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Minnesota Renewable Energy Update

November 2018

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Cover Image: Community Solar Array in Red Wing, MN. Photo by IPS-Solar.

Executive Summary

Minnesota's clean energy progress is continuing at a strong pace. Overall, renewable energy generated 24.9 percent of the state's electricity in 2017 compared to 8.4 percent in 2007, an increase of over 300 percent in the past decade.

Wind alone generated 18.2% of Minnesota's electricity in 2017, with large increases in wind power expected over the next three years from projects that are already approved and currently under construction or in development.

Meanwhile, electricity produced in the state from coal dropped to 39 percent in 2017 from 59 percent in 2007. For the first time, renewables surpassed nuclear energy (23 percent) as the second largest source of electricity generated in Minnesota.

As a result of forward-looking state policies such as the Renewable Electricity Standard, along with technological advances and lower costs for renewables, Minnesota utilities are moving ahead with ambitious plans to expand their electricity generation from clean energy such as wind and solar.

Definition of Terms

Alternating Current (AC) is the form of electricity supplied by the electric grid. The polarity of the current supplied by the grid cycles from positive to negative 60 times in one second (i.e., 60 Hertz).

Direct Current (DC) is the form of electricity generated by solar photovoltaic cells where electrons flow in only one direction: from negative to positive. DC is also the type of electricity used to charge batteries and power semiconductor devices such as computers and LED lights. An inverter or power converter is used to convert electricity from DC to AC.

Capacity (also: Nameplate Capacity) is the maximum electric power an electricity generator can produce under specific conditions defined by the manufacturer. The capacity of utility-scale generators is measured in megawatts (MW).¹

Energy is the amount of electricity a generator produces over a specific period of time. For example, a generator running at 1 megawatt of power that operates constantly over one hour will produce 1 megawatthour (MWh). Minnesota households used an average of 9.2 MWh/year in 2016, according to the U.S. Energy Information Administration.

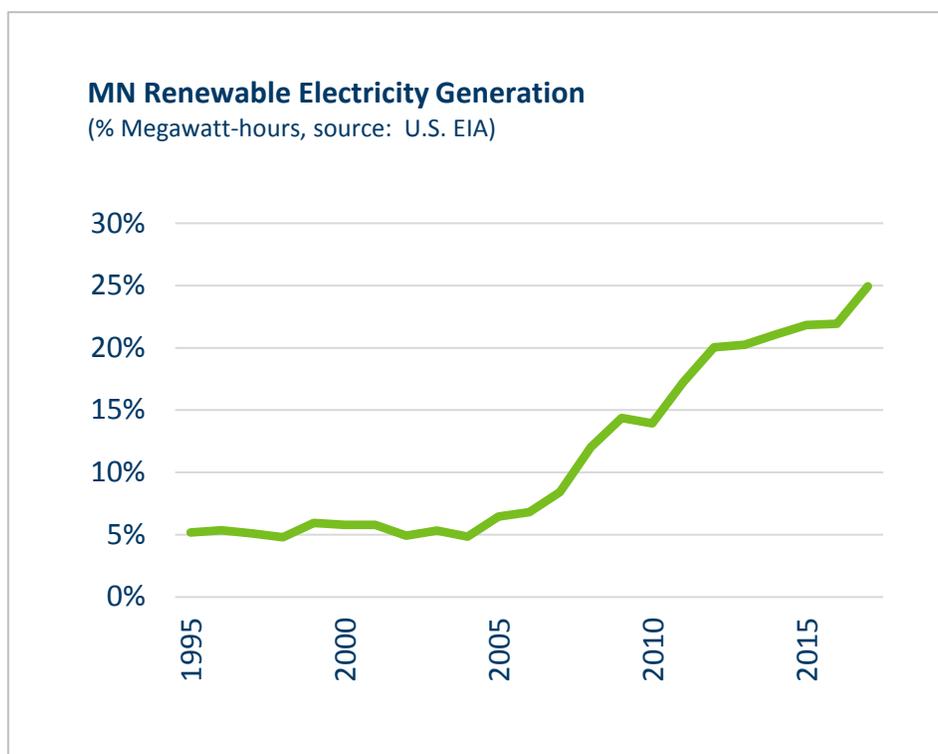
¹ See also: [FAQ: What is the difference between electricity generation capacity and electricity generation?](#) U.S EIA

Minnesota's Renewable Energy Progress

Minnesota's progress towards using more renewable energy continues at a strong pace.

Renewable sources fueled about 25 percent of the electricity generated within state borders in 2017, according to figures compiled by the Minnesota Department of Commerce and the U.S. Energy Information Administration (EIA). Overall, renewable energy generated 24.9 percent of the state's electricity in 2017 compared to 8.4 percent in 2007, an increase of over 300 percent in the past decade². Wind generated 18.2 percent of the state's electricity in 2017, with a significant increase expected over the next several years.

Minnesota's Renewable Electricity Generation Has Increased Dramatically



As utilities build and plan for even more renewable energy resources, Minnesota is already moving beyond its current Renewable Electricity Standard (25 percent by 2025) as set by the state's [Next Generation Energy Act of 2007](#).³

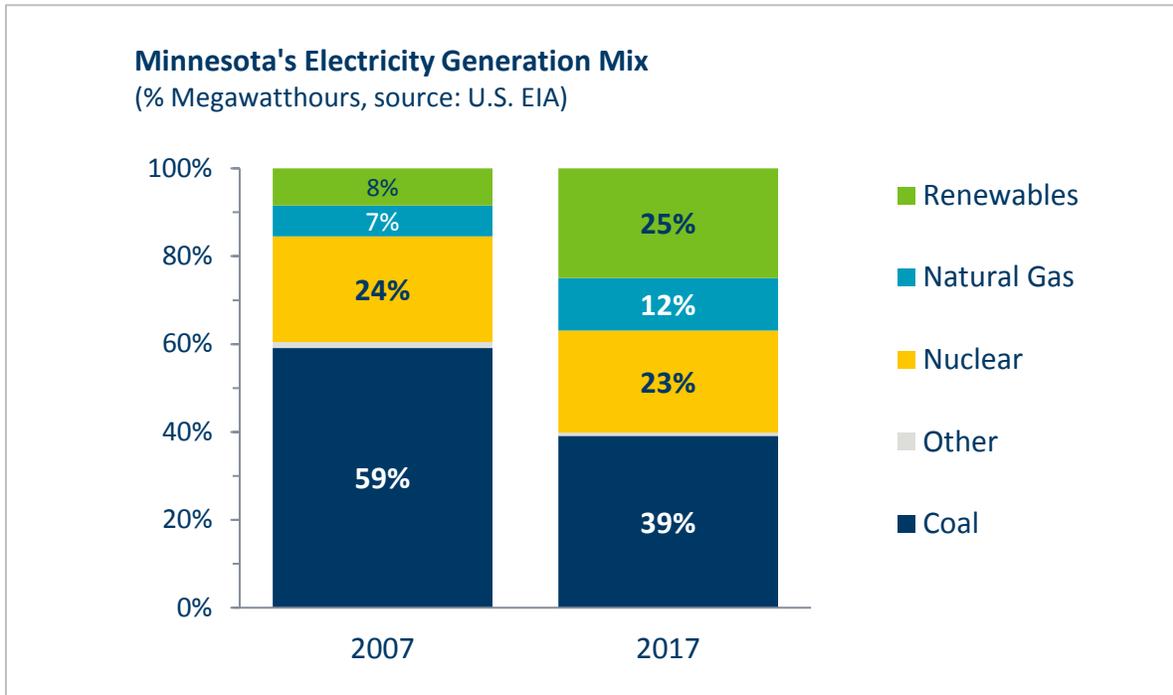
From 2007 to 2017, Minnesota's electricity generation mix changed significantly:

² In 2017, 14.9 Terawatthours of renewable electricity was generated in Minnesota, over three times as much renewable energy as the 3.9 Terawatthours generated in 2007.

³ The percent of electricity generation from renewables in Minnesota is an indicator, rather than a direct measure, of progress on the Renewable Electricity Standard, which refers specifically to retail electricity sales generated or procured using renewable sources. Because it consumes more electricity than is generated from in-state sources, Minnesota also imports electricity (both renewables and non-renewables) from out of state.

- Renewables tripled from 8 percent in 2007 to 25 percent in 2017.
- Solar produced 1.2 percent of electricity in 2017, compared to just 0.02 percent in 2016.
- Wind energy went from 5 percent in 2007 to 18 percent in 2017.⁴
- Natural gas nearly doubled from 7 percent in 2007 to 12 percent in 2017.
- Coal energy decreased from 59 percent in 2007 to 39 percent in 2017.

Renewables Have Increased Significantly While Coal Has Declined



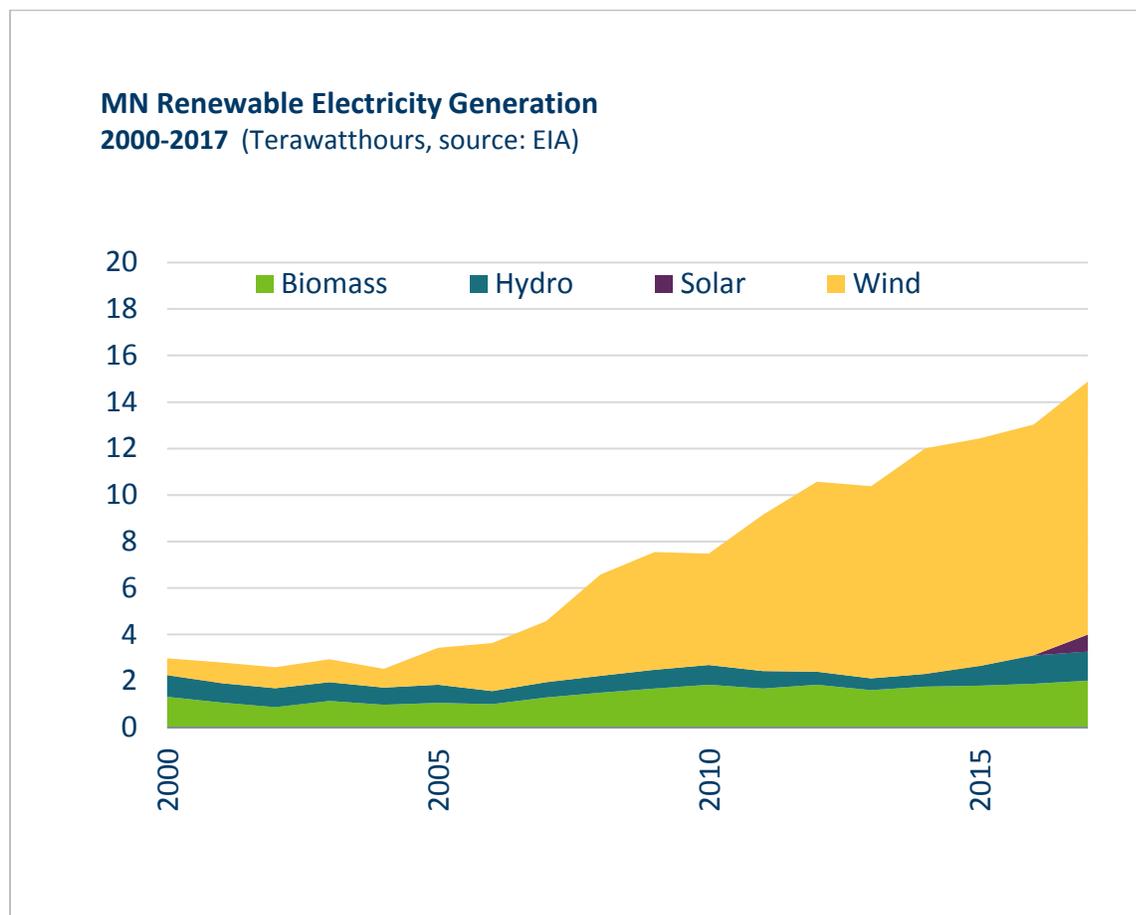
⁴ In 2017, 10.8 TWh of electricity was generated from wind in Minnesota, more than four times as much wind power compared to 2.6 TWh in 2007.

Renewable Energy Mix

Minnesota renewable electricity generation in 2017 came from these sources (see page 2 for Definitions of Terms: capacity vs. energy and AC vs. DC):

- 3,509 MW wind capacity,^{5, 6} contributing 18.2 percent of energy generated in Minnesota⁷
- 596 MW_{AC} (714 MW_{DC}) solar PV capacity,⁵ contributing 1.2 percent⁷ of energy generated in Minnesota
- 487 MW biomass electricity capacity,⁸ contributing 3.4 percent of energy generated in Minnesota⁷
- 203 MW hydroelectric capacity,⁸ contributing 2.1 percent of energy generated in Minnesota⁷

Wind Accounts for Most of Minnesota's Renewable Electricity



⁵ Minnesota State Energy Office

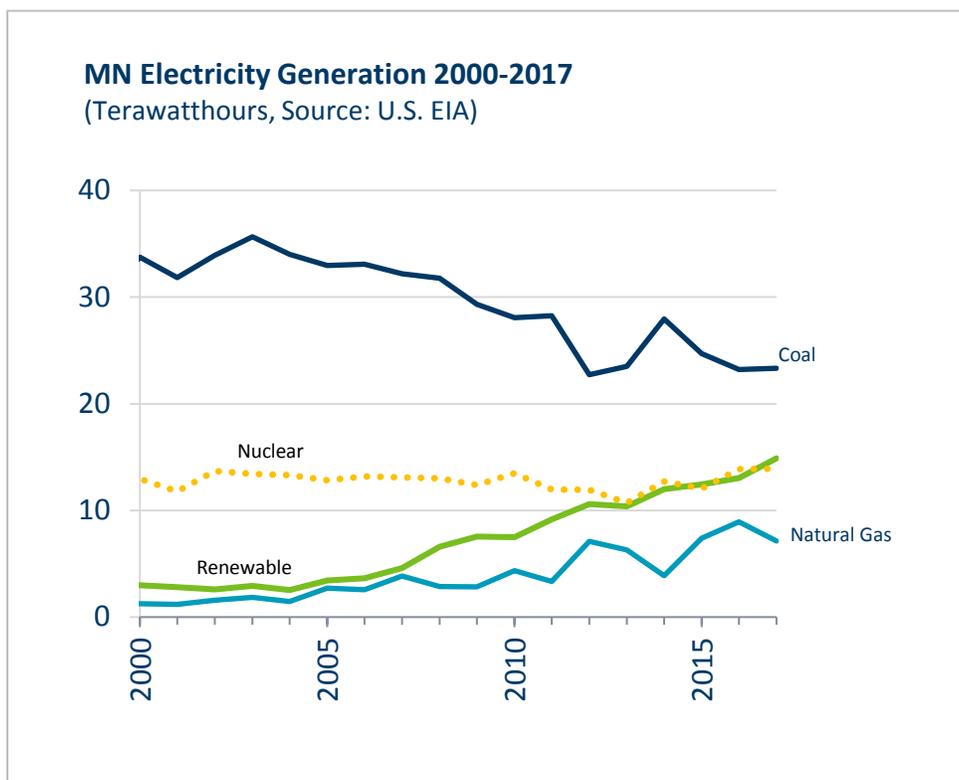
⁶ American Wind Energy Association

⁷ Energy Information Administration

⁸ Midwest Renewable Energy Tracking System

According to data from the U.S. Energy Information Administration (EIA), a shift to cleaner energy sources has continued at a steady pace in Minnesota. For instance, wind energy generated just 4.8 percent of the state’s electricity in 2007 and jumped to 18.2 percent in 2017, while electricity from coal dropped from 59.1 percent in 2007 to 39.1 percent in 2017. Biomass increased from 2.4 percent to 3.4 percent in the same time span.

Minnesota’s Shift to Renewables Is a Long-Term Trend



In each year from 2013 to 2016, renewable energy and nuclear power generated nearly the same level of electricity. In 2017, renewables surpassed nuclear energy as the second largest source of electricity in Minnesota.

Due to temporary factors, some years have seen short-term fluctuations in the mix of energy sources. For example, from 2012 to 2013, coal generation decreased because of an unplanned outage at Xcel Energy’s generation Sherburne County (Sherco) Station, generator #3. During the same period, natural gas increased in response to a drop in natural gas prices. In 2014, tight natural gas supply caused by the “polar vortex” winter, followed by a mild summer, led to decreased electricity generation from natural gas.⁹ In 2017, electricity generated from natural gas decreased because of an increase in natural gas prices from historically low levels.¹⁰

⁹ [2014 State of the Market Report for the MISO Electricity Markets](#), Potomac Economics, June 2015

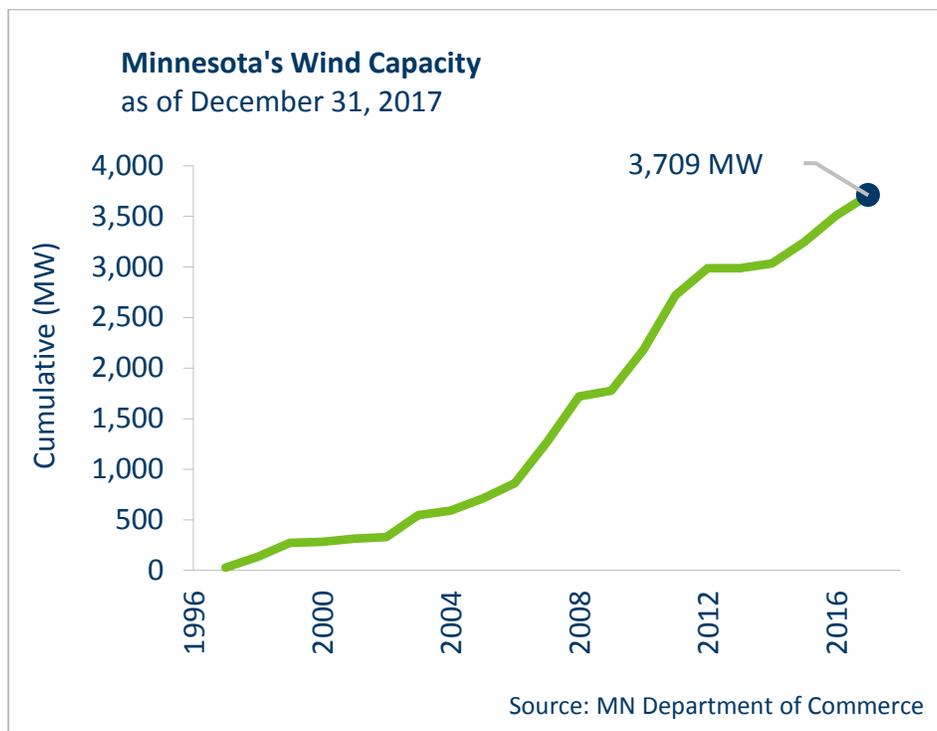
¹⁰ [2017 State of the Market Report for the MISO Electricity Markets](#), Potomac Economics, June 2018

Minnesota’s renewable energy progress is expected to continue in the coming years with additional planned wind and solar power growth. In particular, about 1,300 MW of new in-state wind generation is currently under construction or in development, which will result in an estimated 35 percent increase in Minnesota’s wind-powered electricity within the next several years.

Wind Energy

In 2017, with 18.2 percent of electricity generated in Minnesota coming from wind power, the state ranked seventh in the nation for wind energy as a share of total in-state electricity generation.

Minnesota Has Seen 20 Years of Wind Power Growth



At the end of 2017, Minnesota had 3,700 MW of installed capacity from large wind turbines (>100kW) and 8.7 MW of installed capacity from small wind turbines (≤100kW), for a total of 3,709 MW.

Because of ongoing technology advancement and zero fuel costs, wind is now economically competitive with energy generation from coal and natural gas. Planned retirements of older coal plants, combined with the extension of the federal Production Tax Credit, are driving significant investment in new wind capacity. The U.S. tax code revision in December 2017 has also prompted utilities and developers to assess the impact on Power Purchase Agreement

rates for planned wind additions. Meanwhile, the completion of the 800-mile CapX 2020 transmission project is supporting several gigawatts of new wind proposals.¹¹

Solar Energy

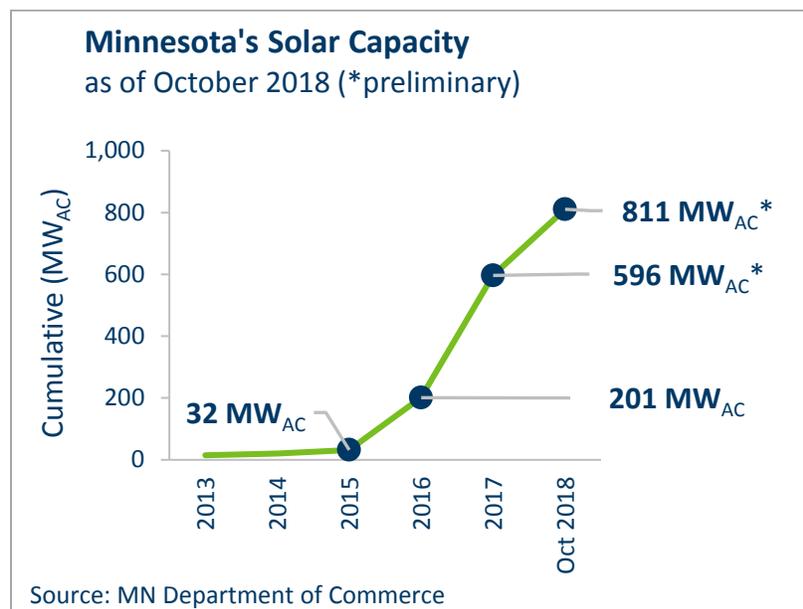
Solar energy's contribution to the state's electric power was still relatively small in 2017 at 1.2 percent of in-state generation. However, Minnesota enjoyed sustained, dramatic growth in electricity generated by solar during 2017, with an increase in capacity of nearly three times over the previous year.

Minnesota reached more than 596 MW_{AC} (714 MW_{DC})of known grid-tied PV capacity in 2017, including over 35_{AC} MW of customer-sited installations <40kW. According to data compiled by the Minnesota Department of Commerce, 395 MW_{AC} of capacity was added in 2017, compared to 169 MW_{AC} during all of 2016. More solar capacity was added in the first half of 2017 alone than the total solar capacity added in the previous decade.

Minnesota's solar market activity in 2017 was a significant part of the national solar market:¹²

- Minnesota was the 6th largest state solar market in 2017.
- Minnesota was the 3rd largest non-residential solar market in 2017.
- Minnesota installed more MW of community solar in 2017 than total U.S. community solar installations in all of 2016.
- Minnesota ranked 15th for cumulative solar capacity in 2017.

Solar Power Has Grown Dramatically Since 2015



¹¹ Midwest Energy News, [Utilities say CapX2020 transmission project prompting wind energy growth](#), November 30, 2017.

¹² [SEIA Solar Market Insight Report 2017 Year in Review](#), March 15, 2018



Looking Forward: Planned Development of Renewable Energy

Minnesota's largest electric utilities are continuing to consider "least-cost" plans for their generation systems. In many cases, the least-cost plan includes significant expansion of renewable energy resources above and beyond Minnesota's Renewable Electricity Standard.

Xcel Energy

In October 2016, when the Minnesota Public Utilities Commission (PUC) met to consider Xcel Energy's Integrated Resource Plan (IRP), it examined costs for Xcel Energy's system assuming three scenarios with 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. The PUC approved Xcel's proposal,¹³ which included in the short-term:

- At least 1,000 MW of wind generation additions by 2020, plus an additional 800 MW by 2030;
- A target of 650 MW of solar generation by 2020, with an additional 750 MW by 2030;
- A retirement date of 2023 and 2026 for coal-fired units 2 and 1, respectively, totaling 1,362 MW of planned retired generation from 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 Allen S. King plant and unit 3 of the Sherco plant.

Under the approved plan, Xcel will produce 40 percent of its energy from renewable resources by 2030 while reducing its carbon dioxide emissions by 60 percent. Xcel's planned wind additions will produce energy at a cost of 1.5 to 2.5 cents per kilowatt-hour, which is

¹³ [PUC Order Approving Xcel Energy's 2016-2030 Resource Plan](#), January 11, 2017, docket E-002/RP-15-21.

competitive with the 2.3 to 2.4 cents per kilowatt-hour costs of Xcel's Sherco coal-fired power plant.¹⁴

In July 2017, the PUC approved Xcel's plan to move ahead with 1,550 MW of wind projects that will save utility customers billions of dollars in fuel costs compared with costs from other sources. The projects will be completed by 2020, ahead of the schedule initially proposed in the company's 2016-2030 resource plan.¹⁵

As Xcel continues to look ahead to the next resource planning cycle, the company is targeting a generation mix that is 85 percent carbon free by 2030, with 60 percent coming from renewable sources and nuclear power supplying the remainder.¹⁶ The utility is also evaluating the impact of the federal 2017 Tax Cuts and Jobs Act on wind and solar Power Purchase Agreements (PPA) rates.

Great River Energy

Great River Energy (GRE) supplies generation and transmission to 28 cooperative utility members. On April 28, 2017, Great River Energy (GRE) filed its 15-year resource plan with the PUC¹⁷, including:

- 400 MW of wind additions by 2021, including the 300 MW Emmons-Logan wind farm in North Dakota;
- 600 MW of wind additions between 2029-2032;
- Planned retirement in 2017 of the 189 MW Stanton Station coal-fired plant in North Dakota; and
- Termination of GRE's purchase obligation for 50 percent of the capacity and energy from Dairyland Power Cooperative's Genoa 3, a 379 MW coal-fired power plant in Wisconsin.

Following the retirement of Stanton Station in 2017, GRE's portfolio reflects more natural gas-fired nameplate capacity than coal-fired capacity.¹⁸ However, coal will continue to provide most of GRE's energy supply, with natural gas supplying peak power (about 3 percent of energy production). GRE projects that its plan will result in renewable energy supply changing from 12 percent in 2016 to 33 percent by 2032. During the same timeframe, energy supplied by coal will decrease from 66 percent in 2016 to 56 percent in 2032 (not including energy purchased from the wholesale market).

¹⁴ [Star Tribune](#), March 16, 2017.

¹⁵ [PUC Order Approving Variance from Xcel Energy's 2016-2030 Resource Plan](#), September 1, 2017, Docket E-002/M-16-777.

¹⁶ [Minnesota Public Radio](#), November 17, 2017.

¹⁷ [Initial Filing, Great River Energy 2018-2032 Integrated Resource Plan](#), April 28, 2017, docket E-017/RP-17-286.

¹⁸ *Utilities usually run natural gas generators at less than their full nameplate capacity because of the cost of natural gas.*

Some GRE members are developing solar resources for their retail customers as a part of a 5 percent renewable self-supply option allowed by their contracts with GRE. In 2017, Connexus Energy announced plans to install 10 MW of solar PV and 15 MW/30MWh of energy storage. Commercial operation is expected by the end of 2018.¹⁹ In January 2018, GRE issued an RFP to add solar PV and storage for peak demand reduction. The RFP specified up to 10 MW_{AC} of solar PV and up to 10 MW/20-40 MWh of energy storage interconnected to the Dakota Electric distribution system by 2019.²⁰

GRE is looking ahead to its next resource plan. In June 2018, the GRE board approved an initiative with a goal of 50 percent energy from renewable sources by 2030, with interim goals of 30 percent renewables by 2020 and 40 percent by 2025.²¹ To meet its new goal, GRE plans to add 200 MW of hydroelectricity from Manitoba and 500 MW of new wind.²²

Minnesota Power

Minnesota Power met Minnesota's Renewable Electricity Standard a full decade early. By 2015, 26 percent of Minnesota Power's retail and wholesale electric sales were from renewable energy sources. However, in June 2016, when the PUC voted to approve Minnesota Power's 15-year resource plan, it asked the utility to solicit proposals for additional wind and solar energy based on a Commerce Department economic analysis demonstrating that wind, solar and energy conservation savings are cost-effective for customers compared to continued operation of coal plants. The resource plan includes a retirement date of 2022 for 130 MW of capacity from coal-fired generator Units 1 and 2 at Boswell Energy Center in Cohasset.²³

Following the solicitation process, Minnesota Power's proposed *EnergyForward* resource package includes the addition of 250 MW of wind and 10 MW of solar to maximize the benefit of the extended Federal Production Tax Credit (PTC) for wind energy and the extended Investment Tax Credit (ITC) for solar energy, and to serve as an energy-price hedge for ratepayers. According to the company, its proposed plan would result in 44 percent of its energy supply coming from renewable resources by 2025 (including energy from large hydroelectric plants in Manitoba), and it would reduce carbon emissions 40 percent by 2030 (compared with 2005 levels).²⁴

As part of its plan, Minnesota Power also proposed a purchase of 250 MW from a 525 MW natural gas plant in Superior, Wis., that would be a joint development with Dairyland Power Cooperative. In October 2018, the PUC approved Minnesota Power's proposed gas plant. The utility is also evaluating the impact of the federal 2017 Tax Cuts and Jobs Act on the proposed

¹⁹ [ABC Newspapers](#), April 21, 2018

²⁰ [Great River Energy](#), [Solar Storage RFP](#), accessed on 4/3/2018.

²¹ [Grand Forks Herald](#), June 6, 2018

²² [Energy News Network](#), June 8, 2018

²³ [PUC Order Approving Minnesota Power's Resource Plan](#), July 18, 2016, docket E-015/RP-15-690.

²⁴ [Minnesota Power Press Release on EnergyForward plan](#), June 7, 2017.

wind and solar Power Purchase Agreement (PPA) rates.^{25, 26} The acquisition plan is pending review and approval by the PUC.²⁷

Minnesota Power's next resource plan is due in October 2019.

Otter Tail Power

In March 2017, the PUC approved Otter Tail Power's (OTP) 15-year integrated resource plan (IRP),²⁸ which includes:

- 200 MW of wind additions in the 2018–2020 timeframe, and up to an additional 200 MW by 2023;
- 30 MW of solar by 2020;
- Retirement of the 140 MW Hoot Lake coal-fired plant in Fergus Falls by 2021; and
- A June 3, 2019, filing date for OTP's next IRP.

This approved plan will double OTP's current wind power capacity and significantly increase solar capacity, resulting in over 30 percent of energy from renewables by 2021.

²⁵ *If a utility decides to purchase power from an independent power producer, they sign a power purchase agreement (PPA).*

²⁶ [Letter on the Status of Minnesota Power's Wind and Solar PPAs](#), January 19, 2018, docket E-015/RP-15-690.

²⁷ *As of July 2018*

²⁸ [PUC Order Approving OtterTail Power's 2017-2031 Resource Plan](#), April 26, 2017, docket E-017/RP-16-386.



Wind — Future

Over the next few years, more than 3,000 MW of new wind is slated for development for the Minnesota market. Of this, over 1,300 MW of wind farms are planned in Minnesota. The following projects have already been approved by the Minnesota Public Utilities Commission. (Several other large wind power projects are pending decisions by the PUC.)

Red Pine Wind. 200 MW in Lincoln County, developed by EDF Renewable Energy for energy sales into the wholesale market. The project completed construction in December 2017 and began commercial operation in February 2018.

Blazing Star I. 200 MW in Lincoln County, developed by Geronimo for energy sales to Xcel Energy. The project is scheduled for completion in 2019.

Freeborn Wind. 200 MW in Freeborn County and Worth County (Iowa) is being developed by Invenenergy for sale to Xcel Energy by 2020.

Palmer's Creek. 44.6 MW in Chippewa County, developed by Fagen Engineering and Wenck, Inc. Project Construction is expected to start in 2018 for completion in 2019.

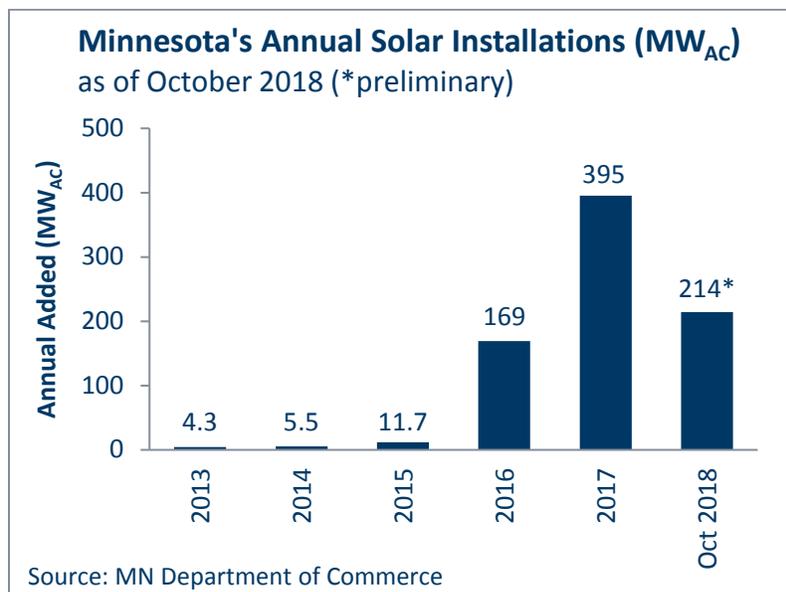
Stoneray. 100 MW in Pipestone and Murray counties, developed by EDF Renewable Energy. Project construction is expected to be completed in December 2018. Power will be sold on the open market until 2020, when a power purchase agreement with the Southern Minnesota Municipal Power Agency (SMMPA) begins.



Solar — Future

Minnesota in 2013 established the [Solar Energy Standard](#) that calls for Minnesota’s investor-owned electric utilities to generate 1.5 percent of their electric power from solar by the end of 2020. With state-level solar-friendly policies, extended federal tax credits and other incentive programs in place, utility-scale and community solar exceeded that standard in Xcel Energy’s territory in 2017.²⁹ Meanwhile, Minnesota Power and Otter Tail Power are planning for additional solar development to reach their solar targets by 2020. In addition, Xcel Energy included a target of 650 MW of solar generation by 2020 and an additional 750 MW by 2030 in its 2016-2030 resource plan approved by the Minnesota Public Utilities Commission in 2016 as a least-cost plan for the utility’s system needs.

New Solar Power More Than Doubled from 2016 - 2017



²⁹ Xcel has enough solar Renewable Energy Credits (RECs) to meet the Solar Electricity Standard, with the exception of the carveout for small-scale solar. As of June 2018, Xcel must accumulate more RECs from projects <40kW to reach its Solar Electricity Standard goal. For details on utilities’ progress in achieving the Solar Energy Standard, see Department of Commerce Comments in Docket No. E999/M-18-205, July 12, 2018.

Community Solar

Community solar offers a centrally-located solar PV system that provides electricity on behalf of participating subscribers, including households, businesses, nonprofit and educational institutions, and government entities. Community solar subscriptions are now available in 30 utility territories in Minnesota.

Installations for Xcel's community solar program (Solar*Rewards Community program) led Minnesota to become the third largest non-residential solar market in 2017. Minnesota installed more megawatts of community solar in 2017 than total U.S. community solar installations in all of 2016.³⁰

Cumulative community solar projects at the end of 2017 were:

- Xcel: 246 MW_{AC} at 66 project sites³¹
- Minnesota Power: 1.04 MW_{AC} at two sites
- Southern Minnesota Municipal Power Association (SMMPA): 1.25 MW_{AC}
- Other utilities: 1.72 MW_{AC} at 18 utilities

Large Solar Installations in 2017

Marshall Solar. 62.25 MW_{AC} solar farm in Lyon County developed by NextEra Energy Resources for Xcel Energy. This project achieved commercial operation in early January 2017.

Aurora Distributed Solar Project. Approximately 95.5MW_{AC} at 15 sites were completed in the first half of 2017 by Enel Green Power for Xcel Energy.

Xcel Community Solar. Xcel reported that approximately 210 MW_{AC} at 54 sites were completed in 2017 by garden operators for Xcel Energy customers as a part of Xcel's Solar*Rewards Community program.

Minnesota Power Community Solar Garden. 1 MW_{AC} was installed in 2017 in Wrenshall by Minneapolis-based United States Solar Corp for customer subscriptions managed by the utility.

Buffalo Solar. 7 MW_{AC} was installed in December 2017 by Minnesota Municipal Power Agency in Wright County near the city of Buffalo.

³⁰ [SEIA Solar Market Insight Report 2017 Year in Review](#), March 15, 2018

³¹ Xcel Energy, [Monthly Update on Community Solar Gardens](#), Docket No. E002/M-13-867, January 16, 2018