MONTANA-DAKOTA
UTILITIES CO.
A Subsidiary of MDU Resources Group, Inc.

In the Community to Serve®

ELECTRIC GENERATION CLIMATE SCENARIO ANALYSIS

2021

EXECUTIVE SUMMARY

Montana-Dakota Utilities Co., a subsidiary of MDU Resources Group, Inc., in 2021 conducted a climate scenario analysis specific to its electric generation resources and following the framework put forward by the Task Force on Climate-related Financial Disclosures (TCFD). Montana-Dakota Utilities conducted this scenario analysis to respond to growing requests and interest from investors for enhanced disclosures on this topic. This analysis explored several pathways that could allow the utility to achieve net-zero carbon emissions by 2050.

This report focuses specifically on Montana-Dakota Utilities' electric utility generation. Future reports may include Montana-Dakota Utilities' broader electric and natural gas distribution business and other MDU Resources Group subsidiaries.

Montana-Dakota Utilities has a current target of reducing carbon dioxide emission intensity by 45% by 2030 compared to 2005 levels from its electric generation resources. As of the end of 2020, the company had reduced its carbon dioxide emission intensity from its coal-fired electric generation resource fleet by approximately 28% since 2005.

All the pathways that Montana-Dakota Utilities considered that could achieve net-zero emissions would require significant advancements in clean-energy technology, as well as new technologies not yet developed. Pathways that rely on renewable generation require building more generation than the company needs for meeting anticipated customer demand — a significant amount, in some cases. The intermittent nature of low-carbon renewable generation requires the company to have backup, on-demand generation resources for periods when the wind is not blowing or the sun is not shining.

Montana-Dakota Utilities' understanding of the issues it faces in achieving a net-zero emissions target while ensuring reliable and cost-effective electricity to its customers has been enhanced by this scenario analysis. The analysis will inform the ongoing development of the company's electric generation strategy.

Forward-Looking Statements

Information in this report includes certain forward-looking statements, within the meaning of Section 21E of the Securities Exchange Act of 1934. The forward-looking statements in this report are expressed in good faith and are believed by the company to have a reasonable basis. Nonetheless, actual results may differ materially from the projected results expressed in the forward-looking statements. For a discussion of important factors that could cause actual results to differ materially, refer to Item 1A — Risk Factors in MDU Resources' most recent Form 10-K and Form 10-Q and subsequent filings with the SEC.

ABOUT MDU RESOURCES GROUP AND MONTANA-DAKOTA UTILITIES

MDU Resources Group, Inc., a Fortune 500 company and a member of the S&P MidCap 400 and the S&P High-Yield Dividend Aristocrats indices, is Building a Strong America® through its regulated energy delivery and construction materials and services businesses. MDU Resources trades on the New York Stock Exchange under the stock ticker MDU.

This climate assessment report focuses specifically on MDU Resources' electric utility generation, which is part of subsidiary **Montana-Dakota Utilities**. This segment generates, transmits and distributes electricity in Montana, North Dakota, South Dakota and Wyoming. It served 143,782 customers at December 31, 2020.

At the time of this assessment, Montana-Dakota Utilities' electric generating resources included coal-fired, natural gas-fired and renewable generating facilities. As of December 31, 2020, renewable resources comprised approximately 27% of the company's nameplate generating assets. As the company's renewable capacity has increased, the carbon dioxide emissions intensity of its generating fleet — meaning the carbon dioxide emissions per megawatt hour of electricity production — has been reduced by approximately 28% since 2005. The company's carbon dioxide emissions intensity is expected to continue to decline through the retirement of aging coal-fired electric generating units and by adding lower- or zero-emission generation resources.

Montana-Dakota Utilities is a member of Midcontinent Independent System Operator (MISO). MISO is a regional transmission organization responsible for operational control of the transmission systems of its members. Through MISO, Montana-Dakota Utilities has access to wholesale energy, ancillary services and capacity markets for its interconnected system. MISO provides security center operations, tariff administration and operates day-ahead and real-time energy markets, ancillary services and capacity markets. As a member of MISO, Montana-Dakota's generation is sold into the MISO energy market and its energy needs are purchased from that market. In 2020, Montana-Dakota Utilities purchased approximately 25% of its net electricity needs for its interconnected system through the MISO market.

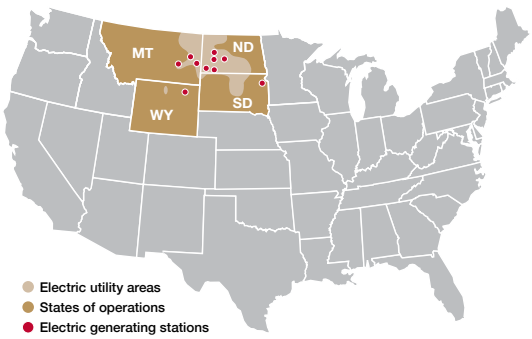
Current information and data about Montana-Dakota Utilities and MDU Resources, as well as the corporation's other subsidiaries, can be found in MDU Resources' most current Sustainability Report and 10-K and 10-Q filings. Visit the corporation's website at **www.mdu.com** for more information.

Montana-Dakota Utilities' Operating Territory

Montana-Dakota Utilities operates in the Northern Plains of the United States. This is generally a rural geography, with open spaces, fertile land for agriculture and ranching, and some of the best wind energy resources in the country.

The communities Montana-Dakota Utilities serves are predominantly rural, with low population density, but the company also delivers electricity to some larger cities in the region, such as Bismarck, North Dakota.

Montana-Dakota Utilities has a variety of types of electric customers. As of December 31, 2020, the company's electric retail sales were 41% residential, 44% commercial, 13% large industrial and 2% municipal. The large industrial customers are involved in mining, energy production and manufacturing.



The climate in Montana-Dakota Utilities' service territory can be extreme, with very hot summers and very cold winters. Hot weather can trigger droughts or severe thunderstorms with torrential rains and high winds. Through winter, the region can experience rain, freezing rain, sleet, heavy snow, arctic winds and blizzards. The company's infrastructure is designed and built to withstand these extreme climate conditions.

Montana-Dakota Utilities' electric segment is regulated under the jurisdiction of a utility regulatory commission in each state it serves — Montana, North Dakota, South Dakota and Wyoming. These jurisdictions have developed renewable generation objectives and/or green tariff programs over time. At this time, none of these jurisdictions have a renewable portfolio standard. The commissions are thoughtful in evaluating and prudent in approving renewable generation resources and transmission infrastructure, as well as in considering impacts that may result from the closure of fossil-fired facilities.

Montana-Dakota Utilities' interstate transmission and wholesale electric power operations are regulated by the Federal Energy Regulatory Commission (FERC) under provisions of the Federal Power Act.

Montana-Dakota Utilities is a relatively small utility and, as such, it will occasionally partner with other regional utility companies to develop larger electric generation facilities by which the economies of scale benefit the company's customers.

MONTANA-DAKOTA UTILITIES' GENERATION MIX

As of the end of 2020, the emissions intensity of Montana-Dakota Utilities' electric generating fleet — carbon dioxide emissions per unit of electricity production — declined by 28% since 2005. Montana-Dakota Utilities' planned coal-fired generation retirements and continued investments in renewable resources and natural gas-fired peaking units are projected to bring the company's emissions intensity reductions to 45% by 2030 compared to 2005 levels.

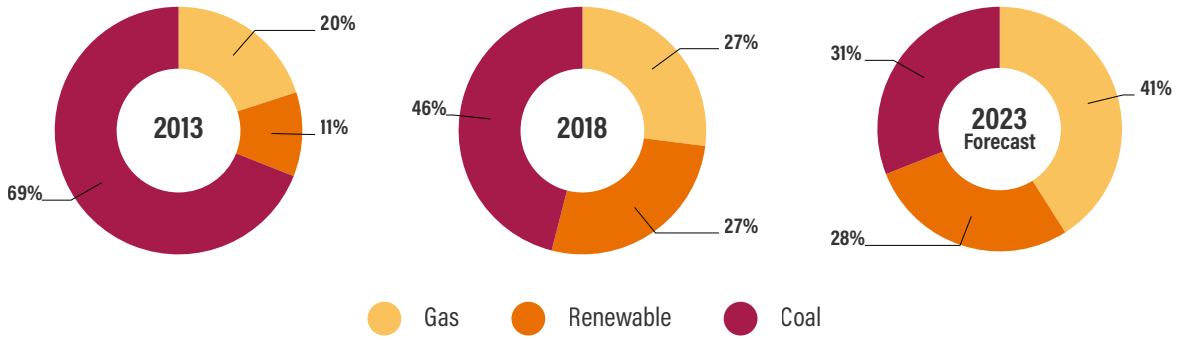
Coal-Fired Generation

Coal has been a critical resource for Montana-Dakota Utilities in meeting customers' energy needs. However, as the company's coal-fired electric generation fleet ages and becomes less economic to maintain, the company has been transitioning to lower-carbon resources such as wind and natural gas peaking turbines.

Montana-Dakota Utilities plans to retire 130 megawatts of nameplate coal-fired electric generation by 2022.

Montana-Dakota Utilities announced in 2019 the intent to retire three coal-fired generating units at two locations. The company ceased operating Unit 1 at the Lewis & Clark Station in Sidney, Montana, in March 2021, and will cease operating Units 1 and 2 at the Heskett Station in Mandan, North Dakota, in early 2022. When these retirements are complete, Montana-Dakota Utilities will have approximately 226 megawatts of coal-fired generating capacity remaining in its portfolio. The company plans to bring online in 2023 a new 88-megawatt natural gas-fired peaking turbine at the Heskett Station site, which will help ensure reliable service to customers and meet the company's capacity requirements.

Generation Capacity Shift Based on Nameplate Rating



Wind Generation

Montana-Dakota Utilities owns more than 200 megawatts of wind-driven generation. In 2020, renewable resources accounted for about 30% of the company's total electricity generation.

Thunder Spirit Wind	Diamond Willow Wind	Cedar Hills Wind
155.5 MW	30 MW	19.5 MW

Other Sources

Montana-Dakota Utilities has been actively evaluating potential solar and energy storage projects as the cost and performance of these technologies continue to improve.

For the most recent information about Montana-Dakota Utilities' electric generation resources, see the company's website at www.montana-dakota.com.

SCENARIO ANALYSIS CONSIDERATIONS

Montana-Dakota Utilities used guidance from the Task Force on Climate-related Financial Disclosures (TCFD) in preparing this report. TCFD is an investor-led organization that provides a framework for improving corporate disclosures as they relate to the emerging financial risk of climate change. According to TCFD, effective company disclosure "focuses on the resilience of an organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario. ... An organization's disclosure of how its strategies might change to address potential climate-related risks and opportunities is a key step to better understanding the potential implications of climate change on the organization."

Montana-Dakota Utilities partnered with M.J. Bradley & Associates, an ERM Group company, to conduct a detailed scenario analysis to better understand how the company's electric generation fleet may need to evolve in a 2°C scenario. Specifically, the analysis evaluated a transition to net-zero emissions by 2050.

Montana-Dakota Utilities evaluated a range of decarbonization pathways for its electric generating fleet and purchased power, including analyzing the estimated relative costs and benefits of alternative options. Montana-Dakota Utilities convened a diverse team from across the company to design the analysis.

The generation pathways developed from this scenario analysis focused on achieving net-zero emissions by 2050 through investments in renewable energy resources and battery storage technologies, retiring coal-fired power plants, deploying novel technologies such as carbon capture, utilization and sequestration on fossil-fired power plants, and increasing investment in energy efficiency measures, among other strategies.

Montana-Dakota Utilities includes some discussion of an accelerated net-zero target in this report.

RISKS AND OPPORTUNITIES

Climate change presents both risks and opportunities for Montana-Dakota Utilities. These risks and opportunities are strategically incorporated into the company's business plans. Current information about Montana-Dakota Utilities' and MDU Resources' risk assessment, management and oversight processes can be found in MDU Resources' most recent Sustainability Report and most recent 10-K on the corporation's website at www.mdu.com.

TCFD puts climate-related risks in two major categories: risks associated with the transition to a lower-carbon economy and risks from the physical impacts of climate change. Montana-Dakota Utilities focuses discussion in this report on the transition risks. Additional discussion on this topic can be found in MDU Resources' most recent 10-K.

Montana-Dakota Utilities' scenario analysis helps the company understand the scope and scale of challenges it may face, as well as potential opportunities, in transitioning to a lower-carbon generation fleet.

Potential Transition Risks	
Policy Risks	Policy actions intended to reduce greenhouse gas emissions may impact capital expenditures and revenues and could require early retirement of certain facilities. Without a greenhouse gas emissions policy, utility commissions may not approve cost recovery of decarbonization. Expanding decarbonization measures could reduce exposure to policy actions. If policy accelerates decarbonization, transmission system infrastructure development may lag because of lengthy permitting and siting processes, and higher build-out of renewables by the broader electric industry increases reliability risks.
Technology Risks	Technology changes may impact electric generation options, which may impact expenditures and resource planning. If technology advancements do not occur at a pace that allows the electric industry to affordably and reliably achieve net-zero emissions by 2050, higher costs would be expected from the necessary generation mix or from climate-change impacts.
Market Risks	Climate change could impact commodity prices, global energy markets, supply chains, labor markets, and availability and pricing of goods, materials and equipment. Transitioning to net-zero at an accelerated rate could compound these impacts.
Reputation Risks	ESG performance can influence customer and community perceptions of an organization.
Potential Physical Risks	
Acute Risks	Acute physical risks refer to those that are event-driven, such as increased severity or frequency of extreme weather events like summer and winter storms.
Chronic Risks	Chronic risks refer to longer-term shifts in climate patterns, such as sustained higher temperatures that may cause heat waves, droughts or other effects.
Potential Transition Opportunities	
Generation Decarbonization	Investments in new technologies to decarbonize the electric generation fleet may increase revenues.
Cross-Sector Decarbonization	Growth in electric demand from electrification of other sectors, such as transportation, could increase infrastructure investments and grow revenues. Demand increases could result in mutual benefits to upgrade aging infrastructure and modernize distribution and transmission systems, which can increase efficiency, reliability and energy system resilience.
Infrastructure Expansion	With growth in intermittent renewable generation, there may be opportunities to modernize aging transmission infrastructure, improving system resilience and enhance reputation and reliability.

Federal and state laws and regulations could create risks and opportunities, such as requiring additional emission control measures, carbon emission allowances, specific types of generating resources, or other significant actions to manage or lower greenhouse gas emissions. This could impact customer costs, electric demand and capacity, reliability or cause other effects.

Public response to climate change also could create risks and opportunities. For example, a shift to distributed generation sources such as household solar may cause shifts in generation demands and infrastructure development.

New distribution and transmission infrastructure and additional or different types of generation resources may be needed in response to climate change. These projects provide potential opportunities for revenue growth.

Montana-Dakota Utilities views climate change-related impacts as opportunities to provide solutions for its customers and communities. The company has opportunities to invest in clean-energy technologies, which can provide jobs, reduce emissions and create efficiencies. Additional capital investments in renewable generation resources helps achieve federal policy goals to decarbonize the electric sector, and those investments would benefit shareholders. Achieving emission reductions in the electric sector also supports decarbonization within the transportation sector, resulting in future growth and investment opportunities for Montana-Dakota Utilities. The company continues to explore these opportunities and incorporates findings into its Integrated Resource Plans, which are completed every two years.

Montana-Dakota Utilities participates in energy infrastructure and transmission grid reliability working groups and education and training opportunities to ensure operational readiness, build key relationships, be aware of technology advancements, and share best practices. Montana-Dakota Utilities devotes considerable time and resources to developing and testing robust plans to counter physical and cyber-related threats.

By analyzing climate change impacts, Montana-Dakota Utilities can make its system more efficient and resilient to changing conditions. The company's planning and risk management procedures include consideration of these risks and opportunities on an ongoing basis.

MONTANA-DAKOTA UTILITIES GREENHOUSE GAS EMISSIONS

Montana-Dakota Utilities discloses greenhouse gas emissions from its electric generation facilities and reports the information on an annual basis to the U.S. Environmental Protection Agency (EPA) under the Greenhouse Gas Reporting Program. The company also voluntarily reports emissions consistent with EEI's ESG/sustainability reporting template. Most of Montana-Dakota Utilities' greenhouse gas emissions are carbon dioxide emissions from its electric generation fleet. The latest data on Montana-Dakota Utilities' greenhouse gas emissions can be found in MDU Resources' most recent Sustainability Report on the corporation's website at www.mdu.com.

As Montana-Dakota Utilities' electric generation mix has evolved over time, the carbon intensity of its fleet has declined from 1.199 metric tons of carbon dioxide equivalent per megawatt hour in 2005 (2,643 pounds per MWh) to 0.859 metric tons of carbon dioxide equivalent per megawatt hour in 2020 (1,894 pounds per MWh). Total greenhouse gas emissions from its electric generation have declined from 2,789,942 metric tons in 2005 to 2,274,960 metric tons in 2020, which is more than an 18% reduction.

2020 Greenhouse Gas Emissions & Generation (by ownership share)

Power Plant (ownership share)	Electricity Generation (MWh)	Carbon Dioxide (metric tons CO2e)	Total GHG (metric tons CO2e)
Lewis & Clark Station 1 (100%)*	232,433	313,871	315,962
Lewis & Clark Station 2 (100%)	1,613	765	766
Heskett Station 1 & 2 (100%)**	469,765	625,086	628,659
Heskett Station 3 (100%)	1,331	1,191	1,192
Glen Ullin Station 6 Waste Heat Recovery Unit (100%)	29,813	0	0
Coyote Station (25%)	552,839	659,875	665,170
Big Stone Station (22.7%)	394,021	427,495	431,026
WYGEN 3 (25%)	209,423	229,974	231,187
Miles City Combustion Turbine (100%)	349	324	325
Glendive Combustion Turbines (100%)	853	602	603
Cedar Hills Wind (100%)	55,889	0	0
Diamond Willow Wind (100%)	98,781	0	0
Thunder Spirit Wind (100%)	600,626	0	0
TOTAL**	2,647,746	2,259,252	2,274,960

*Ceased operations in 2021
**Scheduled to cease operations in 2022
*** Total includes immaterial amounts from oil diesel units not shown in table

PURSUING LOWER-CARBON SOLUTIONS

Montana-Dakota Utilities promotes on an ongoing basis a variety of energy efficiency programs. The company also pursues research and development opportunities, often as a participant in partnership organizations, that explore greenhouse gas emission reductions and climate change-related technologies.

Promoting Efficiencies

Through its energy efficiency offerings, Montana-Dakota Utilities helps customers use less energy while reducing their carbon footprint and energy bills. As an ENERGY STAR partner, Montana-Dakota Utilities' electric energy-efficiency programs saved customers more than 1.4 million kilowatt hours in 2020, which will annually avoid more than 1,000 metric tons of carbon dioxide-equivalent emissions.

In certain states, Montana Dakota Utilities offers customers the opportunity to purchase renewable energy credits from renewable energy projects through tariff rates as approved by state utility regulatory commissions. For example, customers in Wyoming can support renewable energy projects through the Renewable Energy Rider program, which allows customers to voluntarily purchase renewable energy credits from wind, solar and waste heat recovery projects.

In 2020, Montana-Dakota Utilities concluded a multiyear, $4.5 million project to replace streetlights and other company-owned lights throughout the company's service territory with energy-saving LED lights. The company installed more than 25,585 lights, which will annually avoid more than 13,000 metric tons of carbon dioxide-equivalent emissions.

As technologies such as electric vehicles become more viable and cost effective in the company's service territory, Montana-Dakota Utilities is exploring options to best support customers in adopting these technologies.

Research and Development

To prepare for a lower-carbon future, Montana-Dakota Utilities has been active in researching options for carbon capture, utilization and sequestration. The company has been a member of two initiatives led by the Energy and Environmental Research Center at the University of North Dakota. Montana-Dakota Utilities has been an active member of the Plains CO2 Reduction Partnership since its inception in 2003 and the Partnership for CO2 Capture since 2014. The Partnership for CO2 Capture supports pilot-scale demonstration projects.

Montana-Dakota Utilities has actively participated in the environmental working groups of the North Dakota Lignite Energy Council, such as the Lignite Technology Development Workgroup and the Environmental Workgroup. In recent years, these workgroups have focused on carbon dioxide-related issues such as lignite gasification, oxyfuel combustion, pre- and post-combustion carbon capture technologies and beneficial uses of captured carbon.

EEI, of which Montana-Dakota Utilities is a member, in early 2021 announced that it had joined with a number of environmental and technology-focused non-governmental organizations to launch **the Carbon-Free Technology Initiative**. The CFTI focuses on implementation of federal policies that can help ensure the commercial availability of affordable, carbon-free, 24/7 power technology options by the early 2030s. The CFTI focuses on advancing policy recommendations in the following key technology areas:

- Advanced wind and solar energy systems.
- Long-duration storage and advanced demand efficiency.
- Advanced, dispatchable and renewable superhot rock deep geothermal.
- Zero-carbon fuels, such as hydrogen.
- Advanced nuclear energy, both fission and fusion.
- Carbon capture, utilization and storage.

Many of the policy recommendations advanced by CFTI propose to address research and development, demonstration, deployment and issues that have an impact on the cost or performance of a technology, such as siting and permitting across all technology areas. CFTI outlines the need for appropriations, authorizations, and tax and finance policies to advance these technologies.

In addition to Montana-Dakota Utilities' engagement in research and development efforts, the company also participates in MISO's Long-Range Transmission Planning initiative, which focuses on electric grid planning to support a low-carbon future. Transmission planning is fundamental in decarbonizing the electric system and gives the region more options to achieve future climate goals while maintaining reliability.

Montana-Dakota Utilities also follows developments in the **Low-Carbon Resources Initiative** through Intermountain Gas Company, which is another subsidiary of MDU Resources and a sponsor of the LCRI. The LCRI jointly through the Electric Power Research Institute and the Gas Technology Institute to address the need to accelerate development and demonstration of low- and zero-carbon energy technologies. These technologies include low-carbon electric generation technologies and low-carbon chemical energy carriers such as clean hydrogen, bioenergy and renewable natural gas, and these technologies are needed to enable affordable pathways to economywide decarbonization.

MONTANA-DAKOTA UTILITIES' SCENARIO AND GENERATION PATHWAY ASSESSMENTS

The generation pathways developed in this scenario analysis focused on achieving net-zero emissions by 2050 through investments in renewable energy resources and battery storage technologies, retiring coal-fired power plants, deploying novel technologies such as carbon capture, utilization and sequestration on fossil-fired power plants, and increasing investment in energy efficiency measures, among other strategies.

This type of analysis — evaluating different resource portfolios — is not new to Montana-Dakota Utilities. The company has prepared Integrated Resource Plans (IRP) for more than 30 years, evaluating and documenting efforts to determine the best-value resource plan for customers. This risk management process considers the feasibility of supply-side and demand-side resource options to determine a least-cost resource plan to economically and reliably meet customer requirements. It includes investigating factors that could impact the plan, such as potential policy and regulatory changes.

For this TCFD climate assessment, Montana-Dakota Utilities used a custom resource planning tool from M.J. Bradley & Associates to evaluate a wide range of decarbonization pathways with supply-side and demand-side adjustments beyond its current plan.

The company used the net-zero by 2050 fleetwide focus for this analysis to understand the potential business, strategic and financial impacts from a variety of generation pathways. For this analysis, net-zero emissions is defined as reducing total emissions close to zero with limited use of emission offsets (e.g., tree planting) to net out any remaining greenhouse gas emissions from operating fossil-fired generating units.

In the future, electrification may increase in Montana-Dakota Utilities' service territory. The company is monitoring the potential role and timing of transportation and building electrification in its territory's northern climate and will expand its scenario analysis to include additional electrification as that becomes clearer.

The emission reduction pathways in this analysis do not represent a prediction of the future or a commitment to a specific approach. To complete this analysis, the company used various assumptions and factors that may not reflect actual future results. The pathways are designed to test Montana-Dakota Utilities' generation plan against a range of ambitious outcomes, to provide an understanding of the uncertainties ahead, and to help the company evaluate strategies to mitigate climate-related risks and realize opportunities.

In its analysis, Montana-Dakota Utilities explored pathways that would meet customers' predicted future energy needs, including peak summer and winter demand, while targeting net-zero emissions by 2050. This process gave the company a greater understanding of potential costs and implementation challenges, as well as the realization that not all pathways could achieve net-zero emissions by 2050. The analysis did not consider broader system reliability needs or additional regional transmission upgrades that may be required to support a low-carbon future because this work is being done at a regional level, through MISO, as further described later in this report.

While Montana-Dakota Utilities is committed to doing its part in pursuing a lower-carbon future, the company's primary responsibility is to provide its customers with reliable and low-cost electric service. Montana-Dakota Utilities considered that responsibility while conducting its climate scenario analysis and potential pathways to a net-zero future.

Montana-Dakota Utilities' analysis included four decarbonization pathways as well as a reference pathway to reflect "business as usual," with no decarbonization or net-zero advancement beyond Montana-Dakota Utilities' previously announced coal-fired plant retirements.

As of the end of 2020, coal accounts for more than 80% of Montana-Dakota Utilities' electric supply carbon dioxide emissions. All net-zero pathways assume the closure of Montana-Dakota Utilities' coal-fired power plants by 2050 or the use of carbon capture on those plants. All net-zero and reference pathways assume the company continues to operate existing generation resources as needed, including natural gas combustion turbines and engines, wind resources, waste heat facility and diesel-fired generation. Also within the pathways:

- Montana-Dakota Utilities maintained its baseline projections of total energy demand growing at a rate of 0.8% through 2050 and summer/winter **peak demand** growing at a rate of 0.9%.
- Montana-Dakota Utilities limits offset procurement to a maximum of 10% of its current emissions. **Offset credits** are greenhouse gas emissions reductions occurring from non-regulated sources, such as forestation and agricultural sequestration projects. Offsets generally are more cost-effective and less technically challenging than direct emission reductions. Offset purchases would be used to counter emissions from fossil-fired generation in each of the pathways. Montana-Dakota Utilities assumed periodic operation of peaking units without carbon capture technology, and assumed carbon capture technology to be 90% efficient on intermediate and baseload fossil-fired resources to be 90% efficient. Therefore, emissions from fossil-fired units in each pathway would need to be offset to reach net-zero emissions.
- **Renewable** energy resources, particularly wind and solar, dominate the generation mix. Because of the intermittent nature of renewables, grid operators such as MISO discount the nameplate capacity based on the type of renewable. For example, at the time of this report, MISO rates wind generation with a 16-25% capacity credit, depending on the season, which means the company would need to build approximately six times more wind generation as compared to dispatchable generation options to meet capacity requirements. MISO rates solar photovoltaic renewables with a 50% capacity credit in the summer during peak operating periods but gives it little to no capacity credit in the winter when solar resources typically produce little electricity during peak capacity times. The pathways account for a seasonal capacity credit for wind and solar in meeting peak capacity needs.
- Montana-Dakota Utilities' **peak summer and winter capacity** needs for customers are met, but the pathways do not include potential future capacity increases that would result from transportation and building electrification.
- **Purchased power** is limited to a maximum of one-third of Montana-Dakota Utilities' total demand. An emission rate of 0.568 metric tons of carbon dioxide equivalent per megawatt hour was used for purchased power, considering the approximate marginal rate of a natural gas-fired unit.
- **Demand-side energy efficiency** assumptions were limited to the existing rates allowed by Montana-Dakota Utilities' regulatory jurisdictions. Montana-Dakota Utilities plans to undertake a state-by-state energy efficiency study in 2022. If its regulatory jurisdictions should determine energy efficiency technologies are cost effective and should be more broadly implemented, Montana-Dakota Utilities would expect to see reductions in demand and capacity requirements.
- **Energy storage capacity** is added at 10% of added renewable energy capacity.

Resource Options Considered

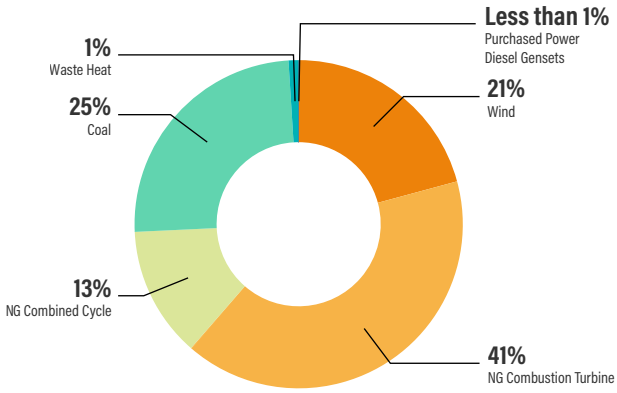
Resource Options	Defined	Modeling Approach
Existing coal-fired generation units	Baseload generating resource capable of 24/7 dispatchable operation.	All pathways assume the closure of all existing coal-fired units by 2050 or implementation of carbon capture technology.
Natural gas simple cycle	Small to medium natural gas-fired peaking units with relatively low capital costs. Designed for limited, flexible, dispatchable operation to address peaks in electricity demand, varied intermittency of renewable resources and transmission system reliability.	Some pathways assume the addition of simple-cycle capacity.
Natural gas combined cycle	Large, high-efficiency natural gas-fired power plant for potential baseload or intermediate dispatchable operation. More efficient than a simple-cycle unit.	Some pathways assume the addition of combined-cycle capacity with carbon capture technolocy.
Wind turbine	This has been the primary renewable technology developed in the Great Plains given the region's abundant wind resource. Wind energy has low operating costs but output varies depending on weather conditions.	The pathways assume increased wind generation but limit capacity credit to meet planning reserve margins, consistent with MISO's zonal resource credits. Wind was given greater emphasis as a generation resource because it is more abundant than sunlight in the northern U.S.
Solar energy	Solar capacity is limited in the Great Plains because of its capital costs. This may change as technology costs decline. Also, solar resources receive limited to no capacity accreditation in the region due to cloud cover and limited daylight in winter.	The pathways assume increased solar capacity but limit capacity credit to meet planning reserve margins, consistent with MISO's zonal resource credits.
Energy storage	Energy storage resources, such as large batteries, are used to store energy mainly during off-peak times to be used later when needed for peak conditions and transmission system needs. Battery system costs are high, limiting deployment, but costs are becoming more competitive in certain applications.	Some pathways assume a combination of renewable energy and battery storage capacity.
Carbon capture	Carbon capture for fossil-fired generation is in the early stages of development. High costs limit its deployment and often require government subsidization. Early projects have faced operational or economic challenges. North Dakota and Montana may be attractive locations for sequestration.	The pathways consider carbon capture for both coal-fired and new natural gas combined-cycle facilities. Carbon capture technology is assumed to capture 90% of emissions.
Nuclear energy	Nuclear energy resources are baseload generating resources capable of 24/7 dispatchable operation. This resource has zero emissions but has additional safety and security considerations. Advancements in small, modular reactor technology would improve viability.	This technology was excluded from Montana-Dakota Utilities' pathways because of cost and the need for additional technology advancements. The company continues to monitor advancements in this resource for future planning consideration.
Hydrogen	Advancements in hydrogen for use in electric generation is a priority since it could replace fossil fuels in combustion units and is a zero to near-zero carbon fuel. It has potential to provide 24/7 dispatchable operation or may be utilized in energy storage systems to meet peak capacity needs.	This technology was excluded from Montana-Dakota Utilities' pathways because of cost and the need for additional technology advancements. The company continues to monitor advancements in this resource for future planning consideration.

Reference Pathway
Business as Usual

The reference pathway reflects "business as usual" generation resource additions, without a decarbonization policy in place, to meet Montana-Dakota Utilities' 2050 capacity and demand requirements. This pathway reflects the company's previously announced coal-fired plant retirements with resource additions of conventional natural gas-fired generation to meet customer demand and system capacity requirements. This pathway:

- Results in just under 2.8 million metric tons of carbon dioxide equivalent emissions per year by 2050.
- It requires the least amount of additional generation capacity build.
- Is not expected to result in significant cost increases for customers.

Resource Capacity Mix for Reference Pathway



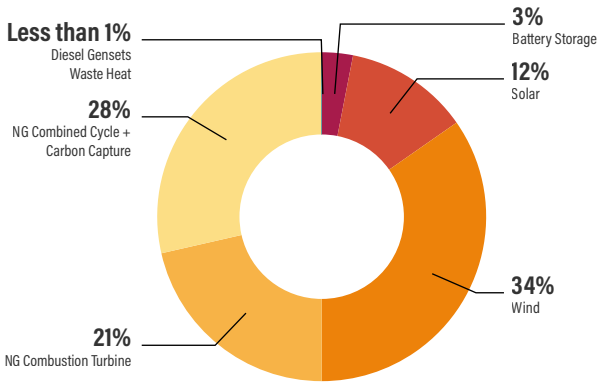
Total Capacity: 1,000 Megawatts

Pathway 1
Natural Gas-Fired Generation Units With Carbon Capture

In this pathway, Montana-Dakota Utilities adds about 340 megawatts of generation beyond what is required in the reference pathway through a combination of renewable resources and natural gas combined-cycle generation with carbon capture technology. Natural gas resource capacity additions are limited by the maximum offsets that can be purchased to counter their emissions. The remaining capacity and electricity needs are then met with additional renewable resources, battery storage and purchased power. This pathway requires the least "overbuild" generation to meet the company's required dispatchable capacity as backup for the renewables. This pathway:

- Achieves near net-zero emissions by 2050.
- Requires the least amount of generation capacity build of the four net-zero pathways, at about 30% more than the company's reference pathway.
- Results in minimal excess generation as natural gas combined-cycle generation with carbon capture provides dispatchable capacity.
- With technology advancements in battery storage and carbon capture, this pathway is expected to be the lowest investment cost of the four net-zero pathways and will result in about the same cost to customers as Pathway 2.

Resource Capacity Mix for Pathway 1

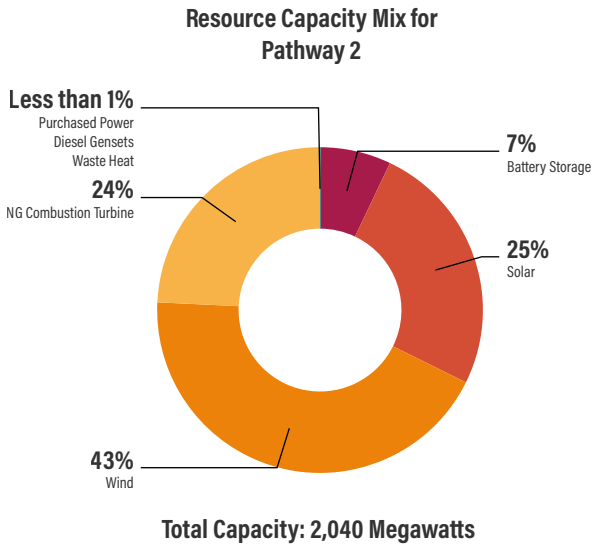


Total Capacity: 1,340 Megawatts

Pathway 2
High Renewables With Natural Gas Simple-Cycle Combustion Turbines

This pathway, adding more than 1,000 megawatts of generation beyond what is required in the company's reference pathway, combines renewables and natural gas simple-cycle units to meet net-zero emissions. Natural gas combustion turbine additions are limited by the maximum offsets that can be purchased to counter their emissions. Wind and solar resources along with battery storage are then added to meet Montana-Dakota Utilities' remaining capacity and energy needs. Compared to Pathways 1 and 3, this pathway would require a significant "overbuild" of generation to meet Montana-Dakota Utilities' required dispatchable capacity as backup for the intermittent renewables. This pathway:

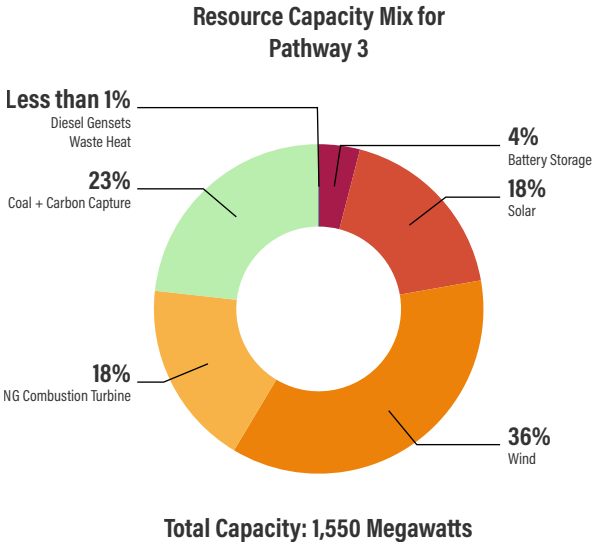
- Achieves net-zero emissions by 2050.
- Requires the second-largest amount of additional generation capacity build of the four net-zero pathways, two times the generation capacity needed in the reference pathway.
- Results in minimal excess generation despite significant renewable capacity build-out because of the dispatchable natural gas turbine capacity added.
- With technology advancements in battery storage, this pathway is expected to have the lowest cost to customers of the four net-zero pathways at about 1.5 times the cost of the reference pathway, and it is expected to have a higher investment cost than Pathway 1.



Pathway 3
Coal With Carbon Capture

This pathway would add over 500 megawatts of generation beyond what is required in the reference pathway, combining coal-fired generation with carbon capture technology along with renewables, including wind, solar and battery storage. Similar to Pathway 1, this pathway would provide a low-carbon solution while providing required dispatchable resources as backup for the intermittent renewables. The use of carbon capture is expected to significantly reduce carbon emissions from coal combustion. The addition of this resource is limited by the maximum offsets that can be purchased to counter its emissions. This pathway:

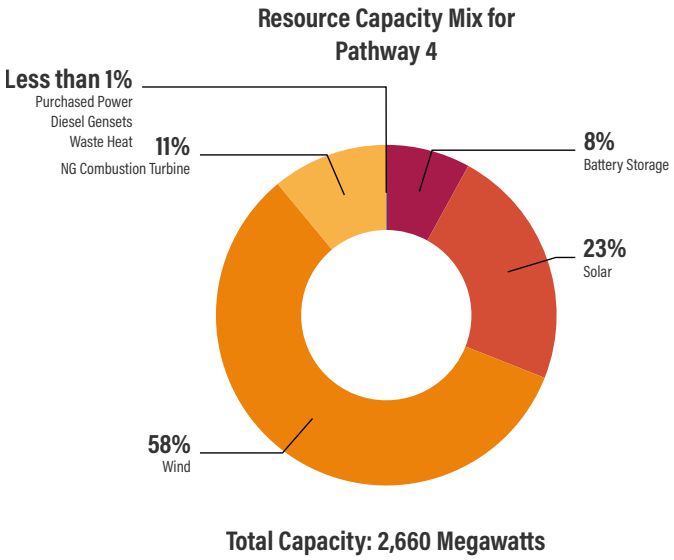
- Achieves near net-zero emissions by 2050.
- Requires the second-least additional generation capacity build of the four net-zero pathways at about 55% more than the reference pathway.
- Results in a very small amount of excess generation as coal-fired generation with carbon capture technology provides dispatchable capacity.
- Is expected to result in the most significant customer cost increases at more than three times the reference pathway unless technology advancements are realized.
- Requires technology advancements in coal with carbon capture and additional incentives to lower costs to be a viable option.



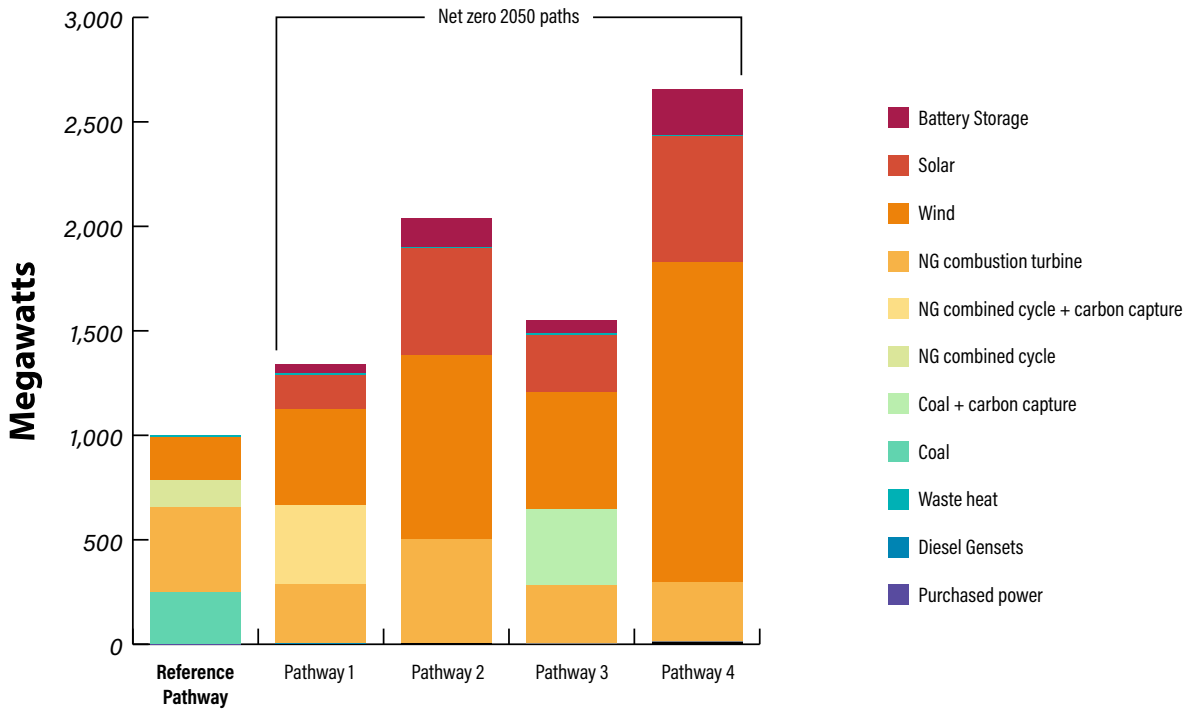
Pathway 4
High Renewables With Battery Storage

This pathway would add more than 1,600 megawatts of more generation than the reference pathway, adding significant renewable resources, including wind and solar, with battery storage as backup for the intermittent renewables. This pathway:

- Produces the least amount of emissions, achieving net-zero emissions by 2050 with minimal use of offsets.
- Requires the largest additional generation capacity build of the four net-zero pathways at more than 2.5 times the generation needed in the reference pathway.
- Is expected to cost customers about two times more than the reference case, and to require higher investment costs than Pathways 1 and 2.
- Could produce significant excess generation from the high volume of renewable resource additions — over 50% more than what the company's demand requires. The excess energy could, at times, be sold into the broader electric market. However, curtailments could be expected depending on capacity needs and market dynamics. Curtailments will be a significant concern if this type of pathway is adopted by the wider utility industry.

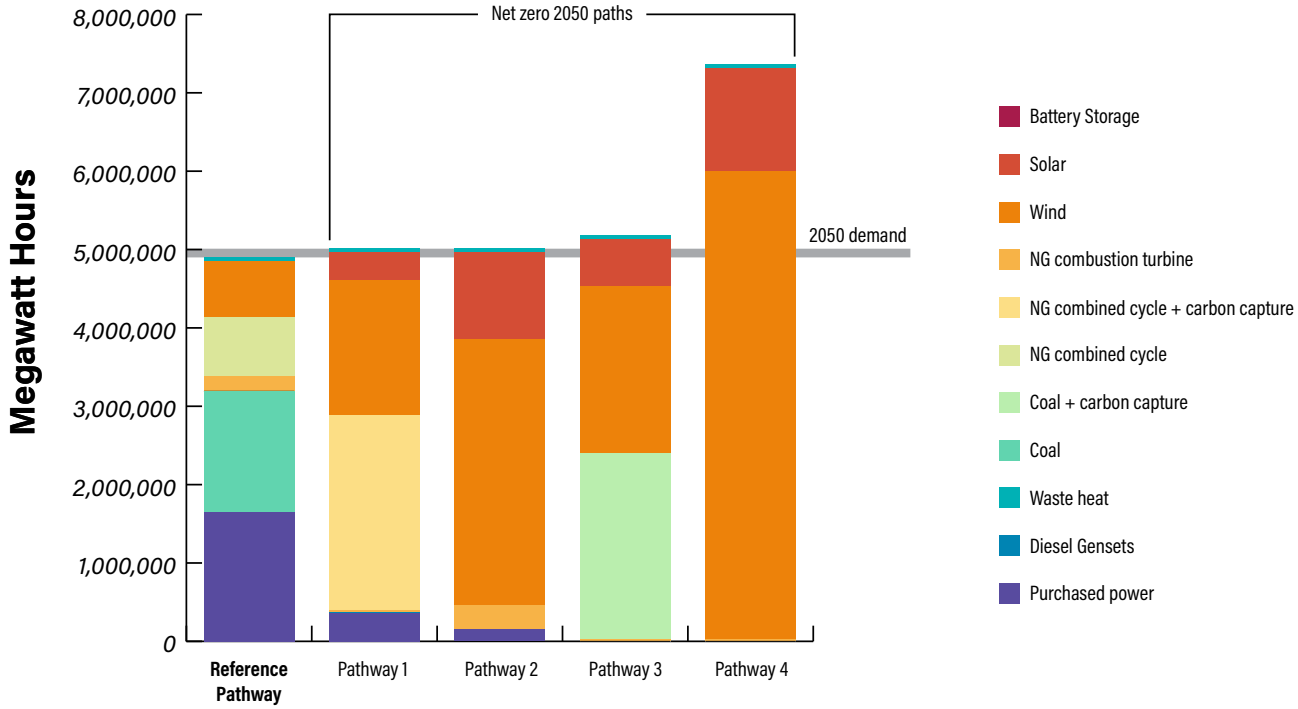


Resources Capacity Mix by Pathway



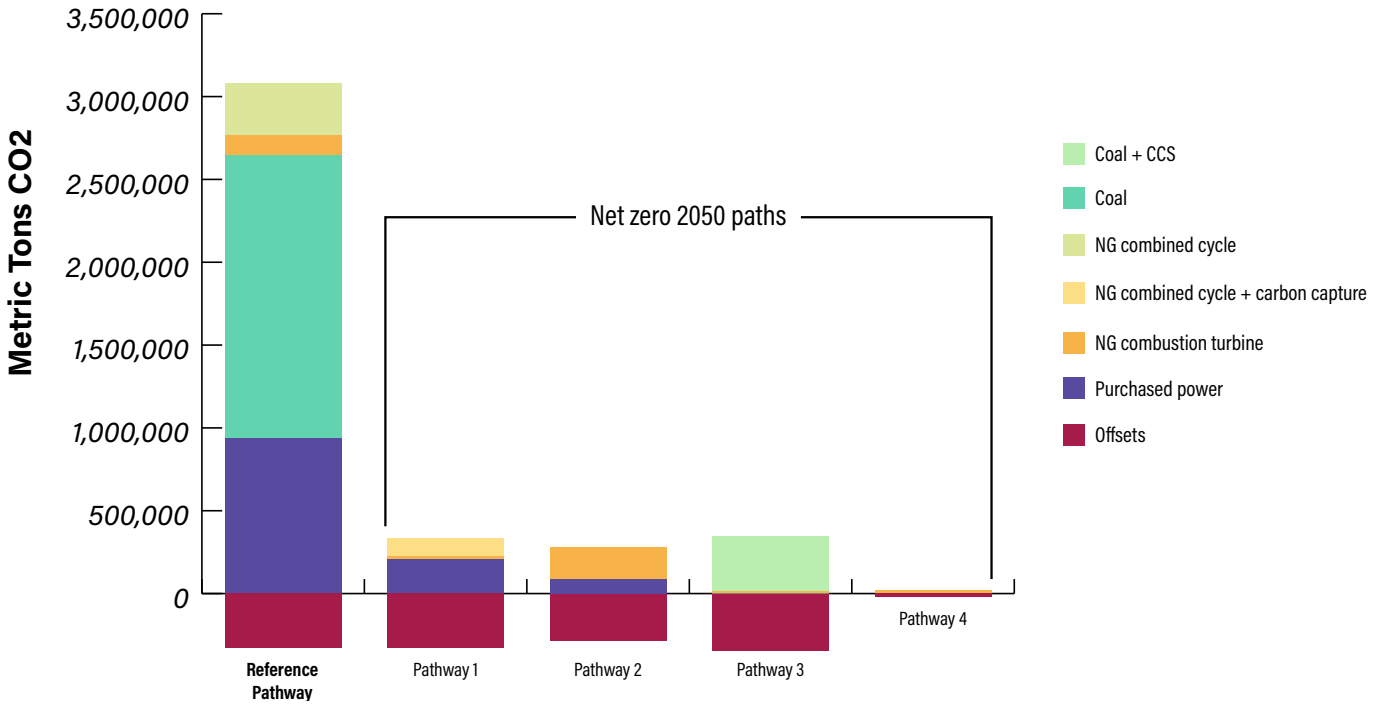
This chart shows the amount of generating capacity for each of the pathways that Montana-Dakota Utilities considered.

Projected Electricity Generated by Pathway



This chart shows the generation resource mix for each of the pathways that Montana-Dakota Utilities considered.

Projected Emissions by Pathway



This chart shows the amount of anticipated carbon dioxide-equivalent emissions for each of the pathways that Montana-Dakota Utilities considered.

KEY INSIGHTS

Limiting global temperature rise to below 2°C will require all sectors of the economy to reduce emissions. According to the U.S. Energy Information Administration, the leading sources of carbon dioxide emissions in 2018 across Montana, North Dakota and South Dakota were the power sector (46%), the industrial sector (24%) and the transportation sector (23%). The electric sector is likely to play an important role in supporting efforts to decarbonize.

Montana-Dakota Utilities' territory spans a region with abundant wind resources, which can make wind generation cost-competitive with conventional fossil-fired generation on a dollar-per-megawatt-hour basis. The region has limited solar resources. Because wind does not always blow and the sun does not always shine, it is not possible to meet peak demand requirements solely with these intermittent renewable resources. Therefore, in all the decarbonization pathways that Montana-Dakota Utilities explored, the company would have to build more generation capacity than it needs for meeting customers' peak capacity requirements.

Regardless of the path forward, achieving net-zero emissions will require implementing a combination of generation and technology resources to ensure Montana-Dakota Utilities' customers continue to receive affordable, reliable and resilient service. Some net-zero emission technologies have not yet been developed or are just emerging as potential solutions. Other opportunities for emission reductions may exist with potential developments in options such as renewable natural gas, hydrogen created from renewable sources, or direct air-capture technologies. It is unknown what technologies will be in place by 2050 to achieve net-zero results. All the pathways that Montana-Dakota Utilities considered include optimistic assumptions that necessary technology advancements will be in place by 2050.

As a member of MISO, Montana-Dakota Utilities will benefit from regional transmission planning that incorporates opportunities for additional lower-carbon generation. The company also expects to rely to some extent on the broader electric grid to help meet its customers' peak energy needs. MISO's Long-Range Transmission Planning initiative is looking at a variety of scenarios to determine what investments need to be made for the future electric grid. The initiative estimates significant transmission upgrade costs, ranging from $30 billion to achieve 40% decarbonization by 2040 to $100 billion to achieve 80% decarbonization by 2040. It is unknown if transmission infrastructure changes can happen quickly enough to meet decarbonization timelines.

MISO's Long-Range Transmission Planning initiative also considers that a situation could exist in which utilities across the region all add significant renewable generation resources, which would produce excess electricity as identified in Pathway 4. If regional utilities all attempt to sell excess power back to the regional transmission grid, curtailments of renewable resources will be required.

If the timeframe for achieving net-zero emissions were accelerated, such as achieving net-zero emissions by 2035, fossil-fired generation resources may need to be retired sooner and lower-carbon generation resource investments would need to be accelerated. This would be expected to increase customer rates in a short timeframe. A lag also would be expected in transmission system infrastructure development because of lengthy permitting and siting requirements. Under an accelerated timeline, the broader electric utility industry would likely deploy high volumes of renewable generation capacity, which could result in system reliability issues and curtailments of excess generation.

There are many challenges associated with the transition to a low-carbon economy. Montana-Dakota Utilities will continue to advance its understanding and evaluation of climate-related transitional and physical risks and opportunities in supplying energy to customers. The company's understanding of the issues it faces in achieving a net-zero emissions target while ensuring reliable and cost-effective electricity to its customers has been enhanced by this scenario analysis. The analysis will inform the ongoing development of the company's electric generation strategy. Montana-Dakota Utilities will continue to review and include in its risk management processes and generation development plans the potential impacts related to climate change.