Kentucky's Energy Resource Assessment: Oil, Natural Gas, Tar Sand, and Coalbed Methane

Strengths

- Kentucky's existing oil and gas infrastructure is extensive
- Finding and production costs are low due to the occurrence of shallow resources
- Significant natural gas exists in known fields (mostly the Devonian black shale)
- Much of Kentucky's subsurface data are available in digital format
- The state is centrally located for access and distribution to northern and eastern industrial markets
- Active federal and state funded oil and gas exploration research is being carried out

Weaknesses

- Industry is dominated by small operators with limited access to investment capital and research funding
- Area is perceived as mature with little possibility of significant discoveries (unattractive to larger companies)
- Perceived as a "promoter" haven with no data to verify production claims
- Coalbed methane (CBM) ownership is not established
- Lack of CBM data contributes to the perception that the resource is unecomomic
- Small, stripper, wells must compete with offshore and overseas wells producing significantly greater volumes
- Cheap energy does not foster energy conservation
- Difficult to raise investment capital
- Deep well opportunities are limited by the cost of technology and drilling and limited funding for exploration research

Threats

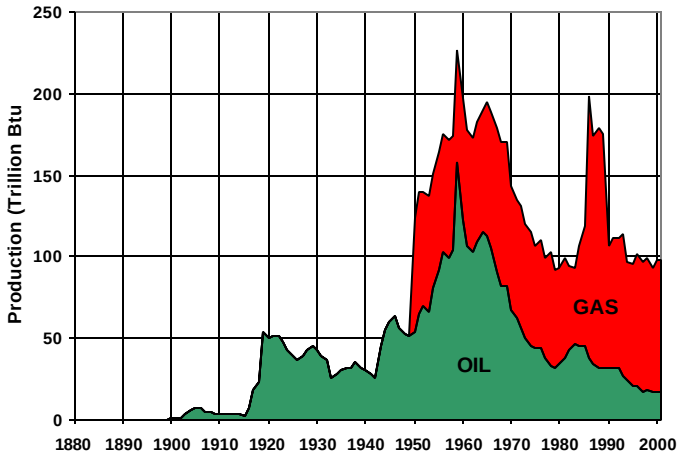
- Resource sterilization
- Price volatility
- Perception that oil and gas operations are fundamentally opposed to environmental issues
- Abandonment of marginal wells limits opportunities for secondary or enhanced production

Opportunities

- Drilling deeper may result in significant new energy resource discoveries
- CBM production could become important
- Tar sands could be produced with innovative secondary or enhanced recovery techniques
- Additional natural gas or oil could be produced from fields during CO_2 sequestration
- Alternative uses for depleted fields include sequestration, gas storage, and waste disposal
- The shift to alternate fuels will create a demand for hydrogen resources that can be served by natural gas
- Small-scale, distributed electric power generation may be facilitated by portable natural gas-powered engines

History

Kentucky's oil and gas industry began in the early 19th century with pioneers searching for salt brines for use in tanning, food preservation, and livestock agriculture. In 1818, Martin Beatty was searching for brine in what is now the Big South Fork National River and Recreation Area in southeast Kentucky. This shallow well initially produced up to 100 barrels per day. Between 1818 and the Civil War, few oil wells were drilled, but they were often spectacular. The "Old American well," drilled near Burkesville, Cumberland County, produced more than 50,000 barrels from its discovery in 1829 until about 1860. The end of the Civil War began the era of exploration for oil and gas. The first commercial gas wells in Kentucky were drilled between 1863 and 1865 in Meade County. The gas was used as fuel to



Kentucky's historic oil and gas production.

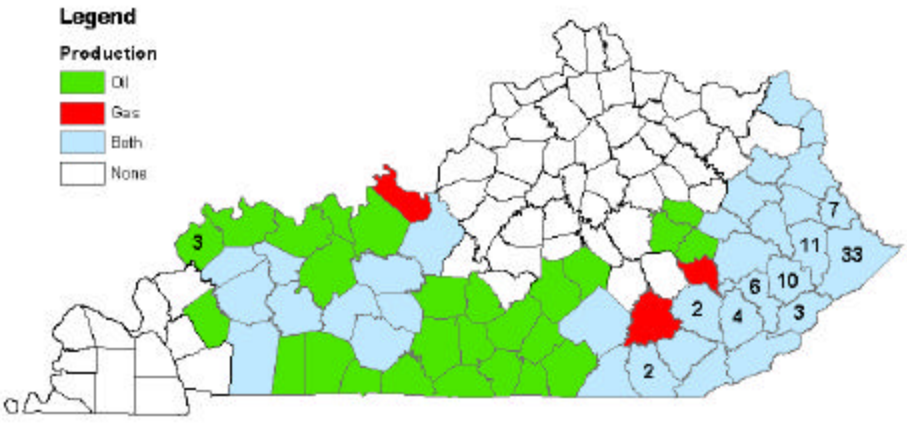
evaporate brines and was later delivered by pipeline to Louisville for lighting and domestic heat. Available historic production data are sparse. The record for statewide oil production starts in 1883. Western Kentucky natural gas production is available from 1933 to 1949. Statewide natural gas data are available beginning 1950. These data indicate Kentucky's total historic oil and gas production exceeds 9.85 quadrillion Btu (765 million barrels of oil and 5.4 trillion cubic feet of natural gas).

Two of Kentucky's potential energy resources have largely been ignored due to lack of information and the low price of oil. Preliminary data indicate natural gas is present in coal beds (coalbed methane or CBM) in both of the state's coal regions. A small pilot project is currently producing CBM in eastern Kentucky. Natural asphalt, known as tar sand, was mined early in the 20th century for road paving material. The tar sand successfully produced in the late 1970's and early 1980's when the price of oil was sufficiently high.

Production

All of Kentucky's counties have been tested to varying depths for oil and gas resources. In 2001, 62 counties reported production. In general, oil production dominates in the western coal field and south central areas of Kentucky; the eastern coal field produces mostly natural gas. Kentucky has an estimated 18,000 producing oil wells and 12,000 producing gas wells. The majority of those producing wells are in the "stripper" category with daily production rates of 60 million Btu or less (10 barrels of oil or 60 thousand cubic feet of gas). Many wells are reported with initial daily production rates in excess of 580 million Btu (100 barrels of oil or 580 thousand cubic feet of gas). However, daily production per well averages much lower: 2.4 million Btu (0.5 barrels) for oil and 19 million Btu (19 thousand cubic feet) for gas in 2001.

In 2001, production totaled 98 trillion Btu (2.8 million barrels of oil and 82 billion cubic feet of natural gas) with a total value of $457 million ($21 million severance tax paid). Annually, Kentucky produces only about 10 percent of the 946 trillion Btu of oil and natural gas consumed in the state (EIA, State Energy Data Report 1999, http://www.eia.doe.gov/emeu/states/main_ky.html).



Kentucky's oil and gas producing counties, 2001. The top ten counties show total production in trillion Btu.

Petroleum is produced at various depths from limestone, sandstone, and shale of Cambrian through Pennsylvanian age. In some areas of the state oil is still produced from depths of less than 100 feet. Wells producing natural gas from the Cambrian Rome Formation are currently Kentucky's deepest producers with some zones exceeding 7,500 feet. The overall average total depth of oil and gas wells drilled in the state is less than 1,500 feet. The average depth for wells drilled in 2001 is more than 2,700 feet. This increase represents the exploration for deeper producing zones and the continuing efforts to develop the Devonian shale natural gas resource, both occur primarily in eastern Kentucky.

Geologic time scale showing major units and their related resources in Kentucky.

Era	System and Series		Began mybp*	Resource
Meso zoic	Cretaceous		144	Lignite?
	Jurassic		208	(not present in KY)
	Triassic		245	(not present in KY)
Paleozoic	Permian		286	(not present in KY)
	Carbonifer-ous System	Pennsylvanian	320	Coal, Oil, Gas, Tar sand
		Mississippian	360	Oil, Gas, Tar sand
	Devonian		408	Oil & Gas
	Silurian		438	Oil & Gas
	Ordovician		505	Oil & Gas
	Cambrian		544	Oil & Gas
Precambrian			4,500	Potential gas

* million years before present

Resource Estimates

Kentucky's potential future oil and gas resources.

Resource Category	Amount	Units	Quadrillion Btu
In known fields			
Remaining oil in place	1.32	billion bbl	7.6
Tar Sand	3.42	billion bbl	19.8
Devonian shale gas	12.00	tcf	12.0
Subtotal for known fields			*39.5*
Speculative			
Coalbed Methane	0.28	tcf	0.3
Devonian shale gas	112.00	tcf	112.0
Mississippian natural gas	0.30	tcf	0.3
Cambrian natural gas	18.49	tcf	18.5
Other oil	0.68	billion bbl	4.0
Subtotal for speculative resources			*135.1*
Total Btu			**174.6**

Known oil and gas resources in Kentucky include estimates of remaining oil in existing fields, heavy oil in the form of tar sands, and natural gas in the Devonian shale for a total resource of nearly 40 quadrillion Btu. Unproven or speculative, resources may represent an additional 135 quadrillion Btu for an estimated total oil and gas resource of more than 174 quadrillion Btu.

Future

It is generally agreed that oil will remain a primary transportation fuel for the next 20 to 40 years. In many of Kentucky's larger and older fields, oil is being produced using secondary or enhanced recovery methods. As long as the price of oil justifies the expense, new technology, including carbon sequestration, will be developed and applied to produce additional oil from the state's known fields. To reduce the dependence on oil, new energy resources must be developed and reach significant levels of deployment in the commercial and public sectors. Given the current economic climate (i.e., a price of oil in the $20 to $30 per barrel range) the trend will be a continued decline in domestic oil production with the abandonment of marginal wells and a corresponding loss of access to resources, jobs, and revenue. Oil, however, is not just a transportation fuel. Many products are derived from crude oil: lubricants, herbicides, pesticides, fertilizer, plastics, pharmaceuticals, and others. As the domestic resource is abandoned, the dependence on foreign resources will continue to increase.

Natural gas is a low carbon fuel that will increase in importance. It is considered a cleaner alternative for oil both as a fuel for domestic transportation and a supplemental fuel for electric power generation. Current production trends reflect the increase in demand for cleaner burning (i.e., lower CO_2 emissions) natural gas. Initially, use of natural gas as a transportation fuel will increase. In Kentucky, this means continued development of Devonian shale gas, coalbed methane, and exploration for potential deep gas resources. Devonian shale gas production will be extended into western Kentucky as the gas gathering, compression, pipeline, and processing infrastructure is expanded. Fuel cells or other technologies will eventually replace natural gas. However, natural gas will likely remain important as a source for hydrogen for fuel cells and as a feed stock for the chemical and manufacturing industries.

In the future, carbon, in the form of carbon dioxide (CO_2), may be a regulated commodity. The CO_2 removed from the atmosphere will require disposal or "sequestration." Kentucky's producing fields will represent a significant opportunity for recycling and disposal of CO_2 often with the benefit of enhanced oil and natural gas recovery.

Regulatory concerns

Coalbed methane (CBM): Kentucky is a "capture" state. That is, the law of capture applies to oil and natural gas. The guidelines established by the National Energy Policy Act of 1992 are in effect. As such, under Federal guidelines, the ownership of CBM may be vested with the owners of the oil and gas rights as opposed to the coal owners. However, no Kentucky statute or court decision directly addresses this issue.

Production data: Production data analysis ("decline curves") is a primary tool for valuation of petroleum producing properties and predicting future well performance. In addition, modeling production data is essential to compiling resource estimates. Without publicly available historic production data, potential investors have little confidence in unsupported claims of well performance. Regulations are needed 1) to increase compliance with the current reporting requirements, 2) to solicit and enable collection of historic production data, and 3) to provide a consistent base for cross-checking information between the Kentucky Revenue Cabinet Severance and Property Tax divisions and the Division of Oil and Gas.

Incentives: Other nations (not the United States) largely control the price of oil and gas. The expense of finding and producing oil and gas is increasing. This leads to the situation where Kentucky's oil and gas producers face a shrinking profit margin in a market where they cannot rely on a stable price. As a result, many marginal wells are being abandoned and a known resource may become forever inaccessible. Tax relief and incentives may be needed to keep marginal wells in operation. For tar sands and deep gas resources, the expense of enhanced recovery technology and drilling may be offset by incentives to attract industry. The cost of these incentives could be recovered by the corresponding increase in severance tax revenue generated by increased production.

Theft: As the price per barrel of oil increases, it will become an increasingly attractive target for theft. Stolen or illegally sold oil generates no revenue for the owners or the State. Enforceable laws and public production data reporting is required and is essential for economic development.

Natural gas storage and transportation: The increasing reliance on natural gas depends on adequate supply. Continued exploration and development is a way to meet these needs. Another method is to store natural gas ensuring a reliable supply during times of peak demand. However, gas storage is economic only in situations where the storage site is local to the end user. Storage may be anticipated in three categories:

- Underground storage of large quantities of natural gas in reservoirs to meet the demands placed on transportation and pipeline companies
- Underground storage for electric utilities for quick delivery during periods of peak demand and generation
- Small-scale storage associated with retail delivery at natural gas fueling stations (analogous to gasoline stations and LP gas storage). This storage will necessarily be in or near population centers.

Research is required to identify and develop more storage reservoirs. Incentives may be needed to ensure this type of development.

Coal test holes: No regulations exist for the proper plugging and abandonment of wells drilled by coal companies on their mineral holdings for the purpose of evaluating coal resources.

Environmental concerns

Abandoned wells: For the protection of fresh water and underground sources of drinking water and other concerns, wells not in production after a period of time are required to be properly plugged and abandoned. Many wells, however, have been improperly plugged, illegally abandoned (since 1960 with the adoption of KRS 353), or orphaned. The Kentucky Division of Oil and Gas has an existing program to identify and plug these wells. That program should be vigorously supported and adequately funded.

Oilfield wastes: Drilling, production, and abandonment of wells and leases generate a variety of oilfield wastes that must be reused, recycled, or discarded. In particular, long-term secondary and enhanced recovery operations may generate low level radioactive wastes known as technically enhanced naturally occurring radioactive materials (TENR or NORM). Guidelines for transportation and disposal need to be adopted.

Resource sterilization: Initiatives to preserve or enhance the environmental quality of the Commonwealth are necessary and must continue. However, these programs should be reviewed with respect to the taking of privately owned resources without compensation or limiting access between resources and potential markets (pipeline right-of-ways and others). These considerations might include provisions for using horizontal drilling to exploit reservoirs from a remote location or multi-lateral wells in areas with limited or environmentally sensitive drill sites.

CO_2 sequestration: Regulations may mandate reduction of CO_2 emissions, and CO_2 capture will necessitate its disposal. Carbon producers, transporters, and consumers will need regulatory guidance to ensure environmentally benign practices. In turn, regulators will require science-based information to support their decisions.