MPSC
Michigan Public Service Commission

About Michigan's Natural Gas Industry

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Exploration and Production

Natural Gas is a naturally occurring mixture of hydrocarbons and non-hydrocarbon gases found in porous geological formations beneath the earth's surface. The principal ingredient of natural gas is methane, or CH_4, which is lighter than air and flammable. Its flammability is the major reason why people and businesses buy natural gas.

Natural gas consumed in Michigan comes from gas and oil fields located primarily in Michigan's Lower Peninsula, the Texas-Oklahoma Panhandle, on and off-shore Louisiana, and Alberta, Canada. Gas producers use the knowledge gained in the United States over the past 150 years to explore for natural gas fields. They develop fields by drilling wells into them that are then connected to gathering pipelines that, after processing, connect to large pipelines for delivery to places like Michigan. Most gas fields are in geological formations that developed 150 to 200 million years ago.

All of Michigan's natural gas production is located in the Lower Peninsula. Currently, the Antrim "play" is the most active play in Michigan with about 9,100 wells producing gas from the Antrim formation in 2018. Current average daily gas production rate of the Antrim wells is approximately 25 thousand cubic feet per day (mcfpd) per well. MPSC records show that a handful of Antrim wells were producing in the northern Lower Peninsula of Michigan and in the St. Clair and Jackson County areas as far back as the 1940s. However, Antrim drilling activity greatly increased in the late 1980s, peaked in 1993 with 1210 permits issued, and has significantly declined in recent years with no new well connection permits issued since 2015. At present, Michigan's Antrim production is entirely located in the northern portion of the Lower Peninsula.

In 2018, Michigan produced about 90 billion cubic feet (2.5 billion cubic meters) of natural gas. Most of Michigan's gas production is purchased by Michigan utilities for their customers, but some is also sold to gas marketing companies that sell gas outside of Michigan. Natural gas produced in Michigan represents about 10-15% of the total gas consumed in Michigan.

Michigan's recorded production history began in the 1930s, when the MPSC issued its first Standard Well Connection Permit to a gas well in the Austin Field located in Mecosta County. This Michigan Stray field was discovered in 1933. Throughout the 1930s and 1940s, Michigan Stray was the dominant producing formation with some fields producing from the Detroit River, Berea, Dundee, Traverse, Salina, Sylvania, Antrim, Richfield, and Reed City formations.

In Southeastern Michigan, during the early 1960s several big Niagaran formation discoveries were made such as Belle River Mills and Ray fields (now natural gas storage fields). The proximity of these fields to utilities that serve large population centers was an added benefit. The early 1970s marked the start of northern Michigan's Niagaran Trend which extends across the northern Lower Peninsula from Manistee to Rogers City. The Niagaran Trend continued to be Michigan's hot spot for drilling throughout the 1970s and early 1980s.

Central Michigan became the exploration focal point in the mid-1980s with the first well drilled in the Prairie du Chien (PdC) formation. The number of new PdC wells peaked in 1990, with 38 Standard Well Connection Permits issued for new PdC wells, and is now on the decline. Some PdC wells (also referred to as deep gas wells) are drilled to a depth of more than 10,000 feet (3,050 meters) making this formation an expensive and technically challenging exploratory target.

At the end of their productive lives, fields were abandoned. Some reservoirs (mostly Niagaran and Michigan Stray) were converted to gas storage fields, and play an important part in meeting Michigan's high winter demands for natural gas today (see Storage).

A gas well starts with a drilling permit from the Michigan Department of Environment, Great Lakes, and Energy's (EGLE) Oil, Gas, and Minerals Division (OGMD). EGLE has jurisdiction over spacing, drilling, deepening, plugging, reworking and abandonment of all wells. After the well is drilled and before production begins, EGLE classifies each well as gas or oil. Natural gas well regulation is split between EGLE and the Michigan Public Service Commission (MPSC). Before a gas well begins producing the producer, or operator, must apply to the MPSC for a Standard Wellhead Connection Permit per rules and laws. An Allowable Withdrawal Order is issued with the permit for all non-Antrim gas wells. Gas wells producing from the Antrim formation are treated differently because they are low-producers and generally not individually metered. The Allowable Withdrawal Order contains 12-month, 6-month and 1-month allowable production limits. The allowable production limits are based on 17 1/2% of the calculated absolute open flow (the amount that could flow or vent from an unrestricted well) as determined by a well flow test. The Commission has approved allowable production limits up to 25% of the calculated absolute open flow on a case-by-case basis if it can be shown that the increased allowable will not create waste or damage the well.

The MPSC monitors the production of gas wells under its rules for Production and Transmission of Natural Gas (per Act 9 of 1929 and Act 3 of 1939). Well operators file monthly production reports with the MPSC for each gas well or unitized area. For Antrim gas fields where the production from the wells is commingled through a single meter for the field, the reports also include the number of wells producing, which allows average per well production to be calculated. MPSC production records are available to the public at the MPSC office. Annual and monthly gas production reports are available for viewing and download on the MPSC's Michigan Natural Gas Production Reports page.

Non-Antrim gas fields with more than one well are prorated by the MPSC. The purpose of proration is to protect correlative rights, provide for equitable purchasing and taking of natural gas from a common source of supply, ensure that each producer recovers production in proportion to the recoverable gas under its land and to prevent waste. Proration keeps each gas well in a field from producing more than its fair share of the total field production. MPSC Staff use field index rating percentages to monitor production imbalances for each well producing in a prorated field. Field index rating percentages are determined for each prorated well and are typically based on reserve estimates and well flow tests. If production imbalances for a prorated

well become too large, production from wells within that field are restricted to bring the field back into balance.

Other information about Michigan's natural gas producing industry can be found at EGLE's Oil, Gas, and Mineral Division and the Michigan Oil and Gas Association. Information about geology, well locations and state mineral leases can be found at DNR's Online maps.

More general production data is also available from the Energy Information Administration's EIA Natural Gas Monthly, a federal government report that contains general statistics covering many areas of the U.S. gas industry.

Transmission

The natural gas that is used by customers in Michigan begins its journey far under the ground in gas and oil fields located primarily in Michigan's lower peninsula, the Texas-Oklahoma Panhandle, on and off-shore Louisiana, Ohio, Pennsylvania, and Alberta, Canada,. High-pressure transmission pipelines are used to transport the gas to Michigan natural gas distribution utilities who then deliver the gas to Michigan customers.

Michigan's transmission pipelines are generally large diameter and operate at high pressures, as high as 1,000 pounds per square inch (6,897 kPa). Modern gas pipelines are as large as 42 inches (1.1 meters) in diameter, with up to 5/8 inch (1.6 cm) wall thickness using steel capable of being stressed to 70,000 psi (482,759 kPa). In order to maintain sufficient pressure to move the gas to market, compressor stations are placed along the pipeline. The engines driving the compressors are generally gas burning, using a small percentage of the gas passing through the station to compress gas coming into the station to a higher outlet pressure. Gas moving from Oklahoma or Louisiana to Michigan requires about 4-6%, while gas moving from Alberta, Canada (which is farther away) requires up to 8% for fuel. The pipelines and related facilities are built and maintained in accordance with the Minimum Federal Safety Standards which are promulgated and enforced by the Office of Pipeline Safety within the U.S. Department of Transportation.

High-pressure transmission pipelines also bring Michigan produced gas to market. When the first interstate pipelines were first built to Michigan in the 1940s and 1950s, they did not need to be built to every town. Many Michigan utilities already had transmission lines that extended to gas producing fields or other Michigan towns. By connecting to utility transmission systems, the utilities were later able to take advantage of competition in the interstate gas market by swinging their purchases between competing pipelines.

Natural gas utilities in Michigan currently purchase their gas supplies from various sellers at the source of the interstate pipelines, and pay the pipelines solely to transport their gas (see pipeline Tariff Books). This allows the utilities to enter into shorter contract terms for gas supply, and improves competition.

The first natural gas imported to Michigan was via Northwestern Ohio Gas Company, which brought gas to Detroit from gas fields around Findlay, Ohio in 1889. This lasted until 1893, when the fields were too depleted to maintain pressure to move the gas to Detroit. In 1894, natural gas was imported from Ontario, Canada to Detroit until those fields lost pressure in 1902. The first interstate gas to be imported to Michigan on a sustaining basis was imported by Panhandle Eastern Pipe Line Company in 1936, which delivered gas from Oklahoma and Texas to Detroit. At 1,200 miles (1,931 kilometers) long, it was the longest pipeline in existence. According to Panhandle, when it started building this pipeline in 1930, its order for steel pipe was the largest single steel purchase ever made from the U.S. steel industry. Improvements in technology, such as electric welding which joins high-carbon steel capable of being stressed to 37,000 psig (255,172 kPa) and machines capable of laying heavier and larger diameter pipe, now allowed for economical long distance transmission pipelines. Pipelines built then were up to 20 inches (0.5 meters) in diameter and could operate with natural gas at internal pressures of 500 pounds per square inch (3,448 kPa). Each decade after brought larger, higher pressure pipelines and new interstate gas pipeline companies to Michigan.

The 1950s and 1960s were high growth periods for natural gas consumption in Michigan. Pipelines could not be built fast enough to meet demand. Michigan Wisconsin Pipeline Company began delivering gas to Michigan in 1949 (now ANR Pipeline Company),Trunkline Gas Company in 1960, Northern Natural Gas Company in 1966, Great Lakes Gas Transmission Company in 1967, Vector Pipeline Company in 2000, Rover Pipeline, LLC in 2017, NEXUS Gas Transmission, LLC in 2018. Each new pipeline was a significant project costing hundreds of millions of dollars. Customer utilities entered into long-term (typically 20 years) contracts to purchase gas from interstate pipelines under terms and rates that were decided by the Federal Power Commission, now the Federal Energy Regulatory Commission in Washington, D.C.

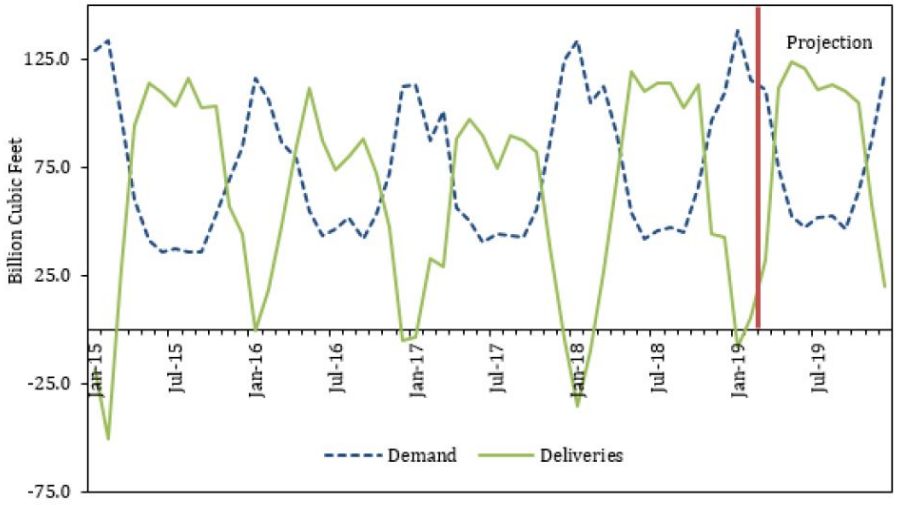
The large diameter pipelines supplied enough gas to completely displace manufactured gas. Many Michigan cities still maintained and used manufactured gas as a supplemental supply because Michigan produced natural gas was not sufficient to meet demand and its productive life was unknown. The last dates that Michigan cities supplied manufactured gas generally coincide with commencement of deliveries of natural gas via these interstate pipeline companies. Today, about 80% of Michigan's annual natural gas requirements are met with gas transported to Michigan by interstate pipeline companies.

Storage

Consumer demand for natural gas in Michigan is seasonal with higher demand during extreme cold periods for home heating purposes and lower demand during the warmer summer months. Natural gas supply, however, is available on a more uniform basis. Because of Michigan's excellent underground geological features, supplies of gas can be delivered on a more uniform

basis. Michigan's underground natural gas storage facilities can balance receipts and deliveries for Michigan as well as provide winter deliveries to neighboring states. As shown in the Michigan Energy Appraisal report for Summer Outlook 2019, withdrawals from Michigan storage are sufficient in mid-winter months to provide gas supply for Michigan and neighboring states.

Michigan Natural Gas Supply and Demand



Michigan's available underground natural gas storage is significant. With about 671 billion cubic feet (19 billion cubic meters) of working gas capacity, EIA statistics show that Michigan has more storage than any other state. This storage provides for more efficient use of transmission pipelines that bring supply to Michigan utilities and helps stabilize prices.

Storage is provided by distribution utilities and gas storage companies under rates and services approved by the MPSC (see Rate Book page). Interstate transmission pipeline and storage companies also provide storage services in Michigan under regulation of the Federal Energy Regulatory Commission (see FERC Tariff Book page).

Michigan's utilities design their winter purchases to reliably meet a peak day requirement occurring in January or later. Over two thirds of the peak day demand is met with gas withdrawn from Michigan's storage fields, and the remainder is obtained from direct pipeline deliveries of gas from within and outside of Michigan.

Michigan's gas storage is also useful as an alternative supply in an emergency. For example, in the spring of 1951, floods washed out a section of Michigan Wisconsin Pipeline Company's (now ANR Pipeline Company) pipeline in Kansas, shutting off its supply to Michigan for about a week. While it was being replaced, storage fields near Austin supplied Michigan's and Wisconsin's gas needs.

Michigan's storage also serves as a way of shifting summer supply to the winter. In the late 1940s demand for natural gas in Michigan grew faster than pipelines could be built to meet it. When a gas shortage occurred in Michigan in 1947, Consumers Energy (then Consumers Power) injected propane from 1,200 railroad tank cars into Michigan Gas Storage Company (then a new

affiliated company) storage fields during the summer to prevent service interruptions the following winter.

All but two of Michigan's 55 storage fields were once producing fields. They are located throughout Michigan's Lower Peninsula. They were converted to storage (the first in 1941) by drilling more wells and building pipeline facilities and compressor stations. Unlike producing fields, gas storage fields are designed such that their entire production can be cycled in and out of the field each year. The geologic structures that make up storage fields in Michigan have a high porosity, which makes them among the best in North America.

According to the MPSC's Natural Gas Storage Field Summary, most of Michigan's storage fields are located in the Niagaran formation. Other formations include Michigan Stray, A-1 Carbonate, and Reed City. Two of the storage fields are salt caverns. Michigan does not have any aquifer or LNG (liquefied natural gas) storage. The MPSC's Energy Operations Division maintains data on each of Michigan's storage fields.

Distribution

The 11 gas utilities that distribute natural gas (and one that distributes propane through a gas pipeline system) in Michigan serve over 98% of Michigan's retail natural gas requirements. Consumers Energy Company and DTE Gas Company provide the majority of gas service to Michigan (see service area map). The MPSC regulates the rates Michigan utilities may charge, except where local government sets rates through their franchise authority. The MPSC also regulates the Michigan service area of two Wisconsin utilities that extend into Michigan's Upper Peninsula. All utilities providing natural gas service in Michigan are privately owned.

The MPSC, via its rules and regulations, requires these utilities to build and maintain their gas facilities to minimum gas safety standards and to accept natural gas within certain quality standards. The Technical Standards for Gas Service and Customer Billing Practices ensure that gas meters are accurate and gas customers are treated and billed fairly. With the advance of technology, new gas facilities are designed and built to last well into the 21st century. Michigan has over 59,000 miles of distribution main and over 3.3 million service lines. These gas facilities are maintained to minimize the potential for leaks. Most new distribution mains are made of polyethylene plastic that range in size from 1.25 inches to 8 inches in diameter. The major cause of shorter life is outside forces by nature and man. The single greatest threat to gas pipeline facilities is damage from digging too close to buried pipelines. Michigan's one-call center, MISS DIG, is designed to prevent this damage by providing a means to locate utility facilities before digging.

All of Michigan's natural gas utilities purchase their gas supply from producers and gas marketers located throughout North America, and have it delivered to their city-gates or service areas by Michigan transmission pipelines and by nine interstate pipelines that serve Michigan. Supply contracts vary in size, and are generally one year or less in length. Some multi-year contracts still exist but are no longer as prevalent as in the past. The utilities also purchase gas on

a daily, weekly, and monthly basis on the "spot market" where prices and terms are negotiated to reflect what the gas market is at that moment. Consumers Energy and DTE Gas Company own extensive underground gas storage, and therefore can contract for their gas supply at a higher load factor (where the pipeline is used more uniformly and results in a lower unit cost) than other Michigan utilities who contract for their storage needs from other companies.

In recent years, the trend for supply contracts is to purchase natural gas under a shorter term contract with pricing mechanisms that follow the market more closely. This captures lower costs when market prices fall and results in higher costs when market prices rise.

The commodity cost is reflected in utility rates through a Gas Cost Recovery (GCR) factor or a Gas Commodity Charge for MPSC-regulated rates, and other recovery mechanisms for locally regulated utilities. The GCR factor is designed to recover exact costs that are reasonably and prudently incurred by the utility, so it increases and decreases as average gas market prices change from season to season.

In addition to selling gas, Michigan's gas utilities also offer transportation only services for gas sold by marketers directly to the customer. Recently, the MPSC has expanded the transportation services into the residential and small commercial classes for several utilities (see Gas Customer Choice).

Natural gas utilities in Michigan began over 100 years ago with the use of manufactured gas in Michigan's cities, and natural gas from gas fields discovered nearby. In those days, gas was used primarily for lighting. For example, the streets of Detroit were dark at night until gas lighting was installed in 1851 where they remained lit by gas until electric lights were installed in 1884. Each day at dusk (unless there was a full moon), lamp lighters would make their rounds to light the lamps.

New utilities that started with manufactured gas were built in Kalamazoo in 1851, Jackson in 1857, Pontiac in 1861, Saginaw and Bay City in 1868, and Flint in 1870.

Back then manufactured gas was generally made from a process that extracted gas from coal (Kalamazoo started with pine resin, then later switched to coal to prevent bankruptcy). The technology generally followed development in states east of Michigan. The process created gas by cooking the coal at high temperatures which yielded gas that had only about half the energy value of natural gas, and contained offensive impurities. Some impurities, such as hydrogen sulfide, were removed. Other impurities, such as carbon monoxide, were not removed. Carbon impurities left in the gas actually helped the gas flame burn brighter for its use as light, thus increasing its "candlepower" quality (the gas mantle would not be invented for several decades). By-products such as coke, ammonia and tar were sold. Later, the process was improved by adding steam, then carbureting with oil to produce gas with a higher heat content. By today's standards, manufactured gas was inferior quality and expensive (although gas burners later developed such that gas lights gave off twice the light of kerosene lanterns). In the 1850's manufactured gas in Detroit sold for $3.50 per thousand cubic feet (Mcf), not much different than recent rates. Only the wealthy could afford the $1.50 per month cost to light a house.

Natural gas production technology also came west to Michigan. Occasionally, a city would also be supplied by natural gas from a nearby field. The higher quality and less expensive natural gas would create utility growth and price competition. This often resulted in two gas companies serving, sometimes with gas mains down opposite sides of the same street. For example, natural gas wells in Port Huron supplied a second utility in 1886. A century ago, geologists knew little of how long newly discovered fields would last, so often a city was piped up for natural gas, only to have the company fold several years later. Its customers would then return to manufactured gas or other fuels. The natural gas utility in Port Huron went bankrupt in 1889.

Until the sustained deliveries of natural gas (see Transmission) phased out manufactured gas in the 1940s, there were many cities in Michigan where more than one gas company served for a short time. In 1874, two manufactured gas companies served Detroit, resulting in competition that led to the companies combining 3 years later. The same thing happened in Port Huron on 1897. In Jackson two utilities competed during the 1880s.

In 1973, manufactured gas made a brief reappearance when Consumers Energy built a synthetic gas plant near Marysville, Michigan. In 1973, the Marysville gas reforming plant could produce up to 100 million cubic feet of gas per day. That doubled in 1974 when a second train was brought on line, providing up to 220 million cubic feet (6.2 million cubic meters) of gas per day from 50,000 barrels/day of liquid hydrocarbon feedstock. The gas was of comparable quality to natural gas. The plant was shut down for economic reasons in 1979.

Market Data

For all but the most sophisticated customers who are trying to determine whether the local utility or some alternative supplier is offering a good deal on supplying natural gas, it is best to compare the offers directly rather than attempt to determine whether the offers are in line with expected gas prices.

Predicting natural gas prices, even for just a few years, has been very difficult for even seasoned professionals. Most experts view the market volatility as an effect of the swings in winter temperatures and increased summer demand for natural gas by gas-fired electric generating plants.

The federal government quit regulating the wellhead price of natural gas in the mid-1980s. Market forces (of supply and demand) now set natural gas prices. Prices can change direction for no apparent reason, often due to weather changes, the economy, hurricanes (which can temporarily affect gas production in the Gulf of Mexico), oil prices, and more recently, expected demand for gas-fired electric generation, which is highly dependent on actual or forecasted summer weather. Past price trends are poor indicators of future prices.

Gas industry professionals rely on industry reports to get a handle on the market (such as Gas Daily, Inside FERC Gas Market Report, and Natural Gas Intelligence), government reports (from the Energy Information Administration of the US Department of Energy), and prices reported for gas futures that are traded on the New York Mercantile Exchange. Today's futures market gives

one an idea of expected gas prices and price trends. The wholesale market is used by industry professionals such as utilities and other gas suppliers to price a portion of their gas, or to hedge current contracts with customers.

The Energy Information Administration's Short Term Energy Outlook is also a good publicly available source for an assessment of national natural gas price, supply, and demand for the short term.

Because gas in underground storage is used to balance differences between supply and demand, the industry monitors available gas in underground storage via weekly surveys (see EIA's weekly natural gas storage report and EIA's natural gas weekly market update).

Gas industry professionals also rely on recent data from other sources to keep up-to-date. The Energy Information Administration reports detailed statistics on the natural gas industry in EIA Natural Gas Monthly, including production, demand, storage, imports, exports, and prices in the United States. Others, such as the American Gas Association, report more general statistics.

Michigan's natural gas rates have historically been below the national average due to Michigan's abundant gas storage. This has allowed utilities and suppliers to buy about 50% of their winter requirements of gas in the summertime, when prices are usually depressed, and store the gas for consumption in the winter months.

Almost 30-50% of residential customer bills are due to the cost of gas supply delivered to Michigan utilities. The remainder of the bills include rates designed to recover distribution and customer related costs. The gas supply costs consist of gas costs at the wellhead plus pipeline transportation (and storage) costs to bring the gas to Michigan utilities. See also current rates, where the gas supply cost is billed as a GCR factor or gas cost (as part of Gas Customer Choice).

Factors Affecting Supply Prices

Demand	Production Supply
• Winter weather (heating) • Summer weather (electric generation) • Economy • Conservation/Demand Response • Other fuel costs, use restrictions	• Production rate • Finding, drilling technology • Producer finances • Pipeline capacity • Land use restrictions • Imports • Infrastructure (pipeline) investment

Because it takes time for supplies to respond to demand changes, prices tend to rise or fall while supply catches up with demand trends. Gas supply prices therefore tend to go in cycles. The changing factors, however make it difficult even for the experts to see any trends within this cycle to predict future prices. Historically, high prices have always led to increased supplies.

Industry organizations and associations also affect prices. The Federal Energy Regulatory Commission in Washington D.C. regulates the rates and services of interstate pipeline companies that bring gas to Michigan. The FERC-approved costs are included in utility gas supply charges.

The North American Energy Standards Board sets standards, and various organizations set policies that affect their member gas companies, and therefore indirectly affect prices and services to Michigan.