2000 Kansas Energy Report

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Executive Summary

This report will examine the history, current status, and future of energy in Kansas. Total energy consumption continues to grow in Kansas. However, Kansas is more energy efficient than 20 years ago. In 1998, 70% less energy was required per dollar of gross state product than it was in 1977. Growth in total energy consumption slowed after 1980, while the State's economy has continued its rapid growth. Kansas and the U.S. are rapidly changing how energy is delivered as we move to increased dependence on electricity. Over the last 40 years, electricity's share of Kansas energy consumption has doubled from 15% to nearly 33%. With the restructuring of the electric industry and increasing uncertain environmental requirements, today's additions to baseload electric generation capacity are overwhelmingly combined-cycle or combustion turbine technology fueled by natural gas. This has resulted in an extremely rapid and accelerating growth in demand for natural gas for electric generation.

Natural gas and petroleum remain the most important energy resources in Kansas, accounting for nearly all primary energy produced in the state. Energy production in Kansas peaked in 1967 at 1573 trillion BTU's. In 1999, primary energy production had declined to approximately 912 trillion BTU's. Natural gas production peaked in 1970 at 900 billion cubic feet (bcf). Petroleum production peaked in 1956 at 124 million barrels (bbls). Of the U.S. states, Kansas is ranked 7th in natural gas production and 8th in oil production. In 2000, hydrocarbon production responding to increased wellhead prices is estimated to have increased slightly from 1999 to over 34.3 million barrels of oil and 550 billion cubic feet of gas. The current year wellhead value of hydrocarbon production will increase over $1.4 billion from 1999 to an estimated wellhead value of $3.046 billion. The increased wellhead value of oil and gas production will have a positive impact on the Kansas economy and state and local tax revenues, and should be felt across the gas and oil producing counties of southeast, central, and western Kansas. However, this positive impact will be balanced by potentially serious effect of increased energy costs and potential spot shortages on the Kansas agricultural, chemicals industry, and general consumer economy. Shortages and price spikes are possible in natural gas and to a lesser extent in petroleum distillate products.

Energy is increasingly a national and global market dominated by high technology, high capital requirements and large integrated companies. Small and mid-sized companies, which must continue to innovate in order to compete, dominate the Kansas energy system. To meet the rapid changes in energy demand, Kansas must work to increase energy supply to prevent shortages and maintain reasonable costs. Kansas and U. S energy supply will continue to be dominated by fossil fuels. However, an economic and measured approach that integrates new energy sources (e.g., wind and ethanol production from agricultural production) into the Kansas energy system can

have a positive impact. Increased synergy and efficiencies are possible among all the various aspects of the Kansas energy system.

In the short-term, Kansas and the U.S. are facing another hydra-like energy crisis that seems to grow new heads every day. With high prices and tight supplies of natural gas and distillates, we are facing a "Winter of Discontent." In the past, similar short-term energy situations have resulted in changes of energy policy that did little to alleviate the fundamental problems of supply and demand.

Introduction

For over 100 years, energy production has been a key component to Kansas' economy. For much of its history, Kansas has produced more energy than it has consumed. The gap between production and consumption, however, has narrowed to the point where in any given year there is no guarantee that Kansas will be a net energy exporter. Changes in technology, government, business, and price have provided, and will continue to provide, challenges and opportunities for the Kansas energy sector.

The last quarter of the 20th century, in particular, saw dramatic changes in:

- Health of the oil and gas industry;
- Structure of the electricity industry;
- Energy consumption and efficiency.

This report will examine the history, current status, and future of energy in Kansas.

Overview of Kansas Energy Sector

The direct production and distribution of energy constitutes approximately 4.1% of the Kansas gross state product[1]. In addition, energy is an essential input into all industrial, agricultural, commercial, transport, and household activities. The composition of Kansas' energy supply and demand balance has changed significantly as continued growth in demand is met and as:

- The relative growth rates for fuels change as a result of government intervention, price fluctuations, and technologic change;
- The connectivity (interdependence) of national and global energy markets increase;
- The method of energy delivery moves toward increased dependence on electricity;
- The structure of the power industry changes; and
- The importance and the pace of technology change in energy production and consumption increases.

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[1] Sum of gross state product (GSP) for fossil fuel production, refining of petroleum products, and electric and gas utilities ($3.159 billion) compared to total Kansas GSP ($76.991 billion). Source: US Department of Commerce, Bureau of Economic Analysis, Regional Accounts Data for 1998, http://www.bea.doc.gov/bea/regional/gsp/.

Energy Consumption

Overview

Kansas energy consumption has increased 41% since 1960, driven by the growth in electricity demand. Since 1960, electricity's share of energy consumption has doubled from 15% to nearly 33% in 1997 (Figure 1). During this span, annual demand for electric power has increased 300%, growing from 24 to 99 billion kilowatt hours (kWh).

The growth of electrical energy consumption is changing the types and quantities of fuels consumed. In 1960, Kansas' primary fuel consumption was at 652 billion BTU, consisting of 57% natural gas, 40% petroleum, with coal providing the balance (Table 1). By 1997 (the latest year of complete data from the EIA), energy consumption was at 1,118.1 billion BTU consisting of 30% natural gas, 33% petroleum, 28% coal, 8% nuclear power, and 1% biomass and renewable energy.

Table 1 - Kansas Energy Consumption by Fuel. (Trillion BTU)

	1960	**1980**	**1997**
Petroleum	258.2	377.5	371.6
Renewables	0.2	0.1	0.3
Natural Gas	373.7	482.0	334.5
Nuclear Power	0	0	89.6
Biomass	3.9	10.1	11.3
Coal	15.7	191.6	310.8
Total	651.7	1,061.3	1,118.1
Electricity	83.5 (24.5 billion kWh)	255.7 (74.9 billion kWh)	338.8 (99.3 billion kWh)

The growth of electricity was fueled almost entirely by coal and nuclear power (Figure 2). During this period, primary energy consumption grew rapidly through 1980, but slowed after 1980 (Figure 3). Natural gas consumption was less in 1997 than in 1960, while petroleum use was up slightly after peaking in 1979 and again in 1988. Coal consumption has increased steadily and nuclear power has been consumed at a consistent level since the mid-1980's.

The change of the fuel mixture also changed where Kansas got its fuel. In 1960, Kansas was capable of producing all of the fuel it consumed. Today, however, only natural gas is produced in excess of consumption in this State. Nearly all the coal is transported by rail from Wyoming and Montana, uranium is mined elsewhere, and Kansas oil production has not kept pace with consumption.

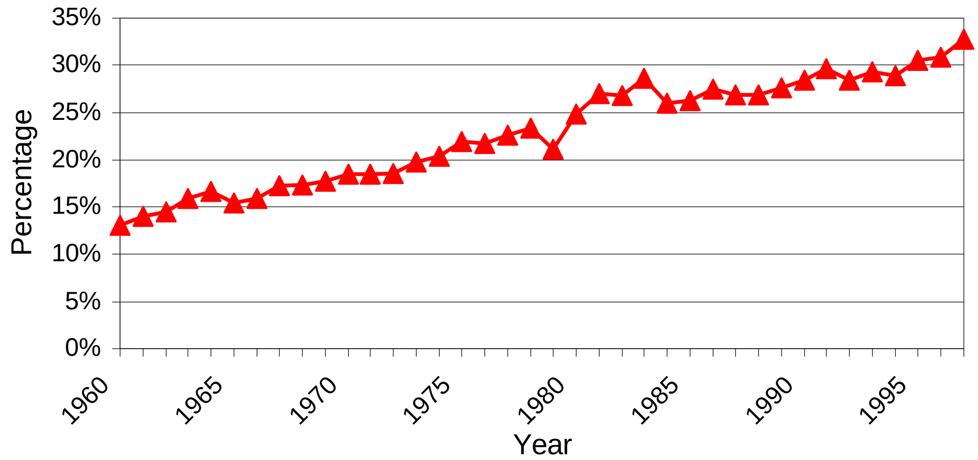

Figure 1 - Electricity's share of Kansas energy consumption has doubled in the past 40 years.

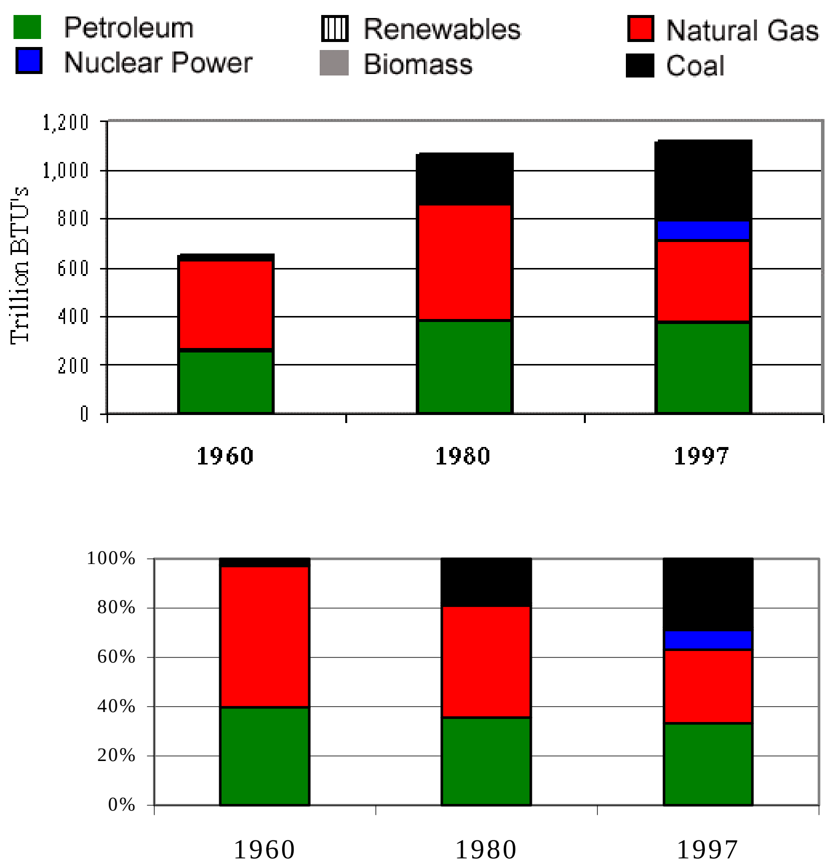

Figure 2a and b - Since 1960, coal consumed in Kansas has increased dramatically from 2% to nearly 30% of Kansas energy consumption. Natural gas share has dropped from almost 60% to 30%.

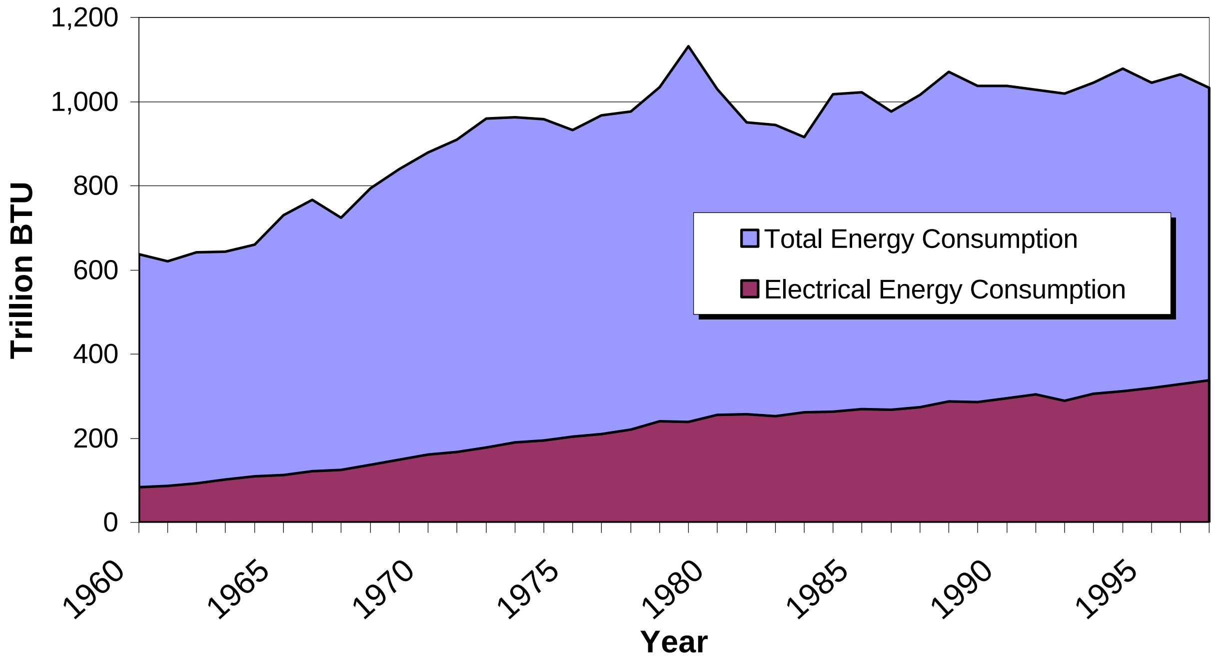

Figure 3 - While overall energy consumption has remained relatively constant in the past 20 years, electricity consumption has continued to grow.

Electricity Consumption

The doubling of electricity's share of Kansas energy use is indicative of the emerging importance of electricity to Kansas in the past 40 years (Figure 1). Kansas electricity consumption has quadrupled since 1960 from 7 billion kWh to 32.3 billion kWh in 1997[2] (Figure 4). This increase in electricity demand was met almost entirely by coal and nuclear power. During the 1970's, a number of large coal plants came on-line to meet demand (Table 2), causing coal's share to grow from 12% of total energy consumed in 1970 to 20% by 1980. The Wolf Creek Nuclear came on-line in 1985 and now supplies 8% of the State's energy and 25% of its electricity.

The emergence of these new power plants caused a shift in the mix of fuels used to generate electricity from mostly oil and natural gas in 1960 to 68% coal and 25% nuclear today (Figure 5). Another affect of this growth was an improvement in the overall energy efficiency of electricity generation (Figure 6). The conversion efficiency of Kansas electricity generation improved from

[2] *State Energy Data Reports*, Energy Information Administration, DOE/EIA-0214 (various years). Can be accessed at www.eia.doe.gov

less than 29% to nearly 32.5%. Possible reasons for this improvement include new power plants that use more efficient technologies, and replacing small, less-efficient oil and natural gas power plants, have higher capacity factors (percentage of time operating at maximum). In addition improvement in power plant control systems and other performance enhancements in the 1980-90's have improved power plants operating efficiency.

Forecast – Natural gas is fueling 98% of the 20,000 Mega Watts (Mw) of new powers plants that have come on line during 2000. An additional 70,000 Mw of gas-fired electrical generation is expected to come on line in the next 30 months[3]. In 2000, from the best data available, electricity demand for natural gas grew twice as fast as forecasted[4]. The accelerating growth in America's and Kansas' use of kilowatts is spurred by the new economy and the Internet (Figure 3). The increase in computer usage and the Internet has contributed an estimated 10-13% of total U.S. electric power demand. The dot-com revolution is powered by fossil fuels.[5] There are no new nuclear, no new coal, or no new hydroelectric power plants of any consequence being built in U.S.

The U.S. is expected to require an additional 300 gigawatts of new capacity over the next two decades to meet expected growth in electric power demands[6]. Of this new capacity, 90 percent is projected to be combined-cycle or combustion turbine technology fueled by natural gas. Before electric industry restructuring, additions to baseload capacity were limited primarily to pulverized-coal steam units. Today, natural gas-fired power plants provide lower capital costs, short lead times, improved efficiencies, and reduced environmental opposition, which offset the higher fuel costs compared to coal. The forecasted increase of 300 gigawatts by 2020 will translate to construction of approximately 1000 new gas-fired power plants and increased natural gas production by almost 6 trillion cubic feet.

A current need is to significantly increase investment not only in power generation, but also in transmission networks, distribution systems, and control systems to provide reliable high quality electric power. During the last decade, transmission capacity has improved, but has not kept up with increased demand. Improved interconnections between electric power grids are creating

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[3] Reports from the North American Electric Reliability Council (NERC) on system conditions including 2000 Summer Assessment and 2000-2009 Reliability Assessment at http://www.nerc.com/~pc/syscond.html.

[4] Based on data from the U.S. Department of Energy EIA consumption of natural gas by electric power producers rose 12% during the first 7 months of 2000.

[5] Cited in *The U.S. is still a Developing Nation. A Comparison of Electric Power Growth Trends Among Nations, and the Implications for the Kyoto Protocol*, David E. Wojick, The Greening Earth Society, September 2000. http://www.greeningearthsociety.org/Articles/2000/developing1.htm. Similar numbers for computers and related network devices are cited in *Not enough Juice*, James Fallows, The Standard, July 2000. http://www.thestandard.com/article/display/0,1151,17223,00.html.

[6] Statement on oil and gas supply and demand by Department of Energy EIA Administrator Jay Hawkes before the Subcommittee on Energy and Power of the Commerce Committee, U.S. House of Representatives on May 24, 2000. http://www.eia.doe.gov/neic/speeches/hrtest524/TestimonyMay242000Final.htm.

large regional markets for electric power[7]. As a result, the Kansas electrical system is increasingly integrated into a larger region of the U.S. This increases the stability of local electric systems to withstand short-term and catastrophic problems. However, it increases the exposure of Kansas to long-term systemic problems that may be the result of policies that developed outside the state. An extreme example is the winter 2000-01 power shortage in California, which is pulling power from adjoining states. As a result of improved electric power grid interconnections, states such as Oregon and Washington are faced with managing the impact of California's energy policies.

Table 2 - Timeline for large-scale growth in Kansas electric utility infrastructure.	
1971	403 MW coal plant at Lawrence Energy Center, Douglas Co.
1973-1977	1,578 MW coal plant at La Cygne, Linn Co.
1978-1983	2,160 MW coal plant at Jeffrey Energy Center, Pottawatomie Co.
1980	388 MW coal plant at Holcomb, Finney Co.
1985	1,235 MW nuclear power plant at Wolf Creek, Coffey Co.

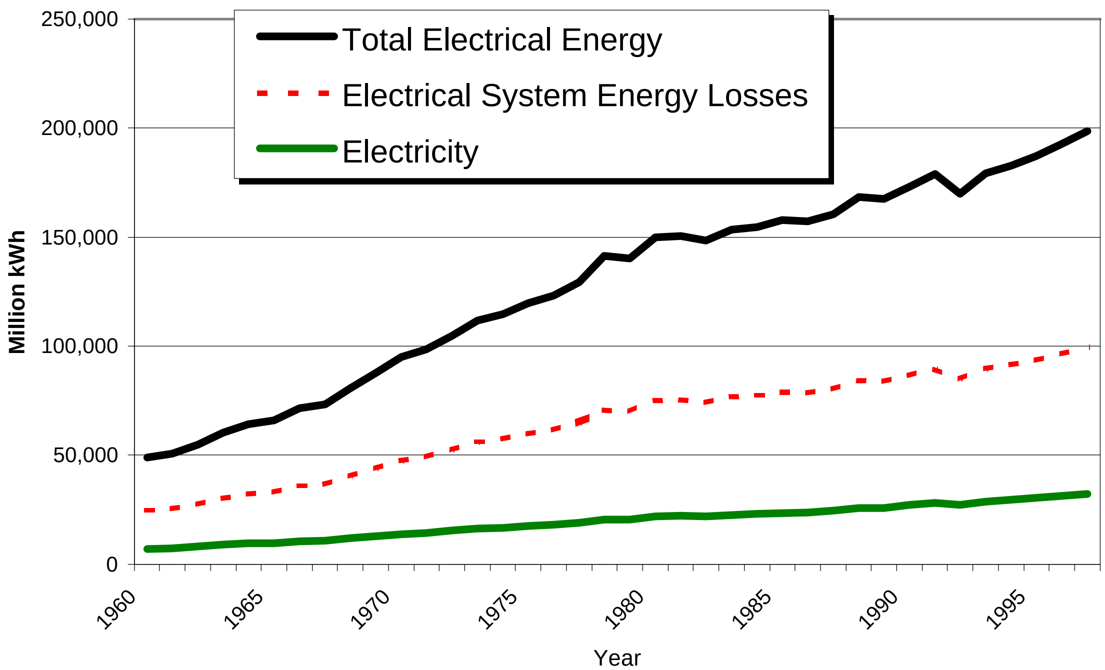

Figure 4 - Kansas electricity consumption has quadrupled since 1960, the conversion efficiency of Kansas electricity generation has improved from less than 29% to nearly 32.5%.

7 Reports from the North American Electric Reliability Council (NERC) on system conditions including 2000 Summer Assessment and 2000-2009 Reliability Assessment at http://www.nerc.com/~pc/syscond.html.

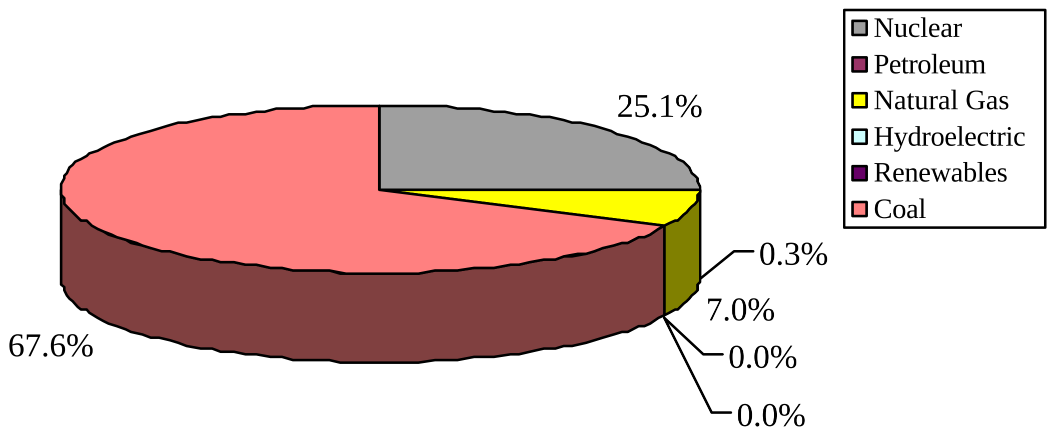

Figure 5 - Over two-thirds of Kansas electricity in 1998 was generated from coal, while nuclear power fueled 25% and natural gas picked up much of the balance.

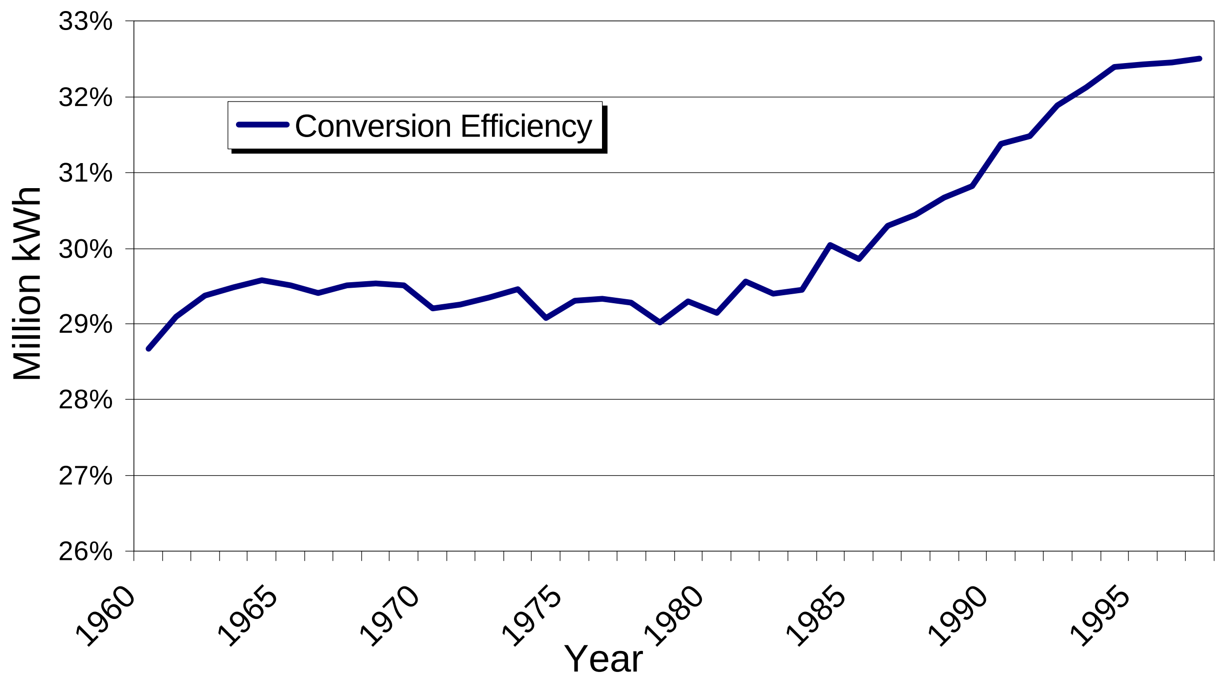

Figure 6 - The conversion efficiency of Kansas electricity has improved significantly since 1980 due to new power plants coming on-line, the retirement of older generating facilities, and the improved operation of baseload power plants. Source: Energy Information Administration

Primary Energy Consumption

Kansas primary energy consumption increased 72% from 1960 to 1997. Most of this growth took place from 1960-1980 when it grew 63%. The 17 years after this saw less than 5% growth (Figure 3 above). Coal and nuclear energy filled most of the new demand with coal consumption increasing from 675,000 short tons in 1960 to 10.4 million short tons in 1997, an increase of 1,400%[8] and nuclear power emerging in 1985 (See Figure 7). Natural gas consumption grew rapidly in the 1960's and remained steady until the early 1980's when Federal price controls restricted the use of natural gas for electricity generation, causing consumption to drop off sharply. Petroleum consumption has not changed dramatically since 1960, but has seen several fluctuations throughout this period. Of the petroleum products, gasoline, distillate fuel (diesel) and LPG use increased by 44%, 250%, and 170% respectively since 1960, while residual fuel and kerosene use declined[9].

Kansans' consume around 1,100 trillion BTU of energy annually. The average use of energy per Kansan in 1997 was 397 million BTU, 13 percent above the US average rate of 351 million BTU. Fossil fuels supply over 90% of this. Petroleum accounts for a third of this energy with natural gas and coal providing around 30% each (Figure 8). Nuclear power, which fuels the Wolf Creek nuclear generating station, accounts for 8% of the total, while biomass comprises 1%. Hydroelectric and other sources of energy (e.g., wind and solar) comprise less than 1% of Kansas' energy consumption.

Petroleum consumption in Kansas is at 193,000 barrels per day, of which transportation fuels, gasoline, and distillate (diesel) have the largest shares (Figure 9). Given the rural nature of the state, liquid petroleum gases (LPG), primarily propane, are used extensively for rural heating and industrial purposes. Energy consumption by sector shows that industrial and transportation sectors are the two biggest consumers (Figure 10).

In all, Kansas is capable of producing 60% of the energy it consumes. Twice as much natural gas is produced in Kansas than is consumed. All of the uranium, most of the coal, and 40% of the petroleum consumed must be produced out of the state. As of 1997, assuming Kansas consumed its own energy first, around 40% of the energy consumed in the state was produced elsewhere (Figure 11). The single largest source is the coal produced in Wyoming and burned in our power plants. The majority of energy imported into Kansas is offset by export of natural gas. While consumption continues to increase, Kansas has become more energy efficient in the last 20 years in terms of the State economy (Figure 12). In 1998, 70% less energy was required per dollar of gross state product than it was in 1977. As energy consumption has leveled off after 1980, the State economy has continued to grow.

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[8] The energy value of coal's growth, as measured in BTU, was slightly less dramatic at 1,200% during this period. The growth came in the form of lower BTU subbituminous coal primarily from Wyoming.

[9] *State Energy Data Report 1996 and 1997*, DOE/EIA-0214 (96, 97), Table 113.

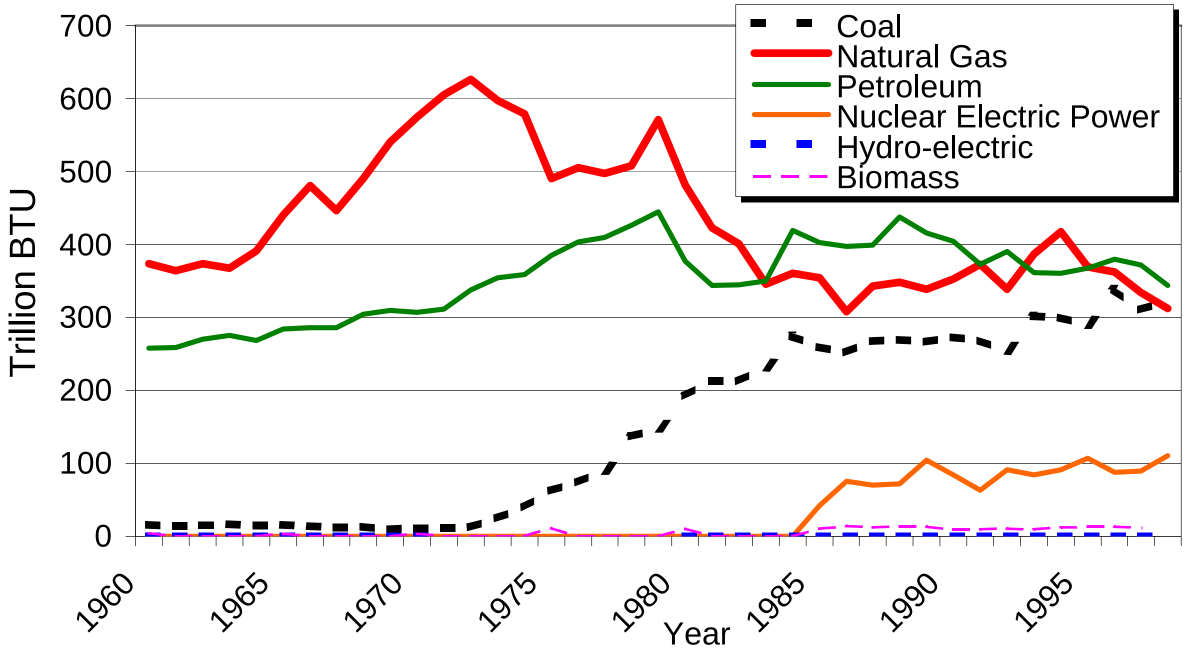

Figure 7 - Since 1960, natural gas consumption has risen and decreased, and consumption of coal and nuclear power has dramatically increased.

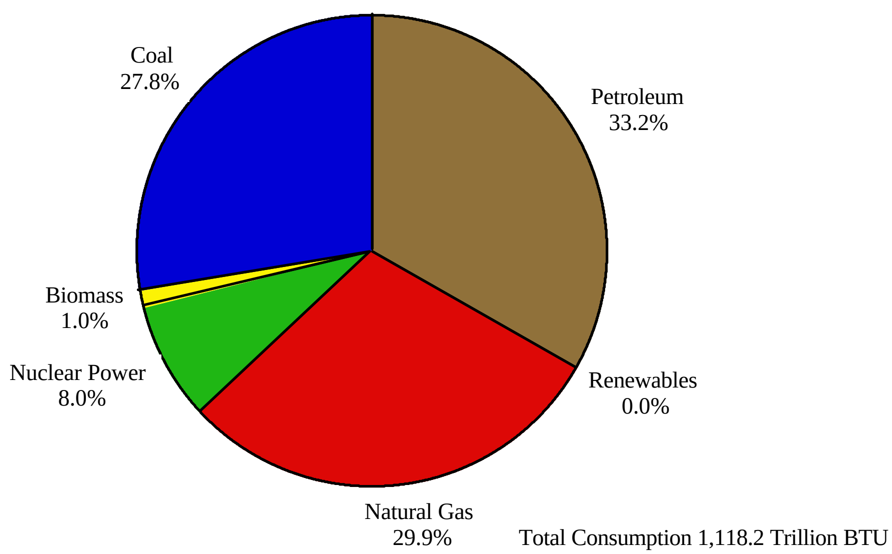

Figure 8 - Kansas relies primarily on petroleum, natural gas, and coal in almost equal shares to meet its own energy requirements. Most of the power generated at electric utilities in Kansas comes from coal and nuclear power. Source: US Department of Energy, Energy Information Agency http://www.eia.doe.gov/emeu/sep/ks/frame.html.

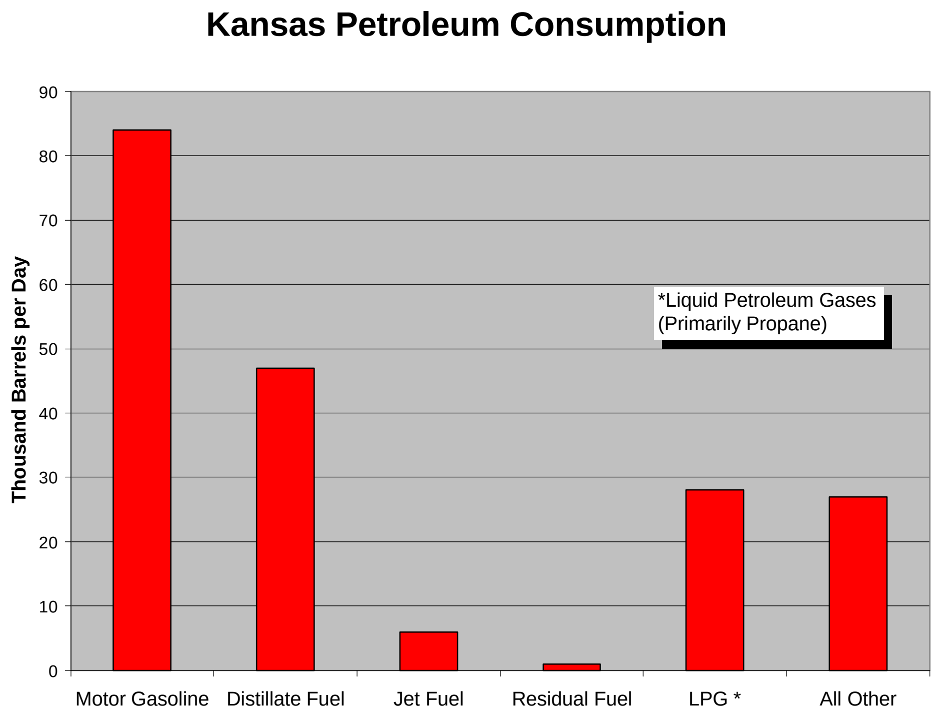

Figure 9 - Kansas consumes 193,000 barrels of petroleum per day. Consumption is primarily motor gasoline and distillate (diesel) for transportation fuels. Source: US Department of Energy, Energy Information Agency http://www.eia.doe.gov/emeu/sep/ks/frame.html.

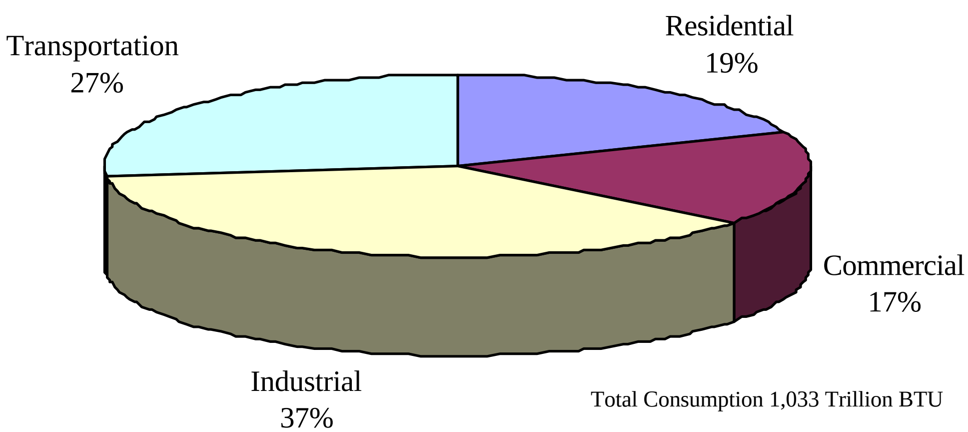

Figure 10 - The industrial and transportation sectors are the largest consumers in Kansas. Source: US Department of Energy, Energy Information Agency http://www.eia.doe.gov/emeu/sep/ks/frame.html.

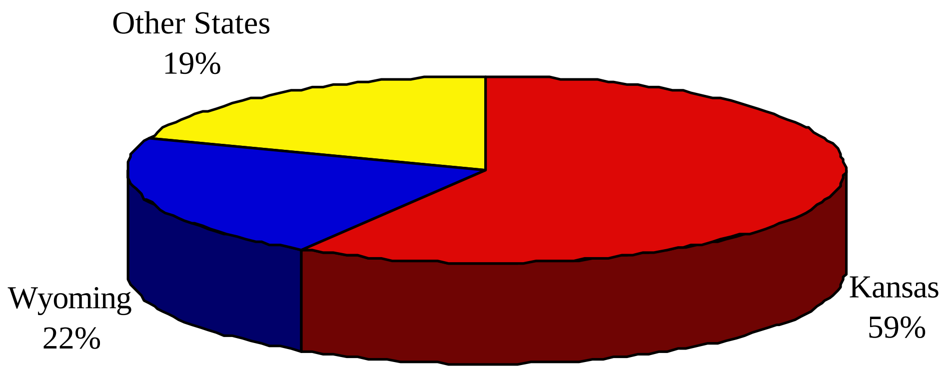

Figure 11 - Over 40% of the energy consumed in Kansas comes from other states.

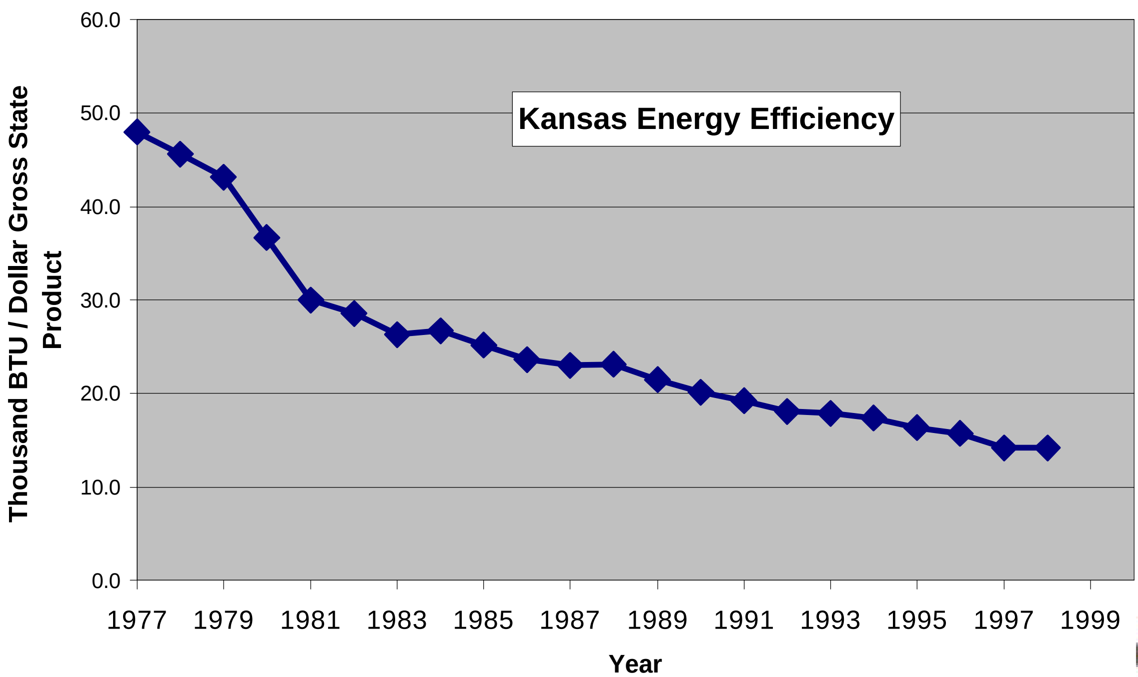

Figure 12 - The Kansas economy has become more efficient in its use of energy since the late 1970's. In 1998, 70% less energy was required per dollar of gross state product than in 1977.

Energy Production

Overview

Natural gas and petroleum are the most important energy resources in Kansas, accounting for nearly all primary energy produced in the state. Energy production in Kansas peaked in 1967 at 1573 trillion BTU. In 1999, primary energy production had declined to approximately 912 trillion BTU (Figure 13). Natural gas production peaked in 1970 at 900 billion cubic feet (bcf)[10]. Petroleum production peaked in 1956 at 124 million barrels (bbls). Of the U.S. states, Kansas is ranked 7th in natural gas production and 8th in oil production[11].

In 1999, a total of 912 trillion BTU of energy were produced in Kansas with 63% from natural gas (566 bcf), 22.0% from petroleum (34 million bbls), 11 % from natural gas liquids (NGL; 34.4 million bbls), and less than 1% from coal (414,000 short tons). The break down of Kansas energy production for 1999 is shown in Figure 14. Since 1960, total energy production in Kansas has dropped by 30%. The majority of this decrease in energy production can be attributed to decreased oil production. Oil's share of the total energy produced in the state has dropped from nearly half of energy production to 22% in 1999 (Figure 13).

Estimates from the Kansas Corporation Commission and the Kansas Geological Survey put 2000 Kansas production at over 34.3 million barrels of oil and at 550 billion cubic feet of gas (Figure 15). Estimated 2000 production is a conservative extrapolation of reported production for the first eight months of the year. The final reported production numbers are expected to be slightly higher. From 1999 to 2000 oil production shows an estimated marginal increase, and gas production remains flat or decreases slightly. Using estimated 2000 average monthly wellhead prices for oil and gas in Kansas, the value of the oil and gas produced in the state is approximately $3.046 billion. Wellhead value in 2000 is an increase of over $1.4 billion dollars from 1999. The increase in total wellhead value is a result of increased prices, especially for natural gas. In 2000, the value of natural gas production ($2.052 billion) is more than twice the value of oil production ($0.924 billion). The significance of the value of Kansas' oil and gas production relative to other parts of the Kansas economy is illustrated by a comparison to agriculture. Over the past 40 years, the value of Kansas oil and gas production is comparable to the value of total statewide crop production as measured by the cash receipts for all the crops produced in the state (Figure 16). In 2000, the wellhead value of Kansas oil and gas production may exceed the value of Kansas crop production.

[10] Unless otherwise noted all oil and gas production figures are from the databases of the Kansas Geological Survey.

[11] Independent Petroleum Association of America, Oil & Natural Gas Producing in Your State http://www.ipaa.org/departments/information_services/state_information.htm.

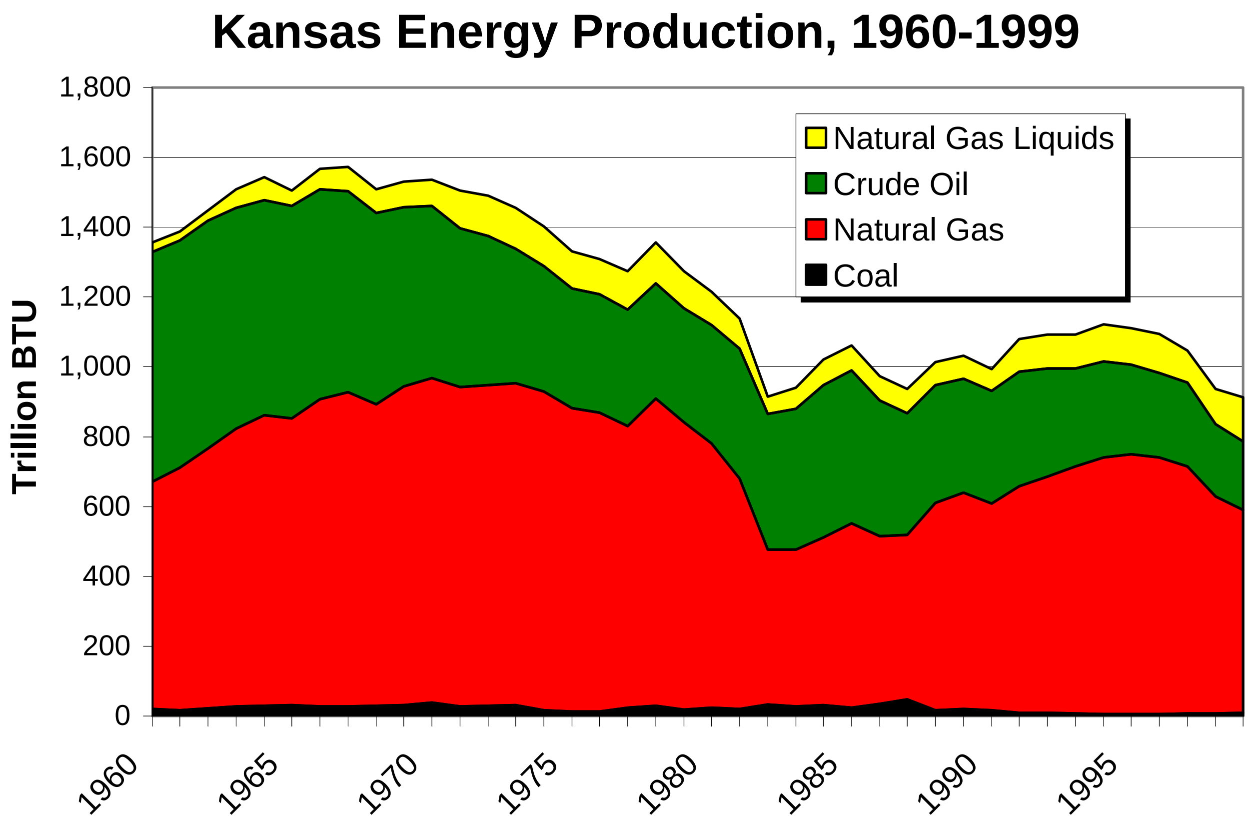

Figure 13 - Kansas total energy production peaked in 1967. The biggest decline in energy production has been in crude oil.

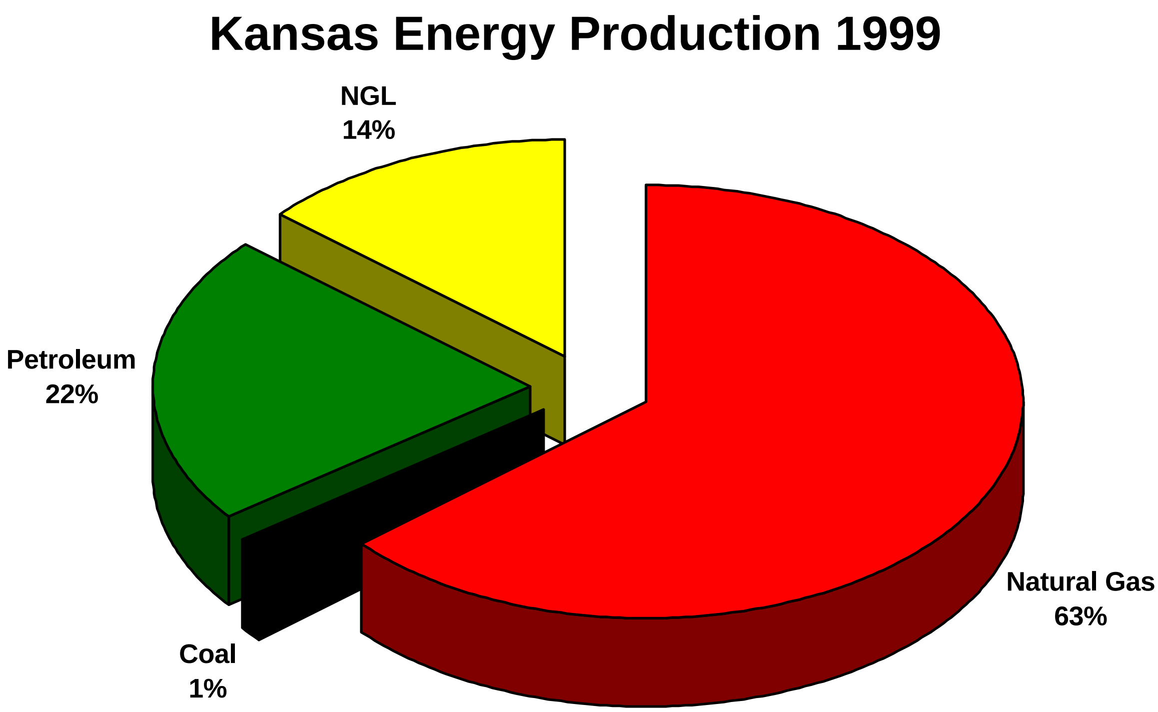

Figure 14 - In 1999, natural gas accounted for approximately two-thirds of Kansas primary energy production. Total primary energy production was 912 trillion BTU.

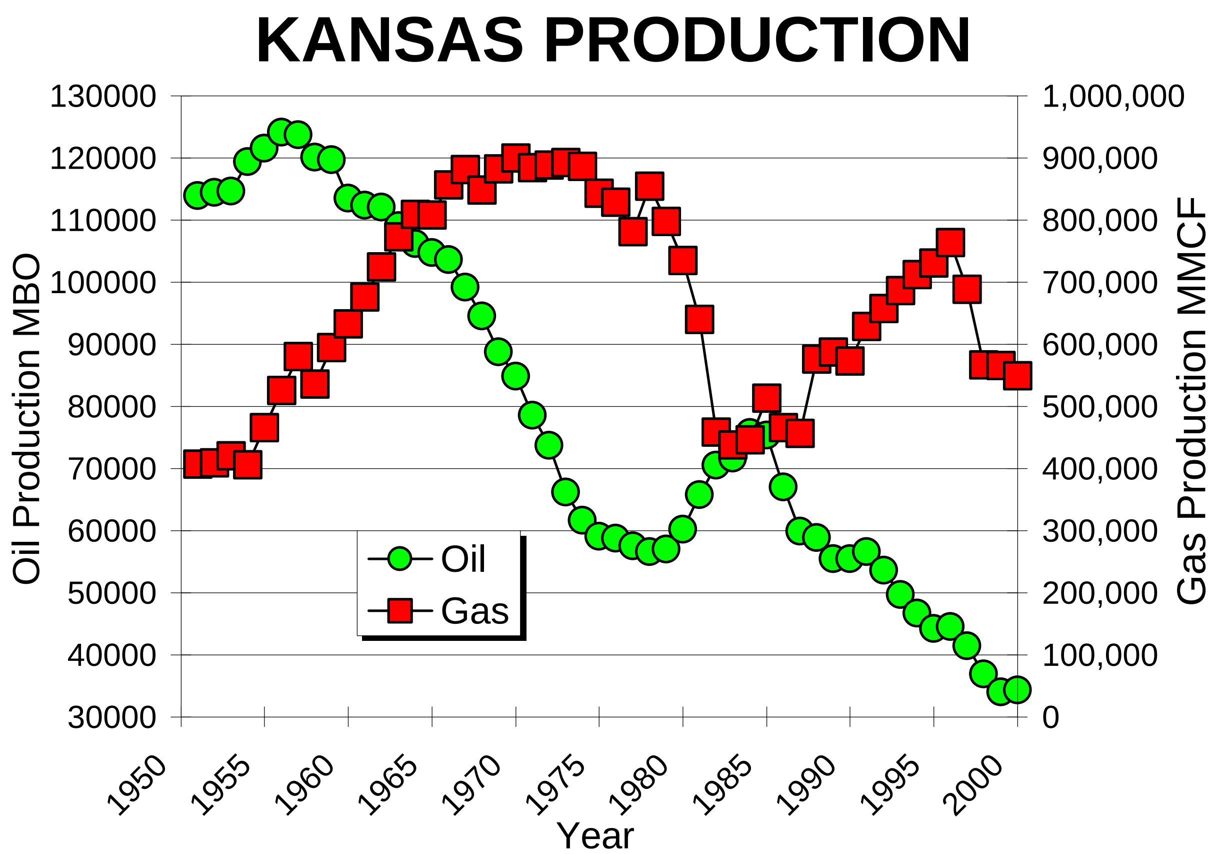

Figure 15 - Kansas oil and gas production from 1951 until 2000. In 1956, oil production peaked at 124 million barrels of oil (mmbo). A second peak in oil production occurred in 1984 at 76 mmbo. Gas production peaked in 1970 at 900 billion cubic feet (bcf). A second peak in gas production of 764 bcf was recorded in 1996. A conservative estimate of production in 2000 is 34 mmbo of oil and 550 bcf of gas.

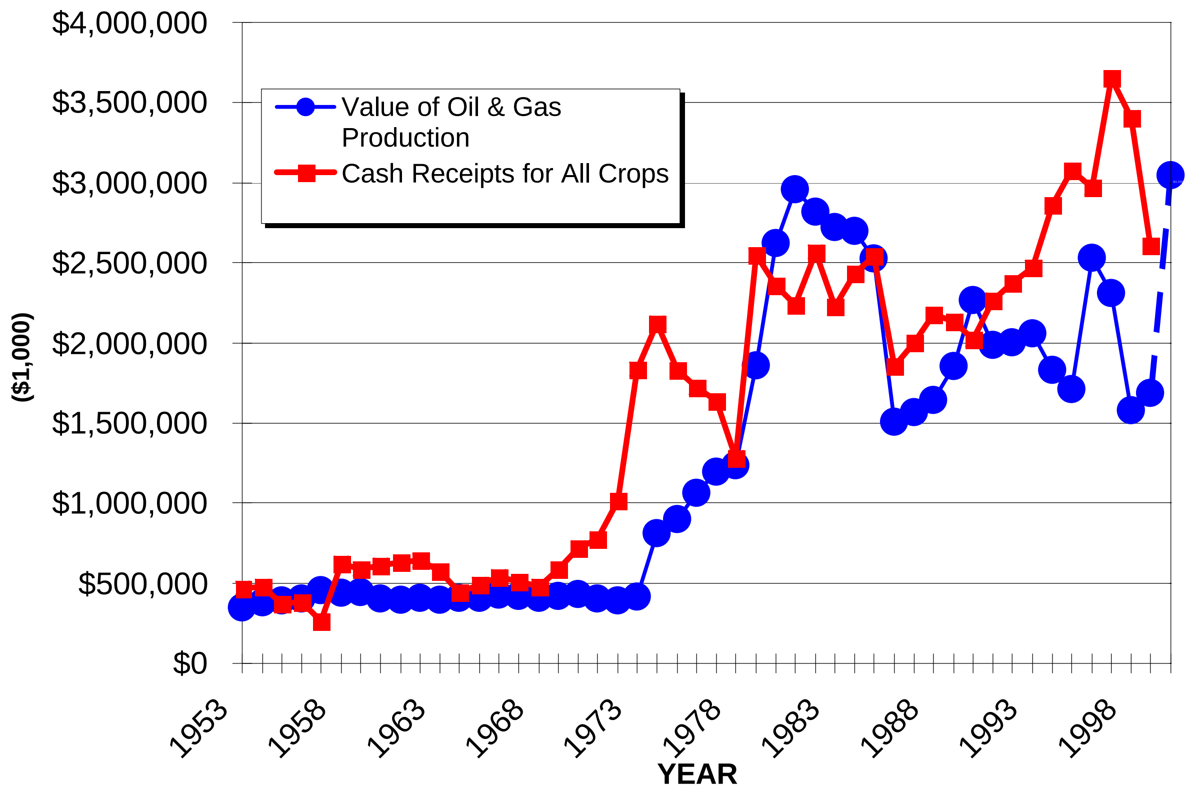

Figure 16 - Wellhead value of Kansas hydrocarbon production compared to cash receipts for all crops. Estimated wellhead value for 2000 is $3.046 billion and represents an increase of $1.4 billion from 1999. Over the past 40 years, the value of Kansas oil and gas production is comparable to the value of total statewide crop production as measured by the cash receipts for all the crops produced in the state.

Oil

Oil currently provides 22% of the energy produced in the State (by BTU), a smaller share than in the past. In 1960 it accounted for 48% of the total production (by BTU). However, Kansas remains as one of the top 10 oil-producing states for many decades with a current ranking of 8th. In 1999, oil production in Kansas was valued at $547 million at the wellhead with production in 2000 estimated to be worth approximately $1 billion due to higher average wellhead prices.

Until the 1973 Arab Oil Embargo, Kansas produced more oil than it consumed (Figure 17). Production peaked at 124.5 million barrels (bbls) in 1956 and was followed by a steady decline to 56 million bbls in 1979. The regulation of oil prices in the early 1970's resulted in a significant increase in consumption. Coupled with a continued decrease in production, Kansas became a net importer of oil for the first time. Deregulation of oil prices in the early 1980's temporarily reversed the downward trend in production and also decreased consumption. Increased drilling produced another production peak of 75 million bbls in 1985. As energy prices collapsed after 1985, production continued to decrease and Kansas became a net importer of oil for the second time (Figure 17). With exception for the period during the Kuwait-Iraq war, oil production has declined as oil prices have continued to decline (in both real and nominal dollars) until early 1999 (Figures 17, 18). Since 1980, production and consumption have decreased, though the gap between consumption and production has widened. In 1998, Kansas' crude oil production was approximately 35 million bbls, while consumption was around 60 million bbls. The significant increase in oil prices since early 2000 has resulted in a slow increase in oil production (Figure 18).

Kansas' oil production is dominated by stripper well production operated by small independent companies. Stripper wells are economically marginal oil and gas wells that produce at relatively low rates. As a result, stripper production is sensitive to changes in the wellhead oil price and well operating costs (e.g., electricity, taxes, and wages). The definition of stripper wells varies. For oil, stripper production is usually defined as production rates of between 5 and 15 barrels of oil per day (BOPD). In 1998, a total of 36,885 wells representing over 98% of the producing oil wells in Kansas averaged less than 15 BOPD and would classified as stripper production[12]. These stripper wells produce approximately 75% of total Kansas' oil production. Each of these well bores represents a very large capital investment that is at risk of being plugged and abandoned. Each existing stripper well represents a resource that is put back into production when prices rise sufficiently to make production economic. Monthly changes in production over the last decade have shown a strong positive correlation to current wellhead prices (Figure 18).

In 1999, 2,273 different operators reported oil production. The average Kansas independent produced just over 15,000 barrels of oil in 1999. The top ten producing companies produced

[12] Producing well numbers are for 1999 Kansas Geological Survey Open-File Report 2000-16, 1999 Kansas Oil and Gas Production: An Examination of the Importance of Stripper Production. http://www.kgs.ukans.edu/PRS/publication/2000/ofr2000-16/index.html

approximately 25% of the oil in 1999[13]. All ten top producing companies are independents. Five of the top ten producing companies are headquartered and primarily operate in Kansas (Oklahoma 2, Texas 3). Independent operators dominate Kansas' oil production. It is estimated that large integrated petroleum companies control less than 5% of Kansas' oil production (e.g., BP Exxon-Mobil or Texaco).

Forecast **–** During the winter of 2000-01 we can expect relatively high and volatile prices for both crude oil and refined products. Of special concern are distillate fuels (heating oil and diesel fuel), which are in short supply (Figure 19). A cold winter in the Northeast and Midwest could result in spot shortages of diesel fuel in Kansas during the early spring of 2001. An over compensation by refiners to winter shortages could result in underproduction of gasoline required for the coming driving season.

It is expected and already observed that the higher oil prices during the year 2000 will increase industry activity and petroleum production in Kansas (Figures 18, 20). In the short-term higher prices will make marginal stripper production economically viable and extend the life of many fields. However, Kansas' oil production is at a very mature stage and has displayed a substantial long-term decline. Maintaining and even increasing petroleum supply over the long term depends on the introduction of new technologies, such as horizontal drilling, 3-D seismic, improved access to digital information, and capital-intensive enhanced oil recovery methods such as CO2 flooding.

In 1999, there were only 20,770 oil and gas well completions in the U.S., down from a peak of 70,000-85,000 wells per year in the period 1980-1985. The average drilling rig count was only 623 per week in 1999, the lowest since the 1940's[14]. Since 1940 the highest weekly US rig count was 4,530 recorded on December 28, 1981. The lowest rig count of 488 was recorded on April 23, 1999. With the recent rise in prices the number of active rigs has increased to just over 1,100 (1,114 on 12/29/00). This is probably near the maximum that our present energy infrastructure of rigs and trained crews can support.

In Kansas average drilling activity reached a historical low of 3 per week in 1999 (Figure 20). In 1982 over 200 deep rigs worked in Kansas. In 2000 with the increase in oil and gas prices, the active deep rig count has increased to approximately 25-30 (25 on 12/29/00). Workover rigs increased from 60 to 80 rigs at work to 150 to 170 rigs at work (Workover rigs are smaller rigs that perform maintenance work on producing wells). Again the infrastructure and trained personnel in Kansas oil and gas industry have been decimated. Our current activity is probably

[13] In 1999, the top ten oil producing companies are in descending order: 1) BEREXCO Inc.; 2) Oxy USA Inc.; 3) Vess Oil Corp; 4) Murfin Drilling Co.; 5) PetroSantander Inc.; 6) Anadarko Petroleum Inc.; 7) Helmerich & Payne, Inc.; 8) Chesapeake Operating, Inc.; 9) McCoy Petroleum Corp.; 10) American Warrior, Inc.

[14] For Kansas, the Baker Hughes Rotary Rig Count was 25 on 12/29/00 and the average rotary rig count in December 2000 was 25. During 1999, the rig count reached a low of 3 in June. Source - Baker Hughes at: http://www.bakerhughes.com/investor/rig/rig_na.htm

the maximum activity that can be supported without a major increase in equipment and personnel.

Over the past two decades economic incentives have not been adequate to attract capital to increase drilling activity and maintain our personnel and capital infrastructure. To rebuild our material and human infrastructure will require a sustained period of stable oil and gas prices. The Kansas industry is dominated by smaller independents operating in mature producing areas within a global market. To substantially increase petroleum production will require attracting technical talent, increased application of technology, and improved access to high risk capital. Risk capital is an essential prerequisite to application of new innovative technologies to increase energy production. Large integrated international companies have relatively easy access to capital markets and significant internal cash flows that can be accessed for innovation capital. Banks, small investors, internal cash flow, and other traditional sources of capital for the Kansas independent cannot meet the capital needed for high-risk projects that represent early or first application of new technologies. If Kansas operators cannot access new technology and high-risk innovation capital, production will continue to decline.

In addition, the continued threat of federal government interference in the market negatively affects the ability of the Kansas industry to attract long-term investment dollars.

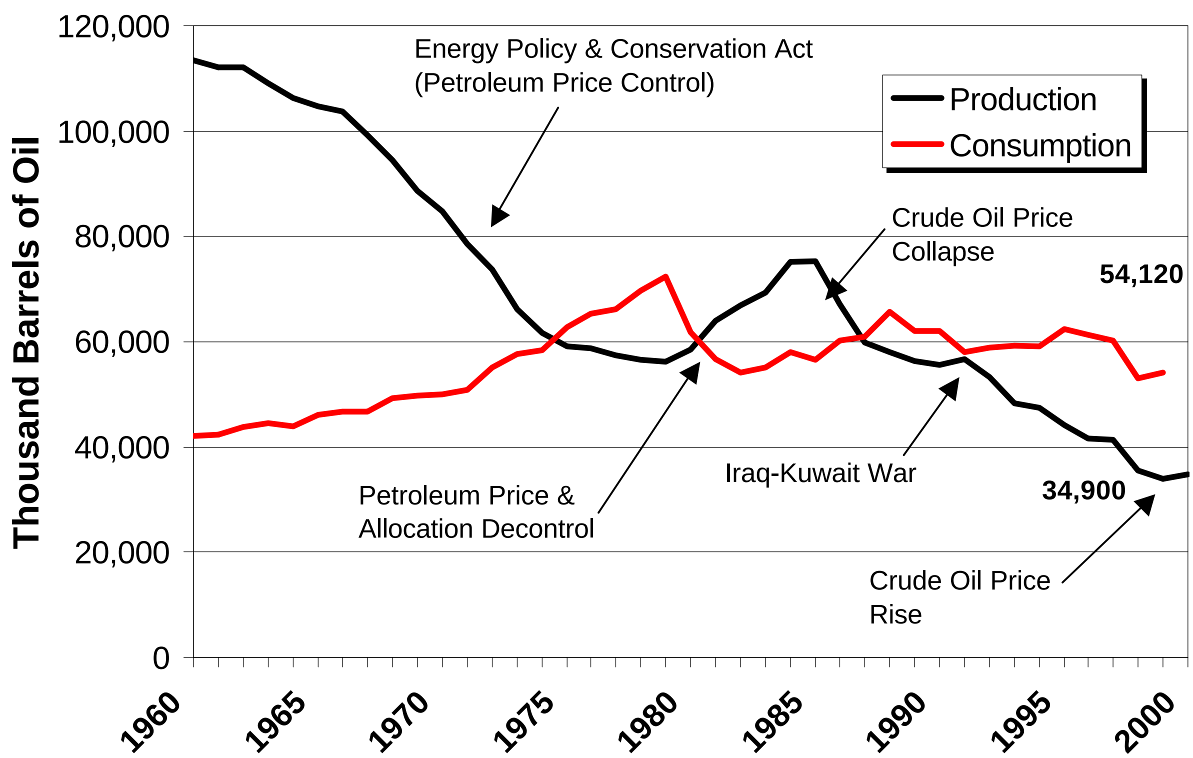

Figure 17 - Kansas oil production and consumption, 1960-2000 with major national and international events that affected both production and consumption.

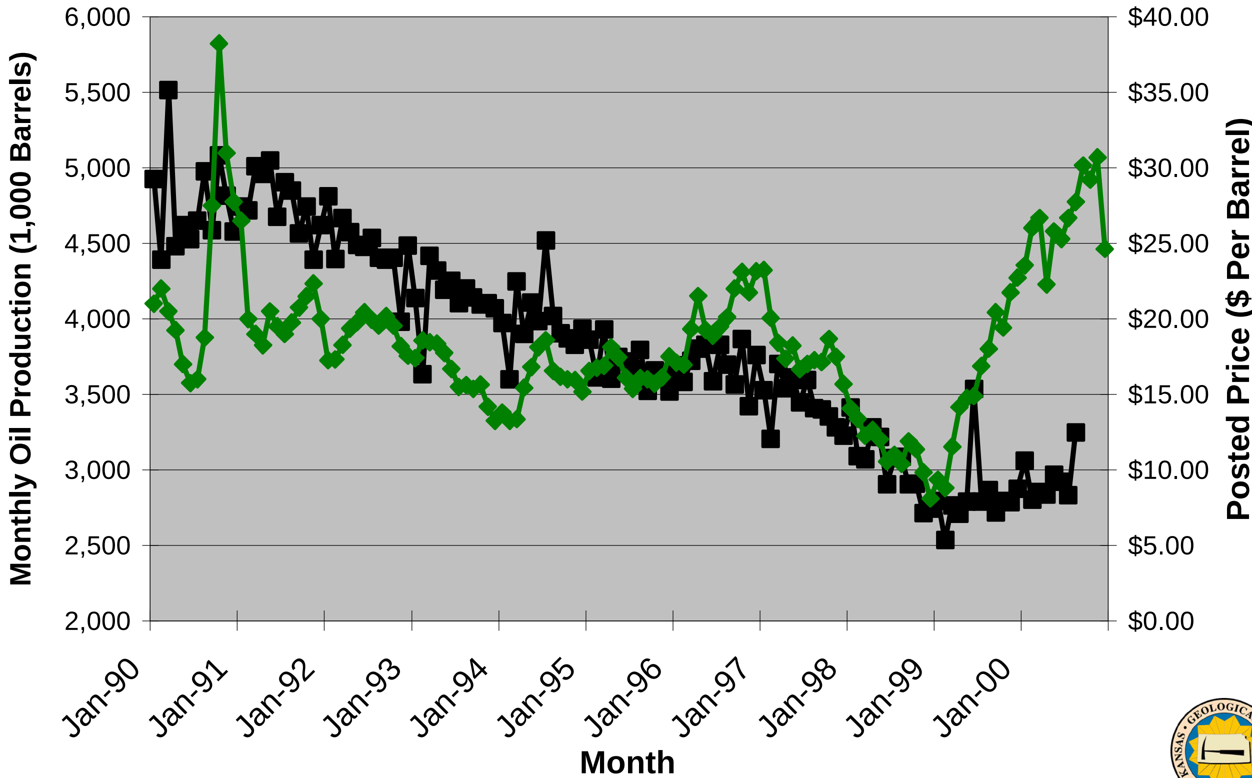

Figure 18 - Monthly Kansas oil production and average monthly wellhead price 1990-2000. Kansas production shows a positive correlation to wellhead price and the effect of rising prices during 2000. Production is through August and prices are the average daily-posted wellhead price through December. Prices are in nominal dollars. Prices are average monthly-posted prices from Koch Petroleum Group for Central Kansas Crude. Prices available at http://www.kochoil.com/.

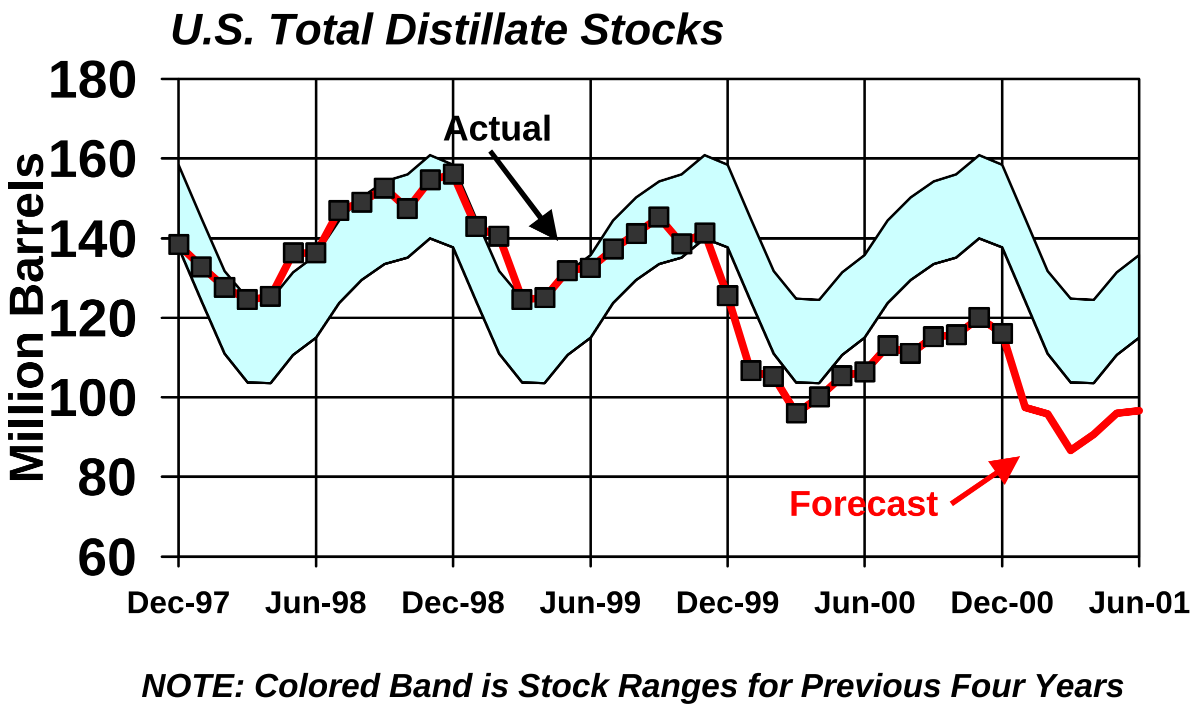

Figure 19 - Monthly U.S. distillate stocks from December 1997 with forecast until June 2001. Sources: U.S. Department of Energy and American Petroleum Institute. Stocks through 12/29/00 total 116.1 million barrels. Forecasted projections follow average monthly storage changes for previous year. Distillates are heating oil and diesel fuel. Kansas, a big consumer of diesel fuel, could be facing spot shortages during the spring of 2001.

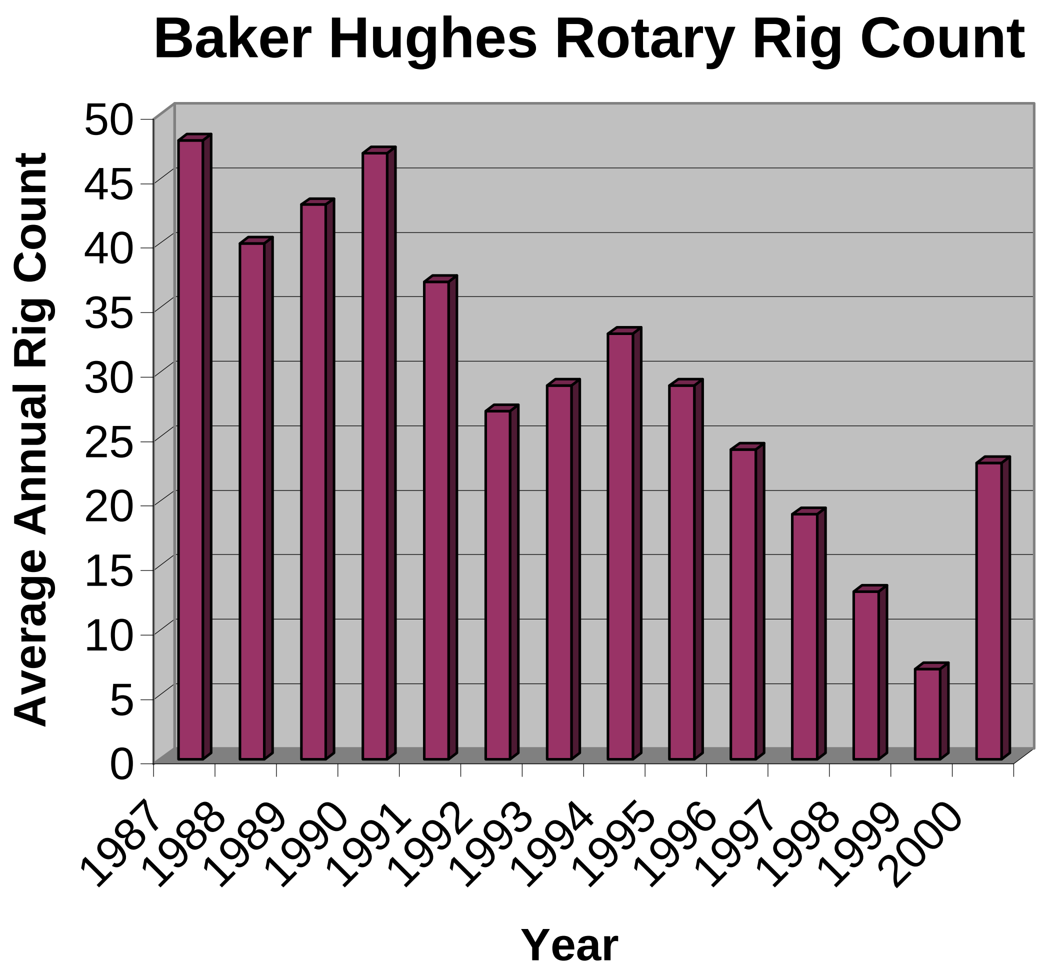

Figure 20 - Average annual Kansas rotary rig count from Baker Hughes. The rotary rig count is a good measure of industry activity and capital investment. Data source: http://www.bakerhughes.com/investor/rig/rig_na.htm.

Natural Gas

Natural gas accounts for approximately two-thirds of Kansas' current energy production. Annual gas production peaked in 1970 at 900 billion cubic feet (bcf) and consumption peaked two years later at 600 bcf (Figure 21). Kansas is one of the top gas-producing states and remains a net exporter of natural gas primarily to the upper midwestern states. In the current year, Kansas should produce approximately 250 bcf more gas than it consumes. Gas production in Kansas is concentrated in southwest Kansas. The fields in this area of the state, including the Hugoton Field, produced 90% of the gas in Kansas (Figure 22). In 1999, gas production of 566 bcf in Kansas was valued at $1.174 billion at the wellhead. Production in 2000 is estimated at over 550 bcf and valued at approximately $2.052 billion. The increased value is attributed to significantly higher average wellhead prices during 2000 (Figure 23).

Economic conditions and government policies have affected Kansas gas production (e.g., the Energy Petroleum Allocation Act of 1973, the Energy Policy and Conservation Act of 1975, the Power plant and Industrial Fuel Use Act of 1978, and the Price and Allocation Decontrol in 1981). The dramatic decrease in gas production during the 1970's from 900 BCF per year to less than 450 BCF per year appears to be related to market distortions resulting from federal government policies (Figure 21). Subsequent decontrol in 1981 of prices, allocations, and uses of fuels, and the 1986 Kansas Corporation Commission's (KCC) modified spacing rules in the Hugoton Field contributed to a second production peak of just over 700 bcf in 1996 (Figures 15, 21). Production has declined since 1996, but appears to have stabilized at approximately 500 bcf. The production decline is attributed to decreased average reservoir pressure in the Hugoton area from over 400 pounds per square inch (psi) to under 60 psi today[15]. As reservoir pressures continue to decline, intelligent energy policies, significant investment capital, and new technologies must be developed to assure continued production.

Kansas gas production is dominated by the large fields of southwest Kansas (e.g., Hugoton, Panoma, Byerly, Bradshaw, and Greenwood). However, stripper gas production in Kansas is significant. Stripper gas production would generally be anything less than 90 thousand cubic feet per day (MCFPD). In Kansas, 63% of the 17,146 producing gas wells averaged less than 90 MCFPD and produced 24.1% of the gas[16]. As with oil, stripper gas production is sensitive to changes in the wellhead oil price and well operating costs (e.g., electricity, taxes, and wages).

In 1999, 1,015 different operators reported natural gas production. The average Kansas independent produced just less than 550,000 mcf of gas in 1999. The top ten producing

[15] Personal Communication from David P. Williams, Kansas Corporation Commission. The 1999 average well head shut-in pressure for the field was 52.5 psig. The original estimated reservoir pressure for the entire Hugoton Field (Chase Group) was 435 psig.

[16] Producing well numbers are for 1999 Kansas Geological Survey Open-File Report 2000-16, 1999 Kansas Oil and Gas Production: An Examination of the Importance of Stripper Production. http://www.kgs.ukans.edu/PRS/publication/2000/ofr2000-16/index.html

companies produced approximately 78% of the gas in 1999. Seven of the top ten producing companies are independents. Kansas' gas production is a mix of the largest integrated companies (e.g., Exxon-Mobil and BP-America) and independent companies (e.g., Anadarko and Helmrich & Payne).[17]

The seasonal nature of natural gas production has changed significantly after the mid-1990's. Prior the mid-1990's natural gas displayed a seasonal pattern with peak production during the winter heating season (Figure 23). This variation in production was also reflected in seasonal price fluctuations. With the construction of underground gas storage, the development of futures markets, and the increased use of natural gas in electric power generation, seasonal variations in production and price have disappeared. As a result, during the summer there is no longer a cheap and plentiful supply of natural gas to power irrigation pumps in southwest Kansas.

Forecast - Demands on natural gas for electric power generation are absorbing all the excess natural gas supply during warm months, gas that traditionally was put into storage for use as a home heating fuel during the winter. As a result entered the winter of 2000-01 with very low natural gas storage levels and extremely high prices (Figures 23, 24).

The last few winters have had above-normal temperatures, masking the increased demand for natural gas resulting from the strong economic growth and the increased electrification. The winter of 1999-2000 had 3,404 Heating Degree Days (HDD). The normal winter is 3,958 HDD. As this winter appears more seasonable, wellhead prices are exceeding $9-10/MCF for periods of time. As storage levels approach historically low levels, the ability of underground natural gas storage facilities to meet peak demand will be significantly degraded[18]. By using natural gas to solve an electric supply problem, we have creating a gas supply problem.

Agriculture in western Kansas depends on natural gas to run irrigation pumps and is particularly vulnerable to high gas prices. Utility companies have a percentage of winter demand covered by longer-term contracts for natural gas. This will partially buffer utilities (and residential consumers) from short-term price increases or at least delay the onset of them. Agricultural interests generally do not have such contracts, buying gas on the spot market. Farmers could be hit with an immediate doubling or tripling of energy costs to irrigate fields. Also, the highest prices may coincide with the end of the heating season and the onset of irrigation as storage levels reach their lowest levels (i.e., April-May-June, Figure 20). Similar negative impacts could be felt in the chemicals industry (e.g., ammonia production).

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[17] In 1999, the top ten natural gas producing companies are in descending order: 1) Exxon Mobil; 2) BP America; 3) Oxy USA, Inc.; 4) Anadarko Petroleum Co., 5) Pioneer (Mesa); 6) Helmrich & Payne Co., 7) Chesapeake; 8) Kansas Natural Gas Co.; 9) Osborn Heirs Co.; 10) Texaco.

[18] Storage deliverability is a function of remaining working gas levels. As working gas volumes decline, the maximum rate that gas can be delivered declines. Working gas levels below 700 bcf can result in late season deliverability below demand requirements. See: J. A. Dieter and David A. Pursell, Underground Natural Gas Storage, Simmons and Company International Energy Industry Research Paper, June 28, 2000. http://www.simmonsco-intl.com/research

If we limp out of the winter 2000-01 with less than 500 Bcf of gas in storage, we will barely get storage back to even half-full before newly installed summer gas-fired electricity plants are cranked up. If summer weather is hot, particularly in the population areas of the eastern U.S., gas storage withdrawals may occur in the summer. If this does not happen in summer 2001, it will almost certainly occur a year later. Once gas withdrawals begin in the summer, the U.S. has one winter left before our storage system runs dry. These demand-side pressures begin to raise questions such as:

- How can enough gas be produced to meet demand at affordable prices?
- Can we increase gas production fast enough to keep up with a demand increasing from 21 trillion cubic feet (tcf) in 1999 to 30 tcf in 2020 or sooner?[19]

The recent low price for natural gas over the last few years has depressed exploration and development efforts in the U.S. and Kansas. In addition, restrictive or prohibited access to federal lands has limited access to many prospective areas for new gas discoveries[20]. With the recent price increases, industrial activity and gas production have increased. However, the U.S. and Kansas industry has been decimated. It will take significant time, increased investment capital, and application of advanced technologies to increase natural gas production. Present rig activity in the U.S. and Kansas needs to increase approximately six-fold in order to sufficiently increase natural gas supply to catch up with the rapidly increasing demand[21]. It will require significant effort and cooperation to increase Kansas rig activity from 25 to 150 along with all the related geologic, geophysical, and engineering activity.

Last year (1999) the value of natural gas production at the wellhead in Kansas was $1.034 billion. This year, we project that figure will reach $2.052 billion. This will certainly have a positive impact on state tax revenues. Severance tax revenues will probably double to over $100 million. Additional Kansas ad valorum and income tax revenues from increased economic activity will be even greater.

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[19] Statement on oil and gas supply and demand by Department of Energy EIA Administrator Jay Hawkes before the Subcommittee on Energy and Power of the Commerce Committee, U.S. House of Representatives on May 24, 2000. http://www.eia.doe.gov/neic/speeches/hrtest524/TestimonyMay242000Final.htm.

[20] 1999, Meeting the Challenges of the Nation's Growing Natural Gas Demand, Report from the National Petroleum Council. Available at http://www.npc.org/.

[21] *Outlook for Natural Gas: Is a Train Wreck Pending?* Presentation by Matthew R. Simmons at U.S. Department Of Energy, Strategic Initiatives Workshop, December 6 - 9, 2000 available at: http://www.simmonsco-intl.com/research/default.asp?viewnews=true&newstype=1#Industry_group_speeches.

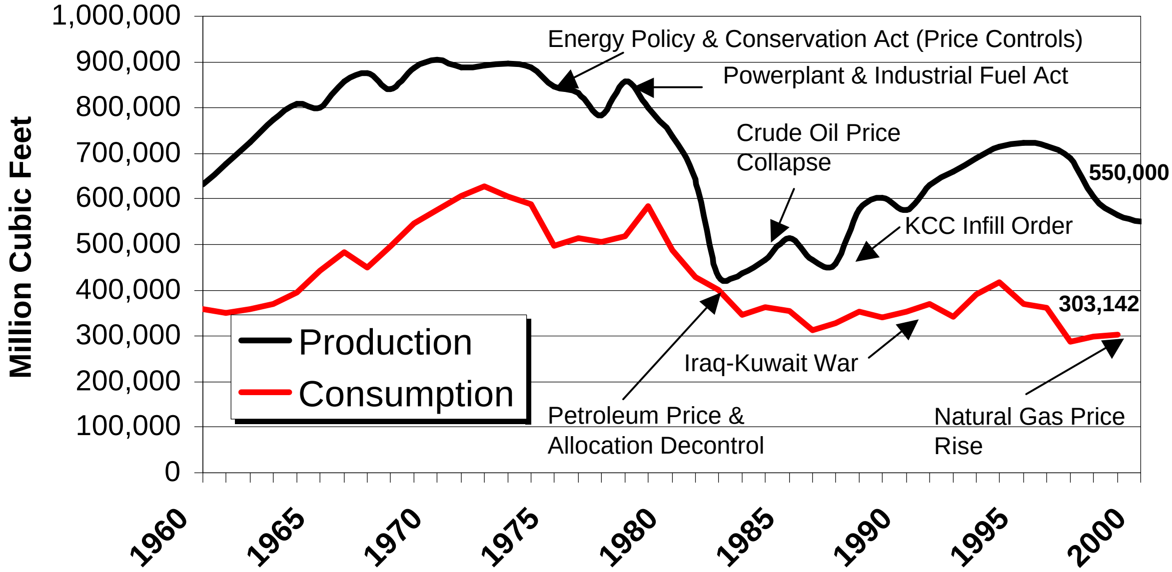

Figure 21 - Kansas natural gas production and consumption, 1960-2000, with major national and international events that affected both production and consumption.

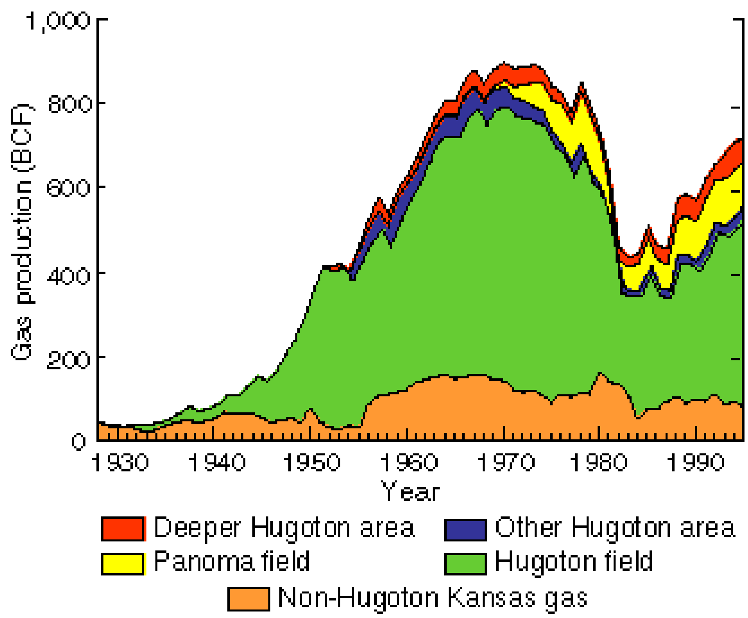

Figure 22 - Gas production in Kansas showing the importance of production from gas fields in the Hugoton area. (BCF = billion cubic feet of gas). Chart from Kansas Geological Survey, Public Information Circular 5, http://www.kgs.ukans.edu/Publications/pic5/pic5_1.html.

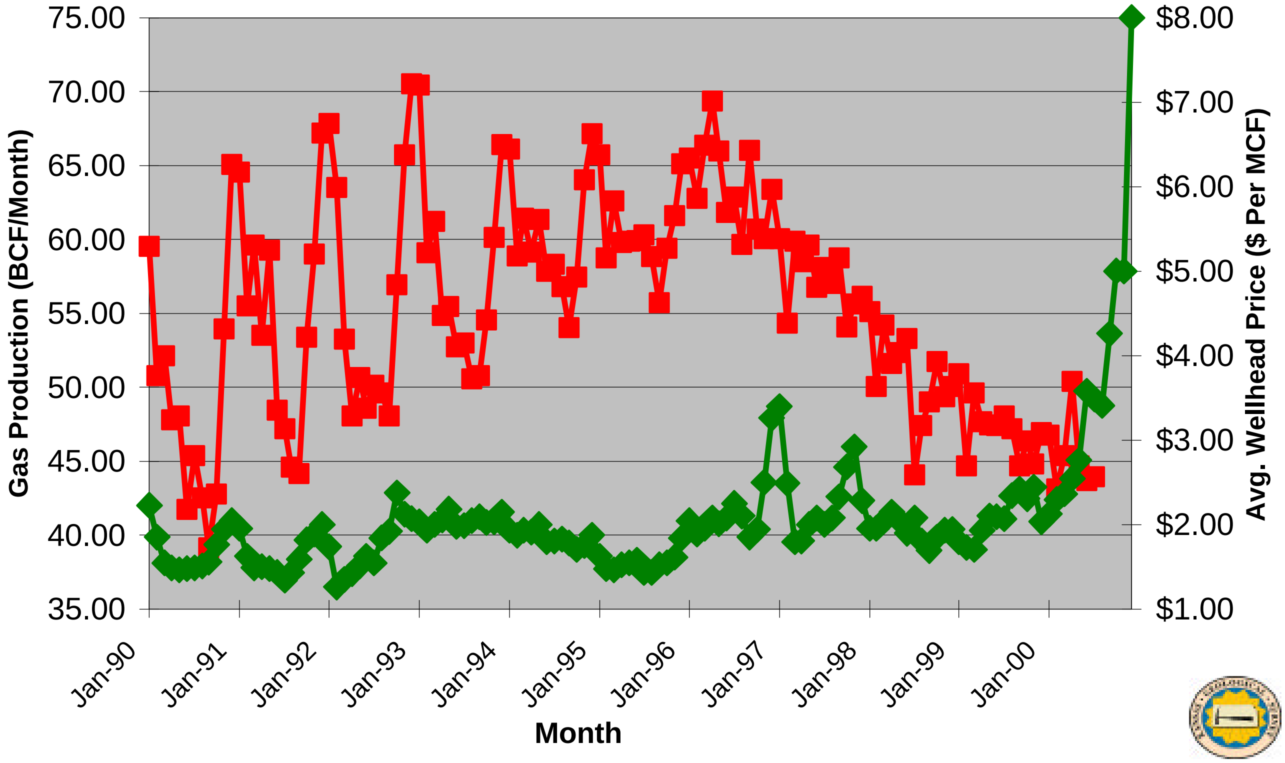

Figure 23 - Monthly Kansas natural gas production and average monthly wellhead price 1990-2000. Kansas production shows significant changes in production patterns. The seasonal production pattern of the first part of the decade disappeared. The steady decline from early 1997 is attributed to declining pressures in the major gas fields of southwest Kansas. However, the decline has slowed and monthly production may be increasing during 2000. Production is through August 2000 and prices are the average daily-posted wellhead price through December 2000.

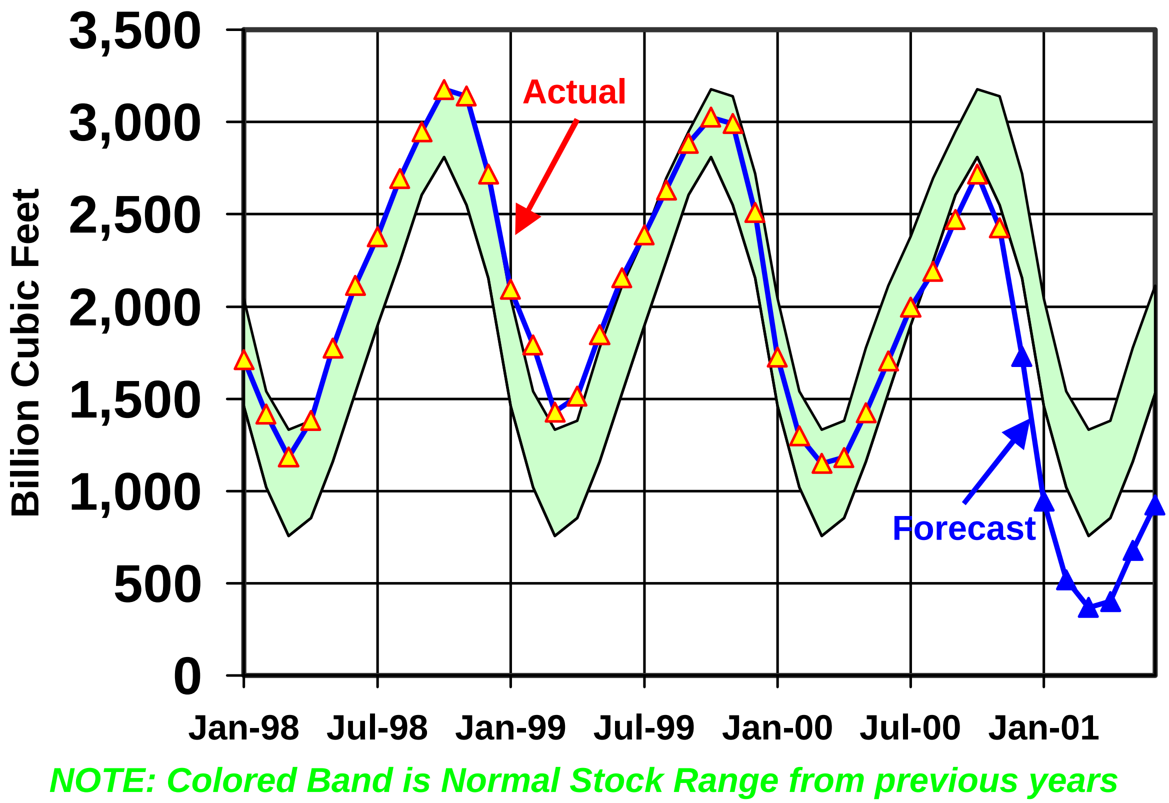

Figure 24 - Monthly U.S. natural gas stocks from January 1998 with forecast until June 2001. Sources: U.S. Department of Energy and American Gas Association. Stocks through 12/29/00 total 1,729 bcf. Forecasted projections follow average monthly storage changes for previous year. Kansas along with the rest of the U.S. could face spot shortages during the spring of 2001.

Coal

Coal production has served a minor but important role in the Kansas energy picture. Up through 1973, more coal was produced in the state than was consumed. With the implementation of federal policies in the 1970's to restrict usage of natural gas for electric generation, coal consumption rose dramatically in the state. During the rest of the decade, annual coal consumption rose twenty-fold from a half million tons in 1972 to over 10 million tons in 1980 (Figure 25). Coal production on the other hand only exceeded 1.5 million tons annually once in that period. For the past decade, production of coal has not surpassed a million tons in any given year, while consumption has increased to around 17 million short tons annually. Coal for Kansas electric generation is primarily imported from Wyoming (Figure 11). The deficit between consumption and production continues to be in contrast to the United States as a whole, which produces more coal than it consumes. In 1997 the U.S. consumed 1.03 billion tons of coal, while producing 1.09 billion tons.

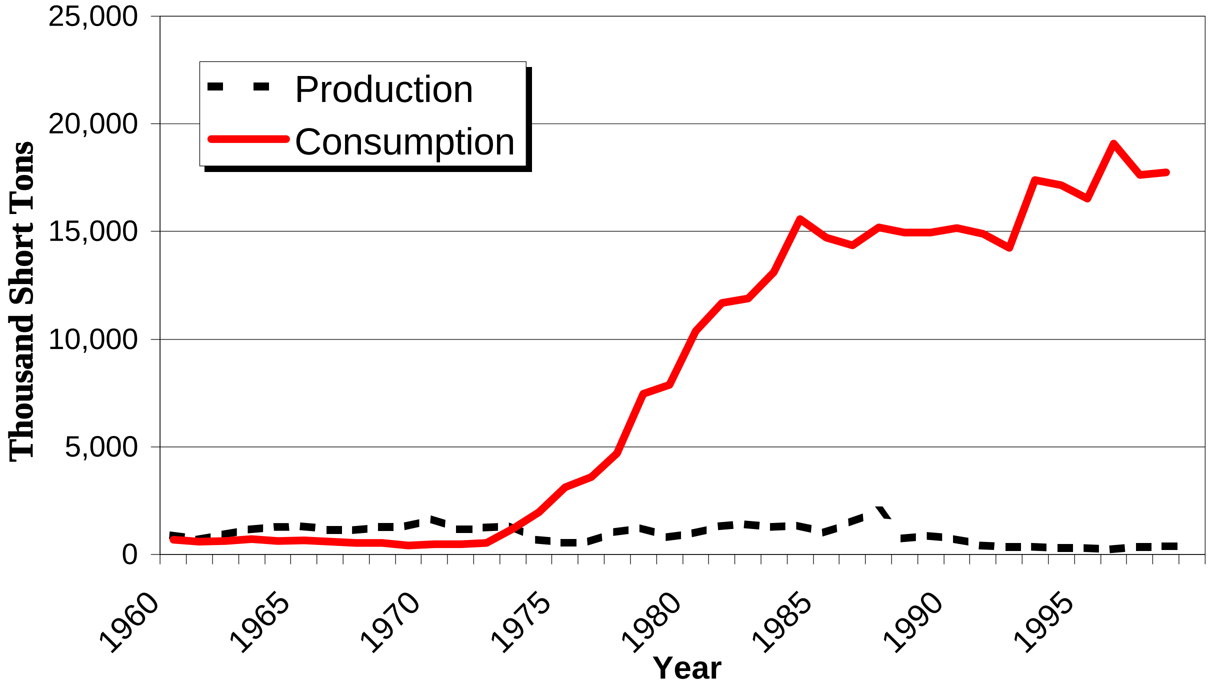

Figure 25 - Kansas coal production and consumption, 1960-1998. The dramatic rise in Kansas coal consumption is the result of federal policies in the 1970's to restrict usage of natural gas for electric generation. The same policies resulted in a rapid decrease in both consumption and production of natural gas in Kansas (see Figure 21).

Renewable Energy

Wind Power

Wind power in Kansas is not a new concept. For decades, ranchers and farmers used the power of blowing winds to pump water to fill stock tanks and to irrigate crops. With changes in needs and technologies, the wind is now also seen as a viable means to generate electricity. A 1991 study by Pacific Northwest Laboratory[22] ranked Kansas as having the third best wind energy resource, after North Dakota and Texas, with the potential to produce 1,070 billion kWh of electricity annually. For comparison, Kansas utilities generated 41.5 billion kWh in 1998. Yet, thus far, the wind resource for electricity generation has largely gone untapped, as Kansas ranks 13th in actual electricity produced from wind, and will soon drop to 19th as current projects in other states come on-line.

Currently, only two utility-sized wind turbines operate in the state, each rated at 750 kW and located at the Jeffery Energy Center in St. Marys. Another 75 residential/commercial-sized facilities in Kansas have a total rated capacity of 1,300 kW[23]. News reports indicate that a 70-turbine project near Greensburg in Kiowa County and two single-turbine projects at school districts including Olathe are in the planning stage[24].

While the development of wind energy will not likely solve all of our energy supply problems in the short-term, the role of this energy source could become important throughout the state. Wind turbine technologies continue to improve, making the machines more efficient at producing electricity from the wind's energy and driving down the cost. The location of turbines on rural property can provide important income, while allowing 95% of the land to still be used for farming or ranching. The development of this energy source, however, may require innovations actions by the State to spur development rather than waiting for the large utilities to do it themselves.

Biomass

There is potential for switchgrass or other fast-growing crops in Kansas to off-set fossil fuels burned in power plants. The benefits of this potential fuel source include:

- It can be grown on marginal lands,
- The vast root system serves as a soil stabilizer and carbon fixer,
- The species is native to our state,
- Expertise exists in the state (K-State, independent researchers).

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[22] Elliot, D.L. and D.L. Schwartz, *Wind Energy Potential in the United States.* Pacific Northwest Laboratory, PNL-SA-23109 (September 1993).
[23] National Renewable Energy Laboratory's, *Renewable Plant Information System*. (http://www.eren.doe.gov/repis/)
[24] Gerry, S., *As Energy Costs Rise, Kansans Turn To Wind Power*, in *Kansas City Star*. 2000: Kansas City, MO.

Experiments are currently taking place in Iowa to determine whether it can become cost-effective.

Ethanol

Biofuels such as ethanol receive a great deal of media coverage whenever gasoline prices get too high, corn prices get too low, or when fuel-additive substitutes (i.e. MTBE) are found to cause groundwater pollution. U.S. ethanol production has increased from 175 million gallons in 1980 to 1.4 billion gallons in 1998, due to state and federal tax subsidies and mandates to use high-oxygen gasolines.[25]

With the State of California phasing out the use of MTBE by 2002 and the EPA suggesting the ban of MTBE, the demand for ethanol may grow substantially. Its growth may depend on whether tax subsidies are renewed and whether reformulated gasoline mandates continue in cities with substantial air pollution problems.

Many cellulose-based crops such as corn, milo, alfalfa, and various crop-wastes have the potential to be distilled into alcohol-fuels such as ethanol. Four facilities produce ethanol in Kansas, one of which innovatively couples ethanol production with talipia fish farming and cattle feed from byproducts[26].

Future ethanol projects in Kansas may see synergistic coupling of ethanol plants with oil production by capturing the CO2 produced during the fermentation of the ethanol fuelstock and using the gas for enhanced oil recovery in the Kansas oil patch. Such a coupling could make two energy sources economical by providing the ethanol producers a market for a waste product and oil producers an affordable source of CO2 for enhanced oil recovery.

Summary

Total energy consumption continues to grow in Kansas. However, Kansas is more energy efficient than 20 years ago. In 1998, 70% less energy was required per dollar of gross state product than it was in 1977. Growth in total energy consumption slowed after 1980, while the State economy has continued its rapid growth. However, Kansas and the U.S. are rapidly changing how energy is delivered. We are moving to increased dependence on electricity. Over the last 40 years, electricity's share of Kansas energy consumption has doubled from 15% to nearly 33%. With electric industry restructuring and increased uncertainty in environmental demands, today’s additions to baseload capacity are overwhelmingly combined-cycle or combustion turbine technology fueled by natural gas. The result is an extremely rapid and accelerating growth in demand for natural gas for electric generation

[25] DiPardo, Joseph, "Outlook for Biomass Ethanol Production and Demand", DOE/EIA, http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

[26] Charlene Scott, "Turning Ethanol Production into a Family Business," Dodge City (KS) Daily Globe, 21 October 2000.

Fossil fuels - oil, natural gas, and coal - make up 91% of the energy consumed by Kansans. Fossil fuels will continue to dominate energy markets in Kansas, the nation, and the world for at least the next 20 - 40 years[27]. Kansas oil and gas fields are entering a third phase of production that will require increased technology and capital investment. Alternative energy sources will increase and if economically viable should be encouraged in the coming years. An economic and measured approach that integrates new energy sources (e.g., wind and ethanol production from agricultural production) into the Kansas energy system can have a positive impact. Increased synergy and efficiencies are possible among all the various aspects of the Kansas energy system. However, Kansas and U. S energy supply will continue to be dominated by fossil fuels. Alternative energy does not appear to have the potential for a major short-term impact on energy supply.

Until the energy price collapse in mid-1980s, Kansas was a net exporter of energy (Figure 26). More energy was produced in the Kansas than was consumed, thereby allowing energy to be exported outside of the State. Since then, the steadily declining oil and gas production that followed steadily declining wellhead prices, coupled with increasing consumption, has pushed Kansas into a neutral position - our consumption of energy is roughly matched by our production.

Worldwide petroleum demand is climbing at about 2.4% annually, and will continue to increase with the growing prosperity in Asia and elsewhere. A new and fast growing "consumer class" is appearing in the emerging economies of the world. China, India, Pakistan, and Indonesia, with 40% of the world's population, use less than 1 barrel of oil per capita/year (U.S. consumption is approximately 24 barrels of crude oil per capita per year). The rest of the world is entering the mass consumer age where everyone wants electric power, consumer items, and motorized transportation. How will the U.S. and Kansas compete on the world market for the energy supply required to maintain our economy?

The U.S. is the third largest producer of oil and the largest producer of natural gas in the world. Kansas remains a significant producer of primary energy. However, we no longer encourage investment in the technology, people, and capital required to maintain our energy infrastructure.

Without a significant increase in primary energy supply in the coming years, Kansas will become a significant net importer of energy. Kansas will need to sell more products outside of the State to pay for our growing energy demands. Innovative methods to increase the production of clean, copious, and low-cost energy will be required to avoid shrinking the Kansas economy.

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[27] 1997, Report of the Energy Research and Development Panel, Federal Energy Research and Development for the Challenges of the Twenty-first Century: President's Committee of Advisors on Science and Technology, November. http://www.whitehouse.gov/WH/EOP/OSTP/Energy/.

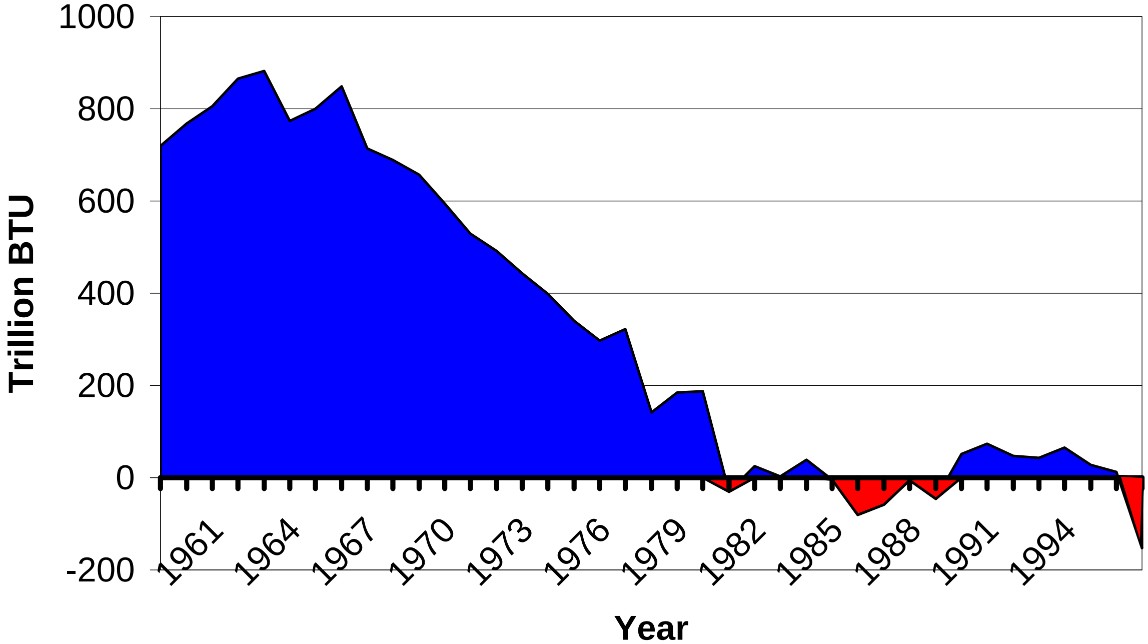

Figure 26 - Kansas net energy production, 1960-1998.