FOSSIL ENERGY RESOURCES IN KANSAS, 1992

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PREFACE

The materials in this book were gathered to provide background to the Governor's Energy Strategy Task Force Fossil Energy Subcommittee. Development of an energy policy recommendation in a state that is both major producer and major consumer is a daunting task. This report is designed to provide a background for development of policy recommendations and to be a starting point for topical study groups.

Materials included in this report include summaries of the ideas provided by public meetings in Chanute, Great Bend and Wichita hosted by the University of Kansas Energy Research Center to determine priority of issues for study, a survey of members of the Energy Policy Committee, and ideas advanced by others who are interested in the issues but not part of the working group. Many of the statistics are provided by the Independent Petroleum Association of America (IPAA) either through their publications or by personal contact. In particular, I wish to acknowledge their assistance in gathering information about tax issues.

This report is not intended to be a definitive and exhaustive study of the energy producing industry in Kansas; it is focused upon the needs for background information for development of a Kansas Energy Policy.

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INTRODUCTION

Energy. Civilization is built on natural resources and energy. Society demands an ever-increasing abundance of energy to sustain its ever-increasing population. Third-world countries demand their share of Earth resources and energy, and look to consuming industrialized nations for supplies, or assistance in developing natural resources that may be indigenous to them. From the domestication of simple fire to the technological marvels of computers, human civilization has depended upon easily obtained energy resources for basic control of the human life environment. Settlement of Europe, Alaska, Siberia, Canada, North Dakota, and Kansas, all required energy for maintaining shelter temperature. Energy is used to cool, heat, manufacture, grow, and process items necessary to modern survival. Fossil energy resources are the source of medicines and chemicals on which our daily lives depend as well as fertilizers, clothing, housing materials, and transportation. In 1973 we were forced to recognize that we live in an energy based-economy. The price of oil is by far more important than the price of gold to the United States economy.

Fossil energy resources are a primary source of national wealth. Like water, mineral, and soil resources, they support the basic social needs of our society. Wealth is created by the production and use of these resources. Wealth moves by wages and taxes through the entire economy. Additional wealth is created by further processing of natural resources to make value-added products. For years, the abundance of these natural resources in America provided the driving force for our economy. Without access to them, our economy would stall.

A few nations with limited endowments of natural resources (most notably, Japan) have found ways to prosper almost exclusively on the wealth created from value-adding activity. In such cases, the country is absolutely dependent upon the suppliers of raw materials for their survival. World War II was fought in the Pacific, in large part, over Japan's efforts to control access to the fossil energy resources and other natural resources which supported its economy.

Development of the vast fossil energy resources of the Middle East since World War II has resulted in a petroleum-based world economy. Like Japan, most nations in this world economy (including the United States) now depend upon imported fossil energy resources as a critical fuel for their economic engines. If not for this petroleum-based world economy, we would not have fought the Arabian Gulf War in February, 1991.

The United States is now the world's leading debtor nation. When a country does not produce its own resources, but purchases them abroad, it sends some of its national wealth to other countries. Wealth may also return in trade, but the United States is experiencing a large net capital export. Careful development and implementation of public policy for natural resource management could decrease the rate at which we move our wealth to the rest of the world. Because the primary contributor to our trade imbalance is the cost of imported energy resources, a well-considered energy policy should form the foundation of such public policy.

GLOBAL AND NATIONAL FOSSIL ENERGY PICTURE

The United States is the largest consumer and importer of oil in the world, using about 17 million barrels of oil a day. Before the Kuwait invasion, we were importing over 50% of our oil. This means that about 8.5 million barrels a day came from non-U.S. sources, much of it (26%) from the Arabian Gulf region.

Global production is about 64 million barrels per day. Of that amount about 16.5 million barrels comes from the Middle East. Probably more than 50 % of the world's reserves of oil are in the Middle East. Global oil production, excluding the Arabian Peninsula, has peaked and is falling off at a 0.9% annual rate. The United States leads the global decline, having lost nearly 2 million barrels per day of domestic production between 1985 and 1990. This loss of about 22% from the 1985 production resulted from reduced exploration, economic shutdown of leases, and normal production decline.

On the demand side, Gerhard forecast a continuing 1.5% global annual increase in demand, which has been exceeded in each of the last two years (Gerhard, 1989, 1991). This trend will continue unless external forces (supply interruptions, great price increases, or extended worldwide recession) mitigate demand.

The Middle East is the only region with substantial potential to increase oil production rates. Global production capacity in 1990 was estimated at 68 million barrels per day, with the 4 million barrels per day in excess production capacity located almost totally in the Middle East.

Through 1991, excluding brief shocks related to Operation Desert Storm, the price of crude oil was fairly stable in the range of $20/barrel. If the forecasted decline in non-Arabian production and increase in world demand are summed and compared with the excess capacity of 4 million barrels per day available in 1990, it is clear that at these prices ($20/barrel) global supply and demand may be equal (at about 66 million barrels per day) by late 1992. This would lead, not to shortages but to subsequent price increases at moderate rates (barring artificial price manipulation). If the non-Arabian production decline does not occur but demand increases as forecast, then global production should balance demand at the 68 million barrel per day capacity level in 1995. Other forecasts of stability or shortage are now appearing in relation to observed declines in Russian oil field production (N. Y. Times News Service, 1991).

Oil, after natural gas, is the most environmentally benign of the significant energy sources. Oil happens to be the easiest energy source to transport and use. Consequently, we use 8.5 million barrels per day in the United States simply for transportation fuel: gasoline, diesel, and jet fuel. That is over half of our current daily use of oil and that is why we have an energy problem. While the U. S. resource declines, the domestic petroleum industry is unable to respond as it did in the 1970's, mostly because of federal policies.

KANSAS FOSSIL ENERGY PRODUCTION AND CONSUMPTION

Let's continue to explore why we are in this position, and what the declining domestic industry means to Kansas in particular. Of the 33 oil and gas producing states Kansas ranks 8th in oil output Kansas oil production peaked in 1984 and 1985 at a little over 75 million barrels for the year, from 51,888 oil wells. That same year, Kansas people consumed 141 million barrels. Kansas is a net importer of petroleum.

There were over 15,460 people employed in the petroleum extraction industry in 1985. Severance and production taxes paid in the state were over $243 million.

By 1990, Kansas production was down to 55.4 million barrels of oil produced from 45,470 wells, demand was down to 81.6 million barrels, and employment in the petroleum extraction industry was down to 8,447. Severance and production taxes were about $206 million (up from 168.5 million in 1989 as a result of the Gulf War temporary oil price increase). There is a lesson in political economics here. During a time of increasing national needs, federal energy policy has caused loss of over 7000 Kansas jobs and millions of dollars in direct Kansas tax revenues (not counting the loss of income to royalty owners and the loss of income to over 7000 workers no longer employed). No wonder state revenues have decreased.

Coal production and consumption have also changed dramatically over the last decade. In 1981 1.35 million tons of Kansas coal was mined. That amount rose in 1987 to over 2.0 million tons, but dropped to 0.721 million tons in 1990. In contrast, over 17 million tons of coal were burned in Kansas in 1990, most from Wyoming and Illinois.

Natural gas is an important resource and export for Kansas. In 1985 Kansas produced 513 billion cubic feet (BCF), while consuming 355 BCF. In 1990, production was 558 BCF. 1990 consumption data are not available, but should approximate the 1989 value of 341 BCF. At present usage, national reserves and potential resources of natural gas amount to about 56 years supply.

Kansas produces no radioactive fuels. Uranium used in the Wolf Creek Plant is imported.

Kansas fossil energy production is constrained by federal policies. For instance, reductions in federal income tax rates for high incomes were introduced in 1981 and again in 1986, but with the consequent loss of tax deductions for exploration investments. Installation of an alternative minimum tax has greatly reduced the availability of venture (risk) capital. Without venture capital, risky wildcat and field extension drilling does not take place. There will be additional citations and discussions in this report which detail other constraints, but in general, federal policy changes in the last decade have worked to decrease investment capital in the energy production industries and have accelerated both the decrease in United States oil production and the flight of companies with working capital to overseas operations. The plight of the oil and natural gas industry is best shown by the number of drilling rigs operating in the United States. In 1981 there were 3970 rigs operating, now, in February 1992, there are about 600 active rigs. Not only are many rigs stacked in yards, many have been scrapped, and hundreds of crews have disbanded to seek other employment. A vast workforce of trained personnel has disappeared from the industry because of lack of drilling activity, with layoffs in major and small companies. With a lack of new recruitments to the study of petroleum geology, petroleum engineering, and mining, this workforce of experience and scientific talent is not likely to be replenished for many years.

NATIONAL VERSUS STATE ACTIVITY IN FOSSIL ENERGY

Several areas of national policy or attitudes affect the conduct of state energy development plans. For Kansas, discouragement towards access to federal lands is not a serious issue, for few federal lands or minerals are present. In most western states, however, federal control over access to minerals is a major impediment to development of resources of all kinds. Tax policy is certainly discouraging, as the prudent investor can make a better return on investment in an insured certificate of deposit than in a high risk oil or gas drilling venture. The federal energy policy now under discussion is slanted heavily towards coal, and the USDOE funding of coal programs, including research, is very high. Review of the National Energy Strategy shows little to assist the independent petroleum industry, although with careful nurturing, some support for reservoir research will be available. In the main, the federal policy recognizes that although the independent industry is now the mainstay of American oil production, the primary large deposits upon which a national strategy of cheap energy can be based are in the Arctic, offshore, and in other countries.

Environmental regulation and court decisions establishing unlimited financial liability (CERCLA) have placed another damper upon natural resource development. Few are willing to risk capital in risky ventures which could be wiped out by small changes in regulations or nuisance lawsuits. The reauthorization of the Resource Conservation and Recovery Act (a real misnomer) in the next congressional session would a major negative effects upon the Kansas industry. One example of the impact of environmental regulation, both national and local, is that no new oil refineries have been constructed in several years, although some 200 have closed down. Efficiencies created in remodeling existing large refineries keep fuels flowing; however, a major shutdown of any large refinery can bring shortages within a few days. Also, OPEC countries are focusing their investments into downstream operations. We are importing increasing amounts of products, where the labor costs are paid overseas and we purchase value-added goods.

Finally, there is little interest in Washington in conservation, with focus on cheap energy. Kansas must recognize the political power of eastern and western seaboard states with no energy resources and major energy-consuming industries and populations. These states will not permit the real cost of energy to rise more than dictated by the OPEC. However, consideration should still be given to fossil energy conservation policies, such as selective energy consumption taxes.

KANSAS ENERGY RESOURCES

Oil

The Kansas oil industry is characterized by small operators (over 3000 registered operators), small lease ownership concentrated in tightly held areas, and small capitalization. Many operators are sole proprietorships, so that decisions can be made rapidly. However, long-term planning and coordination of resource extraction and the regional or play level suffers. Individual companies may operate only within a single play, further dividing an industry whose smaller operators are fiercely competitive and secretive.

Sources of investment capital range from internal company funds for the smallest operators drilling and producing solely for their own accounts, to drilling funds, such as limited partnerships, that bring external capital to the ventures.

For the most part, Kansas is regarded as a mature part of the Midcontinent oil province, with limited opportunities for major plays or very large returns on investment. Generally speaking, a return of 30% before taxes or 5-7% after taxes is normal. Large fields are now found much less frequently than in the past. However, ample opportunity exists for discovery of new fields, especially in the western two-thirds of the state, and for implementation of improved recovery in existing fields. Some 11 billion barrels of oil are believed to remain unproduced and in existing fields. Tables 1 through 3 provide estimated proven oil reserves, marketed production of crude oil production, oil price, and amount of oil imported to U. S.. Additional comparison of information on production, drilling, and economic conditions relating to oil are found in Appendix A.

Subtle traps and bypassed oil are the future of new exploration and development in Kansas, relying on an increasingly sophisticated geological interpretation of reservoir rock formation and location, using advanced interpretations of structural history. Engineering of wells from beginning to final production coupled to geological characterization of reservoirs may recover many more barrels of oil than hitherto possible.

Oil that has lost major portions of light or volatile components is commonly viscous or tar-like, frequently referred to as "heavy oil." These kinds of oil occur in scattered fields across Kansas, but are primarily concentrated in extreme southeastern Kansas. A resource of 200-225 million barrels of heavy oil-in-place is estimated to be present in Bourbon, Crawford, and Cherokee Counties (Ebanks, et al., 1977). This is an important resource for Kansas.

Heavy oils are defined as being below 25 degree API gravity (as compared with a more normal average of 35 degree oils elsewhere in Kansas). These oils are difficult to extract from reservoirs because of their very viscous to nearly solid or tarry nature (Wells et al., 1982). In southeastern Kansas the heavy oil reservoirs are irregularly distributed, discontinuous, sandstones buried at less than 1000 feet. Sandstones of over 20 feet in thickness and with greater than 400 barrels per acre-foot saturation may be suited to recovery by special techniques. The quality of oil appears to be good with average hydrocarbon content of 70% (Ebanks et al., 1977).

Some of the strengths of the Kansas oil industry are lower cost leases, averaging about $10 per acre with a 87.5% net revenue interest to the lessor, limited environmental regulation of land use, and limited population growth interfering with non-urban land use. Air quality and water quality are very good as compared to the rest of the country. Climate plays little role in the cost of operations, neither being too hot nor too cold. Roads and land are not affected by deep frost and year-round operations are the norm.

As the international oil industry changes, the Kansas industry is impacted. Competition is global, with Kansas oil competing for market share with other states and with OPEC, Mexico, and other regional producers. Costs of operating in Kansas thus become crucial in the industry's health - finding costs, lifting costs, and taxes in Kansas are high as compared to other areas due to the low productivity of Kansas wells. Consequently, every increment of costs either saved or expended determines the fate of many of the small stripper wells that produce much of the Kansas oil.

A disturbing trend in the international arena is the concentration of downstream operations into the hands of a few companies. Many of them are national oil companies of OPEC. Some U. S.-based multinational companies have formed partnerships or outright sold interests in their domestic downstream operations (such as Texaco's refinery deal with Saudi Arabia). Foreign companies, are increasing investments into refineries. No new U. S. refineries have been built by U. S. companies in recent years and over 200 have been closed. All this indicates that further multinational control of U.S. oil supplies is unavoidable.

Oil must also compete for market share with other fuels. At the present time, natural gas is an attractive alternative to oil, because of low price and environmentally benign side effects of both development and consumption. Coal, particularly clean western coal, is also competitive as boiler fuel. Despite many well-publicized studies, no other energy source threatens gasoline as an automotive fuel.

Although oil has been a relatively clean fuel source, much environmental criticism has been thrown at the industry because so much oil is found on federal lands and in federal waters. As long as there is a vocal group focusing on preservation of federal lands and resources, the oil industry will be targeted for great environmental attention. This plays in Kansas' favor because of private ownership of land and minerals in Kansas, while hampering development by potential competitors to the west.

By and large, Kansas has a relatively light regulatory load, although it is increasingly being enforced and tightened. Environmental regulation is mostly imposed from federal agencies. Local reporting requirements are minimal as compared to federal levels. Much of the regulatory philosophy is inherited from early days of the industry. It reflects resistance by very small independent operators, mainly in southeastern Kansas, to governmental interference in what they regard as private affairs. The increasing costs of environmental cleanup and litigation is rapidly changing such attitudes, and appropriate technically-based regulation coupled with protection from non-negligent liability may ultimately develop fully voluntary regulatory compliance.

New technology brought to the industry may or may not be effectively used in Kansas. Most of the multinational companies have left Kansas or have only minimal presence, thus demonstrations of new technology developed by industry research laboratories are few. Many operators do not belong to or participate in industry trade groups with technology transfer programs, leaving few options to move new techniques of oil recovery to individual operators. State-supported research groups, such as the Kansas Geological Survey and TORP, and academic groups such as the KU Energy Research Center can be effective, but their programs are not well-funded at this time. Federal efforts to develop and transfer technology to independent operators are increasing and may be the most effective way of increasing the efficiency of small operators. These federal programs fund local organizations to develop and demonstrate technology and technology transfer and educational programs. The Energy Research Center at the University of Kansas is currently developing a major technology transfer program.

Several methods of potentially increasing production from marginal wells and marginal properties are being examined in Kansas. Among these, horizontal drilling, carbon dioxide floods, and better reservoir management appear to have good potential.

At present Kansas produces 155,000 barrels of oil per day and has proved reserves of 338,000,000 barrels. Over 93% of all producing wells are strippers. Kansas lost 1470 wells in 1989 while drilling and completing 917 oil wells, 552 gas wells, and 1071 dry holes.

Natural Gas

g Natural gas in Kansas is an important resource and a potential major income producer. However, current prices and lack of a national distribution system plan stymies further development of the resource. Yet, natural gas is widely perceived as the most environmentally benign fossil fuel, is abundant, and can be easily transported and used. Arguments against widespread further development of natural gas as a fuel are its volatility, its uncertain supplies, and competition from existing fuels for maintaining their current market shares. The NES proposed by the current administration recognizes that there are several barriers to expanded use of natural gas. These identified barriers are economic, regulatory, lack of confidence in supply, limitations on transmission/distribution systems, and extraction problems in unconventional gas resources.

At the national level, curtailments in the mid-1970's and price increases have created mistrust of the fuel. Although reserves are high (Table 4), they are dropping compared with 10 years ago; nationally reserves are down 15%. However, reserves are not a primary issue. Future supplies and their availability to consumers are the major issues hampering increased use of natural gas by major industry or for electricity generation.

In 1986 the Potential Gas Committee, an independent "think group" of volunteer experts, estimated that there was about 461 TCF of probable and possible gas to be discovered, with an additional 278 TCF in a "speculative" category. In 1988, the numbers were 440 TCF and 265 TCF, also, 90 TCF was added to national total potential gas as coal bed methane. Changes in values reflect the booking of reserves from probable potential gas, technology changes, and new information about gas reservoirs.

Table 1 - Estimated Proved Reserves of Crude Oil for Kansas and the U.S. (1) (Millions of Barrels)

	Kansas	U.S.
1981	371 (2)	29,426 (3)
1982	378	27,858
1983	344	27,735
1984	377	28,446
1985	423	28,416
1986	312	26,889
1987	357	27,256
1988	327	26,828
1989	338	26,501 (4)

(1) Amount is for Dec. 31 of year shown.

(2) Energy Information Administration, 1983, U. S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 1982 annual report: U. S. Department of Energy, DOE/EIA-0216 (82), 99p.

(3) U. S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves - 1988 Annual Report, DOE/EIA-0216 (88), Table 1, p. 6

(4) DeGolyer and MacNaughton, Twentieth Century Petroleum Statistics, 1990, 46th Edition, Table 18, U. S. Crude Oil Reserves and Production (data from EIA).

(5) U. S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves -1990 Annual Report, DOE/EIA-0216 (90), Table 1, p. 8.

The 1990 figures (Rochester, 1991) were 519 TCF in probable and possible reservoirs, including a major increase in assigned probable gas to Alaska, and 866 TCF total (compare to 796 TCF, 1988, and 739 TCF, 1986), including 145 TCF of coal bed methane. Adding in estimated reserves of 169 TCF, and dividing by annual consumption of 18.5 TCF, a 56-year supply of gas to the nation is forecast, at present consumption rates, and with the discovery of all of the highest risk speculative gas thought to exist. Since there is essentially no new drilling, that assumption is false, and the likely scenario, unless a price increase occurs or drilling is otherwise stimulated, is that the reserves and probable gas will be exploited, and the possible and speculative gas will not, leaving the nation with 369 TCF, a 20-year supply at current consumption levels. These numbers are why there is market uncertainty about switching to natural gas as boiler fuel.

Several other issues hamper fuller development of natural gas. Transportation of natural gas is by pipeline, and capacity of pipelines are restricted. There is little storage of natural gas near major markets, so that transmission facilities are unable to meet demand during peak needs, such as major cold waves. The failure of the gas industry to adequately supply domestic needs during the 1970's is widely perceived as a lack of gas, when it appears to be a lack of transportation. This situation has not been rectified. Instead, major markets in the northeast and perhaps, in California, are going to be met with Canadian natural gas, much as north-central United States markets have been for some years.

Environmental constraints on pipeline construction, largely due to local unwillingness to have facilities constructed, not to actual environmental damage, may preclude development of a transportation and storage system. Safety concerns are exacerbated by residential explosions and fires, and all manner of petroleum-related storage tank explosions and spills.

Against this backdrop, the Kansas natural gas industry seeks new markets and expanded production.

Kansas natural gas production was first recorded in the 1860's and over 28 TCF has been produced in the state (Beene,1991). In 1990, nearly 560 BCF was produced, from over 14,000 wells in 61 counties. Natural gas is a broad-based Kansas resource; over half of Kansas counties participate in revenues derived from the industry and payrolls associated with the resource development.

Each of 679 gas fields in Kansas has produced more than 200 million cubic feet of natural gas. The largest producing areas are the Hugoton (19.5 TCF, 1990), Panoma (1.6 TCF, 1990), Greenwood (.98 TCF, 1990), and Spivey-Grabs-Basil (.7 TCF, 1990) areas. The single most important reservoir rocks are the Chase Group of the Hugoton area, but nine distinct geologic units produce significant natural gas (Newell et al, 1987).

Production of natural gas in Kansas does not follow national trends (Table 5). Price for Kansas gas lags national norms because of price regulations on Hugoton and other "old" gas. Consequently, although some local market exists, it is widely suspected that the Hugoton area is held as a capacity reserve and storage unit rather than exploited to its maximum efficient rate of production. For instance, production fell 33% between 1981 and 1982 in Kansas, whereas national production was off by approximately 5%. National production went up 3% in 1988 from 1987, Kansas production was up 25%. In 1990, (compared to 1989), Kansas production slumped 5%, while the national production was up 2.6% (Table 5).

1981 Kansas gas sold for 46% of the national average (Table 5). Although this gap has closed somewhat, in 1987 Kansas gas sold for 69% of the national average, in 1988, 80%, and in 1990, latest figures available, 91%. This discounting of Kansas natural gas price hurts the producer, the mineral owner, the state economy, and the state tax collections.

On the other hand, Kansas natural gas consumption is high compared to production, although Kansas is a net exporter of natural gas, unlike its oil setting (Table 6). In 1981, Kansas consumed 67% of its marketed production, and in 1990, 62%. Therefore, increase in price could adversely affect local consumers, especially the irrigation industry.

There is a very large natural gas resource available in Kansas. It is not produced either as much or at as high a price as other natural gas sources in the United States. In order to develop the Kansas natural gas resource, initiatives to insure fair treatment of the resource are needed. Development of additional local markets can help.

Table 2 - Crude Oil Production (Kansas, U. S./World) in thousands of barrels and price of oil ($)

	Kansas	U.S.	World	U.S. ave. Nomial crude oil price
1981	65,810 (1)	2,940,000 (2)	20,376,699 (3)	31.07 (4)
1982	70,525	2,950,000	19,412,160	28.52
1983	71,594	3,020,000	19,347,559	26.19
1984	75,729	3,037,000	19,857,650	25.88
1985	75,407	3,052,000	19,584,920	24.09
1986	67,034	2,973,000	20,492,117	12.51
1987	60,544	2,873,000	20,562,071	15.40
1988	58,824	2,811,000	21,369,982	12.58
1989	55,484	2,586,000	21,920,463	15.85

(1) DeGolyer and MacNaughton, Twentieth Century Petroleum Statistics, 1990, 46th Edition, Table 23, Crude Oil Production, P.A.D. District No. II, (data from DOE).

(2) DeGolyer and MacNaughton, Twentieth Century Petroleum Statistics, 1990, 46 Edition, Table 18, U. S. Crude Oil Reserves and Production (data from EIA).

(3) DeGolyer and MacNaughton, Twentieth Century Petroleum Statistics, 1990, 46 Edition, Table 4, World Crude Production (data from DOE, World Oil).

(4) EIA, Annual Energy Review 1989, DOE/EIA - 0384 (89).

Table 3 - U. S. Crude Oil Imports
(thousands of barrels)

1981	1,604,704	(1)
1982	1,273.214	
1983	1,215,225	
1984	1,253,949	
1985	1,168,297	
1986	1,524,978	
1987	1,705,922	
1988	1,869,005	
1989	2,132,761	

(1) DeGolyer and MacNaughton, Twentieth Century Petroleum Statistics, 1990, 46th Edition, Table 60, U. S. Crude Oil Imports of Refined Products and Crude Oil (from DOE)

Table 4. Estimated Proved Reserves of Dry Natural Gas for Kansas and the U.S. (1) (billion cubic feet)

	Kansas	U.S.
1981(2)	10,443	209,434
1982(3)	9,724	201,512
1983(3)	9,553	200,207
1984(3)	9,387	197,463
1985(4)	9,337	193,369
1986(4)	10,509	191,586
1987(4)	10,494	187,211
1988(4)	10,104	168.024
1989(4)	10,091	167,116
1990(5)	9,614	169,346

1) Amount is for Dec. 31 of year shown.

2) U.S. Crude Oil, Natural Gas, and Natural Ga Liquids Reserves-1982 Annual Report, DOE/EIA-0216 (82), table 8.

3) Natural Gas Annual 1986, vol. 1, DOE/EIA-031 (86),Kansas -table 6, U.S.-table 1.

4) Natural Gas Annual 1989, DOE/EIA-0131 (89), Kansas-Table 6, U. S. - Table I.

5) U. S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves - 1990 Annual Report, DOE/EIA-0216 (90), Table II.

Table 5 - Marketed Production of Natural Gas (Kansas, U.S.)

(Million cubic feet)

		Kansas		U.S.
		Ave		Ave
		Wellhead Price $		Wellhead Price
$				
1981	640,114	.92	19,955,823	1.98
1982	440,951	1.51	18,582,005	2.46
1983	447,207	1.57	16,884,093	2.59
1984	480,211	1.49	18,304,339	2.66
1985	528,032	1.27	17,270,227	2.51
1986	478,963	1.21	16,858,675	1.94
1987	472,752	1.15	17,432,901	1.67
1988	592,845	1.36	17,918,465	1.69
1989	601,196	1.44	18,095,147	1.69
1990	573,603	1.56	18,561,596	1.71

Source: Natural Gas Annual 1990,, Vol. 1, Table 7. p. 38-44, DOE/EIA-D130 (90)/1.

Table 6 - Consumption of Natural Gas in Kansas
(million cubic feet)

Delivered to Consumers

	Residential	Commercial	Industrial	Electric Utilities	Other(1)	Total
1981	74,701	52,036	154,979	79,117	67,297	428,130
1982	81,804	55,470	118,922	61,063	83,661	400,920
1983	80,538	52,535	95,963	47,226	68.942	346,204
1984	79,340	57,516	118,238	32,234	76,343	363,671
1985	78,350	56,522	118,847	21,181	80,567	355,467
1986	70,582	55,730	100,005	15,029	71,334	312,680
1987	69,653	53,609	113,390	16,074	75,338	328,064
1988	76,420	61,120	108,108	18,890	88,385	352,924
1989	76,033	58,554	100,623	19,152	86,928	341,289
1990	71,327	56,045	116,915	26,978	81,514	352,780

1) Other includes lease and plant fuel, and pipeline fuel

Source: Natural Gas Annual 1990, Vol. 2, DOE/EIA 2 tables 14-15, p. 132-141, 170-189

Coal

Coal deposits in Kansas have been exploited for nearly 140 years with a total production of approximately 300 million tons. There were two major peaks of production during this period corresponding to World War I and World War II (Figure 1). The availability and use of natural gas and petroleum in Kansas and the extraction of most of the important Weir-Pittsburg coal reserves were the important factors in the decline of Kansas coal production. The peak production year was 1918 with over 7.3 million short tons produced. Production of coal in 1990 was 0.72 million tons and as recent as 1987 production was 2.0 million tons (1.8 million mt). In the past 20 years 19 different coal mines operated in Kansas. All but one of the mines operated in either Crawford, Cherokee, Bourbon, Linn, or Labette counties in southeast Kansas. In late 1991 only two coal mines are in operation in Kansas, both in eastern Crawford County.

Bituminous coal resources of Pennsylvanian age are widespread in eastern Kansas and represent nearly all the coal resources in the state. There is a small amount of coal in Lower Permian rocks and a limited amount of lignite in Lower Cretaceous rocks in central Kansas. Deep coal resources are known for 32 coal beds, and strippable coal resources for 17 coal beds. Most of the deep coal resources are for coals of the Cherokee Group. At the present time, six coal beds stratigraphically higher than the Cherokee Group are also included in the deep coal resource total.

Stratigraphic Position of Coal

Coal beds having present resource potential are almost entirely in rocks of Pennsylvanian age. Past production, included coals from Permian, and Cretaceous

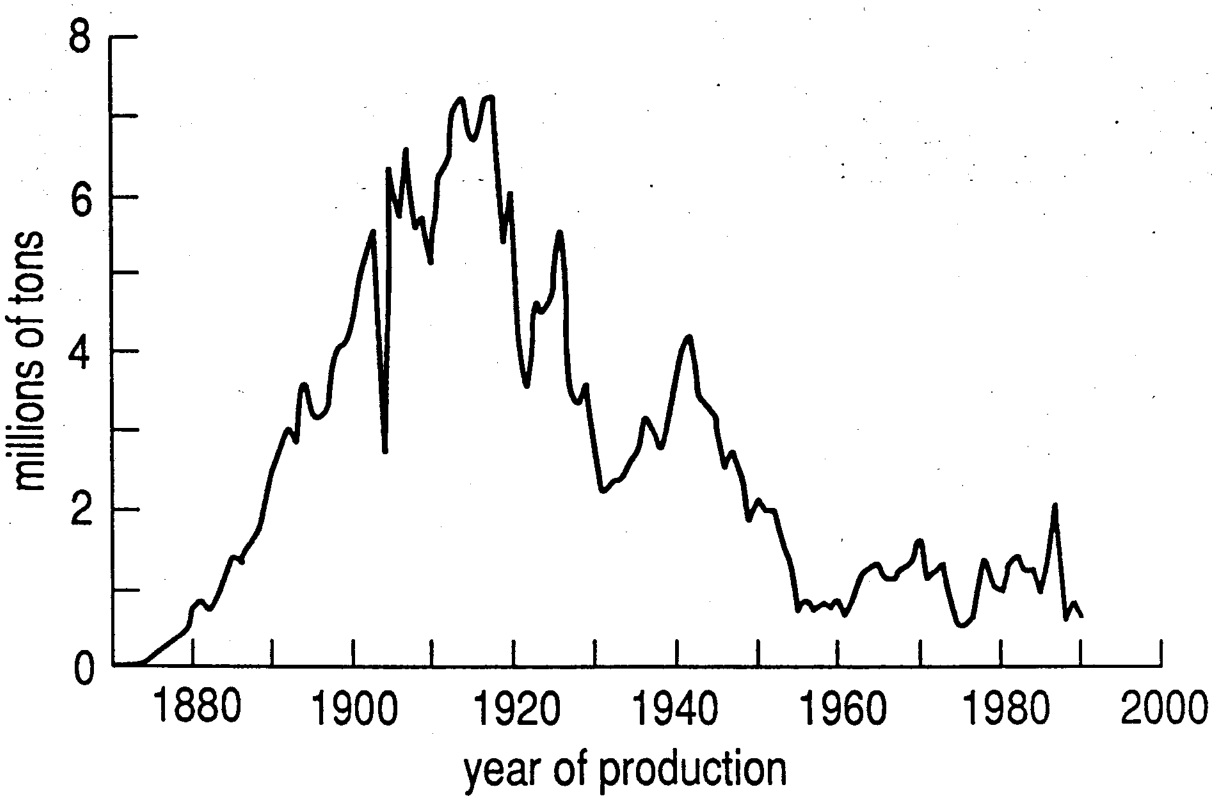

Figure 1. Historic production of coal by year in Kansas.

age rocks in Kansas; but coal from Pennsylvanian age rocks represents 99.9 percent of the total recorded coal production in Kansas. The remaining 0.1 percent represents a small production of 300,000 tons of lignite from the Dakota Formation of Lower Cretaceous age (Schoewe, 1952, p. 99) and about 10,000 tons lignite from Permian rocks (Schoewe, 1951, p. 57). Shown in Table 7 (Brady, 1990, p. 109) is the stratigraphic position of the coal beds with past commercial mining history in the state. Nearly 90 percent of all coal mined in Kansas is from the Cherokee Group and these coals also dominate the resources in the state. Two important exceptions are the Nodaway coal of the Wabaunsee Group and the Mulberry coal of the Marmaton Group. The Mulberry coal was recently mined by the Pittsburg and Midway Coal Mining Company at their Midway mine in eastern Linn County. This coal bed was the leading coal bed produced in Kansas during the late 1980's. Prior to the recent extensive mining of the Mulberry coal in those years, the Cherokee Group coals were the main coal beds mined, especially the Weir-Pittsburg coal. Mining of this one coal bed (Weir-Pittsburg) represents nearly half of the total historic coal production in Kansas. Most of the original shallow-depth coal resources of this important coal bed were either stripped or mined by room and pillar methods. Cherokee coal beds presently mined include the Mineral, Bevier, and Croweburg coals. Other coal beds mined within the past twenty years include the Mulky, Fleming, Dry Wood, Rowe, and two unnamed coal beds. One of the two unnamed coal beds is present above the Bevier coal and the second bed is present below the Neutral coal bed.

Table 7 - Stratigraphic distribution of commercial coal beds mined in Kansas

Period	Group	Formation[1]	Coal Bed[2]
Cretaceous		Dakota Fm.	Lignite in Janssen Member (several beds)
Permian	Council Grove		Blue Rapids Sch. Unnamed
Pennyslvanian	Wabaunsee	Root Sh.	Unnamed "Lorton"
		Pillsbury Sh.	Unnamed "Nyman"
"	Cedar Vale Sh	Elmo	
"	Aarde Sh	Nodaway (*) (u)	
"	Douglas	Lawrence Fm.	Williamsburg
"	"	Stranger Fm	Upper Sibley
"	"	"	Unnamed "Ottawa"
"	"	"	Unnamed "Blue Mound"
"	Kansas City	Chanute Sh.	Thayer
"	Marmaton	Bandara Sh	Mulberry (*) (c)
"	Cherokee	Cabaniss	Mulky (*)
	"	"	Unnamed "Stice"
	"	"	Bevier (*) (u) (c)
	"	"	Croweburg (*) (c)
	"	"	Fleming (*)
	"	"	Mineral (*) (c)
	"	"	Weir-Pittsburg (*) (u) (c)
	"	Krebs	Dry Wood (*)
	"	"	Rowe (*)
	"	"	Unnamed
	"	"	Riverton

(*) Important Production
[1]Formation and informal coal bed names based on Zeller (1968)
[2]If the unnamed coal has a local named, it is shown in quotes.
(c) Coal beds mined commercially in l989.
(u) >500,000 tons underground production

Strippable Resources

Strippable coal resources in Kansas that are present under less than 100 ft of overburden total nearly 2.8 billion tons as summarized in Table 8. The Demonstrated Coal Reserve Base for Kansas as listed by the US Department of Energy is 978.3 million tons for 1990. This figure represents strippable coal in Kansas in place,(that is, in the Measured and Indicated categories of the 0-100 ft overburden less the amount of coal mined from 1976 until 1990). Details of individual coal-bed resources and their reliability category (Figure 2) amounts are also listed in Table 8. A general analysis of the strippable coals, having a stripping ratio (overburden/coal) of 30:1 or less, indicates a total of over 1.3 billion tons of coal. Minimum thickness of the coals evaluated by Brady and others (1976) was 12 inches. General area distribution of the coal resources by stratigraphic group is shown in Figure 3.

Deep Coal Resources

The coal resource quantity for deep coals in eastern Kansas is determined to be about 53 billion tons of coal (Table 9) measured from 32 different coal beds. These preliminary resource quantities are subject to additional review of data. Emphasis in the evaluation of the deep coal resources was on coal beds of the Cherokee Group because of the recognized importance of coal in this geologic group in Kansas. However, six coal beds stratigraphically higher than the Cherokee coals are included in the deep resource total. For deep coals, a thickness of 14 inches or greater is considered in the resource amounts.

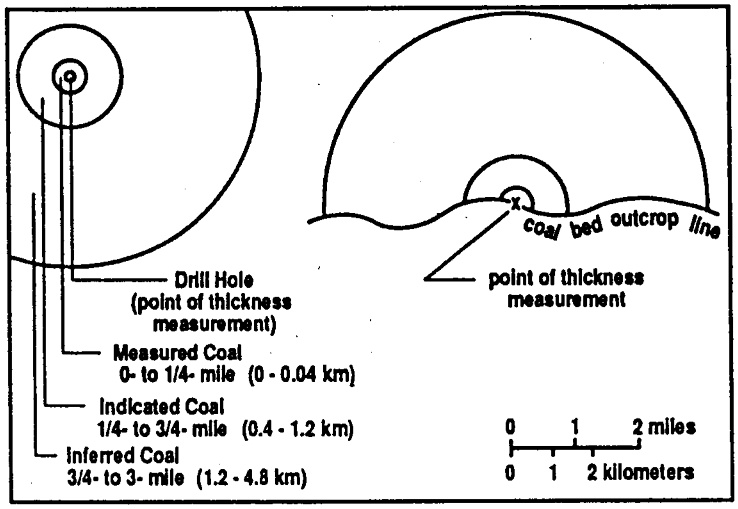

Figure 2. Radius of influence of reliability categories used in coal-resource studies (Modified from Wood and others, 1983, p. 11).

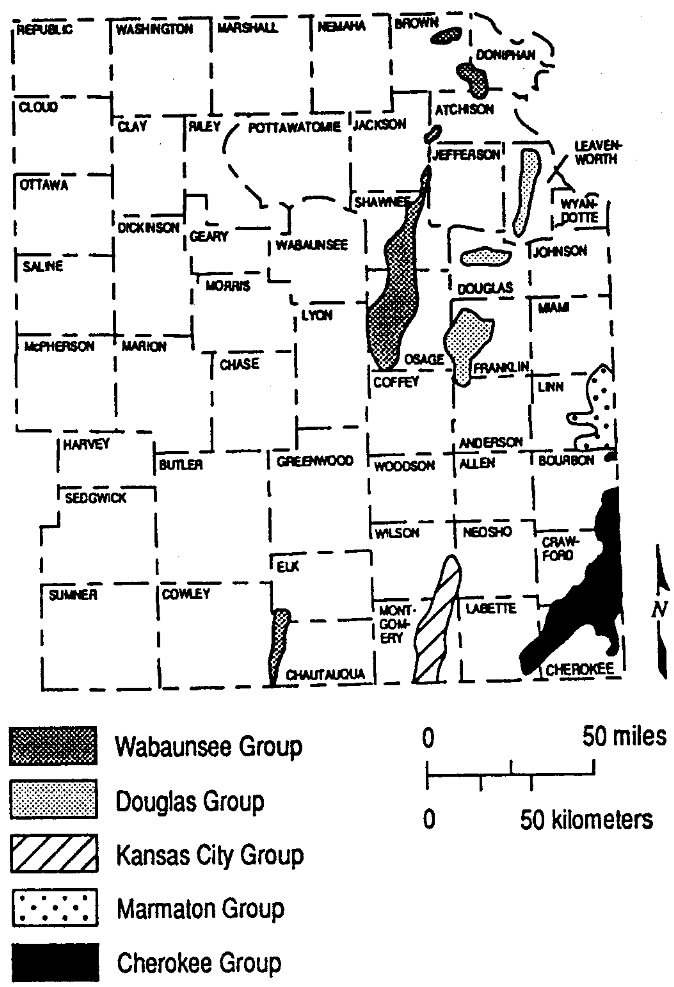

Figure 3. General distribution of strippable coal resources by geologic group. (Modified from Brady and others, 1976, p. 18.).

Table 8 - Summary of strippable coal resources by bed and reliability category.[1]

Tonnages (Million short tons) by Reliability

Category Geologic Group	Coal Bed	0-100 ft Overburden Measured	Indicated	Inferred	0:1 Stripping Ratio Measured	Indicated	Inferred
Wabaunsee	Lorton	0.1	1.3	6.1	0.1	1.3	2.8
	Elmo	5.9	22.4	222.5	3.6	14.0	44.7
	Nodaway	20.3	87.3	389.6	15.0	58.8	87.9
Douglas	U. Williamsburg	14.7	26.6	40.4	7.7	19.4	8.8
	L. Williamsburg	0.8	3.6	49.2	0.6	2.1	16.2
	Sibley	4.7	12.5	63.6	3.4	8.8	21.3
	Blue Mound	0.9	2.7	3.9	0.5	0.8	1.8
Kansas City	Thayer	1.8	9.1	53.6	1.5	6.1	16.0
Marmaton	Mulberry	59.4	137.4	217.8	30.6	67.1	162.0
Cherokee	Mulky	4.9	12.5	86.6	4.2	10.2	38.4
	Bevier	48.7	118.7	113.6	31.6	54.4	59.6
	Croweburg	9.4	35.6	70.7	6.6	19.2	54.2
	Fleming	14.9	26.8	19.6	3.0	2.7	18.9
	Mineral	120.6	88.5	307.2	53.5	25.7	131.7
	Weir-Pittsburg	29.5	47.6	62.9	10.9	36.0	43.4
	Dry Wood	1.3	6.9	25.0	1.4	6.3	19.9
	Rowe	3.8	16.2	82.9	3.8	15.5	67.7
TOTAL		341.7	655.7	1,815.2	178.0	348.4	794.7

[1] Data modified from Brady and others (1976).

Table 9 - Preliminary summary of deep coal resources and reliability category in Kansas.

Geologic Group	Coal Bed	Tonnages (million short tons) by Reliability Category Measured	Indicated	Inferred	Total
Douglas	Williamsburg	1	6	109	116
Kansas City	Thayer	3	20	282	305
Pleasanton	"Dawson"	4	33	473	510
Marmaton	Mulberry	11	83	1,158	1,252
"	"Labette B"	19	120	1,381	1,520
"	"Labette C"	2	17	249	268
Cherokee	Mulky	5	31	413	449
"	"Iron Post"	13	82	771	866
"	Unnamed	6	42	433	481
"	Bevier	90	561	5,477	6,128
"	Croweberg	20	141	1,613	1,774
"	Fleming	13	74	615	702
"	Mineral	87	540	4,975	5,602
"	Scammon	20	148	1,752	1,920
"	Scammon B"	2	18	158	178
"	Tebo	16	117	1,576	1,709
"	"Tebo B"	1	6	99	106
"	Weir-Pittsburg	73	364	2,616	3,053
"	Weir-Pittsburg	5	44	719	768
"	"Abj"	13	91	1,170	1,274
"	"Bbj"	3	23	298	324
"	Dry Wood	4	31	413	448
"	Rowe	35	258	3,135	3,428
"	Neutral	3	26	420	449
"	"Neutral B"	0	2	23	25
"	"Aw"	49	381	4,579	5,009
"	"Bw"	15	109	1,330	1,454
"	"Cw"	29	228	2,862	3,119
"	"Dw"	15	114	1,446	1,575
"	Unnamed	2	17	175	194
"	Riverton	88	654	7,225	7,967
"	Unnamed	5	40	516	561
	Totals	652	4,421	48,461	53,534

From Brady, 1990, p. 117

Deep coal resources were determined from old underground coal mine maps, from deep coal tests by mining companies, and especially from wireline geophysical logs run for oil and gas tests. Gamma ray-density and gamma ray-neutron logs were the logs used for most of the resource estimates.

Coal beds having the largest deep resources in Kansas include the Bevier, Riverton, Mineral, and "Aw" (unnamed coal bed), coals. The distribution of these four coal beds in Kansas are shown in Figures 4A-D (Brady, 1990, p. 118). Total coal distribution of those deep coal resources that are 42 inches or thicker is summarized in Table 10 and their general distribution is shown in Figure 5. Total resource amounts of these thick coal areas are two billion tons.

Coal Quality

Kansas coal of Pennsylvanian age is all high-volatile bituminous rank Nearly 90 percent of the coal produced in the past was high-volatile A. with most of this coal produced in the southeast Kansas area. Large amounts of high-volatile B and C rank bituminous coal were produced mainly from Leavenworth County (Bevier coal produced from deep mines), and Osage County (Nodaway coal produced from strip and deep mines).

A general summary of the chemical quality of strippable coals of southeast Kansas and adjacent areas of southwest Missouri is shown in Table 11. The samples used in this summary were channel samples collected from fresh exposures in coal mines.

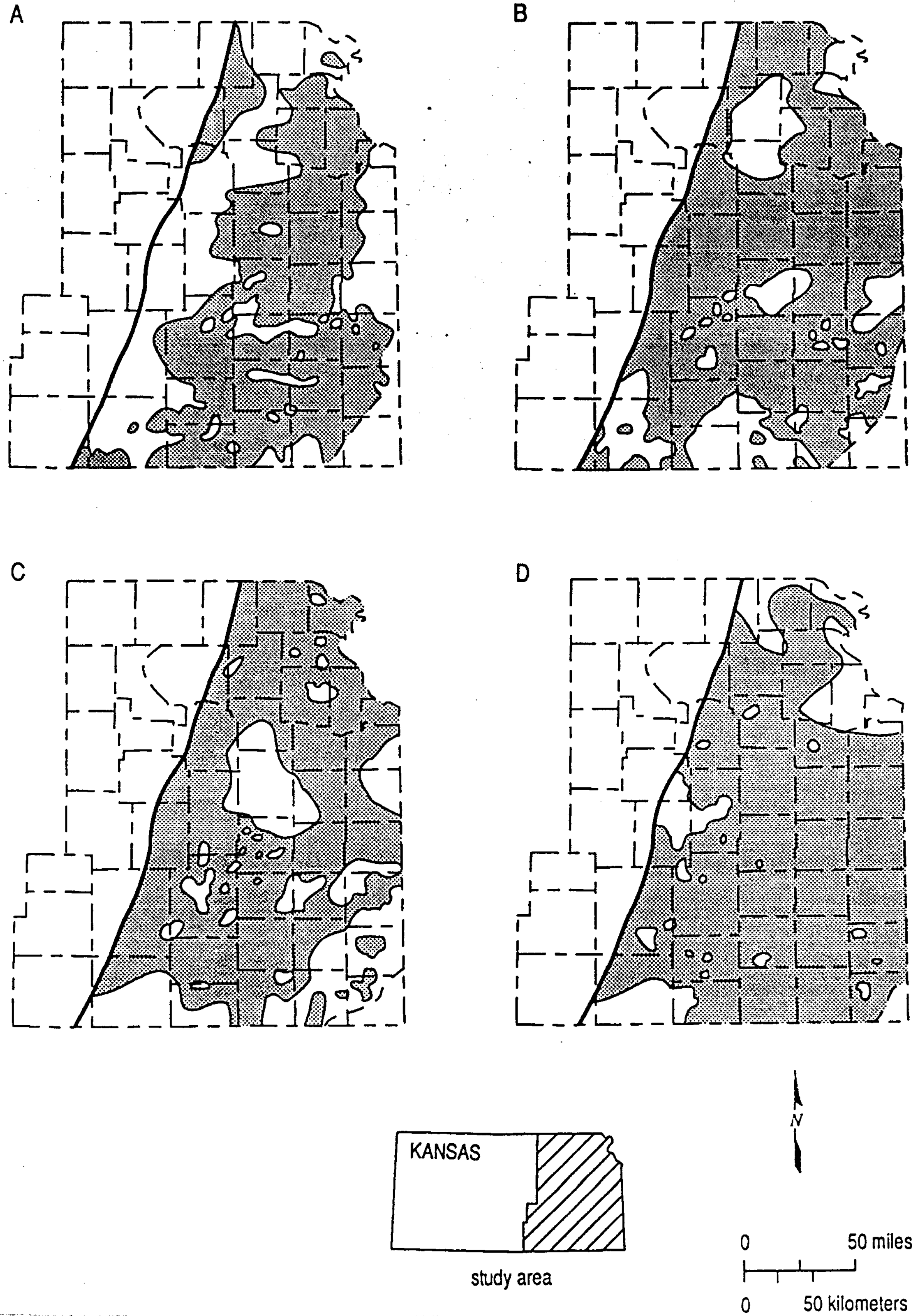

Figure 4. General distribution of four important deep coal beds —Bevier (A), Mineral (B), "Aw" (unnamed coal) (C), and (D) in eastern Kansas with thickness of 14 inches (35 cm) or greater that are under 100 feet (30 m) or more of overburden.

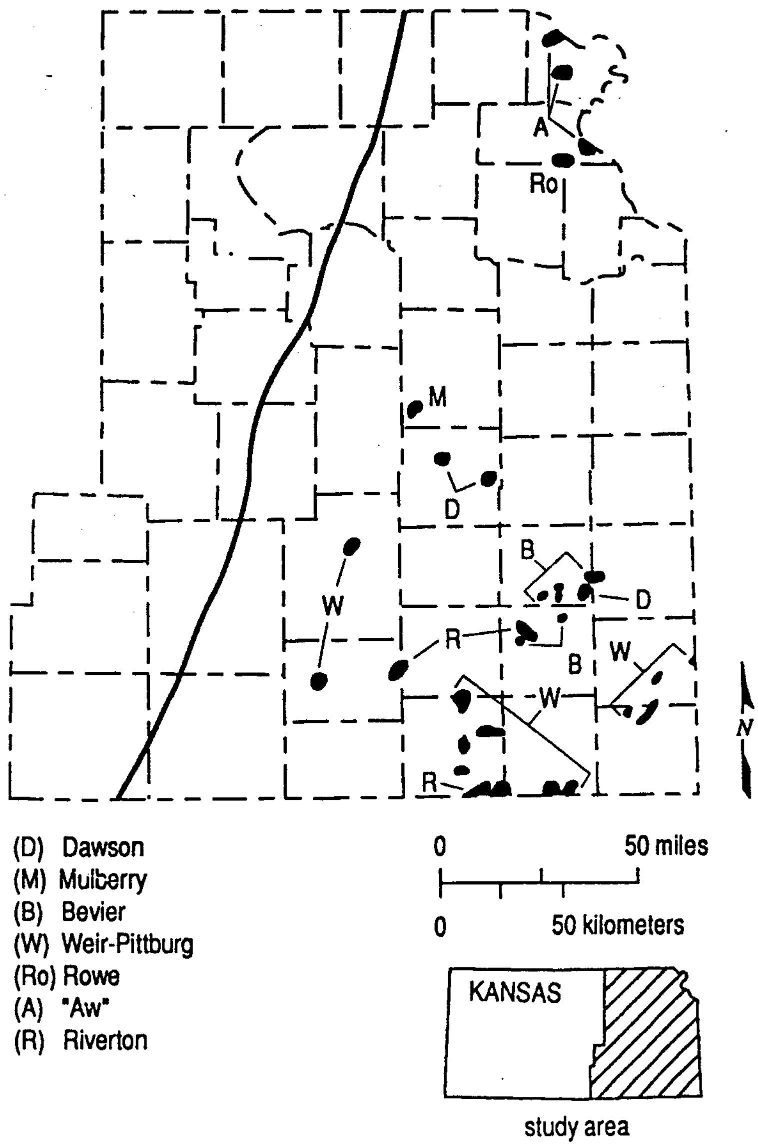

Figure 5. Distribution of deep coal beds 42 inches (1205 cm) or greater in eastern Kansas. Resource amounts are listed in Table 4 (from Brady, 1990, p. 121).

Table 10 - Preliminary estimate of deep coal resources (≥100 ft)in eastern Kansas of beds ≥42 inches by county and reliability category

		Resource total (million short tons)			
Coal	County	Measured	Indicated	Inferred	Total
Dawson	Allen	2	12	88	102
	Coffey	2	17	285	304
Mulberry	Osage	1	7	86	94
Bevier	Allen	2	11	16	29
	Bourbon	-	1	34	35
	Neosho	2	13	11	26
Weir-Pittsburg	Cherokee	1	9	61	71
	Crawford	1	8	36	45
	Elk	1	9	139	149
	Greenwood	1	7	102	110
	Labette	12	40	84	136
	Montgomery	6	39	259	304
	Wilson	-	-	59	59
Rowe	Atchison	1	5	39	45
"Aw"	Atchison	1	5	59	65
	Doniphan	2	13	38	53
Riverton	Elk	2	15	149	166
	Montgomery	-	1	26	27
	Neosho	2	16	161	179
	Wilson	-	-	1	1
	TOTALS	39	228	1733	2000

From Brady, 1990, p. 120

Table 11. Mean values of proximate energy and sulfur values for individual coal beds in southeast Kansas and southwest Missouri

Coal	n	Moisture %	Matter %	Carbon %	Ash %	BTU	kcal/kg	Sulfur %	Sulfate %	Pyritic %	Organic %
Thayer	2	6.8	33.7	41.3	18.3	10,675	5,930	3.9	.53	2.29	1.08
Mulberry	3	6.8	32.3	39.4	21.4	10,310	5,730	4.5	.45	2.35	1.73
Mulky	5	3.0	38.3	47.4	11.4	12,695	7,050	4.6	.23	2.10	2.28
Bevier	2	3.9	36.1	48.6	11.5	12,250	6,810	2.7	.34	1.22	1.15
Croweburg	7	3.4	35.4	44.2	17.2	11,677	6,490	4.5	.35	3.21	.91
Fleming	3	4.6	36.4	43.0	16.0	11,857	6,590	4.9	.60	2.97	1.29
Mineral	5	4.1	35.1	47.1	13.6	12,219	6,790	4.7	.42	2.92	1.22
Dry Wood	5	2.6	32.0	46.1	19.3	11,518	6,400	7.3	.45	5.59	1.27
Rowe	8	2.8	33.8	46.1	17.4	11,757	6,530	7.6	.41	5.99	1.20
"Aw"	1	3.3	31.2	50.4	15.1	12,060	6,700	4.1	.36	3.17	.57

Data from Wedge and Hatch (1980), Swanson and others (1976, p. 279-287), and Brady and Hatch (1991).

Production and use of Kansas Coal

Coals mined in Kansas have had many uses in the past. Early coal was used for steam generation in railroad locomotives, heat for smelters, cement manufacture, home and industrial heating. Other uses included coke production, brick and tile, and other types of industrial manufacturing. A summary of Kansas coal production and mine price is shown in Table 12, with comparison the total U.S. coal production and average price for bituminous coal and lignite. Reduced U.S. mine price through the years is influenced by the increased mining of the thick seam western coals of Wyoming and Montana.

Present use of Kansas coal is almost exclusively power generation and cement manufacture (Table 13). However, small amounts of coal are still used for other industrial purposes such as lightweight aggregate manufacture and home heating. Power generation is the dominant end-use of coal in Kansas, with nearly 17 million tons used for that purpose (Table 13). Concern by state and federal regulatory authorities over the SO_2 and NO_x content of gases emitted from the power plants has resulted in a demand for low-sulfur coals for use in new power-generating plants. This low-sulfur demand has been met by use of Wyoming coal. Some power plants equipped with scrubber systems are using local Kansas or Missouri coals. However, tighter controls on the SO_2 emissions is now forcing some of these plants to blend with lower sulfur coals to meet these new standards. With the Kansas coals having a medium-to-high sulfur content and the thin- coal beds (12-36") of Kansas resulting in a high mining cost, the present Kansas coal market is shrinking rapidly. Origin and amounts of coal shipped to Kansas in 1990 is shown in Table 14. Use of coal in Kansas is listed in Table 15 for the years 1981-1990.

Table 12 - Kansas coal production and average mine Price as compared with U.S. production and coal price

	Kansas		U.S.	
Year	Millions/tons	Ave. price	Millions tons	ave price
	(1)	(2)	(3)	(3)
1981	1.354	27.10	823.8	26.29
1982	1.396	26.61	838.1	27.14
1983	1.305	26.89	782.1	25.85
1984	1.306	26.91	895.9	25.51
1985	.989	26.00	883.6	25.10
1986	1.481	25.65	890.3	23.70
1987	2.021	24.54	918.8	23.00
1988	.734	30.59	950.3	22.00
1989	.856	27.00	980.7	21.76
1990	.721	26.50_e	1035.9	22.00

Information Source

(1) Kansas production summaries, Kansas Mined Land Board (81-87), Surface Mining Section (KDHE) (88-90)
(2) Coal Production-1981-89, DOE/EIA-0118 (Annual reports 1981-89)
(3) Annual Energy Review 1990, DOE/EIA-0384 (90)
e Estimate

Table 13 - Use and distribution of Kansas coal shipped during 1990 (thousands of tons)

Destination Use	Kansas	Missouri	Total
Electric Utilities	278	348	626
Industrial	69	34	103
Residential & Commercial	1	4	5
	348	386	734

Source: Coal Distribution—January-December 1990, DOE/EIA-0125 (9014Q) p. 81, 86

Table 14 - Coal shipped to Kansas in 1990 showing use and source of coal (thousands of tons)

State	Electric Utilities	Industrial	% of total
Kansas*	278	69	2
Wyoming	15,731	-	90
Illinois	11,157	-	7
Colorado	187	-	1
Oklahoma	-	16	-
Kentucky	-	5	-
Indiana	-	3	-
	17,353	93	

*less than 1 for residential and commercial
Source: Coal Distribution - January-December 1990, DOE/EIA-0125 (90/4Q), p. 81

Table 15 - Use of coal shipped to Kansas (thousands of tons)

	Electric Utilities	Industrial Plants	Residential & Commercial	Total
1981 1)	11,165	303	3	14,088
1982 2)	11,092	342	12	11,445
1983 2)	13,069	220	3	13,292
1984 2)	13,924	267	3	14,193
1985 2)	14,088	374	1	14,464
1986 2)	13,952	251	1	14,204
1987 3)	15,108	243	1	15,352
1988 3)	14,204	138	1	14,343
1989 2)	15,343	164	6	15,512
1990 4)	17,353	93	-	17,447

1) Coal Distribution Jan .-Dec. 1985, DOE/EIA-0125 (85/4Q) P. 26, 33, 37, 39
2) " " " " 1097, DOE/EIA-0125 (86/4Q) p.27, 33, 37, 39
3) " " " " 1989, DOE/EIA-0125 (89/4Q) p. 56, 15,19, 21
4) " " " " 1990, DOE/EIA-0125 (90/4Q) p. 81

What potential exists for use of Kansas coals in the near future? Perhaps the biggest hope lies in the use of fluidized bed combustion for power generation in smaller power-generation plants or industrial plants. This new technology should provide some direct benefits to the Kansas coal industry. A second possibility, and perhaps of a more immediate use, is the production of methane gas from deep coal beds.

Fluidized Bed Combustion

Interest has greatly increased in recent years in the use of fluidized bed combustion technology. The important factors of these systems are high combustion efficiency, sulfur dioxide emission control, and the flexibility to use a wide range of fuels. The primary advantage of using fluidized bed boilers for Kansas coals would be the large reduction of sulfur oxides and nitrogen oxide emissions during combustion as compared with conventional coal-fired boilers in power plants.

A typical fluidized-bed design has a bed of limestone and coal within the boiler that is supported by a bar grate through which air is blown. The coal and limestone are lifted and suspended by the air allowing the bed to act like a fluid. The high velocity of the air results in bubbles passing through the bed. These air bubbles evenly mix the bed resulting in rapid heat distribution. At any given time, the bed contains less than 5 percent coal. The sulfur oxides are captured by the limestone in the bed with the optimum sulfur oxide absorption by the limestone between 850°-900°C (Valk, 1986, p. 7).

The fluidized bed combustion boiler can use high-sulfur coal as well as other fuels. The sulfur dioxide is captured by the limestone bed and the combustion temperatures are below the ash melting point so that solids accumulation and boiler tube erosion and corrosion are minimized. Flue gas clean-up requires only particulate removal (Office of Fossil Energy, 1987, Appendix A, p. A-18-21).

This type of power plant, although still in smaller size designs (up to approx. 150 MW), will be important in the use of high-sulfur coals because of its pollution-abatement potential. Cost rather than air-pollution concern would be the primary factor governing fuel use. Kansas coal should then be able to compete favorably with fuels from other states for the eastern Kansas markets where the fluidized bed combustion boilers are anticipated to be installed.

Methane from Coal

Methane is present in large amounts in certain ranks of coal. For years this fact has been considered a major problem in deep coal mines because of the potential for explosions. In recent years, utilization of the methane from coal has become important as a commercial gas source. In areas of the San Juan basin in New Mexico and Colorado and parts of the Warrior basin in Alabama, large amounts of methane are presently being developed from deep coal beds.

Medium-volatile bituminous coal is the ideal rank for methane to be present in large quantities. High-volatile A bituminous coal that is present in southeast Kansas and adjacent areas is slightly lower in rank, but still has potential to release large quantities of methane. If sufficient overburden is present over the coal and a seal, such as a thick shale, overlies the coal bed to prevent loss of the methane, then methane of possible economic quantities could be present and possibly developed.

In areas where the coal is deeper than 500 feet, the coals probably retain a large amount of methane. Drilling and artificial fracturing of the thicker coal beds or multiple coal beds could produce significant amounts of the gas. Stoeckinger (1989) has measured and reported a gas content of 220 cubic feet per ton from a core sample of the Weir-Pittsburg coal bed in Montgomery County. Other coal beds reported by Stoeckinger (1989) have also given good indication of large methane content. Recent developments in Kansas at recovering coalbed methane, as reported by the Oil and Gas Journal (1990, p. 70), shows good promise for this new gas source.

By September, 1991, there were nearly 75 wells completed for coalbed methane in Kansas. Most of the activity has been in southeast Kansas, primarily northern Montgomery County, western Labette County and southern Wilson County. Good potential for economic development in these areas. However, development of these wells to their full potential takes several months because of the need to pump large quantities of water from the coal bed in order to lower the hydrostatic head of the formation water to allow the methane to be desorbed from the coal. Important to the coalbed methane development is the present federal tax credit of 91 cents per million Btu for development of this unconventional gas source. Under present law, the tax credit will be available for coalbed methane wells drilled through 1992, and production from those wells and earlier until year 2001. The tax credit will rise to $1.34 per million Btu by year 2000.

With numerous widespread coal beds and a coal resource of 50 billion tons in eastern Kansas, wells drilled in a large part of the area could encounter multiple coals (up to 12 beds) and 10 to 25 feet of total coal thickness in wells drilled less than 2,500 feet deep. Many gas pipeline networks are in place, and recognized disposal zones for the formation waters exist in eastern Kansas.

ISSUES

A primary premise in this report is that it is in the best interest of Kansas to continue to produce fossil energy, to make that process effective in extracting the maximum amount of resource possible, and to gain revenues through taxes and economic development from that extraction to accrue to all citizens of the state. Extraction and use should be environmentally benign where possible, and when choices have to be made between pristine environments and societal energy needs, the environmental costs should be explicitly taken into account.

Fossil energy development in Kansas is constrained by variables which are independent of technology and dependent upon technology. As examples, taxes, environmental rules and costs, and regulation of the industry itself are variables which respond to external political and economic forces totally independent of their effects upon production of fossil energy. In Kansas, the ad valorem tax levels are set by county economic needs and bear little relationship to production value state-wide (Little, 1990). Another example of an independent variable is the effect of Environmental Protection Agency rules and regulations. While recognizing that the intent of environmental regulations is to internalize costs (e.g. cost of pollution), the additional costs to develop and produce energy, resulting from policies such as the clean air act have devastated the Kansas coal industry. In some states the regulatory cost burden discourages investment and activity, in others, such activity is encouraged. These independent variables are voluntary legislative constraints on fossil energy development and production, and greatly affect the rate at which Kansas is abandoning its coal and oil resources.

Similarly, there are dependent variables which constrain fossil energy production. Some of these are recovery ratios, that is, the rate of recovery of resource as a function of original resource in place. In many cases in Kansas, the primary recovery of oil is only 20-25% of the original oil in place. Technology to increase this ratio can dramatically affect the resource base, taxes collected, and economic impact of the resource. Drilling costs, costs of equipment, availability of skilled labor, and processing costs are constraints which are dependent on technology or which are controllable by the industries affected.

With this background, there are several issues of fossil energy development in Kansas which could be addressed by state energy strategy and plan for legislative action. Some of these issues were identified in 1989 in the Kansas, Inc., study of taxation, but will also be cited here (Little, 1990). Others are newly identified, in part through a series of public meetings held in Great Bend, Chanute, and Wichita by the University of Kansas Energy Research Center during the summer of 1991, some through solicitation by this committee during the fall of 1991, and others generated by the writers of this report from discussions with USDOE Office of Fossil Energy staff and leadership, operators, and policy makers across the country. Generally these issues can be categorized in six related groups:

1. Taxation, including income, ad valorem, severance, and alternative minimum taxes.
2. Environmental liability and regulation.
3. Price, including unequal pricing of gas vis a vis other energy supplies.
4. Development of clean coal technology.
5. Recovery of additional oil from existing pools.
6. Research needs and data base development.

Taxation

Taxation of the Kansas industry differs from some other states by having a combination of income taxes, ad valorem taxes, severance taxes, and sales taxes applicable to various aspects of production. A previous study has already recommended changes in the Kansas tax structure (Little, 1990). Inequities of taxation levels among the counties levying ad valorem taxes has been the largest area of concern and may result in litigation unless addressed shortly. Discrimination between the oil industry and other industries, especially agriculture, in what property is actually taxable will no doubt result in litigation unless legislative relief is forthcoming. For instance, farm equipment has been removed from the property tax rolls, but well-head and operation equipment for the energy industry has not. This inequity may well be in violation of federal constitutional provisions. An example of the changes which took place with the new property appraisals and consequent redistribution of property taxes is taken from the ERC files from which this report is prepared (Table 16).

Table 16 - A Kansas Ad Valorem Tax Comparison

An example of Oil Production and Taxes 1988, 1989

	1988	1989	diff	%diff
OIL PRODUCTION	1192	1206	14	1.17%
ASSESSED VALUE	$4,167.00	$13,874.00	$9,707.00	232.95%
COMPANY TAXES	$236.00	$1,235.00	$999.00	423.31%
PROPERTY TAXES (Min. Owner)	$200.00	$352.00	$152.00	76.00%
TOTAL LEASE TAXES	$436.00	$1,587.00	$1,151.00	263.99%

1989 VALUES FOR LEASE IN 1/2 MILE DISTANT, COMPARED TO LEASE IN TABLE

	1989			
OIL PRODUCTION	1206	1195	-11	-0.92%
ASSESSED VALUE	$13,874.00	$4,458.00	-$9,416.00	-211.22%
COMPANY TAXES	$1,235.00	$335.00	-$900.00	-268.66%
PROPERTY TAXES (Min. Owner)	352.00	$26.74	-$325.26	-1216.38%
TOTAL LEASE TAXES	$436.00	$361.74	-$1,225.26	-338.71%

Two federal tax policy changes are responsible for the loss of high risk investment capital: The income tax revisions of 1981 and 1986, and the alternative minimum tax.

A major tax issue needing in-depth consideration is the application of the alternative minimum tax to the petroleum industry. Industry claims of loss of investment capital because of this tax are as yet unsubstantiated, but the tax does provide that only a portion of normal business expenses may be deducted from federal tax liability for any really active drilling program: intangible drilling costs, that is, labor, supplies, rig drilling time charges, and consumable supplies, are limited deductions, and thus fewer dry wells can be drilled before operator income no longer can cover taxes: it is quite possible to lose considerable money in a year and still be liable for large taxes.

Federal income tax marginal tax rates have declined form 75% to 28%; in consequence, the amount of risk capital available to the petroleum and other high-risk ventures is less. Under the former marginal rate, the individual investor underwrote 25% of unsuccessful ventures, the remainder was a tax deduction, and therefore a tax incentive to invest. Coupled to a industry average return of 12.7% (1989; compare to 14.7% average ROR, for All Mfg. Companies), this stimulated investment towards the occasional "big hit" that would give a very large return on the risked dollars. Since most exploratory holes drilled are dry holes, the investor gained and the economy gained. The taxes now collected rather than invested go to the cost of government, programs, defense, and our trade deficit payments; and do not stimulate the economy as formerly. The availability of risk (venture) capital went down with the changes in marginal tax rates in 1981 and 1986. There is not now sufficient risk capital available to the Kansas industry to sustain any significant expansion of drilling.

Fundamental to all of these arguments is that federal and state tax policies do not recognize the tremendous risk inherent in the petroleum business.

The federal income tax, prior to 1981, provided for a maximum marginal tax rate of 70%, favorable treatment for capital gains, and a 27.5% depletion allowance for petroleum. Today, there is an alternative minimum tax, a marginal tax rate of 31%, no favorable treatment for capital gains, and a 15% depletion allowance. Education is necessary for those who believe that these are closed "loopholes", for the entire national economy reflects the loss of investment capital resulting from these tax changes. Treating all income the same, except for levying higher taxes on income gained from high risk, totally ignores realities of creating risk and venture capital and the need to capitalize an economy expected to grow.

Environmental Liability and Regulation

Kansas has a long history of environmental regulation of its energy industry, but up until now this regulation has not unduly hampered its energy industry. However, those federal regulations stemming from federal government agencies and continuing new legislation pose serious threats to the health and stability of the industry. As an example, the US DOE has estimated the cumulative potential impacts of environmental initiatives now wending their way through congress or federal agencies. Under the medium impacts scenario, using nine major producing states including Kansas, 23% of conventional production would be lost, 35% of unrecovered mobile oil in Texas, Oklahoma and New Mexico would be lost, and 24% of potential for enhanced oil recovery in the country would be lost.

Unlimited financial liability for actions taken under early technologies and regulations are stifling much of industry and commerce today. The principle seems simple, the effects are enormous. Real estate, leases, and equipment cannot be transferred without full examination of sites, including searches of former uses and effects of those uses. Assessment of costs and penalties for undiscovered environmental hazards, and the increasingly minute amounts of chemical contamination ruled to be hazardous have combined to make investment in any real property a serious financial risk. The continuing 15 year efforts of the US EPA to gain control over oil field operations through declarations of drilling fluids as hazardous materials suggest that worse risks are to come. Retroactive application of regulations threatens to stymie industrial development and must be examined in any public policy proposals.

Price

Fossil energy resources price is the major deterministic factor in production. The price of oil has varied wildly over the last seven years, ranging from futures prices over $40 per barrel to field prices below $10. A sustained period of prices below $18 per barrel during the late 1980's depressed industry activity across the country. Rig counts plummeted from nearly 4000 to less than 800, and now have been stable at a very low 822. During the Arabian Gulf War, prices shot up to the $40 range in the futures market but the sustained impact of the war has been minimal. Even the loss of Kuwaiti production did not materially affect the global market; there was sufficient capacity in Saudi Arabia and other countries to make up the difference, and the temporary price increase did stimulate U.S. production. A small increase in price can materially slow down the abandonment of wells, but even more importantly, it can provide incentive to complete delayed maintenance on producing wells and thus increase production.

Natural gas has been depressed in price for a number of years, after a government-imposed shortage in the 1970's. At present, there is about a 56-year supply of natural gas, at current usage levels, assuming that there is sufficient capital to develop the resource; the 56 year supply assumes discovery of all the probable potential gas in the U. S.

Gas is economic and profitable at prices of about $2 per thousand cubic feet (MCF). At present natural gas prices range from about $.81 to about $1.25 per MCF, and those companies with focus on the resource are pulling back, reducing staffs, and otherwise abandoning development of the resource, including some of those active in Kansas. ARCO, Phillips, Exxon, and Shell have all given up on waiting for the fair value of natural gas to be reflected in the marketplace, and have reduced staffs and programs. Somehow the price of natural gas has to rise to reflect its BTU value. It is the most environmentally benign fossil fuel, it is easy to transport, supplies are stable, and supplies are in the domestic U.S. Kansas has an abundant supply of natural gas from the giant Hugoton Field in southwestern Kansas, as well as smaller supplies from other areas. It is a very important fossil energy resource in Kansas.

Equivalent prices for various energy sources may be based upon the million BTU (British Thermal Units) values of each. One current value for Kansas crude oil is about $17.10 per barrel. On this basis, the following BTU/value relationships in Table 17 would hold.

Table 17 - BTU Value Relationships

Crude Oil	$17.10 per bbl.
Natural Gas	$3.30 per MCF
Lignite	$42.00 per ton
Bituminous Coal	$84.00 per ton
Propane	$.27 per gallon
Gasoline	$.39 per gallon
Methanol	$.20 per gallon
Fuel Oil	$.45 per gallon
Electricity	$.01 per KWH

(Frank Novy, personal communication, January 28, 1992)

Development of Clean Coal Technology

Kansas has extensive reserves of coal, but high sulfur and ash content and thin coal beds have greatly limited the use of Kansas coal in normal combustion processes. The USDOE has focused much effort and money in developing clean coal technology so as to enhance the use of eastern and midcontinent coals. There is little effort foreseen from the state to enhance the use of Kansas coal. The best chance for increased use of Kansas coal would be in use of fluidized-bed technology in smaller power plants in eastern Kansas. When cheaper methods of sulfur removal from coal or SO_2 from the stock gases are developed then increased use of Kansas coal could result within Kansas and adjacent states. Coal does remain a significant resource for electrical power generation.

Additional Recovery from Existing Pools

USDOE estimates of oil remaining in Kansas reservoirs after final commercial extraction has been accomplished is on the order of 11 billion barrels of oil. This is a very large resource. Accessing this resource is partly research and partly application of existing technology through small independent operators who normally do not use advanced technology. Development of a full technology development and transfer function within the state may address this issue. Encouragement of use of existing technology may recover some of the petroleum, but the present focus is to prevent the premature abandonment of the resource through the plugging of uneconomic stripper wells. This is a function of tax policy as well as technology. It is estimated by the USDOE that 80% of the 11 billion barrels will be permanently abandoned by the year 2000 if we do not promptly address this issue (USDOE, 1989).

Research Needs and Data Base Development

One of the most effective ways to brake the present slide in Kansas oil production is by development and application of new technology and information to existing fields and development plays. Basic and applied research is now accomplished by the Kansas Geological Survey and activity in tertiary oil recovery is through the Tertiary Oil Recovery Project. Staff shortages and high costs have hampered full development of the research, but studies already accomplished show that applied research and development of new concepts of oil occurrence can greatly extend production and find new resources. The independent petroleum industry has no research ability. Therefore, the corollary development of fossil energy research comparable to agricultural research could materially affect the decline of Kansas oil production and consequent negative economic impacts. Development of the new

University of Kansas Energy Research Center by the Kansas Geological Survey with the assistance of TORP and other university academic groups promises assistance if funding can be developed for a permanent program of applied research and technology transfer. Data base development related to secondary recovery and overall improvements in operator data access and on-site assistance could be a beneficial result of the ERC.

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