



**BASIN ELECTRIC  
POWER COOPERATIVE**

A Touchstone Energy® Cooperative 

# Great Plains Synfuels Plant



Basin Electric owns and operates the Great Plains Synfuels Plant through its for-profit subsidiary, Dakota Gasification Company.

Located eight miles northwest of Beulah, North Dakota, the Synfuels Plant has been owned and operated by Dakota Gas since 1988. It is the only commercial-scale coal gasification plant in the United States that manufactures natural gas using the Lurgi gasification technology.

The plant began operating in 1984 at an original construction cost of \$2.1 billion. Using Lurgi gasifiers, the Synfuels Plant gasifies lignite coal to produce valuable products. The plant is capable of producing 13 products including up to 170 million cubic feet of natural gas, which is sent through the Northern Border pipeline to market.

Over \$1.3 billion has been invested in the Synfuels Plant since 1988 to achieve environmental compliance, improve efficiency, and diversify the product slate. Most recently, about \$700 million was invested in a major expansion to produce urea, liquid carbon dioxide, and Diesel Exhaust Fluid.

## Commitment Honored

Basin Electric purchased the Synfuels Plant from the U.S. Department of Energy (DOE) in 1988, after the original owners defaulted on a loan guarantee. Basin Electric committed to share revenue with the DOE, as well as to not take advantage of available production tax credits for producing synthetic fuels. Available production tax credits expired in 2002 with a value of about \$754 million.

The 20-year commitment to share revenue with the DOE ended in 2009. Since the agreement started in 1988, Dakota Gas has shared more than \$390 million in revenue with DOE. With this revenue and unused production tax credits, the DOE has recovered more than \$1.3 billion of its initial \$1.5 billion investment.

## Gasification Process

Gasifying coal involves dismantling its molecular structure with heat and pressure, creating a raw gas stream that is purified and synthesized into a variety of products.

The heart of the Synfuels Plant is its 14 Lurgi gasifiers. These gasifiers are cylindrical pressure vessels, 40 feet high with an inside diameter of 13 feet.

Each day, 18,000 tons of lignite coal is fed into the top of the gasifiers. Steam and oxygen are injected into the bottom of the coal beds, causing intense combustion at 2,200 degrees Fahrenheit.

The hot gases break down the molecular bonds of coal and steam, releasing compounds of carbon, hydrogen, sulfur, and nitrogen to form a raw gas that exits the gasifiers.

The raw gas is cooled. Tar oil, phenols, ammonia, and water are condensed from the gas stream, and sent downstream for further purification.

The Rectisol unit washes the gas stream with cold methanol, separating carbon dioxide, naphtha, and synthesis gas. Synthesis gas contains methane, hydrogen, and carbon monoxide which is reacted to form a synthetic natural gas (SNG) or it can be reacted to form anhydrous ammonia.

The SNG is then cooled, dried, and compressed. It enters the interstate pipeline meeting the same parameters as natural gas from conventional sources.

## Carbon Dioxide Capture

Dakota Gas captures carbon dioxide (CO<sub>2</sub>) produced at the plant and sells it to two customers. It is transported through a 205-mile pipeline to Saskatchewan, Canada for use in enhanced oil recovery in the Weyburn and Midale fields.

The first CO<sub>2</sub> was sent to Canada in October 2000. Dakota Gas can export about 8,000 metric tons of CO<sub>2</sub> per day to Canada – about 50 percent of the CO<sub>2</sub> produced when running at full rates.

The plant has delivered approximately 42 million metric tons of CO<sub>2</sub> successfully captured and delivered to customers.

The coal gasification process results in a CO<sub>2</sub> stream that is very dry and about 96 percent pure, so it requires no further processing. This is in contrast to CO<sub>2</sub> from power plant flue gas, which is wet and diluted with nitrogen and oxygen, and requires further processing.

The Synfuels Plant's gasification operation draws worldwide attention. Visitors from Germany, China, Italy, Korea, Great Britain, Japan, the United States, and other nations have toured the facilities. National media from "60 Minutes," The History Channel and Fox News, and television reporters from London, Tokyo, and Montreal have produced reports and special programs about the plant.

The Synfuels Plant is a model for energy security. It demonstrates what is possible and necessary to secure America's energy future. The facility produces energy and chemicals from an affordable resource – coal – that's available abundantly within our own borders. And it captures CO<sub>2</sub>, which boosts oil production closer to home.

## Product Development

In 2014, Dakota Gas began developing a production unit for urea, a granular fertilizer used in the agriculture industry. The main production inputs for urea are ammonia and CO<sub>2</sub>, which are available from the existing ammonia unit. Urea has a high nitrogen content and reduced handling, storage, and transportation costs over other nitrogen fertilizers. Such traits make it a desirable fertilizer for the agricultural industry. Diesel Exhaust Fluid (DEF) is available for sale from the urea facility. DEF is used to reduce NO<sub>x</sub> emissions in diesel engines, as mandated by the federal government on all new diesel engines. The plant also produces liquefied CO<sub>2</sub>. The urea facility was declared commercial on Feb. 1, 2018.

In 2013, a second 30,000-ton anhydrous ammonia tank was constructed to allow Dakota Gas to sell more anhydrous ammonia into the regional agricultural market. This tank doubled the storage from 30,000 tons to 60,000 tons.

Previously, the company did not have enough storage to operate the fertilizer plant year-round to satisfy the agricultural demand in the spring and fall. Dakota Gas can produce up to 1,100 short tons of anhydrous ammonia per day. Product is moved primarily by truck.

In 2012, the Synfuels Plant began producing tar oil for sale as a liquid fuel. Though the plant had produced tar oil since it began operation in 1984, it had been burned as fuel in the boilers. A stripper tower was installed to remove water and light hydrocarbons from the tar oil to produce #6 fuel oil. A rail load-out facility was also constructed.

Produced by the flue gas desulfurization scrubbing system, Dakota Gas also markets ammonium sulfate fertilizer. This nitrogen fertilizer contains sulfur, an essential secondary agricultural nutrient. When it is combined with nitrogen, it helps maximize the nitrogen's availability to enhance plant growth. Dakota Gas can produce up to 400 short tons per day, with 40,000 tons of storage available on-site.

## Product Profiles

**Synthetic natural gas (SNG)** is gaseous fuel manufactured

from coal using the coal gasification process. About 35.8 million dekatherms of SNG are produced annually.

**Ammonium sulfate** is an agricultural fertilizer marketed under the name Dak Sul 45<sup>®</sup>. Approximately 100,000 tons is recovered yearly from a flue gas desulfurization system.

**Anhydrous ammonia** is used as fertilizer for farming and as a feedstock for producing various chemicals. Dakota Gasification Company has the ability to produce about 400,000 tons per year.

**Carbon dioxide** is used for enhanced oil recovery. About 2 million metric tons are shipped to Canada annually.

**Crude cresylic acid** is used in the manufacture of pesticides and products such as wire enamel solvent, phenolic and epoxy resins, and antioxidants. Annually, 26 million pounds are produced.

**Krypton and xenon gases** are used for specialty lighting, such as high-intensity lighting and lasers, and for thermopane window insulation. About 3.5 million liters of krypton-xenon are produced annually.

**Liquid nitrogen** is used for food processing refrigeration, as an oil well additive, and in chemical processes. About 300,000 gallons are produced annually.

**Naphtha** contains products that can be used as a gasoline blend stock, in making solvents, and in benzene production. About 8.4 million gallons are produced annually.

**Phenol** is used for the production of resins in plywood manufacturing and in the casting industry. About 28 million pounds of phenol are produced annually.

**Tar oil** is sold as a fuel and feedstock to the carbon black industry. Up to 40 million gallons can be produced annually.

**Urea** is used as an agricultural fertilizer produced from ammonia and carbon dioxide. The urea facility is able to convert a portion of the anhydrous ammonia product to make 1,100 tons of urea daily.

**Diesel Exhaust Fluid (DEF)** is urea liquor, which is required by law for modern diesel engines for emissions control. It is injected into the exhaust stream to react with harmful greenhouse gases. DEF is a non-hazardous solution comprised of a 32.5% or 50% urea concentration. DEF is used in Selective Catalytic Reduction technology to remove harmful NO<sub>x</sub> emissions from diesel engines. Dakota Gas has the capacity to convert a portion of the urea product to produce 64 million gallons of DEF per year.

**Liquefied carbon dioxide** produced in the urea production facility is sold for fracking and enhanced oil recovery projects, mostly in North Dakota, as well as beverage-grade CO<sub>2</sub>. The plant has the capability to produce about 70,000 tons of liquefied carbon dioxide annually.