

SPOTLIGHT ON

NORTH DAKOTA ENERGY

2023 ANNUAL REPORT



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The Great Plains Energy Corridor, housed at Bismarck State College's National Energy Center of Excellence, works with partners in government, education, and the private sector to promote and enhance North Dakota's energy development. Together we provide information, education, outreach programs and special events on a wide range of energy topics.

www.energyND.com

editor's COMMENTS

Thank you for picking up the 2023 edition of the Great Plains Energy Corridor's Spotlight on North Dakota Energy! This report is a statistical overview of all forms of energy in North Dakota for the year 2023. It's updated annually and usually distributed at the end of the first quarter of the following year.

Here's a quick look at some of the highlights from 2023:

► Production of natural gas in North Dakota set a monthly production record in July. Almost 102 billion cubic feet were produced. Prior to that, monthly production had never been higher than 100 billion cubic feet. That record was broken again in September when production reached more than 103 billion cubic feet.

► The second chimney at the decommissioned Heskett Station power plant in Mandan, N.D., was toppled in June. It was the last of the plant's landmarks to be removed. It was toppled using controlled explosives.

► Minnkota Power Cooperative, Grand Forks, N.D., announced the addition of new partners in developing and advancing the technology for Project Tundra, a carbon capture project at its Milton R. Young Station, a coal-based power plant near Center, N.D. The new partners include TC Energy, Mitsubishi Heavy Industries and Kiewit.

► The North Dakota Transmission Authority named Claire Vigesaa as its new executive director, August 1. He replaced John Weeda who retired. Weeda had held the position since 2018. The Transmission Authority facilitates the growth and expansion of the state's electric transmission grid.

► The sixth carbon dioxide storage facility in the state was approved by the North Dakota Industrial Commission in October. It's expected the site will have the storage capacity 123 million metric tons of carbon dioxide. This site is located in Oliver County.

► In an effort to develop clean energy projects across the United States, the Federal Energy Department awarded up to \$925 million to the Heartland Hydrogen Hub of North Dakota. The Hub is part of the Energy and Environmental Research Center at the University of North Dakota.

► The North Dakota Industrial Commission awarded \$12 million to the Energy and Environmental Research Center at the University of North Dakota to study the further development of critical minerals within the state and to explore the potential of using underground salt caverns for storing natural gas.

► The Blue Flint ethanol plant near Underwood, N.D., began a carbon capture project in November. The project will capture more than 200,000 metric tons of carbon dioxide from the process that will be permanently stored underground in the Broom Creek Formation. It was the second ethanol plant in the state to capture carbon dioxide. The first was Red Trail Energy near Richardton, N.D.

► Basin Electric Power Cooperative held a ground breaking ceremony in September for Phase IV of a natural-gas fired electric generating station near Williston, N.D. The expansion of the plant will have a generating capacity of 600 megawatts. It's expected to be in service by 2026.

► The Green Bison Soybean Processing plant in Spiritwood, N.D., opened in September 2023. As a joint venture between ADM (75% owner) and Marathon Petroleum (25% owner), it is North Dakota's first dedicated soybean crushing plant and refinery and will help meet the need for renewable diesel fuel.

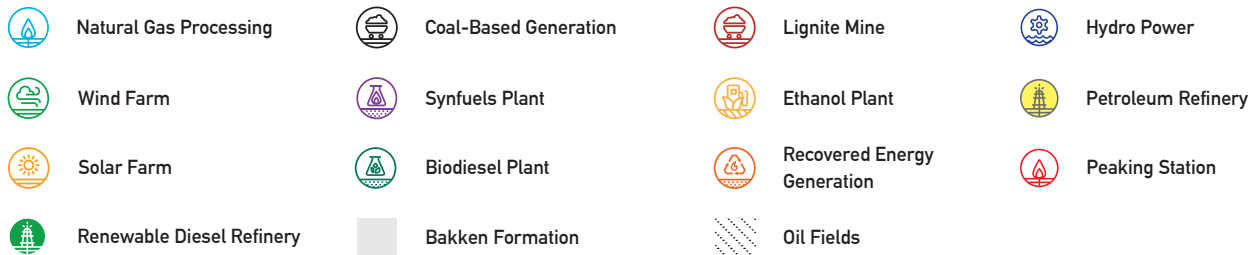
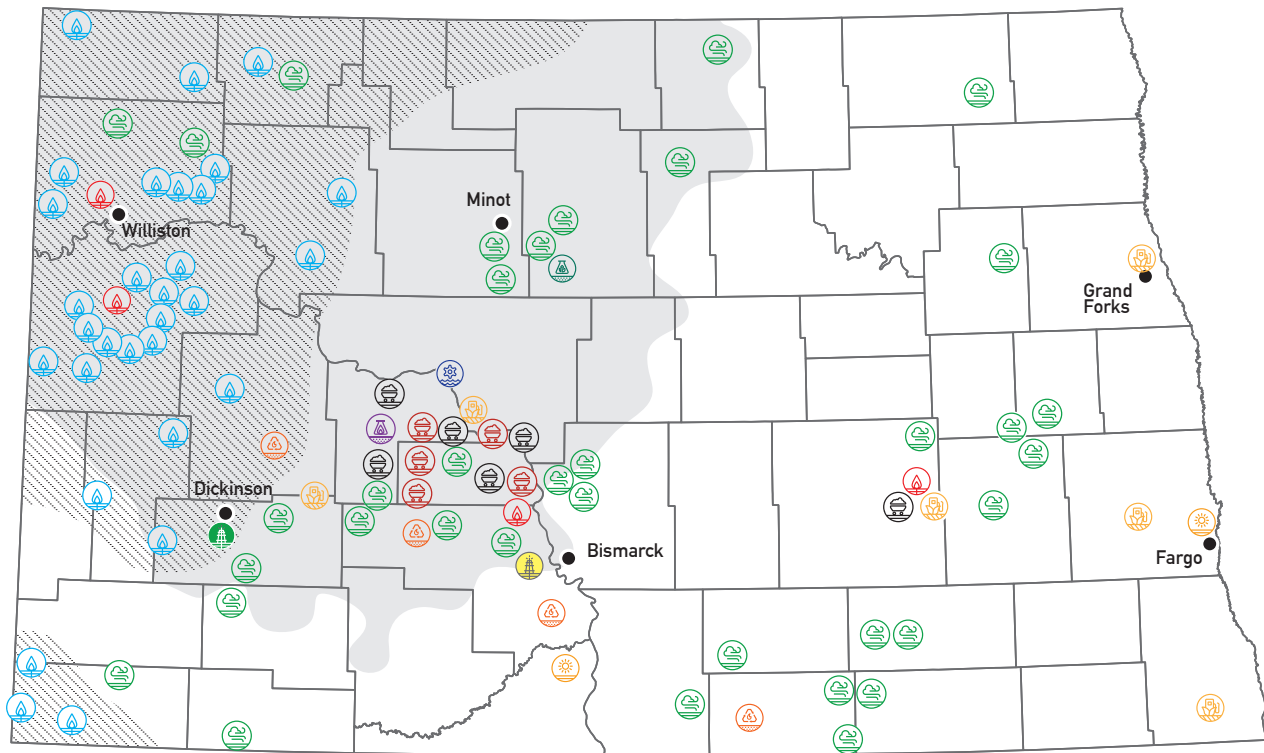
► Minnesota-based Talon Minerals in 2022 announced a plan to develop a facility in central North Dakota to process nickel and other minerals for batteries from raw ore mined in Minnesota, expanding domestic manufacturing of batteries for electric vehicles.

I would like to thank Daryl Hill, who assisted with gathering the information you find in this document. Together, with our industry partners and the EmPower North Dakota Commission, we are able to provide up-to-date information for this year's report.

Thank you for your continued readership!

Alicia Uhde, *Dean,
Automation, Energy and Advanced
Technologies*

energy sites of NORTH DAKOTA

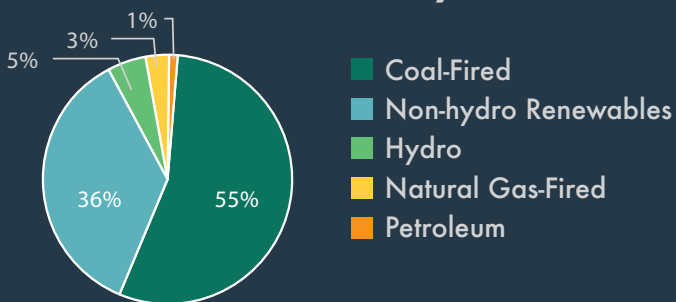


+ Map courtesy of Bismarck State College's National Energy Center of Excellence.

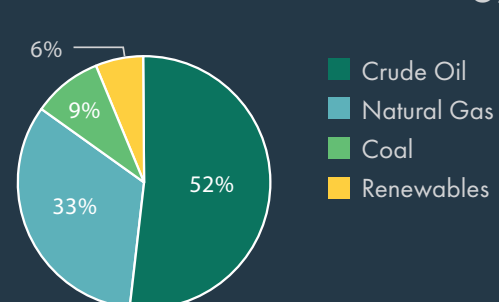
A View From Above

According to the North Dakota Commerce Department, North Dakota ranks second in the nation for total energy production from all sources including coal, natural gas, oil, hydro, and renewables.

North Dakota Electricity Production



North Dakota Total Energy Production



Sources: U.S. Energy Information Administration, North Dakota State Energy Profile

north dakota GENERATION

North Dakota produces electricity from a wide variety of sources, including coal baseload power plants, the hydroelectric turbines at Garrison Dam, a growing statewide network of wind turbines, natural gas and fuel oil peaking plants, heat recovery units, and even a small amount of solar power. There is also work being done to explore the potential of geothermal generation in western North Dakota.

According to the website chooseenergy.com, North Dakota had the lowest-cost electricity for residential use in November 2023, at 10.74 cents/KWh. This compares to the national average of 16.19 cents/KWh. The highest cost for residential electricity among the 50 states is Hawaii at 43.53 cents/KWh.

Electricity is very unique. It is an “instant-use product,” which means that the moment it is produced (generated), it’s being used. It is not stored (on a regional or commercial basis) or warehoused for use at a later time. Electricity that we use in our homes, businesses, and schools is generated as needed and when needed. The demand for electricity varies considerably during the day or during the different seasons. Regardless, a power plant has to be operating to produce the electricity needed.

There are many different ways to produce electricity such as:

- Coal-based power plants
- Nuclear plants
- Wind projects
- Natural gas plants
- Solar projects
- Geothermal
- Hydroelectric

Power plants can be classified as dispatchable or intermittent. Dispatchable power plants are designed to increase or decrease generation as required by the dispatcher. These would be the coal-based and natural gas-fired generators, as North Dakota does not have any nuclear power plants. The plants fueled with natural gas are capable of rapid starts and the ability to quickly achieve full generating capacity (fast ramping). They typically run a small percentage of the time. Intermittent plants are typically comprised of renewable energy sources such as wind or solar and operate when the resource is available. There is interest in solar generation in North Dakota but there are not any utility-scale installations at this time. Wind is abundant in North Dakota and comprises the most common additions to the generating fleet.

It makes no difference how electricity is produced, it’s all the same product. It just comes from different sources.

Every establishment that uses electricity is connected or “hard wired” to a power generation source through the electric grid. That source may be around the corner, down the block or several hundred miles away.

All the generating sources are interconnected through a power pool and a regional transmission operator (RTO). There are two power pools that operate in North Dakota, one is the Southwest Power Pool (SPP) and the other is Midcontinent Independent System Operator (MISO). These power pools connect generating sources from many utilities, so if one source isn’t able to produce electricity, the other sources can “cover” for the source that isn’t producing. The RTOs also operate the wholesale power

market to purchase power from less expensive sources (when available) in an effort to maintain lowest cost to the utilities. (There’s a more detailed description of power pools on page 18).

The fact of the matter is, electricity must be produced instantly, 24 hours a day, 7 days a week, 365 days a year. It must be produced even when temperatures range from below zero, or above 100 degrees.

GENERATION



+ Shown above is the Legacy dragline at the Center Mine near Center, N.D. It is one of three draglines at the mine and has a capacity of 77 cubic yards. In an open pit mine, such as the Center Mine, draglines are used to remove the overburden that covers a seam of coal after topsoil and subsoil have been removed and stockpiled. Draglines operate 24 hours a day, seven days a week. The mine is owned and operated by BNI Coal. The Milton R. Young Station is shown in the background. Photo courtesy of Lights Out Images.

MINING

North Dakota has the second-largest known reserves of lignite in the world (behind only Australia) with an estimated 26.5 billion tons of recoverable resources. It is estimated that the state's reserves would last more than 800 years at the current rate of consumption.

North Dakota lignite mines produced 23.8 million tons in 2023. Nearly 80% of lignite is used to generate electricity. The other 20% is used to make fertilizers, synthetic natural gas, and other products at the Great Plains Synfuels Plant.

Mine	Annual Production	Location	Facilities Served	Owner/Operator
Freedom Mine	11.3 million tons	8 miles northwest of Beulah	Antelope Valley Station and Great Plains Synfuels Plant, Beulah; Leland Olds Station, Stanton	The Coteau Properties Company*
Beulah Mine**	In final reclamation	5 miles southwest of Beulah	Heskett Station, Mandan (Decommissioned in 2022)	Dakota Westmoreland Corporation
Center Mine	4.1 million tons	4 miles southeast of Center	Milton R. Young Station, Center	BNI Coal Ltd.
Falkirk Mine	6.3 million tons	Underwood	Coal Creek Station, Underwood; Spiritwood Station, Spiritwood	Falkirk Mining Company*
Coyote Creek Mine	2.2 million tons	5 miles south of Beulah	Coyote Station, Beulah	Coyote Creek Mining Company*

*Owned by North American Coal Corporation

**Beulah Mine ceased production in March 2022 when the Heskett Station was retired.

GENERATION



+ *The Falkirk Mining Company was granted a permit to excavate lignite coal in an area that included Coal Lake, southeast of Underwood. After mining, Falkirk Mining Company reclaimed the mined land and returned it to its original use and production. Photo courtesy of North American Coal Corporation.*

There are also two leonardite mines in North Dakota – the American Colloid Mine near Scranton and the Leonardite Products Mine near Williston. Leonardite is a highly oxidized form of lignite that is used as a soil amendment and by the oil industry as a drilling additive. Both mines have a processing plant associated with them.

Lignite coal and commercial leonardite are taxed at a flat rate of 37.5 cents per ton by the state of North Dakota. An additional two cent per ton tax is levied for the Lignite Research Fund.

The lignite industry contributed more than \$104 million in tax revenue to the state and local entities in 2023.

RECLAMATION

North Dakota lignite mines practice contemporaneous reclamation, which means simultaneously mining and reclaiming land.

Mining companies typically have three years to reclaim mined land by grading and resspreading the soil and seeding the land. After that, mines keep reclaimed land under performance bond for at least 10 years to prove reclaimed land produces crops or forages as good as or better than before mining.

Between 1,500 and 2,000 acres of land are disturbed by coal mining and reclaimed each year. Mining companies spend an average of \$30,000 to reclaim one acre of land, but costs can be as high as \$29,000 an acre in some instances.

More than 29,000 acres of permitted land in the state have gone through final bond release - the equivalent of about 45 square miles.

The Falkirk Mine was the nation's first surface coal mine to operate a survey drone for reclamation. Pre-mining surveys are used to plan for water management and to determine elevation and placement of topsoil and subsoil. Drones provide an innovative way to retrieve topographical maps of large areas. Time is saved in the field because the drone surveys around 400 acres per 50 minute flight. The data is downloaded to a computer and can be interpreted in a few hours.

GENERATION



- + The Milton R. Young Station is located near Center, N.D. It has two generating units. Unit 1, with a generating capacity of 250,000 kilowatts (KW), began operating in 1970. It is owned and operated by Minnkota Power Cooperative, Grand Forks, N.D. Unit 2 has a generating capacity of 455,000 KW and began producing electricity in 1977. It is owned by Square Butte Electric Cooperative and operated by Minnkota. Coal for the station is provided from the nearby Center Mine, owned and operated by BNI Coal. Photo courtesy of Levi Nelson.

COAL-BASED

One megawatt-hour (MWh) is enough electricity to serve more than 800 homes with an hour's worth of power.

Up until 2022, all of the coal-based power plants in North Dakota were either owned by a consumer-owned or an investor-owned utility. In May of 2022, Great River Energy, a consumer-owned utility, sold its Coal Creek Station to Rainbow Energy, an independent power producer. Rainbow Energy does not have defined ratepayers or a service territory as the other utilities do. This is

an example of how the power industry has evolved.

North Dakota's power plants have invested around \$2 billion in technology to reduce emissions and increase efficiencies. These investments account for 20% to 30% of a power plant's costs.

North Dakota is currently one of only 17 states that continuously meets all of the U.S. Environmental Protection Agency's federal ambient air quality standards, and has never violated them.

The lignite industry supports more than 12,000 direct and secondary jobs.

The lignite industry annually generates more than \$5.8 billion in gross business volume for the North Dakota economy.

Plant	Operating Company	Capacity by MW
Coal Creek Station	Rainbow Energy Marketing Corp.	1,146
Antelope Valley Station	Basin Electric Power Cooperative	900
Milton R. Young Station	Minnkota Power Cooperative	705
Leland Olds Station	Basin Electric Power Cooperative	660
Coyote Station	Otter Tail Power Company	427
Spiritwood Station *	Great River Energy	99
Total		3,937

* Spiritwood Station is a combined heat and power plant. Its primary product is steam, which is sold to the Dakota Spirit Ethanol biorefinery at Spiritwood Energy Park near Jamestown. The plant also produces some electricity for the regional grid.

GENERATION



- + *The Lonesome Creek Station, a natural gas-based peaking station west of Watford City, N.D., is owned and operated by Basin Electric Power Cooperative, Bismarck, N.D. The station consists of six units, each with a capacity of 45 megawatts (MW). Photo courtesy of Basin Electric Power Cooperative.*

GAS-FIRED GENERATING PLANTS

Peaking plants provide power generation companies with rapid response to regional “peaks” to meet the demand for electricity. The additional generating capacity that these smaller facilities provide can be used in extreme weather conditions when demand for electricity exceeds the capacity of baseload facilities. They are also used to provide power when other resources are not available. They can be powered up from stand-by status to full load very quickly and, in most cases, are operated from a remote site. In North Dakota, the peaking plants are fueled by either natural gas or fuel oil.

Basin Electric Power Cooperative, Bismarck, operates two natural gas-fired peaking stations to help provide electrical stability in western North Dakota.

- Lonesome Creek Station, located west of Watford City, has six, 45-MW units, for a total generating capacity of 270 MW. Lonesome Creek started commercial operation in 2013.
- Pioneer Generation Station is located northwest of Williston and has a total generating capacity of 242 MW.

Basin Electric is pursuing its largest single-site electric generation project since the 1980s. The cooperative is constructing about 580 MW of natural gas generation near the existing Pioneer Generation Station with a total investment of \$805 million. The project includes two 235-MW simple-cycle combustion turbines, six reciprocating engines totaling 110 MW, and 15 miles of 345 KV transmission, all to be in service in 2025.

Montana-Dakota Utilities has an 88-MW natural gas-fired unit, Heskett 3. A new, 88 MW combustion turbine Heskett 4 will be constructed adjacent to Heskett 3. It is expected to be online in 2024. These units are located near Mandan, N.D.

Otter Tail Power Company has two fuel oil combustion turbines in Jamestown that have a total capacity of 41.5 MW.

GENERATION



+ This is the 106 MW Glen Ullin Energy Center wind farm in Morton and Mercer counties. It is operated by ALLETE Clean Energy. The electricity produced is supplied to Xcel Energy under a power purchase agreement. Photo courtesy of ALLETE Clean Energy.

WIND

North Dakota has more than 4,250 MW of wind energy capacity installed throughout the state, consisting of almost 2,200 wind turbines.

While the national wind capacity factor averaged 35.5% in 2021, North Dakota wind projects typically see higher rates between 40% to 50%.

No new wind projects were placed in service in 2023, however construction began on a new project in Oliver County.

North Dakota ranks 10th for installed wind capacity, getting 36% of its net electricity generation from wind resources. This puts North Dakota ahead of most of the countries in the world for percentage of electricity from wind generation.

In January, 2023, Otter Tail Power Company closed on the purchase of the Ashtabula III Wind Energy Center from NextEra Energy. The center is

located in Barnes County, N.D. and began operating in 2010.

Otter Tail Power also received site permits from the North Dakota Public Service Commission to upgrade and refurbish wind turbines at the Ashtabula, Ashtabula III, Langdon, and Laverne Wind Energy Centers. The upgrades are expected to be completed in 2024 and 2025. Once completed, the capacity of the wind projects will be increased by 40 MW.

The economic impact of wind energy development in North Dakota in 2022 included \$20.7 million in state and local taxes; \$22.1 million in extra income to landowners; and provided about 1,700 jobs.

The 2018 federal wind energy Production Tax Credit (PTC) provides wind developers a credit of 2.4 cents/KWh (the PTC has now been adjusted to 2.5 cents/KWh to adjust for inflation) for the production of electricity from utility-scale turbines

during the project's first 10 years of operation, for projects qualified in year 2016.

The PTC was phased down in future years to 80% of its present value for projects qualified in 2017, 60% for those qualified in 2018, and 40% for those qualified in 2019, then it was projected to go to zero. The Tax Extender and Disaster Relief Act of 2019 extended the PTCs at the 2018 level of 60% for one more year. As before, the law allows wind projects to qualify for the PTC in the year that they start construction.

Wind Projects in North Dakota	County	Owner Company	Power Purchaser <i>(if other than project owner)</i>	Capacity <i>(by MW)</i>
Ashtabula Wind Energy Center I (2008)	Barnes	NextEra Energy	Minnkota Power	148.5
Ashtabula Wind Energy Center II (2009)	Griggs, Steele	NextEra Energy	Great River Energy (51 MW), Minnkota Power (69 MW)	120
Ashtabula Wind Energy Center III (2010)	Barnes	Otter Tail Power Company		62.4
Ashtabula Wind Farm (2008)	Barnes	Otter Tail Power Company		48
Aurora Wind Project (2021)	Williams	ENEL Green Energy	Basin Electric Power Cooperative (142 MW), Gap, Inc (90 MW)	299.4
Baldwin Wind Energy Center (2010)	Burleigh	NextEra Energy	Basin Electric Power Cooperative	100
Bison Wind Energy Center 1 (2012, 81.8 MW) Bison 2 and 3 (2013, 210 MW) Bison 4 (2015, 204.8 MW)	Oliver, Morton	Minnesota Power		496.6
Border Winds Project (2016)	Rolette	Xcel Energy		150
Brady Wind I Energy Center (2016, 150 MW) Brady Wind II Energy Center (2016, 150 MW)	Stark, Hettinger	NextEra Energy	Basin Electric Power Cooperative	300
Cedar Hills Wind Farm (2010)	Bowman	Montana-Dakota Utilities Co.		19.5
Courtenay Wind Project (2016)	Stutsman	Xcel Energy		200.5
Emmons/Logan (2019)	Emmons, Logan	NextEra Energy	Great River Energy	216.1
Foxtail Wind Energy Center (2019)	Dickey	Xcel Energy		150
Glen Ullin Energy Center (2019)	Mercer, Morton	Allete Clean Energy	Xcel Energy	106
Langdon Wind Energy Center (2007)	Cavalier	Otter Tail Power Company		40.5
Langdon Wind Energy Center I (2007, 118.5 MW) Langdon II (2009, 40.5 MW)	Cavalier	NextEra Energy	Minnkota Power Cooperative (139.5 MW), Otter Tail Power Company (19.5 MW)	159
Lindhahl Wind Project (2017)	Williams	ENEL Green Energy	Basin Electric Power Cooperative	150
Luverne Wind Farm (2009)	Steele	Otter Tail Power Company		49.5
Merricourt Wind Energy Center (2020)	McIntosh, Dickey	Otter Tail Power Company		150
Minot Wind Project (2009)	Ward	Basin Electric Power Cooperative		4.5
New Frontier Project (2019)	McHenry	Meadowlark Wind I, LLC		100
North Dakota Wind Energy Center – Edgeley (2003)	LaMoure	NextEra Energy	Basin Electric Power Cooperative (40 MW), Otter Tail Power Company (21 MW)	61
Northern Divide Wind Energy (2020)	Burke	NextEra Energy	Basin Electric Power Cooperative	197.9
Oliver Wind Energy Center I (2006, 50.6 MW); Oliver II (2007, 48 MW)	Oliver	NextEra Energy	Minnesota Power	98.6
Oliver Wind III Project (2016-2017)	Oliver, Morton	NextEra Energy	Minnkota Power Cooperative	100
Petersburg Wind Project (Infinity Wind Energy) (2002)	Nelson	Minnkota Power Cooperative		0.9
PrairieWinds 1 (2009)	Ward	Basin Electric Power Cooperative		115.5
Rugby Wind Power Project (2009)	Pierce	Iberdrola Renewables		149.1
Sunflower Wind Project (2016)	Morton, Stark	Novatus Energy	Basin Electric Power Cooperative	104
Tatanka Wind Farm <i>Turbines span across two counties in N.D. (90 MW) and one county in S.D. (180 MW).</i>	Dickey	Acciona Wind Energy	Midwest Independent System Operator (MISO)	90
Thunder Spirit Wind (2015-2018)	Adams	Montana-Dakota Utilities Co.		155.5
Valley City Wind Project (Infinity Wind Energy) (2002)	Barnes	Minnkota Power Cooperative		0.9
Velva Wind Farm (2005)	McHenry	Acciona Wind Energy	Xcel Energy	12
Wilton Wind Energy Center I (2006, 49.5 MW); Wilton II (2009, 49.5 MW)	Burleigh	NextEra Energy	Basin Electric Power Cooperative	99
Statewide demonstration and privately owned projects		N/A		Approx. 3
Total				4,257.9

GENERATION



- + The Garrison Dam, shown above, houses the five generators that produce electricity. The pressure of the water behind the dam drives the generators that have a total capacity of 583,000 KW. The dam is located near Riverdale, N.D., and was constructed by the U.S. Army Corps of Engineers from 1947 to 1953. The reservoir impounded by the dam is Lake Sakakawea. Photo courtesy of Kris Oyen, U.S. Army Corps of Engineers.

HYDROELECTRIC

The only producer of hydroelectric power in North Dakota is Garrison Dam, operated by the U.S. Army Corps of Engineers – Omaha District.

Garrison Dam has five turbines

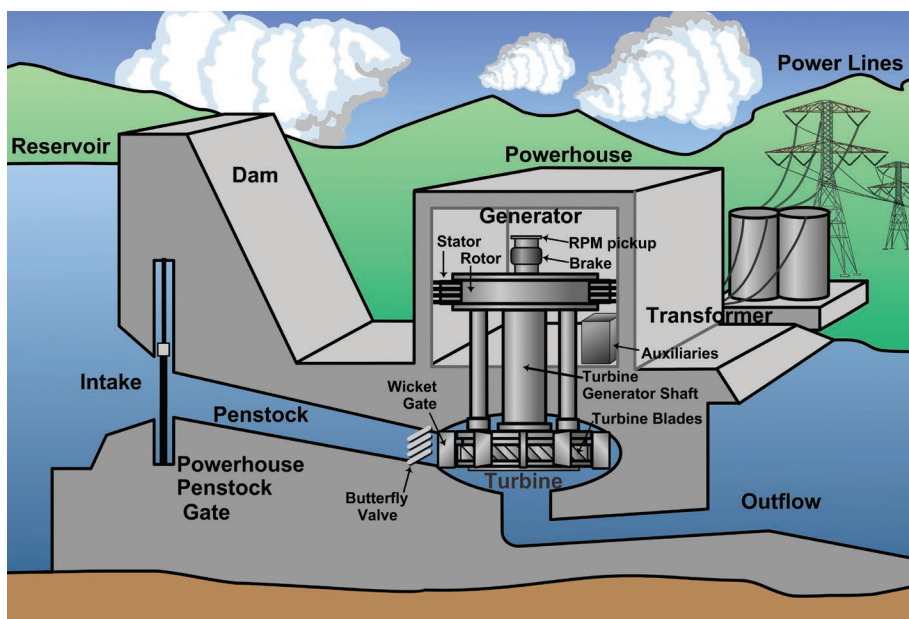
with a total installed capacity of 583 MW. The first unit began operating in January 1956.

In fiscal year 2023, the dam produced 2 million MWh of electricity.

The electricity from Garrison Dam is

marketed by the Western Area Power Administration (WAPA). Customers in North Dakota include municipal utilities, Native American tribes, state agencies, the two Air Force bases, educational institutions, irrigation districts and rural water users, and electric power cooperatives. Much of the electrical power generated at Garrison Dam serves customers in North Dakota and customers in the states of Minnesota, Iowa, Montana, South Dakota and Nebraska. WAPA is one of four power-marketing administrations within the U.S. Department of Energy whose role is to market and transmit electricity from multi-use water projects.

Lake Sakakawea, created by the Garrison Dam, is the third largest reservoir in the United States by volume.



- + This hydropower electric generating plant graphic is courtesy of Bismarck State College National Energy Center of Excellence.

GENERATION

The Project Tundra facility is designed to capture CO₂ at a rate of about 90% from either unit at the Milton R. Young Station located in Center, N.D. The CO₂ would then be stored more than a mile underground. If the project moves forward, North Dakota would be a world leader in the development of next-generation energy technologies. Graphic courtesy of Project Tundra.

CO₂ CAPTURE

One of the most significant projects under consideration is Project Tundra – an initiative led by Minnkota Power Cooperative to build one of the world’s largest carbon capture projects at the coal-based Milton R. Young Station near Center, N.D.

About 4 million metric tons of CO₂ are proposed to be captured annually and stored safely and permanently in deep geologic formations approximately one mile underground near the power plant site. Project Tundra currently has access to the two largest fully permitted CO₂ storage facilities in the United States. In total, the project can store up to 222 million

tons of CO₂ in geologic formations near the Young Station over a 20-year period. Project Tundra is currently in the advanced development states. A final decision on whether to move forward with construction is anticipated in 2024.

Basin Electric is embarking on an innovative project that will benefit the environment by sequestering and permanently storing carbon dioxide (CO₂) from its subsidiary Dakota Gasification Company’s Great Plains Synfuels Plant. The Great Plains CO₂ Sequestration Project is a step toward North Dakota’s goal of being carbon neutral by 2030.

The Synfuels Plant, located near Beulah, N.D., currently captures approximately 2 million metric tons of the plant’s CO₂ emissions, which are piped to Saskatchewan for use in enhanced oil recovery. The proposed project would enable the facility to capture an additional 730,000 to more than 2 million metric tons of CO₂ per year and would serve as part of the largest coal-based carbon capture projects utilizing geologic storage, while also being the first project in the nation to use both enhanced oil recovery and geologic storage. The project will be in operation in early 2024.

GENERATION



- + Verendrye Electric Cooperative, Velva, N.D., has the largest solar program in the state with more than 300 solar-powered water pumps throughout its service territory. The pumps are primarily used in pasture wells in remote areas where building power lines is cost prohibitive. Photo courtesy of Verendrye Electric Cooperative.

SOLAR

Solar energy technology is based on two main types – photovoltaics (PV), which is the most common way of producing solar electricity in North Dakota, and concentrated solar power (CSP). CSP typically uses mirrors to concentrate the sun's rays and create heat that, in turn, drives a heat or steam engine. PV power uses the sun's rays to create direct current electricity.

Blue Jay Solar is a unique partnership between Otter Tail

Power Company and Jamestown High School and is located on the school's property in Jamestown, N.D. At almost 40 KW in size, this small solar project began generating energy in June 2020. It includes 104 solar panels on approximately half an acre. It's expected the project will generate around 50 MWh of electricity annually.

Bismarck State College has an 8 KW PV solar array on campus composed of both crystalline and thin

panel solar systems so students have the opportunity to study both.

Cass County Electric Cooperative, (CCEC) Fargo, N.D., installed a 102 KW solar array in 2016, called Prairie Sun Community Solar. It was the first community solar project in the state and consists of 324 solar panels located on land owned by the City of Fargo. These panels are available to lease by CCEC members.

ELECTRIC VEHICLES IN NORTH DAKOTA

According to the North Dakota Department of Transportation, about 650 electric vehicles are registered in North Dakota. There are 62 charging stations in North Dakota.

North Dakota will receive approximately \$25.9 million from the National Electric Vehicle Infrastructure (NEVI) Formula Program through FY 2026.

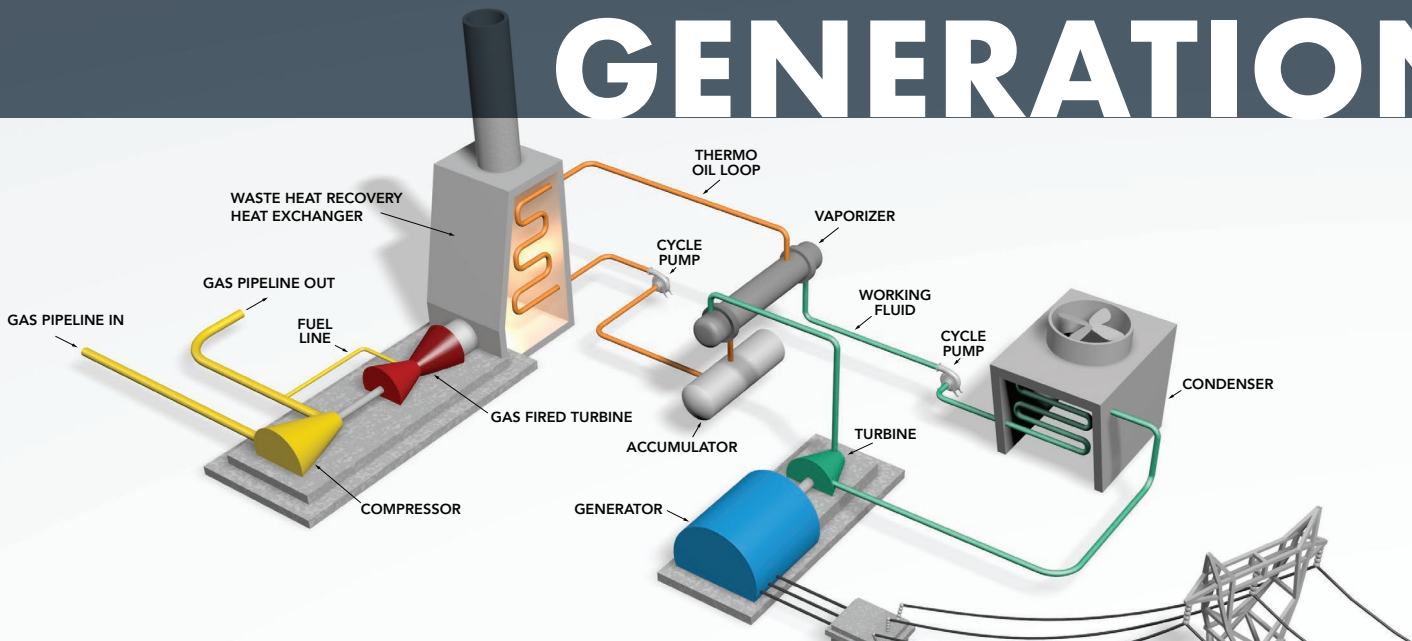
NDDOT has developed a Federally mandated statewide EV Infrastructure

Plan. It was completed in 2023 and provides an analysis of the future of electric vehicles. The Plan is a federal requirement to obtain NEVI Formula Program funding. The Federal NEVI Program is intended to create a network of EV fast chargers across the country to support long distance travel. For North Dakota, the first phase of the program will build chargers along I-94 and I-29, with the later phase of the program focused on building chargers throughout the state.

There are four levels of charging stations commonly used. It is important to note that charging speeds are dependent upon several factors including kilowatts per hour, type of connection and battery being charged.

The majority of chargers (Level 1 and Level 2) throughout North Dakota are designed to recharge an electric vehicle in 12-14 hours. There are also Level 3 chargers that can recharge batteries in about two hours, and Tesla specific chargers.

GENERATION



The heat recovery graphic above is courtesy of Bismarck State College National Energy Center of Excellence.

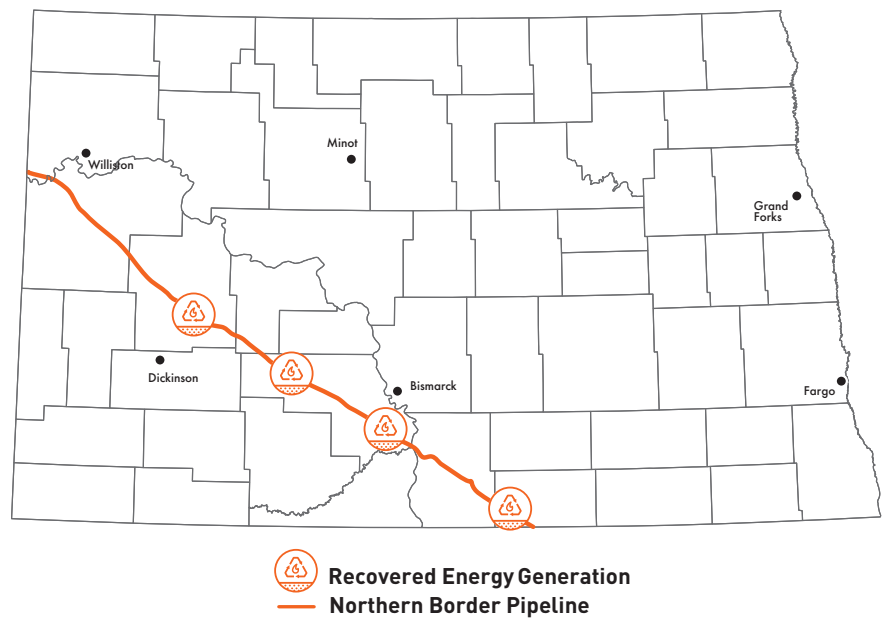
RECOVERED ENERGY

Recovered energy generation (REG), also known as heat-recovery generation or waste heat energy, is a process of capturing the heat from hot exhaust to drive a turbine and create electricity.

There are four REG sites in North Dakota. Basin Electric Power Cooperative purchases the electricity from three sites near Manning, St. Anthony, and Zeeland (5.5 MW each); and Montana-Dakota Utilities owns one site near Glen Ullin (5.3 MW).

The sites produce electricity using exhaust from compressor stations on the Northern Border Pipeline. The Northern Border Pipeline is a natural gas transportation system of 1,398 miles that links the Midwest with reserves in Canada.

A subsidiary of Ormat Technologies developed the recovered energy generation. This is the first use of this technology on a natural gas pipeline in the United States.



+ Map courtesy of Bismarck State College National Energy Center of Excellence.

GENERATION



+ The transmission line shown above is a single circuit alternating current (AC) transmission line. Photo courtesy of EERC.

TRANSMISSION & DISTRIBUTION

North Dakota state legislators and state leadership have long recognized the critical role that the electric transmission network plays in grid reliability, grid resilience and market economics for developing electric generation.

In 2005, the North Dakota Transmission Authority was established by the State Legislature to facilitate, finance, and develop electric transmission infrastructure that enables new energy development.

The electric transmission infrastructure in North Dakota has developed over time. Initial transmission development was made by investor-owned utilities, followed by the federal development of transmission lines from hydroelectric facilities like the Garrison Dam (now operated by Western Area Power Administration-WAPA). In the 1960's, electric cooperative generation & transmission cooperatives began developing both generation and transmission assets.

Combined, these industry players continue to develop, own, and operate more than 65,000 miles of transmission and distribution power lines.

Alternating current (AC) transmission line voltages in North Dakota range from 41.6 KV and 60 KV on the low side to 115 KV, 230 KV and 345 KV on the high side. The majority of the transmission infrastructure is AC. Higher voltages enable transport of electric energy, minimizing losses. Transformers at substations, communities, and even houses, effectively reduce voltages to distribute and utilize electric power efficiently.

Direct current (DC) high voltage transmission lines are becoming more common for long distance point to point delivery. There are two DC transmission lines in North Dakota. A 400 KV DC line carries electricity from the Coal Creek Station owned by Rainbow Energy Center, Underwood, N.D., to a delivery point in Minnesota. The other DC line operates at 250 KV. It originates at the Milton R. Young Station, Center, N.D., and terminates near Duluth, Minn.

A DC line requires a converter station at each end to convert the power from AC current to DC current and back to AC at the termination point. Converter stations are

expensive, but the line construction is less expensive than a comparable AC transmission line. Further, the transmission utilizing DC current is much more efficient (less line loss) than AC transmission. Since the investment in the converter stations is significant, the benefit of DC transmission exists on transmission line distances of 300 miles or longer.

Additional transmission line development is needed in North Dakota to both serve a growing demand for electricity within the state and to provide pathways for energy exports for existing and new electric generation development.

GENERATION



+ The switchyard outside Basin Electric's Antelope Valley Station near Beulah, N.D., connects the electricity produced at the power plant to various transmissions lines for delivery to the electrical grid. There are two generating units at the plant, each with a capacity of 450 MW. Photo Courtesy of Basin Electric.

There are six major transmission projects in North Dakota on the drawing board in 2024.

These transmission projects will strengthen the ability to serve a growing demand for electricity, while also allowing gas/solar/wind generation interconnections and improving export capability.

The Basin Electric/SASK Power projects increase export/import by 650-MW and the total of all projects

increase the import/export capability by about 5,000- MW. These projects are slated to come online over the next 1-7 years.

More transmission will be needed as generation development grows and domestic demand increases.

Transmission capacity requirements have changed, too, because of the change in generation locations – from the mine mouth coal facilities to gas generation in Western North Dakota

and wind generation across the entire state landscape.

Accurate and regular load forecasts are required to provide critical planning for developing long-range transmission line projects.

From need to commissioning, transmission developers suggest a timeline of six years.

Transmission Owner	Voltage	Project Area	Miles of Build	Target Commissioning Date
Basin Electric	345kV.	Roundup to Kummer	35	2025
Basin Electric	345kV.	Lelands Olds – Tioga	175	2026
Basin Electric	230kV.	Wheelock to Sask Power	50	2027
Basin Electric	230kV.	Tande to Saks Power	60	2027
MDU/Ottertail	345kV.	Jamestown – Ellendale	100	2028
MN Allete	DC	HVDC Modernization Project (new converts on the Center and Duluth ends of the existing DC line; increasing capacity from 550MW to 900MW)	–	–
Projects in the Planning Stage	Voltage	Project Area	Miles of Build	Target Commissioning Date
Otter Tail/Xcel	345KV	Bison (Fargo) to Big Stone		
GRID UNITED	525KV DC	St. Anthony, ND – Colstrip, MT	400	(capacity 3,000MW)

United States Power Pools Map



+ There are two power pools in North Dakota: Southwest Power Pool (SPP) and Midcontinent Independent System Operator (MISO). (seen above). Map courtesy of Federal Energy Regulatory Commission.

POWER POOLS

Membership/participation in a regional transmission organization (RTO) – such as MISO and SPP enables generation members to participate in the market to optimize generation operation, with a goal of decreasing energy costs to the consumer and increasing the reliability of the transmission grid. RTOs operate the grid minute-by-minute to ensure that power is reliably delivered to meet the needs of the regional customer base.

Joint planning and operation includes the sharing of reserves and using the lowest-cost energy option within the pool first.

The RTOs ensure that the transportation of traded power is open and fair to all parties. The RTOs are independent and nonprofit entities that lead and manage short and long-range plans to ensure that the grid is reliable and secure.

The engineering models of the power grid reveal potential weaknesses in the grid and shortages of capacity to meet the changing generation resources for which developers are seeking access to the grid. These additions to the grid must be well planned to efficiently meet the needs of the system.

Transmission line costs may easily reach \$1.5 million to \$2.0 million a mile; therefore, careful consideration and planning is necessary as well as cost allocation formulations.

MODES OF HIGH-VOLTAGE ELECTRIC TRANSMISSION



✚ The transmission line above is a 400,000 volt DC transmission line. It carries electricity from the Coal Creek Station owned by Rainbow Energy Center, Underwood, N.D., to a delivery point in Minnesota. Notice there are only two conductors, as opposed to three for an AC line. As with an AC line, this DC line has two overhead ground wires to dissipate energy from a lightning strike. Photo courtesy of Great River Energy.

North Dakota has more than 65,000 miles of transmission and distribution lines. Transmission lines are high-voltage lines that carry large volumes of electricity long distances. Distribution lines carry lower-voltage electricity from a local substation to nearby homes.

The electricity that we use in our homes, offices and factories is alternating current (AC). It is named as such because the voltage goes from positive to negative 60 times per second. Transformers can easily be used to change to high voltage for efficient transmission and then back to lower voltages that are useful for our houses, offices and factories. Transmission of electricity is more efficient at higher voltages. Voltages of 115,000, 230,000, and 345,000, are typical in North Dakota. In other areas, 500,000 and even 750,000 volts are used to meet needs. These lines operate in a three-phase mode so you will see sets of three wires on high-voltage transmission lines. At the home and office, 120 volts and 240 volts are most common.

The other type of high-voltage transmission that is becoming more common in long distance lines is direct current (DC). Those lines operate with one wire at positive voltage and the other wire at negative voltage. Therefore, DC lines are characterized by sets of two wires. There are only two DC transmission lines in North Dakota. Voltages for DC transmission can also vary. One of the DC lines in North Dakota operates at 250,000 volts, while the other operates at 400,000 volts. A DC line requires a converter station at each end to convert the power from AC current to DC current and then back to AC at the other end. It is expensive to build the converter stations, but the line construction is less expensive. The lines are much more efficient than AC transmission of an equivalent amount over an equal distance, meaning there's less line loss. The higher efficiency pays for the expense of building the converters if the distance is over about 300 miles. DC voltage cannot be changed easily without converting back to AC. DC transmission has been demonstrated in uses over 4,000 miles.

PETROLEUM



- + *Marathon Petroleum Company (MPC) has a 13 refinery system with a crude oil refining capacity of approximately 2.9 million barrels per day. MPC plays a significant role providing refined products used every day, such as products produced at the Mandan Refinery, shown above.*

OIL & GAS PRODUCTION

According to the North Dakota Department of Mineral Resources, the price of North Dakota sweet crude oil averaged \$82.18 in November of 2023 compared to \$72.03 in the same month of 2022. The all-time high price per barrel occurred in June 2008 at \$125.62.

The Bakken formation is now considered “mature” by industry – meaning that many of the operators in the state are dedicated to producing their acreage on a consistent and steady pace but that radical growth in production is less likely. Much of the new investments will be in value added industries to capture by-products from the oil and gas production.

- North Dakota continues to be the third-largest oil producer in the nation behind Texas and New Mexico.
- In November 2023, gas production was 90,881,078 million cubic feet (MCF) with an all-time high of 3,175,779 MCF/day in September 2022.

Oil production was 32,951,684 barrels or 1,097,716 barrels per day. Oil production reached an all-time high of 1,519,037 barrels per day in November 2019.

- In November 2023, there were 86 active drilling wells. The all-time high took place in September of 2012, when 370 drilling wells were active. There were 597 wells completed 2023. In 2022, there was an average of 18,636 wells producing, which was a record for the state. North Dakota currently has 19,945 wells capable of producing oil, however, only 17,212 wells are active. This is a record for the state.
- About 87% of producing wells are now unconventional Bakken and Three Fork wells. About 13% are production from Legacy conventional pools.

- The drilling rig count has stalled to the mid-40s. An all-time high of 218 rigs was recorded in May 2012. Newer, more advanced rigs operating today can drill about twice as many wells in a year compared to 2012.

- Leasing activity for new drilling sites is extremely low in North Dakota. Any activity consists of renewals and top leases in the Bakken-Three Forks area. Focus as prices recover will be less about adding new wells and more about completing wells that have been sitting waiting for frac crews. Completing DUC (drilled but uncompleted) wells is more cost efficient for some operators at this time.

A typical North Dakota Bakken well will produce for more than 30 years. However, favorable economic conditions, enhanced oil recovery efforts, and other factors can extend the life of the well.



+ The above map shows the placement of shale plays around the Lower 48 states.
Map courtesy of U.S. Energy Information Administration.

Based on an average oil price of \$50 per barrel, the average Bakken well:

- Produces approximately 1,170,683 barrels of oil.
- Generates about \$31 million net profit.
- Pays approximately \$5,083,579 in taxes.
 - \$2,796,340 gross production taxes
 - \$2,094,794 extraction tax
 - \$192,445 sales tax
- Pays royalties of \$9,487,516 to mineral owners.
- Pays salaries and wages of \$2,128,669.
- Pays operating expenses of \$1,900,977.
- Costs \$7,072,184 to drill and complete.

A well is moved to inactive status after three months of no production. Once the well hasn't produced for 12 consecutive months, it goes into an abandoned status, and the producer

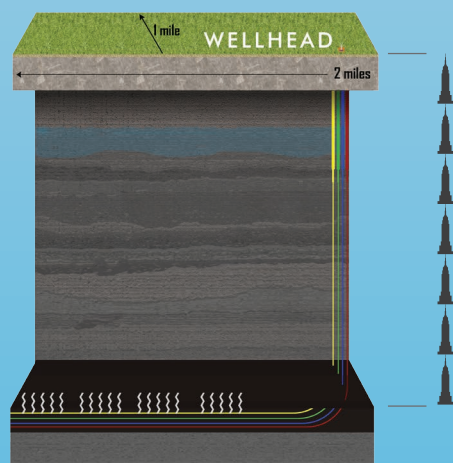
is given six months to return the well to production or plug and reclaim the site. North Dakota requires a plugging and reclamation procedure to be submitted and approved by the North Dakota Industrial Commission for each well site. Once approved, the process involves placing combinations of cement plugs and mechanical plugs at strategic depth in the well. Oil and Gas Division field inspectors witness the placement of plugs and cement in the well. Once

the well has been plugged, the casing is cut off three to four feet below the surface, and a steel plate is welded on top, ending the life of the well.



+ Photo courtesy of EERC.

PETROLEUM



7 Empire State Buildings
800 stories
10,000 feet

EMPIRE STATE BUILDING
Height: 1,454 feet



+ Horizontal drilling in the Bakken allows companies to drill down two miles into the Bakken formation, turn at a 90-degree angle and drill horizontally for as far as four miles. Diagram courtesy of North Dakota Petroleum Council and North Dakota Department of Mineral Resources.

SHALE ENERGY TECHNOLOGY

The Bakken shale play was previously undeveloped because conventional drilling methods were not able to access the trapped oil and gas. Technological advances, including horizontal drilling and the process of hydraulic fracturing, have made it possible for companies to economically drill for oil in the Bakken Formation.

With horizontal drilling, operators are able to drill more wells from a single location, thereby accessing more of the oil and gas resources in the Bakken while using as much as 90% less surface area than with traditional vertical drilling.

Hydraulic fracturing (also called “fracking”) is a process that pumps a specially blended liquid into a

well under high pressure, creating fractures in the underground rock to allow the flow and recovery of oil and natural gas.

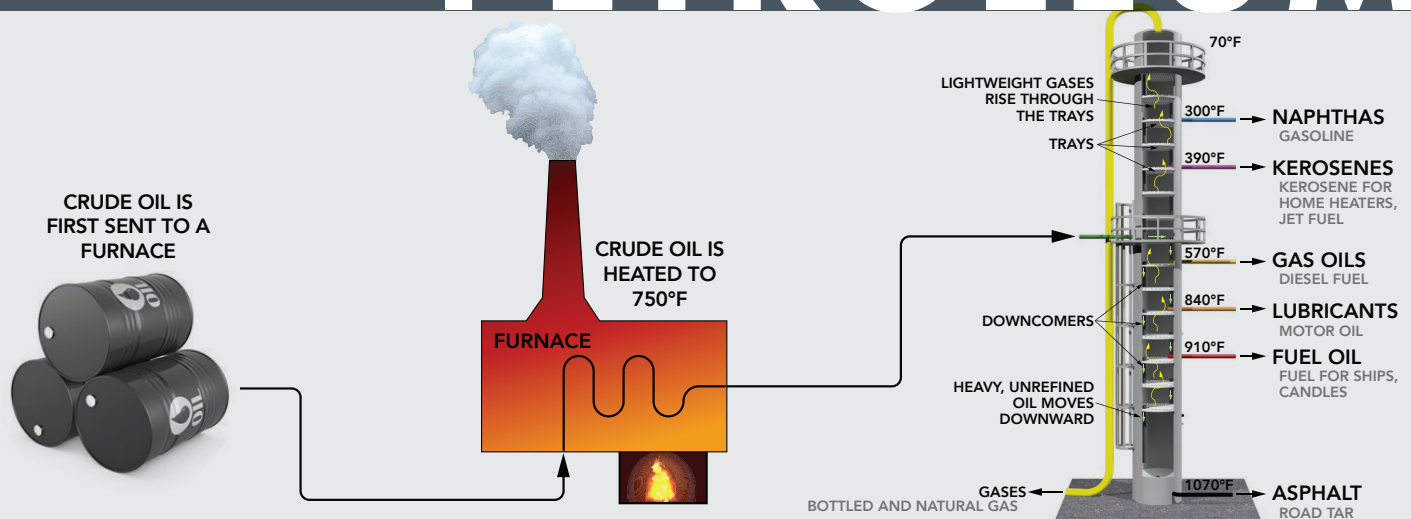
The fluid used in the hydraulic fracturing process is a 98% to 99.5% water and sand mixture. Varieties of chemical additives are used, depending on the well conditions, to limit the growth of bacteria, prevent corrosion of well casing, and increase efficiencies.

The state of North Dakota requires disclosure of the additives that companies use via FracFocus.org, a website that provides public access to

reported chemicals used in fracking and to provide information on the fracking process.

Typically, about 20 million gallons of water are needed to hydraulically fracture the well.

PETROLEUM



- + Oil from the Bakken is a light, "sweet" oil, which means that it is a high-quality oil containing little or no hydrogen sulfide. Refiners prefer sweet crude oil because it yields high-value products such as gasoline, diesel fuel, jet fuel, and heating oil. This diagram of a typical refinery's distillation tower shows how the petroleum is heated and separated into different product streams. Graphic courtesy of Bismarck State College National Energy Center of Excellence.

REFINING

There are two refineries in North Dakota. One processes crude oil and the other processes renewable feedstock (see pg. 29 for more information).

The crude oil refinery located in Mandan is owned by the Marathon Petroleum Corporation (MPC). It began operations in 1954 and is the largest refinery in the state. It was previously owned by Amoco, BP, Tesoro, and Andeavor. In April of 2018, MPC purchased the refinery. MPC employs about 310 people in the Bismarck-Mandan area.

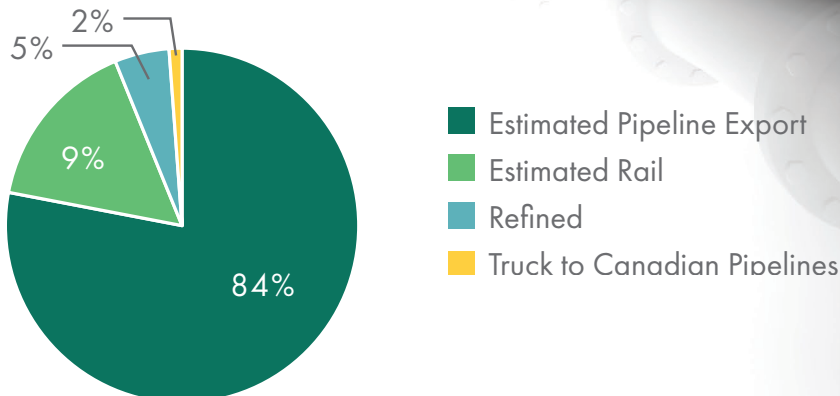
In 2012, to meet the demand for diesel fuel in the region, the Mandan refinery expanded its Distillate Desulfurization Unit capacity to

5,000 barrels per day (BPD). This change expanded the refinery's total hydrotreating capacity to 22,000 BPD. Today, the Mandan refinery has a capacity of 75,000 BPD.

MPC processes Williston Basin crude oil from North Dakota to refine into gasoline, diesel fuel, jet fuel, heavy fuel oils and liquefied petroleum gas. Products are trucked and railed from Mandan and also shipped east via pipeline to eastern North Dakota and Minnesota.

PETROLEUM

Williston Basin Crude Oil Transportation



+ Transportation of Williston Basin crude oil changes depending on the Brent – WTI (West Texas Intermediate) price spread. With additional pipeline capacity and market conditions, the region has seen increased use of pipelines over rail transportation. Data courtesy of the North Dakota Pipeline Authority.

PIPELINES

The North Dakota Pipeline Authority was created by the state legislature in 2007 to assist with development of pipeline facilities to support energy-related commodities.

There are more than 30,000 miles of gathering and transmission pipelines in North Dakota. The United States has the largest network of pipelines in the world.

North Dakota makes use of three product types of pipelines: 18 major crude oil pipelines, nine major natural gas pipelines, and two carbon dioxide pipelines.

A 100,000 barrels-per-day (BPD) pipeline would be equal to 500 truckloads per day or about 140 rail cars.

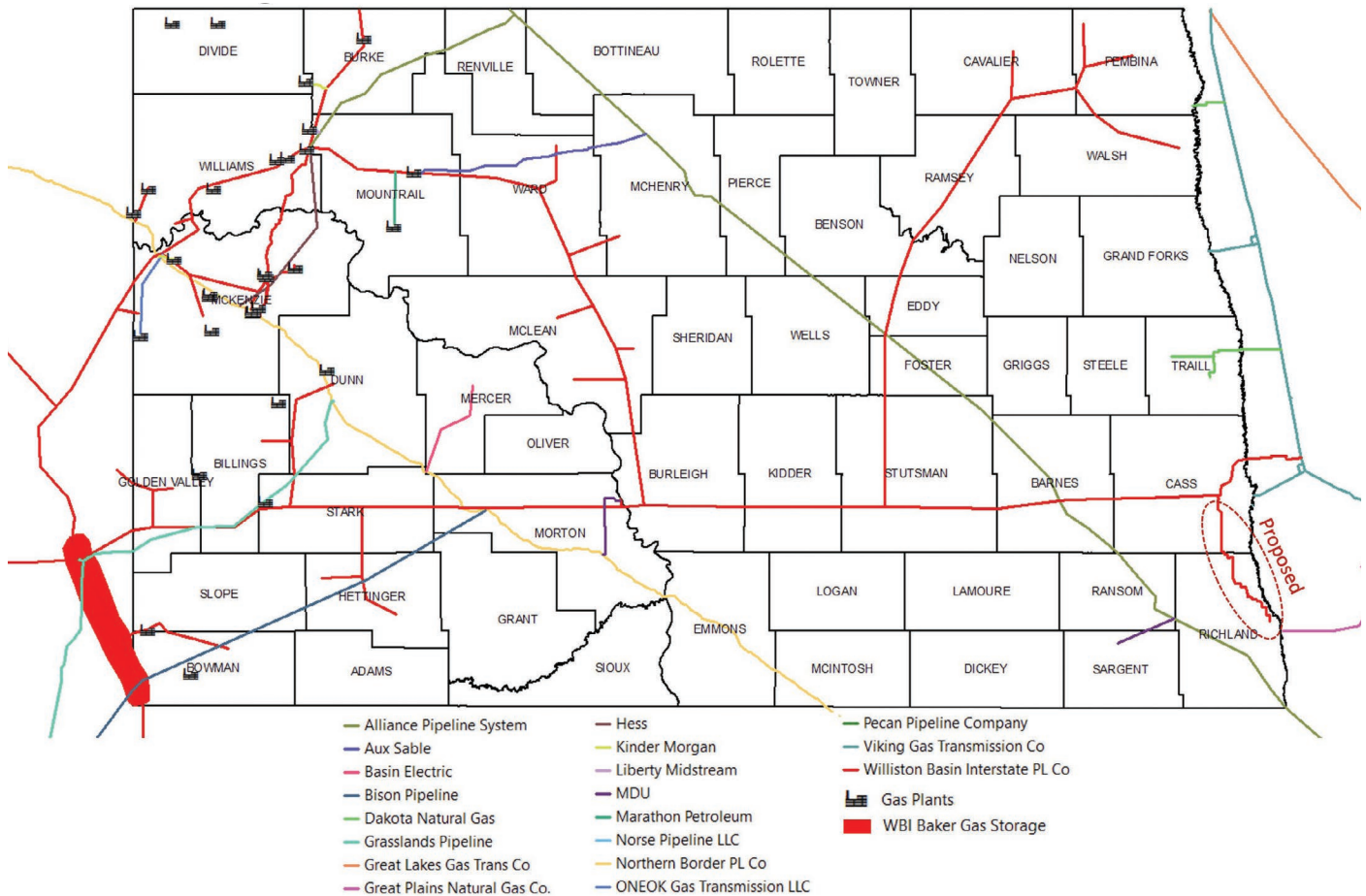
Several additional pipeline expansion projects to transport the increased oil and gas production in the state have been proposed or are in the planning stages.

Bakken natural gas has a high content of natural gas liquids (NGL), such as ethane, propane, butane, and natural gasoline. Updated forecast calculations from the North Dakota Pipeline Authority estimate a potential of 1.2-1.4 million BPD of NGL production from North Dakota in the coming decades.

Pipelines remain the safest mode of energy transportation according to the U.S. Department of Transportation, with more than 99.99% of all petroleum and natural gas products safely reaching their destinations.

During construction of a pipeline, topsoil and subsoil are removed and stockpiled nearby. After pipeline installation, the topsoil and subsoil are returned to the site, and the land is returned to its pre-construction contours and production. This includes getting land into condition for crop production or grazing, or working with wildlife groups to plant native grasses or other vegetation for wildlife forage or habitat.

Major Natural Gas Infrastructure



+ Map courtesy of North Dakota Pipeline Authority.

PETROLEUM MARKETING / PROPANE

According to the North Dakota Petroleum Marketers Association, there are more than 400 petroleum marketers in North Dakota. The list includes service station dealers, convenience stores and truck stops. These operations deal in every aspect of refined petroleum and renewable fuel products, ranging from wholesale and supply to the numerous retail outlets scattered across the state.

In 2023, retail petroleum dealers sold 425,740,477 gallons of taxable gasoline in the state, as well as 672,224,042 gallons of taxable special fuels other than propane (mostly diesel). North Dakota

petroleum marketers continue to support research and development of renewable fuels as viable sources of alternate energy.

North Dakota petroleum marketers also supply another fuel critical to the state – propane. Propane is a domestic fuel, serving to fortify national and energy security. Propane supplies have grown dramatically in recent years because of the numerous oil shale plays in the United States.

Propane serves a variety of residential, commercial and industrial needs. It is used as the prime heating source in 13% of homes in North Dakota. In 2023, the state's propane marketers sold more than 156.2 million gallons of propane.

PETROLEUM



+ The above photo shows the Great Plains Synfuels Plant in the foreground. The plant is owned by Dakota Gasification Company, a subsidiary of Basin Electric Power Cooperative, and is located north of Beulah, N.D. In the background (blue buildings) is the Antelope Valley Station, a 900 MW capacity coal-based electric generating station. The two plants represent a \$4 billion investment in North Dakota's energy development. Photo courtesy of Basin Electric Power Cooperative.

SYNTHETIC NATURAL GAS

The Dakota Gasification Company's Great Plains Synfuels Plant, north of Beulah, N.D., is the only commercial-scale coal gasification plant in the United States that was originally designed to manufacture synthetic natural gas from lignite coal. It has a capacity of 170 million cubic feet of natural gas a day, which is shipped via the Northern Border Pipeline to market.

Since the inception of the plant, there have been great strides to produce commercial products that displace synthetic natural gas and refine co-products that are marketed throughout the United States and worldwide, including fertilizers and petrochemicals.

The plant uses about 18,000 tons of lignite coal each day, supplied via the Freedom Mine. The Synfuels Plant is part of one of the largest carbon dioxide sequestration projects in

the world delivering approximately two million metric tons of carbon dioxide per year that it pipes to the aged Weyburn oil fields in Canada for use in enhanced oil recovery. The Synfuels Plant has captured approximately 44 million metric tons of carbon dioxide since 2000.

In early 2024, the Synfuels Plant will begin capturing additional carbon dioxide for permanent sequestration via the Great Plains Carbon Sequestration Project. The project includes the 6.8-mile Dakota Carbon Pipeline and an injection well which will be located on reclaimed land owned by the Coteau Properties Company. The CO₂ will be injected more than a mile below the surface in the Broom Creek (sandstone)

formation.

The Synfuels plant also has the capability to produce up to 64 million gallons of diesel exhaust fluid a year. Up to 200 tons per day of food-grade liquid carbon dioxide can also be produced.

Besides natural gas, these products include:

- Urea (agricultural fertilizer)
- Cresylic acid
- Phenol
- Tar oil
- Ammonium sulfate (agricultural fertilizer)
- Anhydrous ammonia (agricultural fertilizer)
- Carbon dioxide and liquefied carbon dioxide
- Krypton/xenon gases
- Nitrogen
- Naphtha
- Diesel exhaust fluid

PETROLEUM



+ The Bear Creek Plant, a natural gas and natural gas liquids facility located in Dunn County near Killdeer, N.D., is owned and operated by ONEOK. The facility can process 330 million cubic feet per day. Photo courtesy of N.D. Petroleum Council.

NATURAL GAS PROCESSING

The North Dakota Pipeline Authority recently updated its natural gas forecast which estimates North Dakota could be producing 5.0-6.0 billion cubic feet of natural gas each day in the mid-2030s. This is up from the 2022 natural gas production of roughly 3.5 billion cubic feet per day.

North Dakota currently has 33 natural gas processing plants operating in western North Dakota, with many additional expansion projects being planned or under construction. U.S. natural gas storage is 11% above the five year average.

Both U.S. and world crude oil inventories are approaching normal. The U.S. strategic petroleum reserve is at its lowest level since 1984. The price of natural gas delivered to the Northern Border at Watford City has decreased to \$2.42/MCF. The current oil-to-gas price ratio is 28 to 1. The statewide gas flared volume from October to November decreased by 1.7 MMCFD to 188 MCF per day; the statewide percent flared increased to 5%, while the Bakken gas capture percentage

increased to 95%. The historically high flared percent was 36% in September 2011.

A challenge of the petroleum industry is capturing the natural gas co-produced with oil. As of November 2023, 5% of the natural gas produced in North Dakota was being burned off, or "flared," due to lack of pipelines or challenges on existing infrastructure. In September 2015, the North Dakota Industrial Commission revised the 2014 natural gas targets for Bakken and Three Forks production as follows:

- 74% Capture:
Oct. 1, 2014 – Dec. 31, 2014
- 77% Capture:
Jan. 1, 2015 – Mar. 31, 2016
- 80% Capture:
Apr. 1, 2016 – Oct. 31, 2016
- 85% Capture:
Nov. 1, 2016 – Oct. 31, 2018
- 88% Capture:
Nov. 1, 2018 – Oct. 31, 2020
- 91% Capture:
Nov. 1, 2020 – Present

According to the North Dakota Department of Mineral Resources, private industry has invested more than \$20 billion in additional natural gas gathering and processing infrastructure to reduce flaring, and another \$10-\$15 billion will be needed in the coming years.

Since 2010, natural gas processing capacity in North Dakota has grown nearly 770%, increasing from 491 MMCFD to 4,227 MMCFD in year-end 2023. Additional capacity is being planned to meet growing natural gas production in the near future.

The state's first liquefied natural gas plant is near Tioga. Liquefied natural gas is natural gas that has been converted to a liquid form for easier storage and transportation.

Owner Company	Natural Gas Facility	County	Processing Capacity – Million Cubic Feet Per Day (MMCFD)
1804 Ltd	Spring Brook	Williams	70
Andeavor	Robinson Lake	Mountrail	150
Andeavor	Belfield	Stark	35
Crestwood/ETP	Arrow	McKenzie	150
Aux Sable – Chicago, IL	Prairie Rose	Mountrail	126 *
Caliber Midstream	Hay Butte	McKenzie	10
Hess	Tioga	Williams	415
Kinder Morgan	Norse	Divide	25
Kinder Morgan	Badlands	Bowman	40
Kinder Morgan	Roosevelt	McKenzie	200
Kinder Morgan	Watford City	McKenzie	90
Crestwood/ETP	County Line	Williams	30
Oasis	Wild Basin	McKenzie	320
ONEOK	Lonesome Creek	McKenzie	280
ONEOK	Stateline I	Williams	120
ONEOK	Stateline II	Williams	120
ONEOK	Garden Creek I	McKenzie	120
ONEOK	Garden Creek II	McKenzie	120
ONEOK	Garden Creek III	McKenzie	120
ONEOK	Grasslands	McKenzie	90
ONEOK	Bear Creek	Dunn	130
ONEOK	Bear Creek II	Dunn	200
ONEOK	Demicks Lake	McKenzie	200
ONEOK	Demicks Lake II	McKenzie	200
ONEOK	Demicks Lake III	McKenzie	200
Outrigger Energy II		Williams	250
Petro Hunt	Little Knife	Billings	27
Steel Reef	Lignite	Burke	6
Targa/Hess JV	LM4	McKenzie	200
Targa Resources	Badlands	McKenzie	90
True Oil	Red Wing Creek	McKenzie	15
USG Midstream Bakken	DeWitt	Divide	3
Chord Energy	Ray	Williams	25
XTO – Nesson	Ray	Williams	100
Total			4,227

*Aux Sable facility has the capacity to transport and process up to 110 MMCFD of North Dakota natural gas at its Chicago facility.

PETROLEUM



- + Located near Dickinson, N.D., the refinery shown above is a renewable diesel facility with a capacity of 12,000 barrels per day. It is owned and operated by Marathon Petroleum Corporation (MPC) and processes corn oil and soybean oil to produce renewable diesel and naphtha, primarily for the California market. Photo courtesy of MPC.

RENEWABLE DIESEL

Renewable diesel is a fuel made from fats and oils, such as soybean oil or canola oil, and is processed to be chemically the same as petroleum diesel. It is not refined from crude oil.

It meets specification for petroleum in the United States and Europe. Renewable diesel can be used as a replacement fuel or blended with any amount of petroleum diesel.

Renewable diesel can be blended into petroleum diesel at any level, making it different from biodiesel, which can only be blended at rates between 2% and 20% of diesel fuel by volume.

In January 2023, U.S. production capacity of renewable diesel and other biofuels reached 3 billion gallons per year, surpassing U.S. biodiesel production capacity for the first time.

The Green Bison Soybean Processing plant in Spiritwood, N.D. opened in September 2023. As

a joint venture between ADM (75% owner) and Marathon Petroleum (25% owner), it is North Dakota's first dedicated soybean crushing plant and refinery and will help meet the need for renewable diesel fuel.

The Green Bison Soybean Processing plant provides an important tie between the energy and agriculture industries.

This facility will create 600 million pounds of refined soybean oil per year, fueling the production of renewable diesel. It will also generate 1.28 million tons of soybean meal, supporting animal agriculture production in the region.

As of Jan. 1, 2023, the Energy Information Agency reported 17 domestic plants in 11 states with capacity of 3 billion gallons per year of renewable diesel, biodiesel and ethanol. North Dakota has the only renewable diesel refinery in a three-state region.

Marathon Petroleum Corporation purchased its Dickinson Refinery in 2018 from Andeavor.

Constructed by WBI Energy near Dickinson and originally known as Dakota Prairie Refining, the facility was the first greenfield diesel refinery to be built in the United States since the late 1970s. It came online in May of 2015 and was purchased by Andeavor in 2016.

In 2018, MPC purchased the Dickinson refinery. In late 2020, it was converted to produce renewable diesel fuel from soy oil and other organically derived feedstocks. In the second quarter of 2021, it became a 100 percent renewable facility by reaching its design production capacity of 184 million gallons a year. Approximately 105 employees work at the MPC Dickinson Renewable Diesel facility.

BIOFUELS



- + The Dakota Spirit ethanol plant, owned by Harvestone Low Carbon Partners, is co-located with Great River Energy's Spiritwood Station near Spiritwood, N.D. Steam from the Spiritwood Station is used to power the refining process. Photo courtesy of Harvestone Low Carbon Partners.

ETHANOL

North Dakota's six ethanol plants have an annual production capacity of more than 550 million gallons.

The state's ethanol industry contributes \$1.7 billion in economic activity each year to the state's economy. In addition, state and

local taxes contribute \$8.5 million annually, and employs nearly 1,200 workers directly and indirectly in rural communities across the state.

North Dakota ethanol plants process approximately 50% of the state's annual corn production

(160-180 million bushels) into a high-quality fuel and valuable co-products, including corn oil and distiller's grains.

Plant	Location	Employees	Ethanol Capacity (million gallons)	Corn Used (million bushels)	DDG (tons)	Corn Oil (million gallons)
Harvetone Low Carbon Partners – Blue Flint Ethanol	Underwood	42	73	25	200,000	2.5
Guardian Energy Hankinson	Hankinson	56	155	52	350,000	7.1
Red Trail Energy, LLC	Richardton	48	65	23	180,000	2.8
Tharaldson Ethanol*	Casseltown	64	175	59	305,000	7.5
Harvetone Low Carbon Partners – Dakota Spirit	Spiritwood	40	80	27	210,000	4
Red River Biorefinery**	Grand Forks	*	*	*	*	*
Totals		250	548	186	1,245,000	23.9

* Tharaldson Ethanol also produces 95,000 tons annually of high-protein feed.

** The Red River Biorefinery did not operate in 2023.

One-third of every bushel of grain used for ethanol production returns to the animal feed market in the form of dried distillers grains (DDGs). Nearly 1.4 million tons of DDGs are produced in the state annually.

North Dakota's ethanol industry is a national leader in efforts to decrease its carbon footprint and that of other industries as well. Corn-ethanol's carbon footprint is currently a third less than gasoline and continues to decrease with increased carbon-conscious efforts from corn growers and ethanol plants, such as carbon sequestration and storage projects at two North Dakota ethanol plants. In addition, the corn oil produced is used in the production of renewable diesel to lower the carbon intensity of that product.

Approximately 10% of the ethanol produced annually in North Dakota is blended with gasoline and sold within the state. The remaining 90% is shipped primarily to the east or west coasts.

In a modern ethanol facility, one bushel of corn produces 3 gallons of ethanol, 15 pounds of livestock feed (DDGs), 18 pounds of carbon dioxide, and up to one pound of corn oil.

Unleaded 88 (E15) is approved for use in all 2001 and newer cars and light-duty vehicles, as well as flex-fuel vehicles. These vehicles make up more than 96% of the light duty vehicles on the road today.

North Dakota is a national leader in the installation of flex-fuel blender pumps, which allow most vehicle owners the option of a 15% ethanol blend, and higher percentage ethanol blends for owner/operators of flex-fuel vehicles. State fleet vehicles are authorized to use Unleaded88 (E15) when cost effective and available. There are more than 40 locations statewide that offer E15-E85 fuel blends, with nearly 25 of those locations offering E15 fuel specifically. Nearly all retail gasoline dealers offer E10 fuel.

BIOMASS / BIODIESEL

Biomass includes all plant and animal matter, such as wood waste, energy crops, crop residues, and other forms of organic waste. Harvested biomass can be used to generate various forms of energy, such as heat, electricity and biofuels.

Biodiesel is a domestically produced, renewable fuel that can be manufactured from new and used vegetable oils, animal fats, and recycled restaurant grease. Biodiesel's physical properties are similar to those of petroleum diesel, but with significantly reduced greenhouse gas emissions and toxic air pollutants. Biodiesel can be blended and used in many different concentrations. The most common biodiesel blend is B20 (20% biodiesel, 80% petroleum diesel), which qualifies for fleet compliance under the federal Energy Policy Act of 1992.

North Dakota's only biodiesel production facility is located near Velva. The ADM plant has the potential to produce 85 million gallons of biodiesel per year. The facility is currently producing biodiesel with canola oil provided by an adjacent crushing plant. Because of low in-state usage, most of the produced biodiesel is shipped to other states or to Canada.

Field research is being conducted at the USDA Northern Great Plains Research Laboratory in Mandan, N.D., to explore the potential of using other crop residue to produce jet fuel.

ENERGY RESEARCH

The University of North Dakota's Energy & Environmental Research Center (EERC), Marathon Petroleum Corporation (MPC), TC Energy, and Xcel Energy are leading the development of a Hydrogen Hub. MPC and TC Energy are engaged with the Mandan, Hidatsa, and Arikara Nation and Sumitomo Corporation of Americas to establish their meaningful participation in the initiative. The U.S. Department of Energy has selected the Heartland Hydrogen Hub to advance a regional clean energy project. The funding award is under negotiations for up to \$925 million. HH2H is a collaborative initiative that will produce low-carbon hydrogen, decarbonize regional supply chains, and create clean energy jobs across Minnesota, Montana, North Dakota, South Dakota, and Wisconsin.

North Dakota energy industry partners are working with officials from the state and the U.S. Department of Energy on carbon solutions for the electric generation industry. The Lignite Energy Council, Minnkota Power Cooperative, and the Energy & Environmental Research Center are collaborating to develop these technologies for both electricity generation and carbon dioxide (CO₂) capture.

A carbon capture project that was started at the Coal Creek Station has now been transferred to the EERC. The focus of the work at Coal Creek is to complete a FEED study on the addition of a full-scale postcombustion CO₂ capture system (CCS) that will capture 95% of CO₂ emissions at the 1200-MW Coal Creek Station, located between Washburn and Underwood, N.D. The project officially began on March 2, 2022, and is expected to be completed by August of 2023.

The EERC was designated as the State Energy Research Center (SERC) by the North Dakota legislature in 2019. SERC focuses on emerging topics critical to the state's energy industry and environmental challenges, such as flaring reduction, pipeline safety, efficient lignite use, and increasing oil recovery while decreasing environmental impacts. SERC also focuses on education, hosting an immersive internship program, the Energy Hawks. During this program, students work closely with EERC engineers, research scientists, and project managers while learning about North Dakota's current energy landscape, focusing on future energy challenges, and developing value-added opportunities.

Several other projects underway at EERC include:

- The Intelligent Pipeline Integrity Program (iPIPE) is an industry-led consortium focusing on emerging technologies to prevent and detect and ultimately eliminate leaks from underground pipelines. iPIPE was recognized by the American Petroleum Institute with its Industry Innovation award. iPIPE is managed by the EERC, and its consortium members include Dakota Access Pipeline, DCP Midstream, Enbridge, Hess, MPLx, ONEOK, and TC Energy.
- The Plains CO₂ Reduction Partnership Initiative (established in 2003) addresses regional capture, transport, use, and storage challenges facing commercial carbon capture, utilization, and storage deployment (CCUS). The partnership is led by the EERC, and funded by the U.S. Department of Energy, the North Dakota Industrial Commission (NDIC), and participating member organizations.
- The Bakken Production Optimization Program is to improve Bakken system oil recovery and reduce its environmental footprint. Led by the EERC, the program is funded by its members, the U.S. Department of Energy and the North Dakota Industrial Commission. The results of the program have increased well productivity and the economic output of North Dakota's oil and gas resources, decreased environmental impacts of wellsite operations, and reduced the demand for infrastructure construction and maintenance.

NORTH DAKOTA TAXES

North Dakota is experiencing an upward trend in economic growth, showing the strength of its economy. Oil prices continue to swing from the highs of over \$110 per barrel in the summer months of 2022 to a little over \$70 per barrel in February 2023.

Collections from taxable sales and purchases are steadily increasing. In the third quarter of 2022, taxable sales and purchases increased 27.4%, compared to the same timeframe in 2021.

The unemployment rate in the state is 2.3% as of December 2022, decreasing by more than one percent

from December 2021. Income tax collections for corporate and individual income have also increased in the last year.

The Legacy Fund was established in 2010 as the state's "nest-egg" and is funded by 30% of the state oil and gas taxes. At the end of December 2022, the Legacy Fund's value was \$8.5 billion. Since the fund's inception, there has been a lifetime distribution amount of \$1.3 billion. Legislators can spend the principal of the fund with a two-thirds majority vote in each house. There is an additional limitation restricting any expenditure of Legacy Fund principal to a maximum of 15% in any biennium.

NORTH DAKOTA JOBS

The North Dakota Department of Mineral Resources estimates that, depending on the pace it takes for the price of oil to rebound, an additional 40,000-45,000 wells will be drilled over the next 30 years or so. The state could see a peak of about 87,000 oil related jobs near 2030, with about 70,000 of those jobs being long term.

Job Service North Dakota (JSND) data (Quarterly Census of Employment & Wages 2022) shows that in 2022 an estimated 19,472 workers were in direct or support positions for the industries of oil and gas extraction, coal mining, support activities for mining, utilities and pipeline transportation, with an estimated annual average wage of approximately \$125,158. These statistics do not reflect employment or wages in ancillary businesses or industries working in the energy field, such as trucking, construction, engineering, manufacturing, and repair services.

There continue to be numerous job opportunities in the state. Data from JSND's Online Job Openings Report showed a total of 14,859 openings in January 2024. The two occupational groups most closely associated with opportunities in the oil patch (Construction & Extraction and Transportation & Material Moving) accounted for 513 of those openings statewide. These figures reflect a year-over-year decrease in total openings across the state and a year-over-year decrease in the 17 oil and gas producing counties. The 17 oil and gas producing counties saw a decrease of 19.3% in total job openings over-the-year and a 20.7% decrease over the past five years.





- + *The National Energy Center of Excellence at Bismarck State College challenges students enrolled in energy programs with state of the art learning labs, interactive learning tools and automations.*

EDUCATION / WORKFORCE TRAINING

Energy Hawks is a premier research program for students to better understand North Dakota's current energy landscape and focus on future energy challenges and opportunities. Established in 2018, the University of North Dakota Energy Hawks is a group of graduate and undergraduate students from a wide range of disciplines focused on adding value to North Dakota's energy industry through a broad range of concepts. Through research, interviews, and travel in North Dakota, these students study the opportunities and challenges of the energy industry and develop a series of initiatives for further research and consideration.

Bismarck State College (BSC), North Dakota's Polytechnic Institution, has been training the current and future workforce for the energy industry since 1970. BSC offers certificates, associate and bachelor degree options in 13 disciplines expanding from facility operations and technicians to managers and supervisors. The education and training within the 13 disciplines include industrial operations, mechanical, instrumentation, automation, and energy service technicians to support traditional power stations, wind and solar facilities, electrical transmission, distribution, linework, system operations, petroleum production, oil & gas processing, refining facilities, ethanol, biofuels, and water & wastewater technology. As learners pursue these highly technical skilled programs, they engage in hands-on learning grounded in the principles of STEAM (Science, Technology, Engineering,

Arts and Math) preparing them to solve complex social, economic and community problems and achieve success in the real world.

- Approximately 700 students are enrolled in a BSC energy program either on campus or online every semester, utilizing world-class lab equipment, online simulations and animations, and real-time lab sessions.
- In 2023, 217 students earned a degree or certificate in one of the BSC National Energy Center of Excellence (NECE) programs.
- Of those graduates that replied to a BSC Career Services survey, 100% were continuing their education or were employed (80.9% Employed, 18.5% continuing education and 0.6% armed forces). Recent graduates who were employed reported salaries ranging from \$30 to \$50 or more per hour.
- The NECE also provides customized training for regional, national and international energy companies and training academies to maintain certification/training requirements, educate new hires and to supplement existing training programs.
- In FY 2023, BSC provided non-credit training to 832 individuals representing 53 unique companies and hosted 162 training events.

The North Dakota Association of Rural Electric Cooperatives built a \$5.8 million, state-of-the-art Lineworker Training Center next to its headquarters in Mandan, N.D. It became operational in 2022.

The facility boasts an 18,000 square-foot indoor training arena that provides opportunities for lineworkers and students to practice skills required for the construction and maintenance of overhead and underground electrical infrastructure.

The 26,337 square-foot center provides enhanced, year-round training for students enrolled in BSC's lineworker program and the electric cooperative workforce.

Two classrooms for instruction and a simulator room for Commercial Driver's License training are also included in the facility.

Owned by NDAREC and its members, the training center is leased by BSC to offer the lineworker program. Since 1970, this public-private partnership has trained more than 1,700 skilled apprentice lineworkers.

NDAREC's member-cooperatives provided critical support for the training center, and a \$4 million grant from the Economic Development Administration.

The Harold Hamm School of Geology and Geological Engineering at the University of North Dakota provides education and research in petroleum geology and related fields.

Lake Region State College in Devils Lake offers a wind energy technician program that utilizes a 1.6 MW wind turbine near the campus.

North Dakota State University in Fargo offers a number of programs in engineering, geology, agriculture and other degrees that prepare students for career paths in many fields, including energy. Other state higher education institutions, including Williston State College, Minot State University and the North Dakota State College of Science at Wahpeton, provide a variety of degree programs that prepare graduates for careers in energy fields.

Bismarck State College, Williston State College, Lake Region State College and North Dakota State College of Science are partners in TrainND, which works with businesses to provide tailored training programs in a variety of energy fields, including oil and gas operations, lease operators, well servicing, wind energy, welding, etc.

The Energy & Environmental Research Center (EERC), located at the University of North Dakota in Grand Forks, is a global leader in providing solutions to energy and environmental challenges. The EERC has a multidisciplinary team of 200 highly skilled engineers, scientists and support personnel. The EERC employs and mentors students in many disciplines. Its core research priorities include coal utilization, carbon dioxide management, oil and gas, alternative fuels and renewable energy, and energy–water management.

Via a partnership between the energy industry, the North Dakota Industrial Commission, the State Historical Society of North Dakota, and the Great Plains Energy Corridor at BSC, energy curriculum was added to the 4th and 8th grade North Dakota Studies courses. The two-week curriculum offers photos, videos, maps and animations related to North Dakota's energy resources and is available online at **www.ndstudies.gov**.

Sources: Bismarck State College, University of North Dakota Energy & Environmental Research Center, NDAREC



+ The Lineworker Training Center, a state-of-the-art facility in Mandan, N.D., is leased by BSC and provides training to BSC students enrolled in the lineworker program.



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NORTH DAKOTA'S ENERGY RANKINGS IN THE US

 **Total Energy Production** # 2

 **Crude Oil Production** # 3

 **Coal Production** # 6

 **Wind Production** # 4

 **Ethanol Production Capacity** # 10

 **Natural Gas Production** # 11

 **Total Net Electricity Generation** # 33

Sources: U.S. Energy Information Administration, American Wind Energy Association, Renewable Fuels Association

ABBREVIATIONS:

BTU - British Thermal Unit
KV - Kilovolt
KW - Kilowatt
KWh - Kilowatt-hour
MW - Megawatt
MWh - Megawatt-hour

On the cover: BNI Coal Plant at dusk, 2020. Photo credit: Haylie Flesness