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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](http://www.energyND.com)
Thank you for picking up the 2018 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 2018. 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 2018:

› The development of wind projects in North Dakota continues. The state has some of the best wind resources in the nation. Over the past 15 years, more than 3,000 megawatts of wind generation have been installed. Federal tax credits continue to be an additional factor for wind energy development in North Dakota.

› In February 2018, the U.S. Department of Energy awarded $6 million, and in June 2018, the North Dakota Industrial Commission (through the Lignite Research Program) awarded $15 million to advance Project Tundra. Project Tundra is a research project designed to capture carbon dioxide from an existing North Dakota coal-based power plant. Project Tundra is being developed at Minnkota Power Cooperative’s Milton R Young Station near Center. The goal of Project Tundra is to remove 90 percent of carbon-dioxide emissions from one of the plant’s two units.

› Basin Electric Power Cooperative, a Bismarck, N.D.-based electric utility, has opened an Integrated Test Center at its Dry Fork Station near Gillette, Wyo. Dry Fork is a coal-based power plant with a design capacity of 422 megawatts. The ITC is a research test facility providing space for researchers to test carbon capture, utilization and sequestration technologies using 20 megawatts of flue gas from the plant. Researchers from around the world will be using the facility.

› It’s anticipated that North Dakota’s natural gas production will exceed 4 billion cubic feet per day. The development and expansion of natural gas processing plants will allow North Dakota to catch up on processing capacity through 2021, but additional plants or expansions will be needed in the future.

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!

Retha Mattern, Director
Great Plains Energy Corridor
Bismarck State College

North Dakota is one of the only states with a multi-resource energy policy, guided by the EmPower North Dakota Commission. Through the EmPower North Dakota Commission, leaders from all major energy industries in North Dakota meet with one common goal: to be critical thinkers for the development of the state’s energy resources.

www.EmPowerND.com
According to the U.S. Energy Information Administration, North Dakota ranks sixth in the nation for total energy production—a total of 3,498 trillion BTU. The state ranks fourth in the country for total energy consumption per capita at 776 million BTU.

North Dakota Total Energy Production

- **62%** Crude Oil
- **22%** Natural Gas
- **11%** Coal
- **5%** Renewables

Source: U.S. Energy Information Administration, State Profile and Energy Estimates

Map courtesy of Bismarck State College National Energy Center of Excellence.
North Dakota produces electricity from a wide variety of sources, including coal-fired baseload power plants, the hydroelectric turbines at Garrison Dam, a growing statewide network of wind energy turbines, natural gas and fuel oil peaking plants, heat recovery units that capture waste heat from pipeline compressor stations, 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.

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, during the different seasons, etc. 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 farms
- Natural gas plants
- Solar farms
- Geothermal
- Hydro

Power plants can be classified as baseload, peaking, intermediate, and intermittent. Baseload plants are designed to run all the time. These would be the coal-based and nuclear plants (North Dakota does not have any nuclear power plants). Peaking stations are usually fired with natural gas. These are designed to start operating if the demand for electricity outstrips the capacity of the baseload plants, and can be started on a moment’s notice, while coal based plants require several hours from start to full load. Coal-based and nuclear plants operate most efficiently at full load and are usually the “backbone” of a generating mix. An intermediate plant can be used as a peaking station or baseload. These plants are usually fueled with natural gas. There aren’t any intermediate plants in North Dakota. Intermittent plants are typically comprised of renewable energy sources such as wind or solar, and operate when the resource is available and can supplement the other sources.

The most common sources in North Dakota are coal-based and natural-gas fueled plants and wind farms. 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 – and there are millions of them – is connected or “hard wired” to a power plant somewhere through the electric grid. That plant may be around the corner, down the block or several hundred miles away.

All the plants are interconnected, so if one source isn’t able to produce electricity, the other sources can “cover” for the source that isn’t able to.

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 way below zero to above 100 degrees.

According to the U.S. Energy Information Administration, North Dakota had the fifth lowest-cost electricity for residential use. The average residential electricity price in November 2018 in North Dakota was 9.89 cents/kWh, compared to the national average of 12.95 cents/kWh.

Even though demand for electricity rapidly increased in recent years, primarily driven by the oil and gas production industry in western North Dakota, almost 55 percent of the state’s total electricity supply is provided to the interstate electricity trade.
Great River Energy’s Stanton Station, near Stanton, N.D., was shut down in February 2017. Demolition began that fall and will be complete in the spring of 2019. The restoration (reclamation) phase of the project will begin in the spring of 2019 and should be mostly complete by late 2019.

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

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

North Dakota is currently one of only 15 states that meet all of the U.S. Environmental Protection Agency’s federal ambient air quality standards.

The lignite industry employs 3,800 workers directly and another 10,200 indirect workers.

Lignite industry companies (power plants and coal mines) contribute more than $130 million annually through total annual taxes, including sales, personal, and corporate income taxes.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Operating Company</th>
<th>Capacity by MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal Creek Station</td>
<td>Great River Energy</td>
<td>1,146</td>
</tr>
<tr>
<td>Antelope Valley Station</td>
<td>Basin Electric Power Cooperative</td>
<td>900</td>
</tr>
<tr>
<td>Milton R. Young Station</td>
<td>Minnkota Power Cooperative</td>
<td>705</td>
</tr>
<tr>
<td>Leland Olds Station</td>
<td>Basin Electric Power Cooperative</td>
<td>669</td>
</tr>
<tr>
<td>Coyote Station</td>
<td>Otter Tail Power Company</td>
<td>427</td>
</tr>
<tr>
<td>Heskett Station</td>
<td>Montana-Dakota Utilities Co.</td>
<td>100</td>
</tr>
<tr>
<td>Spiritwood Station*</td>
<td>Great River Energy</td>
<td>99</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>4,046</strong></td>
</tr>
</tbody>
</table>

* 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.
The Falkirk Mining Company was granted a permit to excavate lignite coal in an area that included Coal Lake, southeast of Underwood. The company chose to preserve the woody draws around the lake that provide cover, food, and water for animals, and not mine the coal stored under them. The above picture shows the mining activity around Coal Lake. Photo courtesy of North American Coal.

MINING

North Dakota has the second-largest known reserves of lignite in the world (behind only Australia) with an estimated 25 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 a record 29.1 million tons in 2017, the highest annual tonnage since 2009 and 1.4 million tons more than the 2016 total. Nearly 80 percent of lignite is used to generate electricity, 13 percent is used to make synthetic natural gas, and 7 percent is used to produce fertilizer and other products.

<table>
<thead>
<tr>
<th>Mine</th>
<th>Annual Production</th>
<th>Location</th>
<th>Facilities Served</th>
<th>Owner/Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freedom Mine</td>
<td>14.2 million tons</td>
<td>8 miles northwest of Beulah</td>
<td>Antelope Valley Station and Great Plains Synfuels Plant, Beulah; and Leland Olds Station, Stanton</td>
<td>The Coteau Properties Company*</td>
</tr>
<tr>
<td>Beulah Mine</td>
<td>500,000 tons</td>
<td>5 miles southwest of Beulah</td>
<td>Heskett Station, Mandan</td>
<td>Dakota Westmoreland Corporation</td>
</tr>
<tr>
<td>Center Mine</td>
<td>4.3 million tons</td>
<td>4 miles southeast of Center</td>
<td>Milton R. Young Station, Center</td>
<td>BNI Coal Ltd.</td>
</tr>
<tr>
<td>Falkirk Mine</td>
<td>8.2 million tons</td>
<td>Underwood</td>
<td>Coal Creek Station, Underwood; Spiritwood Station, Spiritwood</td>
<td>Falkirk Mining Company*</td>
</tr>
<tr>
<td>Coyote Creek Mine</td>
<td>2.5 million tons</td>
<td>5 miles south of Beulah</td>
<td>Coyote Station, Beulah</td>
<td>Coyote Creek Mining Company*</td>
</tr>
</tbody>
</table>

*Owned by North American Coal Corporation
Mining companies must reclaim mined land and return it to its original use and production. After mining around Coal Lake (see photo on page 7), Falkirk Mine and its customer Great River Energy donated more than 700 acres to the NDDOT, creating the Coal Lake Wildlife Management Area. Photo courtesy of North American Coal.

MINING

- 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 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 2-cent per ton tax is levied for the Lignite Research Fund.

- More than $1 billion in tax revenue has gone to the state of North Dakota since 1975 from the lignite severance and coal conversion taxes.

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 respraying the soil and seeding the land. After that, mines keep reclaimed land under performance bond for at least ten 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 $60,000 or an acre in some instances.

- More than 28,500 acres of permitted land in the state have gone through final bond release – the equivalent of about 44 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.

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 five, 45-MW units, for a total generating capacity of 225 MW.
  - Pioneer Generation Station is located northwest of Williston, and has a total generating capacity of 247 MW.
  - Both stations employ General Electric LM 6000 combustion turbine generators. Phase III of the Pioneer Generation Station site generates electricity using reciprocating engines.

- Montana-Dakota Utilities has an 88-MW natural gas-fired unit, Heskett 3, located next to its coal-based Heskett Station near Mandan. The unit uses a General Electric 7EA combustion turbine.

- Otter Tail Power Company has two fuel oil combustion turbines in Jamestown that have a total capacity of 42.5 MW.

Sources: Basin Electric Power Cooperative, MDU Resources Group, Inc., Otter Tail Power Company
North Dakota has more than 3,000 MW of wind energy capacity installed throughout the state, consisting of more than 1,500 wind turbines.

In per-capita terms, North Dakota has the highest wind installed electricity capacity, according to the National Renewable Laboratory’s 2016 Renewable Energy Data Book.

Wind developers have expressed an interest in building more than 7,000 MW of additional wind generation in North Dakota in the next several years. While these projects have not been approved or permitted, it is an expression of interest to the transmission system operators of potential projects.

While the national wind capacity factor averaged 37 percent in 2017, North Dakota wind farms typically see higher rates between 40-50 percent.

North Dakota ranks 11th for installed wind capacity, getting 27 percent of its net electricity generation from wind resources.

The economic impact of wind energy development in North Dakota in 2016 was more than $170 million. This includes $60 million in personal income, 500 jobs, and $7.7 million in property taxes.

The 2018 federal wind energy Production Tax Credit (PTC) provides wind developers a credit of 2.4 cents per kWh for the production of electricity from utility-scale turbines during the project’s first ten years of operation, for projects qualified in year 2016. The PTC is phased down in future years to 80 percent of its present value for projects qualified in 2017, 60 percent for those qualified in 2018, and 40 percent for those qualified in 2019, then it goes to zero. As before, the law allows wind projects to qualify for the PTC in the year that they start construction.

The Thunder Spirit Wind project was expanded by 48 MW in 2018. ALLETE Clean Energy was the original developer of the project, but was sold to Montana-Dakota Utilities in October 2018.
ALLETE Clean Energy is constructing the 100-MW Glen Ullin Energy Center wind farm in Morton and Mercer counties that is expected to be completed in 2019. The site will be owned and operated by ALLETE Clean Energy, and electricity produced will be supplied to Xcel Energy under a power purchase agreement.

**CAPACITY FACTOR:**
Capacity factor is the actual electricity output of a power generating facility, divided by the maximum output it could provide if it ran at full output 100 percent of the time for a full year. In other words, if the capacity factor of a wind farm averages 38 percent, that means the total generating capacity of that wind farm is available 38 percent of the time on average.

<table>
<thead>
<tr>
<th>Wind Facility</th>
<th>County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashtabula Wind Energy Center II (2009)</td>
<td>Griggs, Steele</td>
</tr>
<tr>
<td>Ashtabula Wind Farm (2008)</td>
<td>Barnes</td>
</tr>
<tr>
<td>Baldwin Wind Energy Center (2010)</td>
<td>Barnes</td>
</tr>
<tr>
<td>Bison Wind Energy Center 1 (2012, 81.8 MW)</td>
<td>Oliver, Morton</td>
</tr>
<tr>
<td>Bison 2 and 3 (2013, 210 MW)</td>
<td>Oliver, Morton</td>
</tr>
<tr>
<td>Bison 4 (2015, 204.8 MW)</td>
<td>Oliver, Morton</td>
</tr>
<tr>
<td>Border Winds Project (2016)</td>
<td>Rolette</td>
</tr>
<tr>
<td>Brady Wind I Energy Center (2016, 150 MW)</td>
<td>Stark, Hettinger</td>
</tr>
<tr>
<td>Brady Wind II Energy Center (2016, 150 MW)</td>
<td>Stark, Hettinger</td>
</tr>
<tr>
<td>Cedar Hills Wind Farm (2010)</td>
<td>Bowman</td>
</tr>
<tr>
<td>Courtenay Wind Project (2016)</td>
<td>Stutsman</td>
</tr>
<tr>
<td>Langdon Wind Energy Center (2007)</td>
<td>Cavalier</td>
</tr>
<tr>
<td>Langdon Wind Energy Center I (2007, 118.5 MW)</td>
<td>Cavalier</td>
</tr>
<tr>
<td>Langdon II (2009, 40.5 MW)</td>
<td>Cavalier</td>
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<tr>
<td>Lindahl Wind Project (2017)</td>
<td>Williams</td>
</tr>
<tr>
<td>Luverne Wind Farm (2009)</td>
<td>Steele</td>
</tr>
<tr>
<td>Oliver Wind Energy Center I (2006, 50.6 MW);</td>
<td>Oliver</td>
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<tr>
<td>Oliver II (2007, 48 MW)</td>
<td>Oliver</td>
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<tr>
<td>Oliver Wind III Project (2016-2017)</td>
<td>Oliver, Morton</td>
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<tr>
<td>Rugby Wind Power Project (2009)</td>
<td>Pierce</td>
</tr>
<tr>
<td>Sunflower Wind Project (2016)</td>
<td>Morton-Stark</td>
</tr>
<tr>
<td>Tatanka Wind Farm*</td>
<td>Dickey</td>
</tr>
<tr>
<td>Valley City Wind Project (Infinity Wind Energy) (2002)</td>
<td>Barnes</td>
</tr>
<tr>
<td>Velva Wind Farm (2005)</td>
<td>McHenry</td>
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<tr>
<td>Wilton Wind Energy Center I (2006, 49.5 MW);</td>
<td>Burleigh</td>
</tr>
<tr>
<td>Wilton II (2009, 49.5 MW)</td>
<td>Burleigh</td>
</tr>
<tr>
<td>Statewide demonstration and privately owned projects</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
<tr>
<td>Owner Company</td>
<td>Power Purchaser **</td>
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<tr>
<td>-------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>NextEra Energy</td>
<td>Minnkota Power</td>
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<tr>
<td>NextEra Energy</td>
<td>Great River Energy (51 MW), Minnkota Power (69 MW)</td>
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<td>NextEra Energy</td>
<td>Otter Tail Power Company</td>
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<tr>
<td>Otter Tail Power Company</td>
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<tr>
<td>NextEra Energy</td>
<td>Basin Electric Power Cooperative</td>
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<td>Minnesota Power</td>
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<td>Xcel Energy</td>
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<td>NextEra Energy</td>
<td>Basin Electric Power Cooperative</td>
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<td>Otter Tail Power Company</td>
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<td>NextEra Energy</td>
<td>Minnkota Power Cooperative (139.5 MW), Otter Tail Power Company (19.5 MW)</td>
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<td>Tradewind Energy</td>
<td>Basin Electric Power Cooperative</td>
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<td>Otter Tail Power Company</td>
<td>Basin Electric Power Cooperative (40 MW), Otter Tail Power Company (21 MW)</td>
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<tr>
<td>NextEra Energy</td>
<td>Minnesota Power</td>
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<tr>
<td>NextEra Energy</td>
<td>Minnkota Power Cooperative</td>
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<tr>
<td>Minnkota Power Cooperative</td>
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<tr>
<td>Basin Electric Power Cooperative</td>
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<tr>
<td>Iberdrola Renewables</td>
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<td>Novatus Energy</td>
<td>Basin Electric Power Cooperative</td>
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<tr>
<td>Acciona Wind Energy</td>
<td>Midwest Independent System Operator (MISO)</td>
</tr>
<tr>
<td>Montana-Dakota Utilities Co.</td>
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<td>Minnkota Power Cooperative</td>
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<td>Acciona Wind Energy</td>
<td>Xcel Energy</td>
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<td>NextEra Energy</td>
<td>Basin Electric Power Cooperative</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

*Tatanka Wind Farm straddles the North Dakota/South Dakota border with turbines across two counties in N.D. and one county in S.D. The wind farm is 180 MW total with 90 MW in North Dakota.

**If other than project owner.
GEOTHERMAL

- According to the National Renewable Energy Laboratory, western North Dakota has favorable locations for deep enhanced geothermal systems (EGS). EGS is a technology that uses heat from the earth to turn water into steam, which drives a turbine generator to produce electricity.
- The University of North Dakota Petroleum Research Center continues to study the feasibility of using oil well sites in the Bakken to generate up to 300 MW of electricity using geothermal energy.

Sources: National Renewable Energy Laboratory, University of North Dakota Department of Geology and Geological Engineering

HYDROELECTRIC

- The only producer of hydroelectric power in North Dakota is the Garrison Dam, run by the U.S. Army Corps of Engineers, Omaha District. It has been operating since 1955.
- The Garrison Dam has five turbines with maximum combined power output of 583 MW.
- In fiscal year 2017, the dam produced 2.5 million MWh of electricity.
- The electricity from Garrison Dam is marketed by the Western Area Power Administration. Customers in North Dakota include municipal utilities, Native American tribes, state agencies, the two Air Force bases, educational institutions, irrigation districts and rural water entities, and electric power cooperatives. Much of the electrical power generated at Garrison Dam is marketed to customers outside North Dakota, including customers in the states of Minnesota, Iowa, Montana, South Dakota and Nebraska. The Western Area Power Administration 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.

Sources: U.S. Army Corps of Engineers, Western Area Power Administration

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.
- 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.
- Verendrye Electric Cooperative, Velva, N.D., has the largest solar program in the state with more than 290 solar-powered water pumps throughout its service territory, including 19 systems installed in 2018. The pumps are primarily used in pasture wells in remote areas where building power lines is cost prohibitive.
Cass County Electric Cooperative in Fargo installed a 102-kW solar array in 2016, called Prairie Sun Community Solar. It is the first community solar project in the state and consists of 324 solar panels located on land owned by the city of Fargo. The 2018 output was 129,843 kWh, which was about 11.5 percent below the predicted output using modeling tools from the National Renewable Energy Laboratory, due largely to some technical glitches and equipment malfunctions.

Northern Plains and Dakota Valley Electric Cooperatives installed a 16-panel solar system at Northern Plains’ Carrington office in 2015. The total rated output is 6.56 kW, and the cooperatives monitor real-time data from the system as a demonstration of what might be used on a small farm, residence, or business. The solar project operated as expected in 2017, saving 8,675 kWh of energy.

Whiting Petroleum uses PV in North Dakota for some systems in the petroleum extraction process, like automation controls, programmable logic controllers, flare ignitors, and combustor controls. These systems allow an operator to start up, monitor, and shut down operations as needed.

Sources: National Renewable Energy Laboratory, Verendrye Electric Cooperative, Bismarck State College, Cass County Electric Cooperative, Minnkota Power Cooperative, Whiting Petroleum

Photo above shows Northern Plains and Dakota Valley Electric Cooperatives’ demonstration solar array. Total output is rated at 6.56 kW. Photo courtesy of Northern Plains Electric Cooperative.

Prairie Sun Community Solar produced 129,843 kWh in 2018, which would give it a capacity factor of 15 percent. The average member that had one panel would have received a credit of about $37 from the energy produced. The 2018 output represents .01 percent of Cass County’s electric sales. Graph created by Bismarck State College National Energy Center of Excellence using Prairie Sun Community Solar data.
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 owned by Ormat 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.

Sources: Basin Electric Power Cooperative, MDU Resources Group, Inc.

Map courtesy of Bismarck State College National Energy Center of Excellence.
The North Dakota Transmission Authority was established by the state legislature in 2005 to facilitate and develop transmission in North Dakota to accommodate new energy development.

Otter Tail Power Company and Montana-Dakota Utilities Co. constructed the 163-mile Big Stone South to Ellendale Transmission Line. The 345-kV line connects the new Big Stone South Substation near Big Stone City, S.D., to the new Ellendale Substation near Ellendale, N.D. The line was energized in February 2019.

Xcel Energy partnered in early 2017 with the Federal Aviation Administration to further study safe operation of unmanned aircraft system (drone) technology to inspect transmission lines for damage. Xcel Energy has been working the past few years with the University of North Dakota and other partners to conduct test flights in North Dakota using drones. Research will be conducted for 18-24 months and include inspection of more than 20,000 miles of transmission lines in Texas, Minnesota, South Dakota and North Dakota.

A 400-kV direct current transmission line extending from the Coal Creek Station, Underwood, N.D., will be undergoing an upgrade to the inverters at each end of the line. Preparatory work began in 2018, and the majority of the work will be completed in conjunction with a planned outage at Coal Creek in the spring of 2019. The upgrade will result in an increase of line capacity.

Transmission costs vary depending on voltage, terrain type, right-of-way costs, and many other factors. Average transmission costs for a new 345-kV line can be $1.5-$2 million per mile.

Sources: North Dakota Transmission Authority, Otter Tail Power Company, MDU Resources Group, Inc., ALLETE Clean Energy, Minnkota Power Cooperative, Basin Electric Power Cooperative

The transmission line above is a double circuit AC transmission line. It carries 345,000 volts of electricity from the Antelope Valley Station, Beulah, N.D., to its sister station, the Leland Olds Station near Stanton, N.D. Notice there are three wires on each side of the tower. A typical AC transmission line has three conductors. The towers shown here are carrying two AC transmission lines. There are also two wires at the very top of the towers. These two wires are called overhead ground wires. In the event a tower is struck by lightning, the OHGW directs the energy from the strike to ground.
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. Electricity that is generated by rotating generators is generated as AC. 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 using 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 300 miles. DC voltage cannot be changed easily without converting back to AC. DC transmission has been demonstrated in uses over 4,000 miles.
North Dakota’s oil and gas industry has continued steady growth even with sustained lower prices. According to the U.S. Energy Information Administration, the price of sweet crude oil was at $45.75 a barrel in February 2019, as compared to the all-time high price in July 2008 of $136.29 per barrel. Prices in the last half of 2018 have ranged from $42-$76 a barrel. Despite this, increased efficiencies and technology have enabled operators to continue production and remain competitive at lower prices.

In 2012, North Dakota surpassed both California and Alaska to become the second largest oil producer in the nation, behind only Texas. North Dakota is also among the top 20 oil producers in the world.

December 2018 was the all-time high on both oil and gas production. Figures for December 2018 indicated oil production of 43,442,924 barrels or 1,401,385 barrels/day with gas production reaching 82,150,203 thousand cubic feet (MCF), or 2,650,007 MCF/day.

Oil and gas production both rose in 2018. This was due to companies concentrating drilling rigs in the most productive and "gassier" parts of the Bakken Formation.

Average rig count in 2018 was 62 rigs, an increase of 11 from the previous year. The all-time high was 218 rigs in May 2012. Newer, more advanced rigs operating today are able to drill more wells faster. Each rig can drill about twice as many wells in a year compared to 2012. More than 99 percent of drilling takes place in the Bakken and Three Forks formations.

As of December 2018, preliminary figures indicated there were 15,351 producing wells, with 88 percent of those in the Bakken Formation. This is one well shy from the all-time high of 15,352 producing wells in October 2018.

Leasing activity for new drilling sites continues to be very low in North Dakota, consisting mostly of renewals and top leases in the Bakken-Three Forks area. Multiple wells are being added to existing drill pads as the production stays in “harvest” mode. Three or more horizontally drilled wells can be placed on one existing pad and as many as 25 wells on some pads.
A typical North Dakotan Bakken well will produce for 42 years. Economic and enhanced oil recovery efforts can extend the life of the well. Based on an average oil price of $50 per barrel, in those 42 years 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.
- After a well has stopped producing economically, state law requires the operator to plug the well or get it back into production within six months.

Plugging the well involves cementing the production and surface casing at several different depths to ensure no hydrocarbons or saltwater may pass to the surface, in addition to cutting off the surface casing about four feet below the ground. Topsoil and subsoil that were removed during the initial well construction are returned to the site and the land is returned to its pre-drilling contours and reclaimed as close as practicable to the way it was prior to drilling.

The above map shows the placement of shale plays around the Lower 48 states. Map courtesy of U.S. Energy Information Administration.
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 percent 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 98-99.5 percent 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 to 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.

The amount of water needed to hydraulically fracture a well continues to increase. In 2006 the average Bakken well required 2-4 million gallons of water for hydraulic fracturing. In 2018 that average increased to nearly 8-10 million gallons per well, with a small handful of wells using a technique that required 20 million gallons.
Spotlight on North Dakota Energy

There are two oil refineries in North Dakota – one in Mandan, the other is near Dickinson.

The Mandan refinery is now owned by Marathon Petroleum Corp. It was previously owned by Tesoro, and then Andeavor. Marathon purchased the refinery from Andeavor in April 2018. It began operations in 1954 and is the largest refinery in the state. The refinery has a crude oil processing capacity of 71,000 barrels per day (bpd). One barrel is equal to 42 gallons.

Because of high demand for diesel fuel in the region, in 2012 the Mandan refinery expanded its Distillate Desulfurization Unit capacity by 5,000 barrels of diesel per day to bring the plant’s total diesel hydrotreating capacity to 22,000 bpd.

Marathon 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.

Marathon employs more than 275 people in the Bismarck-Mandan area and more than 100 employees in western North Dakota and eastern Montana with the Andeavor Logistics High Plains Crude pipeline system.

Marathon purchased their Dickinson Refinery in 2018 from Andeavor (its original name was Dakota Prairie Refining). That refinery was constructed by WBI Energy, and subsequently purchased by Andeavor in 2016. It was the first greenfield diesel refinery to be built in the U.S. since the late 1970s and came online in May 2015. Located near Dickinson, the refinery can process 19,000 bpd of Bakken crude oil into diesel fuel and other petrochemical components. The diesel fuel is marketed within North Dakota, while the other components are shipped to out-of-state customers or to other refineries for further processing.

Source: Marathon

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.
Sources: North Dakota Pipeline Authority, North Dakota Petroleum Council

The North Dakota Pipeline Authority was created by the state legislature in 2007 to assist 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: 17 major crude oil pipelines, nine major natural gas pipelines, and one carbon dioxide pipeline.

A 100,000-barrel-per-day 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 1.0 million to 1.2 million barrels per day of NGL production from North Dakota during the coming decades.

Pipelines remain the safest mode of energy transportation according to the U.S. Department of Transportation with more than 99.99 percent 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.

Sources: North Dakota Pipeline Authority, North Dakota Petroleum Council

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 as of November 2018.
North Dakota Crude Oil Pipelines

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Updated February 2018

Maps courtesy of North Dakota Pipeline Authority.

North Dakota Natural Gas Pipelines

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Updated February 2018

Maps courtesy of North Dakota Pipeline Authority.
The Dakota Gasification Company’s Great Plains Synfuels Plant, north of Beulah, is the only commercial-scale coal gasification plant in the United States that manufactures synthetic natural gas from lignite coal. It produces up to 175 million cubic feet of natural gas a day, which is shipped via the Northern Border Pipeline to the eastern United States and used for heating homes and industrial feedstock.

The plant uses about 18,000 tons of lignite coal each day, supplied via the Freedom Mine. Besides synthetic natural gas, it produces many additional products that are marketed throughout the United States and worldwide, including fertilizers and petrochemicals.

The Synfuels Plant is the largest carbon dioxide sequestration project in the world, capturing up to 3 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 delivered more than 35 million metric ton of carbon dioxide since October 2000.

Weyburn oil field operators in Saskatchewan, predict that injecting carbon dioxide can extend the life of the Weyburn field by about 30 years.

Contractors broke ground on a urea facility in July 2014 at Dakota Gasification Company’s Great Plains Synfuels Plant. The project was completed in early 2018 and produces about 1,100 tons of urea a day. About 185,000 gallons per day of diesel exhaust fluid are also produced and sold, as well as liquid nitrogen.

The Synfuels Plant recorded its highest ever average capacity factor in 2018 at 94.8 percent. The previous record was set in 1998 at 94.6 percent, and predated current environmental flaring limitations.

Urea is the 11th additional product produced at the gasification plant. Besides natural gas, these products include:

- 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

Sources: Basin Electric Power Cooperative, Dakota Gasification Company
The North Dakota Pipeline Authority recently updated its natural gas forecast which estimates North Dakota could be producing 4.5-5.5 billion cubic feet of natural gas each day in the late 2030s. This is up from the 2018 natural gas production of roughly 2.5 billion cubic feet per day.

North Dakota currently has 30 natural gas processing plants operating in western North Dakota, and six other new facilities are planned or under construction.

A challenge of the petroleum industry is capturing the natural gas co-produced with oil. As of December 2018, 19 percent 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:

- 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 – beginning Nov. 1, 2020

According to the North Dakota Department of Mineral Resources, private industry has invested more than $13 billion in additional natural gas gathering and processing infrastructure to reduce flaring, and another $3.3 billion is planned in the coming years.

Since 2010, natural gas processing capacity in North Dakota has grown nearly 387 percent, increasing from 491 MMCFD to 2,400 MMCFD in year-end 2018. Additional capacity is planned for 2019 and 2020.

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.

Source: North Dakota Pipeline Authority, ONEOK
<table>
<thead>
<tr>
<th>Owner Company</th>
<th>Natural Gas Facility</th>
<th>County</th>
<th>Processing Capacity – Million Cubic Feet Per Day (MMCFD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1804 Ltd</td>
<td>Spring Brook</td>
<td>Williams</td>
<td>45</td>
</tr>
<tr>
<td>Arrow Field Services</td>
<td>Arrow</td>
<td>McKenzie</td>
<td>150</td>
</tr>
<tr>
<td>Aux Sable – Chicago, IL</td>
<td>Prairie Rose</td>
<td>Mountrail</td>
<td>126*</td>
</tr>
<tr>
<td>Caliber Midstream</td>
<td>Hay Butte</td>
<td>McKenzie</td>
<td>10</td>
</tr>
<tr>
<td>Hess</td>
<td>Tioga</td>
<td>Williams</td>
<td>250</td>
</tr>
<tr>
<td>Kinder Morgan</td>
<td>Watford City</td>
<td>McKenzie</td>
<td>90</td>
</tr>
<tr>
<td>Kinder Morgan</td>
<td>Roosevelt</td>
<td>McKenzie</td>
<td>200</td>
</tr>
<tr>
<td>Kinder Morgan</td>
<td>Badlands</td>
<td>Bowman</td>
<td>40</td>
</tr>
<tr>
<td>Kinder Morgan</td>
<td>Norse</td>
<td>Divide</td>
<td>25</td>
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<tr>
<td>Liberty Midstream Solutions</td>
<td>County Line</td>
<td>Williams</td>
<td>30</td>
</tr>
<tr>
<td>Marathon</td>
<td>Robinson Lake</td>
<td>Mountrail</td>
<td>150</td>
</tr>
<tr>
<td>Marathon</td>
<td>Belfield</td>
<td>Stark</td>
<td>35</td>
</tr>
<tr>
<td>Oasis</td>
<td>Wild Basin</td>
<td>McKenzie</td>
<td>320</td>
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<td>ONEOK</td>
<td>Lonesome Creek</td>
<td>McKenzie</td>
<td>240</td>
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<td>ONEOK</td>
<td>Stateline I</td>
<td>Williams</td>
<td>120</td>
</tr>
<tr>
<td>ONEOK</td>
<td>Stateline II</td>
<td>Williams</td>
<td>120</td>
</tr>
<tr>
<td>ONEOK</td>
<td>Garden Creek I</td>
<td>McKenzie</td>
<td>120</td>
</tr>
<tr>
<td>ONEOK</td>
<td>Garden Creek II</td>
<td>McKenzie</td>
<td>120</td>
</tr>
<tr>
<td>ONEOK</td>
<td>Garden Creek III</td>
<td>McKenzie</td>
<td>120</td>
</tr>
<tr>
<td>ONEOK</td>
<td>Grasslands</td>
<td>McKenzie</td>
<td>90</td>
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<tr>
<td>ONEOK</td>
<td>Bear Creek</td>
<td>Dunn</td>
<td>130</td>
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<td>Demicks Lake</td>
<td>McKenzie</td>
<td>200</td>
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<tr>
<td>ONEOK</td>
<td>Demicks Lake II</td>
<td>McKenzie</td>
<td>200</td>
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<tr>
<td>Petro Hunt</td>
<td>Little Knife</td>
<td>Billings</td>
<td>27</td>
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<td>Steel Reef</td>
<td>Lignite</td>
<td>Burke</td>
<td>6</td>
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<tr>
<td>Targa/Hess JV</td>
<td>LM4</td>
<td>McKenzie</td>
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<td>Targa Resources</td>
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<td>True Oil</td>
<td>Red Wing Creek</td>
<td>McKenzie</td>
<td>15</td>
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<td>USG Midstream Bakken</td>
<td>DeWitt</td>
<td>Divide</td>
<td>3</td>
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<tr>
<td>Whiting Oil &amp; Gas</td>
<td>Ray</td>
<td>Williams</td>
<td>25</td>
</tr>
<tr>
<td>XTO – Nesson</td>
<td>Ray</td>
<td>Williams</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>3,322</strong></td>
</tr>
</tbody>
</table>

*Aux Sable facility has capacity to transport and process up to 110 MMCFD of North Dakota natural gas at its Chicago facility.
**ONEOK facilities are under construction with an expected 2019/2020 in service date.
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 2018, retail petroleum dealers sold 445,309,856 gallons of taxable gasoline in the state, as well as 751,611,139 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 100 percent 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 13.4 percent of homes in North Dakota. In 2018, the state’s propane marketers sold roughly 165.4 million gallons of propane.

Source: North Dakota Petroleum Marketers Association

North Dakota’s five ethanol plants have an annual production capacity of nearly 525 million gallons per year, which is more than five times the production a decade ago.

The state’s ethanol industry generates nearly $625 million in economic activity each year and directly employs more than 230 workers in rural communities across the state.

Approximately 160-180 million bushels of corn are used annually, with more than 80 percent of the corn purchased from North Dakota farmers.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Location</th>
<th>Employees</th>
<th>Ethanol Capacity (million gallons)</th>
<th>Corn Used (million bushels)</th>
<th>DDG (tons)</th>
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</thead>
<tbody>
<tr>
<td>Midwest Ag Energy – Blue Flint Ethanol</td>
<td>Underwood</td>
<td>42</td>
<td>70</td>
<td>25</td>
<td>200,000</td>
</tr>
<tr>
<td>Hankinson Renewable Energy, LLC</td>
<td>Hankinson</td>
<td>47</td>
<td>145</td>
<td>51</td>
<td>440,000</td>
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<tr>
<td>Red Trail Energy, LLC</td>
<td>Richardton</td>
<td>48</td>
<td>63</td>
<td>23</td>
<td>180,000</td>
</tr>
<tr>
<td>Tharaldson Ethanol</td>
<td>Casselton</td>
<td>55</td>
<td>175</td>
<td>65</td>
<td>500,000</td>
</tr>
<tr>
<td>Midwest Ag Energy – Dakota Spirit</td>
<td>Spiritwood</td>
<td>40</td>
<td>70</td>
<td>25</td>
<td>200,000</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>232</strong></td>
<td><strong>523</strong></td>
<td><strong>189</strong></td>
<td><strong>1,520,000</strong></td>
<td></td>
</tr>
</tbody>
</table>
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). More than 1.5 million tons of DDGs are produced in the state annually.

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

In a modern ethanol facility, one bushel of corn produces 2.8 gallons of ethanol, 18 pounds of livestock feed, 18 pounds of carbon dioxide, and up to one pound of corn oil.

The five ethanol processing plants in North Dakota also produced 10.33 million gallons of corn oil.

E15 (85 percent gasoline, 15 percent ethanol) is for use in all 2001 and newer cars and light-duty vehicles, as well as flex-fuel vehicles. These vehicles make up nearly 90 percent 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 percent ethanol blend, and higher percentage ethanol blends for owner/operators of flex-fuel vehicles. There are 40 locations statewide that offer E15 – E85 fuel blends, with more than 20 of those locations offering E15 fuel specifically. Nearly all retail gasoline dealers offer E10 fuel.

Source: North Dakota Ethanol Council
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.

At the Marathon oil refinery in Dickinson, production began in June 2018 to co-process renewable feedstock along with Bakken crude oil to produce a five percent renewable diesel blend. A retrofit of the plant allows co-processing of up to 16,800 gallons per day of renewable feedstock using regionally sourced soybean oil and distillers corn oil from ethanol plants.

Research is being done on biomass availability from crop residues, and the potential use of oilseed crops like carinata, canola, and camelina to produce jet fuel for military and commercial aviation uses. The field research is being conducted at the USDA Northern Great Plains Research Laboratory in Mandan.

Sources: Great River Energy, Clean Cities (DOE), City of Bismarck, USDA Northern Great Plains Research Laboratory, Marathon (formerly Andeavor)
Industrial Commission (NDIC) through the North Dakota Renewable Energy Program and with the U.S. Department of Energy (DOE), research has been ongoing since 2016. Preliminary technical and economic feasibility of CCUS technology with ethanol production has been successfully demonstrated for the RTE site in previous phases and current activities are focused on facilities design, geologic characterization, and public outreach.

In other research studies, the University of North Dakota’s Department of Civil Engineering is teaming up with Great River Energy and two regional construction firms to determine whether fly ash from lignite-based power plant can be used as a mineral filler in asphalt pavement.

EERC is also conducting research on extracting rare earth elements from lignite coal. While 90 percent of rare earth elements are produced in China, EERC has received more than $3.5 million in funding to find a way to extract those elements from lignite. Rare earth elements include europium, dysprosium, erbium, terbium, neodymium, holmium, scandium, lutetium, and yttrium, among others. They’re used in everyday items, such as computer memory chips, rechargeable batteries, DVDs, cell phones, catalytic converters, magnets, fluorescent lighting, electronics and more. Critical for defense, they are used by the military in night-vision goggles, precision-guided weapons, GPS, and electronics. They are also essential for green energy applications such as wind turbines and hybrid/electric vehicles. Project sponsors include the DOE, the NDIC Lignite Research Program, Great River Energy, North American Coal, Minnkota Power, and Great Northern Properties.

SkySkopes, Grand Forks, N.D., is developing new technology for the energy industry by using drones, commonly referred to as unmanned aircraft systems (UAS). Sophisticated UAS drones are increasingly being used for power line inspections, optical gas imaging (used for detecting fugitive gas emissions), mapping and imaging, 3-D modeling of terrain and rights-of-way, engineering applications, transportation planning, and pipeline monitoring.

The NDIC, through its Renewable Energy Program, provided funding for the following research projects in 2018:

- Integrated Carbon Capture and Storage for North Dakota Ethanol Production - Phase III ($500,000)
- Preparation of Graphene-Modified LiFePO4 Cathode for Li-Ion Battery ($238,366)
- Low-Pressure Electrolytic Ammonia Production ($437,000)
- Barley Protein Concentrate ($83,810)
- Fargo’s Smart Energy Ramp ($305,000)

Sources: ALLETE, Basin Electric Power Cooperative, Energy & Environmental Research Center
ENERGY EFFICIENCY

- The North Dakota Department of Commerce has an Office of Renewable Energy and Energy Efficiency that promotes efficiency activities within the state in both the public and private sectors.

- According to the North Dakota Department of Commerce, 600 housing units were weatherized in North Dakota in 2017. Homeowners achieve an average of 7-18 percent lower energy costs (about $283/year). Clients can expect savings of over $4,000 during the lifetime of the measures installed. Additional health benefits bring the total savings to over $13,000.

- North Dakota Department of Commerce administers the Energy Conservation Grants, which is funded by one-half of 1 percent of the oil extraction tax deposited in the Resources Trust Fund up to $200,000 for the current biennium. Grants can be used for energy efficiency projects in public buildings. To date, 68 completed projects have received funding, at an average project cost of $33,265.

- According to Auto Alliance, North Dakota’s ranking of electrical vehicle sales for 2016 was 48th in the nation with .04 percent of the market. While electric vehicles are not commonplace in North Dakota, there are 47 public charging stations around the state.

- The North Dakota Industrial Commission awarded a contact in December 2018 to Fargo’s Smart Energy Ramp project. The objective is to demonstrate how a Smart Clean Energy Package that includes renewable energy and artificial intelligence can add value, cost-effectively attract tenants, and enhance economic development while making efficient use of the utility grid in a public-private partnership. A guide will be developed for developers and cities on how to cost-effectively include such a package in the design of future new construction or remodels to further enhance economic development. The project will involve on-site solar, battery storage, electric vehicle charging, and intelligent control at the Roberts Common mixed-use facility (city parking ramp with a private residential and commercial wrap) to optimize the use of renewable energy while minimizing the impact on the utility grid. Meters and sub-meters will be used to consider managing the impact of renewables and EV charging on an efficient and reliable use of the grid.

According to the Office of State Tax Commissioner, North Dakota is again on the path of modest, steady growth. Oil prices have risen to a sustainable, profitable level around $50 per barrel, adequate to support an all-time record production level in the month of December 2018. Unemployment rates throughout the state — especially its metro areas — remain very low with ample available jobs. Taxable sales and purchases for the first three quarters of 2018 were up 13 percent over the same period in 2017. Income tax collections — both individual and corporate — continue to exceed expectations pointing to strong employment and a healthy business climate.

The Legacy Fund was established in 2010 as the state’s “nest-egg” and is funded by 30 percent of the state oil and gas production taxes. At the end of January 2019, the Legacy Fund had received $4.91 billion in deposits. Interest earnings from the Legacy Fund will be transferred to the State General Fund beginning in the 2017-19 biennium, with the first transfer expected June 30, 2019. 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 percent in any biennium.

Sources: North Dakota Tax Department, North Dakota Office of Management and Budget

The North Dakota Department of Mineral Resources estimates that, depending on the price of oil, 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 2017) shows that in 2017 an estimated 22,870 workers were in direct or support positions for the industries of oil and gas extraction, coal mining, utilities, and pipeline transportation, with an estimated annual wage of approximately $101,703. 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 14,001 openings in February 2019. The two occupational groups most closely associated with opportunities in the oil patch (Construction & Extraction and Transportation & Material Moving) accounted for 1,857 of those openings statewide. These figures reflect a year-over-year increase 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 12.3 percent decrease in total job openings over the year and a 28 percent decrease over the past five years.

Sources: Job Service North Dakota, North Dakota Department of Mineral Resources

Clyde Moche, an operator at the Lonesome Creek Station near Watford City, N.D., is shown next to the natural gas fired turbine of one of the plant’s five, 45-megawatt capacity generating units. The plant is owned by Basin Electric Power Cooperative, Bismarck, N.D. Photo courtesy of Basin Electric.
Energy Hawks is a premier research program for students to better understand North Dakota’s current energy landscape and focuses that understanding 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.

The Bismarck State College (BSC) National Energy Center of Excellence (NECE) has been training the current and future workforce for the energy industry since 1970. With twelve program areas offering degree or certificate options, BSC provides expertise in facility operations and technician (instrument, mechanical, energy services) roles across the industry. These include traditional and renewable power generation facilities, electrical transmission, distribution, linework, system operations, petroleum production, oil and gas processing and refining facilities, and water and wastewater technology. In addition, BSC’s Bachelor of Applied Science degree in Energy Management focuses on providing incumbent employees the necessary skill-sets to become the future leaders in supervision and management roles within their organization.

- Approximately 800 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 2018, 326 students earned a degree or certificate in one of the BSC NECE programs.
- Of those graduates that replied to a BSC Career Services survey, 98 percent were continuing their education or were employed. Recent graduates who were employed reported salaries ranging from $20-$40 or more per hour.
- BSC’s NECE also provides customized training for regional and national energy companies to maintain certification/training requirements, educate new hires and to supplement existing training programs.
- In FY 2018, BSC provided non-credit training to 795 individuals representing 99 unique companies and hosted 207 training events.

Dan Brouillette, Deputy Secretary of the U.S. Department of Energy, visits with employees of Great River Energy taking part in control room operation training at Bismarck State College. The BSC National Energy Center of Excellence houses a training simulator for the Coal Creek Station. Photo courtesy of Bismarck State College National Energy Center of Excellence.
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 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, and more.

The Energy & Environmental Research Center (EERC), located at the University of North Dakota in Grand Forks, is a world 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 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

Students in the Bismarck State College Instrumentation & Control program set up and calibrate a valve as part of a lab activity. Photo courtesy of Bismarck State College National Energy Center of Excellence.

ENERGY: Powered by North Dakota provides 4th and 8th grade energy curriculum for North Dakota students.
NORTH DAKOTA’S ENERGY RANKINGS IN THE US

<table>
<thead>
<tr>
<th>Energy Type</th>
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<tbody>
<tr>
<td>Crude Oil Production</td>
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<tr>
<td>Wind Production</td>
<td>#5</td>
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<tr>
<td>Total Energy Production</td>
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<tr>
<td>Coal Production</td>
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<tr>
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<td>Natural Gas Production</td>
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<tr>
<td>Total Net Electricity Generation</td>
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</table>

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

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On the cover: A Marion 8750 dragline – Chief Ironside – used by Falkirk Mine has a bucket with a capacity to hold 125 cubic yards of overburden. The bucket can hold four full-size pickups. Falkirk Mine produces about eight million tons of lignite coal annually and is one of the safest mine operations in the coal industry. The mine employs about 430 people full time. Photo courtesy of North American Coal.