

The Facts About

Michigan's Oil and Gas Industry





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Introduction

Michigan is one of the nation's major sources of oil and natural gas. In fact, oil and gas is a \$2 billion a year industry, making Michigan the 17th largest of 33 petroleum-producing states in the country.

From the time the first commercial oil field was discovered in Saginaw during the summer of 1925, Michigan has produced more than a billion barrels of crude oil and more than four trillion cubic feet (TCF) of natural gas.

With its natural gas storage capacity and vast pipeline network, Michigan is an energy storehouse and supply hub for much of the Northeast and the Midwest states. Michigan is also the sixth largest energy-consuming state in the nation, using oil and gas for residential and commercial heating and cooling, manufacturing, transportation fueling, and generating electricity for industry and private use.

The industry has also provided more than \$550 million in revenues to the Michigan Natural Resources Trust Fund since 1976. The Fund, supported by oil and gas revenues from State-owned lands and mineral rights, has helped buy and improve more than 135,000 acres of public park and recreation lands (and/or fund more than 1,000 recreation and tourism projects) for Michigan's residents and visitors.

The 1,000-member plus Michigan Oil And Gas Association, which represents all phases of oil and gas exploration and production in Michigan, is proud to offer this brief look at one of our state's most productive industries. Key sections of our handbook include:

- Impact On the Economy — page 2
- Brief History and Key Production Areas — page 2
- Significant Oil and Gas Formations in Michigan — page 3
- Steps In Drilling and Producing Oil and Gas — page 4
- Environmental Protection — page 7
- Michigan Natural Resources Trust Fund — page 8
- New Technology — page 10
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Michigan's Oil & Gas Industry and the Economy

Michigan's underground industry significantly contributes to the state's economy in a variety of ways:

- Providing more than 10,000 industry-related jobs.
- Paying 14,000 private mineral owners more than \$80 million in royalties annually.
- Contributing nearly \$1 billion in oil and gas income (royalties, rentals, lease bonuses) to the State of Michigan since 1927.
- Paying more than \$40 million in severance taxes and oil and gas fees to the State of Michigan annually.
- Contributing millions of dollars in local property taxes on oil and gas wells, pipelines and surface facilities each year.
- Providing about \$7 million in privilege fees to the state annually. These fees underwrite the activities of the Michigan Department of Environmental Quality's Geological Survey Division, which is responsible for monitoring and enforcing industry compliance with state and federal laws.
- Producing a total value of \$17.6 billion in Michigan crude oil and natural gas since 1925.
- Generating a total value of \$865 million in Michigan crude oil and natural gas production annually in recent years. This, in turn, results in an additional \$1.1 billion in business activity in Michigan, making oil and gas production a \$2 billion industry in Michigan.
- Michigan, with the largest underground working storage capacity of any state, is a natural gas storehouse for the Northeastern United States with 600 billion cubic feet of storage capacity.
- Michigan produces about 25 percent of the natural gas the state uses.

Michigan's Oil & Gas Industry at a Glance

Crude oil and natural gas have been found in 63 counties in Michigan's Lower Peninsula. Here's a quick look at the industry in Michigan.

First Commercial Well Drilled:	Saginaw County, 1925.
Number of Wells:	More than 47,300 wells drilled since 1925. 14,000 active oil and gas producing wells.
Well Depth:	Ranges from a few hundred feet to approximately 12,000 feet.
Biggest Production Year:	Oil production reached 38.5 million barrels in 1979; gas production reached 305 Billion Cubic Feet (BCF) in 1997.
Barrels of Oil Produced:	Currently producing 10 million annually; 1 billion since 1925.
Cubic Feet of Natural Gas Produced:	Currently producing more than 300 billion annually; more than 4 trillion since 1925.
Largest Mineral Rights Owner:	State of Michigan, with 5.9 million mineral acres.

Michigan Geology

Gas and oil — chemical compounds of hydrogen and carbon — were formed deep beneath the ground millions of years ago as part of the earth's evolution. Usually buried thousands of feet deep and locked in sandstone, limestone, or shale, oil and gas migrate up through the earth until they are trapped by non-permeable rock formations. Science and technology are required to identify and locate these rock formations and extract the oil and gas.

Some of the most significant oil and gas formations in Michigan, as shown in the accompanying maps, include:

1 Traverse, Dundee and Richfield Formations

Production from the Traverse, Dundee and Richfield Formations has been found mostly in the central part of Michigan's Lower Peninsula. Exploration and production in these areas dominated the Michigan oil and gas industry in the 1930s and '40s.

2 Trenton/Black River Formation

The Albion-Scipio Field of the Trenton/Black River Formation produces oil from a common source along a one-mile wide path in Calhoun, Jackson and Hillsdale Counties. The single largest field in the state, Albion-Scipio has produced 125 million barrels of oil since its discovery in 1957.

3 Niagaran Reef Trend

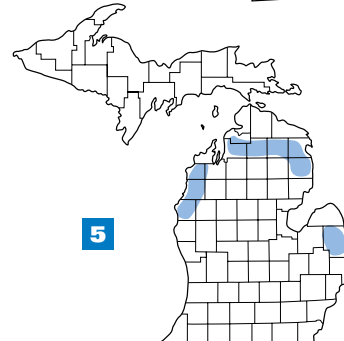
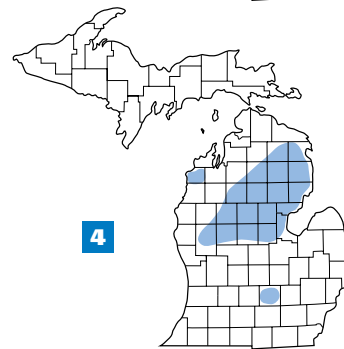
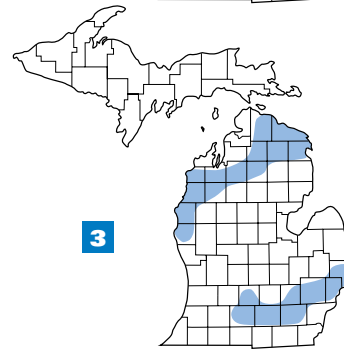
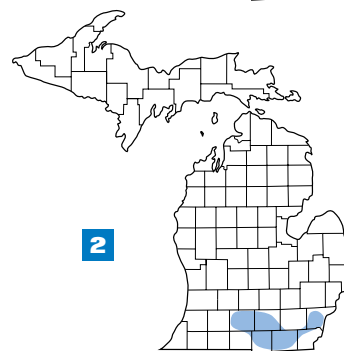
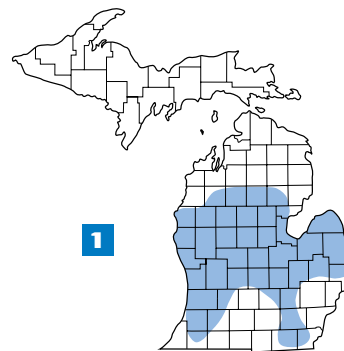
Discovered in 1968, the Niagaran Reef Trend (actually a series of fields) tripled Michigan's oil production and quintupled our natural gas production in the 1970s. The Reef Trend is located along a 12- to 15-mile wide path from Oceana County, through Kalkaska and Otsego Counties, to Presque Isle County. It also runs through southern lower Michigan, with production fields in Eaton, Ingham, Livingston, Oakland, Calhoun, Macomb and St. Clair Counties.

4 Glenwood and Prairie du Chein Formations

The Glenwood and Prairie du Chein Formations are the deepest producing gas formations discovered to date in Michigan. The wells are drilled to depths reaching 11,500 feet. Exploration and development of these fields, which are located in the central part of Michigan's Lower Peninsula, was heavy in the 1980s. Counties with significant Glenwood or Prairie du Chein discoveries include Newaygo, Bay, Osceola, Ogemaw and Arenac.

5 Antrim Shale Formation

Drilling and development of this formation, which began significantly in the late 1980s, has again doubled Michigan's annual natural gas production. The Antrim formation, located throughout Michigan, is presently only commercially productive in the northern part of the State. To date, Antrim exploration and production has centered on Otsego, Montmorency, Alpena, Alcona, Oscoda, Antrim and Manistee Counties.



Michigan's Oil & Gas Industry: From the Ground Up

As tough as it is to get Michigan's oil and gas out of the ground —sometimes requiring drilling more than two miles below the surface of the earth — the real work is finding oil and gas deposits in sufficient quantities to make drilling and production cost-effective. There are several key steps that take place before a drilling rig is ever moved onto a location.

Identifying A Prospect

When the industry begins its search for new oil and gas, many things have to happen before a wildcat, or exploratory, well is drilled. A company relies on geology and geophysics, using the latest technological advancements to target a promising formation in an area that has never produced oil or gas. Although a wildcat well contains a high degree of risk — only about one out of every ten such wells actually has enough gas or oil to be economically productive — success means a new source of energy has been discovered.

Mineral Rights and Leasing

Once a prospect has been identified, an oil and gas company must determine who owns the mineral rights to the area. In most cases, they are owned by the same person who owns the surface rights to the property. However, it is possible for mineral rights to be owned by someone else. These are known as severed mineral rights.

While the mineral owner has a right to extract minerals from the property and will monetarily benefit from any production, the surface rights owner is also compensated for use of the land. This may include right-of-way payments and/or site compensation for facilities or equipment located on their land.

Once the mineral owner has been identified, a lease will be negotiated to give the company the right to enter the property to explore, develop and extract oil and gas from that property. The lease is a contract between the company and the owner of the mineral rights. The owner is paid an amount of money — called a bonus — when the lease is signed. In addition, some leases provide the mineral owner with a rental payment, normally paid annually, if no drilling has started or no royalty payments — based on the amount of oil and natural gas produced — are being made. The lease also spells out the manner in which royalty payments are to be made. A successful venture can be highly profitable for the mineral rights owner. In recent years, oil and gas companies have paid more than \$80 million annually in royalties to private mineral owners.

Permitting

Prior to drilling a well, an oil and gas company must get a drilling permit, which is issued by the Michigan Department of Environmental Quality (DEQ). The DEQ oversees, regulates and manages oil and gas development in Michigan. Seeking a drilling permit, in many cases, also requires working with the following: Michigan Department of Natural Resources; the Michigan Public Service Commission; and the federal Environmental Protection Agency. To apply for a Permit to Drill, the company must be legally registered to do business in Michigan and must be bonded with the DEQ.

Drilling permit applications must provide full details of safety systems and structural integrity of the well design. Surveys of the location must address surface waters, floodplains, wetlands, natural rivers, critical dune areas, threatened or endangered species, and/or other environmentally sensitive areas. Other permit considerations include local zoning designations, and the close proximity to any buildings, fresh water wells, public roads, pipelines and power lines.

Additional requirements include a full Environmental Impact Assessment, landowner notification of drilling plans, and project descriptions for any soil erosion and sedimentation issues.

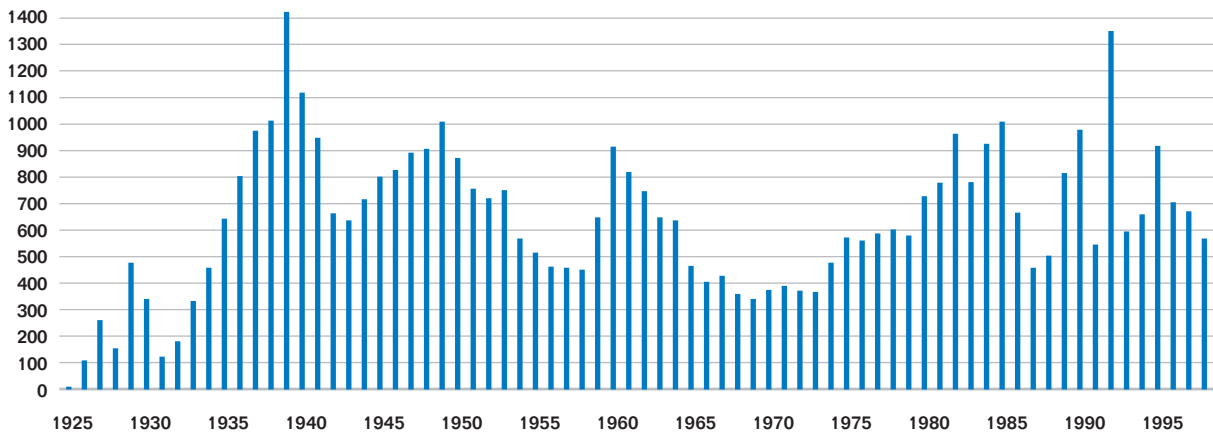
On state-owned lands, well site permits are required from the Department of Natural Resources, with well surface locations approved by both the State Forester and the State Wildlife Biologist.

Prior to final approval of a permit, a DEQ Field Geologist must review the drilling site. If wetlands or surface waters are nearby, there are further inspections by DEQ Land and Water management personnel, and/or fisheries experts.

Drilling

Once leasing has been completed and a drilling permit has been granted by the DEQ, the drilling phase can begin. The oil and gas company must, under the oversight of the DEQ:

- **Establish a location.** Work with the surface owner to select a drilling location, consisting of about one acre. The best sites provide minimal impact on the surface and can use existing roadways.
- **Prepare the location.** The drill site is cleared and leveled; top soil is stockpiled at the edge of the location for use after drilling is completed.
- **Drill.** When the location is prepared, a drilling rig and its associated equipment are moved onto the site. Normally, drilling activity is ongoing 24 hours a day and, depending on the depth of the well, can take anywhere from two to 60 days. Numerous safety procedures are followed to protect Michigan’s other valuable natural resources— water, air and the surface.



OIL & GAS HOLES DRILLED IN MICHIGAN SINCE 1925

Once drilling reaches its final depth, a decision is made to either complete the well for production or plug it as a dry hole. If the well is dry or unproductive, the well bore is plugged with cement, following the instructions of the DEQ. All the equipment removed and the site is restored. In many cases, unless the drilling took place in a wooded area, the impact is not noticeable within a year.

If the well is determined to be a producer, the drilling rig is moved off the location and replaced with a smaller rig, known as a completion rig. Using the smaller rig, again under the oversight of the DEQ, the well bore is cleaned and the formation is treated to allow oil and gas to flow into the well bore and up to the surface. A facility is constructed that will include all production equipment necessary to safely produce oil and gas. A typical production facility will include the wellhead, flow lines from the wellhead to other equipment, storage tanks, dehydration and treating equipment, compressor and meter stations.

Production

A well is ready for operation once the production equipment is in place. In an oil well, the oil is brought to the surface and placed in storage tanks on the site. If gas is produced, either with the oil or independently, it is metered and transported to market via pipelines that are regulated by the Michigan Public Service Commission. Oil is moved on a prearranged basis via truck. Once again, production activity is monitored — normally on a daily basis by the oil and gas company, and frequently by the DEQ.

If an exploratory well is a producer, the company may want to drill additional wells. These are known as development wells. Engineers and geologists study cumulative production, reservoir pressures and other characteristics to determine whether additional drilling locations are needed.

Restoring the Site

Production continues until a well becomes uneconomical. At that time, the well is plugged and the site is restored to as near its original condition as is practical. Site restoration may include reseeding grass and planting vegetation, ground cover and trees to re-establish the original topography.



Michigan's Oil & Gas Industry and the Environment

Michigan's natural resources are a great source of pride to its residents. To preserve and protect these resources, the oil and gas industry works hard to minimize its impact on the environment. However, getting oil and gas out of the ground and delivered to customers sometimes means an inconvenience for a short period of time. State-of-the-art technology has made current operations quieter, cleaner and more efficient than a decade ago and improvements continue to be made each year. Michigan's oil and gas industry works to comply with industry regulations at all levels.

Federal

The Environmental Protection Agency stipulates specific rules and regulations for all industries, including the oil and gas industry. These areas of compliance include the Resource Conservation and Recovery Act (RCRA), the Clean Air Act, the Clean Water Act and the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). The U.S. Environmental Protection Agency specifically regulates the disposal of production waste.

State

The Michigan oil and gas industry is directly regulated by the Michigan Department of Environmental Quality's Geological Survey Division, the Department of Natural Resources and the Michigan Public Service Commission. Specific rules regulating the oil and gas industry are found in Act 451 of the Public Acts of 1994 as amended (Part 615 Supervisor of Wells and the Administrative Rules of 1996), highlights of which include:

Permitting & Construction. Regulations cover every aspect of our industry — permitting a well, well construction and completion, facility construction, production operations, noise abatement, pipelines and, finally, plugging a well and site restoration.

Waste. Almost all of the waste associated with oil and gas production is salt water which is commonly produced with the petroleum. The water, or brine, may contain high levels of non-hazardous chloride. Once water is separated from the petroleum, brine is re-injected into the ground (frequently into the zone from which it came, or deeper to protect fresh water) in a state- and U.S. EPA-approved Class II disposal well. Also, many county road commissions use excess brine for dust and ice control on gravel roads.

Hydrogen Sulfide (H₂S). Also known as sour gas, hydrogen sulfide has a high content of sulfur and is a natural byproduct of many industries, including agriculture, salt, paper-making, sewage disposal, and oil and gas. The State of Michigan has stringent rules and regulations that specifically address the handling of hydrogen sulfide by the oil and gas industry.

Noise. Many new technologies and methodologies in noise abatement have been developed, and regulations have been updated, to make sure oil and gas operations are as quiet as possible.

Uniform Regulatory Control

Because geological formations that produce oil and gas do not conform to surface boundary lines, and due to the highly specialized technical nature of the business, state rules and regulations cover all oil and gas activities. However, as a matter of policy, drilling permit applications are sent to township and county governments by the state for their input. The oil and gas industry also complies with a variety of local ordinances regarding pipeline rights of way, local surface facility zoning in established municipalities, and soil erosion and sedimentation control. In addition, the Michigan Department of Transportation, along with Michigan's county road commissions, regulate the movement of heavy equipment.

The Michigan Natural Resources Trust Fund: Putting Michigan's Oil and Gas Revenues to Good Use

Michigan was the first state in the nation to establish a land trust fund specifically funded by revenues generated from the oil and gas industry. The 1976 landmark legislation created what is now the Michigan Natural Resources Trust Fund. It was hailed by oil and gas industry leaders, environmentalists, conservationists and recreation groups as a significant investment in Michigan's natural resource heritage.

This historic commitment to Michigan's natural resources was spearheaded by the Michigan Oil And Gas Association (MOGA), the Michigan United Conservation Clubs (MUCC) and the Michigan Department of Natural Resources in the 1970s, and has drawn high praise from environmental and industry leaders across the nation.

Although the original purpose of the Fund was solely to preserve and protect Michigan's natural resources through buying and/or improving public park and recreation lands, its financial success made it a target to help balance the state budget. During its first seven years, more than \$100 million was diverted to the Michigan Economic Development Authority and other programs outside its original stated purpose.

In 1984, a statewide referendum called for an end to raids on the Fund. The referendum resulted in the Michigan Natural Resources Trust Fund amendment to the Michigan Constitution, specifying that funds be used to support land acquisition and facility development and improvement.

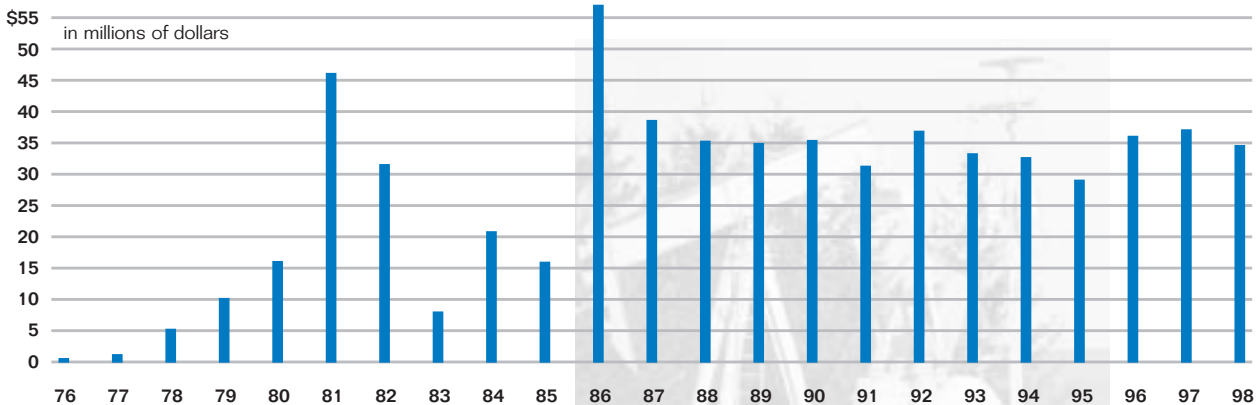
Since its inception, the Michigan Natural Resources Trust Fund has received more than \$550 million from oil, gas and mineral leasing and production on state lands. By law, a portion of these annual revenues, plus earned interest, must be used to acquire and improve Michigan's public recreation facilities.

The Michigan Natural Resources Trust Fund has purchased more than 135,000 acres of ecologically significant or recreational land, including more than:

- 3,000 acres for the Pigeon River Country State Forest;
- 14,000 acres for the state park system;
- 1,000 acres for boating access sites;
- 2,600 acres of water frontage for fishing access sites; and,
- 37,000 acres for state wildlife areas.

Since 1976, the Fund has distributed more than \$371 million — over \$195 million to the Michigan Department of Natural Resources and nearly \$176 million to local governments. The largest portion of the Fund — almost \$305 million — has been used to acquire public recreation lands, while the balance has funded the development of recreational lands.

Among the hundreds of projects funded by the Michigan Natural Resources Trust Fund since its inception are: purchasing 70 miles of river frontage and nearly 25,000 acres along two of the nation’s top trout streams, the Au Sable and the Manistee; helping the City of St. Joseph acquire 22 acres of Lake Michigan shoreline for Silver Beach County Park; helping Banks Township in Antrim County purchase more than 150 acres, including nearly a mile of frontage on Grand Traverse Bay; and, acquiring 10,000 acres of undeveloped land in Mackinac County, including more than five miles of Lake Michigan frontage.



MICHIGAN OIL & GAS ESTIMATED CONTRIBUTIONS TO MICHIGAN NATURAL RESOURCES TRUST FUND BY FISCAL YEAR



Michigan's Oil and Gas Industry in the 21st Century

Oil and gas exploration and production dates back to the 19th century. However, the oil and gas industry employs emerging technologies and is constantly striving to modernize exploration drilling, well completion and production techniques.

Recent industry innovations include:

- **Three Dimensional Seismic.** Improvements to standard seismic techniques (using sound energy to determine if a rock formation is potentially oil- or gas-bearing) allow earth scientists to look at the total shape of the formation — the width, length and depth. This more advanced seismic technology helps oil and gas companies find reserves that previously may have been missed by less sophisticated means. By better understanding the subsurface before drilling, the industry can also reduce the number of dry holes and limit environmental impact.
- **Directional Drilling.** Beginning several hundred feet below the earth's surface, directional drilling involves the controlled deviation of a hole. The total depth of a well can reach a destination from a few feet to several thousand feet away from the surface location of the drilling rig. Drilling can therefore occur beneath environmentally sensitive areas using surface locations far removed from that area. Directional drilling helps target formations that may lie under land or water that is not readily accessible by conventional means.
- **Horizontal Drilling.** One step beyond directional drilling, this innovation allows for drilling horizontally (instead of the more common vertical drilling) from a kick-off point below the surface out to a predetermined target that may be more than one thousand feet away. In addition to protecting environmentally sensitive areas, horizontal drilling also enhances oil and gas recovery over traditional methods. In some cases, one horizontal well can replace several vertical wells, minimizing surface activity.
- **Secondary and Tertiary Recovery.** Only a fraction of the original oil and gas in place — often less than a fourth — can be recovered using traditional methods. New techniques for getting more oil and gas production from existing wells, like hydrojet technology, are being developed. Flooding, or essentially “pushing” oil or gas through the formation with water or carbon dioxide (CO₂) can also enhance recovery by making oil or gas easier to move out of the formation. Although these techniques are very costly in their introductory stages, they ensure maximum production from existing wells.

Conclusion

1999 marks the 75th anniversary of commercial oil and gas exploration in Michigan. The members of the Michigan Oil And Gas Association are proud of their industry, and are committed to being good stewards of the environment. Developing this very important hydrocarbon natural resource while preserving and protecting Michigan's other natural resources is our primary goal.

For more information on Michigan's oil and gas industry — including specific legislative and regulatory provisions, names and phone numbers of Michigan Oil And Gas Association leadership — please call the MOGA office.

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GLOSSARY

Here are plain-English definitions of technical terms and acronyms frequently used in the oil and gas industry.

BCF — billions of cubic feet (of gas). In the oil and gas industry, the cubic foot is the standard unit of measurement of gas at atmospheric pressure.

Barrel — the standard unit of measurement in the U.S. oil industry. A barrel equals 42 U.S. gallons, or 159 liters.

Bonus — consideration paid to the mineral rights owner for an oil and gas lease. The amount of the bonus is negotiated in the lease between the mineral rights owner and the oil/gas producer.

Casing — a large diameter steel pipe placed in a wellbore to support the sides or walls of the hole and prevent them from caving in. Casing is usually cemented in place to provide a seal around the outside of the pipe.

Christmas Tree — valves and special connections installed on top of the casing to control the flow of oil and gas from the well.

Crude Oil — a naturally occurring mixture of liquid hydrocarbons from the ground (before or after any dissolved gas has been separated from it, but prior to any process of distilling or refining).

Directional drilling — a method of drilling at an angle so that the bottom of the hole is several hundred feet offset from the drilling rig's surface location. It is an environmentally safe way of drilling for oil and gas beneath sensitive areas, such as wetlands or lakes. Horizontal drilling (see below) is a form of directional drilling.

Field — a geographical area over which oil and natural gas wells produce from one formation or more. A field may cover many leases and extend for miles.

Gasoline — A volatile, flammable, liquid hydrocarbon mixture refined from crude oil.

Horizontal drilling — a form of directional drilling (see above). The drill bit travels several thousand feet below the surface before being turned to a nearly horizontal angle to seek oil and gas in a predetermined area. An environmentally safe way to recover oil and gas from beneath sensitive areas, such as wetlands or lakes.

Hydrocarbons — see petroleum

Hydrogen sulfide (H₂S) gas — a naturally occurring gas produced primarily through the decomposition of organic materials by bacteria. H₂S has a distinctive rotten-egg odor, which can only be smelled at concentrations well below danger levels, making it difficult to completely eliminate the odor. When an oil and gas formation contains H₂S, it is called "sour gas."

Lease (oil and gas) — a contract in which the oil company buys the right to drill for oil and gas on a specific piece of property. The company also pays the mineral owner compensation — called a royalty — for any oil or gas that is found.

MCF — the most common unit of measurement for natural gas, or thousands of cubic feet measured at a standard temperature (60 degrees) and pressure (14.65 pounds per square inch).

Marginal — see Stripper.

Mineral rights — the ownership of oil, natural gas or other minerals under a tract of land, as distinguished from surface ownership of the same property.

Natural gas — a mixture of gaseous hydrocarbons formed naturally in the earth. Methane is the primary component of most natural gases.

Operator — the company/owner responsible for the drilling, completion and production operations of a well and the physical maintenance of the leased property.

Petroleum — Naturally occurring organic compounds composed of hydrogen and carbon from which gasoline, kerosene and countless other "petrochemicals" are produced. Petroleum refers to all hydrocarbons, including oil, natural gas and condensate, plus their derived products.

Pooling — combining of tracts of land in order to prevent the drilling of unnecessary wells which would result in physical and economic waste.

Post-Production Costs (PPC) — costs incurred in transporting gas from the wellhead to the point of sale.

Reservoir — a rock formation in which oil and/or natural gas has accumulated.

Royalty — a fixed percentage specified in the lease agreement, paid to the owner of mineral rights based upon the amount of oil and natural gas produced.

Severed rights — the owner of all rights to a tract of land can sever the rights to his land. In other words, if a tract of land is severed horizontally, two distinct estates are created: surface rights and mineral rights.

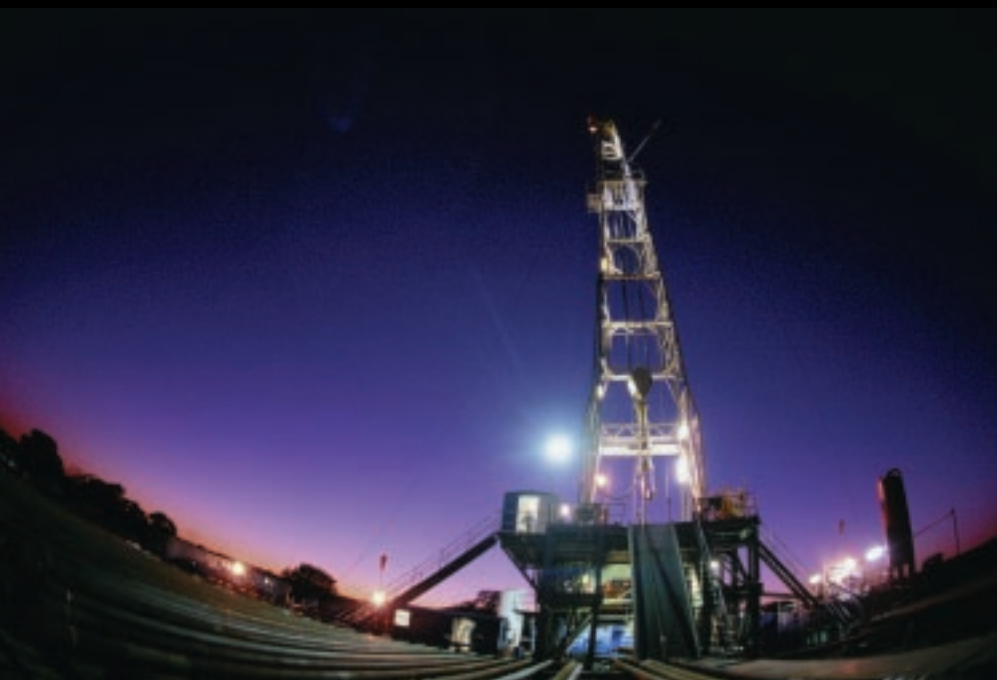
Sour gas — see hydrogen sulfide gas.

Spud — a verb. To "spud" a well means to begin drilling.

Stripper — a phase in the life span of a well when only small quantities of oil and gas can be produced intermittently. Stripper wells usually produce 10 or fewer barrels of oil a day.

Surface rights — surface ownership of a tract of land from which the mineral rights can be severed or separated.

Wildcat — an exploratory well that is drilled to a reservoir from which no oil or gas has previously been produced.



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