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State energy factsheet: Minnesota

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

24%

Ten-year change in Minnesota electricity productivity

-17%

2019-2020 change in Minnesota power sector CO2 emissions

18,750

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

- The decarbonization of Minnesota's power sector continued in 2020 as the state transitioned away from coal towards cleaner sources of generation. Zero-carbon power (consisting of renewables and nuclear technologies) provided 55% of the state's electricity generation in 2020, up from 48% the year prior. Meanwhile, coal's contribution declined from 38% in 2018, to 30% in 2019, to 25% in 2020. This decline is due to the coal's decreasing cost-effectiveness in comparison to other generation sources.
- Over the last ten years, zero-carbon power generation rose by almost half on an absolute basis. These clean sources provided 40% of electricity generation in 2011 and 55% in 2020, ramping from 21TWh to 31TWh of production. Coal-fired power production is half what it was a decade ago, decreasing from 28 TWh in 2011 to 14 TWh in 2020.
- Renewable technologies alone (wind, solar, biomass/waste-to-energy and small hydro) provided 25% of Minnesota's generation in 2019 and 29% in 2020. Over ten years, renewable generation rose from 9.4TWh, or 18% of generation in 2011, to 17TWh in 2020. Renewables accounted for 82% of all new power-generating capacity built in the state in the last decade, at 3.6GW.
- In 2020, wind alone provided 22% of the state's power at 12TWh. Located in the Midcontinent Independent System Operator (MISO) region, Minnesota has access to some of the best wind resources in the country. Even without the benefit of the federal production tax credit (PTC), new wind power is cheaper than new power from a combined-cycle natural gas plant on a \$/MWh basis in Minnesota.
- Energy productivity (the ratio of GDP to electricity demand) is an indicator of how efficiently Minnesota uses energy. Due largely to the Covid-19 pandemic, the state's 2020 economy contracted by an estimated 3.5%, while power consumption fell 6.7%. The result was a 3% gain in energy productivity. Since the start of the decade, power consumption in Minnesota has fallen 9% while state GDP has risen 13%, marking a 24% boost in productivity.
- Even with power generation up in the state, Minnesota continues to import electricity to meet local demand. However, the gap between in-state supply and demand is narrowing. In 2020, Minnesota power imports fell to their lowest level in over two decades. This is thanks in part to the addition of new wind and solar.
- Minnesota's consumption of natural gas in the power sector has risen over the last decade. While this metric dipped slightly from 2019 to 2020, it has nearly tripled from 29 billion cubic feet (Bcf) in 2011 to an estimated 81Bcf in 2020. Gas consumption from all end-use sectors (residential, commercial, industrial, transportation and power) rose 11% in Minnesota in the last ten years.
- These changes in Minnesota's power generation have produced a sharp decline in harmful greenhouse gas emissions from the sector. Emissions from in-state generation have fallen nearly 50% since 2005 and 40% since 2011. From 2019 to 2020 alone, they fell nearly 17%.

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- Electric vehicle registrations in Minnesota are accelerating as battery prices fall. According to the Minnesota Department of Public Safety, from 2016 through February 2021 (over the last ~5 years), annual battery electric vehicle registrations increased 535% to 3,800 units. Annual plug-in hybrid electric vehicle registrations rose 150% to 2,000 units.
- Major Minnesota-based companies continue to procure renewable energy. 3M Co., Cargill Inc., Ecolab Inc., Target Corp., and General Mills have now signed power purchase agreements with wind or solar projects representing over 1.3GW of capacity. Another 15 clean energy projects in Minnesota have signed contracts with corporate or government buyers. Offtakers include Carleton College, Ecolab, Gevo, Ikea, Macalester College, the Minnesota National Guard, Red Wing Shoes and the University of Minnesota Duluth.

Table 1: Key power system metrics, Minnesota v. U.S. average, 2020

Metric	Units	MN	U.S. average	Rank	Comment
Total electricity demand	TWh	62	81	23	Roughly average electricity demand
Total electricity generation	TWh	57	81	28	Roughly average electricity generation
Demand per capita	MWh	11	11	32	Below average electricity used per person
Retail electricity prices	¢/kWh	11	11	16	Roughly average retail prices
Generation from natural gas	%	20	41	37	Below average reliance on gas for power
Generation from renewables (incl. hydro)	%	29	20	17	Above average reliance on renewables
Energy efficiency score	ACEEE index	32	20	9	Well above average on efficiency efforts
CO2 emissions rate	tCO2/MWh	.35	.38	28	Below average power sector emissions rate

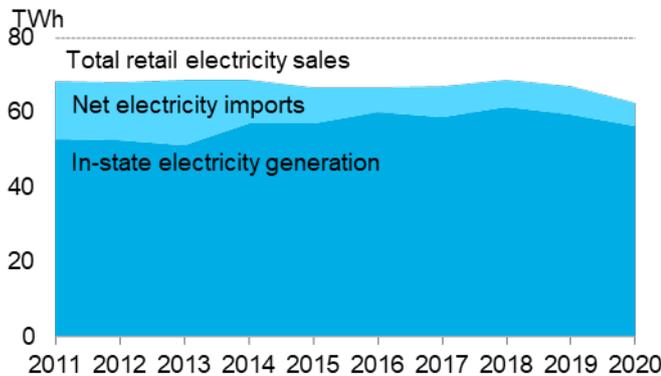
Source: BNEF, EIA, U.S. Census Bureau, ACEEE. Notes: U.S. ranks are in descending order (i.e., 1 = highest, 50 = lowest). For some metrics it is 'good' to have a high ranking, while for others it is 'good' to have a low ranking (e.g., retail electricity prices, CO2 emissions rate).

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 electric-generating capacity. Prior to the Covid-19 pandemic, the growth rate for clean energy jobs in Minnesota was 2.5x faster than overall job growth in the state, and the sector is poised for a strong Covid-19 impact recovery.

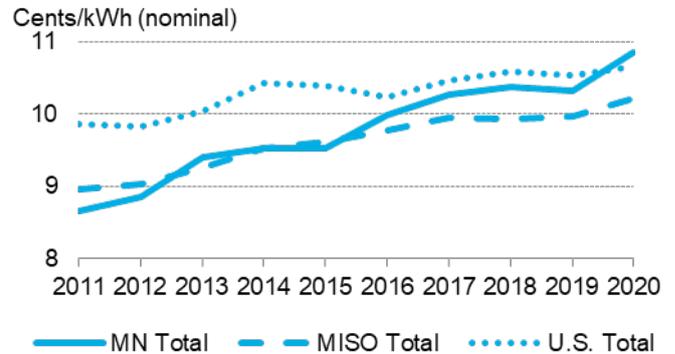
Minnesota consumed 62TWh of electricity in 2020 and imported 5.9TWh (Figure 1). That marks the lowest level of imports for two decades. Imported electricity accounted for 9% of consumption in 2020, essentially the same as in 2019 but down from 22% in 2011. Total electricity consumption in Minnesota fell 6.7% 2019-2020 (on top of a 2.6% 2018-2019 drop). Since the start of the decade, electricity consumption is down 9%.

Figure 1: MN electricity sales and generation



Source: BloombergNEF, EIA. Note: MISO is the electric power market in the Midwest, comprised of part or all of 16 states, including Minnesota.

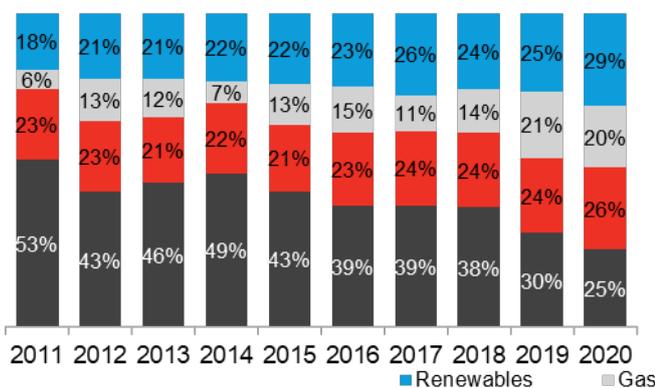
Figure 2: MN retail electricity prices relative to regional (MISO) and U.S. averages



Consumer electricity prices in Minnesota as measured on a cents-per-kilowatt-hour basis have been rising for residential, commercial and industrial clients over the last decade (Figure 2). In 2020, these averaged 10.84cts/kWh, up 5% from 10.33cts/kWh in 2019 and up 25% since 2011 (in nominal terms). Minnesota’s total average electricity prices today are above the Midcontinent Independent System Operator (MISO) region average of 10.21cts/kWh but are in line with the U.S. total average of 10.66cts/kWh.

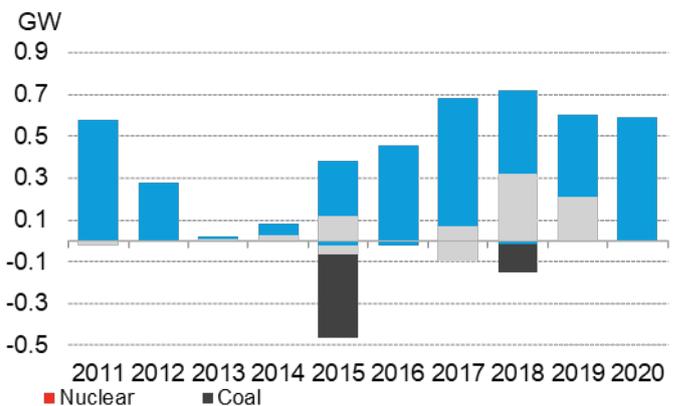
Minnesota’s electricity generation mix continues to trend away from coal-fired generation and toward renewables and natural gas. In the last ten years, no new coal-fired power plants were built in the state, and renewables accounted for 82% of all new capacity, totaling 3.6GW (Figure 4). All other additions were natural gas-fired plants. Over the last decade, Minnesota retired 530MW of coal-fired power plants, and all coal plants located in Minnesota plan to retire by 2035.

Figure 3: Minnesota electricity generation mix by technology



Source: BloombergNEF, EIA.

Figure 4: Minnesota capacity build and retirements

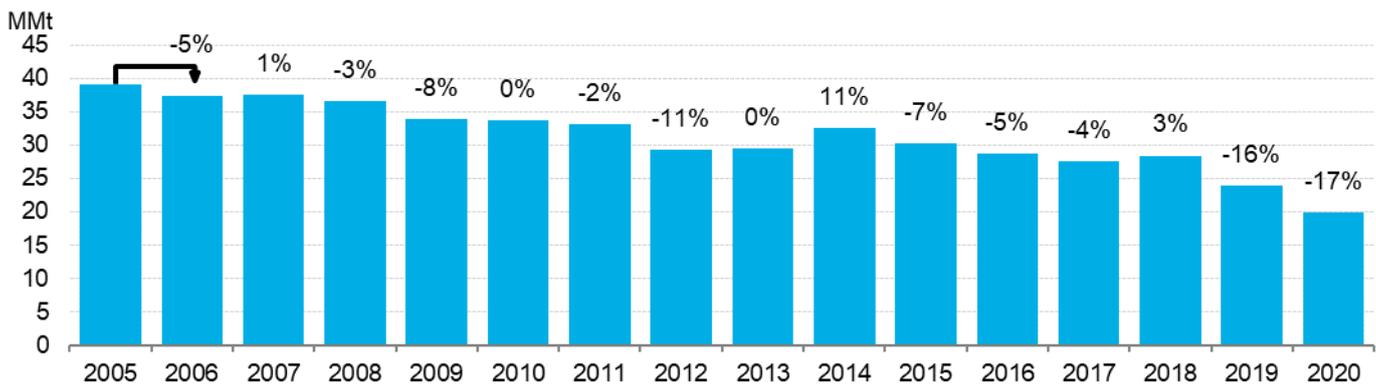


In 2020, Minnesota built exclusively renewable power plants, totaling 588MW. Despite no new gas-fired plant build, last year was the fourth highest year for capacity additions in Minnesota in the last decade. One of the largest plants commissioned was the 250MW Nobles 2 Wind Project,

which is jointly owned by Tenaska, ALLETE, and Bright Canyon Energy. It began commercial operations in December 2020 and has a 20-year power-purchase agreement to supply Minnesota Power, ALLETE's utility subsidiary. The state also added over 100 new, small-scale wind and solar plants.

Due to these shifts, power sector CO2 emissions have fallen 40% in Minnesota in the last ten years and in 2020 slipped nearly 17% from the year prior (Figure 5).

Figure 5: Minnesota power sector carbon emissions, with year-over-year percent changes



Source: BloombergNEF, EIA.

2. Sustainable energy deployment

2.1. Energy efficiency

Minnesota continues to be a leader in pursuing energy efficiency measures, posting a 24% boost in energy productivity over the last decade and a 3% rise between 2019 and 2020 (Figure 6). The American Council for an Energy-Efficient Economy (ACEEE) ranked the state 9th nationwide in 2020 (down one notch from 8th in 2019) with a score of 32 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). In fact, CIP is Minnesota's oldest and most successful energy efficiency policy. According to the Minnesota Department of Commerce, through 2018, Minnesota electric utilities have met or exceeded the 1.5% annual savings goal each year since 2011. Additionally, the state's natural gas utilities have met the required 1% minimum savings goal each year. To date, CIP has saved more than \$6 billion in energy bills. CIP has also proven its worth to the economy, generating \$4 in benefits for every dollar spent on the program.

Looking ahead, 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 2021, Governor Tim Walz proposed expanding Minnesota's EERS through the Energy Conservation & Optimization Act, and this proposal is pending approval at the legislature.

Figure 6: MN productivity (GDP/retail sales)

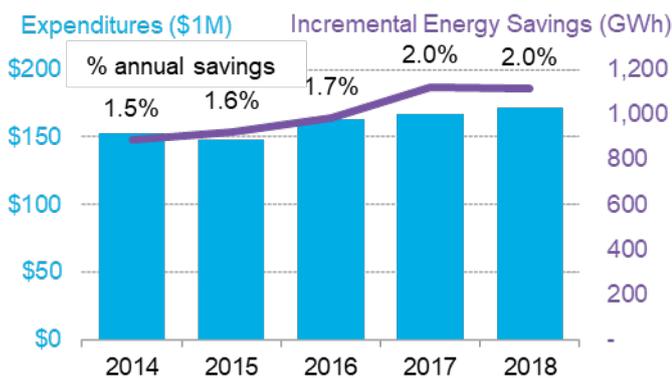


Source: BloombergNEF.

Between 2018 and 2019, state utility revenues rose 3% while their spending on energy efficiency decreased 8.5%. As a result, energy efficiency spending compared to total revenues fell from 2.5% to 2.2% 2018-2019. However, Minnesota’s share of electricity efficiency spending remains second highest in the Midwest. Only in Illinois is spending higher, at 3.2%.

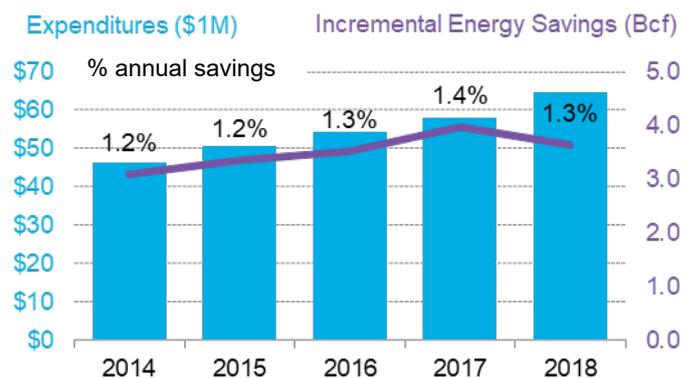
At the local level, several Minnesota communities asserted efficiency and net-zero goals. The Saint Paul Port Authority released plans to build a net-zero community of at least 1,000 housing units on the east side of the city. The community will aim to produce as much energy as it consumes across its entire economy, including in its residential and commercial buildings, transportation and other infrastructure. The plan will ultimately provide upwards of 1,000 new jobs, officials say. In 2020, the Minnesota legislature allocated \$46 million to the Prairie Island Indian Community, which will use the funds to chart a path towards net-zero. The three-year project includes plans to install 6MW of solar, a microgrid, and a geothermal system, and includes plans for lighting and other equipment upgrades.

Figure 7: Conservation Improvement Program Electric Results 2010-2018



Source: MN DOC.

Figure 8: Conservation Improvement Program Natural Gas Results 2010-2018



2.2. Natural gas

Minnesota’s consumption of natural gas in the power sector nearly tripled from 29Bcf in 2011 to 81Bcf in 2020, despite actually shrinking 6% last year. Outside of last year’s exception, this metric has been on the rise in Minnesota and neighboring states as well (Figure 9). Consistently low, Midwestern gas prices are the driving the shift: with one annual exception, prices have hovered well below \$5/MMBtu for the last ten years. In 2020, they sank to an all-time low on slackening demand related to the economic effects of Covid-19. Monthly benchmarks ranged from \$1.6-2.4/MMBtu in 2020 (Figure 10).

Historically, Minnesota’s fleet of gas-fired plants have been busiest in the summer months, when hot temperatures prompt air-conditioning use and electricity demand spikes. However, low-priced gas has allowed these plants to regularly underprice coal-fired plants. The result has been higher year-round gas-fired generation. The contribution of gas has risen so much that some Minnesota utilities have explored using coal units on a seasonal basis. These trends, combined with full coal plant retirements, have cut dependence on coal and boosted reliance on alternative sources.

Figure 9: MN and neighboring states' natural gas consumption from the power sector

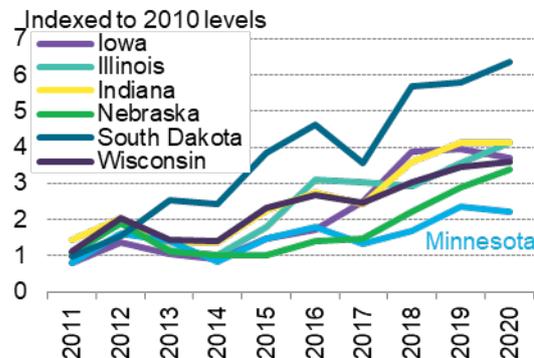
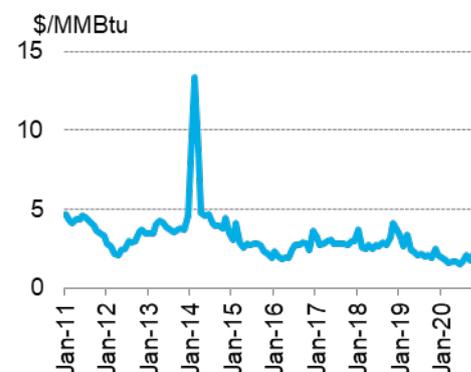


Figure 10: MN natural gas price (based on Chicago CityGate)



Source: BloombergNEF, EIA. Note: Chicago CityGate is a benchmark gas hub in the Midwest.

2.3. Renewables

Minnesota’s Renewable Energy Standard (RES) 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 alone starting 2020. Xcel Energy, the largest utility in the state, is required to meet a target of 30% by 2020, plus a 1.5% solar carve-out.

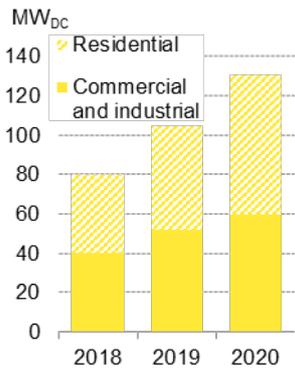
A January 2019 report from the Minnesota Department of Commerce found that all utilities were in compliance with the RES, and there have been calls to boost the target. While few U.S. states boosted their RPS requirements in 2020, in the prior year a number did raise their commitments to 100% clean energy 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. In early 2021, he re-proposed the 100% carbon-free notion but this time by 2040.

Minnesota’s largest utility, Xcel Energy, committed to 100% clean energy by 2050 across all its service territories, which includes Minnesota and service territories across seven other states. In response to a request from the Minnesota Public Utilities Commission, Xcel Energy also assisted in Covid-19 recovery efforts by accelerating timelines for \$3 billion in renewable energy projects. Xcel Energy has said completing those projects will create 3,000 jobs.

Other utilities have followed suit. Minnesota Power, the state’s second largest utility, has also made a 100% clean energy public commitment. In 2020, Minnesota Power became the first utility in Minnesota to generate half its power from renewables. The company recently commissioned a new wind project in southwest Minnesota, bringing its total owned and contracted wind portfolio to 870MW. In Spring 2020, energy cooperative Great River Energy announced its renewable power ambitions, including a plan to install 1.1GW of wind and retire a 1.5GW coal facility by the end of 2022. Juhl Energy is also developing a novel wind/biodiesel plant in the community of Albert Lea.

Major Minnesota companies, including 3M and Target, have joined the trend of pledging to operate on 100% clean energy while other major, non-corporate organizations in the state have taken similar steps. The Red Lake Band of Chippewa Indians plans to create energy sovereignty in the Red Lake Nation through the development of renewable energy projects. With assistance from Solar Bear and IPS Solar, Red Lake Nation plans to install enough clean energy to power the reservation with the goal of free energy for all tribal members.

Figure 13: MN cumulative installed small-scale residential and commercial solar capacity



Source: BloombergNEF.

In 2020, wind was the largest source of renewable energy at 22% of all power generated. Solar technologies provided another 3.1%, hydro 2.0%, and biomass/waste-to-energy 2.1%. Over the last decade, Minnesota built out its non-hydro renewable generating capacity almost from almost scratch, adding 3.6GW. This included 1.3GW of solar and 2.3GW of wind, plus 61MW of biomass and small hydro. Activity has been particularly strong in the past five years with 2.4GW of new renewables added, including 1.2GW of solar and 1.2GW of wind (Figure 11).

In 2017 and 2018, total new solar capacity added outpaced wind by a considerable margin. In 2019, wind and solar capacity additions were split roughly evenly, and in 2020, wind pulled far ahead. As a result, total installed renewable capacity in Minnesota rose to 6.1GW in 2020 (Figure 12). Wind accounts for two-thirds of total capacity while solar is responsible for just over one-fifth.

Figure 11: Minnesota renewable capacity additions

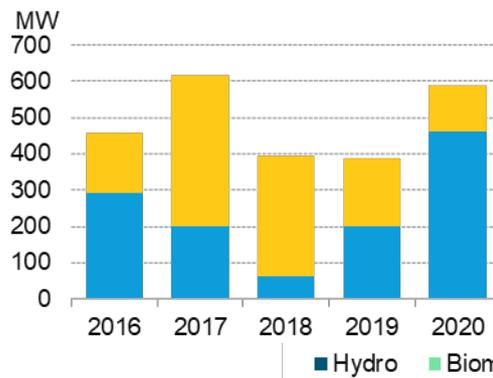
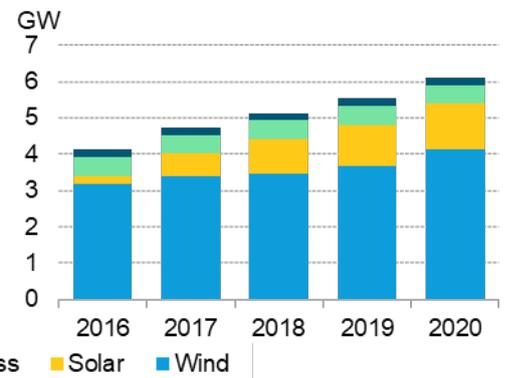


Figure 12: Minnesota cumulative renewable capacity



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

Distributed solar's contributions are growing in Minnesota. In 2020, installed residential, commercial and industrial PV systems rose from 105MW to 131MW (Figure 13). 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.

2.4. Energy storage

In May 2019, the state legislature tasked the Minnesota Department of Commerce with conducting a cost-benefit analysis of adding energy storage to the grid. The study was completed by Energy and Environmental Economics (E3) and submitted 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."

As costs shift, storage becomes cost-effective across potential applications. 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. Connexus Energy completed a solar-plus-storage (PV+S) project with 10MW capacity of PV and 15MW/30MWh of storage in December 2018 for the purpose of reducing costly peaks in power consumption and shifting solar generation to the most valuable hours. Similarly, US Solar and Minnesota Power plan to commission a PV+S project by December 2021, and the energy cooperative Great River Energy announced plans to install a 1MW long-duration battery system by the end of 2022.

Minnesota-based Mortenson Construction is working with Terra-Gen to build a PV+S project with 1.1GW PV capacity and 2.2GWh storage in California. Solar production on the site will use 2.5 million modules to power more than 260,000 homes.

2.5. Electric vehicles

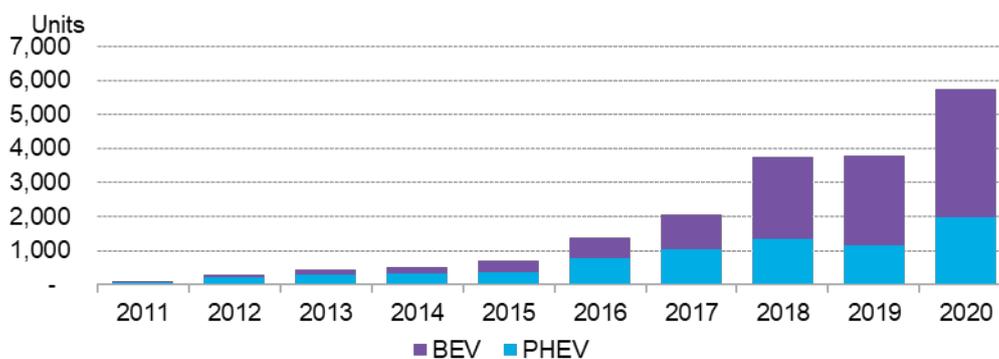
The sales of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) have ramped up in recent years thanks to a combination of lower prices, federal subsidies, and greater consumer choice. In both 2019 and 2020, U.S. consumers purchased or leased a total of 320,000 EVs and PHEVs. By the end of 2020, an estimated 1.7 million of these vehicles were on U.S. roads.

Transportation is the sector that contributes most to Minnesota CO2 emissions. To meet the state’s aggressive goal to cut economy-wide emissions, EV adoption must therefore accelerate dramatically. While Minnesota is not among the very top states for EV/PHEV adoption, new electric vehicle registrations have risen in recent years. According to the Minnesota Department of Public Safety, as of February 2021, the state had approximately 18,750 EVs/PHEVs on the road. From 2016 through 2020, annual battery electric vehicle registrations increased 535% to 3,800 units. Annual plug-in hybrid electric vehicle registrations rose 150% to 2,000 units. Combined annual registrations totaled around 5,800 in 2020 (Figure 14).

At direction from Governor Walz, the Minnesota Pollution Control Agency (MPCA), is considering requiring manufacturers to abide by the low-emission vehicle (LEV) and zero-emission vehicle (ZEV) standards other states have adopted. Under this measure, manufacturers would deliver vehicles that produce fewer GHGs and other air pollutants to Minnesota consumers. If MPCA implements, Minnesota would join 14 other states and the District of Columbia that abide by the LEV standard and the 12 states that abide by both the LEV and ZEV standards. MPCA is now nearing the end of the rulemaking process, meaning the soonest the Clean Cars MN rule could go into effect would be January 2024.

The state has also taken steps to improve consumer education about EVs, established charging corridors along state and interstate highways, and enabled EV adoption in state and local government fleets. Minnesota utilities have sought to make it easier for customers to use EVs by establishing flexible electricity rates to provide power to charge EVs among other programs. In 2020, Xcel Energy announced its goal to power 1.5 million EVs in its service areas by 2030. This would push EVs to 20% market share in those territories, more than 30x their absolute number today.

Figure 14: MN annual electric vehicle registrations

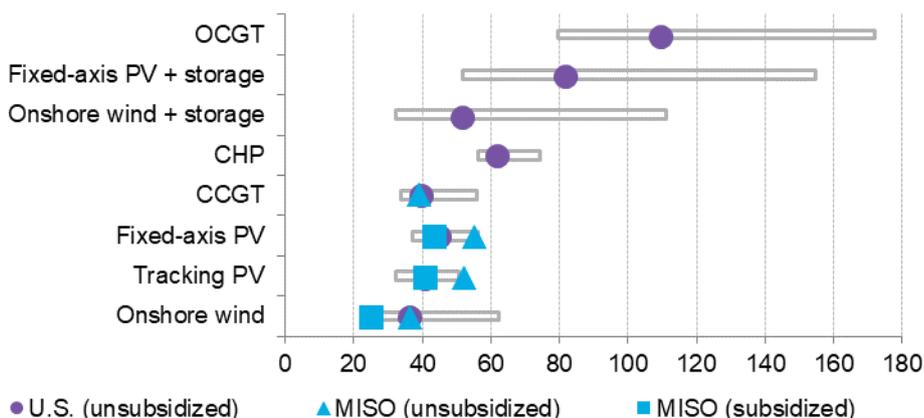


Source: Minnesota Department of Public Safety. Note: PHEV is plug-in hybrid electric vehicles. BEV is battery electric vehicles.

3. Opportunities

The BloombergNEF levelized cost of electricity (LCOE) analysis compares the cost of producing electricity from different technologies in the U.S. (Figure 15). Purple circles in the following chart show U.S. median values (prior to the inclusion of policy – i.e., unsubsidized). The blue triangles and squares show unsubsidized and subsidized Minnesota-specific LCOEs, respectively.

Figure 15: 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 2020



Source: BloombergNEF. Notes: PV is photovoltaic, CCGT is combined cycle gas, CHP is combined heat and power, OCGT is open cycle gas. 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 levers such as tax credits and accelerated depreciation bring down unsubsidized LCOEs to subsidized levels. LCOE for CHP is for reciprocating engines with CHP. Other technologies are not included due to lack of sufficient data.

With utilities on track to meet the Renewable Energy Standard early, there have 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 by the end of 2020 bringing the total number of states with such a policy to eight plus the District of Columbia. Governor Walz put forward 100% clean energy by legislation when he issued his energy plan in 2019. In early 2021, he re-proposed 100% carbon-free electricity, but this time by 2040.

Minnesota is also home to at least five companies who have signed agreements to purchase renewable energy – 3M Co., Cargill, Ecolab Inc., General Mills, and Target Corp. Between them, they have signed deals to secure power from 1,300MW of wind/solar capacity. Among them, Target is the leader, having signed agreements for 456MW of wind and solar. There have also been 64MW of bilateral contracts signed between clean energy projects operating in Minnesota and local offtakers. Buyers have included Carleton College, Ecolab, Gevo, Ikea, Macalester College, the Minnesota National Guard, Red Wing Shoes and the University of Minnesota Duluth.

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 the cheapest form of energy to build, even without incentives (i.e. "unsubsidized"). Unsubsidized 2020 estimates for Minnesota

wind LCOEs came in at \$36/MWh, compared to \$39/MWh for combined-cycle natural gas. With subsidies, Minnesota wind LCOEs came in even lower, at around \$25/MWh.

- The LCOE estimates for PV in Minnesota reached \$41/MWh, after accounting for subsidies, which renders it somewhat competitive with 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. However, U.S. mid-case estimates for these systems are \$82/MWh for PV + storage and \$52/MWh for wind + storage projects.

3.2. Natural gas

- The LCOE analysis also highlights the economic merit of natural gas combined-cycle turbines, especially as increased Appalachia gas production pushes down national gas prices. Minnesota imports much of its gas from South and North Dakota and Canada and will likely continue to do so – but as Appalachia production increasingly displaces these imports, more abundant supplies could be on the horizon for Minnesota.

3.3. Energy efficiency

- Annual energy efficiency spending by Minnesota's utilities has jumped from \$216 million in 2016 to \$223 million in 2019, 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.
- Minnesota's Legislature has been considering an expansion of the CIP program over the past two sessions. This expansion would broaden the suite of efficiency programs utilities could offer to their customers. For example, the bill would allow for fuel switching and electrification to co-exist with and complement traditional energy efficiency. There has also been legislation introduced to increase building performance standards which addresses Minnesota's growing CO2 emissions from its building sector.

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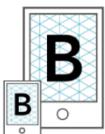
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