term Reliability Assessment*

[8] *See following IRP dockets: Xcel Energy – Docket No. 15-21; Minnesota Power – Docket No. 15-690; OtterTail Power – Docket No. 16-386.*

Ensuring that this new infrastructure is constructed and placed into service in a manner that does not adversely impact the environment, energy costs or other public interests is a challenge that the Department as well as state and regional policymakers must continue to address.

B. Changing Energy Mix

Aging infrastructure, financial risks of investing in large electric infrastructure, lower natural gas prices, anticipated new federal EPA regulations on existing electric generating units to reduce carbon dioxide emissions, and the extension of renewable tax credits are all driving a shift toward less carbon-intensive generation.

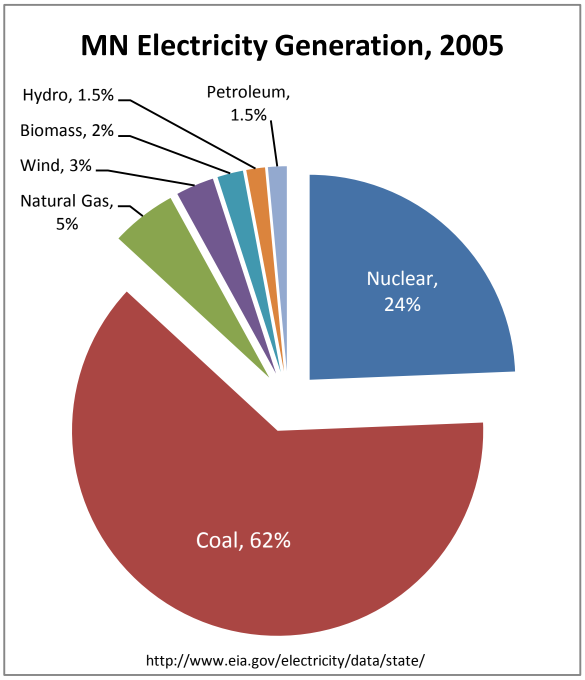
In 2015, 22 percent of the electricity produced in Minnesota came from renewable sources, for the first time surpassing the amount of electricity generated from nuclear energy.

Minnesota has developed a diversified energy portfolio with a mixture of fossil, nuclear, and renewable power generation technologies—coupled with significant energy efficiency and conservation—to reduce risk to the system as a whole as well as reduce environmental impacts.

Although coal remains the primary feedstock for power generation in the state, its use decreased 25 percent between 2005 and 2015. Use of petroleum fuel to generate power decreased 96 percent over the same time period. That difference, plus an additional 7.5 percent in power generation produced in the state, was provided through a

- 520 percent increase in wind
- 170 percent increase in natural gas
- 70 percent increase in biomass.

Figure 1: Electricity generation in Minnesota, percent by source, 2005 and 2015



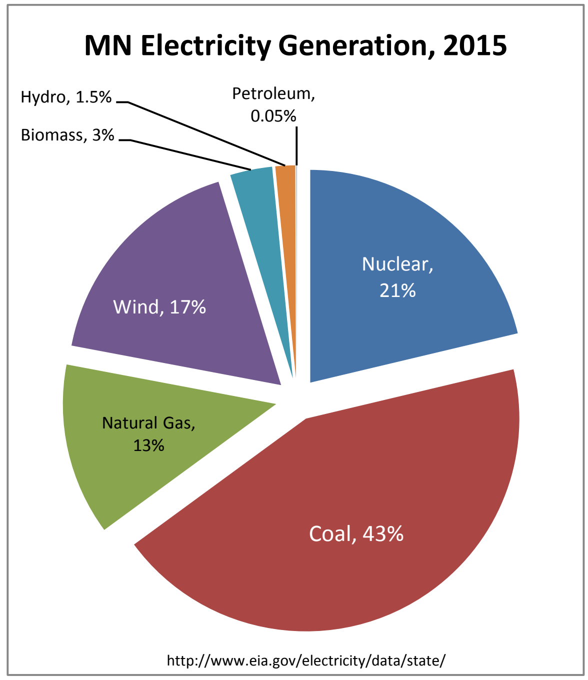
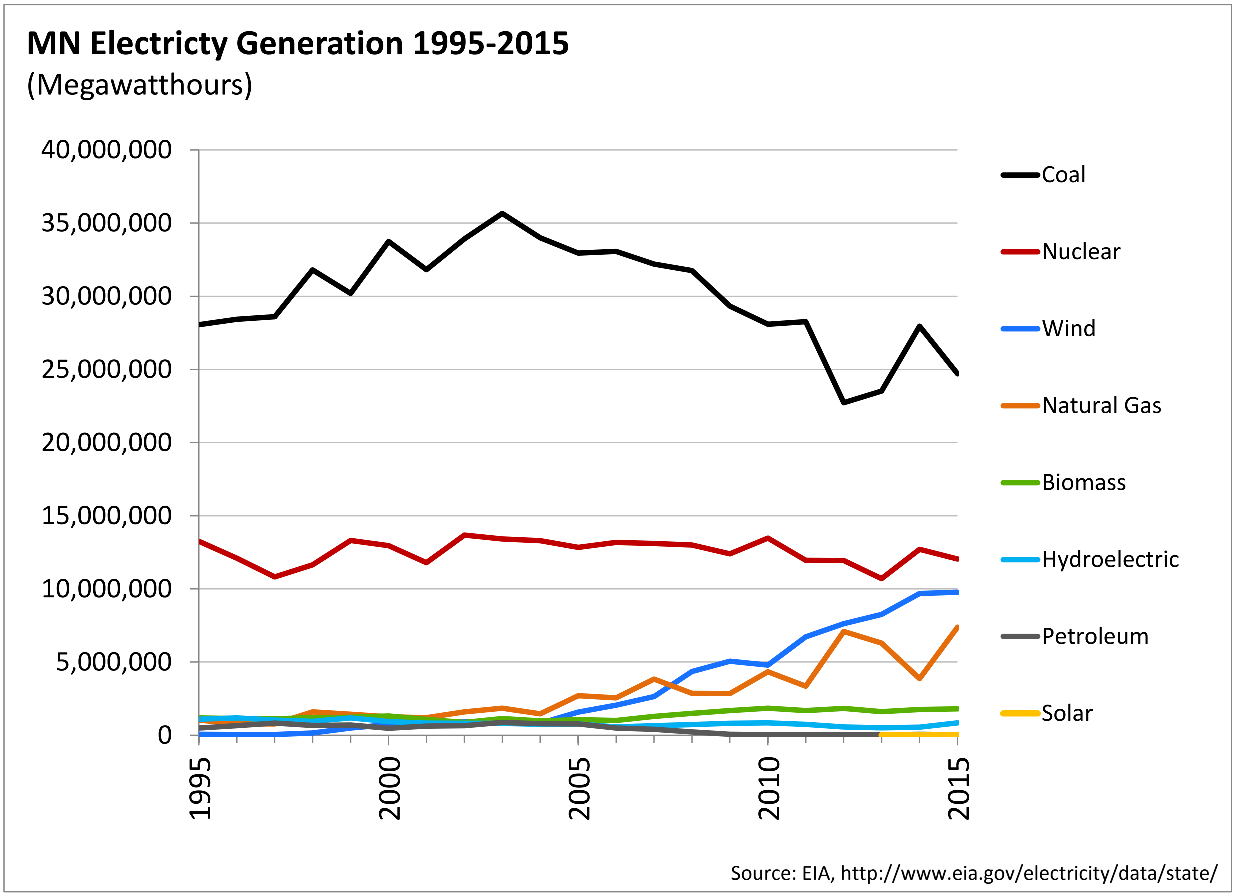


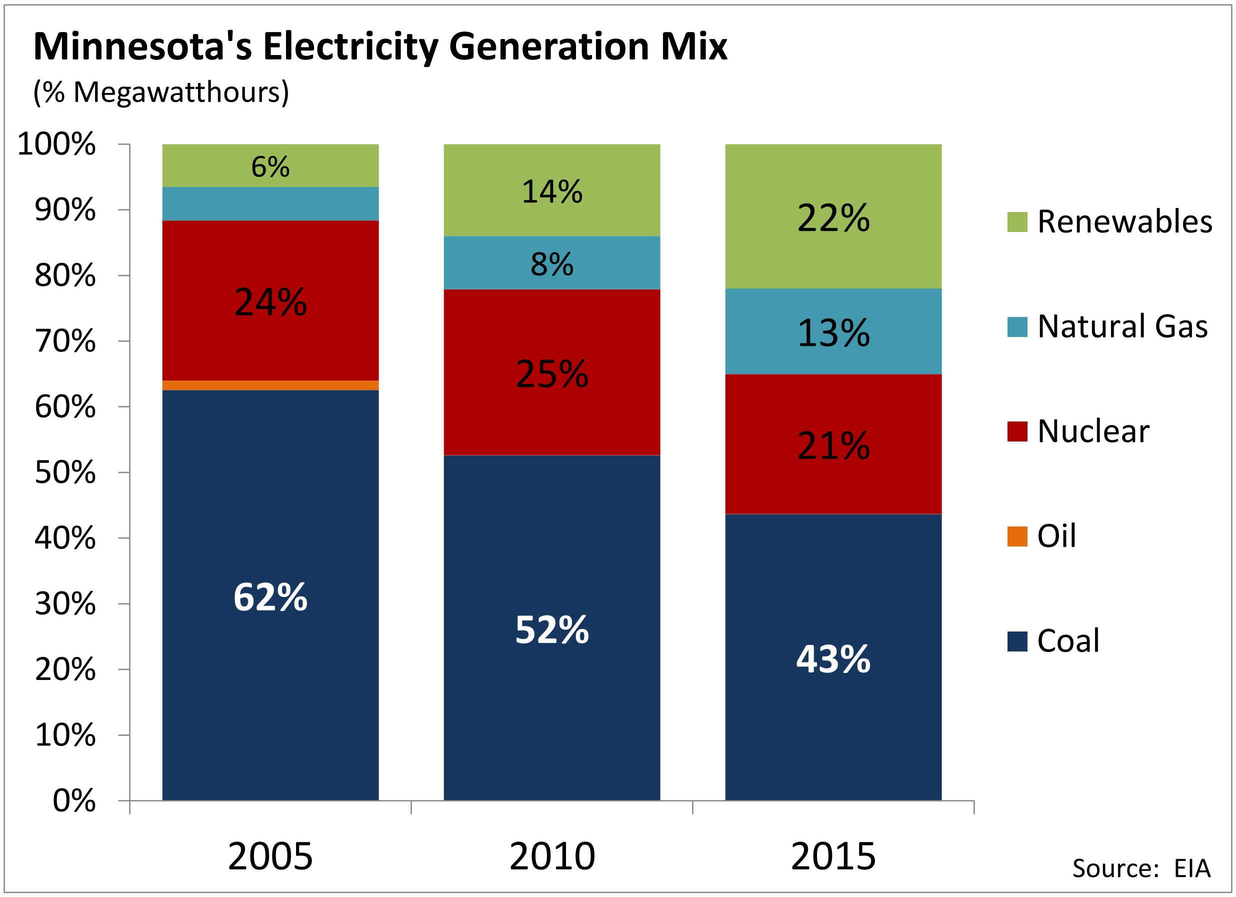
Figure 2: Electricity generated in Minnesota, MWh by energy source, 1995-2015



As is historically the case, coal, nuclear, and natural gas continue to provide the energy for the majority of the electricity produced in the state today. Since these fuels are not produced in the state, they must be imported. Most of the state's coal supply is brought in by rail from Montana and Wyoming. Sources of natural gas vary, depending on market forces, but can include sources from Texas, Louisiana, and Canada.

Electricity generated from coal-fired electric power plants in Minnesota has decreased significantly from 62 percent in 2005 to 43 percent in 2015. Electricity generated from natural gas-fired electric power plants in Minnesota increased from 5 percent in 2005 to 13 percent in 2015. Electricity from nuclear power plants in Minnesota decreased from 24 percent in 2005 to 21 percent in 2015.

Figure 3: Minnesota's Electricity Generation Mix, 2005-2015



Over the last decade, Minnesota has made substantial progress expanding the use of renewable energy sources for electricity production to reduce dependence on fossil fuels and mitigate environmental impacts. In 2008, the amount of electricity generated from wind power surpassed the amount of electricity generated by natural gas. In 2015, 22 percent of the electricity produced in Minnesota came from renewable sources, for the first time surpassing the amount of electricity generated from nuclear energy.[9] As of October 2016, the amount of electricity produced from solar PV is below 0.1 percent of state generation, but over the next four years the amount of electricity from solar is expected to increase to 1.5 percent of state generation.[10]

In August 2015, the EPA announced the Clean Power Plan, which requires states to develop plans for reducing emissions of carbon dioxide. Since coal- and natural gas-fired generating units are the largest source of carbon dioxide in the United States, the Clean Power Plan focuses primarily on those sources. States will have flexibility in terms of how to meet EPA's targets, such as increasing the efficiency of existing power plants, increasing use of renewables and energy conservation, and/or using lower-carbon energy sources. On February 9, 2016, the

[9] U.S. Energy Information Administration, 1990-2015, Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923).

[10] MN Department of Commerce estimate based on U.S. EIA data and utility resource plans.

U.S. Supreme Court granted a stay that temporarily halts the implementation of the Clean Power Plan until pending legal challenges against the rule are resolved in the courts. The U.S. Court of Appeals for the District of Columbia Circuit convened on September 27, 2016 to hear those challenges, but no decision is expected until 2017.

Meanwhile, Minnesota's electric utilities are continuing to consider least-cost plans for their generation systems, whether the Clean Power Plan is implemented or not. For example, in October 2016, when the Minnesota Public Utilities Commission (Commission) met to consider Xcel Energy's Integrated Resource Plan (IRP), the Commission examined costs for Xcel Energy's system assuming no costs for carbon emissions, low-carbon emission costs, and high-carbon emission costs. While the total amount of emissions and costs varied under each of these assumptions, Xcel's proposal was the least-cost approach. Thus, the Commission approved Xcel's proposal, which included, in the short-term:

- at least 1,000 megawatts of wind generation additions by 2020;
- a target of 650 megawatts of solar generation by 2020;
- a retirement date of 2023 and 2026 for coal-fired units 2 and 1, respectively, of the Sherburne County Generating Station (Sherco); and
- a February 1, 2019 filing date for Xcel's next IRP, which is to include a comprehensive study of shutting down the Monticello and Prairie Island Nuclear plants, the coal-fired King plant, and unit 3 of the Sherco plant.

Table 1: Change in electricity generated in MN, MWh by energy source, 2005-2015

Energy Source	Generated in 2005		Generated in 2015		Change in MWh	Change in Percent
	MWh	Percent	MWH	Percent		
Coal	32,949,845	62.1%	24,697,098	43.3%	-8,252,747	-25.05%
Nuclear	12,835,219	24.2%	12,038,606	21.1%	-796,613	-6.21%
Biomass	1,069,631	2.0%	1,806,022	3.2%	736,391	68.85%
Natural Gas	2,707,267	5.1%	7,389,438	13.0%	4,682,171	172.95%
Hydro	774,729	1.5%	849,054	1.5%	74,325	9.59%
Wind	1,582,477	3.0%	9,778,845	17.2%	8,196,368	517.95%
Petroleum	776,309	1.5%	27,939	0.05%	-748,370	-96.40%
Other	323,518	0.6%	389,976	0.7%	66,458	20.54%
Solar	-	-	2,789	0.005%	-	-
Total	53,018,995		56,979,768		3,960,773	7.47%

Notes:

1. *EIA started to track MN solar generation in 2013.*
2. *Source – U.S. Energy Information Administration, 1990-2015 Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923)*

1. Need for Base Load Resources as Fossil Fuel Units Are Retired

Electric utilities serving Minnesota have made very few utility-owned capacity additions since 2011. The majority of the additions are small natural gas units installed by municipal utilities. No base load generation projects greater than 50-megawatt (MW) facilities have been installed since 2011. Given the expected retirement of a portion of the coal-fired plants serving Minnesota, there will be a need to replace this capacity with suitable resources.

Capacity additions require considerable advanced planning. In general, base load and intermediate resources are more difficult for utilities to build than peaking or intermittent resources because base load and intermediate resources are more expensive to construct and generally have greater land and environmental impacts. Minnesota Rules parts 7843.0100-7843.0600 require electric utilities to file proposed Integrated Resource Plans (IRP) every two years (or as determined by the Commission); these plans present the utility's 15-year demand forecast and the utility's proposed capacity additions to meet the forecasted demand. There were two IRPs filed with the Commission in each of the years 2013, 2014, 2015, and 2016. As noted above, the Commission’s recent decisions in Xcel Energy’s IRP will result in a significant shift in Xcel Energy’s resource mix in the current 15-year planning period. IRPs may be followed on the Commission’s e-Docket system.

2. Increased Reliance on Natural Gas Generation

As shown in Figure 1 above, in 2010 natural gas-fired generators produced 13 percent of electric energy generated in Minnesota, 17 percent came from wind turbines, and 43 percent from coal-fired generators. According to the EIA, summer capacity from natural gas has increased from 8 percent of net electric capacity in 2000 to 32 percent of the net electric capacity in 2014. Natural gas generation facilities have long been a small part of Minnesota's supply mix and have traditionally relied on the summer surplus of natural gas pipeline capacity that is available since most consumer furnaces are not being used to heat homes and businesses. However, the state's usage of natural gas-fueled power generation is increasing. As noted above, these upward trends are a result of natural gas pricing and the advantages of fewer emissions. One of the advantages of natural gas-fired generation is its “dispatchability,” i.e., the unit can be started up and shut down more quickly and easily than other types of facilities. However, only a limited number of natural gas generation facilities can be added to the existing natural gas pipeline infrastructure before pipeline upgrades are needed to handle the additional capacity and line pressure needs of natural gas-fueled electric generation.

3. Increased Renewable Electricity Generation

In addition to Minnesota’s Renewable Electricity Standard, in 2013, legislation was passed establishing Minnesota’s Solar Electricity Standard (SES). The SES requires electric investor-owned utilities in Minnesota to procure 1.5 percent of their annual retail sales from solar energy by 2020. Minnesota Statute sections 216B.2422, subpart 3 and 216H.06 require the Commission to establish environmental externality values and to estimate the future cost of carbon regulation and consider these factors in electric resource planning and acquisition decisions (*When an economic activity imposes a cost or benefit on an unrelated third party, the cost or* *benefit is known as an economic external cost or "externality." Externalities can be viewed as positive or negative depending on their impact.* [11]*).* In addition to the aging of coal facilities, other contributing factors to the shift away from coal-fired electric generation in favor of renewable resources include: financial risks of investing in large base load facilities and decreasing costs of alternatives, the renewable and solar energy standards, the incorporation of externality values in resource planning decisions, and the EPA's Clean Power Plan.

Minnesota has a tremendous capacity for renewable energy development, especially its wind energy resources. As of December 2016, Minnesota had over 3,500 megawatts of wind and 246 megawatts of solar capacity installed. There are challenges involved in the increases in renewable energy. Resources dependent upon the wind or the sun are necessarily variable. Without further advances in storage technology, wind and solar resources cannot be "dispatched" (turned on when needed).[12] However, to date this challenge has been mitigated by being part of an integrated electric system, in which all resources act in concert with each other such that another generation resource can be increased when the wind is not blowing or sun is not shining, or decreased when wind production is higher than anticipated. This "following" or filling in behind other resources is similar to the way that the system balances changing load and generation mix, for example filling in behind resources that are offline either for maintenance or for unanticipated outages (e.g., facility failure or issues with fuel availability). While fluctuations in variable resources can be pronounced in a local area, the wind is usually blowing and the sun is usually shining in many places across the regional grid. In addition, wind and solar forecasting combined with upgrades to the electrical grid offer a variety of economical options to respond to changes in electrical production.

In 2013, the Minnesota Legislature adopted a requirement for a study of increasing the state's Renewable Electricity Standards (RES) to 40 percent by 2030, and to higher proportions thereafter, while maintaining system reliability.[13] The study results[14] showed that the addition of wind and solar generation to supply 40 percent or even 50 percent of Minnesota's annual electric retail sales can be reliably accommodated by the electric power system. In 2017, the Department recommended legislation to increase the RES to 50 percent by 2030.

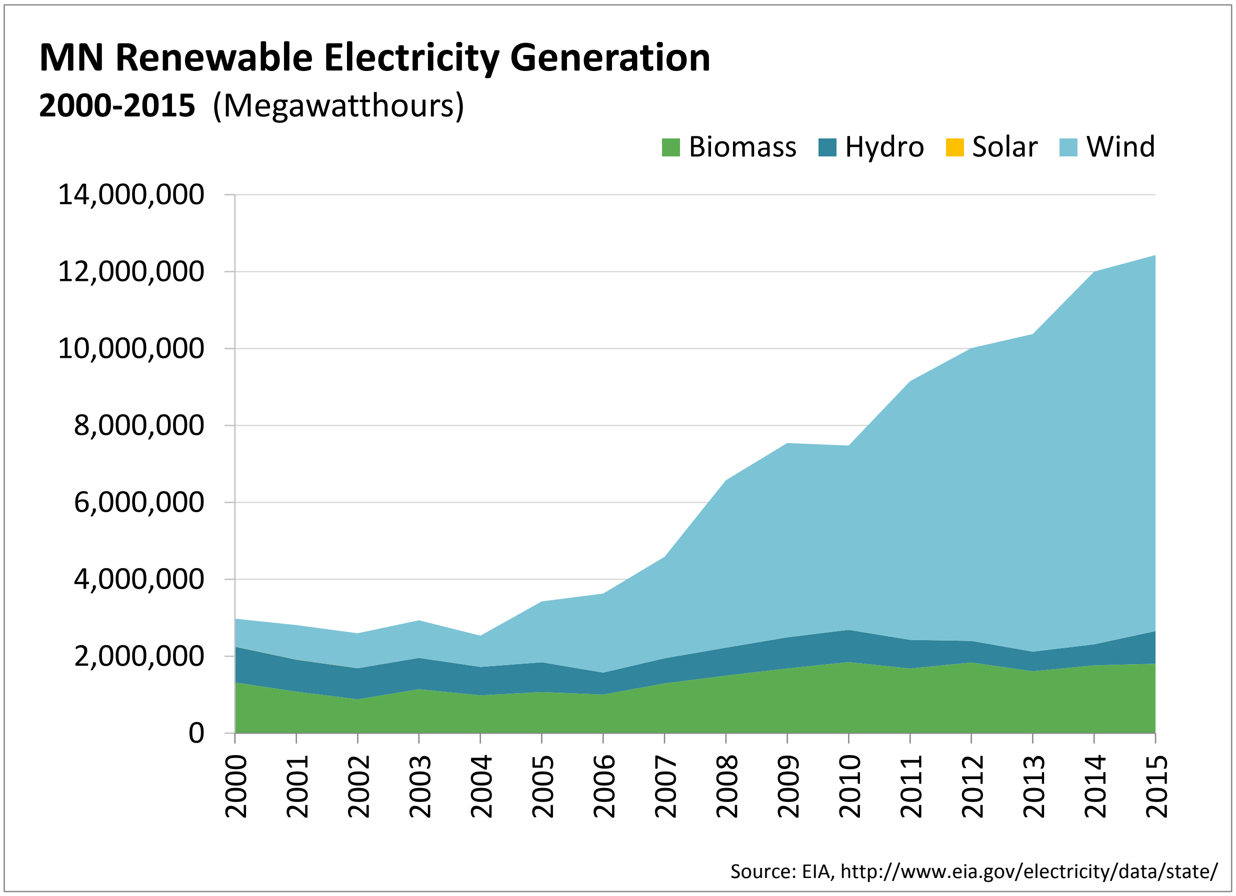
[11] Externality value definition quoted from FINDINGS OF FACT, CONCLUSIONS, AND RECOMMENDATIONS: CARBON DIOXIDE VALUES, In the Matter of the Further Investigation into Environmental and Socioeconomic Costs Under Minnesota Statutes Section 216B.2422, Subdivision 3, State of Minnesota Office of Administrative Hearings for the Commission, E-999/CI-14-643, April 15, 2016.

[12] However, more than 80% of wind resources within the Midcontinent Independent Transmission Service Operator footprint use a Dispatchable Intermittent Resource tariff, allowing the grid operator to turn off the generator during times of local grid congestion.

[13] Legislation passed in 2013 required a Renewable Energy Integration and Transmission Study (MN Laws 2013, Chapter 85 HF 729, Article 12, Section 4). The Minnesota Public Utilities Commission ordered all Minnesota electric utilities and transmission companies to participate in the study (Docket No. E-999/CI-13-486).

[14] Final Report: Minnesota Renewable Energy Integration and Transmission Study, October 31, 2014.

Figure 4: Sources of renewable electricity, 2000-2015



The sources of energy used to generate renewable electricity in Minnesota have changed significantly over time (Figure 4 above).

In 2005, the amount of renewable energy generated comprised about 6.5 percent of total generation in the state. In 2005 wind power provided approximately 46 percent of total renewable generation, hydropower provided about 23 percent, and biomass approximately 31 percent of the total. From the year 2005 to the end of 2015, wind power showed the largest proportional increase compared to biomass and hydro power. By the end of 2015 renewable energy provided almost 22 percent of the total generation. At that time wind provided 79 percent, biomass nearly 15 percent, hydro nearly 7 percent, and solar less than 0.1 percent of the renewable energy used to generate power in Minnesota.

a. Wind Power

Minnesota is a long-standing leader in support of the wind industry with numerous policies, programs, and in-depth studies to remove barriers and encourage growth. Most recently, the 2014 Minnesota Renewable Energy Integration Study showed that the addition of wind and solar generation to supply up to 50 percent of Minnesota's annual electric retail sales can be reliably accommodated by the electric power system.

Wind Highlights

- **Wind Capacity in MN: 3,500 MW as of 12/31/2016[15]**
- **Minnesota ranks 7th nationwide (AWEA)[16]**
- **Portion of in-state generation from wind: 17.2 percent, Minnesota ranks 6th nationwide (AWEA)**
- **Minnesota ranks 2nd for the most distributed wind capacity deployed since 2003[17]**

As a result of favorable policies and world-class wind resources, Minnesota continues to be one of the top states for total wind energy production and capacity. Minnesota generated 17.2 percent of the state's total electricity from wind in 2015, the sixth highest share in the nation; its net generation was 9.8 million megawatt hours in 2015, a twofold increase from 2010.[18]

Continuing declines[19] in pricing for newly built wind projects makes wind an attractive resource for utility capacity additions, competitive with new natural gas-fueled capacity. Conclusions made after comparing the cost of electricity generated using traditional fuels with the cost of electricity generated by renewable resources are dependent upon many factors besides the amount of capital investment needed to build the generator, such as changes in various fuel prices due to international demand, as well as existing and evolving public health, air, and water quality laws.

Minnesota's use of wind power has been increasing over time. As noted above, more than 17 percent of the power generated in Minnesota in 2015 was produced from the wind. That amount compares to about 9 percent in 2010 and 3 percent in 2005.[20]

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[15] Minnesota Department of Commerce estimate based on site permitting records and industry reports.

[16] AWEA U.S. Wind Industry Third Quarter 2016 Market Report.

[17] U.S. Department of Energy, 2015 Distributed Wind Market Report.

[18] U.S. Energy Information Administration, 1990-2015, Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923).

[19] U.S. Department of Energy, 2015 Wind Technologies Market Report.

[20] U.S. Energy Information Administration, 1990-2015, Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923.

Figure 5: Minnesota's Annual Wind Installations, 1997-2016

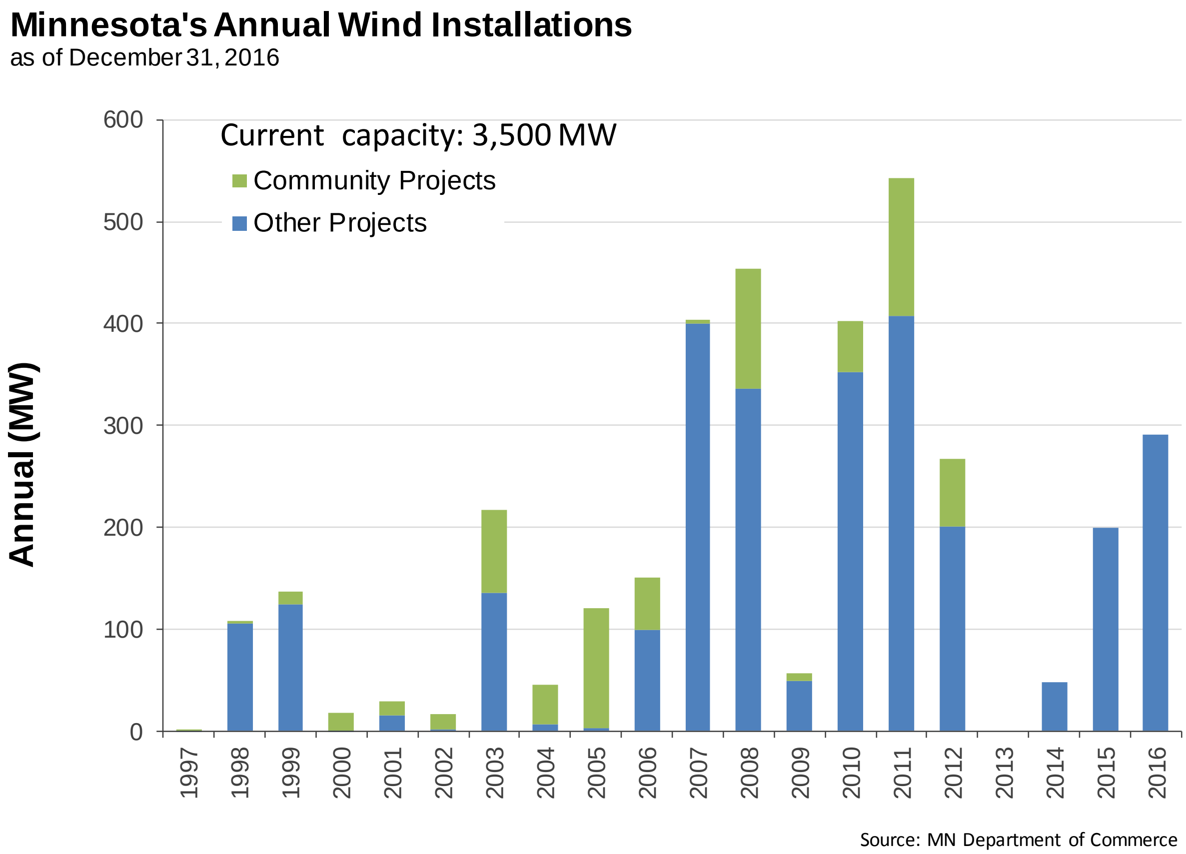


Figure 6: Minnesota's Wind Capacity, 1997-2016

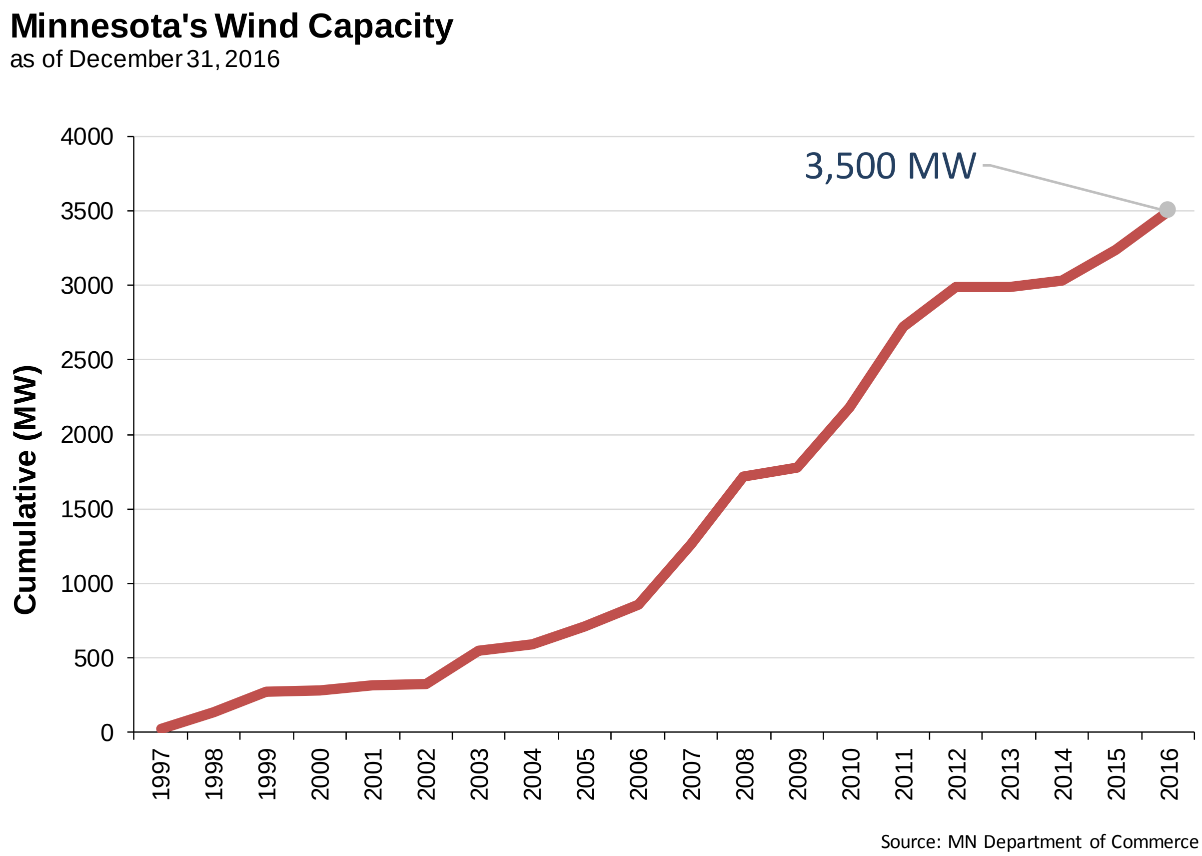
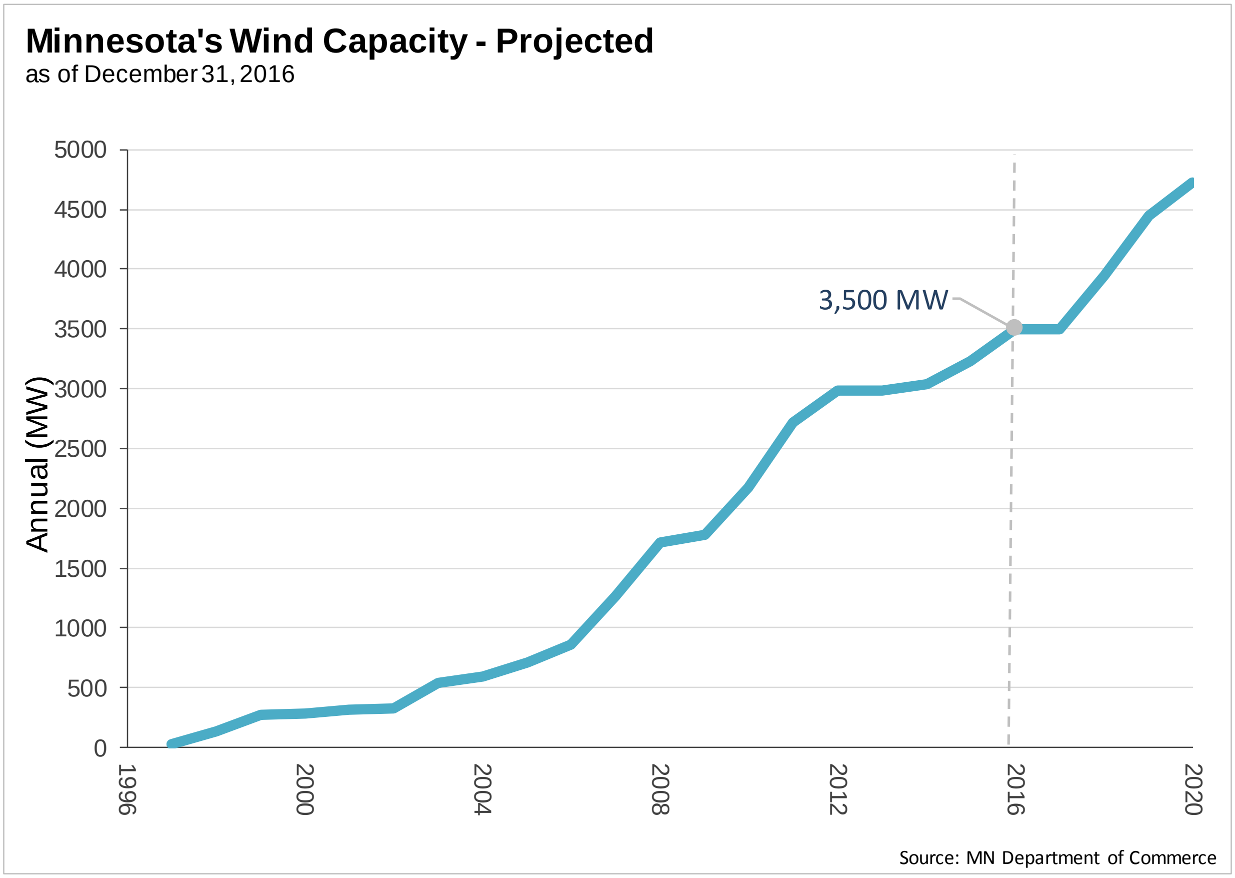


Figure 7: Minnesota's Projected Wind Capacity to 2020



Drivers

State Policy – Renewable Electricity Standard. Minnesota's **Renewable Electricity Standard** requires the state's utilities to generate at least 25 percent of their electricity from renewable energy sources such as wind and biomass by 2025, and 31.5 percent by 2020 for Xcel Energy (altogether about 28.5 percent by 2025). This is roughly equivalent to 6,000 to 7,000 megawatts of renewable capacity by 2025.

Market Driver: Aside from the Renewable Energy Standard, for utilities such as Xcel, Otter Tail Power, and Minnesota Power, wind energy has become highly cost-competitive compared to other alternatives for new energy sources.

Transmission - As an early adopter of wind power, Minnesota used readily available transmission capacity earlier than other states. A key issue for wind project development has been cost allocation for new transmission lines. In 2010, the Federal Energy Regulatory Commission (FERC) approved the Midcontinent Independent Transmission Service Operator's (MISO) Multi-Value Project (MVP) method of cost allocation for certain large transmission projects that spreads costs across the entire MISO region spanning 15 states plus Manitoba.[21] The CapX2020 project has now invested $1.85 billion in completing four high voltage transmission line projects totaling nearly 725 miles across Minnesota, North Dakota, South Dakota and Wisconsin. A fifth project in eastern South Dakota is scheduled for completion in 2017. These new transmission projects help increase reliability and provide pathways to deliver additional wind and solar energy across the Midwest. To aid planning efforts for all interested parties, Minnesota requires utilities that own or operate transmission lines or substations in the state to report on electric transmission projects detailed on www.minnelectrans.com.

State Policy – Minnesota has enacted a number of policies and incentives promoting wind energy development:

- **Net Metering (1982)**
- **Wind Resource Assessment Program (1983 – 2005)**
- **Property Tax Exemption (1992)**
- **Xcel Renewable Development Fund (1994)**
- **Renewable Energy Mandates for Xcel Energy (1994)**
- **Renewable Energy Production Incentive (1995)**
- **Agricultural Improvement Loan Program (1995)**
- **Sales Tax Exemption (1998)**
- **Sustainable Agriculture Loan Program (2001)**
- **Renewable Energy Objectives (2001)**
- **Accelerated and Bonus Depreciation (2002)**
- **Distributed Generation Report (2003)**
- **Community-Based Energy Development tariff (2005)**
- **State Wind Resource Mapping (2005)**
- **Wind Integration Study (2006)**
- **Renewable Energy Standards (2007)**
- **Dispersed Renewable Generation Study (2007 & 2008)**
- **Minnesota Renewable Energy Integration and Transmission Study (2014)**

Federal Policy - Federal Policy has been an important factor in the timing of wind project development. In December 2015, the Consolidated Appropriations Act of 2016 extended the expiration date for the federal renewable electricity production tax credit (PTC) to December 31, 2019 for wind facilities commencing construction by that date. The PTC is an inflation-adjusted per-kilowatt-hour (kWh) tax credit for electricity generated by qualified energy resources and sold by the taxpayer to an unrelated person during the taxable year. The duration of the credit is 10 years after the date the facility is placed in service for all facilities placed in service after August 8, 2005. There is a phase-down beginning for wind projects commencing construction after December 31, 2016.

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21. FERC, ORDER CONDITIONALLY ACCEPTING TARIFF REVISIONS, December 16, 2010, Docket No. ER10-1791-000, Cite: 133 FERC ¶ 61,221.

b. Solar Photovoltaics

Solar energy production is a small but growing energy source in Minnesota. Statewide solar energy production continues to increase as a result of advances in technology and efficiency, declining equipment costs, federal tax incentives, new utility incentives, and increasing public awareness and support for solar. There is also growing interest in solar energy as a distributed generation source located where the energy is used.

In 2016, Minnesota solar capacity increased sixfold, from 37 to 246 megawatts.

A common misconception is that the amount of sunlight received in an area is based on temperature. In reality, Minnesota has a significant solar resource. In fact, it is about the same as that of Houston, Texas.

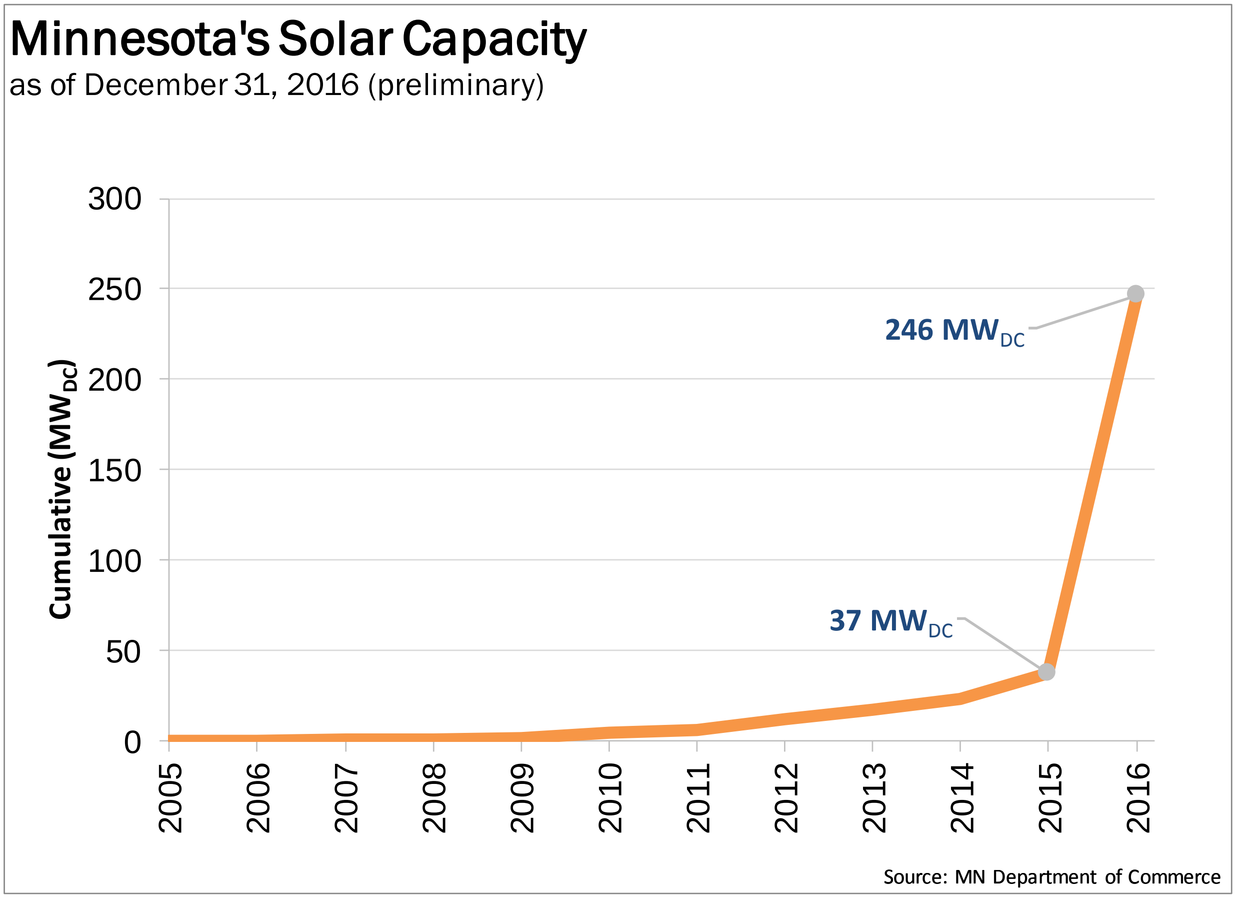
The demand for PV in Minnesota increased rapidly in the last four years as various new incentive programs were introduced to expand the solar market. The Xcel Community Solar Gardens program, the Xcel Renewable Development Fund, and the Made-in-Minnesota Solar Incentive Program offered financial assistance for much of this development, along with other federal and utility incentives.

The cost to install PV technology in Minnesota has decreased from $10 per watt in 2009 to $3-5 per watt in 2016. The recent installed cost reductions are largely attributed to reductions in the price of PV modules.

Additional uses for solar energy

Technology options in Minnesota include photovoltaics (PV) for electricity production and solar heating and cooling (solar thermal), which is commonly used for both water heating and space heating in Minnesota. While the focus of this section is on photovoltaics, passive solar is also an important design consideration that includes special siting, design or building materials to take advantage of the sun's position and availability for direct heating and lighting. Passive solar design also considers the need for shading to protect buildings from excessive heat gain during warm months.

Figure 8: Minnesota's Solar Capacity, 2005-2016



As of December 2016, Minnesota has approximately 246 MW of PV capacity in the state, up from 13.8 MW in April 2013, an increase of about a 1700 percent in less than four years. The amount of electricity produced from solar PV in 2016 was less than 0.1 percent of state generation, but by 2020 the amount of electricity from solar is expected to increase to 1.5 percent of state generation.[22] As shown in Figure 10 below, the amount of PV capacity additions is expected to grow significantly in the next four years. In 2016 alone, Minnesota solar capacity increased sixfold, from 37 MW to 246 MW as utilities add solar capacity to meet the Solar Electricity Standard and as new capacity develops from the Xcel Community Solar Garden program. Some new capacity may also be driven by growth in voluntary market demand for solar energy as demonstrated by emerging green pricing programs, the 2.25 MW Dickenson Solar Project developed by Great River Energy for Wright Hennepin Electric Coop in 2016, and voluntary utility development of community solar.

[22] MN Department of Commerce estimate based on U.S. EIA data and utility resource plans.

Figure 9: Minnesota Annual Solar Installations, 2005-2016

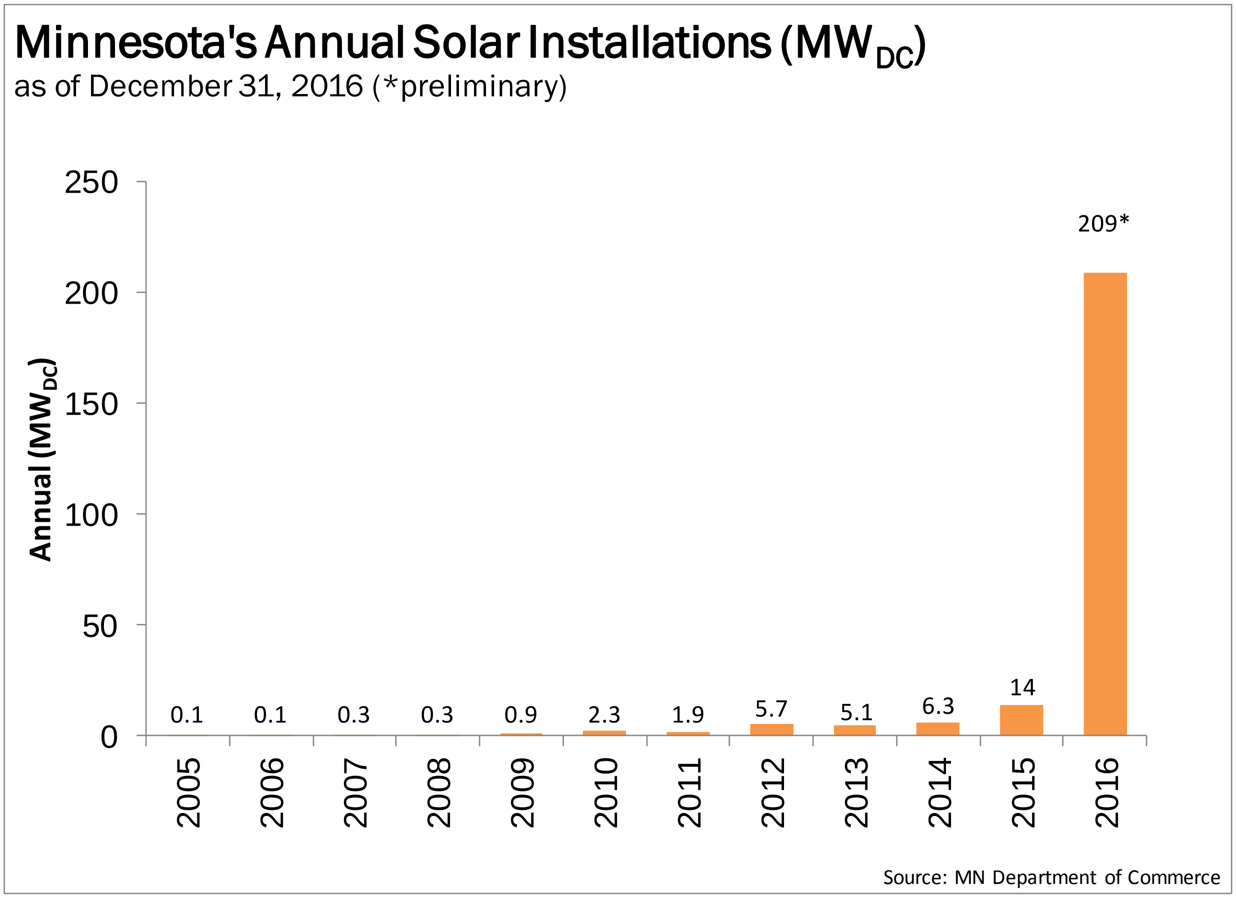
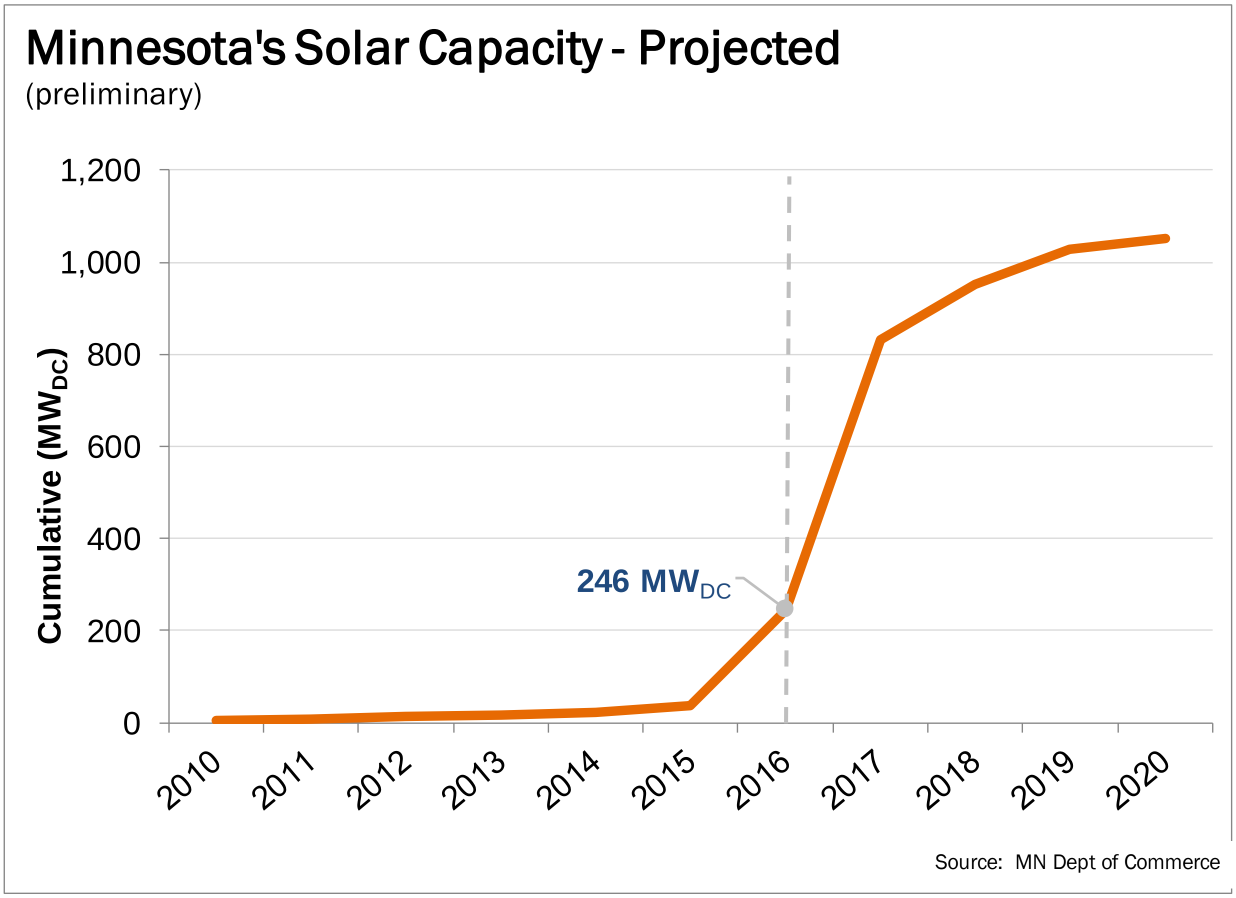


Figure 10: Minnesota's Projected Solar Capacity to 2020



c. Biomass-Based Power

Each Minnesota community has a particular mix of accessible, low-value biomass feedstocks. The supply and cost of available feedstock—such as those from wastewater treatment, food processing, agricultural and forest product residues, municipal solid waste, livestock manures and processing waste, tree and landscape management, and energy crops—vary greatly. While the amount and type of biomass that can be harvested or removed from land can be optimized, its supply is limited. Biomass is being used to produce a range of quality wood products, high-value fuels, food and feed, and heat and power. From 2005 through 2015, total generation from biomass-based feedstocks (including from combustion of wood waste and other bio-solids, landfill methane, and biogas from agricultural byproducts and waste water treatment plants) increased from 1,070 thousand MWh to 1,806 thousand MWh.

Nine landfills are permitted by the Minnesota Pollution Control Agency for biogas-fueled energy production, providing approximately 30 MW in nameplate capacity. Twelve biomass-fueled combined heat and power facilities are permitted in the state which provides more than 135 MW in total capacity.

Table 2: Bioenergy electricity generation by source, in thousand MWh, 2011-2015

Bioenergy Source	2011	2012	2013	2014	2015
'Wood and Wood Derived Fuels	748	839	1,036	1,149	1,177
Other Biomass	932	999	574	614	629
Biomass-based Total	1,680	1,838	1,610	1,763	1,806

Source: U.S. Energy Information Administration, [1990-2015 Net Generation by State by Type of Producer by Energy Source]

d. Hydroelectric Power

According to data obtained from the EIA,[23] hydropower in Minnesota produced 849,054 MWh of power in 2015, up slightly from 840,410 MWh in 2010. Compared to 774,729 MWh in 2005, there's been a modest 10 percent increase over the last 10 years. Costs of maintaining and operating dams compared to other sources of energy for power generation is a primary cause as well as increased concern about the potential negative effect dams can have on Minnesota's river ecosystems. In addition, Minnesota Power's 71 MW Thomson dam was down for repair from 2012 to 2014 due to damage from extreme rainfall and record flooding in 2012.

A 2012 U.S. DOE Report shows the potential for low-impact hydropower at existing non-powered dams along the Mississippi.

Of particular interest to Minnesota, a 2012 U.S. DOE Report shows the potential for low-impact hydropower at existing non-powered dams along the Mississippi.[24] One example of this potential is the 9.2 MW Lower Saint Anthony Falls (LASF) hydro project installed in 2012 at an existing lock and dam near downtown Minneapolis. The LASF project uses run-of-river generation technology that does not require the development of a new reservoir, mitigating impact to existing ecosystems.[25]

Hydrokinetic generation is another emerging area of development. River in-stream energy is derived from the movement (kinetic energy) of water in rivers, streams, and canals. This differs from low-head hydropower systems, which rely on the elevation difference (head) between the intake and turbine. River in-stream devices are placed directly in the flowing water of rivers. Despite a relatively low level of funding and development, hydrokinetic energy could become an economically and environmentally favorable source of distributed renewable energy generation if current cost per MWh projections is achieved.

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[23] 1990-2015 Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923), U.S. Energy Information Administration

[24] "An Assessment of Energy Potential at Non-Powered Dams in the United States," U.S. Department of Energy, 2012

[25] "Minneapolis Hydro Plant Shows Existing Dam Potential," Midwest Energy News, 2012

C. Transmission and Distribution Infrastructure

1. MISO

The day-to-day operation of the electricity system is conducted by the individual utilities and the regional reliability entity, the Midcontinent Independent System Operator (MISO).

After receiving approval from the Commission, Minnesota's four investor-owned utilities (Xcel Energy, Minnesota Power, Otter Tail Power Company, and Interstate Power and Light[26]) joined MISO and transferred functional control (but not ownership) of their transmission facilities to MISO. As an "independent system operator," MISO's operations and activities are subject to the approval of the Federal Energy Regulatory Commission (FERC). Great River Energy, Dairyland Power Cooperative, ITC Midwest, Minnesota Municipal Power Agency, Missouri River Energy Services, Northwestern Wisconsin Electric Company, and Southwest Minnesota Municipal Power Agency also joined MISO.

MISO's primary functions are to monitor the bulk power transmission system and the open-access electricity "market" and develop policies and procedures that ensure that every electric-industry participant has access to the transmission system, and that transmission lines are used to maximize efficiency, minimize congestion, and maintain system reliability.

The Department dedicates significant resources to obtain input from and participate in workgroups within the Organization of MISO States (OMS). These OMS workgroups correspond with MISO workgroup and subcommittees and are very useful for working with other states to provide joint filings to the FERC on the more significant MISO filings. Additionally, the Department collaborates with the Consumer Advocates Sector, which represents the states within the MISO footprint. For instance, Minnesota joined the Joint Consumer Advocates and Large Power Customers to successfully reduce the excessive rate of return on investment that transmission owners were allowed to receive when building certain transmission projects in the MISO region. MISO Advisory Meetings address key reliability, operational, organizational, and infrastructure planning issues of energy resources in the midcontinent region of the United States.

[26] Interstate Power and Light no longer owns transmission facilities in Minnesota and no longer serves Minnesota retail customers. ITC Midwest now owns the transmission facilities of Interstate Power and Light.

2. Transmission Construction and Upgrades

Minnesota's transmission system—the high voltage power lines that transmit electric energy from generation plants to the distribution system—is part of an overall regional transmission grid operated on a coordinated basis with other interconnected transmission systems throughout the Upper Midwest and Eastern United States and Canada.

The 2015 Biennial Transmission Projects Report identifies more than 100 transmission inadequacies in Minnesota in order to support reliability needs and congestion relief.[27]

Historically designed to reliably deliver power to electric load centers such as the Twin Cities metropolitan area, Duluth, Mankato, Rochester, and St. Cloud, and to interconnect utilities for reliability reasons, the transmission grid is now relied on more heavily. It acts as a regional "highway," providing the physical link between sellers and buyers, and facilitates an ever-increasing amount of transactions among an increasing number of market participants, and over increasing distances. At the same time, it continues to serve a critical reliability role.

Transmission is in the spotlight on a state/regional/national basis for four reasons:

1) After decades of the status quo, many new transmission infrastructure additions and upgrades to existing facilities are being proposed and implemented;
2) There remains a number of electric transmission capacity constraints;
3) With states enacting Renewable Energy Standards, there is a need for transmission to deliver renewable energy from its site of generation to consumers; and
4) Electric system configuration changes may be needed due to retirement of coal-fired generating plants and increases in renewable generation, natural gas generation, and distributed generation.

The 2015 Biennial Transmission Projects Report identifies more than 100 transmission inadequacies in Minnesota in order to support reliability needs and congestion relief.[28] Many projects previously identified have been completed since 2011, or are no longer needed due to changes in demand or other factors. Transmission planning in Minnesota involves cooperation and coordination among utilities, neighboring states, and the region's independent transmission system operator, MISO.

As noted above and discussed below, MISO's primary function is to monitor the bulk power transmission system and develop policies and procedures that ensure every electric industry participant has access to the transmission system, and that transmission lines are used to minimize congestion and maintain system reliability. Several Minnesota electric utilities have contracts with MISO to conduct facility studies identifying their transmission needs and potential solutions. A recent MISO study of note is the "Minnesota Transmission Assessment and Compliance Team 2015 Transmission Assessment (2015-2025)" which investigated near-,

[27] *2015 Minnesota Biennial Transmission Project Report.*

[28] *2015 Minnesota Biennial Transmission Project Report.*

mid-, and long-term transmission conditions to determine if existing and planned facility improvements meet NERC Transmission Planning Standards.

In recent years there has been a large number of route permits and certificate of need applications filed and considered by the Commission. It is expected that this relatively rapid pace of expansion will continue.

3. Electricity Transmission Constraints

Typically, large electric generators and consumers of electricity are not located in the same place. In order for the power to be delivered from the place of generation to the place of consumption, transmission line pathways must be developed.

Many major transmission lines into and out of Minnesota are near or at operational limits that could affect reliability.

Eventually, transmission constraints, or bottlenecks, develop in areas where production or demand exceeds the maximum level of power that the transmission line can safely and reliably carry. Bottlenecks limit energy transactions. In turn, this limitation may lead to higher energy costs. More importantly, such transmission constraints can threaten system reliability.

Many major transmission lines into and out of Minnesota are near or at operational limits that could affect reliability. For example, the major transmission lines from Minnesota to states further east tend to be constrained during off-peak hours when demand in Minnesota tends to be low and production of electricity from wind, coal, and nuclear generating units can exceed local demand. Without economically viable large-scale storage solutions, under a constrained transmission system the difference between production and consumption must be exported from Minnesota or production must be curtailed. In addition to constraining existing generating units, this transmission constraint makes it more difficult to add new generation in Minnesota. However, there are transmission lines in the permitting process or that are being constructed that will help address this issue. These transmission lines are expected to be in-service between 2018 and 2023.

Similarly, the transmission system will not, without future upgrades or new additions, support electricity transfers between Canada and Minnesota. However, a transmission line between Minnesota and the Canadian border (called the Great Northern Line) is currently beginning the construction process and will allow additional electricity to move between Canada and Minnesota when it is completed. This transmission line is expected to be in-service in 2020.

4. Potential Electric Transmission Solutions

One way congestion is alleviated is through the construction of additional transmission lines and facilities and by upgrading existing power lines.

Reduced consumption of electricity through energy conservation practices is the least-cost, most effective and efficient tool that electricity consumers can practice. This resource helps manage and/or reduce the demand for the use of transmission facilities.

As noted above, Minnesota's transmission owning entities submit a report every two years identifying inadequacies in the state's transmission infrastructure that need to be addressed to ensure reliable service to Minnesota consumers. The Department actively encourages those utilities to implement actions to resolve the identified inadequacies in a timely manner.

In addition, a variety of demand-side options can also be used to address system congestion. Reduced consumption of electricity through energy conservation practices is the least-cost, most effective and efficient tool that electricity consumers can practice. This resource helps manage and/or reduce the demand for the use of transmission facilities. Timing electricity use so that consumers' demand for electricity is spread throughout a 24-hour period—avoiding so-called "peak" consumption times during the day—can also help alleviate constraints.

In 2015, legislation was passed (Minnesota Statute section 216B.2425, subdivision 8) requiring a public utility operating under a multi-year rate plan to also file, with its biennial transmission planning report, a distribution planning report to "identify interconnection points on its distribution system for small-scale distributed generation resources and [to] identify necessary distribution upgrades to support the continued development of distributed generation resources." The following section discusses the benefits and challenges of distributed generation and other distributed energy resources.

5. Impact of Distributed Energy Resources

If the transmission system is analogous to the interstate highway system, then a hot summer day is like rush hour. The transmission system must be designed to handle peak loads safely and reliably. Just as a five lane freeway may not be needed 24 hours a day, the grid has significant power plant capacity that is used only a small number of hours each year.

Requests for interconnection of Distributed Generation in Minnesota increased more than fivefold over the last five years, from 471 applications in 2011 to 2,674 applications in 2015.

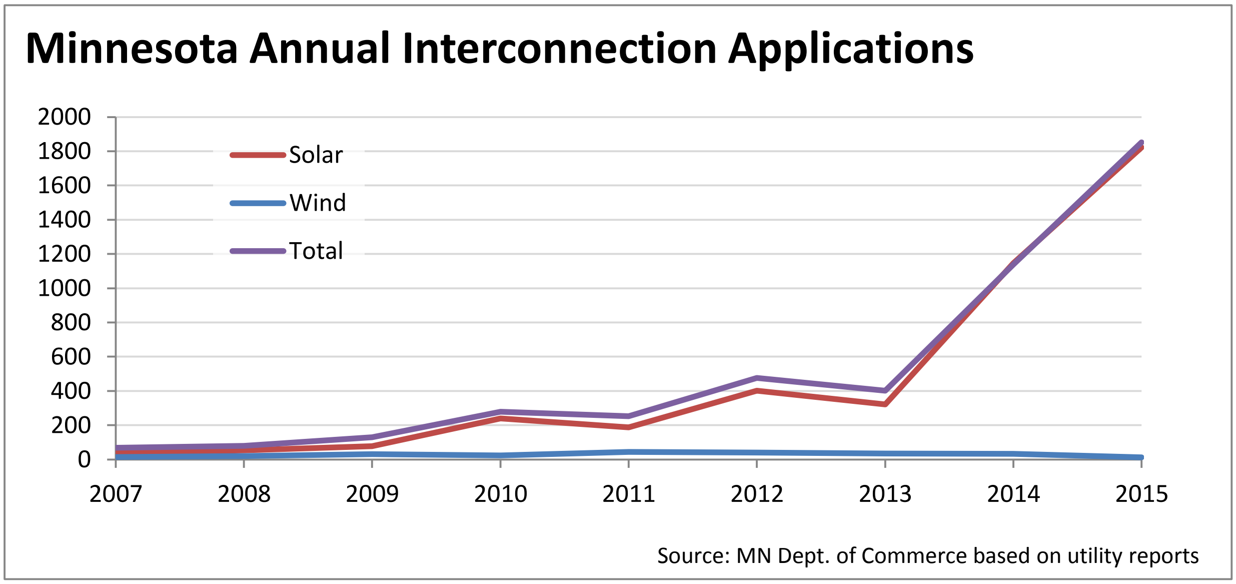
Peak demand has increased more rapidly than average demand over the past ten years in many areas of the country, including the Midwest.[29] If new power plant capacity and transmission are added to meet growing peak load, the system becomes more expensive and less efficient. Alternatively, emerging distributed energy resources, rate designs, and demand response programs can encourage and enable customers to shift energy use for more economical and efficient use of the grid.

Continuing with the highway analogy, the local electric distribution system can be thought of as local streets and roads with a focus on distributing quality electric service to retail customers. Recent and continuing developments in the electric industry are impacting utility distribution systems, including the increase in customer or community-sited generation (a.k.a distributed generation) and increased customer adoption of electric vehicles. Distributed energy resources (DERs) are smaller-scale, decentralized power sources and/or conversion equipment, including renewable energy, cogeneration, demand response, energy storage, and thermal storage that can be combined to balance variable generation and demand. No longer does the network strictly deliver electricity from a large central generation station to end-use customers. Rather, the distribution system is increasingly called upon to enable two-way flows of electricity and information between the customer and the utility grid.

In 2013, legislation was passed establishing Minnesota's Solar Energy Standard (SES). The SES requires electric investor-owned utilities in Minnesota to procure 1.5 percent of their annual retail sales from solar energy by 2020. At least 10 percent of the 1.5 percent goal must be met by energy generated from solar photovoltaic devices with a capacity of 20 kilowatts or less. To help meet the small system requirement, the Legislature authorized funding for a solar electricity production based incentive and solar thermal rebate program known as the Made in Minnesota Solar Incentive program, which helps encourage the development of smaller systems. In addition and to help ensure that more citizens have the opportunity to participate in solar energy, the legislation requires the largest electric utility in the state to offer a community solar garden program, through which subscriptions to solar gardens can be purchased. In response, not only has Xcel developed a Community Solar program, but multiple other utilities have launched voluntary Community Solar programs since 2013. Finally, in accordance with Minnesota Statute section 216B.164, subdivision 10, the Department developed a Value of Solar (VOS) methodology designed to capture the true value, to the utility, the customer and society, of distributed solar generation on a utility's system.

[29] "Peak-to-average electricity demand ratio rising in New England and many other U.S. regions," U.S. Energy Information Administration, 2014.

Figure 11: Minnesota Interconnection Applications, 2007-2015



All of these factors have contributed to an increase in distributed generation and interest in other distributed energy resources. As shown in Figure 11 above, requests for interconnection of Distributed Generation in Minnesota increased more than fivefold over the last five years, from 471 applications in 2011 to 2,674 applications in 2015. As noted in the previous section, Minnesota Statute section 216B.2425, subdivision 8, requires certain utilities to submit biennial distribution planning reports to the Commission. Further, the Commission is holding a series of workshops exploring planning and policy needs for grid modernization, including the ability of "smart grid" technology to facilitate further development of distributed energy resources. One area of technological advance that will enhance and work with smart grid technology is energy storage.

6. Energy Storage

Evolving energy storage technologies, including thermal storage, battery storage, and pumped hydro, vary by their energy storage capacity (MWh), duration, energy density, cycle efficiency, cycle service life, and sustainable power levels (kW) during charge and discharge.

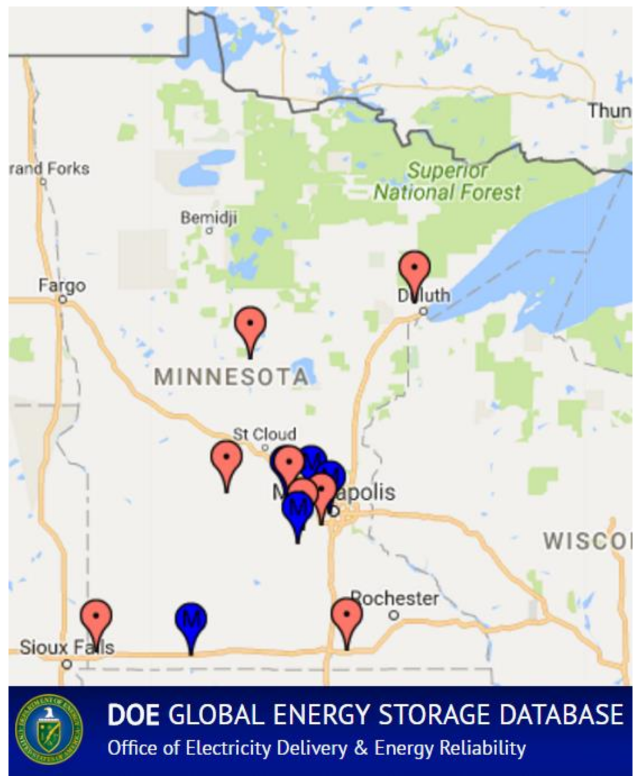
In 2016, utility-owned battery storage made up 75 percent of the U.S. battery storage market. The median cost of using lithium-ion technologies in 2016 decreased versus 2015 by approximately 12 percent for peaker replacement and 24 percent for transmission investment deferral.

As the cost of battery storage has come down, interest in this technology has increased significantly. Lithium-ion technology dominates grid tied battery storage market today (97 percent of capacity in 2016). The 5-year outlook for energy storage is expected to be Li-Ion dominant as well. In 2016, utility-owned battery storage made up 75 percent of the U.S.

battery storage market.[30] The median cost of using lithium-ion technologies in 2016 decreased versus 2015 by approximately 12 percent for peaker replacement and 24 percent for transmission investment deferral, partly attributable to declining capital costs.[31] Utilities seeking generation to replace aging coal plants or balance variable renewable generation on the distribution grid are finding that the flexibility and agility of battery storage make it an increasingly attractive option for strengthening the power grid.[32] An industry report in 2014 predicted that battery storage would begin to replace peaking power plants in 2018.[33] Even beyond price point, the speed-to-market and modularity of deployment could make energy storage an attractive alternative to natural gas peaker plants that take a longer time to permit and build.[34]

Bulk utility-class electrical energy storage systems can be used in a wide spectrum of applications that have unique requirements and economic benefits. The ratings for such systems are typically 200 kilowatts (kW) to 2 MW in energy capacity and 50 kilowatt hours (kWh) to 13 MWh in energy production. Application requirements range from under a minute of power to stabilize voltage and frequency due to power dips and surges, to up to eight hours to reduce peak consumption, follow changing demand, or defer upgrade transmission investments. Fast transient power demands (within fractions of a second) favor use of technologies that can transfer stored energy at a high rate, such as capacitors, superconducting magnetic storage, flywheels, and batteries.[35]

Figure 12: Energy Storage Projects in Minnesota



Source: U.S. DOE Global Energy Storage Database[36]

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30 U.S. Energy Storage Monitor, GTM Research / Energy Storage Association.

31 Levelized Cost of Storage Analysis 2.0, Lazard, December 15, 2016.

32 "The sector favorite: Storage tops utility tech picks for second year running," Utilty Dive, March 1, 2016.

33 "Guide to Procurement of Flexible Peaking Capacity: Energy Storage or Combustion Turbines?" Energy Strategies Group, October 2014.

34 "Energy Storage Teaches Utilities How To Hurry," Forbes, August 2, 2016.

35 Clean Energy Technology Roadmap, Minnesota Department of Commerce, 2009.

36 U.S. DOE Global Energy Storage Database, accessed October 2016.

While select fast responding battery applications are currently competitive with conventional technology in certain markets, "battery life" is more difficult and costly to increase than "battery size."[37] Long period power demands (minutes to hours) favor technologies with a higher level of energy capacity, such as thermal storage, pumped hydro storage, compressed air, or flow batteries.

Thermal Storage in Minnesota

- Otter Tail Power:
  18,000 customers with utility controlled in-floor thermal storage and water heaters, equivalent to 20 MW of peak shifting[38].
- Great River Energy:
  More than 65,000 homes with utility-controlled electric hot water heaters allows capability to shift over 300 MW to off-peak[39, 40, 41]

Utility energy storage technologies allow for:[42]

- System-wide predictability;
- Reduced need to invest in new capacity by providing more flexible use of existing generation capacity and load;
- Minute-by-minute generation/load balance;
- Reduced need to purchase electricity on the spot market or during high peak price times of the day;
- Ability to store inexpensive electricity when demand is low to offset higher cost electricity when the demand is high;
- Avoided wear and tear on relatively high cost peak generation plants;
- Increased line-carrying capacity by improved stability;
- Reduced transmission congestion in areas where systems are becoming congested during periods of peak demand;
- Reduced or deferred utility investments for transmission and distribution system upgrades; and,
- Improved power quality and reliability.

[37] Levelized Cost of Storage Analysis 2.0, Lazard, December 15, 2016.

[38] "Minnesota Energy Landscape," University of Minnesota, Energy Transition Lab, Energy Storage Worskhop, September 23, 2016.

[39] Electric Thermal Storage Water Heating, The Battery in Your Basement, Jeff Haase, Great River Energy, July 15, 2015.

[40] "A battery in every basement': How the lowly water heater could power the smart grid," Utility Dive, February 22, 2016.

[41] 2018-2032 Integrated Resource Plan, Great River Energy, Submitted to the Minnesota Public Utilities Commission, Docket No. ET2/RP-17-286, April 28, 2017.

[42] Clean Energy Technology Roadmap, Minnesota Department of Commerce, 2009.

The rules for energy storage participation in regional wholesale markets continue to be a barrier. MISO first added rules for short-term energy storage in 2009, but participation by energy storage in the Midwest lags behind other regional markets. MISO has worked to address issues identified by stakeholders and identify potential changes to market rules through an energy storage stakeholder process.[43] Additionally, in November 2016, FERC issued a proposed rule that provides stronger direction to regional market operators to create rules for energy storage that recognize "the physical and operational characteristics of electric storage resources," that act as both a load and an energy generation source.[44] The proposed FERC rule also directs grid operators to adjust rules so that distributed energy resource aggregators can compete "under the participation model that best accommodates the physical and operational characteristics of its distributed energy resource aggregation."[45]

Energy Storage Study

The "White Paper Analysis of Utility-Managed, On-Site Energy Storage in Minnesota" report examines the potential costs and benefits of grid-connected electrical energy storage technology located at the utility customer's home or business. The study, completed in 2013 as required by legislation, was commissioned by the Minnesota Department of Commerce and prepared by Strategen Consulting. The report includes an overview of energy storage technologies and applications in Minnesota, including both battery and thermal storage. The study team modeled costs and benefits of battery-based standalone storage and storage integrated with solar photovoltaic (PV) and it considered both residential and commercial customer sites.[46]

The benefits of energy storage are significant when they are fully integrated into the grid so that multiple stakeholders can benefit from it as a system resource. System ownership may be with the utility, independent power producer, or large power consumers. Energy storage will allow all parties connected to the grid to either directly or indirectly share benefits.

D. Renewable Energy Policies

Minnesota has a number of state programs and policies to encourage renewable energy development. The Next Generation Energy Act of 2007 established the energy policy goals of reducing the per capita use of fossil fuel by 15 percent by 2015 through increased reliance on energy efficiency and renewable energy as well as deriving 25 percent of the total energy consumed in the state from renewable energy resources by 2025. The same law established a greenhouse gas reduction goal of 15 percent below 2005 emissions levels by 2015, 30 percent below 2005 levels by 2025, and 80 percent below 2005 levels by 2050.

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[43] "How MISO is reforming market rules to spur storage deployment," RTO Insider, January 26, 2016.

[44] "FERC Proposes to Open up Wholesale Markets for Energy Storage and Aggregation," GreenTech Media, November 18, 2016.

[45] "FERC Proposes to Integrate Electricity Storage into Organized Markets," Federal Energy Regulatory Commission, November 17, 2016.

[46] "White Paper Analysis of Utility-Managed, On-Site Energy Storage in Minnesota,"prepared by Strategen Consulting for the Minnesota Department of Commerce, December 2013.

The Department is involved in the implementation of renewable energy policies such as the Renewable Electricity Standard (generally, 25 percent renewable electricity goal by 2025), green pricing (renewable electricity choice options), and regional certification, tracking, and trading mechanisms for renewable energy, in collaboration with other Midwest stakeholders. It also works collaboratively with the Minnesota Pollution Control Agency on the state's greenhouse gas reduction goals.

1. Renewable Electricity Standard Expanded to include a Solar Electricity Standard

In 2013, the state expanded its existing Renewable Electricity Standard (RES)[47] to include a Solar Electricity Standard (SES) that requires investor owned utilities to obtain 1.5 percent of retail electricity sales from solar electricity by the end of 2020.[48]

The SES includes a 10 percent carve out for small scale solar PV projects of less than 20 kilowatts capacity. The statute also established a goal of obtaining 10 percent of the entire state's retail electricity sales from solar electricity by 2030.

The following three utilities are subject to the SES:

- Minnesota Power
- Otter Tail Power Company
- Xcel Energy

The RES requirements for all electric utilities, except Minnesota Power, Otter Tail Power, and Xcel Energy, are as follows:

- 2012 12%
- 2016 17%
- 2020 20%
- 2025 25%

The RES requirements for Minnesota Power and Otter Tail Power are:

- 2012 12%
- 2016 17%
- 2020 20% + 1.5% solar electricity
- 2025 25% + 1.5% solar electricity

[47] codified in Minn. Stat. § 216B.1691.

[48] Mining and paper mill businesses, some of Minnesota's largest electricity users, may apply for exemption.

Xcel is required to meet the following:

- 2010 15%
- 2012 18%
- 2016 25%
- 2020 30% + 1.5% solar electricity

Table 3: Minnesota RES and SES milestones by utility

Utility	2012	2016	2020	2025
Basin Electric	12%	17%	20%	25%
Central Minnesota Municipal Power Agency	12%	17%	20%	25%
Dairyland Power Cooperative	12%	17%	20%	25%
East River Electric Cooperative	12%	17%	20%	25%
Great River Energy	12%	17%	20%	25%
Heartland Consumers Power District	12%	17%	20%	25%
L&O Power Cooperative	12%	17%	20%	25%
Minnkota Power Cooperative	12%	17%	20%	25%
Minnesota Municipal Power Agency	12%	17%	20%	25%
Minnesota Power	12%	17%	21.5%	26.5%
Missouri River Energy Services,	12%	17%	20%	25%
Northwestern Wisconsin Electric Company	12%	17%	20%	25%
Otter Tail Power Company,	12%	17%	21.5%	26.5%
Southern Minnesota Municipal Power Agency	12%	17%	20%	25%
Xcel Energy	18%	25%	31.5%	31.5%

The Commission uses the Midwest Renewable Energy Tracking System (M-RETS) for tracking compliance with the RES and solar standards. The regional tracking system allows for interstate trading.

Under Minnesota Statute section 216B.1691, subdivision 4(e), Xcel Energy may not sell Renewable Energy Credits (RECs) to other Minnesota utilities for RES-compliance purposes until 2021. Docket E-999/CI- 04-1616 addresses issues that may arise due to changes in national, state, or M-RETS policies and protocols.

While the Commission makes the official determination as to whether utilities are complying with the RES statute, the Department provides a report to the Minnesota Legislature in odd-numbered years summarizing utility compliance. In the report[49] submitted January 15, 2015, the Department noted that all electric utilities were in compliance with the RES and on track to meet goals ahead of schedule.

[49] MN Department of Commerce, Minnesota Renewable Energy Standard: Utility Compliance, January 15, 2015.

Based on the reports and Integrated Resource Plans filed by the utilities, the Department concluded that RES compliance is generally cost-effective.[50, 51]

2. Renewable Energy Credits

The Renewable Electricity Standards (Minnesota Statutes section 216B.1691) and green pricing programs (Minnesota Statutes section 216B.169) create the possibility of a market for renewable energy. Under the notion of RECs, electricity from renewable sources may be treated as an electricity commodity with value attributes that are separate from the value of the energy itself. Many renewable energy contracts between electric utilities and energy producers now contain language specifying the ownership of the RECs. These green credits could potentially be used for green pricing programs, renewable energy standards, and for emissions credits in pollution reduction markets.

The owner and user of a REC is the only party that can claim the environmental benefits of that REC and claim to be using renewable energy because of that REC.[52] Ownership of the REC avoids the potential for double counting of claims.

E. Renewable Electricity Programs

1. Green Pricing Programs

Minnesota's voluntary green pricing program gives consumers the option of purchasing renewable energy beyond the minimum standard set by the state. By paying a premium on their electricity bill, consumers support increased development of renewable energy projects and reduce their reliance on fossil fuels. Increased use of renewable energy sources also benefits the local economy and improves Minnesota's energy security.

The Department regulates green pricing programs (Minnesota Statutes section 216B.169) in the state to protect consumer interests. Renewable energy procured on behalf of green pricing customers cannot be sold twice or counted toward any state's Renewable Energy Standard. Utilities must report on renewable energy procured for green pricing customers to verify that green pricing sales do not exceed green pricing generation. Utilities record RECs for green pricing generation in the Midwest Renewable Energy Tracking System to verify compliance and ensure that the energy is not double-counted.

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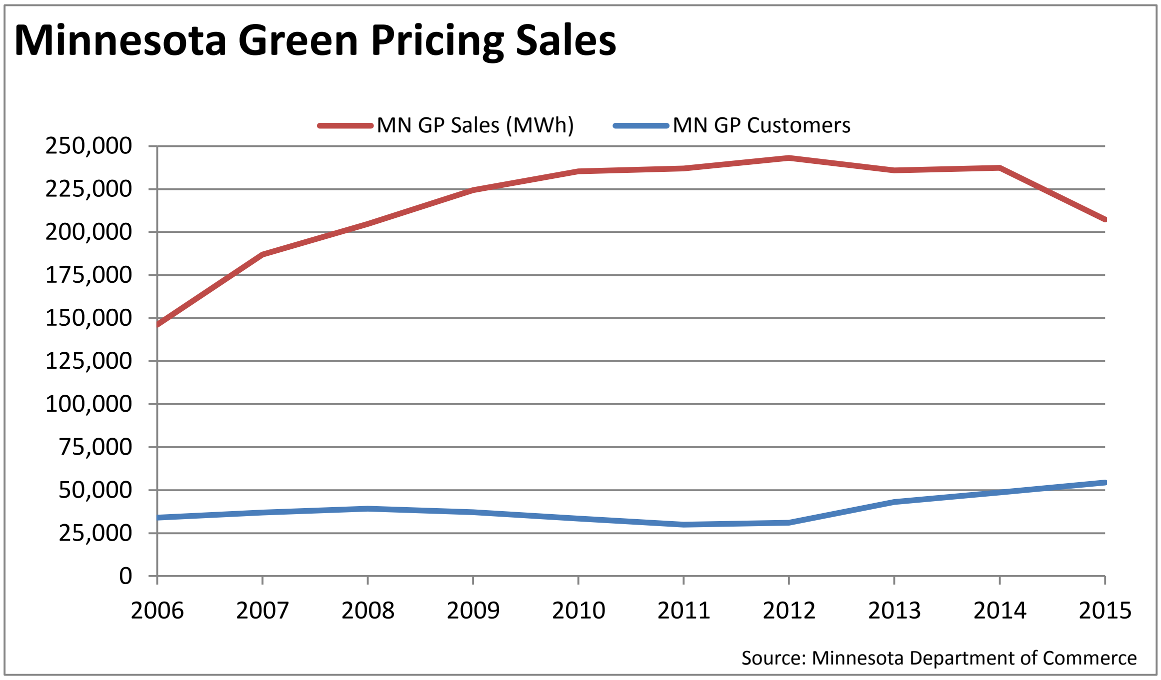
[50] In the Matter of Utility Renewable Energy Cost Impact Reports Required by Minnesota Statutes Section 216B.1691, subd. 2e, Docket No. E999/CI-11-852, Order Establishing Uniform Reporting System for Estimating Rate Impact of Minn. Stat. § 216B.1691, January 6, 2015.

[51] Comments of the Minnesota Department of Commerce, Division of Energy Resources, Docket No. E999/CI-11-852.

[52] Center for Resource Solutions and U.S. Federal Trade Commission, Guides for the Use of Environmental Marketing Claims, 2012.

Figure 13: Minnesota Green Pricing Sales, MWh and number of customers, 2006-2015



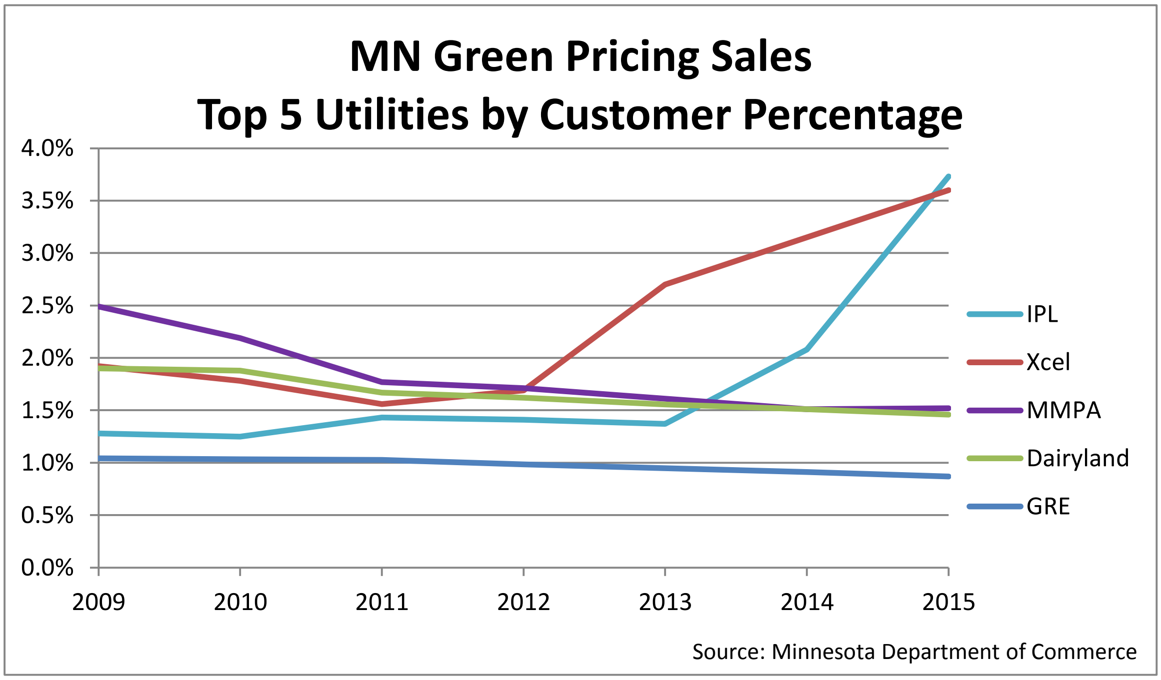
Minnesota green pricing sales for 2015 totaled 207,395 MWh. This is 35,767 MWh less, or 15 percent lower than 2012, largely as a result of lower sales to Xcel's largest WindSource customers. However, the number of green pricing customers has grown by 23,619; an increase of nearly 77 percent from 2012 to 2015.

Over the next few years, the resources used to supply utility green pricing programs will start to reach the end of their power purchase agreement terms, prompting utilities to update their green pricing program design and supply mix. In addition, utilities are developing new green pricing options to better match customer interests.

In 2015, Great River Energy introduced a new green pricing program, ReVolt, to provide customers with green power for new electric vehicles. Also in 2015, Xcel submitted a proposal to the Commission[53] for a new pilot program, Renewable*Connect, using a portion of energy generated by the Odell Wind Farm and North Star Solar Farm that were completed in 2016. This newly designed program would provide 5, 10, and 20-year contracts in response to commercial, industrial, and institutional customers seeking green power with long-term cost certainty and lower cost premiums.

[53] *In the Matter of Xcel Energy's Petition for Approval of a Renewable*Connect Pilot Program*, PUC Docket Number E002/M-15-985.

Figure 14: Top 5 utility green pricing programs by percent of participating customers



Over the past few years, Xcel and Interstate Power and Light (IPL) have seen dramatic increases in the percentage of customers participating in green pricing as a result of improved program marketing.

Figure 15: Top 5 utility green pricing programs as a percentage of total sales

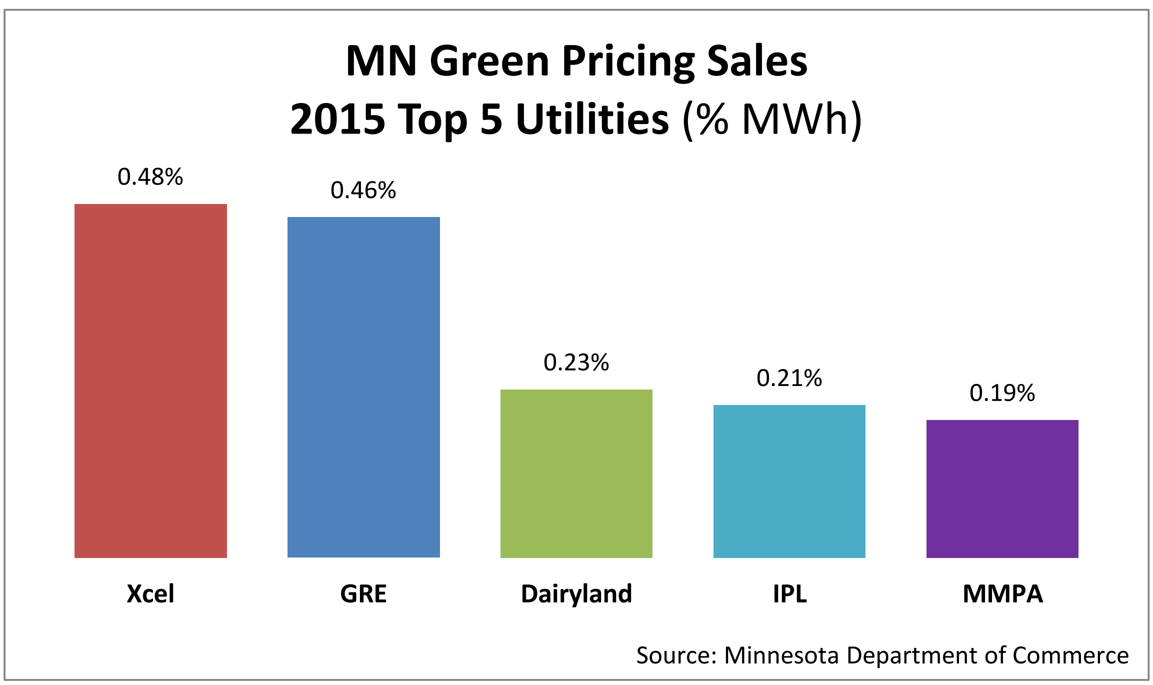


Table 4: Green pricing sales, MWh by utility, 2011-2015

Utility	2011	2012	2013	2014	2015
Basin Electric					193
CMMPA	151	149	172	153	132
Dairyland	2,102	2,039	1,976	1,882	1,836
GRE	52,910	50,093	48,921	49,223	49,627
East River	83	91	104	106	105
IPL/Alliant	2,042	1,964	2,006	1,896	1,679
Minnkota	1,919	1,925	1,883	1,875	1,847
MMPA	3,220	2,996	2,829	2,650	2,653
MN Power	1,744	2,092	1,850	1,721	1,678
MN Valley Coop L&P	226	221			
MRES	924	814	853	813	787
OTP	1,842	1,731	1,627	1,591	1,558
SMMPA	1,298	4,099	3,383	1,506	1,362
Xcel	168,441	174,948	170,185	173,837	143,938
Minnesota Total	236,902	243,162	235,789	237,253	207,395

Source: Minnesota Department of Commerce

Table 5: Green pricing sales, number of customers by utility, 2011-2015

Utility	2011	2012	2013	2014	2015
Basin Electric					17
CMMPA	9	7	14	2	1
Dairyland	560	543	522	507	489
GRE	6,657	6,319	6,088	5,891	5,634
East River	24	22	22	22	18
IPL/Alliant	616	605	588	557	996
Minnkota	424	452	433	379	431
MMPA	873	844	795	743	749
MN Power	657	621	586	539	530
MN Valley Coop L&P	19	18			
MRES	462	445	415	415	394
OTP	328	0	279	265	254
SMMPA	27	31	32	28	28
Xcel	19,195	20,876	33,379	39,271	44,861
Minnesota Total	29,851	30,783	43,153	48,619	54,402

Source: Minnesota Department of Commerce

2. Solar Energy Incentive Programs

On May 23, 2013, Governor Dayton signed the Solar Jobs Act of 2013 into law. The legislation included a transition from capacity–based incentives for solar energy to long-term, performance–based incentives whereby consumers are paid based on the PV system's production in keeping with best practices for market transformation. This structural change to past program design is intended to encourage high performance systems and maximize public benefit. The two required solar programs are described below and may not be combined. In addition, there are several voluntary utility programs.

These programs, voluntary and mandatory, were often combined with federal incentives available. The federal investment tax credit and related incentives were due to expire on December 31, 2016. However, the Consolidated Appropriations Act, signed in December 2015, included several amendments to the tax credits for businesses and consumers which apply to solar technologies. Notably, the expiration date for solar and certain other technology incentives was extended, with a gradual step down of the credits between 2019 and 2022.[54]

a. Made in Minnesota Solar Incentive Program*

The state established the Made in Minnesota Solar Incentive Program (MiM) for consumers in 2013 to help Minnesota meet its solar electricity standard and to catalyze the solar industry for growth over the next decade.

MiM is a solar photovoltaic (PV) and solar thermal incentive program for consumers who install PV and solar thermal systems using solar modules and collectors certified as manufactured in Minnesota. The program is administered by the Department with an annual budget of $15 million for 10 years, including a $250,000 set aside per year for solar thermal rebates. The program is funded with a combination of 5 percent of each public electric utility's total annual Conservation Improvement Program (CIP) budget and the Xcel Renewable Development Fund (RDF).

There are two tiers for certification of crystalline solar modules determined by the specific production processes completed within Minnesota. Incentives for PV are performance-based, established by a system's energy production, and paid over 10 years rather than the historical capacity-based incentive. This structural change to past program design is intended to encourage high performance systems and maximize the public benefit. System size must be less than 40 kW to be eligible.

Solar PV projects must be located in one of three participating investor-owned electric utility service territories, Xcel Energy, Minnesota Power, or Otter Tail Power, and tied directly to an electric meter at the home or business of the host customer of the solar PV installation. Beginning in 2014 through 2023, applications for solar PV and solar thermal are accepted annually from Jan. 1 to Feb. 28 and chosen by a random selection process. However, after all solar thermal applications from IOU customers have been funded, solar thermal applications

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[54] U.S. Dept of Energy, Energy Investment Tax Credit Program Information, Accessed October 28, 2016.

are accepted statewide on a first-come, first-served basis throughout the year until all funds have been committed.

**Note: the Made in Minnesota Solar Incentive Program was repealed in [2017 Laws, Chapter 94, Article 10, section 30]*

Table 6: Made in Minnesota, number of projects by class year

Number of Projects	Commercial				Residential				Tax-Exempt				Totals			Grand Total
	2014	2015	2016	Total	2014	2015	2016	Total	2014	2015	2016	Total	2014	2015	2016	
ALLETE (Minnesota Power)	1	1		2	5	4		9					6	5	0	11
Alliant Energy (IPL)	1	1		2	1	1		2					2	2	0	4
Otter Tail Power Co		1		1	1	2		3	1			1	2	3	0	5
Xcel Energy	24	22	2	48	174	244	55	473	48	18	1	67	246	284	58	588
Grand Total	26	25	2	53	181	251	55	487	49	18	1	68	256	294	58	608

Data as of November 2016

Table 7: Made in Minnesota, kilowatts by class year

Sum of Nameplate Rating (kW)	Commercial				Residential				Tax-Exempt				Totals			Grand Total
	2014	2015	2016	Total	2014	2015	2016	Total	2014	2015	2016	Total	2014	2015	2016	
ALLETE (Minnesota Power)	39	39		78	25	28		53				0	64	67	0	131
Alliant Energy (IPL)	39	26		65	10	10		20				0	49	36	0	85
Otter Tail Power Co		40		40	10	16		26	20			20	30	56	0	86
Xcel Energy	827	599	59	1,485	1,223	1,782	403	3,408	1,749	709	40	2,498	3,799	3,090	502	7,391
Grand Total	905	704	59	1,668	1,268	1,836	403	3,507	1,769	709	40	2,518	3,942	3,249	502	7,693

Data as of November 2016

Table 8: Made in Minnesota, kilowatt-hours by year

Total energy production per utility by sector in kWh	Commercial		Residential		Tax-Exempt		Totals	
	2014	2015	2014	2015	2014	2015	2014	2015
ALLETE (Minnesota Power)		38,079	2,314	24,674			2,314	62,753
Alliant Energy (IPL)		33,833		11,603			0	45,436
Otter Tail Power Co				17,831	242	18,164	242	35,995
Xcel Energy	31,404	560,569	95,285	1,175,077	36,517	1,227,743	163,206	2,963,389
Grand Total	31,404	632,481	97,599	1,229,185	36,759	1,245,907	165,762	3,107,573

Data as of November 2016

b. Utility Run Solar Programs

*Xcel Solar*Rewards Program*

The Solar Jobs Act of 2013 included a requirement for the state's largest utility, Xcel Energy, to develop a performance-based incentive program funded by the Xcel Renewable Development Fund beginning in 2014 for a period of five years.[55] The program is known as Solar*Rewards, the name of the previous capacity-based program that this program replaced in 2014. The

[55] Minn. Stat. § 116C.7792.

annual program budget is $5 million. The program offers incentives to Xcel customers in Minnesota for systems up to 20 kW with a size limit of 120 percent of the customer's on-site annual energy consumption. The incentive is paid over 10 years at $.08/kWh of production and is subject to change based on market conditions with Commission approval.

The new Solar*Rewards program opened in August 2014. In a decision dated March 28, 2014 within Docket 13-1015, the new Solar*Rewards program was approved by the Deputy Commissioner of Commerce.

Table 9: Solar*Rewards applications and capacity from August 2014-December 2015

	Program Year 2014		Program Year 2015	
	Applications	MW	Applications	MW
Completed	163	1.70	170	1.65
Withdrawn	39	0.33	129	1.46
Timed Out	129	2.14	0	0
In Process	0	0	124	1.35

Voluntary Solar Programs

A number of Minnesota electric utilities made the commitment in the past four years to offer incentives for customers who invest in solar. These voluntary programs are meaningful to customers and businesses that would otherwise not make the investment. The programs also signal responsiveness to customer interest in solar. Utilities with solar electric programs include Dakota Electric Association, Austin Utilities*, Owatonna Public Utilities*, Rochester Public Utilities*, Minnesota Power*, New Ulm Public Utilities, and Brainerd Public Utilities. Marshall Municipal Utilities administers a solar thermal program for its customers. These programs are usually funded through the Conservation Improvement Program. [*note: utilities identified with * offer both PV and SWH programs*]

3. Community Solar

Community shared solar or community solar gardens refer to solar projects whereby subscribers receive a bill credit for the electricity generated in proportion to the size of their subscription. Nineteen Minnesota electric utilities have established or are actively developing community solar programs as an option for their customers. The Solar Renewable Energy Credits (SRECS) generated by community solar are owned either by the utility, the developer, or the subscriber based on the agreement. In order for a customer to claim the environmental attributes of solar, the subscriber must retain the SRECS.

a. Xcel Solar*Rewards Community (Required Program)

In 2013, the state required Xcel Energy to develop and administer a community solar program subject to approval by the Commission.[56] Eligible projects may be up to 1,000 kW in size. A community solar project is open to subscribers within the same or a contiguous county where a solar project is located. The minimum individual subscription is 200 watts. Maximum ownership by any one subscriber is 40 percent of the total system size. Subscribers receive a credit on their electricity bill proportional to their subscription ownership. The total capacity of the system is limited to 120 percent of the cumulative subscriber load. The statute placed no limits on the number of community solar projects that can be developed beyond the grid system's technical limitations.

Projects under 40 kW may qualify for the Made in Minnesota Incentive and projects less than 20 kW may qualify for Xcel Solar*Rewards. While only Xcel is mandated to run a community solar program, other investor-owned utilities may elect to develop community solar programs as well subject to approval by the Commission.

Since Xcel launched the program in December 2014, the utility has approved and interconnected four projects (400 kW capacity) of the approximately 2,000 community solar applications received from private developers according to the utility's October 2016 monthly compliance filing. Xcel reported an additional 138 projects (135 MW) in the construction phase within the same report.[57]

b. Voluntary Community Solar Programs

Today, there are 18 known voluntary community solar programs in Minnesota.[58] In most cases, the utility owns and maintains the system and electricity customers subscribe to a portion of the project. Each utility establishes its own subscription prices, and each subscriber chooses the amount of solar electricity. There are additional utility programs being considered for development.

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[56] Minn. Stat. § 216b.1641.

[57] Monthly Update Community Solar Gardens Docket No. E002/M-13-867. October 13, 2016.

[58] Clean Energy Resource Teams. http://www.cleanenergyresourceteams.org/solargardens#current Accessed October 28, 2016.

F. Power Generation and Environmental Protection

Reliable, reasonably priced energy is necessary to sustain modern life and enable a robust economy. The generation and use of electricity, however, can have negative impacts on the environment that must be managed and mitigated. The Department strives to reduce the emissions intensity of electric generation, as well as reduce overall emissions, while keeping rates affordable.

From 2005 to 2015, Minnesota's carbon intensity has decreased 29 percent, at a pace faster than the national average decrease of 20 percent. At this rate, Minnesota is on a path to a carbon intensity below the national average by 2018.

The Legislature, through Minnesota Statute section 216H.02, established the following greenhouse gas (GHG) emission reduction goals: 15 percent reduction from 2005 levels by 2015, 30 percent reduction by 2025, and 80 percent reduction by 2050.[59] Minnesota's Renewable Electricity Standard, the Solar Electricity Standard, the Conservation Improvement Program, and consideration of environmental externality values in resource planning and acquisition decisions will work together with the EPA's Clean Power Plan to help to achieve those goals.

In 2013, the transportation sector surpassed electricity as the largest source of carbon dioxide emissions. In 2014, about 30.7 percent of state GHG emissions were from the generation of electricity and about 31.7 percent of emissions were from transportation fuels.[60]

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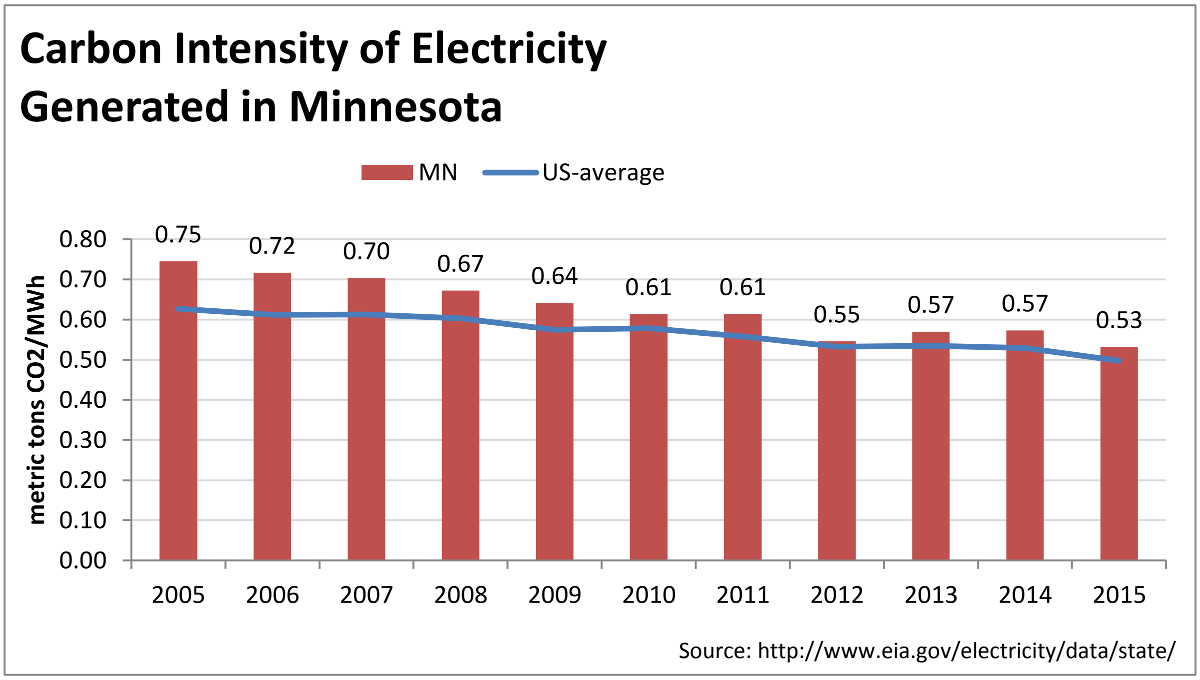
[59] After three years of reporting, Minnesota greenhouse gas emissions are declining, but at a rate that may leave the state short of its reduction goals under the Next Generation Energy Act. Source: Minnesota Pollution Control Agency, Minnesota Greenhouse Gas Inventory.

[60] U.S. Energy Information Administration, Energy-Related Carbon Dioxide Emissions at the State Level, 2000-2013 and State Carbon Dioxide Emissions (2014 Data).

Figure 16: Carbon Intensity of Electricity Generated in Minnesota, 2005-2015



With growing renewable energy capacity, the carbon intensity of electricity generated in Minnesota is decreasing. With 2015 levels at 0.53 metric tons of Carbon Dioxide per Megawatt-hour (tCO2/MWh), Minnesota is slightly above the national average at 0.50 tCO2/MWh, but lower than neighboring states of North Dakota, Wisconsin, and Iowa. Carbon intensity has decreased from 0.75 metric tons in 2005 to 0.53 in 2015, following the trend in decreasing carbon intensity across the US overall. From 2005 to 2015, Minnesota's carbon intensity has decreased 29 percent, at a pace faster than the national average decrease of 20 percent. At this rate, Minnesota is on a path to a carbon intensity below the national average by 2018.[61] Older coal-combustion electric generation facilities contribute a significant portion of the criteria pollutants produced in Minnesota; however, several units are on track to be retired.

G. Summary

Readily available, reliable, clean and competitively priced electricity is critical for the economic vitality, public health, and well-being of all Minnesotans. Because it has no natural deposits of coal, natural gas, or oil products, state policy makers have a long history of supporting local, efficient, and clean electricity to reduce dependence on, and offset economic and environmental effects from, fossil fuel imports.

[61] Analysis based on U.S. Energy Information Administration, 1990-2005 U.S. Electric Power Industry Estimated Emissions by State (EIA-767, EIA-906, EIA-920, and EIA-923) and 1990-2015 Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923). 2015 emissions for neighboring states: North Dakota (0.83 tCO2/MWh), Wisconsin (0.72 tCO2/MWh), Iowa (0.69 tCO2/MWh), South Dakota (0.28 tCO2/MWh).

Ensuring that Minnesotans have reliable, reasonably priced and environmentally sensitive electric service is one of the guiding principles of Minnesota's energy policy and will remain among the Department's top priorities in the coming years. The Department, in concert with other state agencies and interested persons, proactively seeks to preserve and enhance the reliability and quality of the electric system in Minnesota in a cost-effective manner while continuing efforts to mitigate environmental impacts, including conservation, demand-side management, and renewable energy efforts. The Department will continue to provide independent review and analysis of utility plans and assumptions to ensure that operations, maintenance, and system control measures are demonstrably adequate and cost-effective.

Additionally, the Department will continue to foster effective investment in transmission, distribution, and generation infrastructure so that it will be able to handle peak demands and permit the economic and physical flow of power from where it is generated to where it is needed. Reasonably priced, reliable power is critical to Minnesota's economic and social well-being and the Department is dedicated to the task of providing policy makers and regulators with the independent analysis needed so that the economic consequences of issues under consideration are clearly communicated and informed decision making can occur.

NATURAL GAS

Domestic natural gas markets and corresponding prices have changed dramatically over the past several years. Although conventional natural gas production and natural gas imports have decreased, advances in other ways of natural gas extraction, such as horizontal drilling and hydraulic fracturing or "fracking," have allowed access to large volumes of shale gas that were previously uneconomical to produce, resulting in an increase in natural gas production in the United States and Canada.

These developments in unconventional production have created large natural gas supply surpluses despite increases in natural gas demand. The increase in consumption is expected due to the growing use of natural gas to produce electricity and for other industrial uses. The role of natural gas in electricity production has spurred planning entities such as MISO to consider how natural gas and electricity systems need to work better together.

As the future of natural gas is considered, there are issues that warrant focus. These issues can be categorized into four general areas, each discussed below.

- Increasing Demand
- Supply Availability
- Price Volatility
- Service Quality and Reliability

A. Demand – Changing Consumption Patterns

Natural gas consumption in the residential and commercial sectors is influenced primarily by weather. If winters are mild, use of natural gas to heat homes and businesses normally decreases; if winters are severe, weather-related consumption is higher. However, natural gas consumption is also affected by the general level of economic activity and the relative prices of natural gas and alternative fuels. Consumption of natural gas, or demand, is projected to increase in the near term.

Propane is a common alternative heating fuel in Minnesota. However, circumstances have sometimes created propane shortages, endangering lives and pocketbooks. For instance, in 2013/2014, a late-maturing corn crop in Minnesota increased demand for propane at the same time as severe winter weather increased heating demand. In response, Governor Mark Dayton declared a propane emergency and encouraged natural gas utilities to extend service to currently unserved areas. Certain statutory changes have allowed natural gas utilities to charge all customers a portion of the cost of extending service to new or underserved areas.[62]

Statewide, Minnesotans consumed a total of 432 billion cubic feet of natural gas in 2015, a decrease from the exceptionally high level of 475 billion cubic feet in 2014.[63] The high consumption in 2014 (and the end of 2013) was due to the "polar vortexes" in January and February 2014, when weather was exceptionally cold, even for Minnesota.

As shown in Table 13 and Figure 17 of Appendix B, there are three notable consumption trends. First, over time, more natural gas is being used for electric generation. During the energy crisis in the middle and late 1970s, use of natural gas for electric generation declined sharply. Recently, however, natural gas has been used at higher rates to generate electricity. One of the reasons for turning to natural gas as a fuel source for electricity is that gas-fired plants have fewer harmful environmental effects than other traditional fossil fuels, such as coal or fuel oil. Another reason is that natural gas-fired electric generation is more flexible than coal-fired generation because it can be brought on- and off-line quickly. A third reason is that the cost of natural gas relative to other generation resources has materially decreased in recent years.

The second notable consumption trend in Minnesota is the significant increase in natural gas used by industrial customers. The increase in natural gas used by this sector dominates the overall trends in Minnesota, overriding the decreases in natural gas use per customer by residential customers. (Table 13 and Figure 17 show the high level of natural gas use by residential customers in 2014, due the "polar vortexes" at the beginning of 2014.)

Thirdly, as shown in Figure 17 below, after removing the effects of weather, residential consumption of natural gas per customer has declined from 161.6 thousand cubic feet per year in 1965 to 88.06 thousand cubic feet per year in 2012 (or approximately 45 percent over the last 47 years).[64] One of the reasons for this trend is the increased efficiency of household gas-fueled appliances as well as the construction of energy-efficient new housing as specified by building code requirements.

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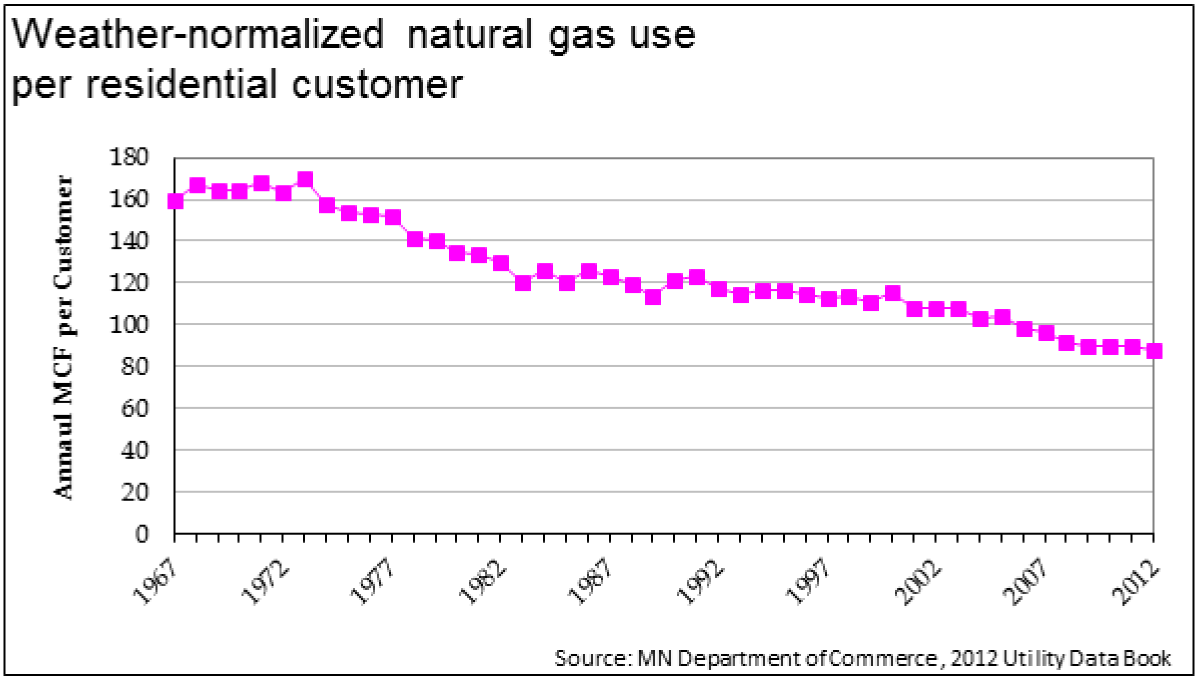
[62] See Minn. Stat. § 216B.1638.

[63] U.S. Energy Information Administration, Natural Gas Summary Data.

[64] MN Department of Commerce, 2012 Utility Data Book, page 132.

Figure 17: Weather-normalized natural gas use per residential customer, 1967-2012



Total residential natural gas consumption in Minnesota grew from 89,020 million cubic feet in 1967 to 117,586 million cubic feet in 2015; on a per-customer basis, natural gas consumption has declined as indicated above. Commercial consumption of natural gas grew from 63,740 million cubic feet in 1967 to 93,004 million cubic feet in 2015. EIA's 2016 Annual Energy Outlook (AEO2016) projects an increase in natural gas consumption to 34.4 trillion cubic feet (Tcf) by 2040.[65]

According to the EIA, the largest potential near-future increase in the use of natural gas will come from electric generation. This trend is only starting to be evident in Minnesota, as shown in Appendix B. At a national level, natural gas consumption for electricity generation increased from 6.85 Tcf in 2008 to 9.61 Tcf in 2015, an average annual growth rate of approximately 8.1 percent .[66] The projected path of natural gas consumption depends almost entirely on the amount consumed in the electric power sector and other large customers such as industrial and commercial customers.

B. Supply Availability

A discussion of natural gas demand is not complete without a corresponding discussion of natural gas supply. Because Minnesota has no native source of natural gas supplies, Minnesota utilities must obtain natural gas from other locations through interstate pipelines. Currently, these interstate pipelines enter the state predominately from Canada, the Mid-

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65 *http://www.eia.doe.gov/forecasts/archive/aeo11/IF_all.cfm#propspectshale*.

66 http://www.eia.gov/forecasts/aeo/pdf/0383(2016).pdf.

Continent and Gulf Coast states, and North Dakota. Nationally, net imports are expected to decline as a percentage of U.S. natural gas supplies, from 13 percent in 2008 to 0.7 percent in 2035.[67]

Natural gas is critical to the U.S. economy and security as a fuel source for residential home heating, industrial processing, and electric generation. Thus, more attention will continue to be focused on potential sources of natural gas supplies to meet such demand. As of 2013, the EIA states there is 2,277 Tcf of technically recoverable U.S. (domestic) natural gas resources waiting to be tapped, an increase of 164 percent from the 862 Tcf level reported in the prior quadrennial report.[68]

According to EIA's AEO2016, total U.S. dry natural gas production will grow in the reference case from 27.2 Tcf in 2015 to 42.1 Tcf in 2040. The percent of total U.S. production coming from shale gas production will increase from 50 percent in 2015 to 69 percent in 2040. The environmental impacts of shale gas production, along with changes in market conditions, may alter projections going forward.[69]

C. Price Volatility

In the AEO2016 reference case, lower 48 wellhead prices for natural gas are projected to slowly rise from current levels, which are in the $2 to $3 per Mcf range, to an average of approximately $5.00 per Mcf (2015 dollars) in 2040.[70] Figure 18 below reflects the average price per Mcf paid for natural gas by Minnesota consumers served by regulated natural gas companies.

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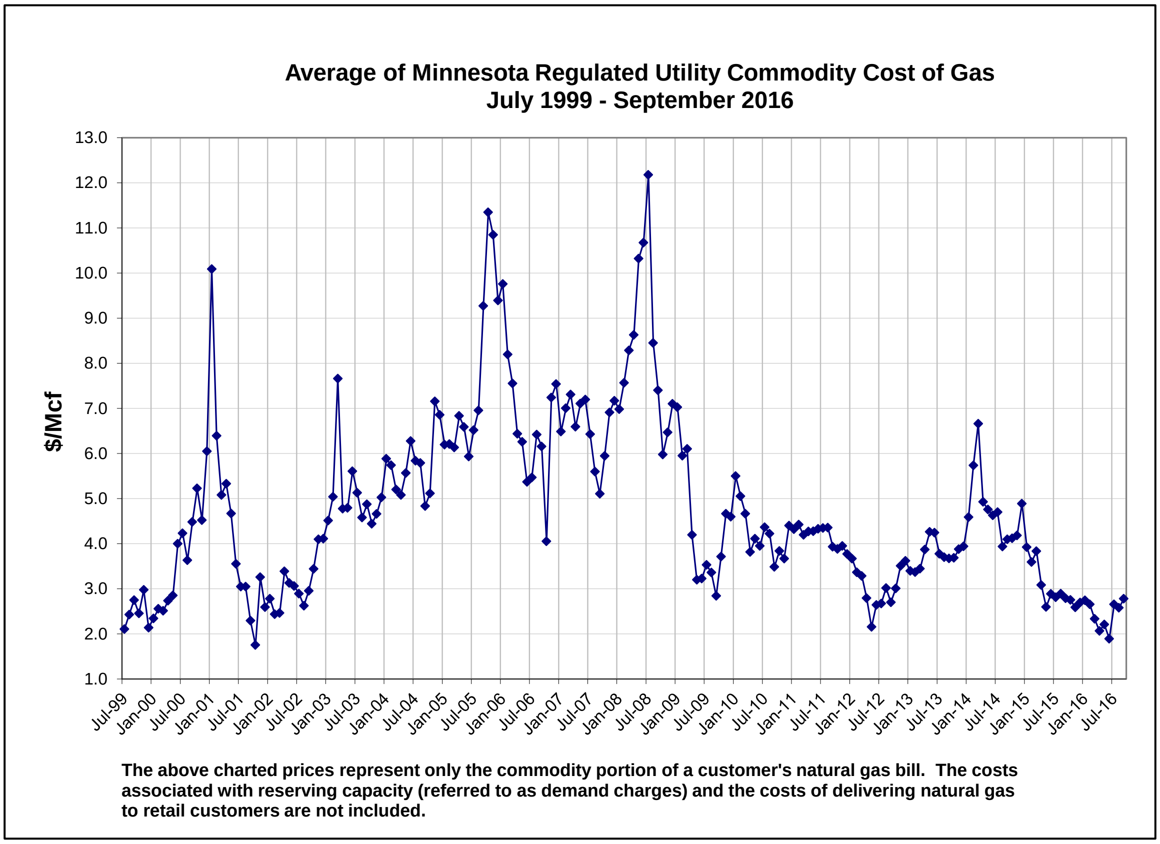
[67] *http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2011&subject=0-AEO2011&table=13-AEO2011&region=0-0&cases=ref2011-d020911a*.

[68] U.S. Energy Information Administration (EIA), Analysis and Projections for World Shale Resource Assessments. Accessed on November 15, 2016.

[69] Annual Energy Outlook 2016 with projections to 2040, Accessed Nov. 30, 2016, Page A-1 and Page ES-5.

[70] Annual Energy Outlook 2016 with projections to 2040, Accessed Nov. 30, 2016, Page ES-4.

Figure 18: Average of Minnesota Regulated Utility Commodity Cost of Gas



As seen from Figure 18, natural gas prices can be quite volatile, although prices have become less volatile since 2008. Nevertheless, several local distribution companies (LDCs) in Minnesota have received approval from the Commission to use financial tools to combat price volatility. There are a variety of financial tools that can be used to stabilize prices for the end-use customer. One way price stabilization is achieved is by entering into financial futures contracts and options through an exchange (e.g., NYMEX). Financial tools also can involve entering into physical hedges with suppliers and other third parties. The purpose of these tools, whether considered to be future contracts or physical hedges, is to reduce the risk of ratepayers paying high prices due to unexpected market shocks such as hurricanes in the oil-producing regions of the United States. Thus, LDCs use these tools to mitigate price risk and volatility.

D. Service Quality and Reliability

In 2010 and 2011, the Commission established comprehensive natural gas service quality reporting standards for the six regulated LDCs operating in Minnesota. The utilities file annual service quality reports detailing performance on such metrics as the number and type of customer complaints, involuntary service disconnections, gas line mislocates resulting in damage to the line, and gas service interruptions. This information has been helpful to assess each utility's ability to meet customer service expectations and continue to provide safe, reliable natural gas service in Minnesota.

E. Summary

The overall domestic demand for natural gas has continued to grow, as has the domestic supply, through the new methods of gas production. There is a need to develop infrastructure to further develop these new supplies, but Minnesota is well positioned in this regard as it has been the recipient of significant investment by Northern Natural Gas (NNG), the largest interstate pipeline in Minnesota, to improve and expand interstate pipeline capacity. Although increased shale gas production has resulted in lower prices, the natural gas market remains dynamic and potentially volatile. Unexpected changes in regulation of natural gas production, unconventional gas well production levels, or the export of domestically produced gas into the global market may push prices higher in a relatively short period of time. Finally, the safe and reliable delivery of natural gas in Minnesota is assured through close monitoring of our LDCs' customer service performance.

TRANSPORTATION FUELS

A. Overview

Minnesotans consumed a total of 115.6 million barrels (4,855 million gallons) or the equivalent of 607.8 trillion BTUs of total petroleum products in 2014. Since Minnesota has no oil reserves, Minnesota imports all of its petroleum products in the form of crude oil or finished product.[71]

In 2013 the transportation sector surpassed electricity as the largest source of carbon dioxide emissions in Minnesota.

In 2014, the transportation sector in Minnesota consumed approximately 23.5 percent of the state's total energy consumption. The majority of petroleum products consumed in Minnesota are for air, land, and water transportation. These products include asphalt and road oil as well as transport fuels like diesel, jet fuel, and motor gasoline. Most agricultural use of petroleum falls under the transportation category[72].

In 2013 the transportation sector surpassed electricity as the largest source of carbon dioxide emissions in Minnesota. In 2014, 31.7 percent of emissions were from transportation fuels and

[71] U.S. Energy Information Administration, Table CT3. Total End-Use Energy Consumption Estimates, 1960-2014, Minnesota.

[72] U.S. Energy Information Administration Profile Analysis, Accessed Nov. 30, 2016.

30.7 percent of state GHG emissions were from the generation of electricity.[73]In 2014, Minnesotans spent $11 billion on transportation fuels, the majority of which were imported from out of state.[74]

Refineries

Minnesota does not have any crude oil production, but it does have two oil refineries. Much of the crude oil processed at these refineries comes from Canada.

Minnesota has the largest oil refinery located in a non-oil-producing state.

The Pine Bend Refinery, located in the Twin Cities suburbs, is one of the top processors of Canadian crude oil in the United States. The Pine Bend Refinery is the largest oil refinery in Minnesota, and it is also the largest of all oil refineries located in non-oil-producing states. The Pine Bend Refinery produces motor gasoline, diesel fuel, propane, butane, and jet fuel for markets throughout Minnesota and the Upper Midwest. The refinery also supplies asphalt, heating fuels, and sulfur for fertilizers. Minnesota's other refinery is the St. Paul Park Refinery, located along the Mississippi River. St. Paul Park became Minnesota's first oil refinery when it was relocated from Texas in 1939. The refinery has been expanded over the years and now produces a variety of products refined from sour and sweet crude oils from the United States and Canada, including motor gasoline, diesel fuel, jet fuel, and asphalt[75].

Fuel Transport

Most petroleum products enter and leave Minnesota by pipeline. Some are transported by barge, rail, ship, or truck. All but a small portion of the United States' imported Canadian crude oil and liquid petroleum gases (LPG) pass through Minnesota on their way to other parts of the Midwest, Eastern Canada, and New England.

Refined petroleum products are available in Minnesota through area refineries or via pipelines. Electric utility and other industrial customers then use barge, rail or trucks to transport the finished products to their individual locations. Smaller volume customers, such as farms, homes, and gas stations, receive their petroleum products via truck delivery.

Several pipeline systems bring crude oil from Canada and the western United States into Minnesota. The Clearbrook terminal in northwestern Minnesota is now a key distribution point, supplying crude oil to refineries in Minnesota, Wisconsin, and beyond. Pipelines that can carry one-seventh of the petroleum used in the United States converge in Clearbrook, Minn. Additional pipelines cross the state, distributing petroleum products from refineries in Minnesota and other states. [76]

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[73] U.S. Energy Information Administration, Energy-Related Carbon Dioxide Emissions at the State Level, 2000-2013 and State Carbon Dioxide Emissions (2014 Data).

[74] U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota.

[75] U.S. Energy Information Administration Profile Analysis, Accessed Nov. 30, 2016.

[76] U.S. Energy Information Administration Profile Analysis, Accessed Nov. 30, 2016.

Pricing

The price of petroleum products is largely comprised of the basic cost of crude oil, processing, transportation, and assessed taxes. World political and economic market forces primarily determine the cost of crude oil. Federal and state governments assess taxes on petroleum products.

Many factors influence the other aspects of the price of finished petroleum products. Some price changes are due to supply and demand imbalances. For example, supply shortages sometimes occur due to maintenance, damage on the pipelines or at refineries, or increased consumption in developing markets, such as India and China. Since each petroleum product needs to be stored individually, some supply shortages result from simple logistical problems associated with coordinating production and storage to meet current and future demand.

Higher than expected demand for a particular product can also create temporary shortages that lead to higher prices. Very cold weather increases the heating use of heating oil, natural gas, and propane products and very wet weather generally increases the agricultural use of petroleum products for grain drying.

Activity in the commodities market can further influence price changes. Spikes or sudden drops in prices are sometimes the markets' response to perceptions of future supply and demand imbalances. Over the past 30 years, the cost per barrel of crude oil reached a peak price around the $145 per barrel mark in July 2008 and declined to under $30 per barrel in January/February 2016. The price has varied up and down within this range during the time period 2008 to 2016. These crude price fluctuations have translated into variable prices at the gas pump up to or above $4 per gallon during early summer 2008 and again by early summer 2011, 2012, and 2013. Consumption is impacted by increased or decreased price.

Motor gasoline accounts for almost half of the petroleum consumed in Minnesota. Overall Minnesota's per capita petroleum consumption is slightly less than the national average (less than 3 percent of the state's households heat with fuel oil or kerosene).

Supply

One factor that impacts the price of petroleum products is supply. Crude oil is necessary for the production of petroleum products. The world's annual supply of crude oil depends on the interplay of many complex factors including demand, weather, politics, technology, and economics. In 2014, the total world consumption of crude oil was estimated at approximately 92.5 million barrels per day.[77] Scientists estimate that ongoing natural processes create new crude oil at the rate of 7 million barrels per year. These numbers indicate an eventual depletion of the available crude oil, although it may be possible to find or manufacture new sources and substitutes for these products.

New sources of oil have come from the tar sands in Alberta, Canada, and oil sands in the Bakken formation underlying large areas of northwestern North Dakota, northeastern

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[77] *EIA at: Total World Petroleum Consumption.*

Montana, southern Saskatchewan, and southwestern Manitoba. Development of these tar and oil sands ramped up in 2009 as other supplies declined and prices increased. While this means that the United States may get more of its oil from Canada and domestically in future decades, it may also come with a larger environmental price. Extracting this oil requires more energy than conventional drilling, which means more greenhouse gases before the oil even reaches the pump. Also, opposition to drilling, fracking, pipelines, and rail transport of the crude oils may impede development.

As with natural gas and electricity, the available infrastructure such as ocean shipping and pipeline capacity also has a large impact on petroleum prices. Higher prices for petroleum, however, allow development of lower grades of crude that were previously too costly to produce.

Four trends may impact the price of petroleum products.

- First, in the 1990s, crude oil and refined petroleum products, like natural gas, became publicly traded commodities on world mercantile exchanges. During times of actual or perceived supply disruptions or shortages, prices now fluctuate more erratically.
- Second, nearly every major international oil company and most independent marketers are forming E-commerce sites to trade commodities independently. Their effect on energy prices and supply will depend largely on which sites survive.
- Third, petroleum refiners significantly changed their operations in the 1990s. They reduced refining costs by moving toward just-in-time production. Storage is now more in the control of independent terminal and pipeline operators.
- Finally, international demand has increased due to the expansion of overseas markets, particularly in India and China.

In 2015, U. S. net imports (imports minus exports) of petroleum (crude and petroleum products) from foreign countries were equal to about 24 percent of U.S. petroleum consumption, the lowest level since 1970. This is down from 49 percent in 2010, 58 percent in 2007, 60 percent in 2006 and 60 percent in 2005. Our largest sources of net crude oil and petroleum product imports were from Canada and Saudi Arabia. Much of the crude oil that is fed into refineries in Minnesota is delivered by pipelines from Canada. However, since political pressures in all oil producing areas impact the market, Minnesotans are not insulated from price fluctuations due to political and economic unrest.

B. Supply Reliability

Limitations on production and supply infrastructure will continue to be a challenge for the industry throughout the country.

1. Refinery Operating Practices

Inventories of petroleum products are often maintained on a "just-in-time" basis. That is, refineries are operated at or near the lower operational inventories for all products. This results in a market that is not as capable of adjusting to significant changes in demand. Some areas of the state are more adversely affected during these times of product shortfalls. Low inventories often cause price increases, as retailers are forced to try to curb demand in order to have sufficient product to get through these periods.

2. Commercial Drivers' Hours of Service

The Federal Motor Carriers Safety Administration has rules concerning the maximum number of hours that commercial drivers who deliver petroleum products may operate a vehicle. These rules require all drivers to account for the amount of time that they are actually waiting for product to be loaded in their vehicle towards their hours of service allotment.

During periods of high demand for all petroleum products, which includes gasoline, diesel, home heating oil, and propane, drivers oftentimes need to drive longer distances and encounter long truck-filling wait times. These occurrences may cause drivers to approach their maximum hours of service without satisfying the demand for those fuels. Fuel suppliers may choose to have additional drivers on hand to satisfy these periods of peak demand, although employing additional drivers may lead to increases in delivered fuel prices. In times of extreme hardship, Minnesota's Governor has the authority to extend drivers' allowed hours of service.

3. Seasonal Demand Fluctuation

September is typically a time of reduced demand for petroleum products, because the peak summer driving season comes to an end. However, generally at this same time there is a demand for diesel fuel for the autumn harvest and transport of crops to market. Also this is the time of year when a spike in demand for fuel oil and propane occurs for the heating season’s “first fill” of heating fuel. Petroleum refineries in the United States tend to choose September or later winter months when there is a lower than normal demand for products as the time to schedule routine maintenance for critical equipment, known as refinery turnaround. In the late autumn to midwinter in 2011-2012, Minnesota experienced a considerable shortage of diesel and heating fuel oil. Fortunately this period of time had a reduced demand for heating fuel because it was one of the mildest winters on record in the state of Minnesota and surrounding states.

Similarly, in the autumn to late winter of 2013-2014, the Midwest experienced what was referred to as the “perfect storm” of events which created a prolonged propane supply emergency. Some of the contributing factors to this event were a very large corn harvest occurring simultaneously in many of the upper Midwest states, a high demand for propane for corn drying, a temporary shutdown of the Kinder Morgan Cochin propane pipeline which supplied about 40 percent of Minnesota’s propane demand, first fill of propane for space heating, and the onset of a prolonged very cold winter referred to as a “polar vortex.” These events necessitated many actions by states and industry to satisfy needs across the region. Propane prices spiked with highs of $6 per gallon reported. That propane event prompted passage of legislation, increased industry investment in propane infrastructure, and promotion of “summer fills” to utilize the large volume of existing end-user storage facilities to best advantage.

Scarce petroleum inventory issues introduce increased price uncertainty and less supply resilience into the market. There is less flexibility in the supply chain to buffer the market from supply disruptions such as refinery fires or even routine maintenance. Where these events used to cause regional disruptions in supply and price, they now cause upward price pressures on all areas of the country, not just those affected by infrastructure changes. These factors, combined with the ongoing political unrest in many petroleum exporting countries, underscore the importance of diversifying transportation fuel supplies in order to decrease Minnesota's dependence on factors outside the state's control.

C. Alternative Fuels and Advanced Vehicle Technologies

1. Ethanol

Ethanol is an alternative fuel made from a variety of plant-based feedstocks collectively known as "biomass." Fuel ethanol contains the same chemical compound as beverage alcohol. It is produced by fermenting sugar from starch crops, almost exclusively corn in the Midwest, or found in plants like sugar cane. Ethanol can also be made from cellulosic materials, such as grass, wood, crop residues, or newspapers. Minnesota's fueling stations are required to sell E10, a blend of 10 percent ethanol with gasoline for use in gasoline powered engines. Ethanol is also available in Minnesota in mid- and high-blends ranging from E15 to E85. These blends are for use in flex-fuel vehicles (FFVs). FFVs are manufactured by many major domestic vehicle manufacturers and designed to operate on gasoline, E85, or a combination of the two fuels. Based on registration records, there were approximately 400,000 FFVs registered in Minnesota in 2015.

In 2003, legislation was enacted requiring all of Minnesota's gasoline to be blended with 10 percent ethanol under certain conditions (239.791). In addition, in 2013, a statute aimed at the promotion of petroleum replacement (239.7911)was amended with the goal that at least 14 percent of the liquid fuel sold in the state be derived from renewable sources by 2015, and at least 30 percent of the liquid fuel sold in the state be derived from renewable sources by 2025.

The EPA granted two partial waivers that allow but do not require the introduction into commerce of gasoline that contains greater than 10 volume percent (vol%) ethanol and up to 15 vol% ethanol (E15) for use in model year (MY) 2001 and newer light-duty motor vehicles, subject to certain conditions. On October 13, 2010, EPA granted the first partial waiver for E15 for use in model year 2007 and newer light-duty motor vehicles (i.e. cars, light-duty trucks and medium-duty passenger vehicles. In 2011, EPA granted the second partial waiver for E15 for use in model year 2001 and newer light-duty motor vehicles.

The number of E85 fueling stations fluctuated in the last four years, but Minnesota continues to lead the nation in the number of E85 retail stations in operation. In 1997, there were approximately seven E85 fueling stations in Minnesota. Ten years ago, there were 287 E85 fueling stations in the state.[78] As of September 2016, Minnesota was home to 309 E85 fueling stations, up from 289 in 2015, but down from 357 four years earlier.

Demand for mid-ethanol blends has grown substantially, and 62 Minnesota service stations offer various blends of ethanol, such as E50, E40, E30, E20, and most recently E15 for use in FFVs. In 2015 (the latest year with complete annual data), Minnesota sold 14.3 million gallons of E85 and 3.9 million gallons of mid blends of ethanol from E15 to E50 with E15 being the most popular mid-blend making up 79 percent of sales. The combined total of E85 and mid-blend sales was 18.1 million gallons and represents a decrease of approximately 12 percent, or 2.4 million gallons, from the 2011 total E85 sales of 20.5 million gallons.

In 2015, E85 prices ranged from $2.32 per gallon to $3.49 per gallon, averaging $2.89 per gallon, which is $0.43 per gallon or 11 percent less than 87 octane (E10) gasoline. However, ethanol has lower energy content than gasoline and E85 vehicles average fuel economy is about 15 percent less, depending on the model and driving habits.

As of 2016, Minnesota had 20 ethanol plants with a production capacity of 1 billion gallons,[79] with one fewer ethanol plant and production holding constant in the previous four-year period.

2. Biodiesel

Minnesota was the first state to mandate the use of biodiesel, establishing a B2 mandate that took place September 29, 2005. Since then the mandate has moved to 5 percent (May 1, 2009) and most recently to B10 beginning July 1, 2014 for the "summer" months (April through September) and reverts to B5 for the winter months. It is estimated that the state's B10/B5 requirement will replace over 65 million gallons of diesel fuel with domestic, renewable biodiesel—and with Minnesota's biodiesel plants capable of producing 63 million gallons of biodiesel a year, in-state production capacity will cover almost all of that demand.

According to the Minnesota Department of Agriculture, as of 2016, Minnesota had three biodiesel production facilities.[80] The three Minnesota plants and their production capacities are:

- REG Corp, Albert Lea—annual production capacity of 30 million gallons
- The Minnesota Soybean Processors (MnSP) plant, Brewster—annual production capacity of 30 million gallons
- EverCat Fuels, Isanti (opened in 2009)—annual production capacity of 3 million gallons

Minnesota's biodiesel mandate (Minnesota Statute section 239.77) requires that 10 percent biodiesel (B10) is blended with #2 diesel fuel from April 1 to September 30 each year, with the blend lowered to B5 during the colder weather months of October through March. The revised

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[78] 2015 Minnesota E85 + Mid-blends Report. 2015 Minnesota E85 and Midblends Station report. Accessed Nov 4, 2016.

[79] Minnesota Department of Agriculture, Minnesota Ethanol Program.

[80] *Minnesota Biodiesel Program. Minnesota Department of Agriculture About the Minnesota Biodiesel Program*.

statute requires that the mandate increases to B20 on May 1, 2018. Implementation of the B10 mandate was delayed until July 1, 2014 due to inadequate blending infrastructure in the southwestern area of the state, and inadequate regulatory protocol for Minnesota Weights and Measures enforcement. Both of those obstacles were addressed in the summer of 2013, and B10 was implemented in 2014.

In winter, the mandate decreases to 5 percent unless state officials and technical experts determine that accepted federal standards recognize higher blends as suitable for year-round use in Minnesota. In addition, before implementing B20 blending requirements, state officials must ensure that a variety of conditions are met, including sufficient fuel and/or feedstock supply, adequate blending infrastructure, and the existence of federal standards for mandated blends.

3. Natural Gas and Propane

Propane and natural gas (compressed and liquefied) are options for fueling Minnesota vehicles that feature low tailpipe emissions. Recently, because of the decrease in price of natural gas, there has been growing interest in natural gas vehicles. Despite higher up-front costs for natural gas fleets, long-term operating costs are significantly reduced at today's prices.

Minnesota Valley Transit Authority operates three natural gas buses and Schwan's Food Services operates nearly all of its vehicles on propane. CenterPoint Energy has a compressed natural gas (CNG) public fueling station in Minneapolis. McNeilus Cos., based in Dodge Center, Minn., the nation's largest supplier of garbage and cement trucks, has a small, private on-site fueling station in Minnesota. Fleets for two Minnesota companies, Andersen Windows and Dart, are using CNG from fueling sites in Wisconsin. Randy's Sanitation in Delano also fuels with CNG. In the Twin Cities area, Dick's Sanitation of Lakeville, Waste Management's Blaine operation, and Ace Sanitation of Ramsey report acquiring CNG trucks and fueling infrastructure in order to transition fleets to CNG as well (sources below).

Positive Connections in Chaska, Minn. operates school buses that began using propane autogas in 2011. There is strong interest from Minnesota school bus companies and shuttle services in converting fleets to propane.

4. Electric Vehicles

In 2016, the number of electric vehicles (EVs) worldwide reached 1,000,000 cars. As of June 2016, there were 4,000 electric vehicles (EVs) registered in Minnesota.[81] Interest in EVs is growing as the result of significant efforts by the federal government, industry, and advocates in recent years. Substantial investments in electric vehicle supply equipment (EVSE) were made in Minnesota in the last four years, increasing public charging infrastructure from 50 to 250 stations.

[81] Drive Electric Minnesota. Nov. 1, 2016.

Battery costs have been cut by a factor of four since 2008 and continue to decrease.[82] EVs in recent model years typically have a range of 100 miles on a fully charged battery. According to the U.S. Department of Transportation Federal Highway Administration, 100 miles is sufficient for more than 90 percent of all household vehicle trips in the United States. Recent automaker announcements suggest that EV trip ranges will soon commonly exceed 200 miles at roughly a $30,000 price point after the federal tax credit. These trip ranges are expected in the next two years for the Chevy Bolt in 2017 and the Tesla 3 in 2018, among others.

Great River Energy plays role in PEV advancement

Electric Cooperative Great River Energy is making it easier for members to drive plug-in electric vehicles. GRE has provided a $500 rebate to 102 owners of PEVs through its ChargeWise program since the program opened in 2013, and recently created Revolt, a first-of-its-kind program that allows members to upgrade the electricity used to fuel their PEVs to wind energy at no additional cost. Six hundred GRE members own EVs in 2016.

Today there are nearly 253 known publicly accessible EV charging stations in Minnesota[83] with more planned. Several of these stations are coupled with grid-connected solar electricity that offsets conventional grid energy used to charge an EV. Station owners sometimes purchase renewable electricity through their utility for charging electric vehicles.

The U. S. DOE Alternative Fuels Data Center[84] maintains a map showing electric vehicle charging stations across the country. This national map offers comprehensive information by state, then city. There are four types of EV charging:[85]

- Level 1: Common household circuit, rated to 120 volts (V) AC. These chargers use the standard three-prong household connection, and are usually portable equipment. 2 to 5 miles of range per 1 hour of charging.
- Level 2: Rated at 240V AC (residential) and 208V AC (commercial). Commonly installed at EV owners' homes for home charging and often used for public charging equipment. This charging option can operate at up to 80 amperes and 19.2 kW in commercial applications. These units require a dedicated 40 amp circuit. 10 to 20 miles of range per 1 hour of charging.
- DC Fast Charging: Typically 208/480V AC three-phase input. Enables rapid charging. Especially useful along heavy traffic corridors at installed stations.
- Inductive Charging: Inductive charging equipment, which uses an electromagnetic field to transfer electricity to an EV without a cord, was recently introduced

[82] Global EV Outlook. International Energy Agency Free Publications, Accessed Nov. 30, 2016.

[83] Map of Electric Charging Station Locations by State, U. S. DOE Alternative Fuels Data Center, Accessed Oct 31 2016.

[84] U. S. DOE Alternative Fuels Data Locator, Accessed Oct 31 2016.

[85] Developing Infrastructure to Charge Plug-in Electric Vehicles, U. S. DOE Alternative Fuels Data Center, Accessed Nov 4, 2016.

commercially for installation as an aftermarket add-on. Currently available wireless charging stations operate at power levels comparable to AC Level 2.

All commercially available EVs have the ability to charge using AC Level 1 and AC Level 2 charging equipment. The climate-related benefits of EVs are maximized when their use is coupled with renewable energy, a voluntary policy promoted by state agencies. Many Minnesota EV drivers obtain 100 percent renewable electricity through programs such as Xcel Energy's WindSource and Great River Energy's Revolt programs, making driving nearly emissions free.

D. Summary

Since Minnesota has no oil reserves, the state imports all petroleum products in the form of crude oil or finished product. Minnesotans consumed 115.6 million barrels (4,855 million gallons) of petroleum products in 2014. The transportation sector consumed about 24 percent of the total energy used in the state. In 2013 the transportation sector surpassed electricity as the largest source of carbon dioxide emissions in Minnesota.

In 2014, Minnesotans spent $11 billion on transportation fuels, the majority of which were imported from out of state.[86] Motor gasoline accounts for almost half of the petroleum consumed in Minnesota. Overall Minnesota's per capita petroleum consumption is slightly less than the national average.

Twenty ethanol plants in Minnesota with a production capacity of 1 billion gallons not only help meet state consumption for E85, E10 and mid-blends, but also supply other states with about 80 percent of the ethanol produced exported to other markets.

Minnesota implemented B10 on July 1, 2014 from April through September and B5 in other months. It is estimated that this biodiesel mandate will displace 65 million gallons of diesel—and with Minnesota's biodiesel plants capable of producing 63 million gallons of biodiesel a year, in-state production capacity is equivalent to the state's biodiesel blending needs.

As of June 2016, there were more than 4,000 electric vehicles (EVs) registered in Minnesota. Substantial investments in electric vehicle supply equipment (EVSE) were made in Minnesota in the last four years, increasing public charging infrastructure from 50 to 250 stations. Several stations are coupled with grid-connected solar electricity that offsets conventional grid energy used to charge an EV. Station owners sometimes purchase renewable electricity through their utility specifically for EV charging.

ENERGY CONSERVATION

[86] U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota.

To provide a long-term adequate supply of secure, high-quality energy, it is important to need as little of it as possible. Minnesota has, for decades, supported strong conservation programs—through its utility conservation programs as well as strong building energy codes. These conservation programs have helped Minnesotans by reducing the number of power plants and pipelines that have been needed, as well as the need for fewer new transmission lines. The reduction in generation has also helped with keeping greenhouse gas and other harmful emissions lower.

A. Conservation Improvement Program

The Conservation Improvement Program (CIP) is a statewide program funded by ratepayers and administered by electricity and natural gas utilities to help Minnesota households and businesses lower their energy costs by using electricity and natural gas more efficiently, reduce carbon dioxide and other emissions, and defer costly utility infrastructure investments.

The Department oversees each utility CIP to ensure that ratepayer dollars are used effectively and that energy savings are reported as accurately as possible. CIP programs are intended to incentivize consumers and businesses to save energy by purchasing energy efficient equipment and/or changing behaviors. Typical programs for residential customers include:

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

Additionally, common programs for commercial or industrial customers include:

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

These CIP program activities have a positive impact on Minnesota's statewide economy. A 2008-2013 assessment of the economic impact of CIP found that the program generates at least four dollars in benefits to Minnesota for every dollar invested.[87] Conducted by an energy and environmental consulting firm, Cadmus, the study assessed the statewide economic impact of CIP activities completed from 2008 through 2013, including the energy savings that will result through 2032. Key findings of the study include that CIP generated more than $5.9 billion of new economic output and nearly 55,000 job years over the study's timeframe. (A "job year"

[87] The Aggregate Economic Impact of the Conservation Improvement Program 2008-2013 Prepared by Cadmus for the Minnesota Department of Commerce, Accessed Nov. 30, 2016.

equals one job for one year.) Overall, the assessment found that every dollar invested in CIP provides $4.00 to $4.30 in energy savings, environmental benefits, and new economic activity.

1. Regulatory Requirements

The Next Generation Energy Act of 2007 (NGEA) established energy-saving goals for electric and gas utilities that operate in Minnesota. Beginning in 2010, NGEA established an Energy Efficiency Resource Standard (EERS) for Minnesota utilities, in which electric and natural gas utilities are required to achieve savings of 1.5 percent of gross annual retail sales, excluding sales to certain facilities that have been granted exemption from CIP charges. As an owner of a nuclear power plant, Xcel Energy is required to achieve savings of 2.0 percent of average retail sales annually. The Minnesota EERS is one of the most aggressive standards in the country, and efficiency programs have been operating throughout the state since the early 1980s.

The utilities may reach this annual goal directly through its CIP. Each electric and natural gas utility develops its own CIP plan, offering a variety of programs to assist residential and business customers in becoming more energy efficient. Traditionally, utility CIPs have focused on incentivizing energy-efficient products. As utilities strive to meet energy savings goals, many are piloting new approaches, offering packaged services and measuring savings that result from building operation and maintenance or behavioral measures, such as fine-tuning building control systems or simply turning off lights when not in use.

Utilities are required to submit CIP plans to the Department for review and approval prior to implementation, and are subsequently required to report their CIP's annual spending and savings performance to demonstrate that they have complied with the requirements in Minnesota Statute section 216B.241, as outlined below: [88]

Energy Savings Requirements

- *Minimum Annual Energy Savings Goals (All Utilities):* Minnesota Statute section 216B.241 subdivision 1c requires each utility to have an annual energy savings goal equal to 1.5 percent of gross annual retail sales.
    - Utilities may petition the Commissioner of the Department of Commerce to adjust their savings goals to a minimum of 1 percent based on a conservation potential study, a utility's historic CIP experience, or other factors at the discretion of the Department.
    - *Allowance for Electric Utility Infrastructure (EUI) Project Savings:* Minnesota Statute section 216B.241 subdivision 1c (d) allows an electric utility to claim energy savings resulting from EUI projects on top of a minimum energy savings goal of 1 percent from energy conservation improvements, provided the EUI projects result in energy efficiencies greater than what would occur through normal maintenance activity.

[88] The CIP statutes are available at the website for the Office of the Revisor of Statutes: https://www.revisor.mn.gov/statutes/?id=216B.241.

Spending Requirements

- *Minimum Spending Requirements:*
  - *Electric Utilities:* Minnesota Statute section 216B.241 subdivision 1a requires each electric utility to invest a minimum of 1.5 percent of its Minnesota gross operating revenues (GOR), excluding revenue from any CIP-exempt customers, on CIP.
  - *Gas Utilities:* Minnesota Statute section 216B.241 subdivision 1a requires natural gas utilities to invest a minimum of 0.5 percent of its Minnesota gross operating revenues (GOR), excluding revenue from any CIP-exempt customers, on CIP.
- *Low-Income Spending Requirements:*
  - *Electric Utilities:* Minnesota Statute section 216B.241 subdivision 7(a) requires each electric utility to invest a minimum of 0.2 percent of its residential Minnesota GOR on CIP programs that directly serve the needs of low-income persons, including renters.
  - *Gas Utilities:* Minnesota Statute section 216B.241 subdivision 7(a) requires each natural gas utility to invest a minimum of 0.4 percent of its residential Minnesota GOR on CIP programs that directly serve the needs of low-income persons, including renters.

Spending Caps

- *Research and Development (R&D) Spending Cap:* Minnesota Statute section 216B.241, subdivision 2(c) allows each utility and association to spend up to 10 percent of a utility's minimum spending requirement on R&D projects.
- *Distributed and Renewable Generation (DRG) Cap:* Minnesota Statute section 216B.241, subdivision 1 allows each utility and association to spend up to 5 percent of a utility's minimum spending requirement on DRG.

Green Building Requirements

Green Building Standards: Minnesota Statutes section 216B.241, subdivision 1f(c) and section 216B.241, subd. 9(e) require that each utility and association offer one or more programs that support green building certification of commercial buildings and that support goals consistent with Sustainable Buildings 2030 standards.

2. Technical Assistance

To ensure that the statutory requirements outlined above are met, the Department provides technical assistance and tools to help utilities identify energy efficiency opportunities, calculate savings, and report program results.

In its effort to ensure that energy savings are reported as accurately as possible, the Department maintains the Minnesota Technical Reference Manual (TRM), which contains pre-approved algorithms that utilities can use to calculate energy savings. The TRM is not intended to define a single set of approved calculation methods; rather, the TRM is a standard set of methodologies and inputs that CIP administrators may reference when developing, implementing, and reporting on CIP programs. While the Department encourages utilities to use the TRM measure designs, utilities may propose—with justification—variations that reflect different program designs or enhanced calculation methods that will result in more accurate savings estimations.

Additionally, the Energy Savings Platform (ESP) provides a centralized forum in which utilities can report their CIP plans and performance. ESP is a Cloud-based software application for energy efficiency program management and reporting developed by Energy Platforms, LLC with funding from the Department. All Minnesota utilities are granted free access to all features within ESP. The establishment of this platform has led to increased CIP reporting compliance among Minnesota utilities and has increased the accuracy of the energy savings and expenditures reported.

3. Research and Development

To help utilities reach their energy savings goal, the NGEA authorizes the Commissioner to assess utilities $3,600,000 annually for grants for applied research and development (R&D) projects, and $2,600,000 of this total amount is allocated to the Conservation Applied Research and Development (CARD) program through which the Department awards grants in a competitive request for proposal (RFP) process.

The Department typically publishes one or more RFP annually, based on a review of current CIP needs with input from utilities and other stakeholders. All RFPs are publicly posted, often during the spring, although not necessarily. Competition for funding is high and all proposals undergo evaluation based on explicit criteria outlined in the RFP. A normal funding cycle takes eight to nine months from posting of the RFP until work begins on selected projects.

CARD projects help quantify the savings, cost-effectiveness, and field performance of advanced technologies; characterize market potential of products and technologies in the State; and investigate and pilot innovative program strategies. Completed CARD projects provide utilities with informative and timely information to enhance energy efficiency program designs within their CIP portfolios. Reports for completed projects are typically available on the Department website, where they are accessible to stakeholders and other interested parties.

4. Summary

The Department strives to ensure that the electric and natural gas savings reported through CIP are accurate and that programs are operated cost-effectively[89] through the CIP planning and review process. Minnesota's conservation and efficiency programs have been widely heralded in their successes and achievements. The American Council for an Energy Efficient Economy, a highly respected research and advocacy organization, has ranked Minnesota in the top 10 states in the nation in nine of the 10 years it has issued the annual State Energy

[89] *Cost-effectiveness in Minnesota CIPs are defined according to four benefit-cost tests: Societal, Ratepayer, Participant, and Utility. More information on these tests is provided in the Legislative Auditor's Report noted above. The DER focuses on the Societal test as a measure of program cost-effectiveness consistent with its mission as a public agency.*

Efficiency Scorecard.[90] Through the CIP statutes and using the tools discussed above, utilities and the Department are challenged to increase the energy and carbon dioxide savings from CIP even further, while still maintaining cost-effective programs.

B. Efficient Buildings and Integrated Energy Systems

1. Sustainable Building 2030

In 2000, the Minnesota Legislature required the Departments of Administration and Commerce to develop sustainable building design guidelines mandatory for all new buildings receiving funding from the bond proceeds fund after January 1, 2004. In 2008, the guidelines expanded to become the Minnesota Sustainable Building 2030 program—cost-effective, energy-efficiency performance standards that can significantly reduce carbon dioxide emissions by lowering energy use in new and substantially reconstructed buildings. Sustainable Building 2030 (SB 2030) is administered by the Center for Sustainable Building Research at the University of Minnesota with annual funding coming from the Department through a utility assessment. All new and substantially renovated buildings funded in whole or part by Minnesota bond monies must comply with the guidelines.

While the Sustainable Building 2030 standards are voluntary for all other buildings, they have served as a model for reducing both energy and carbon. It's a model that can be cost-effective and beneficial for both the building owners and the citizens throughout Minnesota. SB 2030 reflects the goals of the national Architecture 2030 program. Architecture 2030 establishes the goal of achieving net-zero energy use in buildings by 2030 and outlines specific incremental performance targets in order to meet this goal. The SB 2030 program requires all state-bonded projects that began schematic design after August 1, 2009 to meet an energy reduction of 60 percent compared to the average building. Starting in 2015, projects have begun to meet the 70 percent reduction standard. The 93 buildings designed to the SB 2030 energy standard so far are predicted to save approximately 534 million kBtus/year—a savings of $8.3 million per year.[91] When new projects are added each year and standards rise, recurring annual savings to the State and other building owners will grow significantly.

2. B3—Energy Benchmarking

The same legislation that created the initial sustainable building guidelines also required the Departments of Administration and Commerce to benchmark all public buildings by 2004. Twelve years later, Minnesota has a vibrant benchmarking tool—B3 Benchmarking—that has benchmarked 8,594 public buildings in the state representing more than 323 million square feet.[92] Benchmarking is a building energy management system for public buildings in Minnesota including state, higher education, local government, and public school buildings.

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[90] *American Council for an Energy Efficient Economy, State Energy Efficiency Scorecard.*

[91] Source: Conservation Applied Research and Development (CARD), Clean Energy Resource Teams (CERTs), and Sustainable Buildings 2030 (SB2030) 2016 Legislative Report.

[92] Source: B3 Benchmarking Website, Accessed 10/25/16.

B3 Benchmarking provides public entities with a means to help manage individual buildings, improve their building portfolio efficiently, and monitor energy improvements.

Measures for cost-effective energy savings are most likely to be found in buildings with poor energy performance. The relative energy performance of most buildings can readily be determined by energy benchmarking. Energy benchmarking is also valuable to:

- Quantify the success of a maintenance or operation change to improve energy performance;
- Track effectiveness of capital improvements or a performance contract intended to reduce energy; and
- Be alerted to significant variance from a performance track record which could be a sign of an otherwise unrecognized operational problem.

The ENERGY STAR Portfolio Manager is another popular energy benchmarking tool used by both private and public facility managers. The state goal is to achieve certification of 1,000 commercial buildings as ENERGY STAR –labeled.[93] The Portfolio Manager statistics for Minnesota as of mid-2011 include 4,723 buildings benchmarked, representing more than 564 million square feet.

3. Building Energy Codes

The American Recovery and Reinvestment Act of 2009 (ARRA) established minimum energy codes for all states to qualify to receive U.S. DOE State Energy Program formula grant funding. In a March 23, 2009 letter to the Secretary of Energy, the Governor certified that Minnesota would satisfy all of the ARRA requirements:

- Implement a residential building energy code that meets or exceeds the 2009 edition of the Internal Energy Conservation Code (IECC);
- Implement a commercial building energy code throughout the state that meets or exceeds the ASHRAE Standard 90.1–2007; and
- Create a plan to achieve 90 percent compliance with the above energy codes within eight years.

Minnesota adopted the 2012 IECC residential energy code on February 14, 2015 and the 2012 IECC and ASHRAE 90.1-2010 commercial code on June 2, 2015.

C. Efficiency in Public Buildings

1. Guaranteed Energy Savings Program

Governor Dayton signed Executive Order 11-12 in April 2011 entitled "Providing for Job Creation through Energy Efficiency and Renewable Energy Programs for Minnesota's Public Buildings." EO 11-12 established the Office of Guaranteed Energy Savings Program (GESP)

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[93] Minn. Stat. § 216B.241, subd. 1f.Facilities energy efficiency.

within the Department. Technical, contractual and financial assistance is provided to state agencies, local government units, school districts, and institutions of higher learning that elect to implement energy efficiency and renewable energy improvements through the Guaranteed Energy Savings Master Contract program.

GESP utilizes an Energy Savings Performance Contract (ESPC), which is a performance-based procurement and financing mechanism that leverages energy and operational savings achieved through the installation of energy efficient and renewable energy equipment and implementation of operational best practices, to finance the cost of the building retrofit and renewal project, with no net cost increase to the public entity. To date several state agencies, colleges, and cities are working with GESP staff.

2. Local Energy Efficiency Program

Minnesota Statutes 216C.42 & 216C.43 enable the Department to manage a technical assistance program to local units of government (cities, counties, school districts, park districts, or any of these operating jointly) to complete Investment Grade Audits.

The Local Energy Efficiency Program (LEEP) has pre-qualified engineering firms in a master contract, which then are selected at a local government level to perform the investment grade energy audit. The Department provides technical and contractual assistance, helping identify site-specific goals, providing standard tools and contracts, and reviewing the energy study. LEEP also grants local units of government access to low-interest lease-purchase financing in the Energy Savings Partnership, a standard financing agreement enabled in the same statute as LEEP.

D. Combined Heat and Power

Combined heat and power (CHP) systems, also known as cogeneration, generate electricity and useful thermal energy in a single, integrated system. It includes a suite of technologies that can use a variety of fuels to generate electricity or power at the point of use, allowing heat that is normally wasted in conventional power generation to be recovered as useful energy for heating and/or cooling purposes. Combining electricity and thermal energy generation into a single process through CHP can save up to 35 percent of the energy that is required to perform these tasks separately.

CHP can potentially help support Minnesota's energy policy goals by increasing the average efficiency of Minnesota's electric and thermal generation systems, reducing aggregate greenhouse gas emissions, and improving the energy security and resilience of local energy systems.

Studies show that substantial potential exists for CHP development in Minnesota. There is an estimated 1,000 MW of potential new CHP that could achieve simple payback in less than 10 years, which is about equal to the current CHP capacity in the state.[94] Minnesota's energy economy already relies on CHP systems for around 6 percent of the state's total electric generating capacity (representing 961 MWs at over 50 sites). Most of this CHP capacity (83 percent) is found in large systems like chemical and paper processing facilities. Appendix C provides a listing of CHP installations in the state.

During 2014, the Department funded two CHP research studies to evaluate Minnesota's CHP technical potential and regulatory issues affecting CHP development. The first study, "Analysis of Standby Rates and Net Metering Policy Effects on CHP Opportunities in Minnesota" by the Energy Resources Center, examines the effects of existing standby rates and net metering rules on CHP and waste heat-to-power projects.[95] The second study, "Minnesota CHP Policies and Potential" by FVB Energy, evaluates CHP regulatory issues and policies and develops an up-to-date analysis of CHP technical and economic potential.[96] Some of the key findings from the studies include:

- Significant CHP potential exists in Minnesota. There is around 1,000 MWs of economic potential with a payback of under 10 years;
- Utility investment will be needed to significantly grow CHP in Minnesota;
- The Conservation Improvement Program provides advantages as a policy vehicle for advancing CHP; and
- There are important issues and ratepayer risks that must be considered for utility CHP investment.

1. CHP Action Plan

During 2014 and 2015, to continue to build on the Department's CHP analysis and findings and focus on more specific policy details and recommendations, the Department sought to leverage existing federal funding and was awarded a U.S. DOE grant to carry out a strategic stakeholder engagement process and develop an Action Plan for CHP deployment in Minnesota. The goal of this project was to plan, coordinate, and execute a stakeholder engagement process that results in a guide to help policy makers, utilities, industries, and trade allies make informed decisions that lead to greater CHP implementation in Minnesota.

A series of findings were derived from each of the project's stakeholder engagement components. In addition, public comment received under a Commission Generic Proceeding

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[94] Spurr, Mark and Anne Hampson. "Assessment of the Technical and Economic Potential for CHP in Minnesota," *FVB Energy and ICF International,* Jul. 2014.

[95] Miller, Graeme, Cliff Haefke, and John Cuttica. "Analysis of Standby Rates and Net Metering Policy Effects on CHP Opportunities in Minnesota." *Energy Resources Center*, Apr. 2014.

[96] Spurr, Mark and Anne Hampson. "Assessment of the Technical and Economic Potential for CHP in Minnesota." *FVB Energy and ICF International,* Jul. 2014.

Spurr, Mark. "Minnesota Combined Heat and Power Policies and Potential." *FVB Energy*, Jul. 2014.

on Standby Rates provided additional pertinent input. Findings were developed for each of the following engagement components outlined in the list below and in Figure 19:

- Pre-Engagement Stakeholder Survey: Gauging Stakeholder Perspectives
- Stakeholder Meetings One and Two: Presentation of Key Background Information
- Comment Period One: Stakeholder Feedback on CHP Barriers and Opportunities
- Minnesota PUC Generic Proceeding on Standby Rates
- Stakeholder Meetings Three and Four: Stakeholder Discussions and Path Forward
- Post-Engagement Stakeholder Survey: Identifying Stakeholder Priorities for CHP Action Plan
- Comment Period Two: Stakeholder Feedback on Draft CHP Action Plan Recommendations

Figure 19: CHP Stakeholder Engagement Process

As a result of this process, the Department and stakeholders have a more nuanced understanding of the opportunities and barriers to CHP projects in Minnesota. Over the course of the project, the Department engaged a diverse list of around 250 stakeholders from utilities, advocacy groups, trade associations, think tanks, consulting firms, government agencies, etc. The outcomes of the project include:

- Four in-person stakeholder meetings with 70 participants each.
- Two stakeholder surveys with 91 valid completed responses
- Two public comment periods with 25 written submissions
- 38 reports and presentations produced and disseminated
- Two webinars to share project results
- Creation of a dedicated website with all of these resources posted[97]

Stakeholder input was gathered, analyzed, and synthesized into a CHP Action Plan with recommendations and next steps. The CHP Action Plan established a set of six priority near, intermediate, and long-term action items, including developing a utility program CHP energy savings attribution model, quantifying CHP potential in wastewater facilities, education and training resources, leveraging existing financing programs, examining options for CHP to be

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[97] "Combined Heat and Power Stakeholder Meetings Webpage." *Minnesota Department of Commerce*, 2016.

counted as utility infrastructure resources, and continuing discussion of standby rate structures through the PUC's ongoing proceeding.

Table 10 summarizes the six near-term and longer-term priority areas and recommendations that are identified in the Action Plan:[98] Detailed tasks and milestones were assigned to each of the priority action items. For example, the CHP Evaluation Methodology and Criteria priority area was divided into four major activities (scoping, subcommittee meetings, model and criteria drafting, and finalization and issuance) with related tasks and milestones. The Department is now taking the next steps to implement the recommendations presented in the Action Plan.

Table 10: CHP Action Plan Recommendations

Priority Areas	Action Items	Timing
CHP Evaluation Methodology and Criteria	Establish CHP Energy Savings Attribution Model and Project Evaluation Criteria	Near-Term (2015-2016)
Mapping CHP Opportunities	Map CHP Opportunities at Wastewater Treatment Facilities and Public Facilities	Intermediate-Term (2016-2017)
Education and Training Needs and Options	Expand Education and Training Resources on the Department's Website	Near-Term (2015-2016)
CHP Ownership Problems and Solutions	Leverage Existing Financing Programs Applicable to CHP	Near-Term (2015-2016)
CIP CHP Supply-Side Investments	Examine Electric Utility Infrastructure Policy	Long-Term (2015-Onward)
Standby Rates	Continue Discussion Through PUC's Standby Rate Proceeding	Long-Term (2015-Onward)

E. Summary

Minnesota continues to effectively implement a broadening energy efficiency strategy led by utility-driven efficiency programs, advanced public sector building efficiency efforts, and a recently adopted more stringent statewide mandatory energy code for residential and commercial buildings. These efforts have been acknowledged annually by the American Council for an Energy-Efficient Economy (ACEEE) that has consistently ranked Minnesota in the top 10 of its energy efficiency state scorecard.

OTHER KEY PROGRAMS

A. Affordability

For many Minnesota households, energy costs place continuing stress on the family's budget. Energy costs account for up to 13.4 percent of a typical low-income household budget

[98] "Final CHP Action Plan." *Minnesota Department of Commerce*, 2015.

compared to 7 percent for all households in the United States.[99] Households' inability to pay energy bills results in utilities focusing attention and resources on bill collection, disconnection, and reconnection activities. The costs of such efforts are typically borne by the utility's other ratepayers.

In most Commission proceedings, Department analysts work to reduce the overall costs of providing utility service and to keep rates affordable for all Minnesotans.

For low-income households needing additional help with paying utilities bills, assistance is available through federal programs administered by the Department. Several Minnesota statutes specifically address low-income energy concerns. These statutes mandate programs that include an electric rate discount, affordability program, conservation and energy efficiency services, and protection against utility disconnection during cold-weather months.

1. Low Income Home Energy Assistance Program

Minnesota's Low Income Home Energy Assistance Program (LIHEAP) helps eligible low-income households meet their immediate winter heating needs. LIHEAP is funded by the U.S. Department of Health and Human Services. The Department contracts with 30 local service providers—nonprofit organizations, counties, and tribal organizations—to provide energy assistance services throughout Minnesota.

Households with incomes up to 50 percent of the state median income are eligible for the program. The household's energy assistance benefit is determined by income, household size, fuel cost, and fuel type.

Households with the lowest incomes and highest heating bills receive the largest grants. Assistance provided to households is usually in the form of a payment to their energy vendor. The program assists both renters and homeowners.

During the past 35 years, the number of Minnesota households receiving LIHEAP assistance ranged from a high of 172,065 in FFY 2011 to a low of 81,486 in FFY 1998. In those 35 years, the average energy assistance benefit has ranged from a high of $634 in FFY 2010 to a low of $286 in FFY 1999. The FFY 2016 average benefit was about $480. Variations in the average benefit amount result primarily from inconsistencies in the amount of annual federal funding received by the program and variation in the number of households applying each year.

Additional money is available to households for reconnection or prevention of losing their heat due to emergency situations including:

- Disconnection from energy service;
- Pending insufficient fuel or utility service disconnection; and
- For homeowners' repair or replacement of faulty heating equipment.

[99] *Source: U.S. Department of Health and Human Services, 2011 LIHEAP Home Energy Notebook.*

Assistance with emergency situations is available 24 hours a day, seven days a week, during the heating season. The local service providers also provide advocacy and referral services throughout the program year.

2. Low Income Weatherization Assistance Program (WAP)

The Department administers the Weatherization Assistance Program (WAP) funds for income eligible households in Minnesota. The goal of the program is to provide cost-effective energy conservation measures and education to low-income households. The program prioritizes households with members who are seniors, disabled, or children, as well as those that have high energy usage or a high energy burden. Typically, less than 1 percent of the state's 500,000 EAP/WAP-eligible households receive weatherization services annually due to funding limitations. WAP contracts with 24 local service providers, including four tribal governments, to provide services statewide.

Federal funds constitute a large portion of the program resources. Additional funding is provided through an annual LIHEAP transfer and locally through program partners, including local gas and electric utilities. Services include an energy audit, energy conservation measures, and health and safety work. In addition, all dwellings served receive a final inspection conducted by a certified professional. Examples of measures done through WAP include air sealing, attic and wall insulation, lighting upgrades, refrigerator replacement, ventilation, and heating plant repair or replacement.

National studies confirm that cost-effective weatherization and energy education done through WAP provide energy savings from 30 percent to 45 percent in each low-income home weatherized.

The regular DOE weatherization funding is completed through an annual contract based on an allocation awarded by Congress. For the fiscal year ending in June 2015, the amount received was $8,193,811. The Minnesota WAP is guided by DOE rules and regulations. Department field staff is required to monitor 5 percent of all dwellings weatherized. Both fiscal and on-site field monitoring visits examine internal controls, local expenditures, procurement and actual work completions. On-site inspections of completed jobs are assessed for compliance with DOE rules, regulations, and the Minnesota Policy Manual. In addition, the Department provides technical support and training for staff members of service providers.

3. Energy Financing Programs

The Department oversees the administration of six third-party administered and one self-administered energy efficiency revolving loan fund programs that together serve the residential, commercial and industrial business, nonprofit, and public sectors. Nearly $18 million of funds have been leveraged by these programs. In addition, the Department oversees administration of three third-party administered Energy Efficiency Loan Loss Reserve Fund Programs serving the residential, nonprofit, and public sectors. Nearly $3.6 million of funds have been leveraged by these programs. Third-party loan administrators include the Saint Paul Port Authority, the Southwest Regional Development Commission, Center for Energy and Environment, the Minnesota Housing Finance Agency, and Community Reinvestment Fund.

Rev It Up Program

In 2015, the Department launched the Community Energy Efficiency and Renewable Energy Loan Program, or "Rev It Up" Program, under Minnesota Statute 216C.145 & 146 where the Department has authority to issue up to $100 million in revenue bonds to help local government units support projects among small businesses, public buildings, industrial or commercial businesses, and healthcare facilities. The first request for proposal solicitation demonstrated interest in this new financial offering, and the Department is planning to expand the outreach and marketing of this program.

B. Clean Energy Resource Teams (CERTs)

Clean Energy Resource Teams (CERTs) is an innovative partnership between the Minnesota Department of Commerce, University of Minnesota Extension and Regional Sustainable Development Partnerships, the Great Plains Institute, and Southwest Regional Development Commission. The program connects citizens with the resources they need to identify and implement community-scale renewable energy and energy efficiency projects (www.cleanenergyresourceteams.org).

Established in 2003, CERTs was initially funded by a grant from the Minnesota Legislative-Citizen Commission on Minnesota Resources (LCCMR). At present, approximately half of CERTs' core funding comes from the Conservation Improvement Program (CIP) Research and Development fund.

There are seven Minnesota CERT regions; six across greater Minnesota and one in the metro area. Teams are comprised of small business owners, farmers, utility representatives, members of environmental groups, government staff, elected leaders, and academics.

CERTs provide technical support to communities throughout the state by offering resources on Property Assessed Clean Energy (PACE) and community solar gardens Clean Energy Resource Teams Commercial Property-assessed Clean Energy (PACE) Programs in Minnesota Accessed November 30, 2016. Clean Energy Resource Teams Community Solar Gardens accessed November 30, 2016. CERTs also manages the Clean Energy Project Builder.

CERTified Campaigns. CERTs implements direct energy savings projects with its CERTified Campaigns, by providing Minnesotans with clear, actionable ways to implement energy efficiency projects. The campaigns have saved approximately 63 billion BTUs since 2009 with programs ranging from pre-rinse spray valves to LED lighting in turkey producer barns. Clean Energy Resource Teams Past Campaigns accessed November 30, 2016.

Utility Program Support. CERTs partners with Minnesota utilities to help them meet their Conservation Improvement Program (CIP) energy savings goals by offering assistance to utilities' existing programs and by exploring new models to increase CIP participation. One such outreach is through CERTs Right Light Guide which offers information to consumers on understanding brightness, color, costs, and other features when selecting new energy efficient LEDs and CFLs. Over 65 Minnesota utilities have customized the Right Light Guide to include their own branding and over 90,000 copies have been distributed by utilities to their customers and by the Department and other partners at events such as the Minnesota State Fair.

Seed Grants. CERTs has offered community energy project seed grants three times since the last Quad Report. CERTs provided seed grant funding for 98 projects since 2012. Seed grant projects can be found at: Clean Energy Resource Teams CERTs Seed Grant Projects accessed November 30, 2016.

Networking & Communication. CERTs is instrumental in providing networking support to Minnesota programs that encourage people to participate in clean energy projects. CERTs holds regularly scheduled forums, workshops, and conferences that provide opportunities for small business owners, farmers, utility representatives, members of environmental groups, government staff, elected leaders, and academics to meet and share energy efficiency and clean energy experiences from across Minnesota. CERTs boasts a robust network of regional and statewide media outlets, and in part through their biweekly Minnesota Energy Stories e-digest Clean Energy Resource Teams CERTs Blog Accessed November 30, 2016.

C. Energy Information Center

Established in 1976 by the Legislature in 216C.11, the primary objective of the Energy Conservation Information Center is to develop an energy literate citizenry by educating Minnesotans about energy efficiency and renewable energy technologies through the development and dissemination of unbiased, accurate energy-related information. A core function of the State Energy Office, the Energy Information Center provides energy data collection, analyses, and tools for the dissemination of information and education by the Department as well as maintaining a toll-free information service. Highlights of the last four years include:

- Informed the public of the range of state, federal, and utility funded incentives, rebates, grant, and loan programs to help fund energy efficiency, conservation, and renewable energy projects
- Publicized programs such as the Weatherization Assistance Program, Renewable Energy Equipment Grant Program, the Made in Minnesota Solar Incentive Program, and other utility-based solar incentive programs.
- Redesigned and enhanced content of the Department website (http://mn.gov/commerce/industries/energy/).
- Exhibited annually at regional fairs and events such as the Minnesota State Fair Eco Experience, Duluth Harvestfest, Rochester Earthfest, Redwood Falls Farmfest, and the Minnesota Power Energy Design Conference.
- Updated the consumer based Home Energy Guide and distributed more than 22,000 copies over the last two years.
- Published consumer information on dubious energy efficiency products and practices offered for sale to help consumers make informed energy purchases.

- Continued the long tradition of responding to energy-related questions via email (energy.info@ state.mn.us) and designated phone lines; metro - 651-539-1886, greater Minnesota - 800-657-3710.

D. Eco Experience

Since 2012, the Department has coordinated the primary energy exhibit in the Eco Experience at the Minnesota State Fair. This exhibit occupies up to 5,000 square feet of space and is a coordinated effort of Department staff and the Minnesota Pollution Control Agency. Additional partners provide support and congruent messaging on energy-related topics.

In 2016, over 260,000 people visited the Eco Experience and the Department distributed nearly 8,000 publications, including the popular Home Energy Guide and fact sheets on Community Solar and Efficient Lighting. The Home Energy Guide offers practical information on ways to improve a home's performance ranging from simple, no cost behavior changes to more comprehensive energy-related investments: Minnesota Department of Commerce Home Energy Guide accessed Nov. 30, 2016.

The 2016 Eco Experience featured displays on several key topics, including:

- **Efficient Lighting**, with partner, Clean Energy Resource Teams provided nearly 40 examples of LED bulbs and fixtures and described the importance of shopping by lumens and color temperature;
- **Insulation and Air Sealing**, with partner Minnesota Building Performance Association, which demonstrated options for wall and attic insulation and the importance of air sealing to reduce energy loss and eliminate ice dams and other structural issues in homes;
- **Solar Options,** that featured the MN Solar Suitability App, accessed November 30, 2016 allowing homeowners an on-the-spot assessment of the viability of solar on their property; additional displays described the advantages of Community Solar and utility green pricing programs;
- **Efficient Appliances,** which showcased ENERGY STAR kitchen and laundry appliances from partner Best Buy, along with sustainable interior finish options from partner Natural Built Home; and the
- **Home Energy Squad,** featuring partners Xcel Energy, CenterPoint Energy, Center for Energy and Environment, and Neighborhood Energy Connection addressing energy-saving opportunities for home owners.

E. State Energy Program

The U.S. Department of Energy (DOE) State Energy Program (SEP) provides funding and technical assistance to state and territory energy offices to help them advance their clean energy economy while contributing to national energy goals. Minnesota state statutes set many energy policies, including the reduction of per capita use of fossil fuel through increased reliance on energy efficiency and renewable energy. The federally funded State Energy

Program helps Minnesota achieve some of its public policy goals. The primary goal of Minnesota's State Energy Program is to assist in reaching those energy policy goals through the acceleration of market acceptance of high-efficiency and renewable energy technologies and practices. To do so the State Energy Office does the following:

- Provide Minnesotans with high quality, unbiased, accurate information they can use in making choices that affect their energy use;
- Provide targeted financial and technical assistance to advance the implementation of conservation, energy efficiency and renewable energy technologies, and other emerging technologies or initiatives;
- Educate Minnesota's construction industry and Minnesota consumers about best practices in building efficient, safe and durable buildings;
- Provide Minnesotans with accurate information regarding clean transportation fuels and other advanced vehicle technologies;
- Meet with individual companies seeking to commercialize, site or expand innovative clean energy projects in the state and provide impartial review of primary technical, economic, market and policy/regulatory concerns in a confidential and supportive setting so that innovators are best positioned to progress;
- Examine effective policy options for reducing greenhouse gas emissions from sources within the state; and
- Work collaboratively with industry to ensure sound energy assurance practices and measures are in place to protect consumers from disruptions to fuel supply.

The DOE's Office of Energy Efficiency and Renewable Energy (EERE) State Energy Program (SEP) dedicates a portion of its funding each year to provide competitively awarded financial assistance to U.S. states and territories to advance policies, programs, and market strategies that accelerate job creation and reduce energy bills while achieving energy and climate security for the nation. Minnesota has been successful in procuring a number of competitive grant awards since 2012, totaling approximately $1.8 million in funding, to address the following areas:

- Advancing the Guaranteed Energy Savings Program for state and local unit of government energy projects;
- Exploring use of combined heat and power in energy efficiency programs;
- Developing near-term strategies for achieving energy policy goals through an Energy Action 2025 plan;
- Advancing wastewater treatment efficiency in municipalities throughout the state;
- Assisting local units of government with their local energy planning priorities; and
- Addressing supply-side efficiency in the electric power generation sector through the Conservation Improvement Program.

The DOE's SunShot Initiative is a competitive grant program that funds cooperative research, development, demonstration, and deployment projects to drive down the cost of solar electricity with a goal for solar PV to become cost-competitive with traditional forms of electricity by 2020 without subsidies. The Department applied for and was awarded three SunShot grants totaling approximately $2.4 million since 2011, including two pending awards scheduled for contracting in December 2016.

- "Minnesota Rooftop Solar Challenge", was a $263,000 grant project, completed in 2012, that identified best practices to enable solar energy market transformation including state regulations, utility interconnection practices, zoning standards, and financing. Partners included utilities, the solar industry, local units of government, and non-profit organizations.
- "State Strategies to Bring Solar to Low- and Moderate-Income Communities" (pending) is a three-year, multistate project to develop a strategic plan with recommendations to expand market penetration of solar PV among low and moderate-income residents and communities in Minnesota (Minnesota's share of the multi-state grant award is$215,000).
- "Minnesota Solar Pathways"(pending), is a three-year, $2 million project to develop a scenario-based modeling tool through an extensive stakeholder process to estimate the solar capacity potential statewide and evaluate grid management approaches to overcome solar integration challenges. Partners include utilities, the solar industry, corporations with sustainability goals, local units of government, and non-profit organizations.

F. Energy Assurance

The Department is required to have an energy emergency plan to receive U.S. DOE funds for the State Energy Program and also received an American Recovery and Reinvestment Act (ARRA) funded grant for Energy Assurance Planning. The planning initiative focused on building energy assurance capability to allow the state to better coordinate and communicate statewide on energy security, reliability, and emergency response issues.

The ongoing objectives of the Energy Assurance initiative are to:

- Strengthen and expand state and local government energy assurance planning and resiliency efforts by incorporating response actions for new energy portfolios and smart grid applications;
- Create jobs; and
- Build in-house state and local government energy assurance expertise and emergency response capabilities.

The Energy Assurance Planning grant process was completed in coordination with the Minnesota Department of Public Safety-Division of Homeland Security and Emergency Management and is incorporated into the State of Minnesota Emergency Operations Plan. Energy Assurance is an ongoing activity of monitoring, updating, and interacting with other states, federal agencies, and industry.

1. Microgrids

Microgrids represent one of many tools available to policy makers, community leaders, and the energy industry for improving the ability to maintain critical community services during emergencies.

Microgrids are localized grids that can disconnect from the traditional grid to operate autonomously and help mitigate grid disturbances to strengthen grid resilience. Because they are able to operate while the main grid is down, microgrids can strengthen grid resilience and help mitigate grid disturbances as well as function as a grid resource for faster system response and recovery.[100]

A number of factors are driving increased interest in microgrids, including:

- **Energy Assurance:** The need for stable and sustainable energy supply at sites deemed critical for public services and safety
- **Reliability:** The need for greater resilience and reliability at high-priority commercial, industrial, military, and other sites, where outages can cause serious disruption, risks, and financial costs
- **Disruptive Technologies and Forces:** Transformative industry trends that make distributed generation, energy storage, and energy management technologies more useful and cost-effective for a wider range of applications
- **Economic Development:** Opportunities for encouraging and facilitating economic development, attracting new businesses, creating jobs, and advancing technology capabilities

In 2013 the Department leveraged ARRA grant funding for Energy Assurance Planning to contract for the White Paper "Minnesota Microgrids: Barriers, Opportunities, and Pathways toward Energy Assurance."[101]

The final report covers five key areas:

- Microgrid drivers and opportunities in Minnesota;
- Regulation and policy—identification of applicable state, federal and regional regulations;
- Minnesota's microgrid potential—modeling results of prospective microgrid capacity
- Microgrid development models; and
- Roadmap—Policy options and pathways to remove barriers to microgrids.

Substantial opportunities exist in Minnesota for developing microgrids that provide tangible and important benefits to the state. But, Minnesota law is primarily silent on microgrids, creating significant barriers to deployment. The report identifies a key need to update interconnection standards to incorporate prevailing industry standards, and establish a pilot program to facilitate microgrid development.

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[100] U.S. Department of Energy, The role of Microgrids in helping advance the nation's energy system, website accessed November 2016.

[101] Minnesota Microgrids: Barriers, Opportunities, and Pathways Toward Energy Assurance, prepared by Microgrid Institute for the Minnesota Department of Commerce, September 30, 2013.

G. Other Collaborative Initiatives

1. Value of Solar

Minnesota became the first state in 2013 to enact a state law to develop a statewide methodology for calculating the value of solar energy to the utility, its customers, and society. State law allows utilities to voluntarily use the Value of Solar (VOS) tariff in lieu of net metering,[102, 103] and identifies VOS as a bill credit rate for Xcel community solar gardens.[104]

The Department developed the methodology for calculating the VOS based on significant stakeholder input. The Department submitted the methodology to the Commission on January 31, 2014 and the PUC approved the methodology on April 1, 2014. [105]

The VOS methodology takes into account the following values of distributed PV: energy and its delivery; generation capacity; transmission capacity; transmission and distribution line losses; and environmental value. Under a VOS tariff, solar customers are billed for their total electricity consumption at the applicable retail rate and receive a VOS credit for their total solar electricity production.

Following the creation of VOS tariffs in Austin, Texas (2006) and Minnesota (2014), policymakers across the United States are investigating how best to quantify the benefits and costs of solar.[106]

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102 Minn. Stat. § 216B.1691, subd. 10.

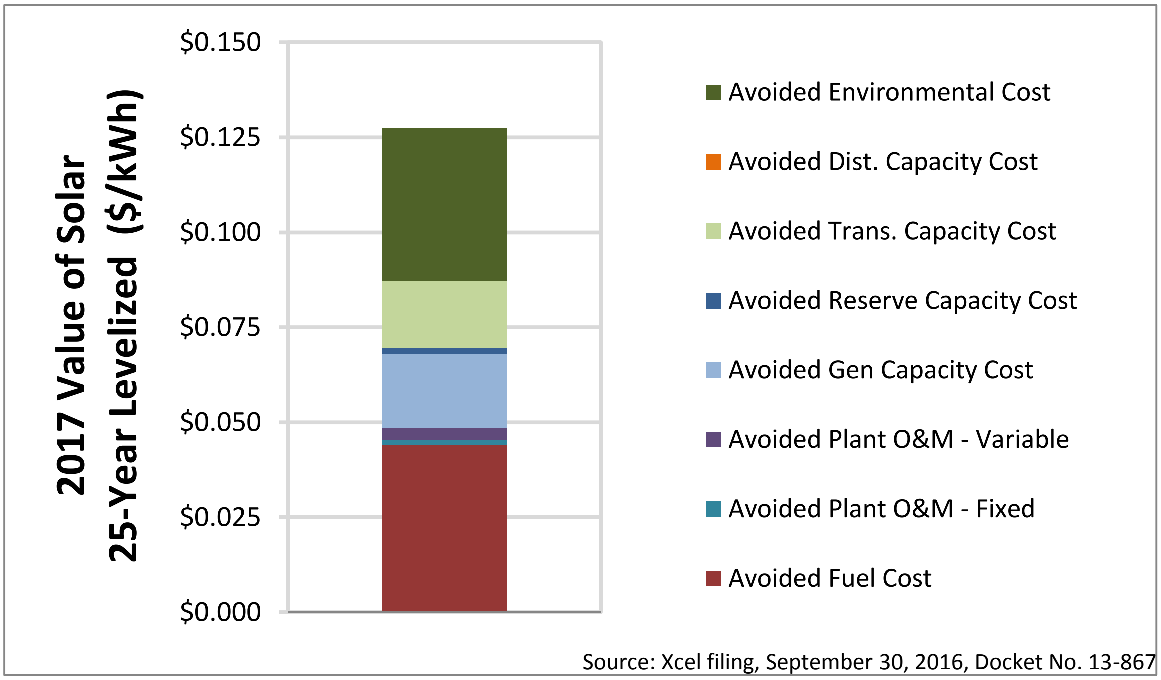
103 In 1981, Minnesota became the first state to enact a statewide net metering policy. As of 2016, 41 states plus the District of Columbia and three territories have mandatory net metering rules, according to the Database of State Incentives for Renewables and Efficiency, accessed November 2016.

104 Minn. Stat. § 216B.1641.

105 Minnesota Department of Commerce, Minnesota Value of Solar: Methodology, April 1, 2014.

106 Solar Electric Industry Association, Solar Cost-Benefit Studies, web content accessed November 2016.

Figure 20: Xcel 2017 Value of Solar Calculation for Community Solar Gardens



a. Ongoing development of VOS for Xcel Community Solar Gardens

Minnesota statute[107] specifies that subscribers to the Xcel Community Solar program shall receive bill credits at the VOS rate or, until that rate for the utility has been approved by the Commission, the applicable retail rate.

On September 6, 2016, the PUC approved the VOS rate for Xcel's Community Solar Garden program for applications filed after December 31, 2016.[108] The PUC order also requires Xcel to include location-specific values in the 2018 VOS calculation. Figure 20 above shows the stack of value components in Xcel's 2017 VOS rate calculation filed on September 30, 2016.

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107 Minn. Stat. § 216B.1641.

108 Minnesota Public Utilities Commission, Order Approving Value of Solar Rate for Xcel's Solar Garden Program, Clarifying Program Parameters, and Requiring Further Filings, September 6, 2016, Docket No. E-002/M-13-867.

2. Minnesota Renewable Energy Integration and Transmission Study (MRITS)

In 2013 the Minnesota Legislature adopted a requirement for a study of increasing the state's Renewable Electricity Standards (RES) to 50 percent by 2030, and to higher proportions thereafter, while maintaining system reliability.[109]

MRITS builds upon prior renewable integration studies and related technical work and was coordinated with other regional power system study work.

The study results showed that the addition of wind and solar generation to supply 50 percent of Minnesota's annual electric retail sales can be reliably accommodated by the electric power system, allowing Minnesota to become a net electricity exporter.

The Minnesota utilities and transmission companies, in coordination with the Midcontinent Independent Transmission Service Operator (MISO), conducted the engineering study.

The study results[110] showed that the addition of wind and solar generation to supply 50 percent of Minnesota's annual electric retail sales can be reliably accommodated by the electric power system, allowing Minnesota to reduce imported electricity and become a net electricity exporter.[111]

3. Scoping Study

Legislation passed in 2013 required the Department to develop the scope for a study of how Minnesota can achieve a sustainable energy system that does not rely on fossil fuels.[112] The Department and Rocky Mountain Institute held a day-long stakeholder workshop on October 22, 2013, collected written stakeholder comments, and reported the results[113] of the scoping process to the Legislative Energy Commission on January 1, 2014. The Rocky Mountain

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[109] Legislation passed in 2013 required a Renewable Energy Integration and Transmission Study (MN Laws 2013, Chapter 85 HF 729, Article 12, Section 4). The Minnesota Public Utilities Commission ordered all Minnesota electric utilities and transmission companies to participate in the study (Docket No. E-999/CI-13-486).

[110] Final Report: Minnesota Renewable Energy Integration and Transmission Study, October 31, 2014.

[111] In 2014, Minnesota imported 19% of the electricity consumed in the state. For further details in electricity imports, see Appendix B, Electricity Consumption by Source.

[112] Scoping for Renewable Energy Study: MN Laws 2013, Chapter 85 HF 729, Article 12, Section 7.

[113] Scoping an Energy Future Study for Minnesota, prepared by the Rocky Mountain Institute for the Minnesota Department of Commerce, January 1, 2014.

Institute Presented the study results[114] at the February 12, 2014 meeting of the Legislative Energy Commission.[115]

4. Climate Solutions & Economic Opportunities

The Climate Solutions and Economic Opportunities (CSEO) project identifies strategies to help Minnesota reduce greenhouse gas (GHG) emissions by 30 percent by 2025 and 80 percent by 2050, goals laid out in the Next Generation Energy Act passed in 2007 by the Minnesota Legislature. Minnesota has made progress in reaching those goals, but it is not on track to meet either of them.

All of the immediate action policies in the CSEO analysis focus on the electric sector and would account for 64 percent to 79 percent of the identified GHG reductions that could be made between now and 2030.

In 2008, the Minnesota Climate Change Advisory Group (MCCAG) identified policies to reduce GHG emissions across sectors of the economy, including electricity supply, residential and commercial buildings, industry, transportation, waste management, and agriculture. While this work helped influence ideas on a state climate plan, many of these policies did not move forward.

In 2014, Minnesota began updating this work with the Climate Solutions and Economic Opportunities (CSEO) project. The purpose of this study was to evaluate Minnesota specific strategies from across Minnesota's economy for their potential to reduce harmful greenhouse gases that contribute to climate change, and for their potential to grow the state's economy. To set priorities for this reanalysis, stakeholders were convened by the Environmental Quality Board (EQB), the Department of Commerce, and the Minnesota Pollution Control Agency to discuss advances in technology and new policies ideas.

The final report[116] identifies strategies for immediate and long-term action:

- All of the **immediate action policies** focus on the electric sector and would account for 64 percent to 79 percent of the GHG reductions the analysis shows could be made between now and 2030.
    - The analysis shows that a 50 percent Renewable Electricity Standard alone would result in more than one quarter of the total greenhouse gas reductions needed to reach Minnesota's 2030 target.
    - In addition to renewable resources, great opportunity exists to reduce emissions and save money via energy efficiency. Efficiency opportunities identified in the report include expanding utility conservation improvement

[114] Lena Hansen, Rocky Mountain Institute, Scoping an Energy Future Study for Minnesota presentation.

[115] February 12, 2014 Legislative Energy Commission meeting: Presentation of Minnesota Energy Future Study Scoping Report.

[116] Minnesota Environmental Quality Board, Climate Solutions and Economic Opportunities, July 2016.

programs from 1.5 percent to 2 percent annually, increasing combined heat and power systems, broadening implementation of Minnesota's Sustainable Building (SB) 2030 initiative, and increasing efficiency efforts for wastewater treatment facilities. Increased application of SB 2030 would meet nearly 20 percent of the greenhouse gas reductions needed to achieve the 2030 target.

- **Long-term Strategies** are critical for reaching Minnesota's 2050 goals, but they require more time for development. Generally these policies reduce the use of single-occupancy internal-combustion vehicles and protect or increase carbon stores in soils and trees.

5. Minnesota 2025 Energy Action Plan

Minnesota currently imports 72 percent of the energy it consumes, mostly fossil fuels such as coal and oil. However, the state does have abundant renewable energy resources. Legislation passed in 2013 requires the Legislative Energy Commission, in consultation with stakeholders, the Department, and other state agencies, to develop a framework for Minnesota to transition to a renewable energy economy within the next few decades.[117]

In 2013 more than half of the energy inputs in Minnesota ended up as waste, such as heat that's vented off power plants or released from vehicle engines.[118]

To assist with the stakeholder engagement process and develop analysis on the state's baseline energy landscape, the Department of Commerce and Legislative Energy Commission successfully applied for a 2014 grant from the U.S. Department of Energy. The project team worked closely with over 50 stakeholders across the state from 2015-2016 to identify consensus-driven, near-term strategies to help meet Minnesota's energy goals.

The 2025 Energy Action Plan lays a path for Minnesota to meet or exceed its renewable energy and energy efficiency goals, while boosting the state's economy. The report recommends ways to leverage opportunities over the next decade to reduce this dependence and increase Minnesota's use of clean, affordable, reliable, and resilient energy.

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

Importantly, most strategies in this action plan do not require additional legislation to be successful; rather, the action plan identifies strategies that can be advanced immediately,

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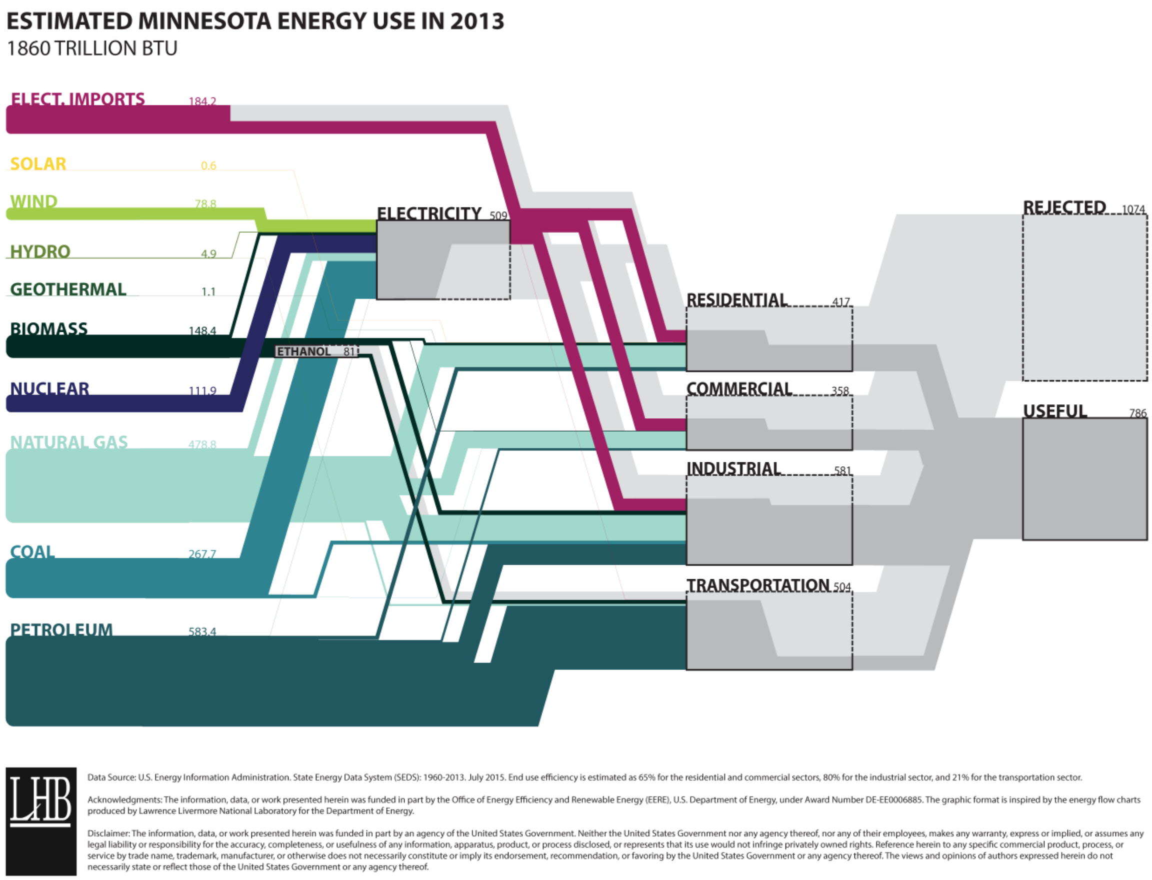
[117] Minn. Stat. § 3.8852: Planning Strategy for Sustainable Energy Future.

[118] Minnesota's 2025 Energy Action Plan, figure 4, page 21.

either individually or in combination. Within each strategy, the action plan also identifies cross-sector opportunities and related initiatives.

Figure 21: Estimated Minnesota energy use in 2013



a. Energy Landscape

Total Energy Use

- 42 percent of energy inputs in Minnesota were put to use in 2013. More than half of the energy ended up as waste, such as heat that's vented off power plants or released from vehicle engines.[119]

Minnesota's per capita energy consumption ranks 18th nationally, despite having the third-coldest winters in the U.S.

[119] Minnesota's 2025 Energy Action Plan, *figure 4, page 21.*

- 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.[120]
- In 2013, residential and commercial buildings accounted for 42 percent of energy use in Minnesota, followed by industrial and agricultural processes at 34 percent and transportation at 24 percent.[121]
- Residential and commercial buildings account for two-thirds of the state's electricity use and more than half of natural gas delivered in Minnesota.[122]
- Since 2003, gross state product has increased by 12 percent, while overall energy use has remained flat. This means Minnesota's overall energy intensity (i.e., the energy required to produce one dollar of gross state product) has been declining in the last two decades.[123]
- Minnesota's per capita energy consumption ranks 18th nationally, despite having the third-coldest winters in the U.S.[124]

Energy Efficiency

- Minnesota is on track to meet its energy efficiency standard of 1.5 percent savings in electricity and natural gas per year.[125]

Fossil fuels

- Minnesota has no indigenous fossil fuel reserves.[126]
- MN imported 72 percent of its energy in 2013.[127]

Renewable Energy

- In 2015, over 22 percent of electricity generated in Minnesota came from renewable energy sources. Minnesota is on track to meet its renewable electricity standard for over 25 percent renewable electricity by 2025.[128]
- Minnesota is not on track to reach the goal of 25 percent renewable sources for total energy used by 2025. Strategies in the 2025 Energy Action Plan put Minnesota on a pathway to meet this state goal.[129]

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120 Minnesota's 2025 Energy Action Plan, *p. 52.*

121 Minnesota's 2025 Energy Action Plan, *fig. 6, p. 22.*

122 Minnesota's 2025 Energy Action Plan, p. 68.

123 Minnesota's 2025 Energy Action Plan, fig. 8, p.24.

124 Minnesota's 2025 Energy Action Plan, p. 23.

125 Minnesota's 2025 Energy Action Plan, p. 8, 28.

126 Minnesota's 2025 Energy Action Plan, p. 17.

127 Minnesota's 2025 Energy Action Plan, p. 17.

128 Minnesota's 2025 Energy Action Plan, fig. 3, p.20 and p. 29.

129 Minnesota's 2025 Energy Action Plan, fig ES1, p. 8 and fig. 2, p. 19.

Transportation

- In 2014, Minnesotans spent $11 billion on transportation fuels, the majority of which were imported from out of state.[130]

Greenhouse Gas Emissions

- 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. Strategies in the 2025 Energy Action plan help create pathways to reduce greenhouse gas emissions in Minnesota.[131]

[130] Minnesota's 2025 Energy Action Plan, p. 38.

[131] Minnesota's 2025 Energy Action Plan, fig. 10, p. 25-26, p. 31.

APPENDIX A
Minnesota Public Utilities Commission (MPUC)

Rate Plan

Minnesota Statutes, Section 216C.18, Subdivision 1a, requires the Public Utilities Commission ("Commission" or "MPUC") to prepare a Rate Plan as part of the Quadrennial Report. The Rate Plan is to address the Commission's rate design policy pertaining to certain statutory energy goals: cogeneration and small power production (Minnesota Statute section 216B.164); energy conservation improvement (Minnesota Statute section 216B.241) and the use of fossil fuels and renewable energy (Minnesota Statute section 216C.05). In addition, the Commission is to make recommendations on possible administrative or legislative actions to accomplish those goals.

As directed by the statute, this Rate Plan Report focuses on how the Commission uses rate design to carry out its responsibilities and actions with respect to the three statutory energy goal areas cited above. This Report will first briefly touch on the Commission's broader responsibilities in energy utility ratemaking to put its energy policy responsibilities in context.

The Commission has many other responsibilities that are integral to implementing the state's energy policies that are not directly related to rate design, and thus will not be addressed in this Report. There statutory responsibilities include granting certificates of needs, site permits, and route permits for energy generation facilities and transmission lines; approving electric utility resource plans and reviewing utility transmission plans; setting planning values for environmental pollutants, and reviewing utility compliance with Renewable Energy Standards (RES) and Solar Energy Standards (SES).

Overview of Rate Making

Policy Direction on Overall Energy Rate-Making

Minnesota statutes include the following direction to the Commission in carrying out its energy utility rate-making responsibilities:

- Rates shall be just and reasonable, not unreasonably preferential or discriminatory, and consistent with the financial need of public utilities to provide service. (Minnesota Statute section 216B.03)
- Due consideration must be given to the public's need for adequate, efficient, and reasonable service and the need of the public utility for sufficient revenue to meet the cost of furnishing service and to earn a fair and reasonable return on its investments. (Minnesota Statute section 216B.16, subdivision 6)

- Rates shall, to the maximum extent possible, be set to encourage energy conservation and the use of renewable energy. (Minnesota Statute section 216B.03)
- Cogeneration and small production shall be encouraged consistent with the protection of rate- payers and the public (Minnesota Statute section 216B.164).

The Commission is directed to balance a number of factors when setting rates and implementing energy policy, including cost to consumers, financial needs of utilities, fairness to different groups of customers, reliability, and the environment.

Commission Activity on Energy Rate-Making

Rate Cases: General rate cases are a primary means by which the Commission establishes the overall level of revenues for the utility, how much of that revenue is to be collected from each customer class/group, and the design of specific rates and tariffs. Rate design issues typically include the level of fixed charges versus variable energy charges—higher fixed charges may allow more stable revenue collection for utilities but the resulting lower amount of revenue collected through energy charges may decrease the incentive for customers to conserve. The Commission balances these and other potentially competing goals when determining specific rate structure and design for energy utilities.

Rate Riders: There are more than 20 special revenue recovery mechanisms, often referred to as rate riders, allowed in Minnesota statutes. Riders generally allow changes, usually increases, in utility costs to be reflected in rates without requiring the utility to file a general rate case. The electric utilities have riders in place for transmission, renewable energy projects, Conservation Improvement Programs (CIP), emissions controls, mercury controls, fuel costs, among others. The Commission generally undertakes an annual review each rider and sets the related factors to be added to customer bills.

Alternative Rate Design for Xcel Energy: As a result of issues arising in Xcel Energy's 2013 electric rate case, the Commission decided to open a more generic proceeding to examine innovative rate design options, such as time-of-use or critical peak rates, and explore whether to require any related pilot programs, for Xcel Energy. The Commission has held two stakeholder workshops and solicited written comments to help explore such options, and is planning to continue its efforts over the next year.

Distributed Generation/Cogeneration and Small Power Production

Policy Direction on Distributed Generation

In 1978, Congress enacted the federal Public Utilities Regulatory Policies Act (PURPA), which among other things requires retail electric utilities to purchase power from cogeneration facilities and certain independent power producers, and gave state regulatory authorities the responsibility to implement many of its provisions, including setting avoid cost rates. In 1981, Minnesota enacted Minnesota Statute section 216B.164 to frame implementation of PURPA in this state; provisions regarding net-metering were added in 1983. Substantive additions were made in 2013 and 2015.

Commission responsibilities with respect to distributed generation include:

- Giving the maximum possible encouragement to cogeneration and small power production consistent with the protection of ratepayers and the public. (Minnesota Statute section 216B.164, subdivision 1)
- Setting rates for purchases by utilities of energy from cogeneration facilities and small power producers (collectively known as Qualifying Facilities), and for excess energy from net-metered customers. (Minnesota Statute section 216B.164, various subdivisions)
- Resolving disputes between electric utilities (public utilities, cooperatives, and municipal utilities) and qualifying facilities (Minnesota Statute section 216B.164, subdivision 5)
- Developing a Value of Solar (VOS) rate that compensates solar customers for the value to the utility system, customers, and society from interconnecting small solar. (Minnesota Statute section 216B.164, subdivision10)
- Implementing a Community Solar Garden program for Xcel Energy (Minnesota Statute section 216B.1641)
- Adopting interconnection standards for distributed generation (Minnesota Statute section 216B.1611)

Commission Activity on Distributed Generation

Rulemaking to implement 2013 statutory changes: Minnesota Statute section 216B.164 was amended in 2013 with respect to public utilities, including increasing the ceiling for net-metering of wind and solar facilities. The Commission adopted rules to implement these changes in 2015.

Alternative tariff (Value of Solar): 2013 amendments to Minnesota Statute section 216B.164 also authorized utilities to ask for Commission approval of a Value of Solar (VOS) tariff to replace standard net-metering for solar facilities, and required the Minnesota Department of Commerce (Department) to develop a methodology for calculating a VOS rate. The Commission initiated a proceeding for establishing and reviewing the VOS methodology. To-date, no electric utility has requested approval to use a VOS rate in place of net-metering.

Community Solar Gardens: Legislation enacted in 2013, Minnesota Statute section 216B.1641, required Xcel Energy to establish a Community Solar Garden (CSG) program for Commission review and approval. Xcel Energy's CSG program began accepting applications in December 2014. The program has been evolving and refinements are being implemented over time, including bill credit rates for subscribers.

Inquiry into the Reasonableness of DG Fees Under 2015 Legislation: Minnesota Statute section 216B.164 was amended in 2014 with respect to cooperative and municipal utilities, including allowing these entities to charge additional fees to recover fixed costs, which must be reasonable and appropriate based on a recent class cost of service study. The Commission received a number of complaints about the level of the fees being proposed by cooperatives, and has opened an inquiry into whether the fees conform to statutory requirements.

Revising DG Interconnection Standards: The Commission adopted interconnection standards in 2004, pursuant to Minnesota Statute section 216B.1611. In 2016, the Commission is in the process of revising and updating these interconnection standards to reflect technology changes and lessons learned from experience in Minnesota and other jurisdictions.

Energy Conservation Improvements

Policy Direction on Energy Conservation Improvements

The Department has the responsibility for implementing and overseeing utility conservation improvement programs (CIP) under Minnesota Statute section 216B.241. The Commission has responsibility for:

- Implementing utility cost recovery mechanisms to assure that public utilities recover their costs associated with CIP programs approved by Commerce. (Minn. Stat., Section 216B.241, subdivision 2b)
- Developing and implementing CIP performance incentive mechanisms for public utilities related to meeting energy savings goals. (Minnesota Statute section 216B.16, subdivision 6c and 216B.241, subdivision 2c)
- Developing criteria and standards for decoupling utility revenues from changes in energy sales to reduce a public utility's disincentive to promote energy efficiency, and implement pilot programs. (Minn. Stat., Section 216B.2412)
- Deciding appeals of Commerce's CIP program and CIP customer exemption decisions. (Minnesota Statute section 216B.241, subdivision 1a(e) and subdivision 2(e))

Commission Activity on Energy Conservation Improvements

CIP Financial Incentives: In 2008, the Commission was directed to review its CIP financial incentives under Minn. Stat. § 216B.16, subdivision 6c. The Commission approved a new shared-savings financial incentive in 2010 that awards a utility a percentage of the net benefits created by a utility's energy conservation investments. The Commission made adjustments in 2012, and asked Commerce to conduct an in-depth review of the program in 3 years. Based on that review and stakeholder comments, the Commission approved modifications to the incentive program, and requested another in-depth review by July 1, 2019.

Annual CIP Cost-Recovery Adjustment Riders: The Commission allows all natural gas and electric public utilities include their CIP program-related costs in base rates established in rate cases. The Commission also allows these utilities to track the difference between actual costs and incurred costs for annual recovery in a rider. As part of this annual review, the Commission approves utilities' financial incentives for inclusion in the rider.

Decoupling: The Commission issued its Order "Establishing Criteria and Standards to be Utilized in Pilot Proposals for Revenue Decoupling" on June 19, 2009. The Commission approved a 3-year partial decoupling pilot program for CenterPoint Energy (CPE) in January 2010, and approved a full decoupling pilot program for CPE, effective July 1, 2015. The Commission approved a 3-year pilot full decoupling program for Minnesota Energy Resources (MERC) effective January 1, 2013, and a broader decoupling program for MERC in its recent rate case, to take effect in 2016. The Commission recently approved a decoupling pilot for Great Plains Natural Gas Company.

At the time this Report was prepared, decoupling programs for Xcel Energy and Otter Tail Power were being discussed in their pending electric rate cases.

Renewable Energy Rates

As noted in the introductory section, the Commission has a wide variety of statutory mandates and responsibility with respect to implementing the state's energy policy, including reviewing compliance with the RES and SES, reviewing and approving electric utility resources plans, and granting certificates of need for energy facilities. The focus of this section is limited to specific rate design matters related to renewable energy policy that have not already been addressed in earlier sections of the Report.

Policy Direction on Renewable Energy Rates

Minnesota Statutes include the following general direction to the Commission:

- Rates shall, to the maximum extent possible, be set to encourage energy conservation and the use of renewable energy. (Minnesota Statute section 216B.03)

Commission Activity on Renewable Energy Rates

Green pricing: Minnesota Statute section 216B.169 provides for electric utilities to offer renewable and high-efficiency energy rate options. While changes to this statute in 2010 no longer make offering such rates mandatory, the electric utilities continue to offer such rates, and proposing modifications. The Commission adopted tariff changes for each utility to implement this provision and continues to review the rates and proposed changes to them.

Electric Vehicle Charging Tariffs: Legislation enacted in 2014 (Minnesota Statute section 216B.1614) required electric public utilities to file proposed tariffs with the Commission to allow residential customers to purchase electricity for recharging an electric vehicle under several rate options, including time of use, renewable, and standard mix of energy supply. The Commission has approved such tariffs for each public utility, and will continue to monitor the results and modify the tariffs if necessary.

Future Policy Directions

The energy industry today face changing market conditions and customer expectations, emergence of new technologies, as well as active pursuit of alternative public policy options. Achieving reliable, affordable and environmentally sound energy services requires pursuit of creative policy alternatives balancing the interests of ratepayers, shareholders, and the general public interest. The Commission will continue to strive to set the appropriate balance as it helps to implement state energy policy and decides rate cases, riders, resource plans, and other proceedings. The Commission will also continue to pursue generic inquires on grid modernization, interconnection requirements, and rate design, as well as participating in regional and national discussions that have direct bearing on Minnesota's interests.

APPENDIX B
Minnesota Energy Consumption, Expenditures, and Prices

This data comes primarily from two sources: data collected internally pursuant to Minnesota Statute section 216C.17 through the Department's Regional Energy Information System (REIS), and data obtained through the U.S. Energy Information Administration (EIA).

Because the Department sought to provide the most current data available (2014) from these different sources data references may cite differing years. Although utilities submit some of the same data to both REIS and EIA, updates are not necessarily provided to both systems at the same time.

Consumption – how much energy does Minnesota use?

Total Energy Consumption by Source (2014)

Minnesotans consumed a total of 1,912 trillion BTUs of energy (electricity, natural gas, petroleum products, coal, and renewable energy) in 2014, or approximately 2 percent greater consumption than in 2010. Characterizing energy consumption by fuel type or commodity, the use of petroleum was the highest overall concentration of energy consumption in Minnesota in 2014. Compared with 2010, the consumption of petroleum products declined by over 2 percent in 2014.

The increase in total energy consumed was mostly comprised of natural gas, the actual consumption of which increased approximately 14 percent from 2010 to 2014, and renewable energy, which increased approximately 19 percent from 2010 to 2014.

Figure 22: Total energy consumed in Minnesota, percent by source, 2014

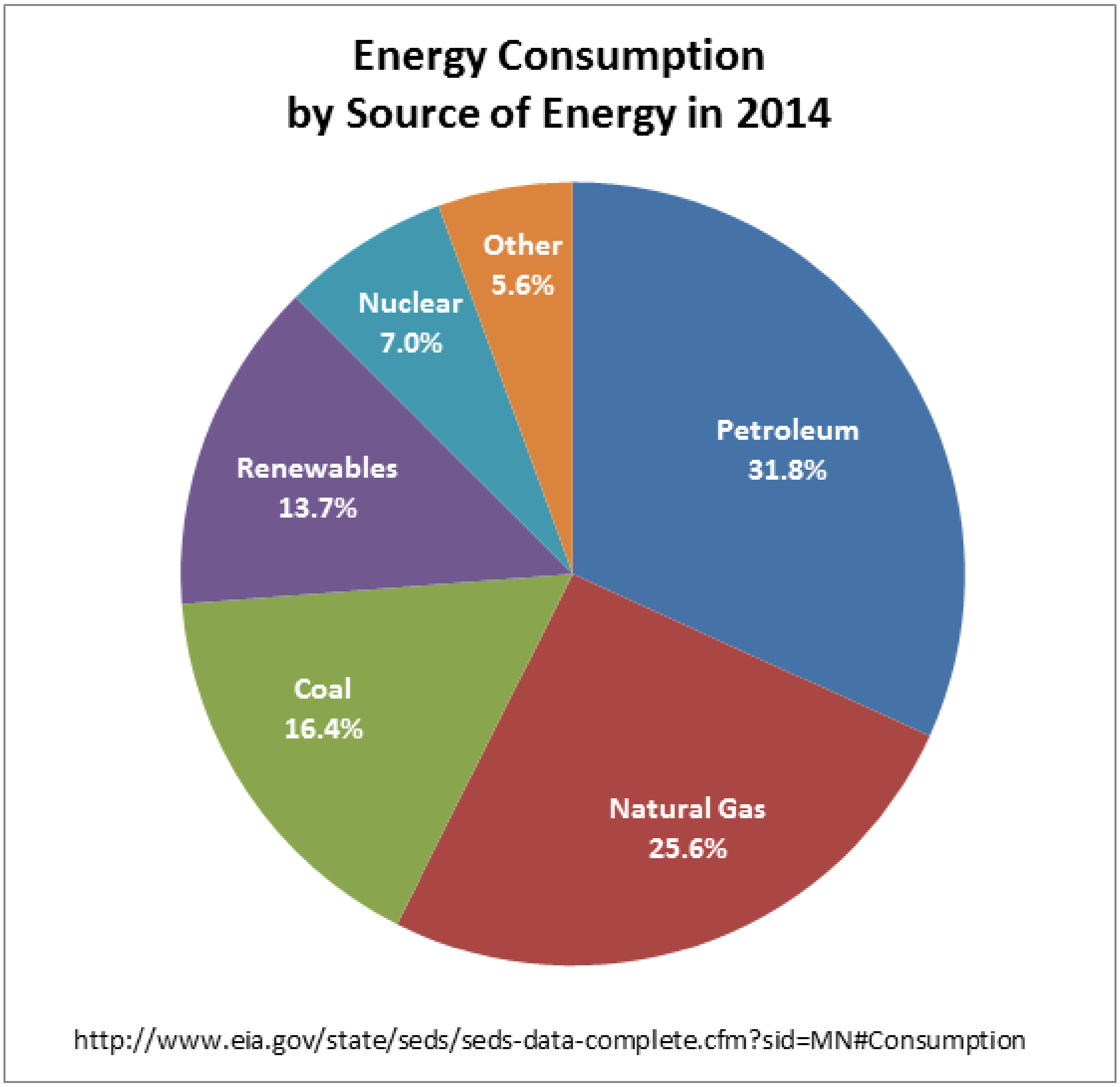


Figure 23: Minnesota Total Renewable Energy Consumption, 2014

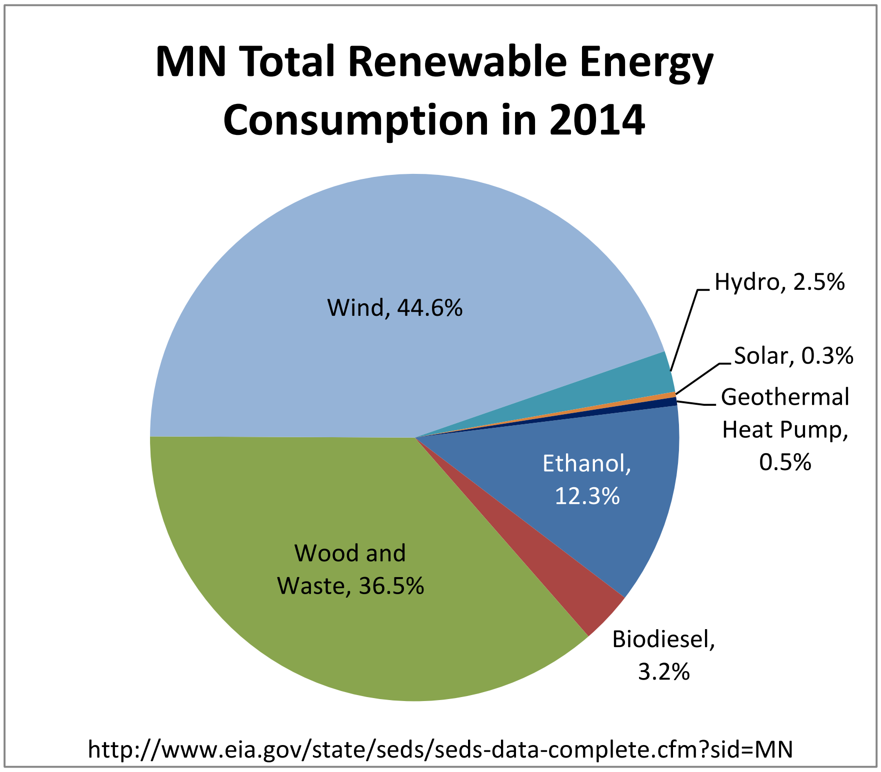


Figure 24: Total energy consumed in Minnesota, BTU per source, 1994-2014

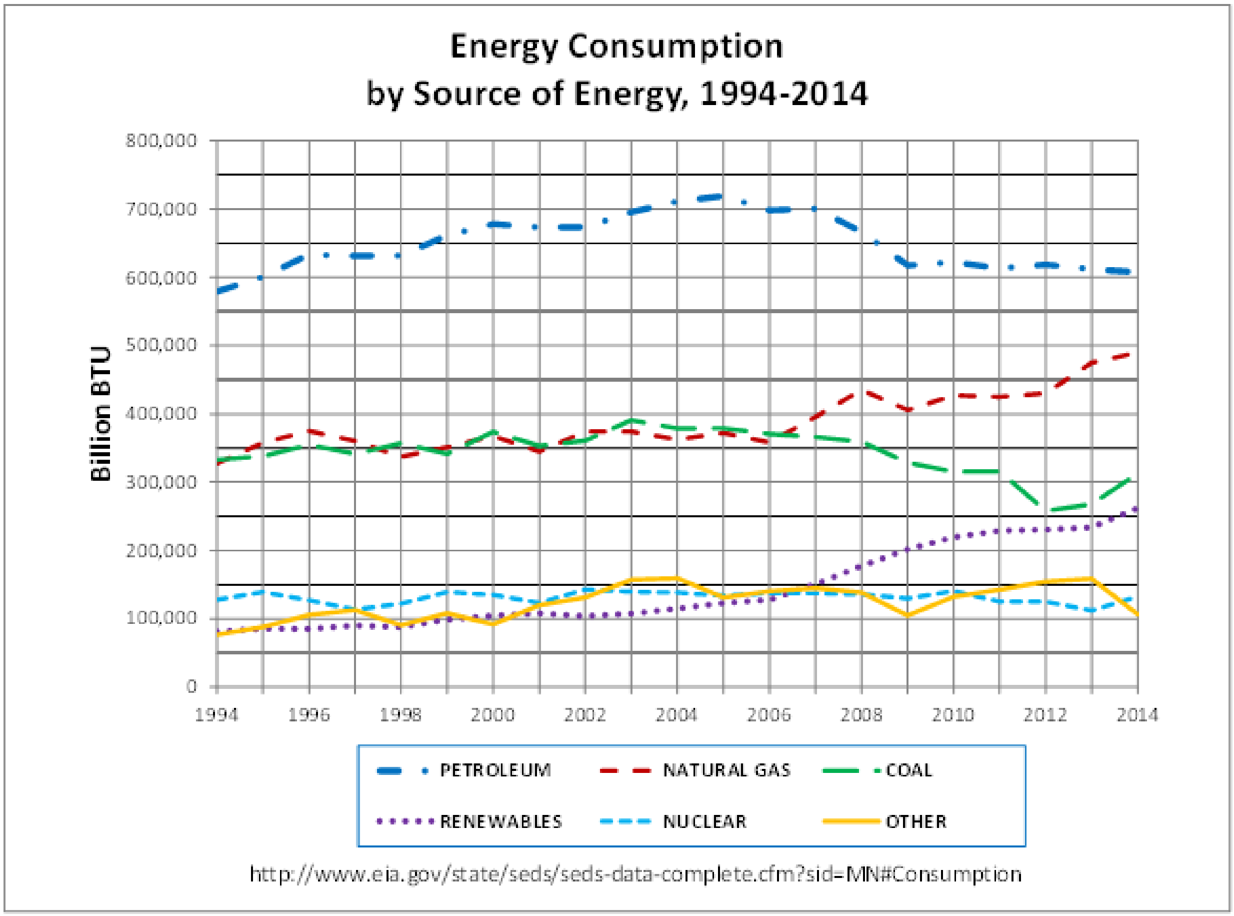
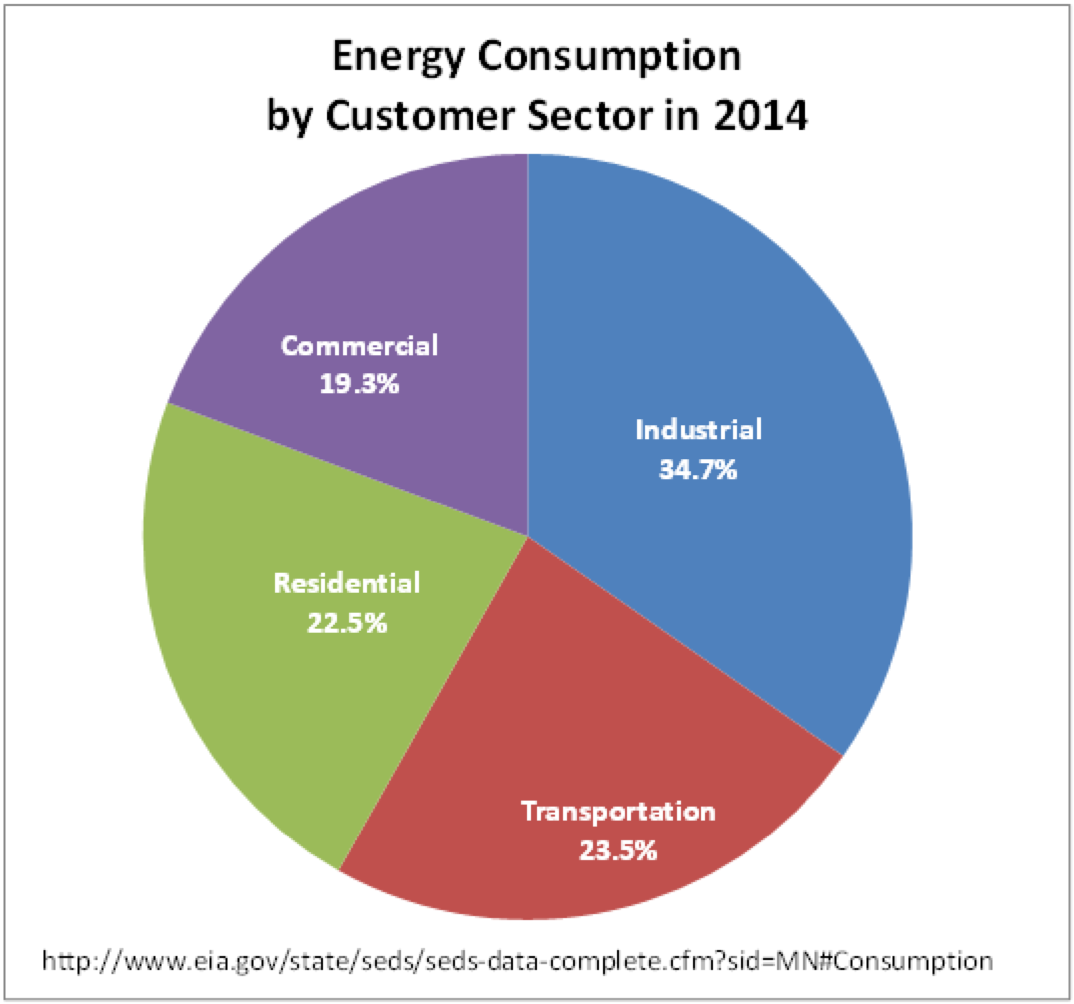


Figure 24 above shows trends in energy consumption by source over twenty years from 1994 to 2014. Starting around 2006, an overall trend can be seen in decreasing consumption of petroleum and coal, and an increase in natural gas and renewable energy consumption.

Total Energy Consumption by Sector – 2014

Figure 25: Total energy consumed in Minnesota, percent by sector, 2014



The total and relative amounts of energy Minnesotans consumed in 2014 by commercial, residential, industrial and transportation customer sectors are shown in Table 11.

Table 11: Total energy consumed in Minnesota, percent and BTU per sector, 2014

Sector	Billion BTU	Percentage
Total	1,912,065	100.0%
Industrial	663,280	34.7%
Transportation	449,109	23.5%
Residential	430,726	22.5%
Commercial	368,950	19.3%

Figure 26: Total energy consumed in Minnesota, BTU per sector, 1994-2014

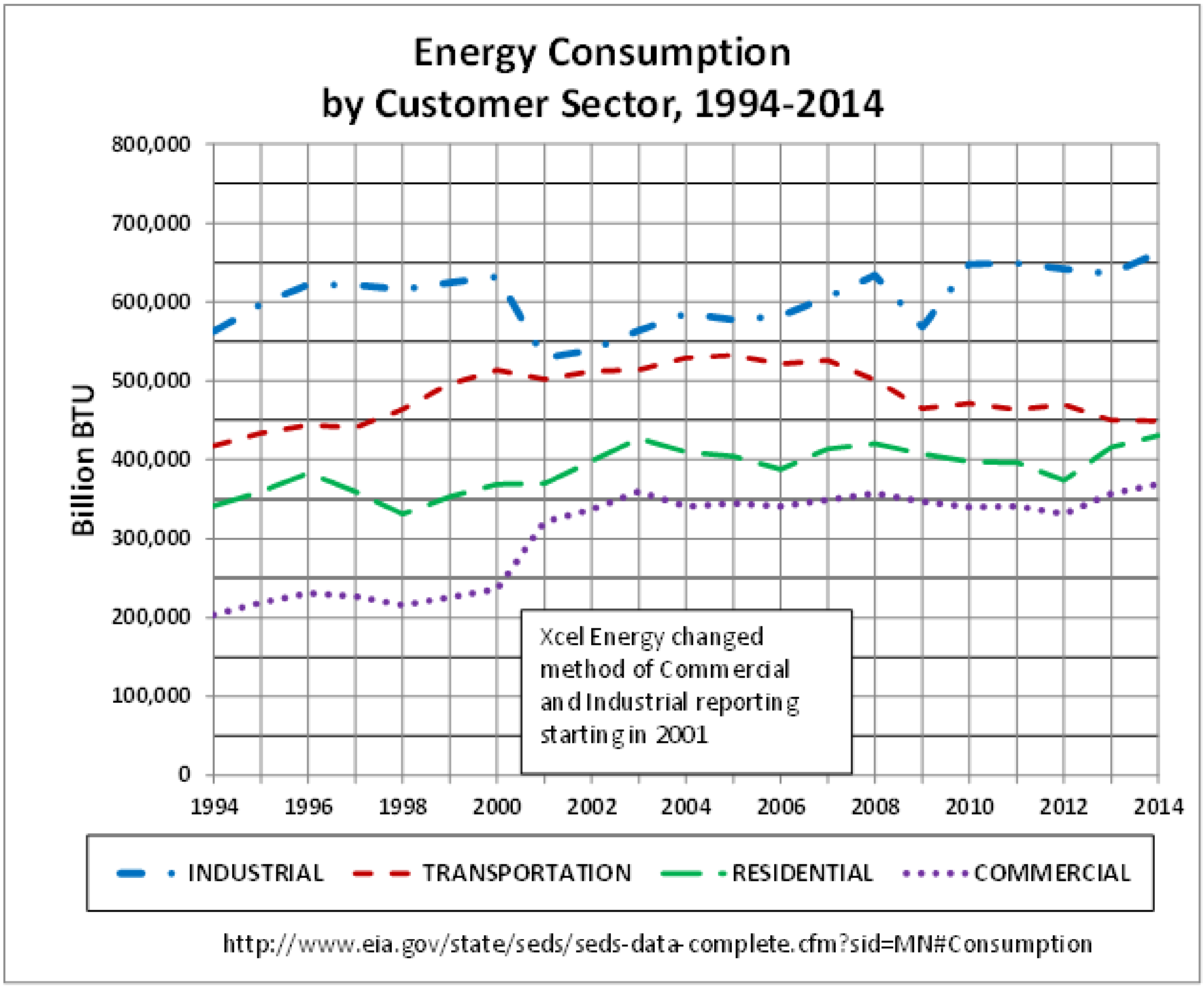


Figure 26 above shows trends in energy consumption in BTUs per customer sector over the twenty year period from 1994 to 2014. Since 2003, Energy use in the Residential and Commercial sectors has remained relatively flat, despite an increase in population and economic activity. Energy use in the industrial sector has gradually increased with the exception of a drop in 2009 from economic disruption. Since 2004, energy use in the transportation sector has decreased. *Note that Xcel Energy changed its method of reporting Commercial and Industrial sectors starting in 2001.*

Electricity Consumption by Source

In 2014, the electric sector used 706 trillion BTUs of energy for the production of electricity consumed in Minnesota. Compared with 2010, total use of energy for electricity consumption rose by 0.2 percent in 2014.

Table 12: Electricity consumed in Minnesota, BTU and percent by source, 2014

Source	Billion BTU	Percentage
Total	705,860	100%
Coal	289,683	41.0%
Nuclear	132,904	18.8%
Wind	91,872	13.0%
Natural Gas	31,690	4.5%
Biomass	22,132	3.1%
Hydro	5,032	0.7%
Petroleum	673	0.1%
Solar	25	0.004%
Net Interstate Imports	108,829	15.4%
Net US Imports	23,025	3.3%

Figure 27: Minnesota Electricity Consumption by Source, 2014

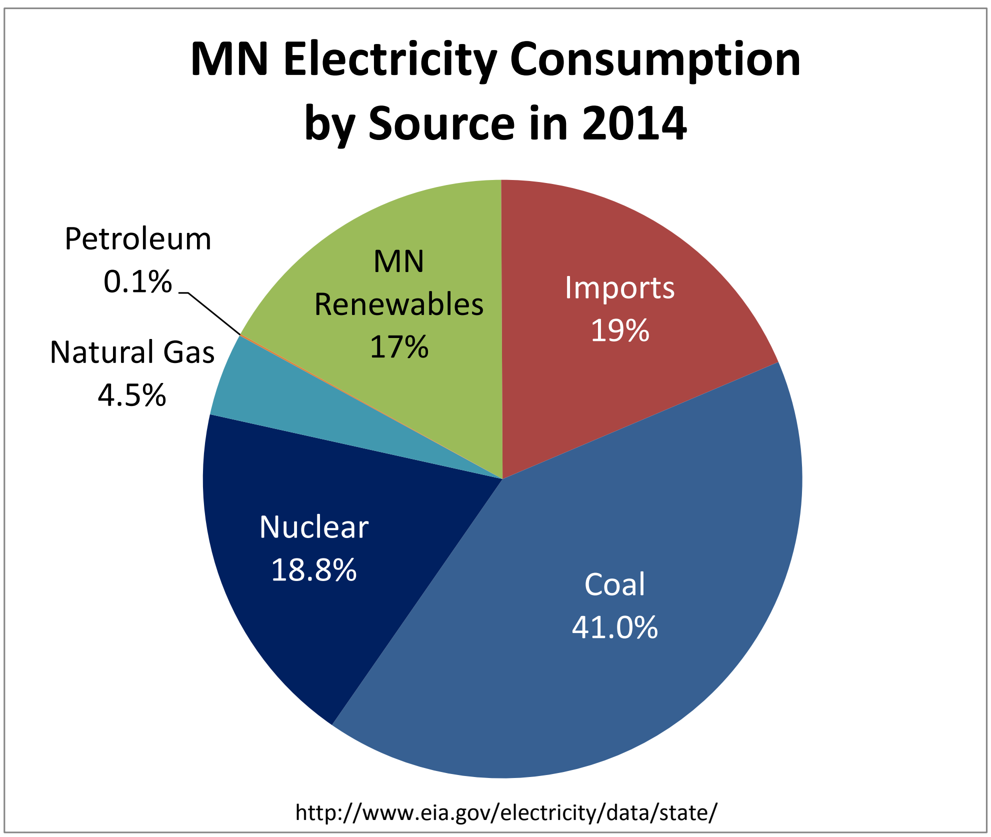


Figure 27 above shows the sources of energy used to generate electricity consumed in Minnesota in 2014. Coal is the largest fuel source for electricity generation at 41 percent.

Nearly one fifth of the electricity consumed in Minnesota is imported from generators located in neighboring states and Canada. Electricity used in Minnesota is powered 18.8 percent from nuclear generators, 17 percent from renewable energy, and 4.5 percent from natural gas.

Figure 28: Minnesota Electricity Consumption by Source of Energy, 1994-2014

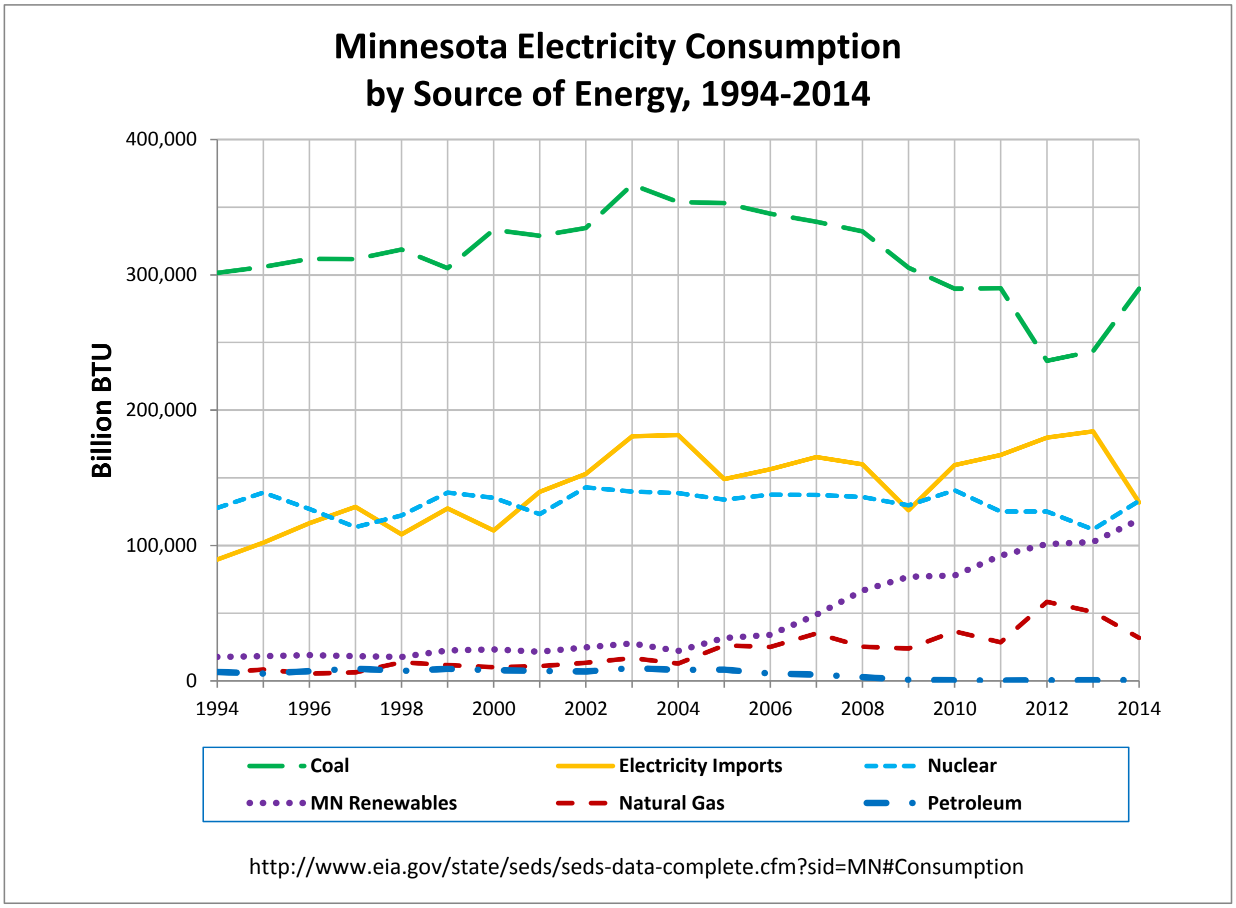


Figure 28 above shows the changing mix of energy sources used to generate electricity consumed in Minnesota from 1994 to 2014. Use of renewable energy sources for electricity production has increased steadily from 22 trillion BTUs in 2004 to 119 trillion BTUs in 2014. The amount of coal used to generate electricity decreased 21 percent from a high of 367 trillion BTUs in 2003 to 290 trillion BTUs in 2014. A dip in coal use and corresponding increase in imports and natural gas from 2012 to 2013 is the result of a generator outage at Xcel Energy's Sherburne County Generating Station (Sherco).

Electricity Consumption by Sector

In 2014, citizens, institutions, and firms in Minnesota consumed (purchased) 68,719 gigawatt hours of electricity. Compared with 2010, total electricity consumption rose by slightly more than 1 percent in 2014.

Dividing electricity consumption by economic sector, industrial, residential and commercial customers consumed nearly identical amounts of electricity in Minnesota in 2014. Relative amounts of electricity Minnesotans consumed in 2014 by the three major customer sectors are shown in Table 13 below. The transportation sector consumed less than 0.1 percent of the total electricity consumed in Minnesota in 2014.

Table 13: Electricity consumed in Minnesota, GWh and percent by sector, 2014

Sector	Gigawatt Hours	Percentage
Total	68,719	100%
Industrial	23,076	33.6%
Commercial	22,828	33.2%
Residential	22,791	33.2%
Transportation	24	0.03%

Figure 29: Electricity consumed in Minnesota, percent by sector, 2014

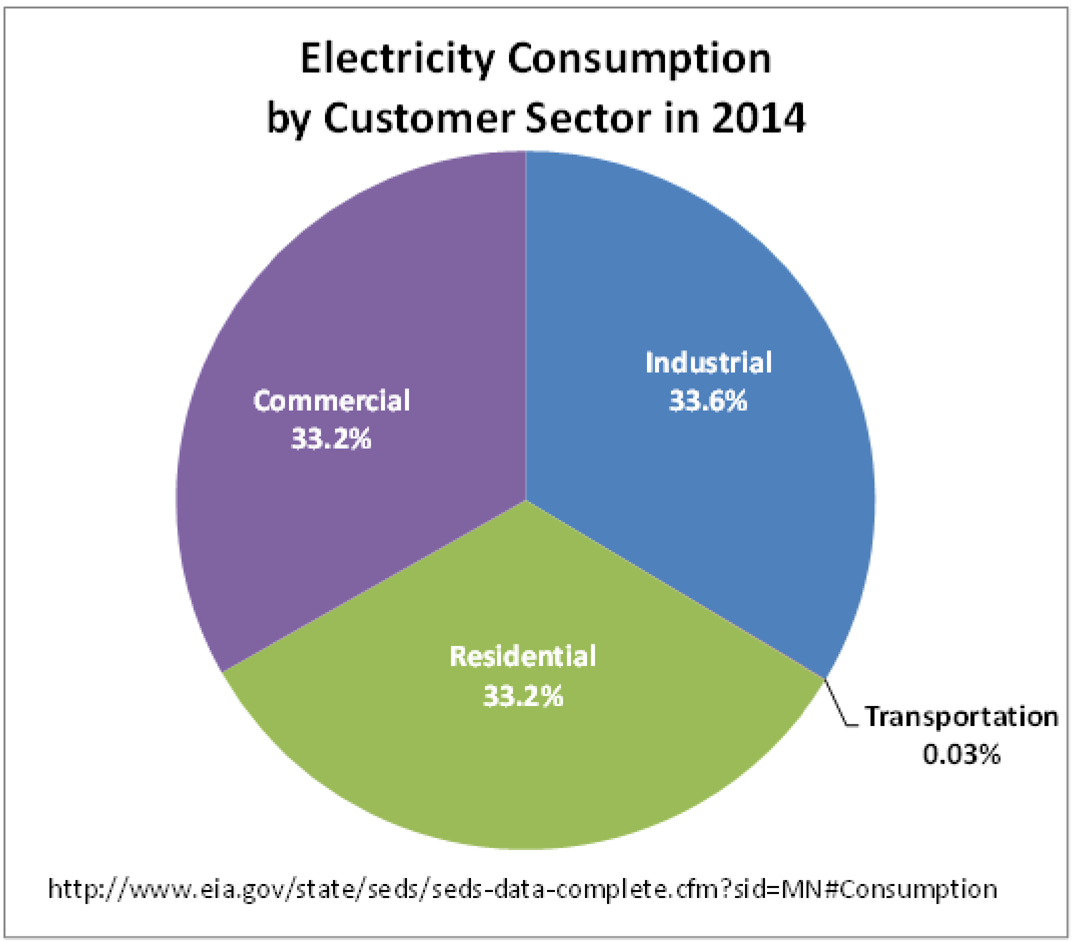
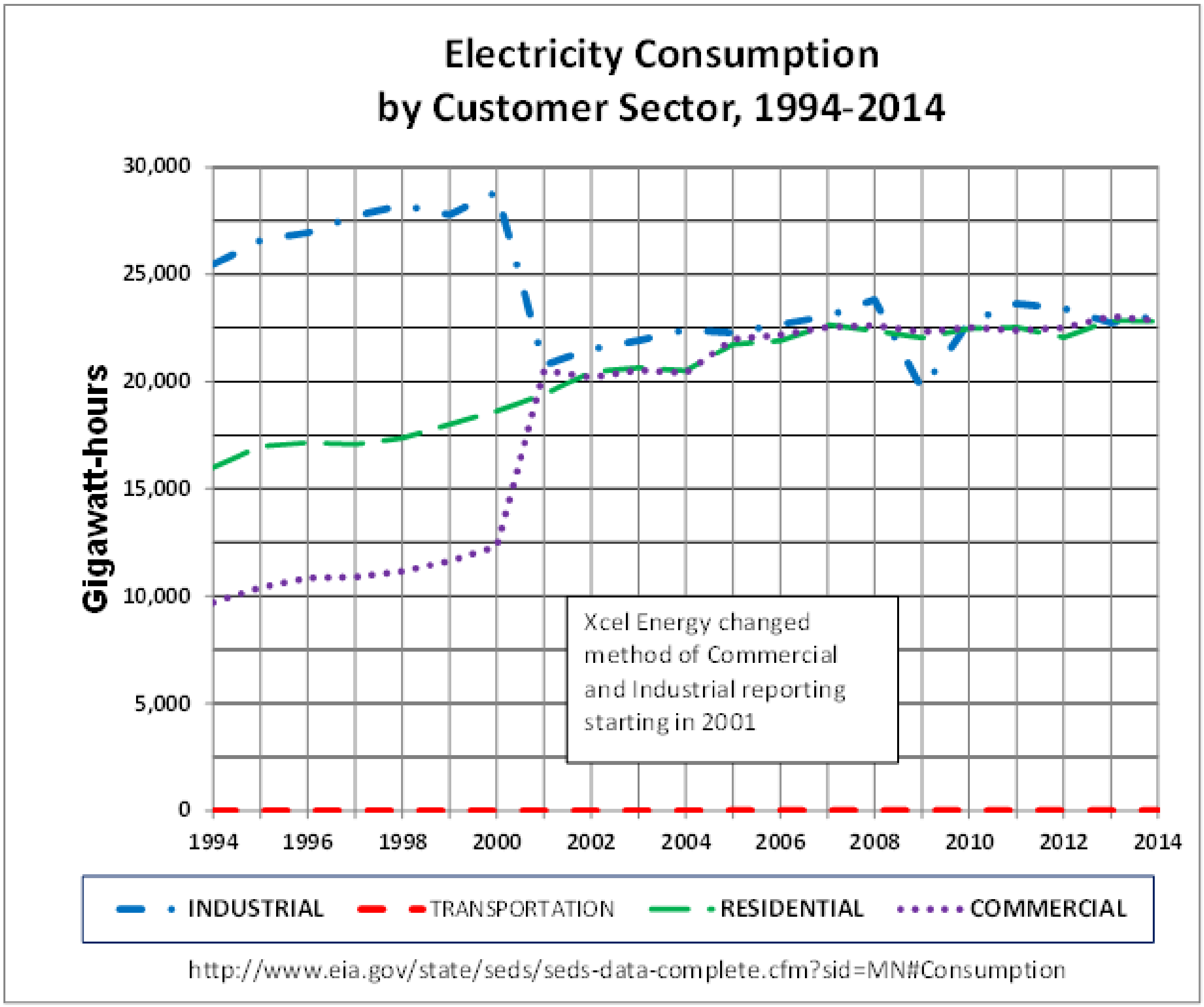


Figure 30: Electricity consumption in Minnesota, GWh by customer sector, 1994-2014



Note: Xcel Energy changed its method of commercial and industrial sector reporting starting in 2001.

Figure 30 above illustrates Minnesota's changing demand for electricity. Total demand for electricity has increased an average of approximately 1.5 percent annually over the period from 1994 to 2014. A simple trend- line fit to the total demand indicates an average annual increase of approximately 878 gigawatt-hours per year over the last 20 years. However, most of this increase occurred through 2008 and the total electricity usage has been fairly steady since 2010. This is at least partially due to energy conservation and efficiency, as well as the effect of economic cycles.

Additional detail regarding the residential demand for electricity can be noted from the above Figure. The annual electricity demand per residential customer over the time period from 1994 to 2014 is shown. The graph indicates a steady increase in demand until the early 2000s, with an apparent leveling off in the last 5 to 10 years.

Data on electricity consumption by customer sector from 2004 to 2014 is shown in Table 14

Table 14: Minnesota electricity consumption by sector, 2004-2014

Minnesota Electricity Consumption by Sector, 2004 – 2014

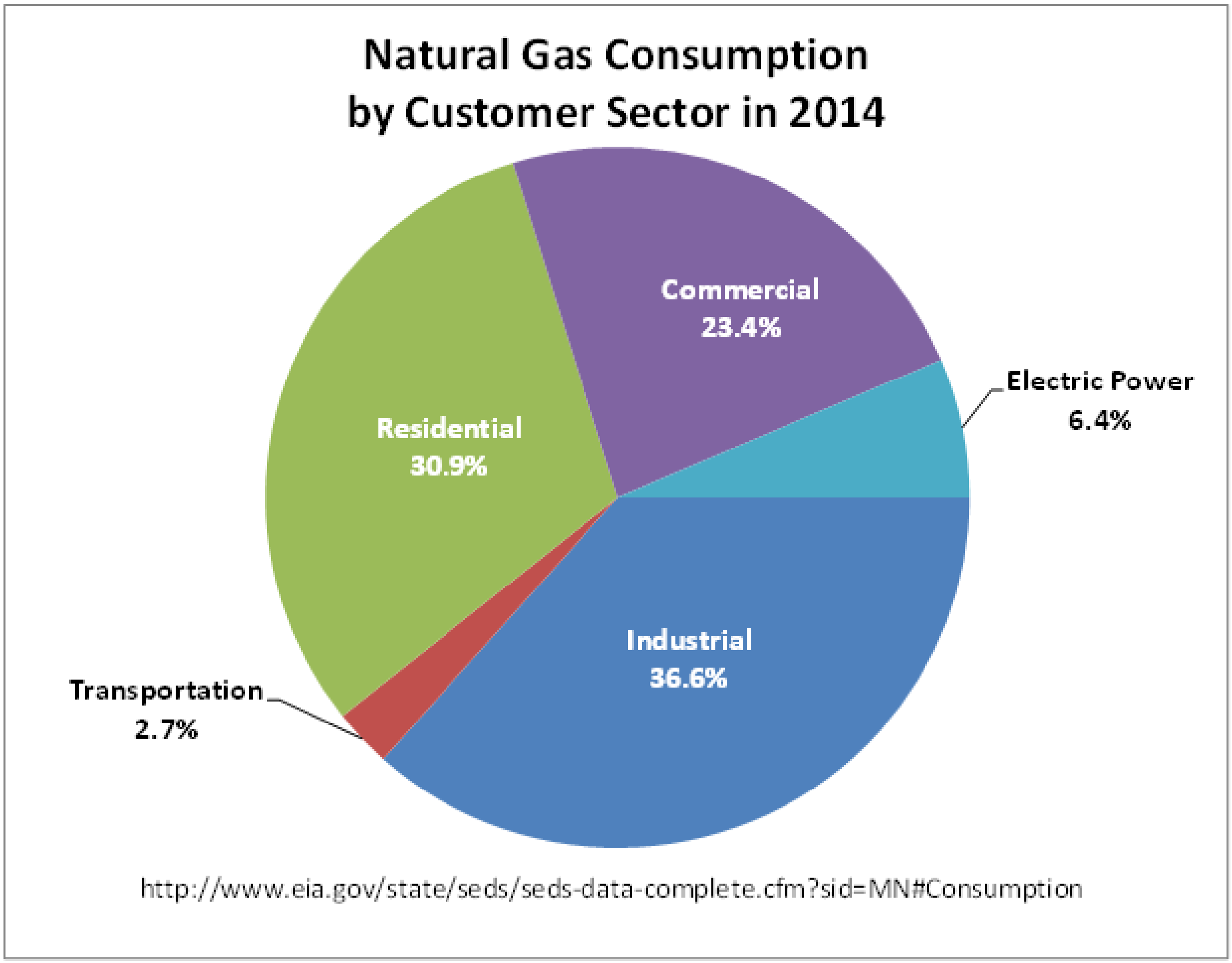
	Industrial			Residential			Commercial			Transportation			Total Electricity		
Year	GWH	GWH Change	**% Change**	GWH	GWH Change	**% Change**	GWH	GWH Change	**% Change**	GWH	GWH Change	**% Change**	GWH	GWH Change	**% Change**
2004	22,415			20,507			20,407			11			63,340		
2005	22,266	-149	**-0.7%**	21,743	1,236	**6.0%**	21,985	1,578	**7.7%**	25	14	**127.3%**	66,019	2,679	**4.2%**
2006	22,664	398	**1.8%**	21,909	166	**0.8%**	22,175	190	**0.9%**	21	-4	**-16.0%**	66,770	751	**1.1%**
2007	23,041	377	**1.7%**	22,646	737	**3.4%**	22,523	348	**1.6%**	21	0	**0.0%**	68,231	1,461	**2.2%**
2008	23,810	769	**3.3%**	22,357	-289	**-1.3%**	22,604	81	**0.4%**	22	1	**4.8%**	68,794	563	**0.8%**
2009	19,637	-4,173	**-17.5%**	22,034	-323	**-1.4%**	22,311	-293	**-1.3%**	22	0	**0.0%**	64,004	-4,790	**-7.0%**
2010	22,798	3,161	**16.1%**	22,465	431	**2.0%**	22,515	204	**0.9%**	22	0	**0.0%**	67,800	3,796	**5.9%**
2011	23,619	821	**3.6%**	22,524	59	**0.3%**	22,371	-144	**-0.6%**	19	-3	**-13.6%**	68,533	733	**1.1%**
2012	23,416	-203	**-0.9%**	22,060	-464	**-2.1%**	22,496	125	**0.6%**	17	-2	**-10.5%**	67,989	-544	**-0.8%**
2013	22,734	-682	**-2.9%**	22,850	790	**3.6%**	23,041	545	**2.4%**	19	2	**11.8%**	68,644	655	**1.0%**
2014	23,076	342	**1.5%**	22,791	-59	**-0.3%**	22,828	-213	**-0.9%**	24	5	**26.3%**	68,719	75	**0.1%**
Since 2004		661	**2.9%**		2,284	**11.1%**		2,421	**11.9%**		13	**118.2%**		5,379	**8.5%**

Notes:

1. *GWH = Consumption in Gigawatt-hours*
2. *GWH Change = Change in consumption from previous year*
3. *% Change = Percent change in consumption from previous year*
4. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota*

Natural Gas Consumption by Sector

Figure 31: Natural gas consumed in Minnesota, percent by sector, 2014



Minnesota does not have natural gas reserves. All natural gas supply to the state is imported, with the exception of small amounts of renewable natural gas. Minnesotans consumed a total of 474.25 billion cubic feet of natural gas in 2014.

The relative amounts of natural gas Minnesotans consumed in 2014 by customer sector are shown in Figure 31.

Table 15: Natural gas consumed in Minnesota, MMcf and percent by sector, 2014

Sector	Million Cubic Feet	Percentage
Total	474,251	100.0
Industrial	173,556	36.6
Residential	146,647	30.9
Commercial	110,905	23.4
Electric Power	30,437	6.4
Transportation	12,706	2.7

Figure 32: Natural gas consumption in Minnesota, MMcf by customer sector, 1994-2014

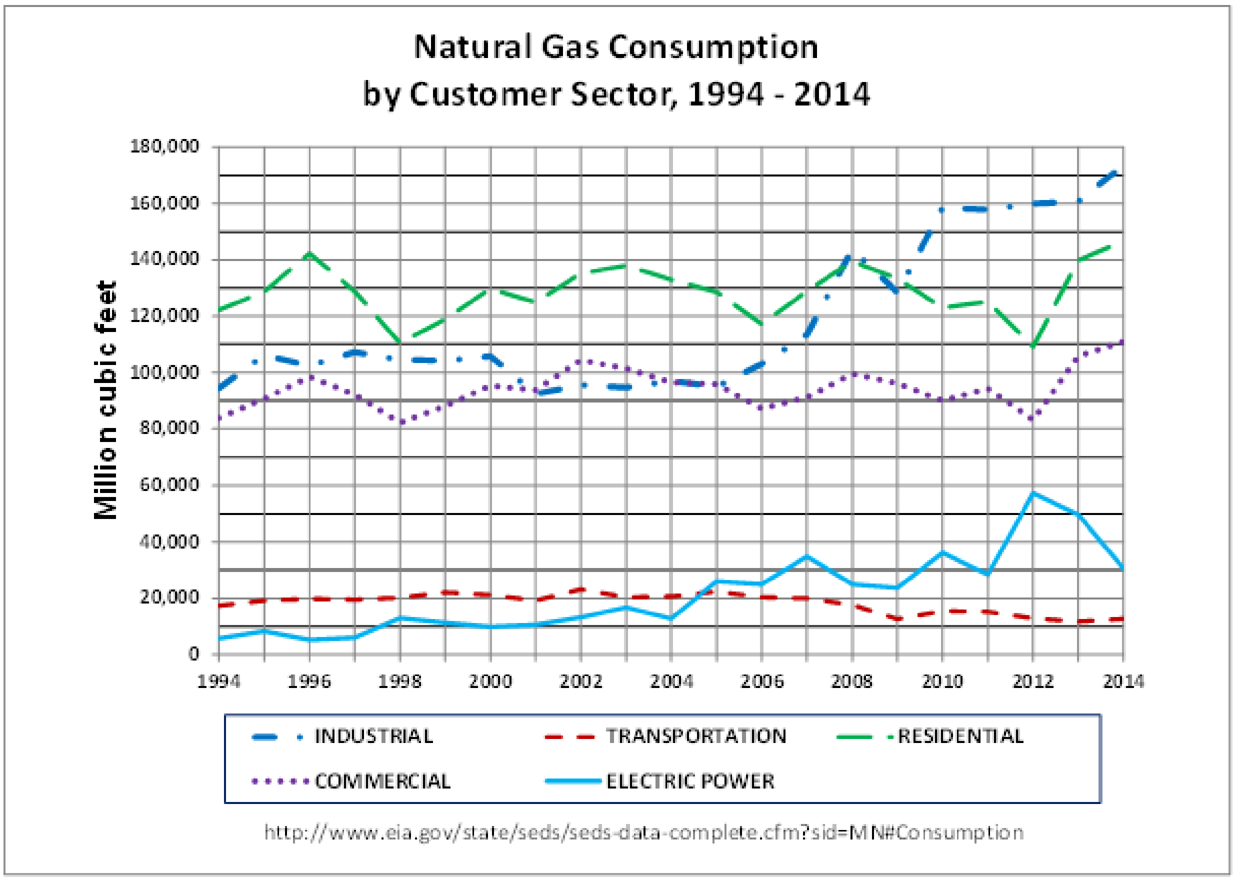


Figure 32 shows two notable consumption trends. First, use of natural gas for electricity generation is starting to increase. During the energy crisis in the middle and late 1970s, use of natural gas for electric generation declined sharply. Recently, however, natural gas has been used at significantly higher rates to generate electricity. While this upward trend is only slightly evident in this figure, the increase is more noticeable starting in 2003, as newly approved natural-gas facilities began to go online in Minnesota. One of the reasons for turning to natural gas as a fuel source for electricity is that gas-fired plants have fewer harmful environmental effects than other traditional fossil fuels such as coal or fuel oil. Another reason is that natural gas is becoming more cost effective relative to other generation sources.

Natural Gas consumption by customer sector from 2004 to 2014 is shown in Table 16 below.

Table 16: Change in MN natural gas consumption, MMcf by sector, 2004-2014

Minnesota Natural Gas Consumption by Customer Sector, 2004 – 2014

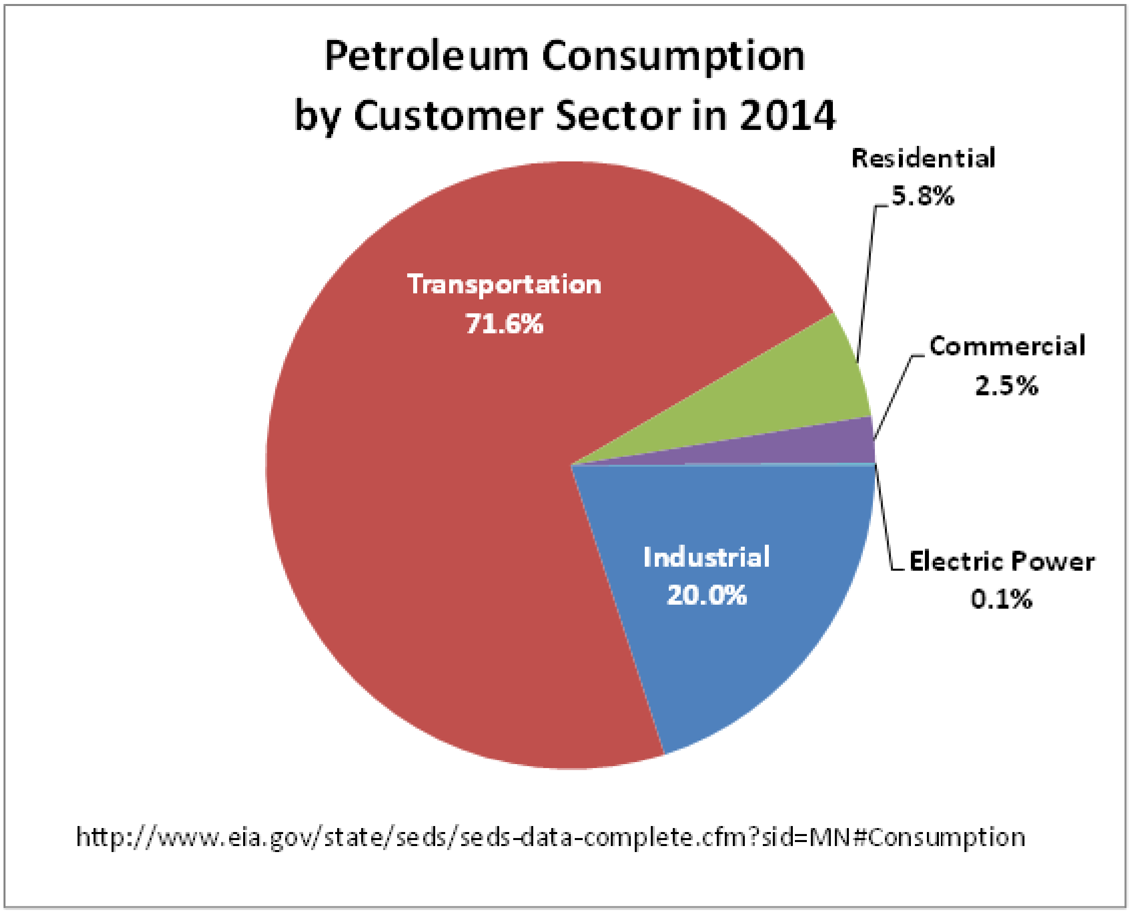
	Industrial			Residential			Commercial			Transportation			Electric Power			Total Natural Gas		
Year	MMcf	MMcf Change	**% Change**	MMcf	MMcf Change	**% Change**	MMcf	MMcf Change	**% Change**	MMcf	MMcf Change	**% Change**	MMcf	MMcf Change	**% Change**	MMcf	MMcf Change	**% Change**
2004	97,103			132,893			96,541			20,588			12,773			359,898		
2005	94,989	-2,114	-2.2%	128,625	-4,268	-3.2%	95,916	-625	-0.6%	22,271	1,683	8.2%	26,024	13,251	103.7%	367,825	7,927	2.2%
2006	103,009	8,020	8.4%	117,153	-11,472	-8.9%	87,170	-8,746	-9.1%	20,328	-1,943	-8.7%	24,911	-1,113	-4.3%	352,570	-15,255	-4.1%
2007	113,504	10,495	10.2%	128,842	11,689	10.0%	91,275	4,105	4.7%	19,924	-404	-2.0%	34,790	9,879	39.7%	388,335	35,765	10.1%
2008	143,837	30,333	26.7%	139,489	10,647	8.3%	99,526	8,251	9.0%	17,599	-2,325	-11.7%	24,900	-9,890	-28.4%	425,351	37,016	9.5%
2009	128,361	-15,476	-10.8%	133,319	-6,170	-4.4%	96,218	-3,308	-3.3%	12,571	-5,028	-28.6%	23,665	-1,235	-5.0%	394,134	-31,217	-7.3%
2010	158,457	30,096	23.4%	122,993	-10,326	-7.7%	89,963	-6,255	-6.5%	15,479	2,908	23.1%	36,076	12,411	52.4%	422,968	28,834	7.3%
2011	157,776	-681	-0.4%	125,160	2,167	1.8%	94,360	4,397	4.9%	15,230	-249	-1.6%	28,244	-7,832	-21.7%	420,770	-2,198	-0.5%
2012	159,947	2,171	1.4%	109,103	-16,057	-12.8%	83,174	-11,186	-11.9%	12,849	-2,381	-15.6%	57,190	28,946	102.5%	422,263	1,493	0.4%
2013	160,732	785	0.5%	139,897	30,794	28.2%	105,937	22,763	27.4%	11,667	-1,182	-9.2%	49,640	-7,550	-13.2%	467,873	45,610	10.8%
2014	173,556	12,824	8.0%	146,647	6,750	4.8%	110,905	4,968	4.7%	12,706	1,039	8.9%	30,437	-19,203	-38.7%	474,251	6,378	1.4%
Since 2004		76,453	78.7%		13,754	10.3%		14,364	14.9%		-7,882	-38.3%		17,664	138.3%		114,353	31.8%

Notes:

1. *MMcf = Consumption in million cubic feet*
2. *MMcf Change = Change in consumption (million cubic feet) from previous year*
3. *% Change = Percent change in consumption from previous year*
4. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota*

Petroleum Consumption by Sector

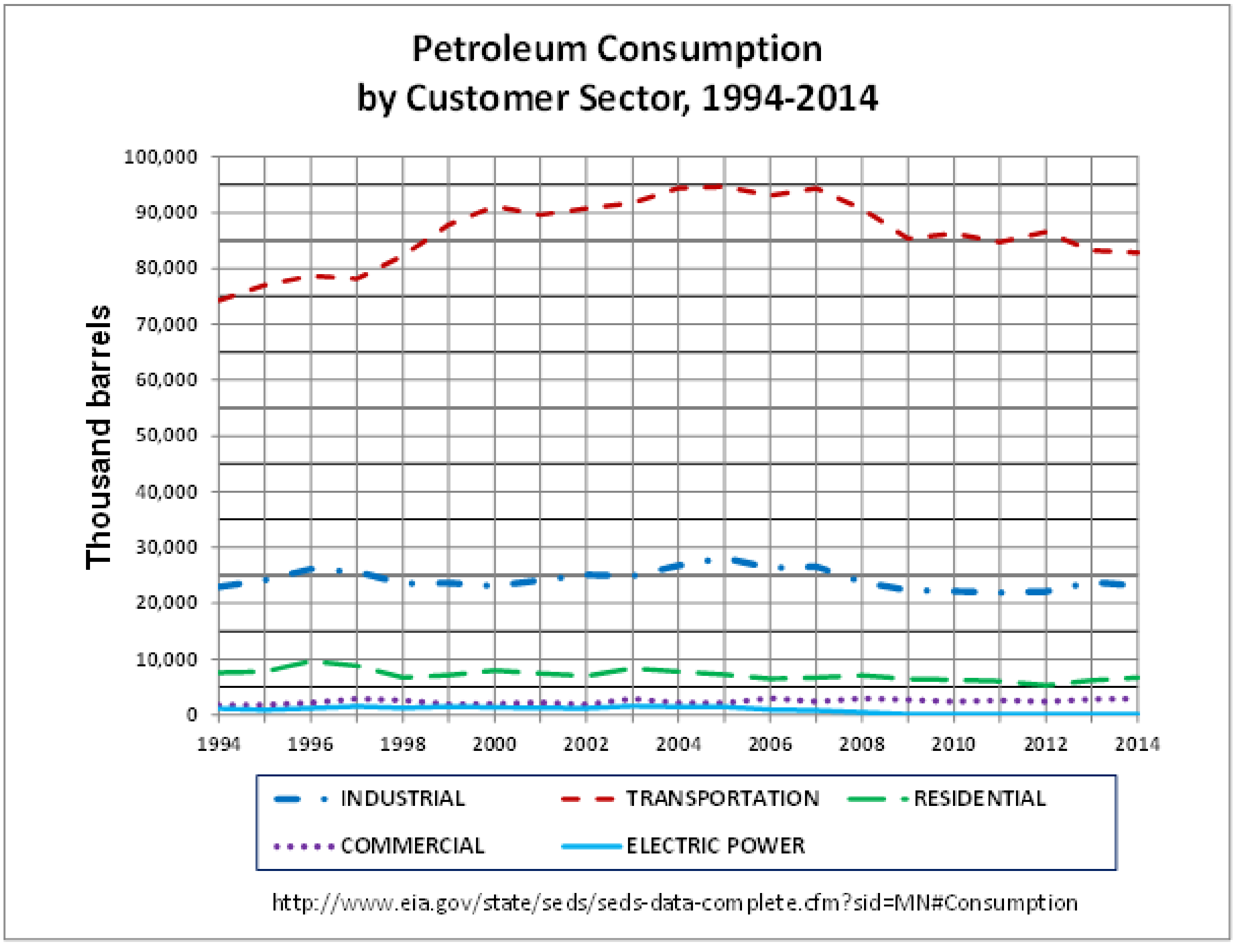
Figure 33: Petroleum consumed in Minnesota, percent by sector, 2014



Minnesotans consumed a total of 607.7 trillion Btus (115.6 million barrels) of petroleum products in 2014. This number continues the general downward trend in consumption since 2005. Figure 33 above shows the proportion of total petroleum consumption in Minnesota for the residential, commercial, industrial, transportation, and electric power generation customer classes.

In 2014, almost 72 percent (82.8 million barrels) of all petroleum products consumed in the state were for transportation purposes, although most agricultural use of petroleum is also included in the transportation category.

Figure 34: Petroleum consumption in Minnesota, barrels per customer sector, 1994-2014



Petroleum consumption by customer sector from 2004 to 2014 is shown in Table 17.

Table 17: Change in MN petroleum consumption, barrels by sector, 2004-2014

Minnesota Petroleum Consumption by Customer Sector, 2004 – 2014

	Industrial			Residential			Commercial			Transportation			Total Petroleum		
Year	1,000 Bbls	Amt Change	% Change	1,000 Bbls	Amt Change	% Change	1,000 Bbls	Amt Change	% Change	1,000 Bbls	Amt Change	% Change	1,000 Bbls	Amt Change	% Change
2004	26,779			7,748			2,062			94,365			132,351		
2005	28,112	1,333	5.0%	7,181	-567	-7.3%	2,083	21	1.0%	94,645	280	0.3%	133,440	1,089	0.8%
2006	26,339	-1,773	-6.3%	6,454	-727	-10.1%	2,971	888	42.6%	93,035	-1,610	-1.7%	129,726	-3,714	-2.8%
2007	26,599	260	1.0%	6,666	212	3.3%	2,347	-624	-21.0%	94,285	1,250	1.3%	130,701	975	0.8%
2008	23,773	-2,826	-10.6%	7,026	360	5.4%	2,945	598	25.5%	90,641	-3,644	-3.9%	124,843	-5,858	-4.5%
2009	22,380	-1,393	-5.9%	6,413	-613	-8.7%	2,680	-265	-9.0%	85,363	-5,278	-5.8%	116,963	-7,880	-6.3%
2010	22,143	-237	-1.1%	6,256	-157	-2.4%	2,354	-326	-12.2%	86,227	864	1.0%	117,043	80	0.1%
2011	21,912	-231	-1.0%	6,009	-247	-3.9%	2,582	228	9.7%	84,738	-1,489	-1.7%	115,293	-1,750	-1.5%
2012	22,137	225	1.0%	5,308	-701	-11.7%	2,353	-229	-8.9%	86,537	1,799	2.1%	116,395	1,102	1.0%
2013	23,766	1,629	7.4%	6,193	885	16.7%	2,807	454	19.3%	83,207	-3,330	-3.8%	116,041	-354	-0.3%
2014	23,127	-639	-2.7%	6,681	488	7.9%	2,915	108	3.8%	82,792	-415	-0.5%	115,633	-408	-0.4%
Since 2004		-3,652	-13.6%		-1,067	-13.8%		853	41.4%		-11,573	-12.3%		-16,718	-12.6%

Notes:

1. *Petroleum consumption for generating electric power is not shown in the table, but is included in the Total Petroleum columns.*
2. *Petroleum consumption amounts for generating electric power generally decreased from 1,396 to 117 thousand barrels from 2004 to 2014.*
3. *1,000 Bbls = Consumption in thousands of barrels.*
4. *Amt Change = Amount change in consumption (thousands of barrels) from previous year.*
5. *% Change = Percent change in consumption from previous year.*
6. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota*

Transportation Consumption by Fuel Type

In 2014, the transportation sector of Minnesota consumed 449,109 billion Btus of energy, which reflects a decrease of over 4 percent from 2010. Not surprisingly, gasoline was the largest source of consumption in the transportation sector in 2014.

Figure 35: Transportation Energy Consumed in Minnesota, percent by fuel type, 2014

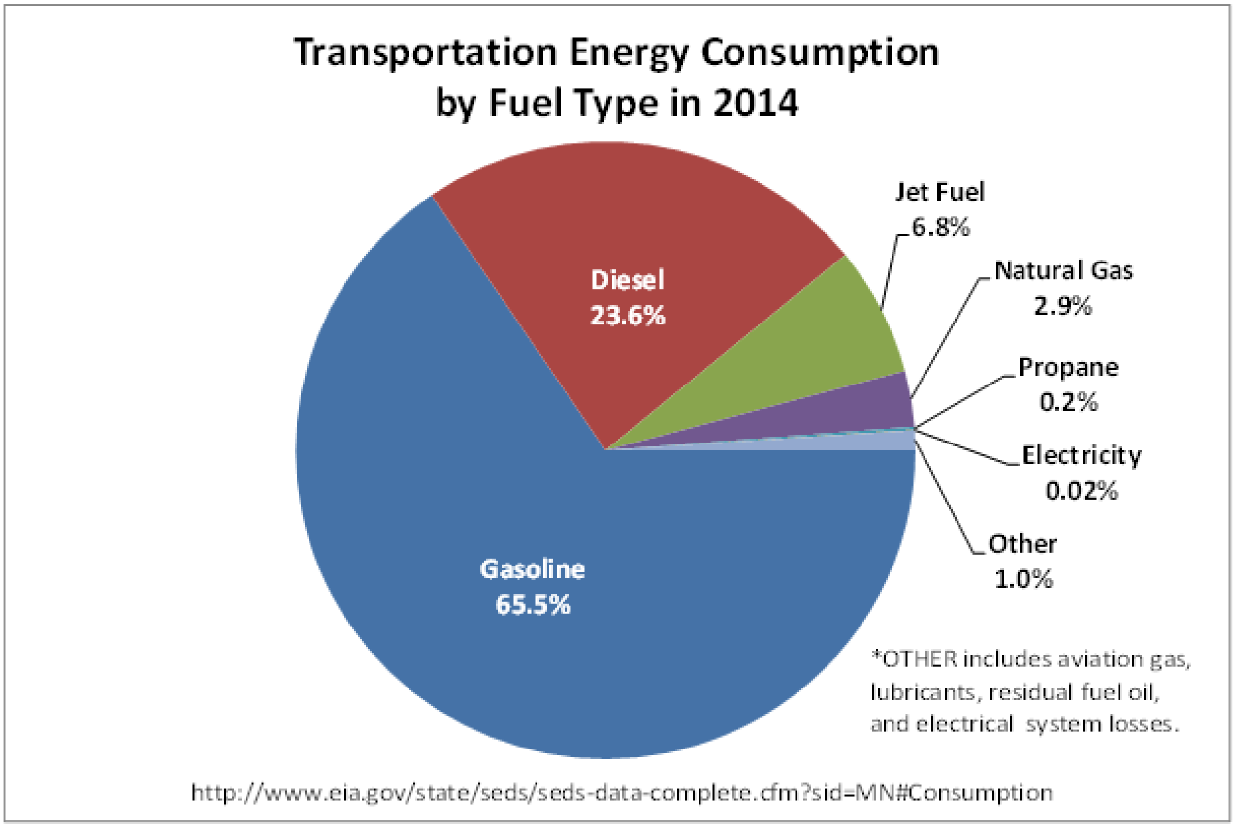
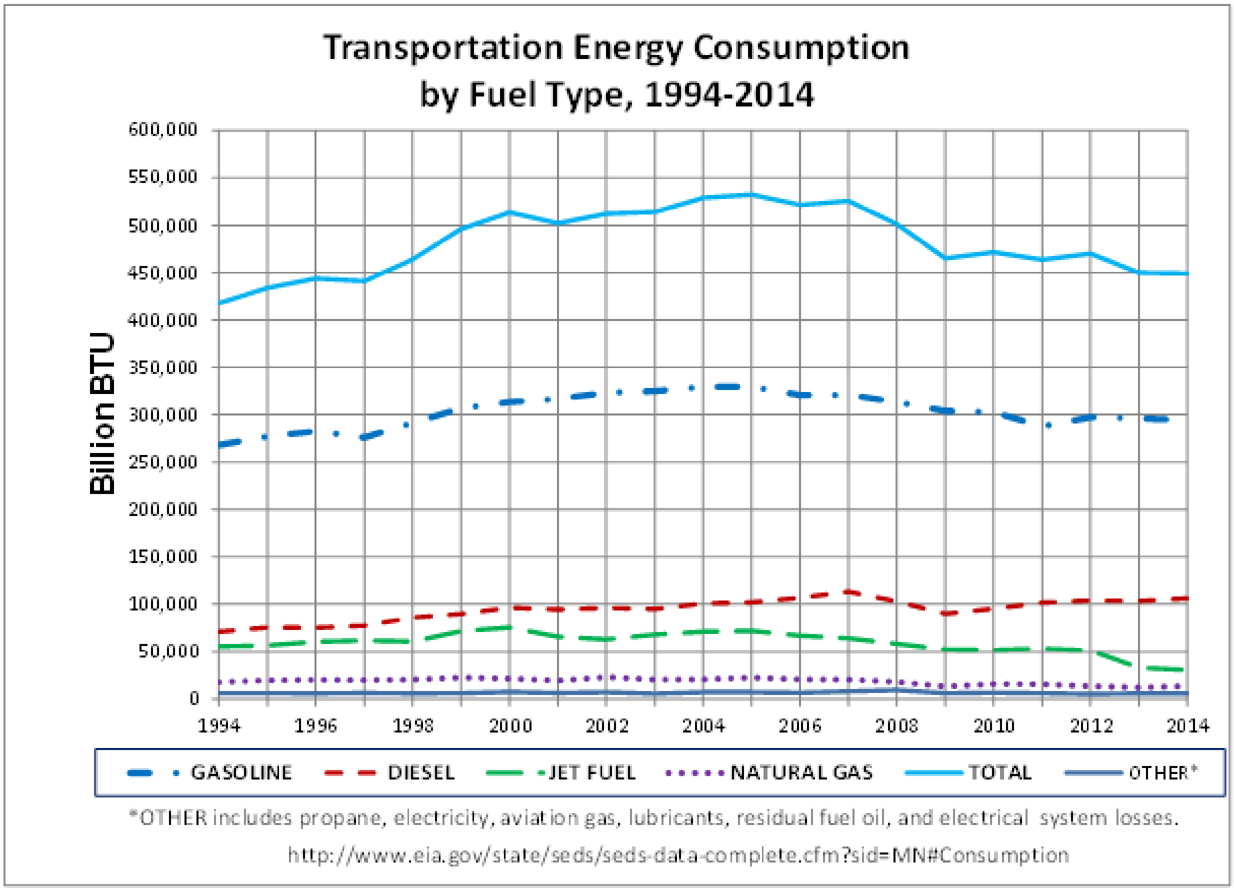


Table 18: Transportation energy consumed in MN, Btu and % by fuel type, 2014

Fuel Type	Billion Btu	Percentage
Total	449,109	100.0
Gasoline	294,169	65.5
Diesel	105,886	23.6
Jet Fuel	30,430	6.8
Natural Gas	13,118	2.9
Propane	758	0.2
Electricity	81	0.02
Other Petroleum and Losses*	4,667	1.0

**Includes aviation gasoline, lubricants, residual fuel oil, and transportation sector's share of electrical system energy losses.*

Figure 36: Transportation energy consumed in Minnesota, Btu by fuel type, 1994-2014



Expenditures – How Much Does Minnesota Spend on Energy?

Total Expenditures – All Sectors

In 2014, Minnesota's total real expenditures for energy--electricity, natural gas and petroleum—were $25.3 billion. (Price and expenditure data in this report have been converted, using 2014 base-year values to adjust for inflation.)

The largest proportion (47.1 percent) of the expenditures went towards transportation energy consumption, followed by the residential (19.9 percent), industrial (18.9 percent), and commercial (14.1 percent) sectors.

Figure 37: Total energy expenditures in Minnesota, percent by sector, 2014

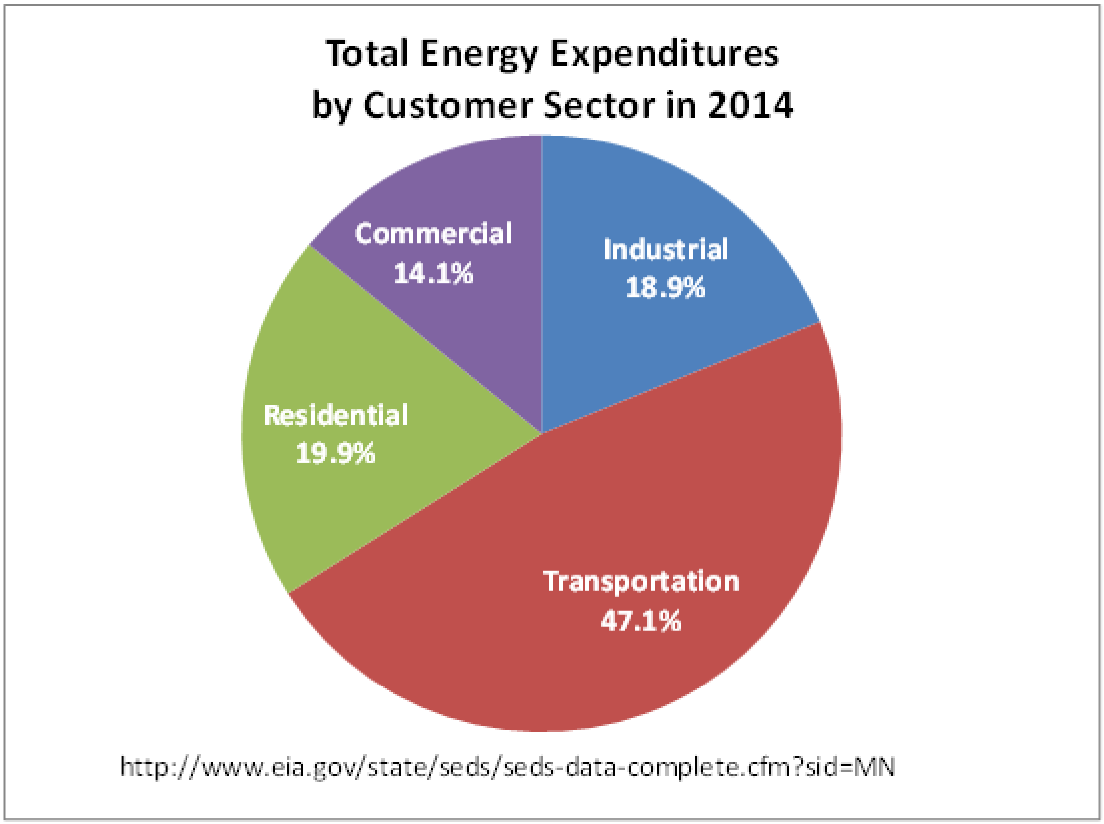
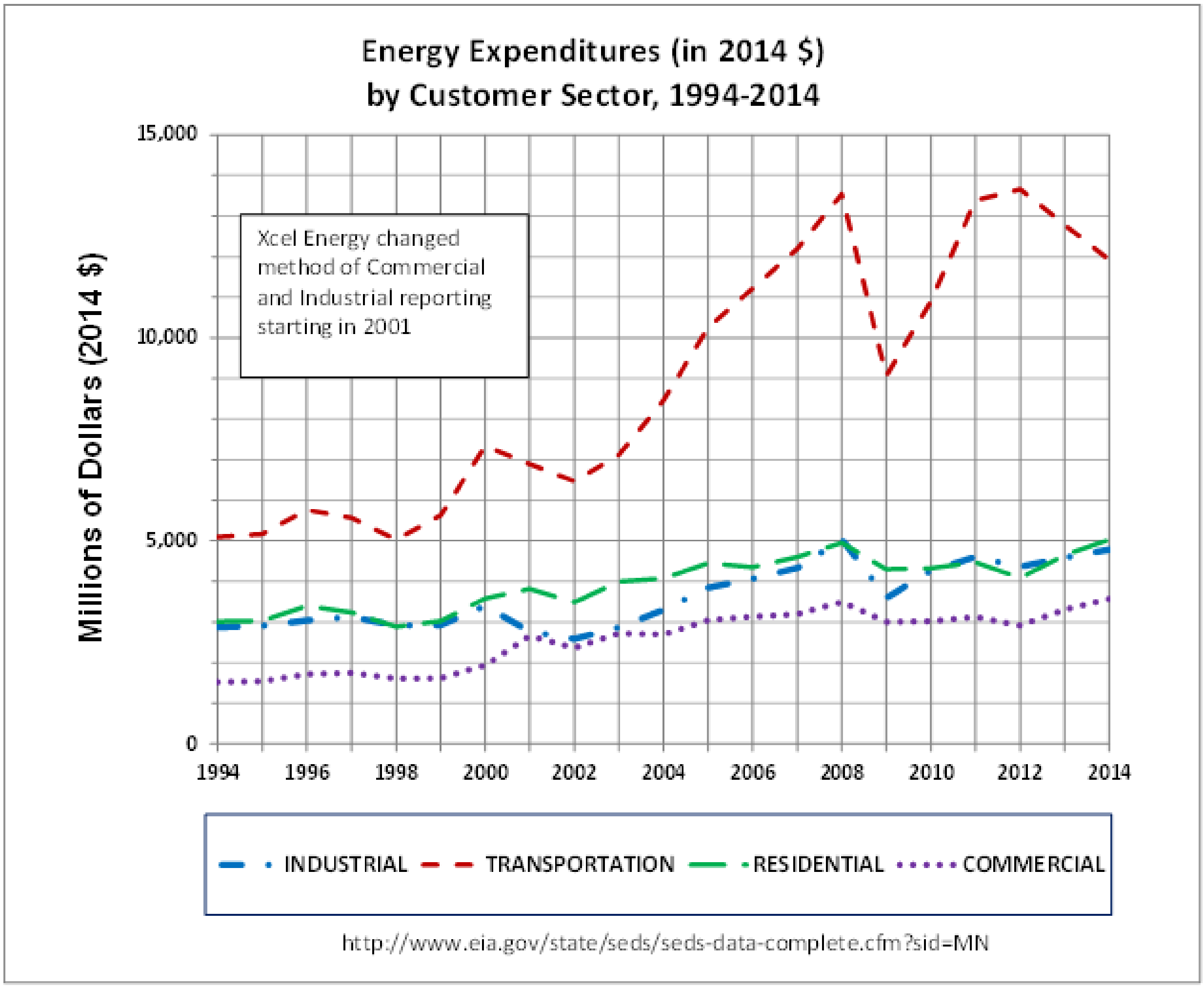


Figure 38: Total energy expenditures (inflation adjusted dollars using 2014 base year) in Minnesota by sector, 1994-2014



Total energy expenditures by customer sector 2004 to 2014 are shown in Table 19 below.

Table 19: Change in total energy expenditures in Minnesota by sector, 2004-2014

Total Energy Expenditures in Minnesota by Sector, 2004 – 2014
(Millions of dollars)

	Industrial			Residential			Commercial			Transportation			Total Energy		
Year	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**
2004	2,699	3,296		3,338	4,076		2,206	2,694		6,925	8,456		15,167	18,522	
2005	3,253	3,849	16.8%	3,764	4,453	9.3%	2,576	3,048	13.1%	8,666	10,253	21.2%	18,259	21,603	16.6%
2006	3,539	4,062	5.5%	3,793	4,354	-2.2%	2,733	3,137	2.9%	9,775	11,220	9.4%	19,841	22,772	5.4%
2007	3,872	4,329	6.6%	4,115	4,601	5.7%	2,856	3,193	1.8%	10,906	12,193	8.7%	21,749	24,317	6.8%
2008	4,595	5,039	16.4%	4,515	4,950	7.6%	3,186	3,493	9.4%	12,360	13,553	11.2%	24,656	27,035	11.2%
2009	3,309	3,601	-28.5%	3,951	4,300	-13.1%	2,760	3,004	-14.0%	8,331	9,066	-33.1%	18,352	19,971	-26.1%
2010	3,970	4,268	18.5%	4,028	4,331	0.7%	2,809	3,020	0.5%	10,140	10,901	20.2%	20,947	22,521	12.8%
2011	4,375	4,608	8.0%	4,243	4,469	3.2%	2,967	3,125	3.5%	12,713	13,392	22.8%	24,298	25,595	13.7%
2012	4,217	4,361	-5.4%	3,952	4,088	-8.5%	2,822	2,919	-6.6%	13,210	13,663	2.0%	24,201	25,031	-2.2%
2013	4,507	4,587	5.2%	4,568	4,650	13.7%	3,248	3,307	13.3%	12,559	12,784	-6.4%	24,882	25,327	1.2%
2014	4,782	4,782	4.3%	5,028	5,028	8.1%	3,572	3,572	8.0%	11,930	11,930	-6.7%	25,312	25,312	-0.1%
Since 2004			45.1%			23.4%			32.6%			41.1%			36.7%

Notes:

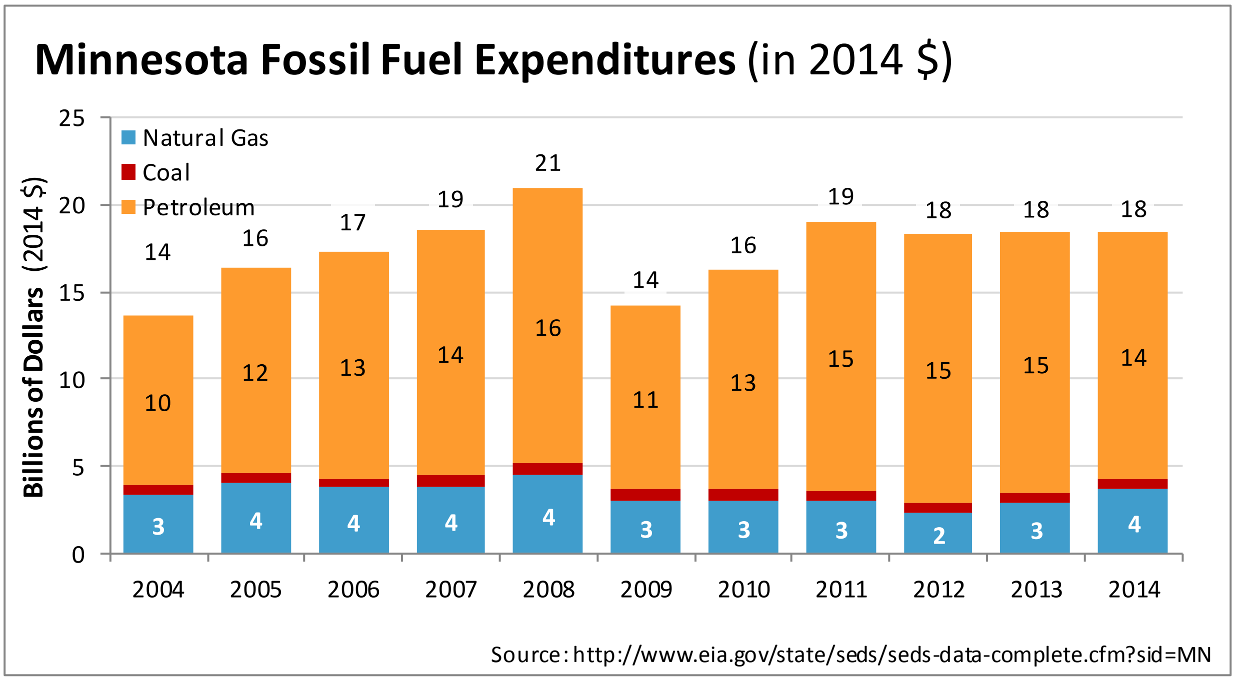
1. *Nominal = Expenditure in millions of dollars for year shown.*
2. *Real (2014) = Expenditure in millions of real dollars for year shown, inflation-adjusted to 2014 base year.*
3. *Real % Change = Percent change in real dollar expenditure from previous year.*
4. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota.*

Total Fossil Fuel Expenditures

In 2014, Minnesota's total expenditures for fossil fuels—coal, natural gas and petroleum—were $18.4 billion (Price and expenditure data in this report have been converted, using 2014 base-year values to adjust for inflation.)

The largest proportion (76.7 percent) of the expenditures went towards petroleum expenditures (not including ethanol or biodiesel), followed by natural gas (19.8 percent), and coal (3.5 percent).

Figure 39: Minnesota Total Fossil Fuel Expenditures (in 2014 $), 2004-2014



Total fossil fuel expenditures 2004 to 2014 are shown in Table 20 below.

Table 20: Change in total fossil fuel expenditures in Minnesota, 2004-2014

Total Fossil Fuel Expenditures in Minnesota, 2004 – 2014
(Billions of dollars)

	Coal			Natural Gas			Petroleum			Total Fossil Fuels		
Year	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**
2004	0.421	0.514		2.771	3.384		7.985	9.751		**11.177**	**13.649**	
2005	0.446	0.528	2.8%	3.417	4.043	19.5%	10.020	11.855	21.6%	**13.884**	**16.426**	20.3%
2006	0.476	0.547	3.5%	3.263	3.746	-7.4%	11.316	12.988	9.6%	**15.056**	**17.281**	5.2%
2007	0.568	0.635	16.2%	3.424	3.828	2.2%	12.632	14.123	8.7%	**16.624**	**18.587**	7.6%
2008	0.623	0.683	7.5%	4.057	4.448	16.2%	14.475	15.871	12.4%	**19.155**	**21.003**	13.0%
2009	0.567	0.617	-9.6%	2.789	3.035	-31.8%	9.743	10.602	-33.2%	**13.098**	**14.254**	-32.1%
2010	0.573	0.616	-0.2%	2.798	3.008	-0.9%	11.721	12.602	18.9%	**15.092**	**16.226**	13.8%
2011	0.636	0.669	8.7%	2.792	2.941	-2.2%	14.598	15.378	22.0%	**18.025**	**18.988**	17.0%
2012	0.538	0.557	-16.9%	2.252	2.330	-20.8%	14.963	15.476	0.6%	**17.753**	**18.362**	-3.3%
2013	0.567	0.577	3.6%	2.838	2.889	24.0%	14.667	14.929	-3.5%	**18.071**	**18.395**	0.2%
2014	0.643	0.643	11.4%	3.647	3.647	26.2%	14.121	14.121	-5.4%	**18.410**	**18.410**	0.1%
Since 2004			25.1%			7.8%			44.8%			34.9%

Notes:

1. *Petroleum expenditures are adjusted to remove expenditures for ethanol and biodiesel transportation fuels per Minn. Stat. § 239.791 and § 297.77.*
2. *Nominal = Expenditure in billions of dollars for year shown.*
3. *Real (2014) = Expenditure in billions of real dollars for year shown, inflation-adjusted to 2014 base year.*
4. *Real % Change = Percent change in real dollar expenditure from previous year.*
5. *Source – U.S. Energy Information Administration, [State Energy Data System (SEDS): 1960-2014, Minnesota.]*

Electricity Expenditures by Sector

In 2014, Minnesotans spent approximately $56.5 billion dollars on electricity, including residential, commercial and industrial consumption. Approximately 42 percent of the electricity expenditures in Minnesota went towards residential consumption, with 35 percent and 23 percent going towards commercial and industrial consumption, respectively.

Figure 40: Electricity expenditures in Minnesota, percent by sector, 2014

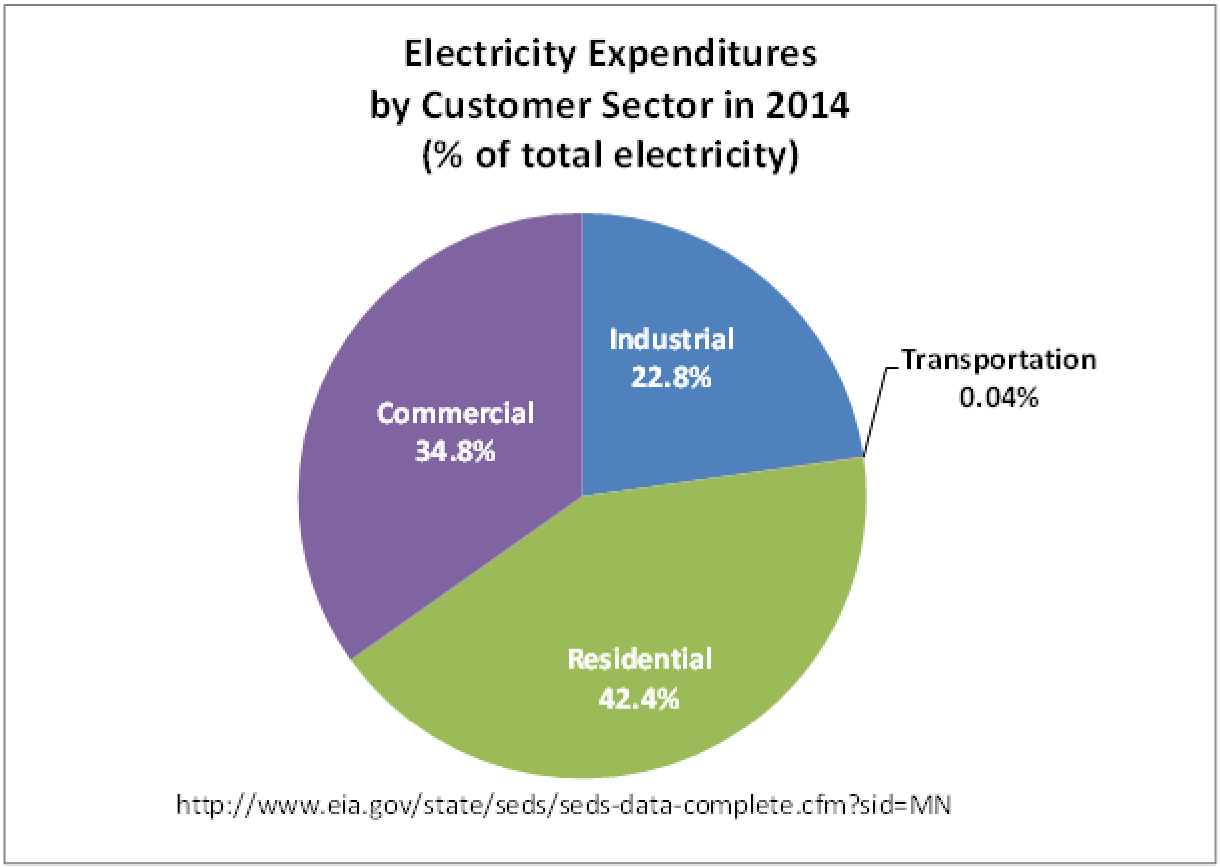
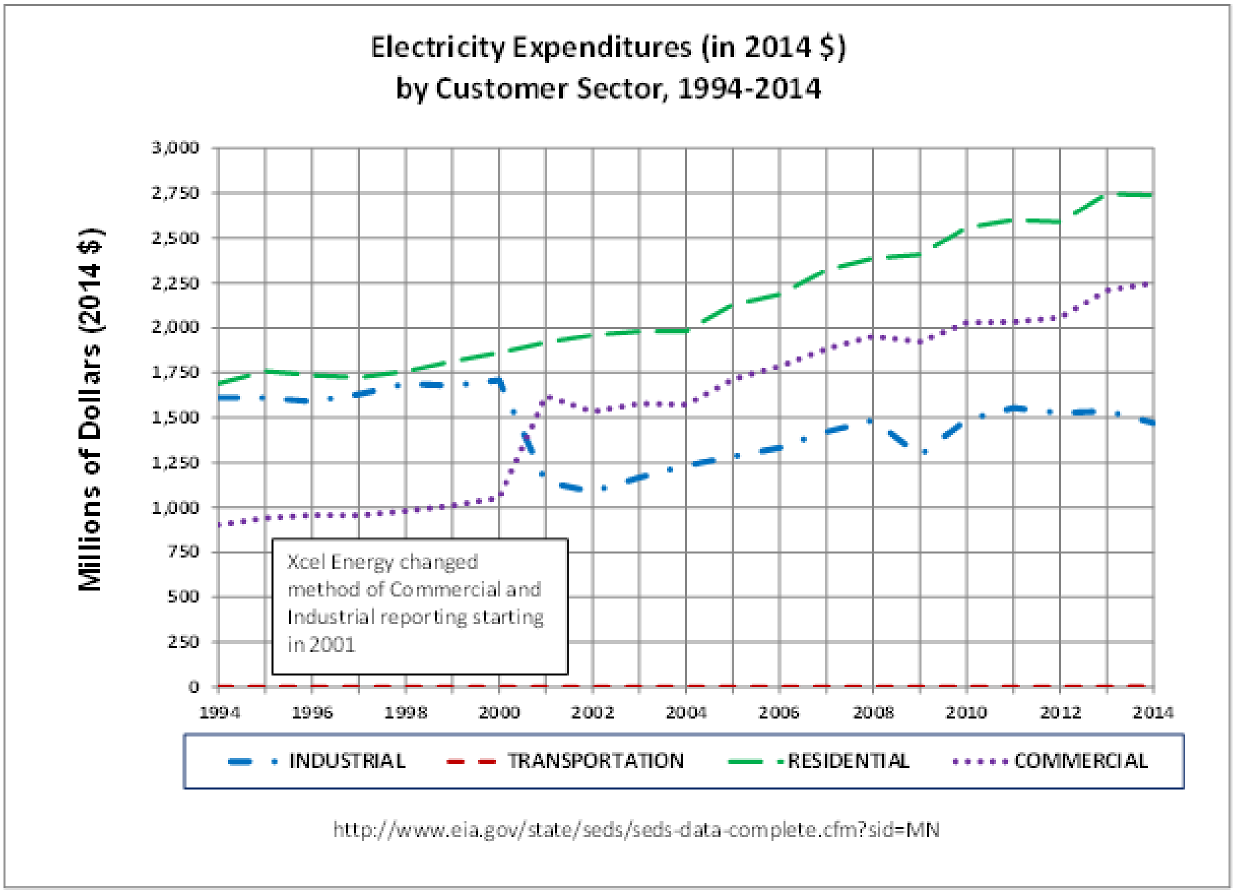


Figure 41: Electricity expenditures (inflation adjusted dollars using 2014 base year) in Minnesota by sector, 1994-2014



Note: Xcel Energy changed its method of commercial and industrial sector reporting starting in 2001.

Electricity expenditures by customer sector 2004 to 2014 are shown in Table 21.

Table 21: Change in electricity expenditures in Minnesota by sector, 2004 – 2014

Electricity Expenditures in Minnesota by Sector, 2004 – 2014 (Millions of dollars)

	Industrial			Residential			Commercial			Transportation			Total Electricity		
Year	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**
2004	1,009	1,232		1,624	1,984		1,287	1,572		0.7	0.9		3,922	4,789	
2005	1,085	1,284	4.2%	1,799	2,129	7.3%	1,448	1,713	9.0%	1.5	1.8	107.6%	4,334	5,128	7.1%
2006	1,161	1,333	3.8%	1,905	2,187	2.7%	1,556	1,786	4.3%	1.7	2.0	9.9%	4,625	5,308	3.5%
2007	1,271	1,421	6.6%	2,079	2,324	6.3%	1,684	1,883	5.4%	1.7	1.9	-2.6%	5,035	5,629	6.1%
2008	1,355	1,485	4.6%	2,177	2,386	2.7%	1,781	1,953	3.7%	1.8	2.0	3.8%	5,314	5,826	3.5%
2009	1,185	1,290	-13.2%	2,212	2,408	0.9%	1,766	1,922	-1.6%	1.7	1.8	-6.3%	5,166	5,621	-3.5%
2010	1,385	1,489	15.4%	2,379	2,558	6.2%	1,887	2,029	5.6%	1.7	1.8	-1.2%	5,653	6,078	8.1%
2011	1,475	1,554	4.4%	2,470	2,601	1.7%	1,930	2,033	0.2%	1.6	1.7	-7.8%	5,876	6,190	1.8%
2012	1,476	1,526	-1.8%	2,505	2,590	-0.4%	1,989	2,057	1.2%	1.5	1.6	-7.9%	5,970	6,175	-0.2%
2013	1,509	1,535	0.6%	2,698	2,746	6.0%	2,171	2,210	7.4%	1.9	1.9	24.7%	6,379	6,493	5.2%
2014	1,471	1,471	-4.2%	2,738	2,738	-0.3%	2,249	2,249	1.8%	2.3	2.3	18.9%	6,460	6,460	-0.5%
Since 2004			19.4%			38.0%			43.1%			169.1%			34.9%

Notes:

1. *Nominal = Expenditure in millions of dollars for year shown.*
2. *Real (2014) = Expenditure in millions of real dollars for year shown, inflation-adjusted to 2014 base year.*
3. *Real % Change = Percent change in real dollar expenditure from previous year.*
4. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota.*

Natural Gas Expenditures by Sector

In 2014, Minnesotans spent approximately $3.6 billion dollars on natural gas, including residential, commercial, industrial, and transportation consumption, as well as consumption for electrical power generation. Natural gas use for transportation purposes was minimal (less than 0.1 percent of total natural gas expenditures). Approximately 40 percent of the natural gas expenditures in Minnesota went towards residential consumption, with 26 percent and 29 percent going towards commercial and industrial consumption, respectively. Electrical power generation accounted for approximately 5 percent of the natural gas expenditures.

Figure 42: Natural gas expenditures in Minnesota, percent by sector, 2014

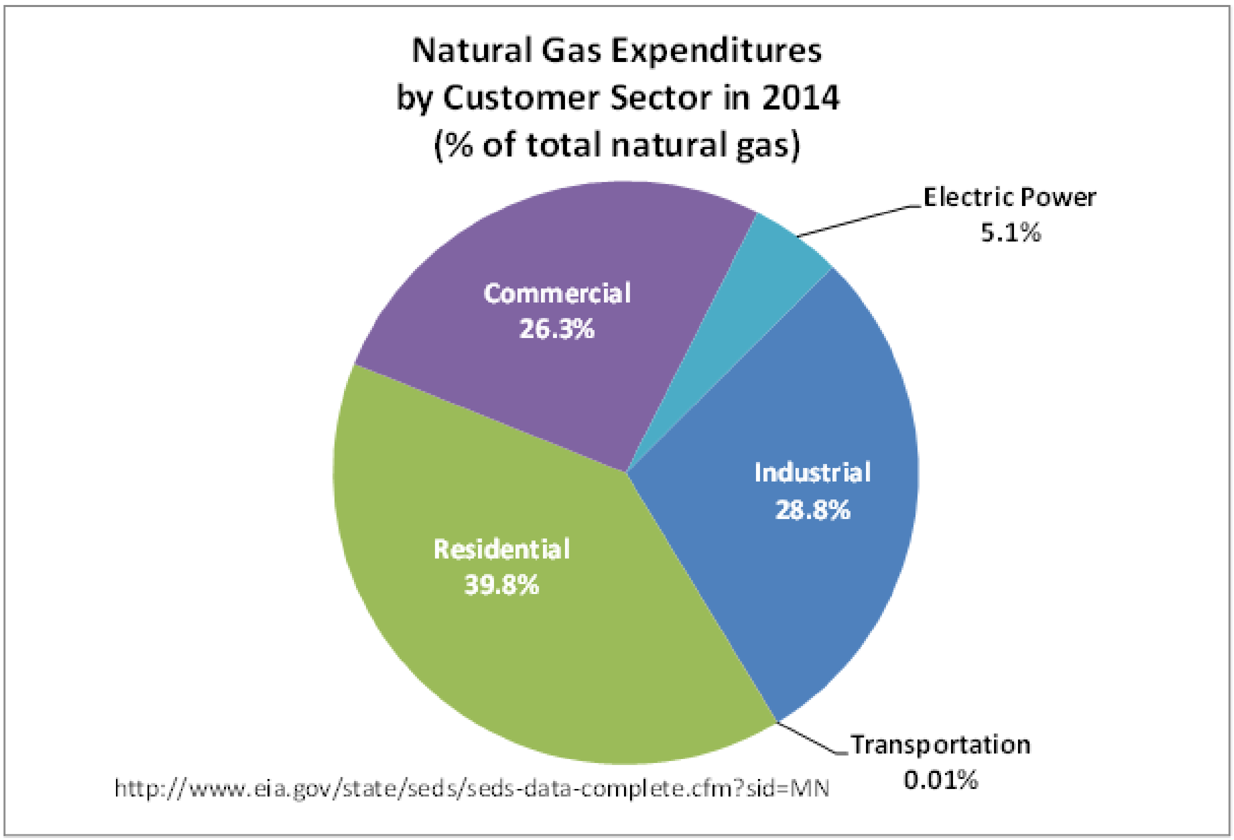
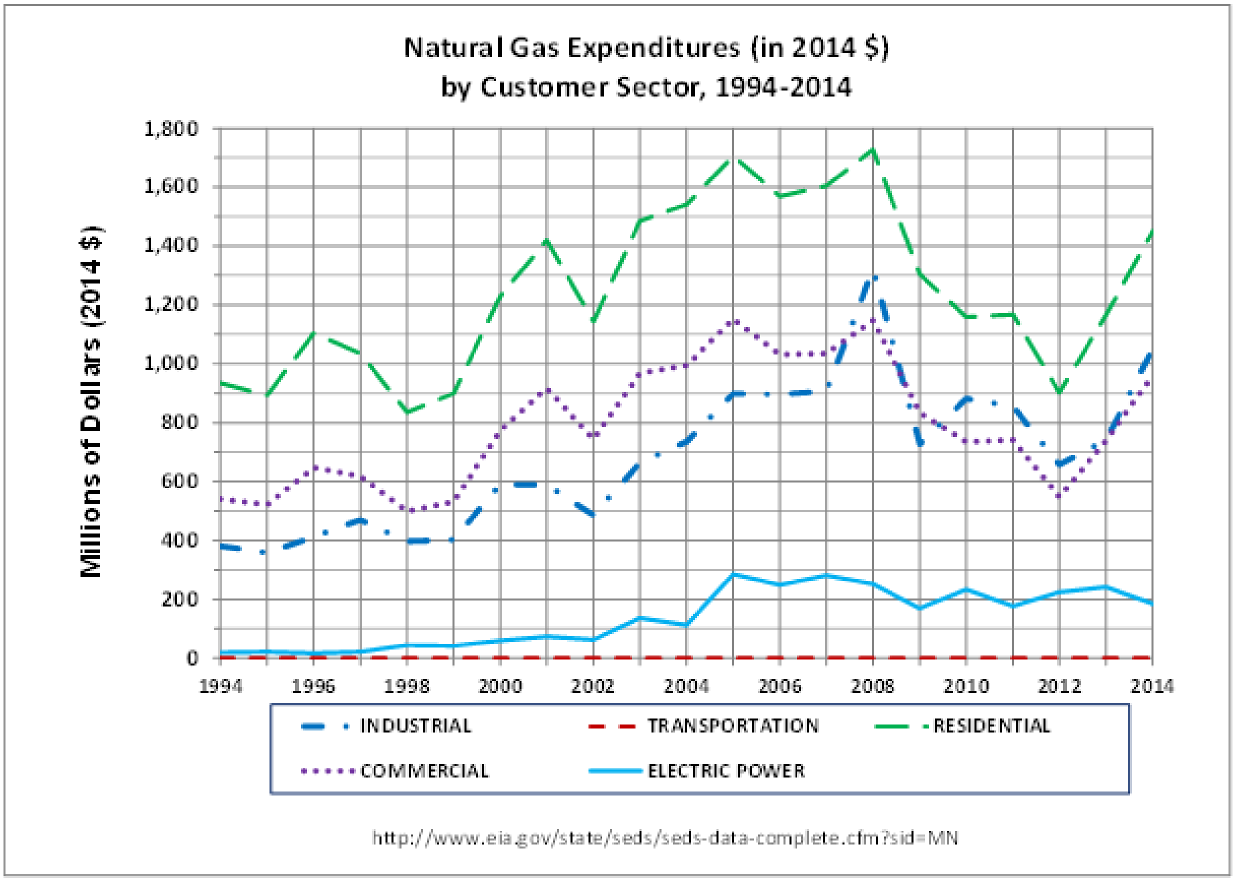


Figure 43: Natural gas expenditures (inflation adjusted dollars using 2014 base year) in Minnesota by sector, 1994-2014



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Natural gas expenditures by customer sector 2004 to 2014 are shown in Table 22 below.

Table 22: Change in natural gas expenditures in Minnesota by sector, 2004- 2014

Natural Gas Expenditures in Minnesota by Sector, 2004 – 2014
(Millions of dollars)

	Industrial			Residential			Commercial			Transportation			Electric Power			Total Natural Gas		
Year	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**
2004	602	736		1,263	1,542		814	994		0.4	0.5		92	112		2,771	3,384	
2005	759	898	22.1%	1,442	1,706	10.7%	975	1,153	16.0%	0.1	0.1	-75.8%	242	286	154.3%	3,417	4,043	19.5%
2006	780	896	-0.3%	1,367	1,569	-8.0%	899	1,032	-10.5%	0.2	0.2	94.0%	217	249	-12.8%	3,263	3,746	-7.4%
2007	811	907	1.3%	1,435	1,605	2.3%	926	1,035	0.3%	0.2	0.2	-2.6%	252	281	12.9%	3,424	3,828	2.2%
2008	1,205	1,321	45.7%	1,575	1,727	7.6%	1,047	1,148	10.9%	0.3	0.3	47.1%	230	252	-10.4%	4,057	4,448	16.2%
2009	669	727	-44.9%	1,199	1,304	-24.5%	766	833	-27.4%	0.2	0.2	-33.8%	155	169	-32.9%	2,789	3,035	-31.8%
2010	819	881	21.1%	1,077	1,158	-11.2%	684	735	-11.8%	0.2	0.2	-1.2%	217	233	38.0%	2,798	3,008	-0.9%
2011	812	856	-2.8%	1,108	1,167	0.7%	704	741	0.9%	0.1	0.1	-51.0%	168	177	-24.4%	2,792	2,941	-2.2%
2012	635	657	-23.3%	872	902	-22.7%	529	547	-26.2%	0.1	0.1	-1.8%	217	224	26.9%	2,252	2,330	-20.8%
2013	728	741	12.9%	1,146	1,166	29.4%	727	740	35.2%	0.3	0.3	195.2%	237	241	7.8%	2,838	2,889	24.0%
2014	1,051	1,051	41.8%	1,450	1,450	24.4%	960	960	29.8%	0.4	0.4	31.0%	185	185	-23.5%	3,647	3,647	26.2%
Since 2004			42.9%			-5.9%			-3.4%			-18.1%			64.3%			7.8%

Notes:

1. *Nominal = Expenditure in millions of dollars for year shown.*
2. *Real (2014) = Expenditure in millions of real dollars for year shown, inflation-adjusted to 2014 base year.*
3. *Real % Change = Percent change in real dollar expenditure from previous year.*
4. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota.*

Petroleum Expenditures by Sector

In 2014, Minnesotans spent $15.2 billion dollars on petroleum products, including residential, commercial, industrial, and transportation consumption, as well as consumption for electrical power generation. Approximately 79 percent of the total petroleum products expenditures went for consumption by the transportation sector. The industrial, residential, and commercial sectors comprised approximately 14 percent, 5 percent, and 2 percent of the total expenditures for petroleum products, respectively. Electrical power generation accounted for less than 0.1 percent of the expenditures for petroleum products.

Figure 44: Petroleum expenditures in Minnesota, percent by sector, 2014

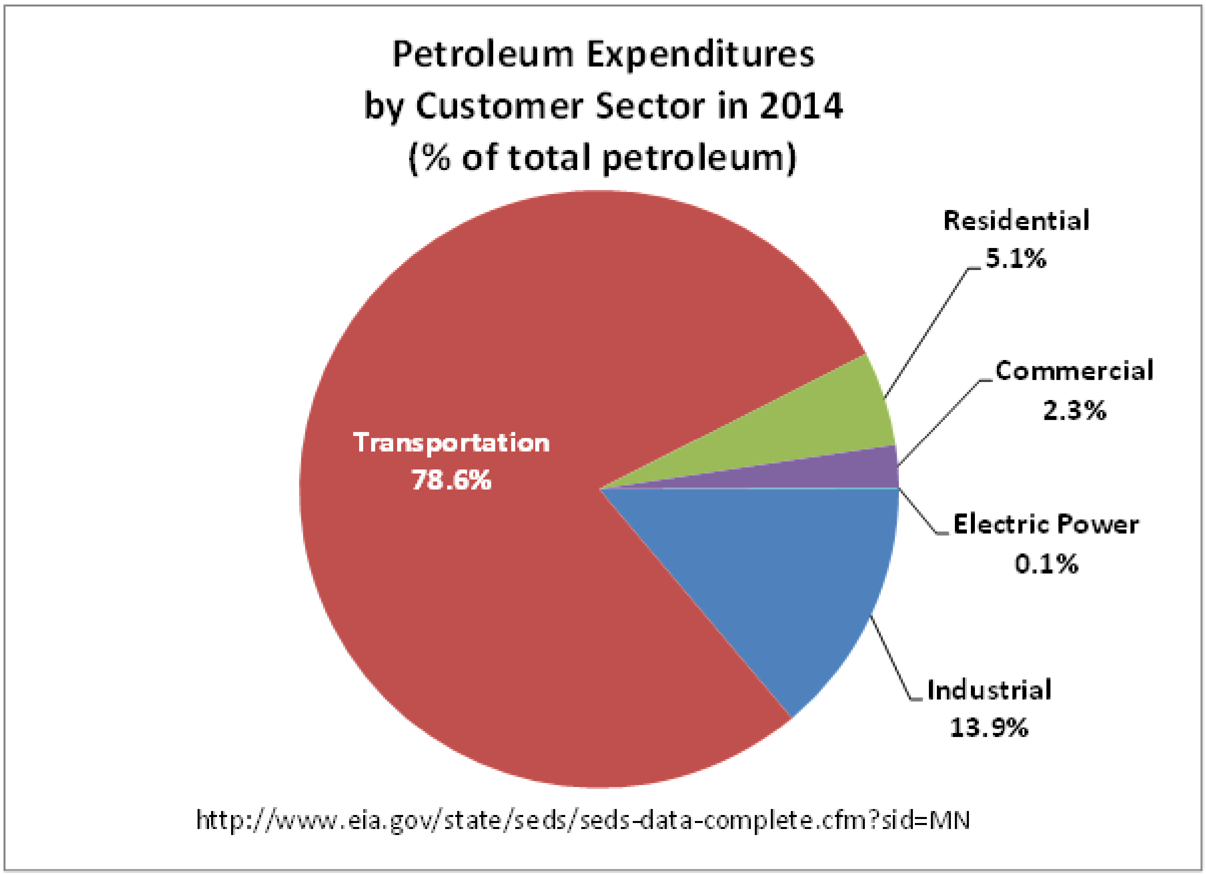
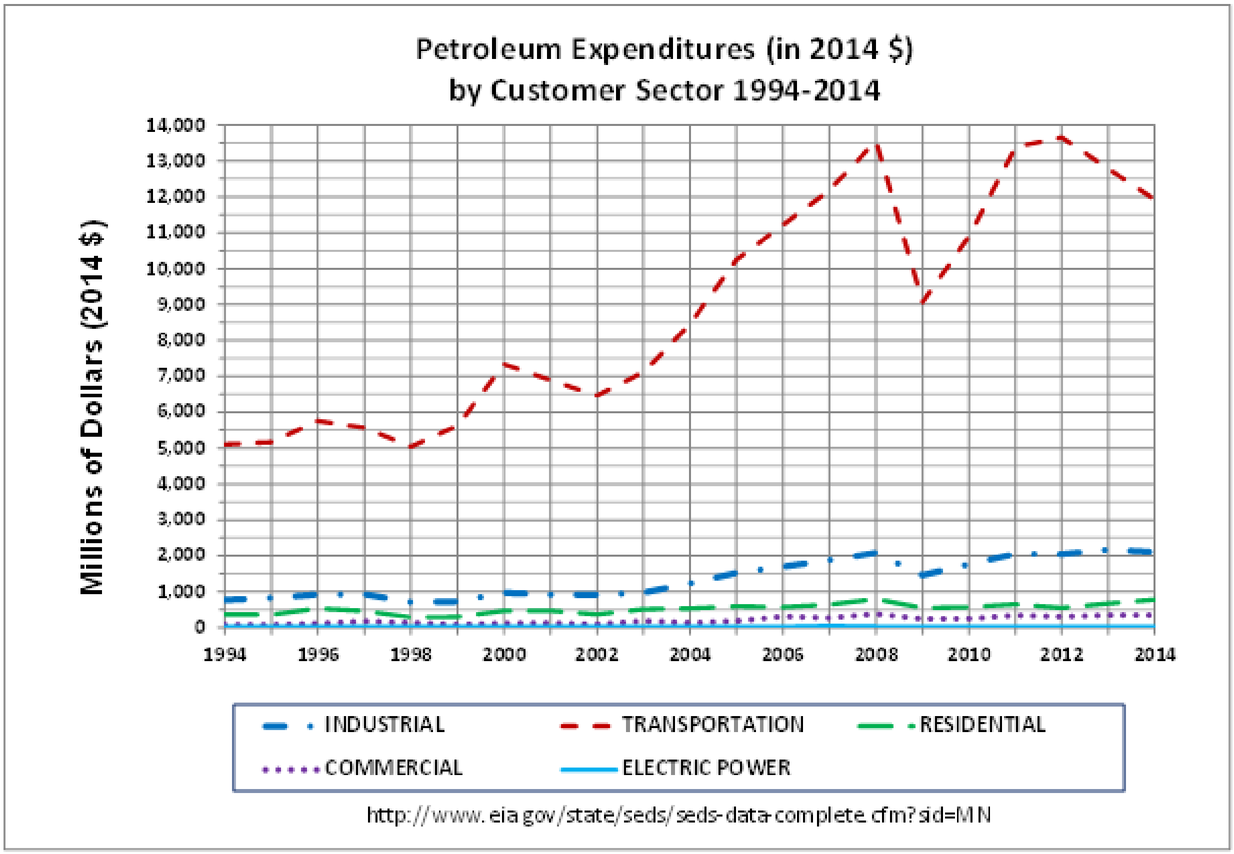


Figure 45: Petroleum expenditures (inflation-adjusted dollars using 2014 base year) in Minnesota by sector, 1994-2014



Petroleum expenditures by customer sector 2004 to 2014 are shown in Table 23.

Table 23: Change in petroleum expenditures in Minnesota by sector, 2004- 2014

Petroleum Expenditures in Minnesota by Sector, 2004 – 2014
(Millions of dollars)

	Industrial			Residential			Commercial			Transportation			Electric Power			Total Petroleum		
Year	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**
2004	1,008	1,231		436	533		102	124		6,924	8,455		10	12		8,480	10,355	
2005	1,291	1,527	24.1%	499	590	10.8%	147	174	39.6%	8,664	10,251	21.2%	20	23	89.9%	10,620	12,565	21.3%
2006	1,480	1,698	11.2%	497	570	-3.5%	270	309	78.2%	9,773	11,218	9.4%	15	17	-26.2%	12,034	13,812	9.9%
2007	1,674	1,872	10.2%	572	639	12.2%	239	267	-13.8%	10,904	12,191	8.7%	41	46	170.0%	13,430	15,015	8.7%
2008	1,901	2,084	11.3%	723	793	24.0%	347	380	42.5%	12,358	13,550	11.2%	22	25	-46.8%	15,352	16,832	12.1%
2009	1,343	1,461	-29.9%	505	549	-30.7%	219	238	-37.4%	8,329	9,064	-33.1%	10	11	-56.6%	10,405	11,323	-32.7%
2010	1,635	1,758	20.3%	535	575	4.6%	229	246	3.5%	10,138	10,899	20.3%	6	7	-37.5%	12,543	13,485	19.1%
2011	1,947	2,051	16.6%	621	654	13.7%	323	340	38.0%	12,712	13,390	22.9%	7	7	10.6%	15,609	16,442	21.9%
2012	1,975	2,042	-0.4%	529	547	-16.3%	297	307	-9.8%	13,209	13,662	2.0%	8	8	13.6%	16,017	16,567	0.8%
2013	2,133	2,171	6.3%	660	672	22.7%	342	348	13.5%	12,557	12,781	-6.4%	9	9	10.6%	15,700	15,981	-3.5%
2014	2,104	2,104	-3.1%	778	778	15.8%	345	345	-0.9%	11,927	11,927	-6.7%	15	15	60.9%	15,168	15,168	-5.1%
Since 2004			70.9%			45.9%			177.2%			41.1%			22.0%			46.5%

Notes:

1. *Nominal = Expenditure in millions of dollars for year shown.*
2. *Real (2014) = Expenditure in millions of real dollars for year shown, inflation-adjusted to 2014 base year.*
3. *Real % Change = Percent change in real dollar expenditure from previous year.*
4. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota.*

Price – How much does Minnesota's Energy Cost?

Electricity Prices by Sector

Figure 46: Electricity price per kWh in Minnesota by sector, 1994-2014

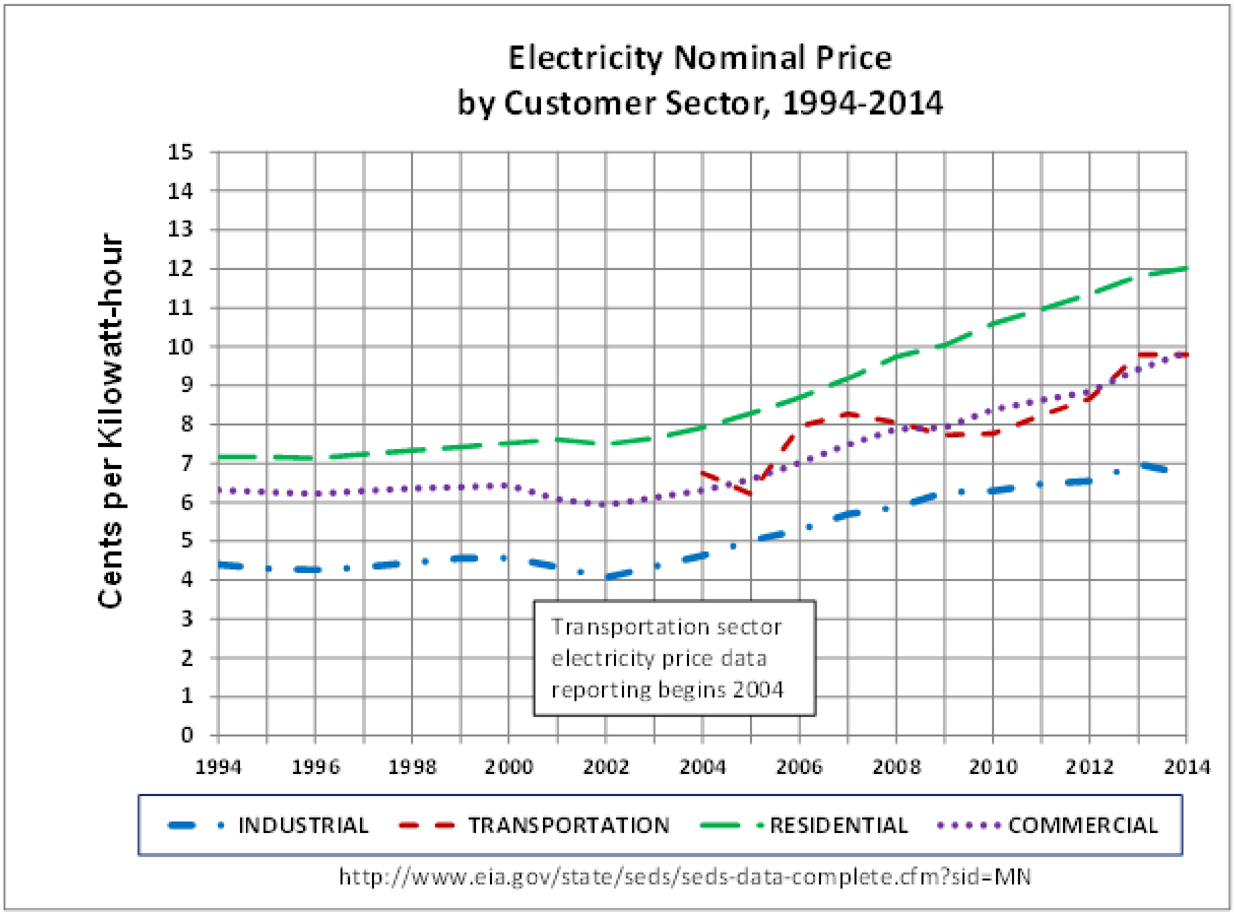
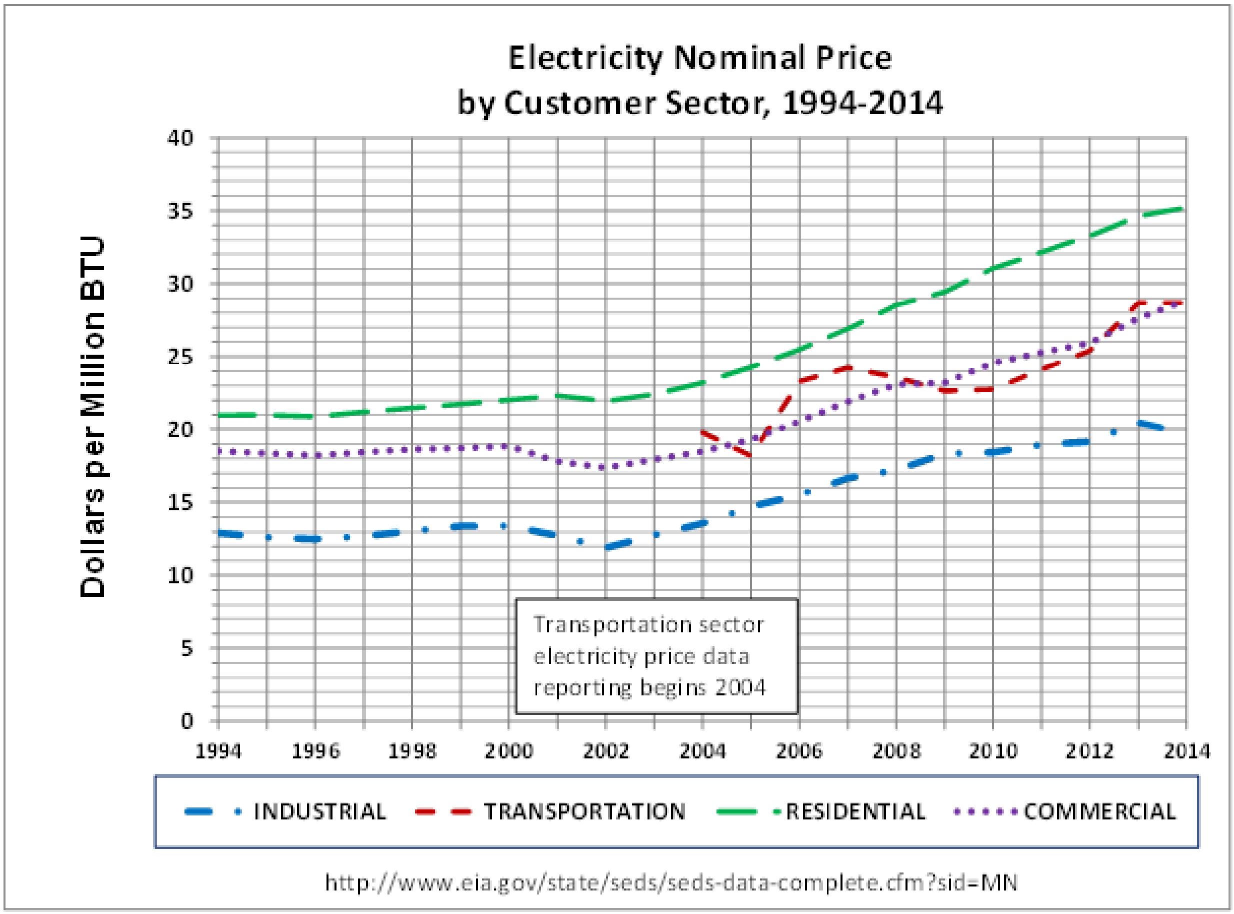


Figure 47: Electricity price per MMBtu in Minnesota by sector, 1994-2014



Electricity prices by customer segment for 2004 to 2014 are shown in Table 24 and Table 25 , by cents per kWh and dollars per MMBTU, respectively.

Table 24: Change in electricity prices (cents per kWh) in MN by sector, 2004-2014

Electricity Prices in Minnesota by Sector, 2004 to 2014
(Cents per kilowatt-hour)

	Industrial			Residential			Commercial			Transportation			Average All Sectors		
Year	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**
2004	4.63	5.65		7.92	9.67		6.31	7.70		6.75	8.24		6.25	7.63	
2005	5.02	5.94	5.0%	8.28	9.79	1.2%	6.59	7.79	1.1%	6.21	7.34	-10.9%	6.63	7.84	2.8%
2006	5.29	6.07	2.2%	8.69	9.98	1.9%	7.02	8.06	3.4%	7.95	9.12	24.3%	7.00	8.03	2.4%
2007	5.69	6.36	4.8%	9.18	10.26	2.8%	7.48	8.36	3.8%	8.27	9.24	1.3%	7.46	8.34	3.8%
2008	5.88	6.44	1.3%	9.73	10.67	4.0%	7.88	8.64	3.3%	8.04	8.82	-4.6%	7.81	8.56	2.7%
2009	6.26	6.81	5.7%	10.04	10.93	2.4%	7.92	8.61	-0.3%	7.73	8.41	-4.6%	8.16	8.88	3.7%
2010	6.29	6.76	-0.7%	10.59	11.39	4.2%	8.38	9.01	4.6%	7.77	8.35	-0.7%	8.43	9.07	2.1%
2011	6.47	6.81	0.7%	10.96	11.55	1.4%	8.63	9.09	0.8%	8.23	8.67	3.7%	8.68	9.14	0.8%
2012	6.54	6.76	-0.7%	11.35	11.74	1.7%	8.84	9.14	0.6%	8.67	8.96	3.4%	8.89	9.20	0.6%
2013	6.98	7.11	5.1%	11.81	12.02	2.4%	9.42	9.59	4.9%	9.79	9.96	11.2%	9.45	9.62	4.6%
2014	6.73	6.73	-5.4%	12.01	12.01	-0.1%	9.85	9.85	2.7%	9.79	9.79	-1.8%	9.57	9.57	-0.5%
Since 2004			18.9%			24.2%			27.9%			18.8%			25.3%

Notes:

1. *Nominal = Price in cents per kilowatt-hour (cents/KWH) for year shown.*
2. *Real (2014) = Price in cents/KWH for year shown, inflation-adjusted to 2014 base year.*
3. *Real % Change = Percent change in real dollar price (cents/KWH) from previous year.*
4. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota.*

Table 25: Change in electricity prices (dollars per MMBtu) in MN by sector, 2004-2014

Electricity Prices in Minnesota by Sector, 2004 – 2014
(Dollars per million BTU)

	Industrial			Residential			Commercial			Transportation			Average All Sectors		
Year	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**
2004	13.57	16.57		23.22	28.36		18.49	22.58		19.78	24.15		18.32	22.37	
2005	14.71	17.40	5.0%	24.26	28.70	1.2%	19.30	22.83	1.1%	18.19	21.52	-10.9%	19.43	22.99	2.8%
2006	15.50	17.79	2.2%	25.48	29.25	1.9%	20.57	23.61	3.4%	23.30	26.74	24.3%	20.51	23.54	2.4%
2007	16.67	18.64	4.8%	26.90	30.08	2.8%	21.92	24.51	3.8%	24.23	27.09	1.3%	21.85	24.43	3.8%
2008	17.22	18.88	1.3%	28.53	31.28	4.0%	23.09	25.32	3.3%	23.57	25.84	-4.6%	22.89	25.10	2.7%
2009	18.34	19.96	5.7%	29.43	32.03	2.4%	23.20	25.25	-0.3%	22.65	24.65	-4.6%	23.91	26.02	3.7%
2010	18.43	19.81	-0.7%	31.04	33.37	4.2%	24.56	26.41	4.6%	22.77	24.48	-0.7%	24.72	26.58	2.1%
2011	18.95	19.96	0.7%	32.13	33.85	1.4%	25.28	26.63	0.8%	24.11	25.40	3.7%	25.43	26.79	0.8%
2012	19.16	19.82	-0.7%	33.27	34.41	1.7%	25.91	26.80	0.6%	25.40	26.27	3.4%	26.06	26.95	0.6%
2013	20.46	20.83	5.1%	34.61	35.23	2.4%	27.61	28.10	4.9%	28.69	29.20	11.2%	27.69	28.19	4.6%
2014	19.71	19.71	-5.4%	35.21	35.21	-0.1%	28.87	28.87	2.7%	28.69	28.69	-1.8%	28.04	28.04	-0.5%
Since 2004			18.9%			24.2%			27.9%			18.8%			25.3%

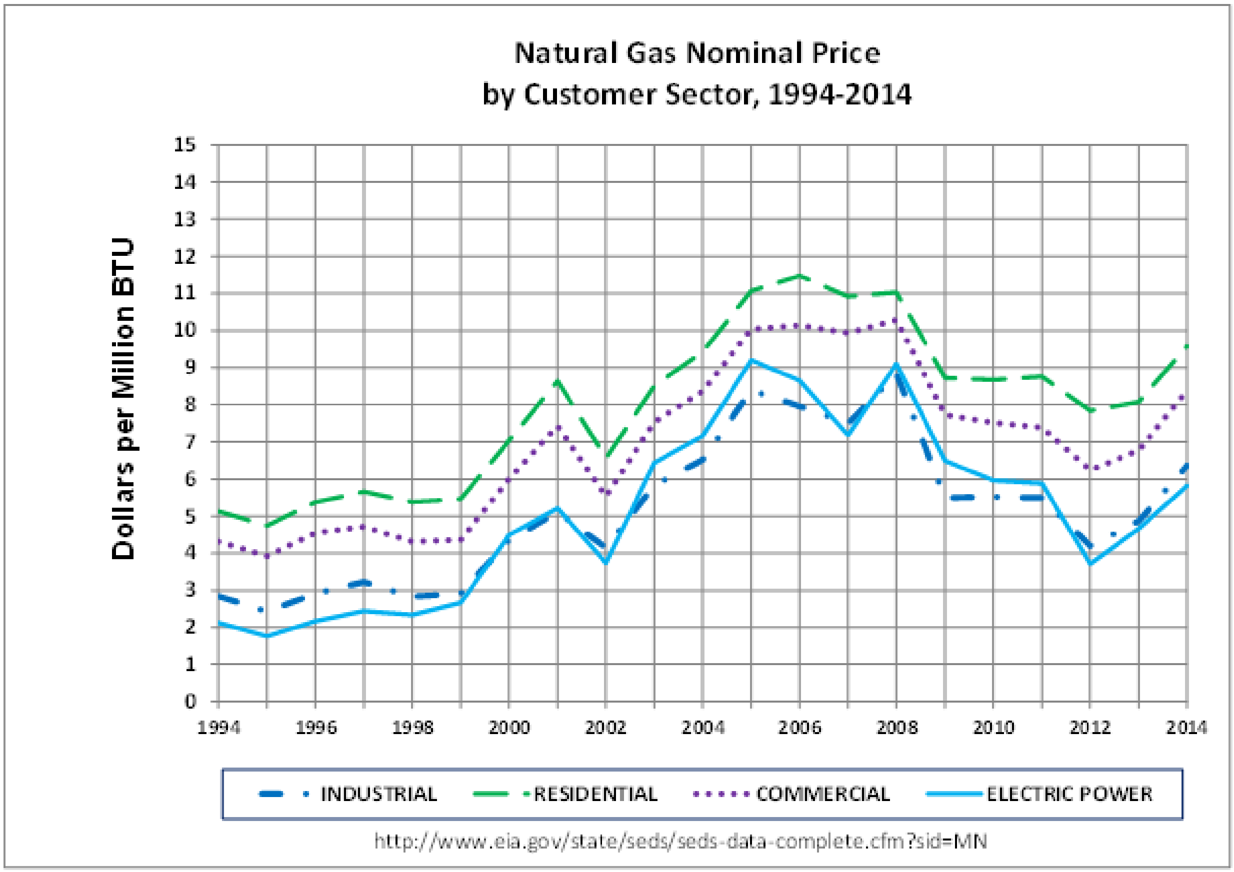
Notes:

1. *Nominal = Price in dollars per million BTU ($/MMBtu) for year shown.*
2. *Real (2014) = Price in real $/MMBtu for year shown, inflation-adjusted to 2014 base year.*
3. *Real % Change = Percent change in real dollar price ($/MMBtu) from previous year.*
4. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota.*

Natural Gas Prices by Sector

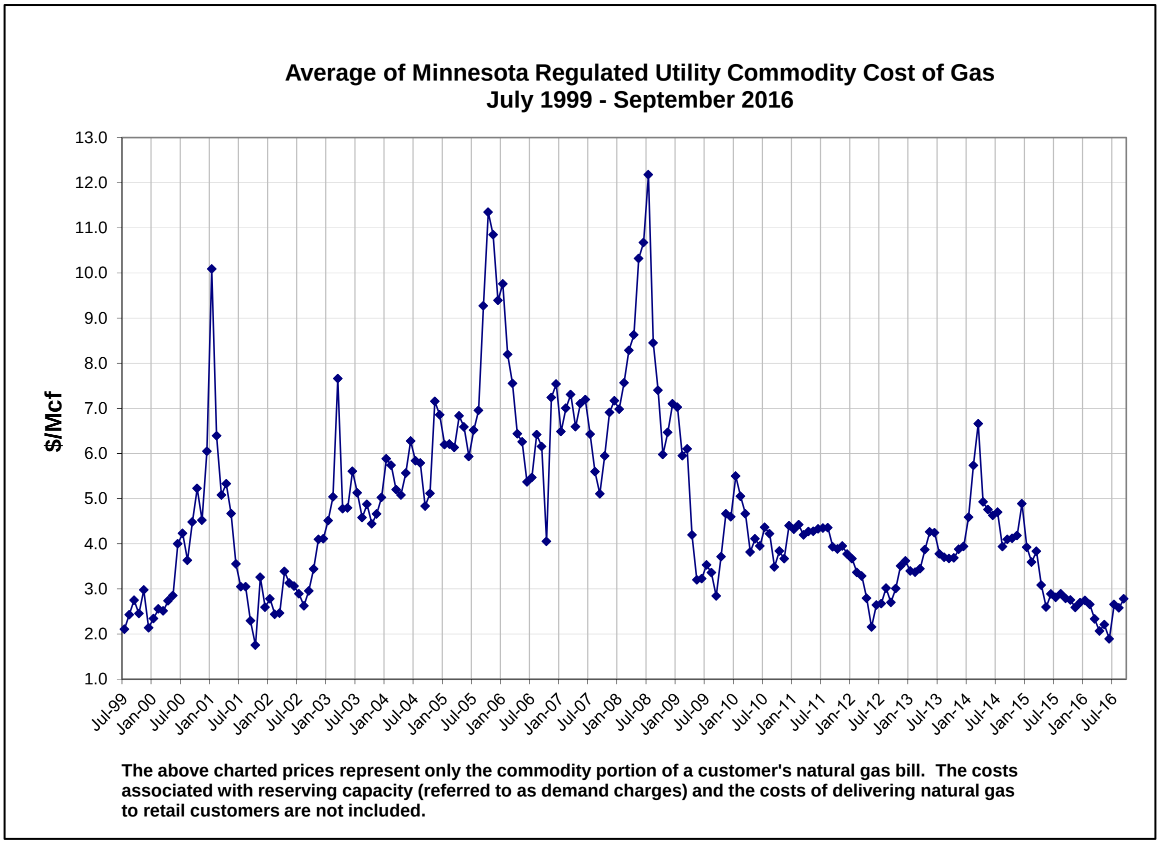
The nominal price of natural gas by customer sector is shown in Figure 48 in dollars per MMBtu.

Figure 48: Natural gas nominal price per MMBtu in Minnesota by customer sector, 1994 -2014



The price trends for natural gas are shown in Figure 49. As seen from this figure, natural gas prices can be quite volatile, although prices have become less volatile since the spring of 2010.

Figure 49: Average price ($ per Mcf) paid for natural gas by Minnesota consumers served by regulated natural gas companies, 1999-2016



Natural gas prices by customer segment for 2004 to 2014 are shown in Table 26 in dollars per million BTU.

Table 26: Change in natural gas prices ($ per MMBtu) by sector in MN, 2004-2014

Natural Gas Prices in Minnesota by Sector, 2004 – 2014
(Dollars per million BTU)

	Industrial			Residential			Commercial			Transportation			Electric Power			Average All Sectors		
Year	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**
2004	6.52	7.96		9.43	11.52		8.37	10.22		4.42	5.40		7.16	8.74		8.24	10.06	
2005	8.39	9.93	24.7%	11.07	13.10	13.7%	10.04	11.88	16.2%	5.69	6.73	24.7%	9.20	10.88	24.5%	9.93	11.75	16.8%
2006	7.96	9.14	-8.0%	11.48	13.18	0.6%	10.14	11.64	-2.0%	11.43	13.12	94.9%	8.65	9.93	-8.8%	9.86	11.32	-3.7%
2007	7.50	8.39	-8.2%	10.92	12.21	-7.3%	9.94	11.11	-4.5%	12.53	14.01	6.8%	7.18	8.03	-19.1%	9.31	10.41	-8.0%
2008	8.84	9.69	15.6%	11.03	12.09	-0.9%	10.28	11.27	1.4%	19.06	20.90	49.2%	9.11	9.99	24.4%	9.99	10.95	5.2%
2009	5.49	5.97	-38.4%	8.73	9.50	-21.4%	7.73	8.41	-25.4%	18.17	19.77	-5.4%	6.49	7.06	-29.3%	7.30	7.94	-27.5%
2010	5.52	5.93	-0.7%	8.67	9.32	-1.9%	7.52	8.09	-3.9%	16.33	17.56	-11.2%	5.96	6.41	-9.3%	7.00	7.53	-5.3%
2011	5.49	5.78	-2.6%	8.76	9.23	-1.0%	7.39	7.78	-3.7%	10.44	11.00	-37.4%	5.88	6.19	-3.3%	7.01	7.38	-1.9%
2012	4.20	4.34	-24.9%	7.84	8.11	-12.1%	6.24	6.45	-17.1%	10.36	10.72	-2.6%	3.71	3.84	-38.0%	5.56	5.75	-22.1%
2013	4.87	4.96	14.1%	8.08	8.22	1.4%	6.77	6.89	6.8%	6.72	6.84	-36.2%	4.66	4.74	23.6%	6.31	6.42	11.7%
2014	6.36	6.36	28.3%	9.58	9.58	16.5%	8.39	8.39	21.8%	7.35	7.35	7.5%	5.82	5.82	22.7%	7.88	7.88	22.7%
Since 2004			-20.1%			-16.8%			-17.9%			36.2%			-33.4%			-21.7%

Notes:

1. *Nominal = Expenditure in millions of dollars for year shown.*
2. *Real (2014) = Expenditure in millions of real dollars for year shown, inflation-adjusted to 2014 base year.*
3. *Real % Change = Percent change in real dollar expenditure from previous year.*
4. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota.*

Petroleum Prices by Product

Figure 50: Nominal Price for petroleum products in Minnesota ($ per million BTU), 1994-2014

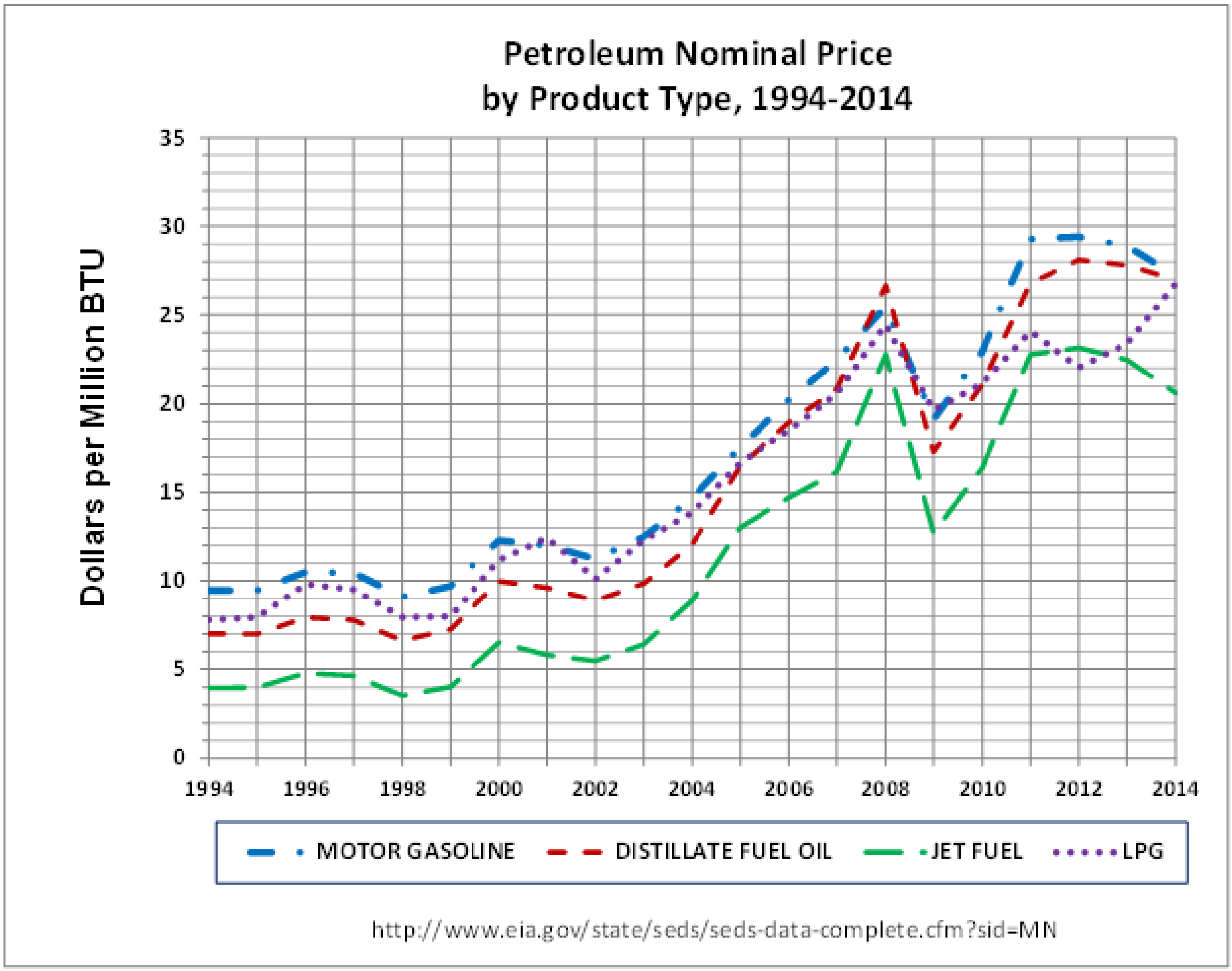
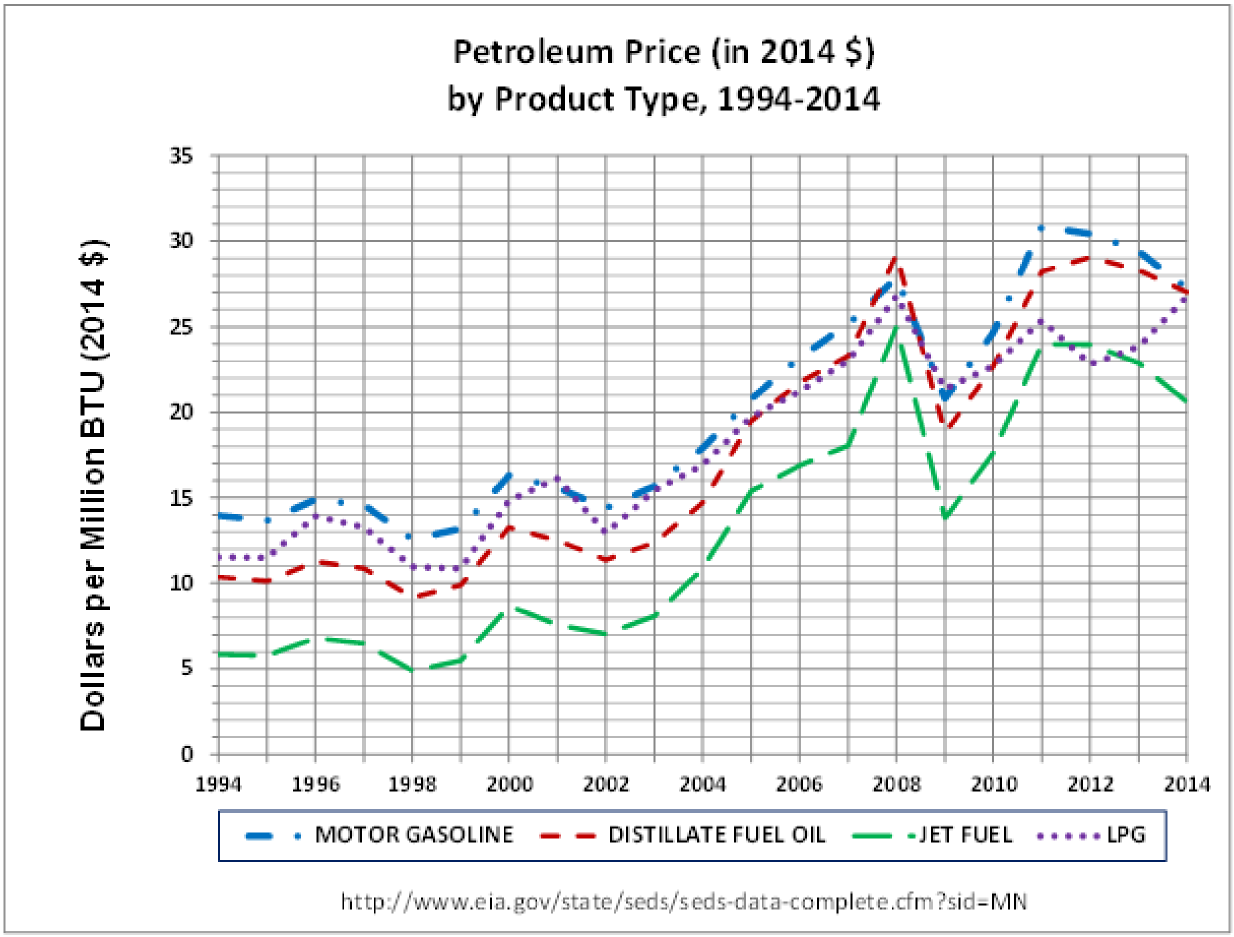


Figure 51: Real Price (using 2014 as the base year) for petroleum products in Minnesota ($ per million BTU), 1994-2014



Petroleum prices by product type are shown in Table 27 for 2004 to 2014.

Table 27: Change in prices for petroleum products in MN ($ per million BTU), 2004-2014

Petroleum Prices in Minnesota by Product Type, 2004 – 2014
(Dollars per million BTU)

	Motor Gasoline			Distillate Fuel Oil			Jet Fuel			LPG			All Petroleum Products		
Year	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**	Nominal	Real (2014)	**Real % Change**
2004	14.67	17.91		12.06	14.73		8.90	10.87		13.86	16.93		12.61	15.40	
2005	17.57	20.79	16.0%	16.49	19.51	32.5%	13.02	15.40	41.7%	16.67	19.72	16.5%	15.68	18.55	20.5%
2006	20.21	23.20	11.6%	18.95	21.75	11.5%	14.70	16.87	9.5%	18.49	21.22	7.6%	18.37	21.08	13.7%
2007	22.49	25.14	8.4%	20.83	23.29	7.1%	16.16	18.07	7.1%	20.57	23.00	8.4%	20.41	22.82	8.2%
2008	25.45	27.90	11.0%	26.66	29.23	25.5%	22.79	24.99	38.3%	24.45	26.81	16.6%	24.41	26.76	17.3%
2009	19.13	20.82	-25.4%	17.28	18.80	-35.7%	12.70	13.82	-44.7%	19.64	21.37	-20.3%	17.96	19.54	-27.0%
2010	22.94	24.66	18.5%	21.09	22.67	20.6%	16.39	17.62	27.5%	21.12	22.71	6.2%	21.52	23.14	18.4%
2011	29.29	30.85	25.1%	26.80	28.23	24.5%	22.76	23.98	36.1%	24.08	25.37	11.7%	27.27	28.73	24.2%
2012	29.42	30.43	-1.4%	28.10	29.06	3.0%	23.15	23.94	-0.1%	22.05	22.81	-10.1%	27.78	28.73	0.0%
2013	28.88	29.40	-3.4%	27.80	28.30	-2.6%	22.48	22.88	-4.4%	23.40	23.82	4.4%	27.49	27.98	-2.6%
2014	27.24	27.24	-7.3%	27.02	27.02	-4.5%	20.59	20.59	-10.0%	26.76	26.76	12.3%	26.62	26.62	-4.9%
Since 2004			52.1%			83.5%			89.4%			58.1%			72.9%

Notes:

1. *Nominal = = Price in dollars per million BTU ($/MMBTU) for year shown.*
2. *Real (2014) = Price in real $/MMBTU for year shown, inflation-adjusted to 2014 base year.*
3. *Real % Change = Percent change in real dollar price ($/MMBTU) from previous year.*
4. *Source – U.S. Energy Information Administration, State Energy Data System (SEDS): 1960-2014, Minnesota.*

APPENDIX C
Combined Heat & Power Facilities in Minnesota

Table 28 below provides a snapshot of CHP installations in the state. This CHP facility information was compiled from the U.S. Department of Energy's (DOE) CHP Installation Database.[132]

Table 28: CHP facilities in Minnesota

City	Facility Name	Application	Op Year	Capacity (KW)	Fuel Class – Primary Fuel
Albert Lea	Albert Lea Wastewater Treatment Plant	Wastewater Treatment	2003	120	Biomass - Digester Gas
Alexandria	Pope-Douglas Resource Recovery Facility	Solid Waste Facilities	1998	800	Waste
Altura	Diamond K Dairy / Ponderosa Dairy	Agriculture	2013	300	Biomass - Digester Gas
Bemidji	Plant Site On Highway 2	Pulp and Paper	1992	11,000	Wood Waste
Brainerd	Potlatch Corporation	Pulp and Paper	1959	600	Coal
Brooten	Jer-Lindy Farms	Agriculture	2008	37	Biomass
Burnsville	Fairview Ridges Hospital	Hospitals / Healthcare	1989	150	Natural Gas
Cloquet	Community College	Colleges / Univ.	2005	30	Natural Gas
Cloquet	Potlatch Corporation	Pulp and Paper	1975	55,000	Waste - Black Liquor
Coon Rapids	YMCA Coon Rapids	Amusement / Recreation	2004	90	Natural Gas
Cottage Grove	3M Plant	Chemicals	1997	251,000	Natural Gas
Crookston	ACS Crookston	Food Processing	1954	6,500	Coal
Duluth	ML Hibbard	Utilities	1988	48,600	Biomass
Duluth	Duluth Paper Mill	Pulp and Paper	1986	10,600	Wood Waste
East Grand Forks	American Crystal Sugar Company	Food Processing	1990	7,500	Coal
Garvin	Northern Border Pipeline Compressor Station (CS-13)*	Pipelines	2010	5,500	Waste Heat
Garvin	Northern Border Pipeline Compressor Station (CS-12)*	Pipelines	2009	5,500	Waste Heat
Grand Rapids	Rapids Energy Center / Blandin Paper Mill	Pulp and Paper	1969	28,600	Wood Waste
Hancock	District 45 Dairy	Agriculture	2010	2,130	BIOMASS - Digester G
Hibbing	Hibbing	District Energy	1965	35,900	Coal

[132] CHP Installation Database, U.S. Department of Energy.

City	Facility Name	Application	Op Year	Capacity (KW)	Fuel Class – Primary Fuel
International Falls	Boise Cascade Corporation	Pulp and Paper	1990	29,200	Natural Gas
Lake Crystal	Poet Biorefining - Ethanol	Chemicals	2008	1,024	Waste Heat
Le Sueur	High Island Dairy	Agriculture	2014	650	Biomass
Little Falls	Little Falls Plant	Chemicals	2006	2,000	Biomass
Mankato	Mankato	Food Processing	1987	6,150	Coal
Maplewood	Ramsey County Correctional Facility	Justice / Public Order	2004	90	Natural Gas
Minneapolis	U.S. Navy / FMC	Military / National Security	2008	1,119	Waste
Minneapolis	University Of Minnesota Plant Upgrade	Colleges / Univ.	2001	16,200	Natural Gas
Minneapolis	Dakota Station	Misc. Manufacturing	2000	60	Natural Gas
Minneapolis	FMC	Military / National Security	1994	1,119	Waste
Moorhead	American Crystal Sugar Company	Food Processing	1948	5,000	Coal
Morris	Riverview Farms (site #1)	Agriculture	2010	1,000	Biomass - Digester Gas
Morris	Riverview Farms (site #2)	Agriculture	2010	1,000	Biomass - Digester Gas
New Ulm	New Ulm	District Energy	1965	21,000	Natural Gas
Ottawa	Center Point Energy	Misc. Manufacturing	1993	1,250	Natural Gas
Perham	Tuffy's Pet Foods	Food Processing	2002	4,500	Municipal Solid Waste
Princeton	Haubenschild Dairy	Agriculture	2004	155	Biomass - Digester Gas
Rochester	Wastewater Treatment Plant	Wastewater Treatment	2007	2,000	Biomass - Digester Gas
Rochester	Mayo Clinic	Hospitals / Healthcare	1999	5,200	Natural Gas
Rochester	Franklin Heating Station	Hospitals / Healthcare	1999	11,750	Natural Gas
Rochester	Olmsted Waste-To-Energy Facility	Solid Waste Facilities	1987	4,200	Municipal Solid Waste
Rochester	Southern Minnesota Beet Sugar	Food Processing	1976	7,500	Coal
Rochester	Saint Marys Hospital Power Plant	Hospitals / Healthcare	1971	12,950	Natural Gas
Shakopee	Koda Energy	Food Processing	2009	19,700	Biomass
Sherburne	Liberty Paper	Pulp and Paper	1976	100,000	Coal
Silver Bay	Northshore Mining Corporation	Metal Mining	1955	105,000	Coal

City	Facility Name	Application	Op Year	Capacity (KW)	Fuel Class – Primary Fuel
Spring Valley	Spring Valley	District Energy	1949	3,900	Oil - Distillate Fuel
St. Paul	Schmidt Artists Lofts	Office Building	2014	65	Natural Gas
St. Paul	District Energy St. Paul	District Energy	2008	900	Waste
St. Paul	WestRock St. Paul Facility	Pulp and Paper	2007	12,000	Natural Gas
St. Paul	Metro Plant	Wastewater Treatment	2005	5,000	Biomass - Digester Gas
St. Paul	St. Paul Cogeneration Plant	District Energy	2003	33,000	Biomass
St. Peter	Northern Plains Dairy	Agriculture	2003	260	Biomass
Virginia	Virginia	District Energy	1954	26,200	Coal
Willmar	Willmar	District Energy	1970	26,000	Coal
Winona	Winona Wastewater Treatment Facility	Wastewater Treatment	2009	65	Biomass

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