# An Examination of Pennsylvania's Oil and Gas Industry


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# An Examination of Pennsylvania's Oil and Gas Industry

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The Center for Rural Pennsylvania is a bipartisan, bicameral legislative agency that serves as a resource for rural policy within the Pennsylvania General Assembly. It was created in 1987 under Act 16, the Rural Revitalization Act, to promote and sustain the vitality of Pennsylvania's rural and small communities.

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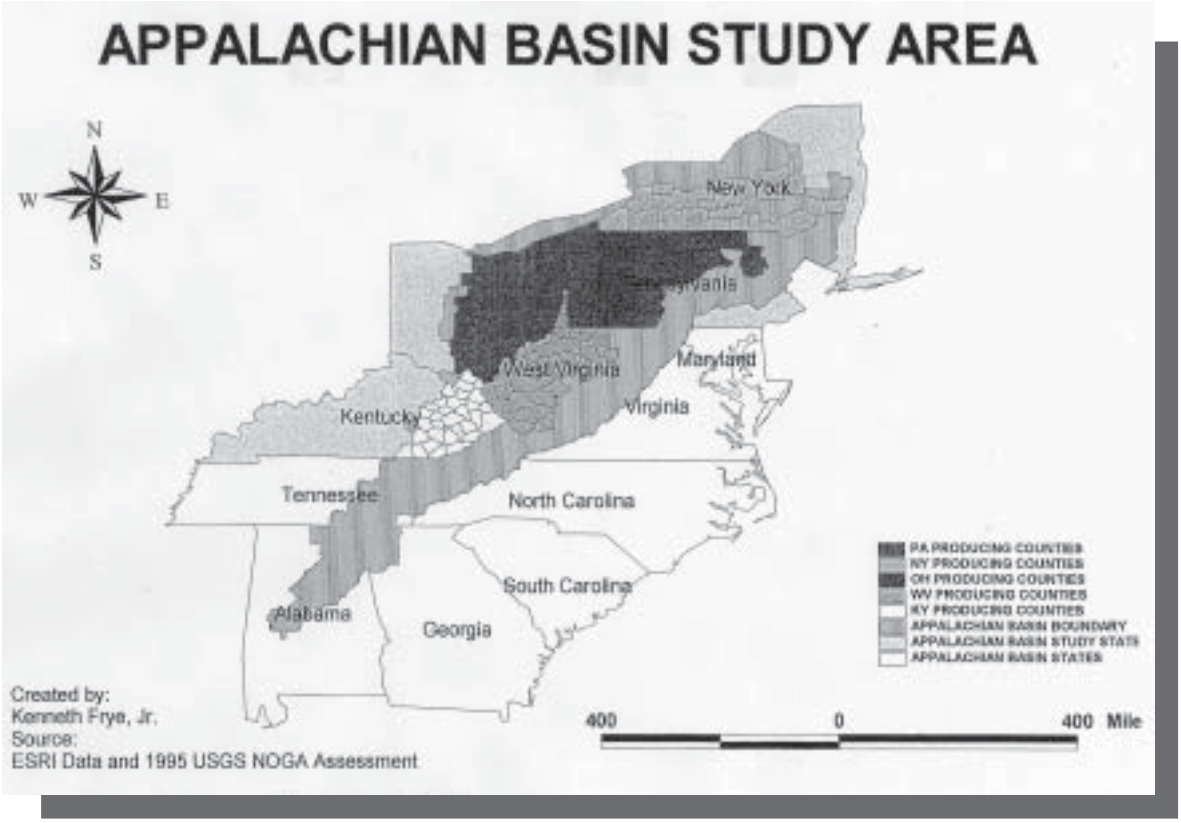
# Introduction

In 1859, near Titusville, Crawford County, Pennsylvania, 'Colonel' Edwin Drake drilled the first commercially valuable oil well, giving rise to the modern petroleum industry and consequently changing the world forever. While no longer a leader in the industry, western Pennsylvania still remains an attractive and viable source for energy production in the eastern United States.

## The Appalachian Basin

Oil and gas in western Pennsylvania were deposited in varying intervals as the Appalachian Basin was being developed. During the Paleozoic Era, the area now known as the Appalachian Basin was situated between the North American continent to the West and other landmasses to the East. As weathering processes eroded the land, rivers flowing from the East and West carried sediments into the basin. Along with these sediments, organic materials were also deposited, which according to popular belief became the foundation for the oil and gas formed within the rocks. As additional amounts of sediment were carried into the basin, the additional overburden acted to press down on the underlying crust and compact the previously deposited sediments, allowing for more sediments to be carried into the basin. This resulted in thicker sequences of rocks along the axis of the basin, while gradually thinning towards the edges. Following deposition, the sediments of the Appalachian Basin turned into solid rock, and then later deformed as a result of the creation of the Appalachian Mountains. Since the creation of the Appalachian Basin, the geology has changed very little. The thickest sequences of rocks still remain along the axis of the basin, and gradually thin out at the margins. The axis of the basin, and therefore deepest part is situated under western Pennsylvania and West Virginia.

Herein lies the geologic setting for oil and natural gas production within the Appalachian Basin, and the predicament of Pennsylvania's oil and gas industry.



### Pennsylvania on the Axis

Because Pennsylvania is situated along the axis of the basin, production companies must drill through rock that is thicker than in neighboring states along the basin margin. In essence, to get to the same rock unit, one would have to drill deeper in Pennsylvania than in Ohio or New York. This puts Pennsylvania at a disadvantage because much of the cost of production is tied to drilling costs.

Although nothing can be done to change the geologic setting of the Appalachian Basin, other factors can be manipulated to create a beneficial impact on the vitality of Pennsylvania's oil and gas industry. Economic factors, such as price, affect all of the states in the basin equally, however regulatory practices, such as permitting, are controlled by individual states and may affect production from state-to-state. The same is true for taxation policies. Reservoir management practices could also play a role in strengthening the industry.

Although the oil and gas industry has its foundation in the application of physical laws to the location and production of oil and gas, much of the vitality of the industry is tied into a global, regional and local network of economic and political considerations. Furthermore, the industry, which had its birth in the rural counties of Pennsylvania in the mid 1800s, has suffered a decline in Pennsylvania. This decline has had a great economic impact in rural Pennsylvania.

## Data Limitations

As with all secondary data, there are some limitations. For one, there are differences in how each state administers the reporting of production figures. It would be ideal to have a unified reporting procedure among the states, but this is not realistic at this time.

For example:

- West Virginia has a 5 percent severance tax on gross production, but the production figures are submitted to the revenue office and not the West Virginia Department of Environmental Protection (DEP), which processes the data. WV DEP informed the project team that producers do not always report their data in a timely manner, nor does the state provide enough resources for inputting the reported data into the database (*From interview with Katharine Lee Avary, Petroleum Geologist and Head of Oil and Gas Program, West Virginia Geologic and Environmental Survey, 2003*).
- Since 1991, Pennsylvania has had a requirement to report production but it has not been enforced. Prior to 1991, reporting was not required and was done on a voluntary basis (*From interview with John Harper, Section Chief-Oil, Gas, and Subsurface Services, Pennsylvania Bureau of Topographic and Geologic Survey, 2003*).
- Ohio has a unified reporting system and the Ohio Geological Survey receives dedicated funds from permitting fees. These funds can be used, in part, to maintain the database (*From interview with Mike McCormac, Geologist, Ohio Division of Mineral Resources Management, 2003*).

Another limitation is that producers may manipulate production to maximize their profits. Because the business of oil and gas is extremely competitive, producers often opt to protect as much information as possible pertaining to exploration and production. Since some states do not require producers to report exact production figures directly to the departments responsible for collecting them, producers might report data either partially or not at all. For example, producers may decide to stop production when the price is low, so a particular well may have no production for a given year. Then, if the price of oil or natural gas increases the next year, that producer may resume production with that well and not report it, so that profits can be maximized.

Therefore, it is impossible to determine the extent to which the production figures represent the 'true' oil and gas production within each state. Despite conversations with state and private entities in an attempt to determine how close the data in this study was to actual production figures, a standard deviation was never determined.

# Methodology

This project was conducted in 2003-2004 to examine issues that could potentially affect the oil and gas industry of Pennsylvania. These issues were examined as they pertained to Pennsylvania as well as to other oil and gas producing states within the Appalachian Basin.

The first step was to examine the trends in both oil and gas production within the Appalachian Basin. By graphing and mapping this data, which was obtained from state agencies, the researchers could both clarify the production picture and assess the overall health of the industry.

In the second part of this study, the researchers investigated measures of vitality that affect the oil and gas industry of the Appalachian Basin. This step covered statewide instances of environmental activism, state regulatory practices, tax credits, permitting requirements, and other factors that could affect the industry. Data for this segment came from state geological surveys and industry consultant project partners.

Conclusions and policy considerations were formulated from the data collected and interviews conducted during the study period.

Due to data availability, oil and gas production figures were collected for the years 1975 through 2001. Most state databases are reasonably complete beginning in 1975 and all state databases were relatively complete through 2001.

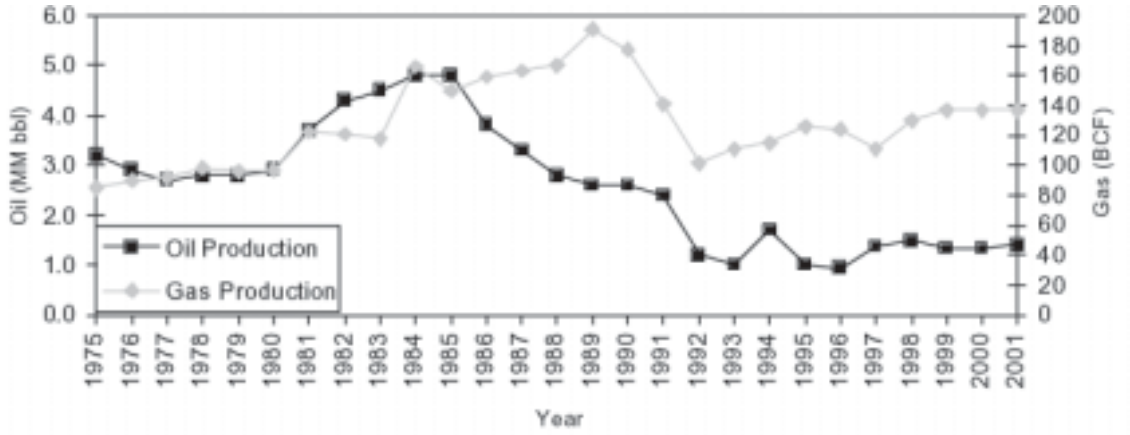
In collecting data from the agencies involved, the project team discovered that each state reported data in various formats. Since the units of record for both oil and natural gas varied from agency to agency, data for the study was converted to million barrels (MM bbl) for oil production, where one barrel of oil contains 42 U.S. gallons (158.76 Liters); and to billion cubic feet (BCF) of gas for natural gas production.

Oil production for Pennsylvania remained fairly steady for the time period of this study as shown in Chart 1. The highest production occurred in the mid-1980s at nearly 5 MM bbl, succeeded by low production in the mid-1990s, at less than 1 MM bbl. This was followed by a slight increase in production, at about 1.4 MM bbl in 2001. For purposes of comparison, a larger oil producing state, such as Alaska, produced 738 MM bbl in 1988 (source: IPAA). Thus, clearly Pennsylvania is not a very large player in domestic oil production despite its prominent role in the history of the industry.

Gas production in Pennsylvania has ranged from a low of 85 BCF in 1975 to a high of 191 BCF in 1989. (See Chart 1).

As seen in Chart 2 on page 8, all five states showed an increase in oil production in the early 1980s, which is most likely associated with federal tax credits. Although none of the states

**Chart 1: Pennsylvania Oil and Gas Production, 1975-2001**



examined in this study are major players in the domestic oil industry, Ohio clearly leads in production, eclipsing Pennsylvania production by more than four times.

Chart 3 shows that West Virginia is the leader in natural gas production among the five study states.

**Chart 2: Appalachian Basin Oil Production, 1975-2001**

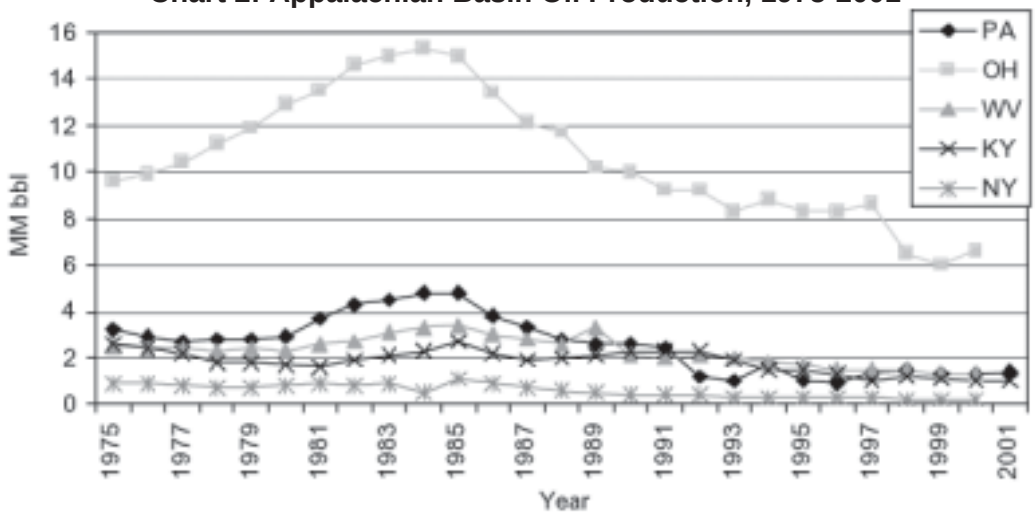
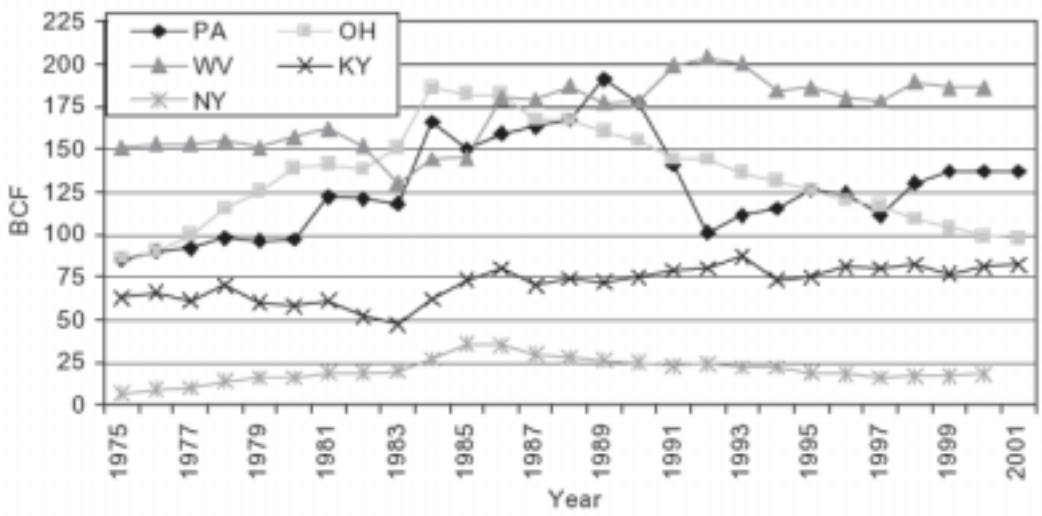



**Chart 3: Appalachian Basin Natural Gas Production, 1975-2001**



# Factors Affecting the Growth and Viability of the Industry

## Drilling Permits

To determine additional measures of growth and viability in Pennsylvania's oil and gas industry, an initial list of parameters was created and discussed among the project team. After considering the differences in data collection methods among states, the researchers determined that the most prudent measure of industry vitality would be to document changes in the number of permits issued to producers from each state. Disparities in the means of collecting data by the respective state agencies involved in this study left vacancies in the period of study for each state so the study period was confined to only include the years that were congruent to each state in respect to permit data availability.

Chart 4 shows the permit data obtained from each state in the study. The data collected was indicative of total permit activity across the state, regardless of whether the well was being drilled for the first time or being drilled deeper to develop other reservoirs. Specific tracking of re-drilled wells or expired permits being reissued is not tracked accurately at this time.

Analysis of the available data collected shows that Pennsylvania leads the Appalachian Basin in the issue of permits for drilling. The assumption is that more activity leads to increased economic value in the oil and gas industry. Given the costs incurred by drilling a well for oil or natural gas, a production company's main goal is to produce a successful well; therefore permit applications are believed to indicate attempts to produce reserves from Pennsylvania's reservoirs that would prove to be economically viable for the production company in question.

## Economic Incentives

An examination of reported production during the course of the study period indicated that production in the Appalachian Basin has remained fairly steady from 1975 through 2001. However, there was a spike in both production and permit activity during the early 1980s. It may be that the introduction of federal tax credits on production of natural gas helped spur activity within the Appalachian Basin during that period. These tax credits were issued to producers to facilitate the production of natural gas from normally economically disadvantaged sites, or "plays," such as the tight sands and gas shales found in Pennsylvania. The incentives, known as the Act 29 Devonian Shale and Tight Sands Credit, were first imposed during the mid 1980's,

**Chart 4: Appalachian Basin Permit Activity, 1975-2001**

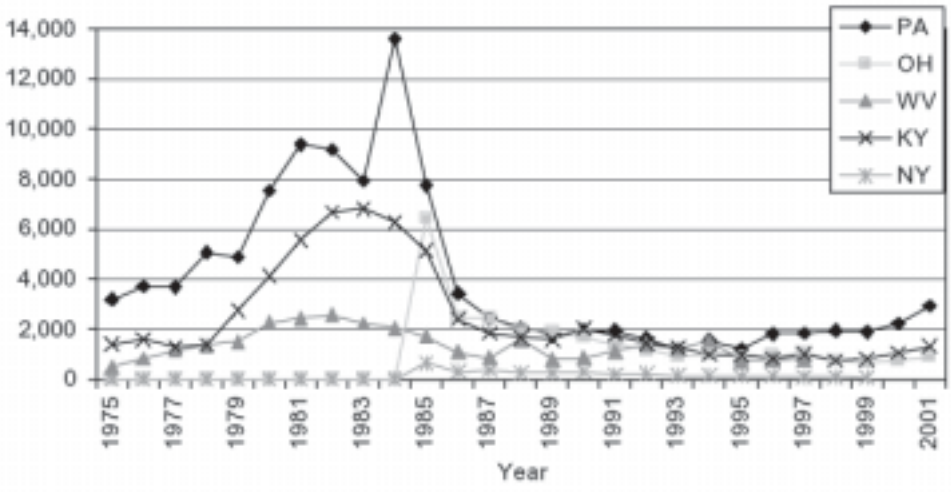


**Table 1: Severance Tax and Permit Fees**

| State | Severance Tax | Type of Severance Tax Imposed | Permit Fee | Length of Permit Validity |
|---|---|---|---|---|
| Pennsylvania | NO | N/A | $250/oil, $350/gas | 12 months |
| Ohio | YES | $0.10 per bbl and $0.025 per MCF + county ad valorum tax | $250 | 12 months |
| West Virginia | YES | 5% on gross production | $450 | 24 months |
| Kentucky | YES | 4.5% on all production + variable county tax | $300 | 12 months |
| New York | YES | Based on real property value | $100 + $190 per 500 feet drilled | 6 months |

and lasted until 1991. The incentive offered by the Federal Energy Regulatory Commission (FERC) was approximately $1 per MCF of gas for the production of non-conventional fuels produced from coal seams and Devonian age shales, and approximately $ 0.66 per MCF for production from sandstone formations classified as tight (sandstone maintaining a permeability of less than 0.01 millidarcies) by FERC.

Given the steady price of natural gas during the years leading up to the introduction of the tax credits, coupled with the technology of the time, production from tight sands and shales previously was simply too uneconomical for both privately and publicly held production companies.

## Regulation

One major regulation that varies among the states is the severance tax imposed on production. The U.S. Department of Energy (DOE) defines severance taxes as those levied against producers according to either the quantity of oil or natural gas that is produced (dollar-per-unit tax), the value of the oil or natural gas that is produced (ad valorem tax), or how much a particular area is expected to produce (property tax). Currently, as seen in Table 1, New York, Ohio, West Virginia and Kentucky all impose some form of taxation on production. Pennsylvania does not employ a severance tax system on production. It may be that this fact, along with Pennsylvania's reserve base, makes the state very attractive for development, as shown by Pennsylvania's lead in permit activity.

A second regulation that affects the oil and gas industry in the Appalachian Basin is the process of permitting wells. Also seen in Table 1, each state charges different fees for the right to drill a well, and each state has a different time period within which the permit is valid. In Pennsylvania, a permit is valid for one year; however, once the well is drilled, the permit is valid until the well is plugged.

Through interviews with state personnel and in collecting data in states that do and do not impose severance taxes, it appears that the presence or absence of a severance tax system does not influence the reporting of production data or the quality of the database.

## Environmental Issues

To continue expanding on the production of natural resources within the Appalachian Basin, there are environmental concerns that must be addressed by the oil and gas industry. Some concerns focus on the impact that producing oil and gas will have on groundwater sources, including secondary methods of recovery instituted on older fields, and potential problems associated with the hydraulic fracturing of coal seams in the production of coal bed methane. In New York, concern has arisen over secondary production in older fields, due in part to the integrity of the casings of these fields. Given the techniques involved in producing the remaining oil within the reservoirs, the integrity of these wells could be compromised and could potentially have damaging repercussions to underground sources of drinking water. If it

becomes economically viable to employ secondary recovery on Pennsylvania's oil fields, this issue would need to be addressed to prevent groundwater disruptions. Likewise, the U.S. Environmental Protection Agency has asked the Ohio Oil and Gas Association to comment on the potential impact that hydraulic fracturing of coal seams would have on drinking water derived from underground sources.

In Pennsylvania, public concerns have arisen due to the granting of leases on state-owned forestland. Of the approximately 2.1 million acres of state owned forestland, the state recently offered 500,000 acres for leasing opportunities. However, the leasing auction was postponed and the lease area was reduced to 218,210 acres due to pressures from environmental groups and citizen write-in campaigns.

The leases in question were intended to spur activity in the Trenton-Black River natural gas producing formation, a formation largely undeveloped in Pennsylvania but successful elsewhere in the basin.

The Pennsylvania Department of Conservation and Natural Resources' (DCNR) Bureau of Forestry has also experienced criticism recently from the oil and gas industry. The Bureau of Forestry's Strategic Plan issued a ban on shallow drilling of oil and gas but permitted the exploration of deeper drilling. The reason for the uproar from the industry was due to differences between the two methods. According to industry personnel, deep gas drilling is a far more risky venture and involves drilling larger boreholes and cleared areas, resulting in a greater chance for environmental impact. Shallow drilling, on the other hand, involves much less waste and can be confined to very small areas with little environmental impact.

## Producer Practices

Aside from economic incentives, there are also several practices instituted by the oil and gas industry that can influence production. Currently, many operators quickly reduce reservoir pressure to produce as much oil or natural gas as possible in an effort to pay off the investment in the well as quickly as possible. However, this practice compromises the maximum potential that can be experienced from the well. According to a study conducted on two similar natural gas producing Upper Devonian sandstone wells located in western Pennsylvania, the well that had its pressure held produced nearly twice as much gas as the well that had its pressure drawn down rapidly to produce gas more quickly. In essence, if steady pressure were applied basin wide, the initial production and profits would be somewhat lower than usual, but the life of the fields would be extended greatly, and greater profits would be experienced during the long term.

Technological innovation has also played an important role in increasing production and enhancing recovery of oil and gas. One key innovation introduced during the early 1980s was slim-hole drilling technology. This technology allowed production companies to reduce drilling costs and drill deeper wells, while maintaining or even increasing production levels.

Along with slim-hole drilling, hydro-fracturing techniques were improved to allow higher rates of secondary recovery and better methods of reservoir management.

The improvement of geophysical surveying has improved the understanding of reservoir characteristics. Geophysical surveying is a method of mapping underground rock formations through the use of energy waves that penetrate deep into the earth.

Finally, exploration of unconventional settings by various production companies has also increased reserves. These settings, such as tight sands, shale, and coal-bed methane, are often difficult to make economical without incentives, however, they can be sources of large quantities of reserves.

# Conclusions

Oil and natural gas were first commercially produced in northwestern Pennsylvania, giving rise to the modern petroleum industry and changing the world forever. Despite not remaining an industry leader, western Pennsylvania still remains an attractive and viable source for natural energy production in the eastern United States.

***After analyzing the data and information collected for this study, a number of interesting considerations were discovered that could influence the growth and vitality of the oil and gas industry in Pennsylvania and the Appalachian Basin in the years to come.***

After analyzing the data and information collected for this study, the researchers uncovered a number of interesting considerations that could influence the growth and vitality of the oil and gas industry in Pennsylvania and the Appalachian Basin in the years to come.

A notion that was quickly dismissed was the misconception that 'nothing was in Pennsylvania', and that it was only a matter of time before the industry all but died out. Pennsylvania's geologic setting is in the deeper and thicker sedimentary sequences of the Appalachian Basin that potentially lead to greater amounts of reserves. The *Atlas of Major Appalachian Natural Gas Plays* shows that a vast number of potential reserves that have been exploited in other states are left largely untouched within Pennsylvania.

One factor that may account for the untapped resources is competition between the petroleum and coal industries of Pennsylvania. Because the coal industry became so prevalent throughout southwestern Pennsylvania, many successful natural gas plays were left underdeveloped.

Pennsylvania maintains several advantages to revitalizing the oil and gas industry, including a well established pipeline network that not only transports oil and natural gas from other parts of the Appalachian Basin, but also from other parts of the country, such as Texas and the Gulf Coast to the energy dependent northeast. This network is significant in that it enables Pennsylvania to distribute its own energy at little to no cost, enabling it to take advantage of this valuable commodity.

Pennsylvania is beginning to keep pace with other states in the Appalachian Basin in regard to electronic databases of oil and gas data. DCNR's Internet Record Imaging System (IRIS), combines the Pennsylvania Geological Survey's wells information system and oil and gas base map GIS system with corresponding scanned images of oil and gas documents, such as completion reports and electronic well logs.

Although detailed maps of the major natural gas plays already exist in the *Atlas of Major Appalachian Natural Gas Plays*, detailed maps using today's technology could potentially assist in reducing the risk incurred by exploring the deep reservoirs found in Pennsylvania. Recently,

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***Pennsylvania is also in a unique position to take advantage of sequestering carbon dioxide from industry in an effort to curb global warming.***

the United States Geological Survey completed a project to map the petroleum producing reservoirs of the United States, including the Appalachian Basin. Although these maps are fairly accurate, complete accuracy is often difficult due to the competitive nature of the oil and gas business. Also, not all areas are prime candidates for indepth mapping of the subsurface. Much is dependent on the play being explored, as well as what area is available for leasing. Essentially, mapping of privately held land would probably best be left up to production companies. However, public lands, such as state forests could be candidates for higher detailed mapping to make such areas attractive for future development. At this time, it is difficult to ascertain who would be better suited to undertake such a project and be as successful as possible, yet remain economical.

Pennsylvania is also in a unique position to take advantage of sequestering carbon dioxide from industry in an effort to curb global warming. This benefit could be accomplished through cooperative efforts developed between the oil and gas industry and the industries responsible for creating the excess.

Currently, the U.S. Department of Energy is undertaking projects that expand on the idea of carbon sequestration both in underground reservoirs as well as other opportunities.

In fact, the department's National Energy Technology Laboratory is currently heading a nationwide partnership to determine the most effective methods for permanent carbon dioxide storage. In December 2004, the second phase of its Regional Carbon Sequestration Partnerships program began. The partnerships of state agencies, universities, private companies, and national laboratories will field test and validate promising carbon sequestration technologies.

Carbon sequestration is relevant to oil and natural gas production in that various enhanced recovery methods require the use of a gas (such as carbon dioxide) to restore the pressures that were lost through the production of oil in a reservoir. In other areas of the country, natural gas, which is produced along with the oil, is often pumped back into the reservoir to assist in the production of additional amounts of oil. By collecting carbon dioxide from industries that generate large amounts of the gas, such as electric generating plants, production companies would be able to use this gas to improve the percentage of recoverable reserves. In effect, it would be merely trading one gas for another, allowing the environmentally conscious to be satisfied with reductions of greenhouse gases, while still satisfying the ever present demand for energy.

# Policy Considerations

After gathering and analyzing data about the oil and gas industry in Pennsylvania, the researchers developed the following policy considerations.

**1. Reimplement tax credits on production**. Given the current demand for energy, more could be done to exploit the reserves in Pennsylvania. Considering the variables involved in producing Pennsylvania's reserve, as well as reserves across the Appalachian Basin, tax incentives on production would serve to stimulate the industry, benefiting both the industry and the state. This recommendation would most likely involve Pennsylvania support for a national energy policy.

**2. Expansion of Royalty–In–Kind Programs.** Royalty-In-Kind Programs are programs in which a landholder is paid in gas rather than money. Currently, the federal government exercises this program in certain areas of Pennsylvania, yet the land area is insignificant. Pennsylvania, especially the western half, is in a unique situation as it contains significant reserves of natural gas, and has a well-established pipeline infrastructure.

**a. Pennsylvania could use its resources and infrastructure to actively lure industry to the state to take advantage of lower energy costs.** This idea is not new. Many businesses located in California have been crossing the border into neighboring states to take advantage of lower energy costs. If an industry could be partnered with a reputable production company to purchase a business site with proven reserves and available mineral rights, the company could proceed to drill a well or several wells to produce their own gas to operate the business, thus reducing the energy costs of these businesses by allowing some independence from utility companies and fluctuating energy costs. It should be noted that the company or industry would not be totally free of utility companies for energy, but would rather supplement their dependence by engaging in such a royalty-in-kind program. This program could result in tremendous energy savings over many years for the businesses involved, and allow the companies to maintain jobs or even expand in the face of rising energy costs, thus providing much needed stimulus to Pennsylvania's rural counties.

**b. Pennsylvania could take advantage of this program as well.** Given the vast amount of state forest land (approximately 2.1 million acres), Pennsylvania could take advantage of future lease auctions to encourage development on state lands, consequently providing the commonwealth with additional royalty revenues for various state institutions, such as universities, hospitals, penal institutions and various state offices. DCNR employs a similar program in which revenue generated from an oil and gas lease fund is used for conservation, recreation, or dam maintenance purposes.

**c. An ambassador program through the Pennsylvania Department of Community and Economic Development could spearhead these Royalty-In-Kind Programs.** The responsibility of the ambassador would be to select and attract businesses or industries to rural Pennsylvania, much like a tourism office is in charge of attracting tourism to an area. In essence, given Pennsylvania's current reserves, infrastructure, and technological know-how, a Royalty-In-Kind program would give Pennsylvania a definite edge in attracting expanding businesses to the state, which would ultimately create new jobs as well as support existing jobs that provide services to oil and gas exploration and development. This program could be successful given the current rising costs of energy.

**3. Use of New Technologies and Incentives**

• Abandoned oil and gas wells can be found throughout the commonwealth. However, these abandoned wells were drilled during varying economic times or with technology that was not as extensive as that used today. Given promising conditions, some companies could re-work these fields with new technology to produce any remaining reserves. How much potential remains in these abandoned reservoirs remains unclear, however, these fields might provide some additional benefits to rural Pennsylvania.

• In Pennsylvania, many reservoirs require the employment of secondary and tertiary recovery methods to obtain maximum production from a reservoir. New treatments are constantly being developed or modified to obtain a maximum yield from a reservoir. DOE is exploring methods of storing excess $CO_2$ (carbon dioxide), called carbon dioxide sequestration. A marrying effort of enhanced recovery technologies and carbon dioxide emitting industries would in effect be trading one gas for another. For example, power-generating plants that use natural gas to create energy could capture the carbon dioxide that is produced from the energy creation and return it to the reservoirs that produced the natural gas in the beginning. Thus, the economics for the businesses involved would improve, and greenhouse gas emissions could be reduced. Given Pennsylvania's position with both of these industries, this idea could potentially provide additional economic stimulus to Pennsylvania, especially rural counties where these industries are located.

• Another avenue to be explored is that of reservoir management practices. Currently, once a well has been drilled, operators are in a position to recover the investment of drilling as quickly as possible. However, this often leads to mismanagement of the reservoir, and in some cases either limits the total amount of reserves that can be produced from that well or ruins the ultimate potential of the well completely. By offering incentives to producers who opt to defer quick profits in return for extended reservoir life and maximum yield, the initial financial shortfall can be offset while conserving a valuable resource.

• Such methods of reservoir management would probably be handled most effectively by an agency, such as DOE. DOE has the resources to apply a basin-wide study to yield solid solutions to the previously mentioned practices, and the ability to offer incentives for producers who efficiently manage their areas. DOE could also offer workshops to explain the benefits of conservation efforts, both in the Appalachian Basin and elsewhere.

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# Web Sources

http://www.naturalgas.org/regulation/history.asp
This educational website covers various topics that are relevant to the natural gas industry.

http://www.ipaa.org/
This website represents the Independent Petroleum Association of America, which is an organization that represents the independent petroleum producers of the United States.

http://www.npto.doe.gov/processdraw/processdraw.html
This website of the National Petroleum Technology Office includes a series of diagrams with descriptions of the various methods of recovering oil from underground reservoirs.

http://www.unb.ca/che/che5134/petro.htm
This website of the University of New Brunswick contains course notes pertaining to course CHE-5134 - Petroleum and Natural Gas Processing, instructed by Dr. Todd Pugsley. It is useful in offering basic information about the oil and gas industry and offers text referrals for future research.

http://www.dep.state.pa.us/dep/deputate/minres/OILGAS/oilgas.htm
This website of the Pennsylvania Bureau of Oil and Gas Management currently hosts production data from 1994, along with regulations pertinent to the oil and gas industry in Pennsylvania. Contacts: Donald Kutzner and David English.

http://www.dec.state.ny.us/
This website of the New York Department of Environmental Conservation, which oversees the oil and gas industry in New York, currently hosts production data summaries from 1967 to 1999, oil and gas statistics from 1991 to 2000, and permit activity from 1985 to 1999. The website also hosts information pertinent to the oil and gas industry in New York. Contact Donald J. Drazan

http://www.wvgs.wvnet.edu/
This website of the West Virginia Geologic and Economic Survey currently hosts oil and gas production data for West Virginia from 1979 to 1999. Contact Katharine Lee Avary.

http://www.ohiodnr.com/geosurvey/
This website of the Ohio Department of Natural Resources, which maintains and oversees the oil and gas industry in Ohio, includes a database that covers the Ohio oil and gas wells in an individual well format. It currently does not host production data for oil and gas wells, the survey was contacted for the pertinent data. Contact: Mike McCormac.

http://www.uky.edu/KGS/emsweb/index.html
This website of the Kentucky Geological Survey and the University of Kentucky currently hosts a variety of information concerning the oil and gas industry in both Kentucky and the Appalachian Basin. Contact: Brandon Nuttall.

http://www.pcf.ab.ca/glossary/default.asp
This website of the Petroleum Communication Foundation hosts a glossary of terms relevant to the petroleum industry.

*(continued on next page)*

http://karl.nrcce.wvu.edu/
This website of the Petroleum Technology Transfer Council includes recent trends in the production of petroleum within the Appalachian Basin. It is a helpful source in determining the plays within the Appalachian Basin that will receive future attention in terms of production. Contact: Dr. Douglas Patchen.

http://energy.cr.usgs.gov/oilgas/noga/
This website of the U.S. Geological Survey includes data obtained during the most recent (1995) assessment of the oil and gas producing plays within the Appalachian Basin. Contact: Laura Biewick.

http://www.netl.doe.gov/coalpower/sequestration/partnerships/
This website of the National Energy Technology Laboratories details the current work being done to reduce the amount of carbon dioxide in the atmosphere.

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