INFORMATION BRIEF
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Generating Electricity: Minnesota's Changing Fuel Mix

The fuels used to generate electricity in Minnesota have changed significantly since 2000. Propelled by advancing technologies, economics, and public policies, renewable fuels and natural gas have almost quintupled their share of the state's fuel generation mix, while coal's market share has fallen from two-thirds to under 40 percent. This information brief describes these changes, the forces driving them, and the outlook for future generation sources.

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Mixture of Fuels for Electricity Generation

Minnesota's Electricity Fuel Generation Mix Has Changed Significantly Since 2000

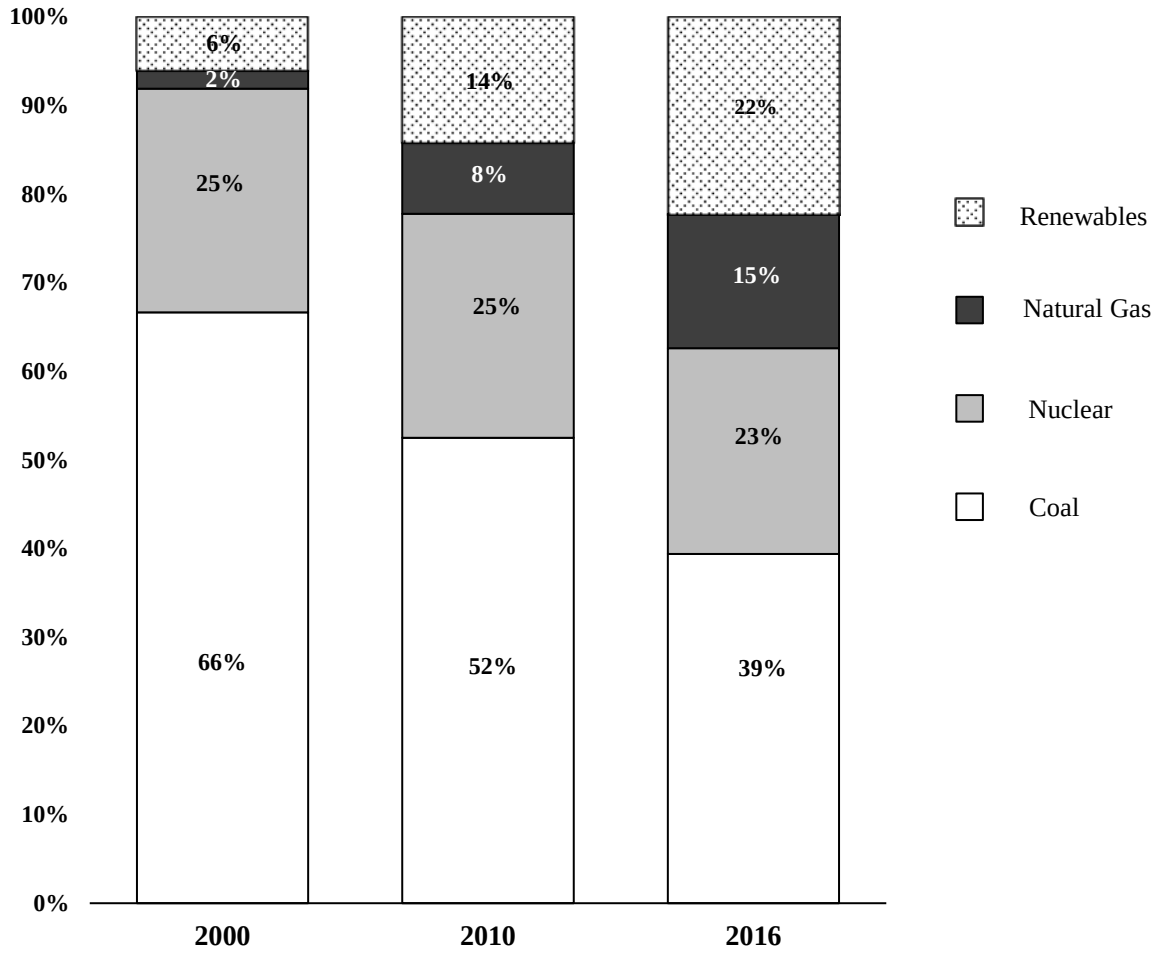
The mix of fuels that generates Minnesota's electricity supplies remained remarkably stable for a generation, but has changed significantly in the last decade.

From the mid-1970s through 2000, over 90 percent of the state's electricity was generated from a combination of coal and nuclear power, with the former supplying about two-thirds of the total. Other fuels, such as oil, natural gas, and renewables, played strictly minor roles.

That stability ended in the first decade of the 21st century, as shown in Figure 1. Coal's share of the mix fell 14 percentage points between 2000 and 2010, while the proportion of natural gas quadrupled to 8 percent, and the share of renewable fuels (wind, biomass, and solar) more than doubled to 14 percent. That trend has continued to accelerate. In 2016, coal's share fell below 40 percent, while renewables (mostly wind) provided 22 percent and natural gas accounted for 15 percent of the total.[1]

[1] While these changes reflect national trends, Minnesota's electric generation profile continues to differ from the national average, which in 2016 stood at: coal, 30 percent; nuclear, 20 percent; natural gas, 34 percent; and renewables, 15 percent. U.S. Energy Information Administration, "Frequently Asked Questions: What is U.S. electricity generation by energy source?" www.eia.gov/tools/faqs/faq.php?id=427&t=3.

Figure 1
Minnesota's Electricity Generation Mix, 2000-2016
(Percent of Total Megawatt Hours)



Source: Minnesota Department of Commerce, *Minnesota Renewable Energy Update*, 2015 and 2016

Forces Driving the Changes

New Technologies, Market Economics, and Public Policy Have Propelled These Changes

- **New drilling techniques greatly increased supplies of natural gas, lowering prices, while coal prices rose.** The development and spread of horizontal drilling and hydraulic fracturing methods in both oil and gas drilling resulted in a 50 percent increase in U.S. natural gas production between 2005 and 2015. As a result, the average price paid by

U.S. utilities for natural gas during this period decreased by 61 percent, while coal prices increased by 63 percent.[2]

- **Improvements to wind technology have increased the amount of energy generated by newer wind turbines, allowing areas with lower quality wind resources to be exploited.** Between 2006 and 2016, the nameplate capacity (maximum output) of wind turbines increased by 34 percent, the length of blades by 38 percent, and capacity factors—the ratio of energy generated to the amount of energy that would be generated if the system operated continuously at its maximum output level—by 33 percent. This increased productivity has resulted in declining prices per unit of output. Power purchase agreements between utilities and wind developers in the Plains region have fallen by approximately 64 percent (from approximately $55/MWh to about $20/MWh) between 2009 and 2016.[3]

- **Substantial declines in the cost of solar energy system components—including the importation of Chinese solar panels subsidized by that country's government—and increases in efficiency led to a reduction in the median installed price of utility-scale solar by about 60 percent between 2008 and 2015.**[4]

- **Federal and state financial subsidies for wind and solar energy have further reduced costs for those technologies.** Federal tax credits for solar systems reduce costs by about 20 percent. The federal production tax credit for wind lowers its cost by about 33 percent.[5]

  Minnesota provided a subsidy of 1.5 cents per kilowatt-hour generated for 200 MW of wind development in 2004.[6] Two state programs—one initiated in 2010 and terminated in 2015, the other enacted in 2013 and terminated in 2017—subsidized solar panels manufactured in Minnesota and installed by residential and commercial customers generating electricity for their own use. A solar subsidy program initiated in 2013 applies only to residential and commercial customers of Xcel Energy.[7]

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[2] Natural gas supplies: U.S. Energy Information Administration, *U.S. Natural Gas Marketed Production*, www.eia.gov/dnav/ng/hist/n9050us2A.htm. Prices: U.S. Energy Information Administration, *Electric Power Annual*, Table 7.4, www.eia.gov/electricity/annual/html/epa_07_04.html. Coal prices are for subbituminous coal.

[3] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *2016 Wind Technologies Market Report*, pp. 26, 39, 59. At a meeting of Minnesota's Legislative Energy Committee held on September 14, 2017, an Xcel Energy representative testified that the company was paying $15 to $20 per MW for new wind projects.

[4] Mark Bolinger and Joachim Seel, *Utility-Scale Solar in 2015*, Lawrence Berkeley National Laboratory, August 2016, p. I, https://emp.lbl.gov/sites/default/files/lbnl-1006037_report.pdf.

[5] *Lazard's Levelized Cost of Energy Analysis – Version 10.0*, December 2016, p. 4. Both of these federal credits are being phased out. See fn. 18.

[6] Minn. Stat. § 216C.41. Minnesota had wind capacity of 3,499 MW at the end of 2016. American Wind Energy Association, http://awea.files.cms-plus.com/FileDownloads/pdfs/Minnesota.pdf.

[7] Minn. Stat. §§ 116C.7791 and 216C.412-216C.415 (the terminated programs) and § 116C.7792.

- **Minnesota's Renewable Energy Standard (enacted in 2007) and its Solar Energy Standard (enacted in 2013) require utilities to generate 25 percent of retail electricity sales from renewable energy sources by 2025 (30 percent by 2020 for Xcel Energy), and an additional 1.5 percent from solar energy by 2020.**[8] Utilities subject to this requirement have met, and in some cases exceeded, the interim 2016 target of 17 percent (25 percent for Xcel).

- **Federal environmental regulations reducing air and water pollution from coal-burning power plants have contributed to some utility decisions to retire coal plants rather than invest in pollution control equipment.**[9]

- **Electricity demand has been flat for a decade, forcing older and more expensive coal plants to compete against both cheaper natural gas plants and policy-mandated lower-cost renewable additions to the state's generating fleet in a static market.** Minnesota's electricity sales were lower in 2015 than in 2006.[10] Minimal demand growth is a result of a host of factors: price responses to rising retail electricity prices; increased efficiency of electricity-using appliances and lighting; Minnesota law requiring utilities to make energy efficiency investments that result in annual savings equal to 1.5 percent of retail sales.[11]

Minnesota utilities have responded to those forces, in part, by retiring coal-fired generating plants or converting them to natural gas, as shown in Table 1. Conversions to gas eliminated 1,201 MW of coal capacity, while past and announced retirements account for an additional 2,164 MW. Collectively, these plants represent about 29 percent of Minnesota's electric-generating capacity for all electric utilities in 2015.[12]

[8] Minn. Stat. § 216B.1691, subds. 2a and 2f.

[9] Trevor Houser, Jason Bordoff, and Peter Marsters, Columbia University Center on Global Energy Policy, *Can Coal Make a Comeback?* April 2017, pp. 20-22, http://energypolicy.columbia.edu/sites/default/files/energy/Center%20on%20Global%20Energy%20Policy%20Can%20Coal%20Make%20a%20Comeback%20April%202017.pdf.

[10] U.S. Energy Information Administration, *Detailed State Data: Annual Data, 1990-2015, Retail Sales of Electricity by State by Sector (EIA-861)*, www.eia.gov/electricity/data/state.

[11] Minn. Stat. § 216B.241, subd. 1c.

[12] U.S. Energy Information Administration, *Minnesota Electricity Profile 2015*, https://www.eia.gov/electricity/state/minnesota/.

Table 1
Coal Plants Converted to Natural Gas or Scheduled for Retirement by Minnesota Utilities

Generating Plant	Utility	Year Built	Coal Capacity (MW)	Converted/Retired/Year
Black Dog, Units 1 & 2	Xcel Energy	1952	176	Converted to natural gas/2002
High Bridge Station	Xcel Energy	1923	243	Converted to natural gas/2008
Riverside Station	Xcel Energy	1911-1969	387	Converted to natural gas/2009
Austin Northeast	Austin Utilities	1971	32	Converted to natural gas/2012 Retired 2016
Laskin, Units 1 & 2	Minnesota Power	1953	110	Converted to natural gas/2015
Black Dog, Units 3 & 4	Xcel Energy	1955/1960	253	Idled 2015/Conversion to natural gas by 2019
Taconite Harbor, Unit 3	Minnesota Power	1967	75	Retired/2015
Silver Lake	Rochester Public Utilities	1949	100	Retired/2015
Stanton Station*	Great River Energy	1960	189	Retired/2017
Boswell, Units 1 & 2	Minnesota Power	1958/1960	140	Retirement scheduled/ 2018
Taconite Harbor, Units 1 & 2	Minnesota Power	1957	150	Idled 2016; retirement scheduled/2020
Hoot Lake	Otter Tail Power	1921-1964	148	Retirement scheduled/2021
Sherco, Unit 2	Xcel Energy	1977	682	Retirement scheduled/2023
Sherco, Unit 3	Xcel Energy	1976	680	Retirement scheduled/2026

* This plant is located in South Dakota.

Source: Minnesota Public Utilities Commission

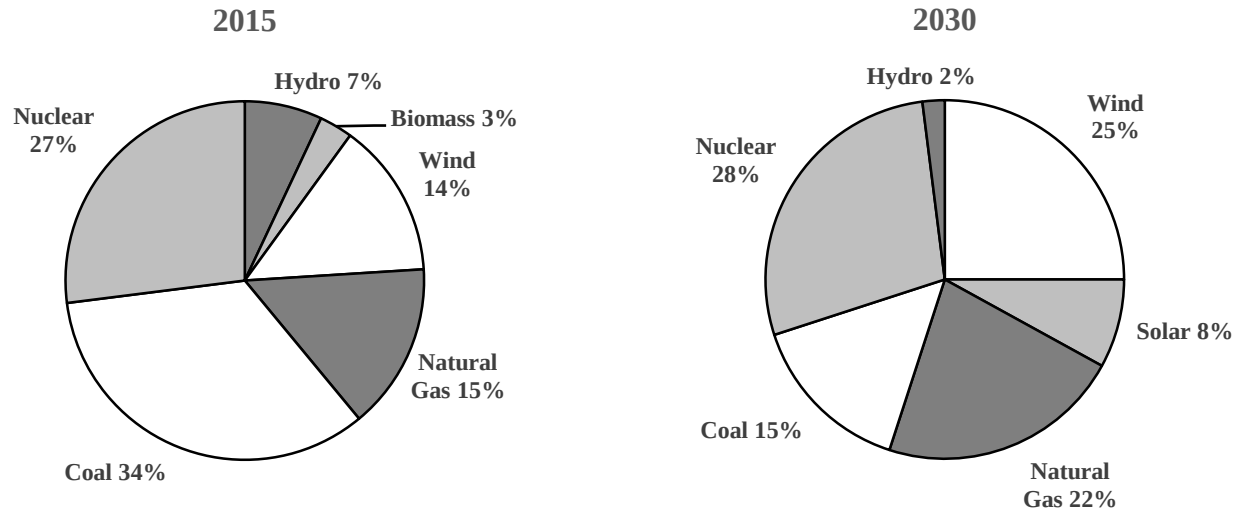
Short-term Trends for Minnesota

For Minnesota's Largest Utilities, These Trends Are Set to Continue in the Short Term

The planned acquisition of future generating facilities by Minnesota's largest utilities, as reflected in orders of the Minnesota Public Utilities Commission with respect to these companies' most recent Integrated Resource Plans, indicates that the shift to renewable sources of electric generation will continue in the near future.

The commission ordered Xcel Energy, which accounts for half the state's electricity sales, to acquire at least 1,000 MW of wind by 2019 and 650 MW of solar by 2021, concluding that "the record clearly showed that acquisition of wind and possibly solar resources in the next five years represents the least-cost method of meeting Xcel's near-term resource needs."[13] As indicated below in Figure 2, by 2030, wind, solar, and natural gas will account for 25 percent, 8 percent, and 22 percent, respectively, of the company's mix, with nuclear power representing 28 percent of the total, and coal falling to 15 percent.[14]

Figure 2
Xcel Energy's Fuel Generation Mix: 2015 and 2030



Source: Xcel Energy, *Upper Midwest 2016-2030 Resource Plan*

[13] Minnesota Public Utilities Commission, In the Matter of Xcel Energy's 2016-2030 Integrated Resource Plan, *Order Approving Plan with Modifications and Establishing Requirements for Future Resource Plan Filings*, Docket No. E-002/RP-15-21, January 11, 2017, p. 7.

[14] Xcel Energy, *Upper Midwest 2016-2030 Resource Plan*, www.xcelenergy.com/company/rates_and_regulations/filings/upper_midwest_2016-2030_resource_plan.

Minnesota Power achieved its 2025 Renewable Energy Standard goal of 25 percent ten years early.[15] The company's Energy*Forward* strategy—introduced in 2013—proposed going beyond that level to a portfolio of one-third renewable resources, one-third coal, and one-third natural gas and other fuels. The commission's June 2016 *Order* called for the company to initiate a competitive bidding process for 100 to 300 MW of additional wind by the end of 2017 and up to 100 MW of solar by 2022, in addition to the 33 MW of solar that would fulfill its Solar Energy Standard target.[16]

The commission approved Otter Tail Power's 2017 Integrated Resource Plan that proposed adding 200 MW of wind and 30 MW of solar by 2020,[17] bringing the company's proportion of generation from renewable fuels to more than 26 percent. The commission also modified the company's plan to include an additional 100 to 200 MW of wind in the 2022-2023 timeframe, raising its renewable portfolio above 30 percent.

Factors Affecting Future Generation Sources

Factors That May Affect Minnesota's Future Electricity Fuel Generation Mix

Minnesota's future sources of electric generation will continue to be determined by the interactions of technological change, economic competitiveness, and public policy. Among the factors to watch are the following:

- The tapering and termination of federal subsidies for solar and wind energy[18]
- The shelving of the federal Environmental Protection Agency's Clean Coal Plan
- The rate of adoption of electric vehicles, which will raise electricity demand
- Improvements in energy storage technologies and their price competitiveness, which will boost the economics of renewable fuels

[15] Minnesota Public Utilities Commission, In the Matter of Minnesota Power's 2016-2030 Integrated Resource Plan, *Minnesota Power's 2015 Integrated Resource Plan*, Docket No. E-015/RP-15-690, September 1, 2015, Appendix H, "Minnesota's Renewable Energy," p. 2.

[16] Minnesota Public Utilities Commission, In the Matter of Minnesota Power's 2016-2030 Integrated Resource Plan, *Order Approving Resource Plan With Modifications*, Docket No. E-015/RP-15-690, July 18, 2016, p. 15.

[17] Minnesota Public Utilities Commission, In the Matter of Otter Tail Power Company's 2017-2031 Integrated Resource Plan, *Order Approving Plan with Modifications and Setting Requirements for Next Resource Plan*, Docket No. E-017/RP-16-386, April 26, 2017, pp. 3, 10.

[18] The production tax credit for wind (originally set at 2.4 cents per kwh) is reduced by 20 percent each year for projects constructed in 2017 through 2019. The investment tax credit for wind (which may be elected in lieu of the production tax credit) declines from 30 percent for projects constructed in 2016 to 24 percent for those begun in 2017, 18 percent in 2018, and 12 percent in 2019. Both credits terminate in 2020. The solar investment tax credit of 30 percent applies to projects whose construction begins before the end of 2019, falling to 26 percent for those begun in 2020, 22 percent for projects constructed in 2021, and 10 percent thereafter, at which point residential projects are no longer eligible.

- The remedy applied by the president to the October 2017 finding by the U.S. International Trade Commission that the Chinese government subsidized the price of solar panels exported to the United States, harming the domestic solar cell industry. A tariff on these panels would increase the price of solar energy relative to other fuel sources.[19]
- The fate of the rule proposed to the Federal Energy Regulatory Commission by the federal Department of Energy to increase wholesale energy tariffs to fully compensate fossil-fuel and nuclear fuel generation units maintaining a 90-day fuel supply for their contribution to the reliability and resiliency of the electric grid.

For more information about electric utilities, visit the utility regulation area of our website, www.house.mn/hrd/.

[19] Marc Gunther, "Could a Trade Dispute with China Bring an End to U.S. Solar Boom?" *Yale Environment 360*, June 27, 2017, https://e360.yale.edu/features/could-trade-dispute-with-china-bring-an-end-to-u-s-solar-boom; Joe Ryan and Chris Martin, "Solar Developers Hoard Panels as U.S. Tariff Threat Looms," *BloombergMarkets*, September 12, 2017, https://www.bloomberg.com/news/articles/2017-09-11/solar-developers-hoarding-panels-as-threat-of-u-s-tariffs-looms.