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-14%

2018-2019 change in Minnesota power sector CO2 emissions

13,000

Battery-electric and plug-in hybrid electric vehicles on Minnesota roads

State energy factsheet: Minnesota

This report provides a fact-based overview of Minnesota's power sector. It presents key metrics, highlights recent trends and discusses the outlook and opportunities for clean energy.

- The decarbonization of Minnesota's power sector continued in 2019 as the state transitioned from coal toward cleaner sources of generation. Zero-carbon power (consisting of renewables and nuclear generation) provided 49% of the state's power in 2019, up from 48% the year prior. Zero and lower-carbon resources combined to produce 68% of the generation mix, up from 62% in 2018. Meanwhile, coal's contribution slipped from 38% in 2018 to 32% in 2019.
- Over the decade of the 2010's, zero-carbon generation rose by about one third on an absolute basis, rising from providing 39% of power in 2010 to 49% in 2019 (21.1 terrawatt-hours (TWh) to 28.9TWh). Zero and lower-carbon resources went from providing 48% of power (25.5TWh) to 68% (39.9TWh) over that same time. By contrast, coal's contribution fell from 52% of power (28TWh) to 32% (19TWh).
- In the renewables sector, wind, solar, biomass/waste-to-energy and small hydro provided 24% of Minnesota's power in 2018 and 25% in 2019. Over the last ten years, cumulative generation from these technologies increased from 14% of demand to 25% (7.7TWh to 14.8TWh). In terms of power plant builds, renewables have accounted for 84% of all capacity added in the last decade, totaling 3.4GW.
- In 2019, wind alone provided 18% of Minnesota's power with 10.6TWh of production. Located in the Midcontinent Independent System Operator (MISO) region, Minnesota has access to some of the best wind resources in the country. Without the production tax credit (PTC), new wind builds are cheaper than new combined-cycle natural gas plant builds on a \$/MWh basis in Minnesota. With the PTC and investment tax credit (ITC), utility-scale wind and solar technologies are the cheapest form of new builds in the state.
- Minnesota continues to reduce energy waste through implementing energy efficiency measures. Energy productivity, or the ratio of gross domestic product (GDP) to energy demand, is a proxy for how efficiently an economy uses energy. Total power consumption in Minnesota fell 5% from 2018 to 2019. However, since the start of the decade, power consumption is up 2% while state GDP is up 24%, marking a 22% boost in productivity.
- Minnesota continues to be a net importer of electricity across state lines to meet local demand but the gap between demand and supply is narrowing. Minnesota imports of electricity fell to their lowest level in over two decades thanks in part to the addition of new local wind and solar projects.
- Increased local electricity generation has coincided with a sharp decline in harmful carbon emissions from the Minnesota power sector. Emissions have fallen 37% since 2005 and 27% since 2010. From 2018 to 2019 alone, they fell nearly 14%, largely due to decreased coal-fired generation and increased gas-fired and renewables generation.
- Electric vehicle sales in Minnesota are accelerating as battery prices have fallen. According to the Minnesota Department of Public Safety, from 2015 through 2019, annual battery electric vehicle sales increased almost 690% to 2,600 units. Annual plug-in hybrid electric vehicle sales rose 200% to 1,200 units.
- Major Minnesota-based corporations continue to advance their efforts to procure renewable energy. 3M Co., Cargill Inc., Ecolab Inc., Target Corp., and General Mills have now signed

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agreements to power their operations with either wind or solar energy from projects representing over 1.0GW of capacity.

- In addition, 10 clean energy projects located in the state of Minnesota have signed bilateral contracts with corporate or government offtakers as well. The list includes Carleton College, Ecolab, Gevo, Ikea, Macalester College, the Minnesota National Guard, Red Wing Shoes and the University of Minnesota Duluth.
- Minnesota’s consumption of natural gas in the power sector has increased over the last decade as new plants have come online within the state. Total natural gas consumption from power has nearly doubled from 36 billion cubic feet (Bcf) in 2010 to an estimated 69Bcf in 2019. From 2018 to 2019 alone, natural gas consumption from power rose 8.7%. Total gas consumption from all end-use sectors (residential, commercial, industrial, transportation and power) increased 1.3x in Minnesota and 1.5x in the region over the last ten years. This growth is slow relative to the rest of the region, which averaged 3.2-fold consumption growth in the last decade and 9.4% growth from 2018 to 2019.

Table 1: Key power system metrics, Minnesota v. U.S. average, 2019

Metric	Units	MN	U.S. average	Comment	Rank
Total electricity demand	TWh	65	73	Below average electricity demand	23
Total electricity generation	TWh	59	81	Below average electricity generation	29
Demand per capita	MWh	12	11	Roughly average per capita demand	30
Retail electricity prices	¢/kWh	11	11	Roughly average electricity prices	19
Generation from natural gas	%	19	39	Below average reliance on natural gas for electricity	37
Generation from renewables (incl. hydro)	%	25	18	Above average reliance on renewables	17
Energy efficiency score	ACEEE index	33	20	Above average on efficiency efforts	8
Utility electricity efficiency budget (2017)	% state revenue	2.5	1.7	Above average utility efficiency budget	12
CO2 emissions rate	tCO2/MWh	.41	.41	Roughly average power sector emissions rate	24

Source: BNEF, EIA, U.S. Census Bureau, ACEEE. Notes: U.S. ranks are in descending order (i.e., 1 = highest, 50 = lowest). For some metrics it is ‘good’ to have a high ranking, while for others it is ‘good’ to have a low ranking (e.g., retail electricity prices, CO2 emissions rate).

1. Bird’s eye view of Minnesota’s electric sector

Minnesota’s electric sector continues to decarbonize and become less reliant on imports due to substantial additions of renewable and natural gas electric-generating capacity.

The gap between the volumes of power Minnesotans consume in their homes, businesses, and schools and what is actually generated within the state has shrunk over the last decade due to growing in-state capacity in the form of new wind, solar, and natural gas plants. Minnesota consumed 65TWh of electricity in 2019, importing 6TWh (Figure 1). That marks the lowest level of imports in at least two decades. In all, imported electricity accounted for 9% of consumption in

2019, down from 10% in 2018 and 21% in 2010. Total electricity consumption in Minnesota fell 5% from 2018 to 2019, which may in part be due to greater efficiency. Since the start of the decade, electricity consumption is up 2%.

Consumer electricity prices in Minnesota as measured on a cents-per-kilowatt-hour basis have been rising over the last decade (Figure 2). In 2019, these averaged 10.57cts/kWh, up 2.0% from 10.37cts/kWh in 2018 and up 25.8% since 2010 (not adjusted for inflation). Minnesota electricity prices are today essentially in line with the U.S. national average retail electricity price of 10.58cts/kWh but are above the average Midcontinent Independent System Operator (MISO) region electricity price.

Figure 1: MN electricity sales and generation

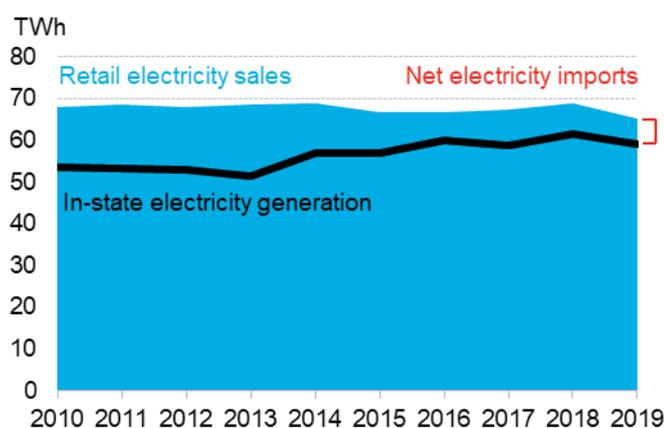
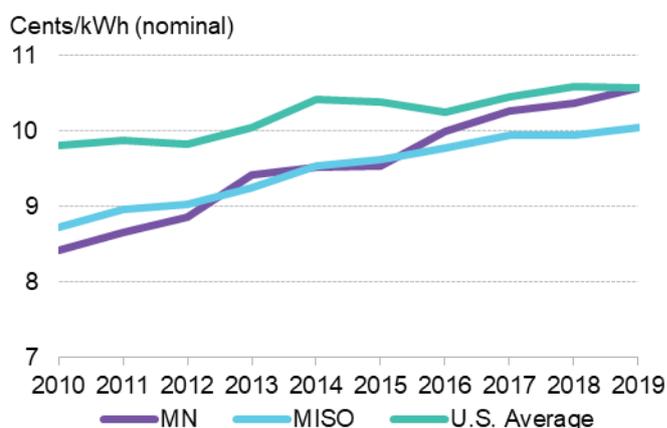


Figure 2: MN retail electricity prices relative to regional (MISO) and U.S. averages (covers residential, commercial, industrial, and transportation customer segments)



Source: BloombergNEF, EIA. Notes: 2019 values are projected, accounting for seasonality, based on the latest monthly values from EIA (available through November 2019). MISO is the electric power market in the Midwest, comprised of part or all of 16 states, including Minnesota.

Minnesota’s electricity generation mix has over the last decade trended away from coal-fired consumption and toward renewables and natural gas. The building of new coal-fired power plants has ceased in Minnesota (Figure 4). Renewables have accounted for 84% of all new capacity added since 2010 and totaled 3.4GW. Natural gas-fired plants accounted for the balance. Over the decade, Minnesota also retired 530MW of coal-fired generation.

In 2019, Minnesota built 425MW of new renewable power-generating capacity representing just over two-thirds of all capacity added in the year. Among the larger projects commissioned was the 100MW Stoneray Wind Farm owned by EDF Renewable Energy Inc. The plant, which uses Siemens Gamesa turbines, plans to sell its power to the Southern Minnesota Municipal Power Agency and was fully commissioned in February 2019. The state also saw the commissioning of a small but novel 2.3MW wind and 500kW solar hybrid project developed locally by Juhl Energy for the Lake Region Electric Cooperative in Pelican Rapids.

In 2019, Minnesota added 194MW of new gas-fired generation. Overall, 2019 marked the third highest year of the decade in terms of total new net capacity added.

Figure 3: Minnesota electricity generation mix by technology

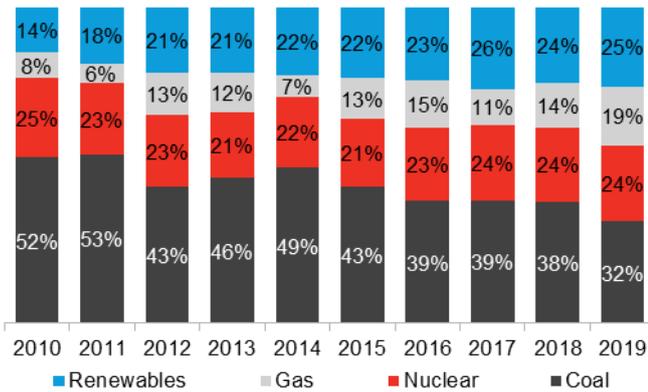
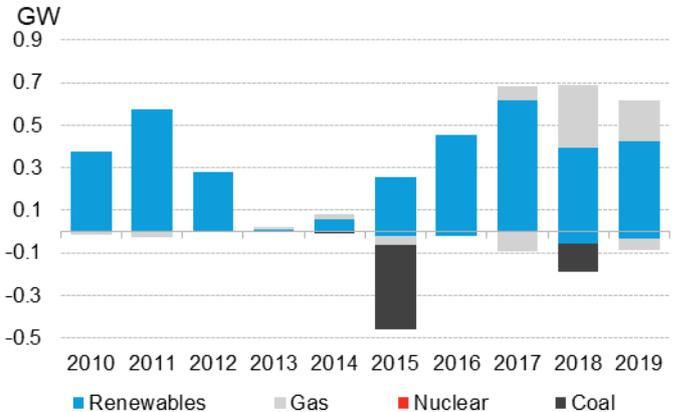


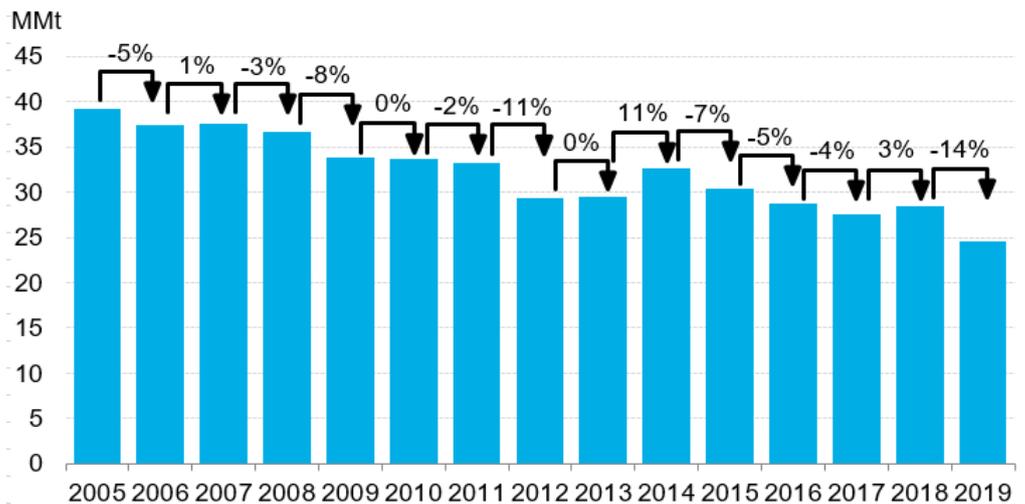
Figure 4: Minnesota capacity additions (build, above x-axis) and retirements (below x-axis)



Source: BloombergNEF, EIA. Note: 2019 values are projected, accounting for seasonality, based on the latest monthly values from EIA (available through November 2019).

Due to these shifts in generation and installed capacity, electric-sector carbon emissions have fallen by 27% in Minnesota in the last ten years and by nearly 14% in 2019 alone (Figure 5).

Figure 5: Minnesota power sector carbon emissions



Source: BloombergNEF, EIA. Note: 2019 values are projected, accounting for seasonality, based on the latest monthly values from EIA (available through November 2019).

2. Sustainable energy deployment

2.1. Energy efficiency

Minnesota continues to be a national leader in pursuing energy efficiency measures, demonstrating a 22% boost in energy productivity over the last decade and an 8% boost between 2018 and 2019 alone. The American Council for an Energy-Efficient Economy (ACEEE) ranked the state 8th nationwide in 2019 with a score of 32.5 out of 50 for its overall energy efficiency programs and policies.

Utility energy efficiency programs, overseen by the Minnesota Department of Commerce through the Conservation Improvement Program (CIP), have paved the way for Minnesota to cost-effectively achieve the savings required by its annual 1.5% Energy Efficiency Resource Standard (EERS). According to the Minnesota Department of Commerce, through 2017, Minnesota electric utilities have met or exceeded the 1.5% annual savings goal each year since 2011. Additionally, overall, the state's natural gas utilities have met the required 1% minimum savings goal each year.

In terms of total energy saved, 2017 was Minnesota's most successful CIP program year to date. The ACEEE listed Minnesota's natural gas savings percentage as the highest in the nation and the state's electric utilities achieved the eleventh highest energy savings percentage nationally. Minnesota's electric and natural gas savings for 2016 and 2017 totaled 2,110GWh and 7.5Bcf, respectively. Combined these energy savings are equivalent to around 14.7 trillion-BTUs of energy.

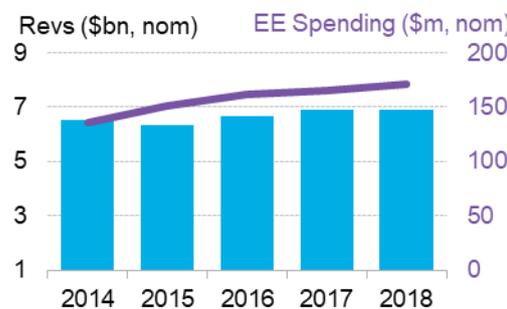
Looking into the future, the Minnesota Energy Efficiency Potential Study 2020-2029, led by Center for Energy and Environment, found that meeting or exceeding, on average, the current CIP energy savings goal of 1.5% for electric utilities and the statutory minimum of 1.0% for gas utilities is achievable over the next decade. In March 2019, Governor Tim Walz proposed increasing the EERS but his plan would require legislative approval.

Figure 6 shows Minnesota's annual electricity revenues (blue bars, left axis, \$bn) and energy efficiency spending (purple line, right axis, \$m) from 2014 to 2018 (the most recent year for which complete data is available).

Revenues collected by the state's utilities stayed flat year-on-year while spending on energy efficiency rose by 6.1%. Energy efficiency spending as a percent of total revenues rose to 2.5% from 2.4% in 2017. In dollar terms, utility spending on efficiency rose from \$165 million in 2017 to \$172 million in 2018.

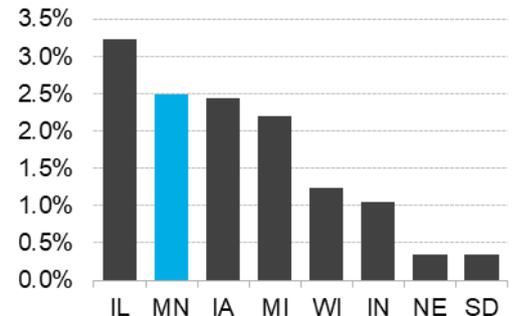
Minnesota's level of spending on utility electricity efficiency is second highest in the Midwest when compared to seven other states as measured on a percentage basis (Figure 7). Only Illinois' level of spending is higher, at 3.2% of total revenues collected.

Figure 6: Minnesota utility electricity revenues (left axis) and electricity efficiency spending (right axis)



Source: ACEEE, EIA.

Figure 7: States' utility electricity efficiency spending as a fraction of state-wide electricity revenue, 2018



2.2. Natural gas

Minnesota’s consumption of natural gas in the power sector has increased over the last decade as new plants have come online within the state. Total gas consumption from power has nearly doubled from 36Bcf in 2010 to an estimated 69Bcf in 2019. In 2019 natural gas prices were lower than the past three years, as a result, from 2018 to 2019 alone, gas consumption from power rose 9%.

Gas use in the power sector has been on the rise in virtually all of Minnesota’s neighboring states as well (Figure 8). This can largely be attributed to consistently lower prices for gas seen throughout the Midwest since 2009. With one brief exception, natural gas hovered well below \$5 per million British thermal units (MMBtu) during the 2010s. The local price of gas stayed in the \$2-3/MMBtu range in 2019 (Figure 9).

Figure 8: MN and neighboring states’ natural gas consumption from the power sector

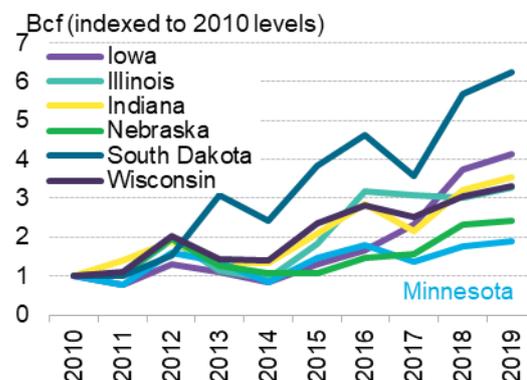
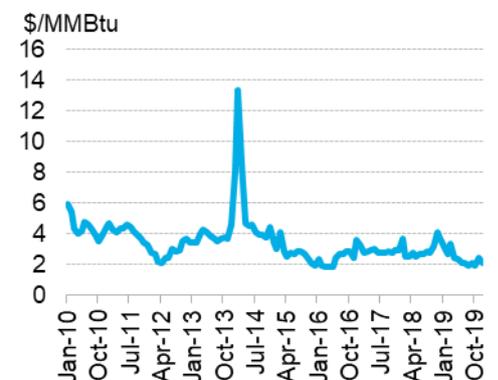


Figure 9: MN natural gas price (citygate)



Source: BloombergNEF, EIA. Note: 2019 values are projected, accounting for seasonality, based on the latest monthly values from EIA (available through November 2019).

Historically, natural gas plants in Minnesota have run primarily to meet peak electricity demand – as opposed to meeting 24-7 demand. Accordingly, their operations remained largely concentrated in the summer months, when hot temperatures call for high electricity use to meet cooling needs. However, low natural gas prices have allowed natural gas-fired generators to underprice coal even for 24-7 demand during certain seasons in recent years. Recently, utilities have begun exploring economic and seasonal operation of coal units. Low natural gas prices combined with coal retirements and seasonal dispatch, will serve to reduce the state’s dependence on coal and increase its reliance on other sources of electricity such as natural gas and renewables.

2.3. Renewables

Minnesota has a mandatory Renewable Energy Standard (RES) that requires most of the state’s investor-owned utilities (IOUs) to obtain 25% of their retail electricity sales from renewable sources by 2025, plus an additional 1.5% from solar under a solar carve-out. Xcel Energy, the largest utility in the state, is required to meet a target of 30% by 2020, plus the 1.5% solar carve-out.

A January 2019 report from the Minnesota Department of Commerce found that all utilities were in compliance with the RES and there have been calls to boost the overall target. Other states have moved to up their clean energy commitments to 100%, often by 2040 or 2050. In March

2019, Minnesota Governor Tim Walz unveiled a plan for the state to achieve 100% carbon-free power by 2050. The proposal would require approval from the state legislature to become law.

For its part, Minnesota’s largest utility Xcel Energy has already voluntarily pledged to achieve 100% clean energy by 2050 across all its service territories, which includes Minnesota along with seven other states. In 2019, wind was the largest renewable energy resource at 18% of all power generated within state lines. Solar technologies provided another 2.8%, biomass/waste-to-energy 2.7%, and hydro 1.5%

During the 2010’s, Minnesota built its non-hydro renewable generating capacity almost from scratch, adding just under 3.5GW during the decade. This included 1.2GW of solar and 2.2GW of wind, plus 67MW of biomass and small hydro. Activity has been particularly strong in the past five years with 2.1GW of new renewables added, including 1.2GW of solar and 955MW of wind (Figure 10). In 2017 and 2018, total new solar capacity added outpaced wind by a considerable margin. But in 2019, wind and solar capacity additions were split roughly evenly between the two technologies.

As a result, total installed renewable capacity in Minnesota rose to 5.5GW in 2019 (Figure 11). Wind accounts for two-thirds of total capacity while solar is responsible for just over one-fifth.

Figure 10: Minnesota renewable capacity additions

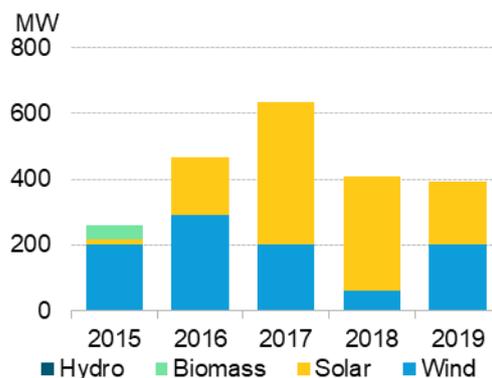
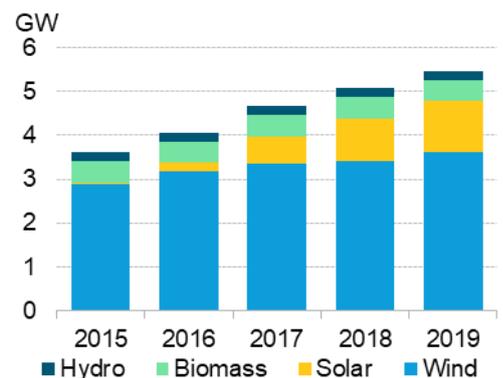


Figure 11: Minnesota cumulative renewable capacity

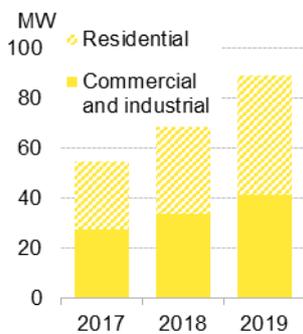


Source: BloombergNEF, EIA. Note: Includes BNEF data on distributed (i.e., residential, commercial, and industrial) solar capacity.

Distributed solar is making growing contributions in Minnesota. In 2019, installed residential systems and commercial and industrial systems rose to 89MW from 69MW the year prior (Figure 12). A 2013 law that created the solar carve-out under the state’s RES also established a framework to promote community solar. This led to a boom in community solar activity. At the end of 2019, a total capacity of 660MW of community solar gardens were available to subscribers at 30 utilities in Minnesota, including Minnesota Power with 1MW and Xcel with 656MW, according to the Minnesota Department of Commerce.

As wind costs continue to decline in this wind-rich part of the country, utilities are also looking to contract or own wind resources based on economics rather than mandates. Xcel Energy in particular is pursuing ownership of wind resources in Minnesota and surrounding states. The utility announced a target of 60% renewable energy in Minnesota by 2030, which, when coupled with its two nuclear plants, would make its electricity mix 85% carbon free by 2030. It later upped

Figure 12: MN cumulative installed residential and commercial solar capacity



Source: BloombergNEF.

its overall long-term commitment to provide 100% carbon-free electricity across all its service territories by 2050.

2.4. Energy storage

On the policy front, in May 2019, the state legislature required the Minnesota Department of Commerce to contract for a cost-benefit analysis of adding storage to Minnesota’s electrical grid. The study was completed by Energy and Environmental Economics (E3) and submitted back to the legislature in January 2020. The study found that “solar plus storage is cost-effective today and stand-alone storage could become cost-effective in 2025.” Similarly, in its long-term plan to decarbonize its generation, Xcel Energy said that it anticipated energy storage playing a greater role in the 2030’s.

As electric vehicle sales drive down lithium-ion battery prices, the economics of batteries for stationary storage continues to improve. In Minnesota, Connexus Energy completed a solar-plus-storage project in 2018 for the purpose of reducing costly peaks in power consumption and shifting solar generation to the most valuable hours. The 10MW of solar PV and 15MW/30MWh of energy storage became operational in December of that year. BNEF has not identified any further major utility-scale storage projects to have been commissioned in Minnesota since that time.

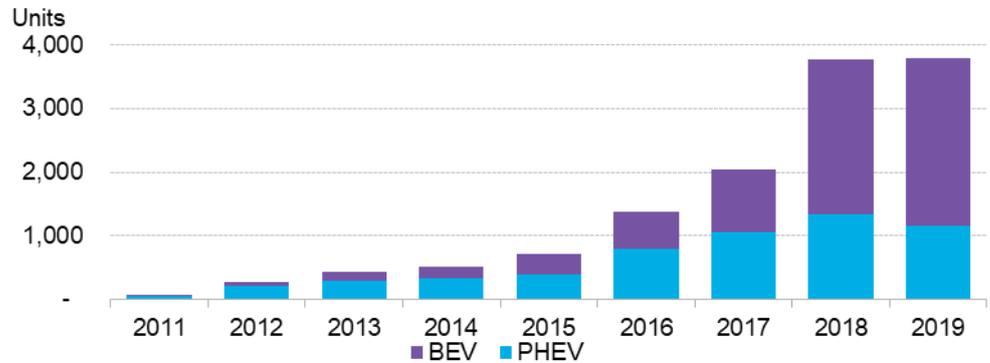
2.5. Electric vehicles

The sales of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) have ramped up in recent years thanks to a combination of lower prices, federal subsidies, and greater consumer choice. In 2019, U.S. consumers purchased or leased a total of 320,000 EVs and PHEVs. There are now an estimated 1.4 million of these vehicles on U.S. roads.

Minnesota is not among the very top states for EV/PHEV adoption but has seen sales rise in recent years. According to the Minnesota Department of Public Safety, as of the end of 2019, the state had approximately 13,000 EVs/PHEVs on the road. From 2015 through 2019, annual battery electric vehicle sales increased 690% to 2,600 units. Annual plug-in hybrid electric vehicle sales rose 200% to 1,200 units. Combined annual sales totaled 3,800 in both 2018 and 2019 (Figure 13). By contrast, in California, the leading state for EV/PHEV adoption, 75,000 such cars were sold in 1H 2019, accounting for 0.9% of total vehicle sales.

The Minnesota Pollution Control Agency is considering requiring manufacturers to abide by the Low-emission vehicle (LEV) and Zero-emission vehicle (ZEV) standards through Clean Cars Minnesota. Through this measure, manufacturers would deliver vehicles that produce fewer GHGs and other air pollutants to Minnesota consumers. If this effort passes, Minnesota would be joining 14 other states and the District of Columbia that abide by the LEV standard and the 11 states that abide by both the LEV and ZEV standards. Minnesota has also taken strategic actions to improve consumer education, establish charging corridors along state and interstate highways, and enable EV adoption in state and local government fleets. Minnesota utilities have sought to make it easier for their customers to use EVs by establishing flexible electricity rates to provide power to charge EVs among other programs.

Figure 13: MN electric vehicle sales

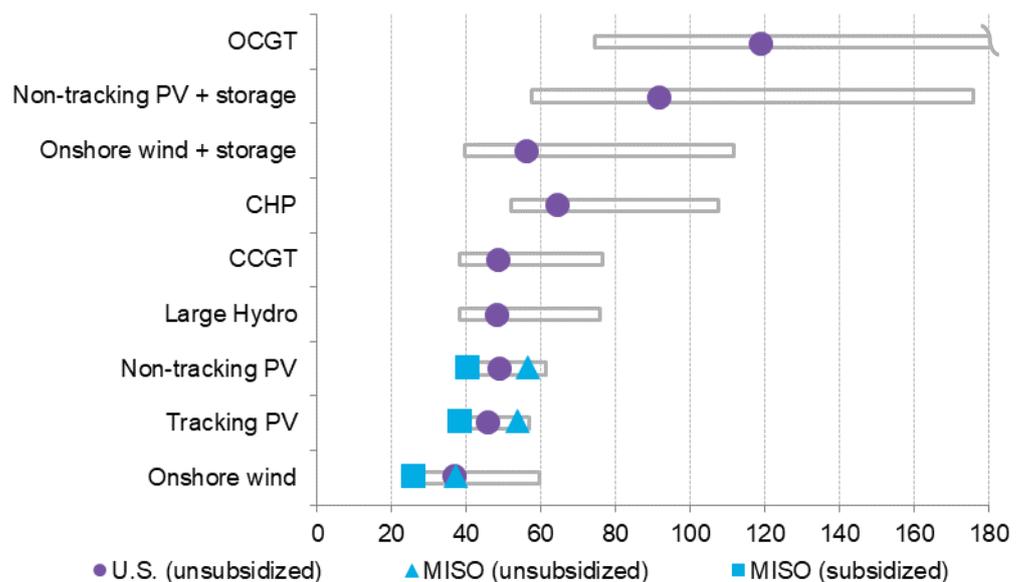


Source: Minnesota Department of Public Safety. Note: PHEV is plug-in hybrid electric vehicles. BEV is battery electric vehicles.

3. Opportunities

The BloombergNEF levelized cost of electricity (LCOE) analysis compares the cost of producing electricity from different technologies in the U.S. (Figure 14). The purple circles in the following chart show U.S. averages (prior to the inclusion of policy – i.e., unsubsidized) where possible, and regional or global averages otherwise. The blue triangles and squares show unsubsidized and subsidized Minnesota-specific LCOEs, respectively, for onshore wind and solar PV without tracking.

Figure 14: Unsubsidized levelized cost of electricity (LCOE) of select technologies in the U.S. compared to subsidized and unsubsidized LCOE of onshore wind and solar PV in MISO, 2H 2019



Source: BloombergNEF. Notes: Variations in MISO versus U.S. average result from variations in capacity factor, capex and financing rates. Bars indicate the range of unsubsidized LCOE for each technology in the U.S., AMER, or world-wide. Key policies such as the \$24/MWh Production Tax Credit (PTC) and accelerated depreciated (MACRS) bring down unsubsidized LCOEs to subsidized

levels. LCOE for combined heat and power (CHP) is for reciprocating engines with CHP. Other technologies are not included due to lack of sufficient data.

3.1. Renewables

- Minnesota has access to some of the best wind resources in the U.S. As a result, LCOE analysis suggests that new wind build in the state is likely already cheaper than new combined-cycle natural gas plants even without incentives (i.e., "unsubsidized"). 2019 estimates for Minnesota wind LCOEs came in at \$37/MWh unsubsidized, compared to a U.S.-wide mid-case estimate of \$48/MWh for combined-cycle natural gas. With subsidies, Minnesota wind LCOEs came in even lower, at around \$26/MWh.
- The LCOE estimates for PV in Minnesota reached \$38/MWh after accounting for subsidies, which renders it competitive with the estimates for natural gas combined-cycle turbines.
- Other technologies like waste-to-energy, CHP (combined heat and power) and biomass have generally seen lower levels of policy support and deployment than wind and solar, which may contribute to their higher LCOEs.
- Potential costs for PV projects that are paired with energy storage capacity and wind projects coupled with storage vary widely. This range is attributable to the wide variety of battery sizes that can potentially be paired with projects.

3.2. Natural gas

- The LCOE analysis also highlights the economic merit of natural gas combined-cycle turbines, especially as increased natural gas production in the Northeast has pushed down gas prices nationwide. Minnesota imports much of its gas from its western neighbors (South and North Dakota), and will likely continue to do so – but as Northeast production increasingly displaces other sources of demand for Canadian gas, more abundant natural gas supplies could be on the horizon for Minnesota.
- The overall cost competitiveness of natural gas and renewables compared to coal-fired generation appears to be contributing to falling generation from the latter.

3.3. Energy efficiency

- Annual energy efficiency spending by Minnesota's utilities has jumped from \$136 million in 2014 to \$171 million in 2018, the last year for which there is complete data. As the state's cumulative energy savings grows (its 1.5% EERS compounds annually), electric utilities may have to expand existing customer programs and pilot new projects to meet goals.
- While Minnesota leads many states on efficiency, it has the opportunity to achieve additional savings. A study prepared for the Minnesota Department of Commerce found that investor-owned utilities could achieve a 10-year average annual energy savings of 1.9% under a typical planning scenario used in Minnesota that considers constraints in implementation. Likewise, cooperative and municipal utilities could achieve a 10-year average annual energy savings of 1.7%. Governor Walz in March 2019 outlined his, "One Minnesota Path to Clean Energy" plan to require utilities to meet higher requirements.

With utilities on track to meet the Renewable Energy Standard early, there have also been calls for Minnesota to mandate 100% clean energy, potentially by 2050. This comes after a total of six states passed 100% clean energy mandates in 2019 bringing the total number of states with such

a policy to eight plus the District of Columbia. Governor Walz put forward 100% clean energy legislation when he issued his energy plan in 2019.

Minnesota is an active participant in the United States Climate Alliance, a coalition of 24 states and Puerto Rico that under the leadership of their governors have pledged to cut greenhouse gas emissions in an effort to have the U.S. overall meet the obligations of the Paris Agreement.

Finally, Minnesota is home to at least five companies who have all signed agreements to purchase renewable energy generation – 3M Co., Cargill, Ecolab Inc., General Mills, and Target Corp. Between them, these companies have signed deals to secure enough power to require 1,035MW of wind/solar capacity. Among them, Target is the leader, having signed agreements for 449MW of wind and solar.

Nationally, a record 13.6GW of new clean energy power purchase agreements were signed in 2019. That represented another record, by far, for such activity. There have also been 64MW of bilateral contracts signed between clean energy projects operating inside Minnesota and local offtakers. Buyers have included Macalester College, Ecolab, the Minnesota National Guard, Ikea Group, and others.

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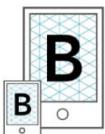
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