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Economic Contribution of the Petroleum Industry to North Dakota

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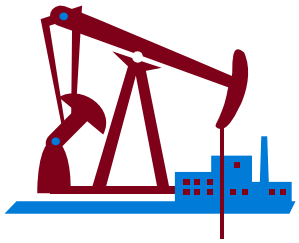

North Dakota's largest basic sector industries, which include agriculture, manufacturing, and energy, provide much of the economic stimuli for the state's economy. These large industries are generally comprised of distinct sectors or economic groups. North Dakota's energy industries can be conveniently separated into the activities that produce and distribute electricity, coal, and petroleum.

North Dakota's rank among the nation's top 10 oil producing states is common knowledge to those in the petroleum sector. Yet, despite the obvious importance of oil and gas production to North Dakota, there has been no assessment of the contribution of the petroleum industry to the state economy.

Recent upswings in oil activity, due in part to increased energy prices, the availability of improved exploration and extraction technology, and substantial potential for oil recovery from various formations in the Williston Basin, have brought new attention to the petroleum industry in North Dakota. Increase in leasing activity, more well drilling rigs operating in the state, substantial increases in severance tax collections, and other financial and economic aspects of the industry have all been discussed in the media. The purpose of this report is to estimate the economic contribution (direct and secondary effects) of the petroleum industry to the economy of North Dakota.

BACKGROUND

The industrial organization of the petroleum industry in the United States is often divided into upstream and downstream components. The upstream components of the petroleum industry generally include exploration, development, and production of crude oil and natural gas. The downstream components include transportation, processing, distribution, marketing, and retail delivery of petroleum products.

The petroleum industry in North Dakota consists of both upstream and downstream components. For this study, the petroleum industry was limited to in-state exploration, extraction, transportation, and processing of crude oil and natural gas. The distribution, marketing, and retail sale of petroleum products (e.g., diesel, gasoline, propane, natural gas) was not included.

The exploration and extraction phases of the petroleum industry are not organized like other industries in the state. Firms that own producing wells (oil operators) contract much of the work of exploration and extraction of oil and gas to firms that specialize in various aspects of those processes. As a result, much of the expenditures incurred in the state for oil and gas production start with the oil operator but flow through the firms that provide support and service within the oil fields.

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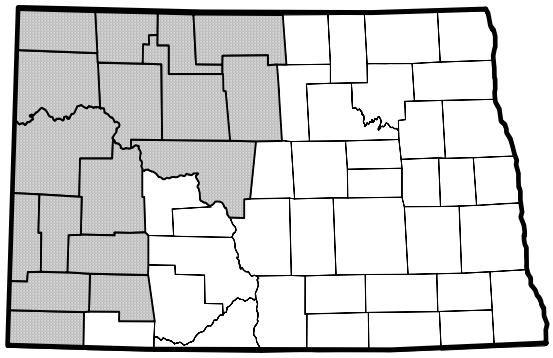
Oil and gas wells typically have royalty interests, owner/operator interests, and working interests. Royalty interests receive a share of the value of a well's output but do not share in the expenses associated with the well. Owner and working interests share, based on various percentages or arrangements, the remaining revenues and all of the expenses of a well. The well owner or operator is generally responsible or in charge of all operations.

Oil and gas production is limited to the western third of North Dakota (Figure 1). Of the 16 counties currently producing oil, production is concentrated in Billings, Bottineau, Bowman, McKenzie, Stark, and Williams Counties. Those counties accounted for nearly 87 percent of state oil production in 2006 (North Dakota Industrial Commission 2007).

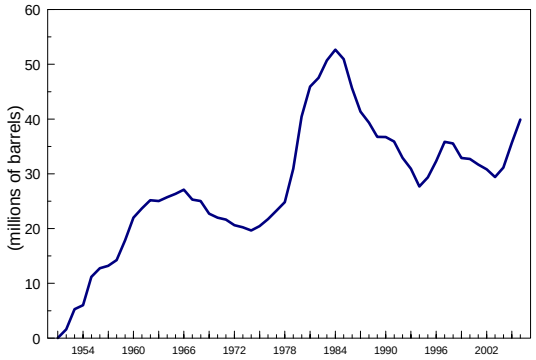
Figure 1. Oil Producing Counties, North Dakota



Nationally, North Dakota is ninth among oil producing states based on crude oil production from 1981 through 2005 (U.S. Department of Energy 2007). North Dakota ranked eighth nationally among oil producing states in 2005. From 1981 through 2005, North Dakota accounted for only 0.3 percent of national natural gas production and was ranked 20th among all states in 2005 (U.S. Department of Energy 2007).

Oil output in North Dakota has fluctuated substantially since commercial production began in the early 1950s (Figure 2). The first oil boom started in the early 1950s and lasted into the early 1960s. Oil production then rapidly declined until the next oil boom, which started in the mid 1970s and lasted until the mid 1980s. More recently, oil production has fluctuated between multiple years of increasing output and years of declining production. Currently, oil and gas production is increasing (Figure 2).

Figure 2. North Dakota Crude Oil Production, 1951 through 2006
Source: North Dakota Industrial Commission (2007).



The annual value of oil production in North Dakota was estimated using monthly average price and production data from the North Dakota Industrial Commission (2007). The overall value of oil production in North Dakota, in nominal terms, has generally paralleled oil output despite price fluctuations over time (Figure 3).

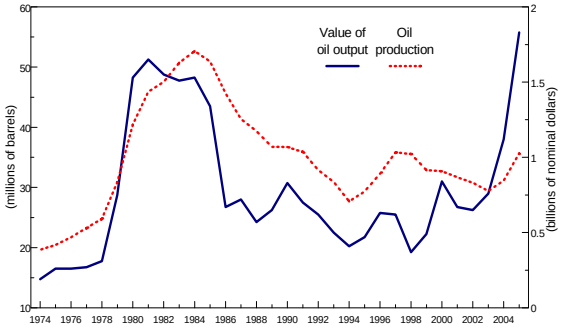


Figure 3. Production and Market Value of Crude Oil, North Dakota, 1974 through 2005
Source: North Dakota Industrial Commission (2007).

PROCEDURES

An economic contribution analysis, as defined in this study, represents an estimate of all relevant in-state expenditures and returns associated with an industry. The economic contribution approach has been used for several other industries in North Dakota (Bangsund and Leistritz 2004, 2005; Coon and Leistritz 2006).

Industry Surveys

Firms that own or operate oil wells in the state were surveyed to obtain information on expenses for oil and gas exploration and extraction, general business expenses in the state, employment, physical measures of oil and gas production, and leasing and drilling activity. The survey of oil operators resulted in useable information from 17 firms. The firms' production from owned/operated wells represented about 20 percent of the state's 2005 production of crude oil and natural gas.

Another survey was conducted for firms engaged in pipeline transportation of crude oil and unprocessed natural gas produced in North Dakota and for firms involved with processing of crude oil and natural gas in North Dakota. The survey was used to obtain estimates of the amount and type of expenditures made in North Dakota and in-state employment by those firms. Firms operating pipelines for the transport of refined or processed petroleum products were not included in the study.

A third survey was used to obtain information from firms that provide service and support to oil operators in the state. The survey solicited information on the type and extent of involvement in the petroleum industry, in-state expenditures, and employment in North Dakota. The mailing list was obtained from lists of contractors or vendor lists provided by firms responding to the oil operator survey. A total of 42 firms responded to the survey, with 40 firms providing useable information.

Estimation Techniques

The three surveys of firms directly involved in the petroleum industry in North Dakota provided data to set the level of spending and to determine the type and distribution of spending among sectors of the North Dakota economy. Benchmark expenses for extraction, transportation, and administrative expenses were estimated per barrel of oil equivalent (BOE). Total state production in 2005, expressed in BOE, was then used with survey estimates of in-state expenditures per BOE to generate state-level estimates for extraction, transportation, and administrative spending. In-state employment by oil operators was estimated in the same manner. Benchmark expenses for exploration were estimated per well drilled and were used with data on the number of wells drilled in North Dakota in 2005. Data from the Oil and Gas Division of the North Dakota Industrial Commission was used with survey data on acreage and bonus payments for private leases and total wells drilled to arrive at state-level spending for private lease bonuses. Other in-state expenditures, such as severance taxes, public lease bonuses, and royalty payments represented a combination of survey data, state-level statistics, and information obtained

from various state and federal governmental agencies.

Input-Output Analysis

Economic activity from a project, program, policy, or activity can be categorized into direct and secondary impacts. Direct impacts are those changes in output, employment, or income that represent the initial or first-round effects of the project, program, policy, or activity. Secondary impacts (sometimes further categorized into indirect and induced effects) result from subsequent rounds of spending and respending within the economy. Input-output (I-O) analysis traces linkages (i.e., the amount of spending and respending) among sectors of an economy and calculates the total business activity resulting from a direct impact in a basic sector (Coon et al. 1985).

This process of spending and respending can be explained by using an example. A single dollar from a North Dakota wheat producer (*Households* sector) may be spent for a loaf of bread at the local store (*Retail Trade* sector); the store uses part of that dollar to pay for the next shipment of bread (*Transportation* and *Agricultural Processing* sectors) and part to pay the store employee (*Households* sector) who shelved or sold the bread; the bread supplier uses part of that dollar to pay for the grain used to make the bread (*Agriculture-Crops* sector) ... and so on.

RESULTS

The economic contribution of the petroleum industry was primarily based on estimates of in-state expenditures from exploration, extraction, transportation, and processing of crude oil and natural gas. Estimates of in-state expenditures were combined with estimates of oil and gas royalties, state severance taxes, and lease bonuses to determine total direct impacts. Subsequently, the direct impacts were applied to the North Dakota Input-Output Model to estimate the secondary impacts.

Direct Economic Impacts

The direct impacts from the petroleum industry in North Dakota included expenditures for exploration, extraction, transportation, and processing of crude oil and natural gas in North Dakota. Direct impacts also included various revenue streams originating from either oil and gas exploration, such as lease bonuses, or oil and gas production, such as severance taxes and royalty payments.

Exploration

The economic effects of exploration come from expenditures within North Dakota for activities such as seismic testing, geological research, lease expenses, environmental research, land survey work, excavation, road building, construction of drill site, delivery of electricity, pipeline development, and actual drilling of oil and/or gas wells.

In-state expenditures for exploration and drilling were estimated at about $1.5 million per well drilled[1]. The petroleum industry drilled 240 wells in North Dakota in 2005, yielding about $362.9 million in direct impacts. Lease bonuses in North Dakota were estimated at over $82 million in 2005, which included $12.5 million for state leases, $4.7 million for federal leases (public domain lands only) (U.S. Department of Interior 2007), and about $65 million for private mineral leases. The $4.7 million in federal lease bonuses from public domain lands represented the portion returned to North Dakota. Federal lease

[1] Industry sources indicated that average drilling costs in 2006 were nearly three times higher than in 2005.

bonuses for acquired lands (i.e., primarily National Grasslands) were included in royalty payments and not included in exploration impacts. The combination of exploration expenses and lease bonuses resulted in $445.1 million in direct impacts in 2005 (Table 1).

Extraction

The economic effects of extraction come from expenditures for removing crude oil and natural gas from the ground, maintenance and inspections of equipment, and all other production related activities, such as well work overs, well idling, shutdown, and abandonment activities. Also included were the general business expenditures incurred in North Dakota by oil operators. Royalty revenues, both private and public, as well as state collections from the gross production tax and extraction tax (severance taxes), were included as direct impacts.

Estimates of total in-state expenditures in 2005 for extraction/production and general business expenses were derived from the survey of oil operators and estimated on a BOE basis. North Dakota produced 35,659,583 barrels of oil and 57,970,459 mcf of natural gas in 2005. Those volumes of oil and gas resulted in an estimated $304.4 million for in-state expenditures for extraction and $218.3 million for general business expenses. State royalties were about $18 million (North Dakota State Land Department 2007). Total federal royalties returned to North Dakota were about $19.4 million (U.S. Department of the Interior 2007, U.S. Forest Service 2007).

Total royalties reported by oil operators were estimated at 13 percent and 13.3 percent of well output for oil and gas, respectively. Private royalties were estimated by subtracting state and gross federal royalties from estimated total royalties. Private royalties from oil and gas production in North Dakota in 2005 were estimated at $197 million. Total collections from the gross production tax and extraction tax in calendar year 2005 were about $91.6 million and $60.9 million, respectively (Office of State Tax Commissioner 2007). Total direct impacts in the extraction/production segment of the industry were estimated at $909.6 million (Table 1).

Processing

The processing segment of the industry included transportation of crude oil and natural gas by truck and pipeline to collection points and processing centers, natural gas processing, and crude oil refining. Estimates of in-state expenditures for natural gas pipeline operation, crude oil pipeline operation, natural gas processing, and crude oil refining were obtained from the survey of processors. Direct impacts included $26.7 million in transportation expenses paid to in-state entities by oil operators. Processing activities, which included pipeline transportation of unprocessed natural gas and crude oil, natural gas processing, and crude oil refining were estimated to have in-state expenditures of $105.8 million. Total direct impacts were estimated at $132.5 million (Table 1). To avoid double counting of potential impacts, in-state purchases of crude oil and unprocessed natural gas by processors were excluded in the study.

Table 1. Total Direct Impacts, Petroleum Industry, North Dakota, 2005

Economic Sector	Industry Component			
	Exploration	Extraction	Processing	Totals
	---------- 000s $ ----------			
Construction		983	22,591	23,574
Transportation		10,414	27,479	37,893
Communications and Public Utilities	6,793	39,214	19,691	65,698
Ag Processing and Misc Manufacturing		36,822	5,090	41,912
Retail Trade	67,249	58,785	4,527	130,561
Finance, Insurance, and Real Estate	19,618	30,767	6,287	56,672
Business and Personal Services	25,133	25,713	4,190	55,036
Professional and Social Services	10,526	10,541	900	21,967
Households (personal income)	273,629	468,012	31,380	773,021
Government	42,174	228,318	10,350	280,842
Total	445,122	909,569	132,485	1,487,176

Secondary Economic Impacts

Secondary economic impacts were estimated for exploration, extraction, and processing components of the industry. Results from the North Dakota Input-Output Model revealed that secondary economic impacts from exploration in North Dakota in 2005 would be nearly $775 million. The $910 million in direct impacts for oil and gas extraction (production) activities produced an estimated $1.4 billion in secondary economic impacts. Finally, the transportation and processing segment was responsible for $238 million in secondary economic impacts. Total secondary economic impacts from all components of the petroleum industry were estimated at $2.4 billion. Across all industry segments, considerable secondary impacts were generated in the *retail trade* ($774 million), *households* ($740 million), *government* ($121 million), and *communications and public utilities* sectors ($119 million).

Government Revenues

Governmental revenues, usually based on tax collections, are another important measure of the economic effect of an industry on an economy. The petroleum industry is unlike many other industries in North Dakota in that severance taxes (taxes placed on the value of oil and gas removed from the ground) are based on gross revenues produced by the industry. In contrast, taxation for most other industries is more traditional and usually limited to real property and net income. Another distinction that makes the petroleum industry different from most industries is that governments can hold mineral leases and receive royalties and lease bonuses. Of course, the petroleum industry also generates revenues from traditional sources, such as personal income, corporate income, sales and use, and property tax collections.

Severance taxes, sales and use taxes, personal income taxes, corporate income taxes, property taxes, royalties, lease bonuses, charitable donations, and licenses, fees, and permits combined for $280.8 million in government revenues that were directly attributable to the petroleum industry in North Dakota in 2005 (Table 2). Exploration, extraction, and processing segments of the industry were responsible for about 9, 87, and 4 percent, respectively, of the total government revenues from the petroleum industry in North Dakota.

Table 2. State and Local Government Revenues, Petroleum Industry, North Dakota, 2005

Revenue Type	Included as direct impacts	Estimated from secondary impacts
	---------- 000s $ ----------	
Severance Taxes	152,509	not applicable
Royalties	38,054	not applicable
Lease Bonuses	17,145	not applicable
Property Taxes	13,980	not applicable
Sales and Use Taxes	8,226	35,820
Corporate Income Tax	8,035	not available
Personal Income Tax	6,741	19,663
Licenses, Permits, Fees	5,118	not available
Charitable Donations	184	not available
Undetermined Taxes[a]	30,850	not applicable
Total	280,842	55,483

[a] Represents general in-state taxes paid that were not specifically identified by survey respondents.

Gross Business Volume

The total economic effect of an industry on a local, state, or regional economy can be measured by estimating the total amount of business activity generated by that industry. Total business activity, sometimes called gross business volume, is generally defined as a combination of direct and secondary economic impacts.

The in-state gross business volume (direct and secondary impacts) of oil and gas exploration was estimated at $1.2 billion in 2005. Extraction of oil and gas generated a gross business volume of $2.3 billion in 2005. The processing component of the petroleum industry in 2005 was estimated to generate a gross business volume of about $370 million (Table 3).

Industry-wide direct impacts from the petroleum industry were estimated at $1.487 billion in 2005. Total secondary economic impacts associated with the industry were estimated at $2.4 billion. The gross business volume for the petroleum industry in North Dakota in 2005 was estimated at $3.9 billion (Table 3).

Table 3. Direct and Secondary Economic Impacts, Petroleum Industry, North Dakota, 2005

Economic Sector	Industry Component			
	Exploration	Extraction	Processing	Totals
	---------- 000s $ ----------			
Construction	31,111	55,150	30,439	116,700
Transportation	3,973	17,249	28,737	49,959
Communications and Public Utilities	46,523	107,557	30,682	184,762
Ag Processing and Misc Manufacturing	16,970	90,650	12,644	120,264
Retail Trade	324,000	508,403	71,801	904,204
Finance, Insurance, and Real Estate	77,254	132,104	21,392	230,750
Business and Personal Services	46,489	63,075	9,772	119,336
Professional and Social Services	43,540	67,586	8,560	119,686
Households (personal income)	509,869	885,562	117,090	1,512,521
Government	80,028	296,983	25,637	402,648
Other sectors[a]	40,320	93,695	13,842	147,857
Gross Business Volume	1,220,077	2,318,014	370,596	3,908,687

[a] Includes various agricultural and mining sectors.

Employment

Estimates of direct employment within the petroleum industry were generated from the survey of oil operators, processors, and service and support firms. Employment figures from the survey of oil operators were extrapolated to state totals based on a BOE basis, while employment data from the survey of processors was extrapolated based on state-level processing volumes.

Oil operators (firms owning or operating wells) contract much of the work of exploration and extraction of oil and gas to firms that specialize in various aspects of the those processes. The questionnaire used in the service and support survey was designed to address the degree of job support attributable to only petroleum activities in North Dakota for those firms working in the oil fields.

Employment in North Dakota by oil operators in 2005 was estimated at 1,794 full-time equivalent (FTE) positions. Employment in the processing segment of the industry, which included some pipeline employment, was estimated at 471 FTE jobs. Total employment in the oil field for contract work, which includes exploration and extraction segments of the industry, was estimated at 3,001 FTE jobs. The petroleum industry[2], as defined and evaluated in this study, was estimated to create and support 5,267 FTE positions in North Dakota in 2005.

Secondary employment is a term used

[2] The American Petroleum Institute reported that the petroleum industry in North Dakota was responsible for 5,796 jobs in 2005, which included 1,379 jobs in transportation and 1,681 jobs in wholesale operations; two components of the petroleum industry that were only partially included in this study. The American Petroleum Institute also estimated that retail gasoline stations in the state were responsible for 4,115 jobs in 2005; employment that was considered in addition to the 5,796 jobs attributable to other segments of the petroleum industry (American Petroleum Institute 2006).

to describe jobs that are created and supported by the volume of business activity generated by an industry, but does not include jobs that are part of the industry. The petroleum industry in North Dakota was estimated to generate $2.4 billion in secondary business activity, which was sufficient to support 20,650 FTE jobs in North Dakota.

SUMMARY AND CONCLUSIONS

The purpose of this study was to estimate the economic contribution of crude oil and natural gas exploration, extraction, transportation, and processing in North Dakota in 2005. Data for the study came from a survey of oil operators (i.e., firms that own or operate oil wells), a survey of pipeline and processing firms, and a survey of firms that provide service and support in the oil fields. Each survey collected information on the amount and type of in-state expenditures and employment in North Dakota.

Estimates of total in-state expenditures in 2005 for exploration (e.g., seismic testing, well drilling) were estimated at $363 million and bonuses for net federal, state, and private leases were estimated to be $82 million. The combination of in-state expenses for exploration and lease bonuses resulted in $445.1 million in direct impacts. The secondary economic impacts associated with exploration activities were estimated at $775 million, which produced a gross business volume of $1.2 billion (Figure 4).

Estimates of oil and gas production expenses, administrative expenses for oil operators, private and public mineral royalties, and state severance taxes were derived from survey data and information from various government agencies. Total direct impacts for extraction were estimated at about $910 million, which included $304 million for in-state production expenses, $218 million for general business expenses, $234 million in net federal, state, and private oil and gas royalties, and $153 million in state severance taxes. Total secondary economic impacts associated with extraction activities were estimated at $1.4 billion. The in-state gross business volume of oil and gas extraction was estimated at $2.3 billion in 2005 (Figure 4).

In-state expenditures for pipeline operation, natural gas processing, and crude oil refining were estimated to have a direct impact in North Dakota of $132 million. The processing segment of the industry produced a gross business volume of $370 million, which included $238 million in secondary impacts (Figure 4).

Industry-wide direct and secondary economic impacts from the petroleum industry were estimated at $1.5 billion and $2.4 billion, respectively. The gross business volume for the entire industry in North Dakota in 2005 was estimated at $3.9 billion. A gross business volume of $3.9 billion translates to about $86 per BOE. Based on active wells in the state, the overall economic effect (direct and secondary impacts from all segments of the industry) would be about $1.15 million annually per active well.

Additional measures of the petroleum industry's economic importance to the state include direct employment for 5,267 full-time jobs, economy-wide personal income of $1.5 billion, statewide retail sales of over $900 million, direct contributions to local and state government tax revenues of over $280 million, indirect contribution of $55 million in general state tax collections, and secondary employment of 20,650 full-time equivalent jobs.

The industry generally receives little outside attention when production is declining or energy prices remain modest; however, when oil revenues increase either through expanded production and/or higher prices, the industry garners much attention from policymakers, business leaders, and the

general public. While this study is a snapshot in time, results from this study would suggest that recent upswings in energy prices, drilling activity, and oil and gas production in North Dakota have made the petroleum industry one of the largest single industries in the state. By comparison, gross business volumes for the wheat industry and coal industry in North Dakota were recently estimated at $3.56 billion and $1.8 billion, respectively. Current activity levels in the petroleum industry clearly make it one of the key forces in the North Dakota economy.

North Dakota Petroleum Industry

Key Segments of the Industry

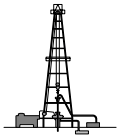
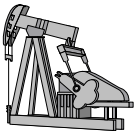
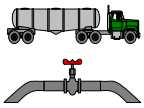
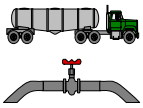
	Exploration	Extraction	Transportation	Processing	Distribution	Retail
	drilling and locating oil reserves 	bringing oil and gas to the surface 	moving oil and gas from pumps to processing centers 	oil refining and natural gas processing	moving products from processors to retail markets 	selling petroleum products to end users
Direct Impacts	$445 million	$910 million	$132 million		not included	
Secondary Impacts	$775 million	$1.4 billion	$238 million			
Gross Business Volume	$1.2 billion	$2.3 billion	$370 million			
Direct Employment	4,795 full-time equivalent jobs		471 full-time equivalent jobs			
Secondary Employment	20,650 full-time equivalent jobs					
Government Revenues	$42 million	$228 million	$10 million			

Figure 4. Economic Effects of Key Segments of the Petroleum Industry, North Dakota, 2005

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Further Information

This document is a summary of a more comprehensive report which contains additional information. Single copies of this summary publication are available free of charge. Please address your inquiry to the Department of Agribusiness and Applied Economics, North Dakota State University, PO Box 5636, Fargo, ND 58105-5636, phone (701-231-7441), fax (701-231-7400), or e-mail: Norma.Ackerson@ndsu.edu.

The main report and this summary document are also available electronically at the following web sites: http://ageconsearch.umn.edu/ or http://www.ndoil.org/ .

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The authors assume responsibility for any errors of omission, logic, or otherwise. Any opinions, findings, or conclusions expressed in this publication are those of the authors and do not necessarily reflect the views of the North Dakota Petroleum Council or the NDSU Department of Agribusiness and Applied Economics.

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