Black Gold: The Economics of Oil in North Dakota

by Mark A. Gonzalez

Hollywood loves a millionaire, and many millionaires have been depicted as oil tycoons, including Jett Rink, the unruly wildcatter in the 1956 epic, "Giant," Jed Clampit, the avuncular simpleton in the TV series, "The Beverly Hillbillies," and J.R. Ewing, the conniving, power-hungry, oilman in "Dallas." Oil is a high-risk, big-stakes business that has cost many a fortune and provided a fortune to others. Oil has not only fueled the world's modern-day industrial economy, but it has lined the coffers of local, state, and federal governments, supplemented the income of numerous mineral owners, and provided income to many geologists, engineers, roughnecks, and roustabouts. Oil has been produced in North Dakota for 50 years, and today I take a brief glance at what this industry means to the people and the state and local governments of North Dakota.

The Big Picture: Oil Production and Consumption in the United States

Although the United States has less than 5% of the world's population, it is responsible for 26% of the world's oil consumption. The U.S. consumes about 17-18 million barrels* of oil per day. To satisfy this demand, the U.S. produces about 5.9 million barrels of domestic oil and must import about 11-12 million barrels of oil per day, about 60% of its needs. This equates to a demand of nearly 3 gallons of petroleum per day per person in North America, considerably higher than any other region of the world (Table 1). Note that northern countries have a higher per capita consumption than tropical countries. For example, Canada and Norway both have higher per capita consumption than the United States. However, if one looks at the oil consumed per $1 million of gross domestic product (GDP), then the United States is the most energy efficient of the major countries in the world (Table 2). Canada is, surprisingly, among the least efficient countries.

Oil (41%) and gas (24%) together supply 65% of the U.S. energy supply (Table 3). The balance of U.S. energy needs is provided by coal (23%), nuclear (8%), and renewable (4%) energy (Table 3). Oil provides 97% of the transportation fuels used by Americans.

Table 1: Annual Per Capita Total Primary Energy Consumption

Region (Selected Countries)	Energy Consumption (Million Btu)
North America	290
(Canada)	(410)
(United States)	(360)
(Mexico)	(60)
Western Europe	125
(Iceland)	(455)
(Norway)	(425)
(Germany)	(170)
(Spain)	(132)
Eastern Europe and former U.S.S.R	125
Middle East	100
Central and South America	50
(Virgin Islands, US)	(2300)
(Costa Rica)	(38)
(Nicaragua)	(13)
(Haiti)	(3)
Far East and Oceana	29
Africa	15

(from Department of Energy, Energy Information Agency, http://www.eia.doe.gov)

Table 2. Tons of Oil-equivalent Consumed Per $1 Million of GDP, 1988

Top 10 (in efficiency)	Tons	Bottom 10	Tons
United States	76	Finland	198
Switerland	80	Mexico	233
Japan	89	New Zealand	234
Denmark	90	Iceland	244
Italy	110	Turkey	260
Germany	113	Canada	312
Austria	114	Hungary	363
France	116	Korea	371
United Kingdom	117	Poland	422
Ireland	121	Czech Republic	453

* Note: During the early years of commercial oil production, oil was stored in wooden barrels that held 42 gallons, or 159 liters. Over time, this volume emerged as the standard barrel. See "From the State Geologist" in the *NDGS Newsletter*, vol. 24, no. 4, Winter 1997 for a more thorough treatise on the origin of the 42-gallon oil barrel.

Table 3. Total U.S. Energy Consumption by Primary Energy Source

Petroleum	40.7%
Natural Gas	24.1%
Coal	23.3%
Nuclear	7.9%
Hydro	3.8%
Other	0.2%
Total:	100.0%

(Source: Department of Energy, Energy Information Agency; http://www.eia.doe.gov/)

Petroleum products have proven to be versatile in providing energy for transportation, heating, cooking, and lighting. In addition to fuels, crude oil is refined and used in the production of over 4,000 petrochemical products, including plastics, synthetic fibers, synthetic rubbers, detergents, and chemical fertilizers. The average North Dakotan consumes 1,275 gallons of fuel each year. These quantities are considerably higher than the average per capita consumption (620 gallons of fuel) in the United States and reflect the large amount of energy used to heat our homes in the winter, the long distances traveled in our rural state, and the petroleum-intensive nature of modern farming. In fact, North Dakotans have the fourth highest per capita energy consumption in the United States, behind only residents of Alaska, Wyoming, and Louisiana.

Crude oil prices are highly volatile and vary daily. Prices are determined primarily by supply and production rates set by the international cartel, OPEC, Organization of the Petroleum Exporting Countries. The OPEC cartel comprises eleven countries—Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela. Although OPEC decisions strongly influence the price of oil, they do not entirely control price because several large oil-producing countries, for example, the former Soviet Union, the United States, Mexico, Canada, China, Norway, and Oman, do not belong to OPEC.

Close-up: Petroleum production in the State of North Dakota

The petroleum industry is North Dakota's sixth largest industry behind government, agriculture, tourism, manufacturing, and the lignite industry, according to the NDSU Agricultural Economics Department.

In the first half of the twentieth century, 64 "oil" wells were drilled in the State—none of them produced oil. In 1951, oil was discovered in North Dakota during drilling of the Clarence Iverson #1 well near Tioga (see *NDGS Newsletter*, Vol. 28, No. 1, Summer 2001). Since 1951, 14,000 oil and gas wells have been drilled in North Dakota. These wells have produced more than 1.3 billion barrels of oil, worth over $20 billion. Currently, North Dakota is the ninth-largest oil producing state (Table 4), although recent, unofficial numbers indicate North Dakota has overtaken Kansas for the eighth position. In 2000, nearly 33 million barrels of oil were produced in North Dakota, an average of 90,000 barrels per day. Recent production levels are down considerably from the early 1980s, when the price exceeded $40 per barrel and production peaked at nearly 53 million barrels (Figure 1). In addition to oil, an estimated 52.4 billion cubic feet of natural gas were produced in North Dakota during 2000.

Table 4. Production of Crude Oil by State (Top 10 States; thousand barrels)

Rank	State	Annual Total	Daily Average
1	Texas	443,396	1,211
2	Alaska	355,198	970
3	California	271,132	741
4	Louisiana	105,424	288
5	Oklahoma	69,976	191
6	New Mexico	67,198	184
7	Wyoming	60,726	166
8	Kansas	34,463	94
9	North Dakota	32,718	89
10	Mississippi	19,843	54

(Source: Department of Energy, Energy Information Agency; http://www.eia.doe.gov/)

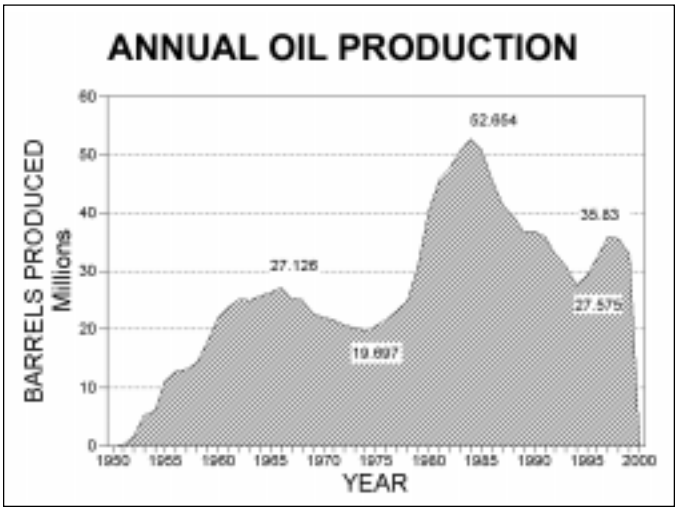

Figure 1. Annual oil production in North Dakota since 1951. Production is in millions of U.S. barrels. (Source: NDGS and N.D. Oil and Gas Division)

Most of the oil production in North Dakota comes from 17 western counties (Figure 2). Stark, Billings, McKenzie, Bowman, and Williams counties produce the lion's share of the State's oil. In 2000, more than 2,000 people were employed in North Dakota's oil patch. In 1981, employment in the oil patch peaked at more than 10,000 jobs. The reduction in production and employment does not indicate a major reduction in supply, but rather it is linked directly to the price of oil. Whenever oil dips to less than $15/barrel, oil production and drilling activities decrease dramatically. Oil production virtually ceases when the price dips below $10/barrel. A price of $20/barrel or more generally leads to a dramatic increase in drilling and oil production (Figure 3). These fluctuations in price and production lead to the so-called "boom" and "bust" periods in the oil patch.

Figure 2. Major oil-producing counties in North Dakota. (from the North Dakota Petroleum Council)

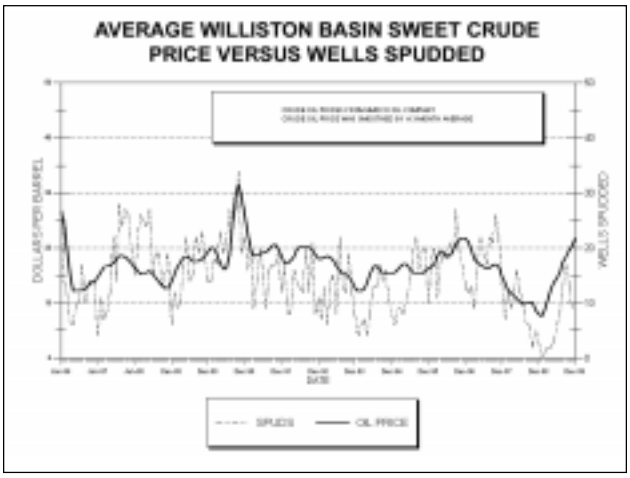

Figure 3. Graph of the monthly average posted price for Williston Basin 40-gravity "sweet" crude oil and the number of wells spudded monthly since January 1, 1986. (Sources: Oil prices are from Amoco Oil Company (now Tesoro), and the wells spudded from the N.D. Oil and Gas Division.)

The number of workers employed in the oil patch is only a fraction of the people employed in the oil industry overall. Each drilling rig results in approximately 120 direct and indirect jobs. Others are employed in refineries, gas plants, pipelines/companies, retail gasoline stations, wholesalers, and transportation. The petroleum industry employed an estimated 9,000 people in North Dakota in 2000 (ND Petroleum Council, 2001).

Jobs in the mining industry, which includes oil and gas extraction, generally pay good wages. The average wage in the mining industry was about $43,000 in 1999. This was about $19,000 above the statewide average wage of $23,750.

Oil Tax and Lease Revenues

Over the past 50 years, the State of North Dakota has received more than $500 million from oil and gas leases, bonuses, royalties, and rentals on State land. In addition, the State has received more than $1.9 billion in oil-tax revenues. Since 1981, North Dakota has collected both a production and an extraction tax from crude oil. These taxes have amounted to as little as $35 million in 1999, when oil prices dipped to a recent historic low and production levels fell accordingly, to as much as $177 million in 1983 (Figure 4). In 2000, oil tax revenues rose to $73.4 million, a 63% increase from 1999 revenues. Additional revenue is provided by federal agencies, such as the U.S. Forest Service and the Bureau of Land Management for oil and gas revenues generated on lands they administer in the State. In 2000, federal revenues returned to the State exceeded $20 million, much of which was used by counties for schools and roads.

To put these numbers in perspective, consider that the State budget for the current biennium is $800 million dollars

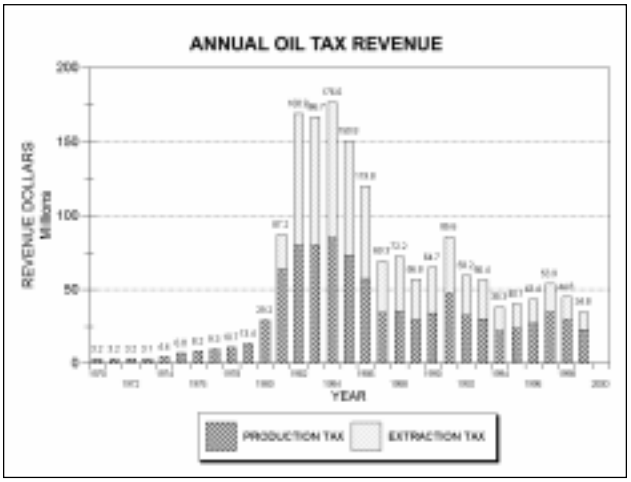

Figure 4. Bar graph of the annual production and extration tax revenue from crude oil production for the period 1970 to 1999. The extraction tax took effect January 1, 1981. (Source: N.D. State Tax Commission)

per year. State sales and income taxes provide the majority of this money, but oil and gas revenues make up approximately 6% to 12% of the State's budget during a typical biennium. [NOTE: Lignite mining produces another $65 million in tax revenue per year, or approximately 8% of the revenue for the State's budget.] Without these revenues, the State would be forced to increase sales and/or income taxes, or would have to substantially reduce expenditures and services provided. Furthermore, the tax on income received as royalty or paid by people who have oil revneues are not included in these calculations.

Certainly, all North Dakotans, from teachers in the public school system, to anyone who drives a state- or county-maintained road in western North Dakota, benefits from a strong oil industry. The quality of life in North Dakota is substantially improved and supported by oil-tax revenues.

Extracting the Black Gold from the Earth

Typically, oil is extracted from reservoirs or pools beneath the earth's surface. The terms "reservoir" and "pool" might conjure an image of a large liquid body, but oil does not exist in this form. Instead, petroleum, along with water, fills the void spaces in a rock, such as the spaces between grains of sand in a sandstone. Because oil and natural gas almost always coexist with groundwater and are less dense than water, they tend to rise through pervious rocks, such as sandstone and porous limestone, toward the earth's surface until their upward movement is obstructed by an impervious layer of rock, such as shale. Various geologic structures, such as anticlines (Figure 5), domes, or faults can trap petroleum and provide settings for economic extraction of the petroleum "pooled" in the porous rock. After a hole is drilled, it is lined with an impervious steel casing to protect the hole from collapse, to protect the potable groundwater supply, and to allow production of petroleum only from selected intervals within the well. In oil-bearing zones, the casing is perforated to allow oil to flow into the hole, where it can be pumped to the surface (Figure 5).

When a well is first drilled, oil may flow to the wellbore on its own accord due to the pore pressure of the reservoir rock. This pressure is referred to as the reservoir energy. As oil is progressively drawn from the well, the reservoir energy decreases. When reservoir energy decreases to the point that oil can no longer flow into the borehole and to the surface, a pump is applied to reduce the wellbore pressure, thereby drawing fluids out of the pore spaces, into the drill hole, and to the surface. At some point, the cost required to extract the oil is greater than the value of the oil. When this condition exists, the oil well is taken out of production, plugged, and abandoned.

Abandoning a well does not mean the reservoir has run out of oil. Indeed, a reservoir typically retains 80% or more of its original volume of oil even when production in the reservoir ends. Many old, mature oil fields have been brought back into production as new technologies have been developed to restore reservoir energy and enhance oil recovery. For example, some fields are injected with water, steam, detergents, natural gas, or carbon dioxide to decrease the viscosity and/or to increase the fluid pressure and enhance oil recovery.

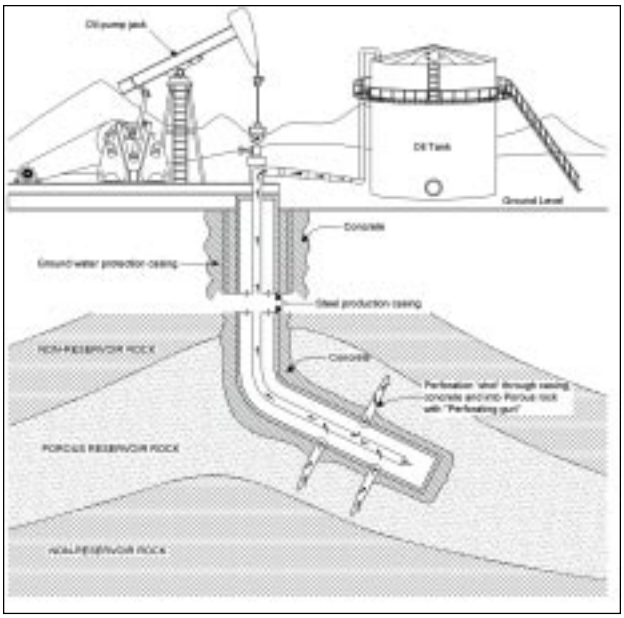

Figure 5. Schematic diagram of pumping oil well and wellsite storage tank. (modified from Brister, 2001)

Another strategy, which has gained widespread practice, is to drill horizontal and directional wells, which follow oil-producing layers and increase the surface area of the drill hole in contact with oil-bearing rocks (Figure 5; see also the article written by Paul Diehl in the *NDGS Newsletter*, Vol. 28, No. 2, Winter 2001). In recent years, the oil-producing zones are an average of 10,000 feet deep in the Williston Basin; therefore, it is sometimes economical to drill one hole to a depth of 10,000 feet and then to drill multiple branches through the oil-producing zone. However, horizontal wells cost more to drill than do vertical wells. Therefore, oil companies must evaluate the drilling costs, expected increase in production rates, and total production volume to determine whether a horizontal well is more profitable than multiple, vertical wells.

Black Gold Fever

So who benefits from North Dakota oil? There are as many beneficiaries as there are North Dakotans and then some. First and most obviously, those individuals and corporations that have invested capital to explore, locate, and develop oil fields will recoup their investments if sufficient oil is recovered in a reasonable time from a producing well.

Also, the owner of mineral rights will obtain a royalty. The mineral rights may be held by government bodies, private individuals, corporations, or Indian tribes. The State of North Dakota owns the mineral rights for most state lands. In 2000, the State received more than $10 million from oil and gas leases, bonuses, royalties and rentals from production on state lands.

The federal government oversees more than one million acres of land in western North Dakota, much of it in major oil fields in the Little Missouri National Grassland. The federal government (U.S. Forest Service and Bureau of Land Management) returns 50% of its oil and gas revenues ($22 million in 2000) to the State and local counties.

The oil and gas industry is the sixth leading industry in North Dakota; however, in south-central North Dakota (the counties of McLean, Sheridan, Mercer, Oliver, Burleigh, Morton, Grant, Sioux and Emmons), the energy industry (oil, gas, and coal combined), is the largest industry, accounting for 44% of the economy.

Summary

Though North Dakota has a long, proud, rich heritage of ranching and farming, the energy sector plays a progressively greater role in the economy of North Dakota. The industry provides direct and indirect employment for thousands of people, and enriches the treasuries of many towns, counties, and the State. All North Dakotans are beneficiaries of the oil and gas tax revenues. Most of the tax revenues and other oil and gas receipts are added to the state budget, and some of the tax revenues are used to endow trusts, such as the Lands and Minerals Trust and the Board of University and School Lands Trust. These trusts will continue to benefit the State even after the oil industry has disappeared from North Dakota.

Every time an oil-well pump revolves, it is generating a small windfall for the residents of our State. It's not just the Jett Rinks, Jed Clampits, and J.R. Ewings of the world who prosper from Black Gold; it is every North Dakotan.

Acknowledgments

I am indebted to Ken Urlacher for creating Figures 2 and 5 and to Paul Diehl, petroleum geologist, John Bluemle, and Lorraine Manz, who provided valuable insight and information that helped to improve the manuscript.

References

American Association of Petroleum Geologists, 2001. http://www.aapg.org/

American Petroleum Institute, 2001. http://www.api.org/faqs/

Bluemle, J.P., 2001. The 50th Anniversary of the Discovery of Oil in North Dakota: *North Dakota Geological Survey Miscellaneous Series* No. 89, 58 p.

Brister, B.S., 2001. Have you Ever Wondered…Who "gets rich" when an oil well is drilled in New Mexico? *New Mexico Bureau of Mines and Mineral Resources, Lite Geology*, No. 23, pp. 2-8.

Energy Information Administration of the Department of Energy, 2001. http://www.eia.doe.gov/

Heck, T. J., 2000. Oil Exploration and Development in the North Dakota Williston Basin: 1998-1999 Update: *North Dakota Geological Survey Miscellaneous Series* No. 88, 27 p.

North Dakota Lignite Energy Council, 2001. http://www.lignite-energy-council.org

North Dakota Petroleum Council, 2001. North Dakota Oil and Gas Industry: Facts and Figures.

Organization of the Petroleum Exporting Countries, 2001. OPEC Online: http://www.opec.org.