KANSAS ENERGY PLAN 2003

State Energy Resources Coordination Council

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Published by the Kansas Geological Survey,
in cooperation with the
Kansas Corporation Commission

www.kansasenergy.org

Kansas Geological Survey
Open-file Report 2003-3

KANSAS ENERGY PLAN 2003
Table of Contents

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Acknowledgments

Several KGS staff helped with the production of this report, including Jennifer Sims, who prepared graphics from a variety of sources; Marla Adkins-Heljeson, who prepared tables and edited parts of the report; John Charlton, who assisted with photography; and Dana Adkins-Heljeson, who provided data and tables from the KGS web site. Richard Nelson, Kansas State University, wrote the biomass section, and Jeff Roskam, ICM, Inc., contributed to the section on ethanol. Donna Johnson, Pinnacle Technology, and Jim Ploger, KCC, reviewed the section on wind energy. Appendix 3 is excerpted from Tim Carr's KGS Open-file Report 2000-57. Appendix 4 contains consumption forecast summary tables prepared by Soojong Kwak, KCC, and Michael Volker, Midwest Energy, Inc.

Executive Summary

After nearly a century of being one of the nation's leading energy exporters, Kansas is now a net energy importer (Figure 1). Kansas's net energy balance is expected to worsen for the foreseeable future, with serious implications for the economic well being of the state. Fossil energy fueled the Kansas economy and provided substantial exports to other states for much of the 20th century. By about twenty years ago, Kansas's energy production and consumption were roughly in balance. This was due to a combination of declining oil, gas, and coal production, and increasing imports of coal for electricity generation and gasoline for transportation. However, since 1997, the net energy balance has shifted strongly to the negative side (Figure 1). By 2007, we estimate that Kansas's net imports will be 650 trillion Btu a year, which means that Kansas could be importing more than $2.5 billion of energy to meet its demand.

The State Energy Resources Coordination Council (SERCC) is tasked with developing plans to increase the state's energy self-sufficiency and restore the state to being a net energy exporter. Specific tasks of the Council include preparing a comprehensive energy plan, updated annually. The Council is also tasked with developing forecasts of Kansas energy production and consumption for the next five years.

Achieving energy self-sufficiency will likely require a combination of the following:

- extending the life of the state's oil and gas fields,
- increasing conservation and efficiency, and
- developing new sources of energy, of which the most promising in the near-term appear to be ethanol, wind, and coalbed methane.

Energy Production and Consumption Forecasts

The Kansas energy balance continues to worsen, with production declining and demand increasing. Imports are increasing sharply to make up the shortfall. The state production and demand were about balanced from 1982 to 1997 (Figure 1). Since 1997, however, the state has become a net importer of energy. By 2007, the state is projected to need 650 trillion Btu more energy annually than it produces. Unless conservation and production increase dramatically, the shortfall will have to be made up from imports.

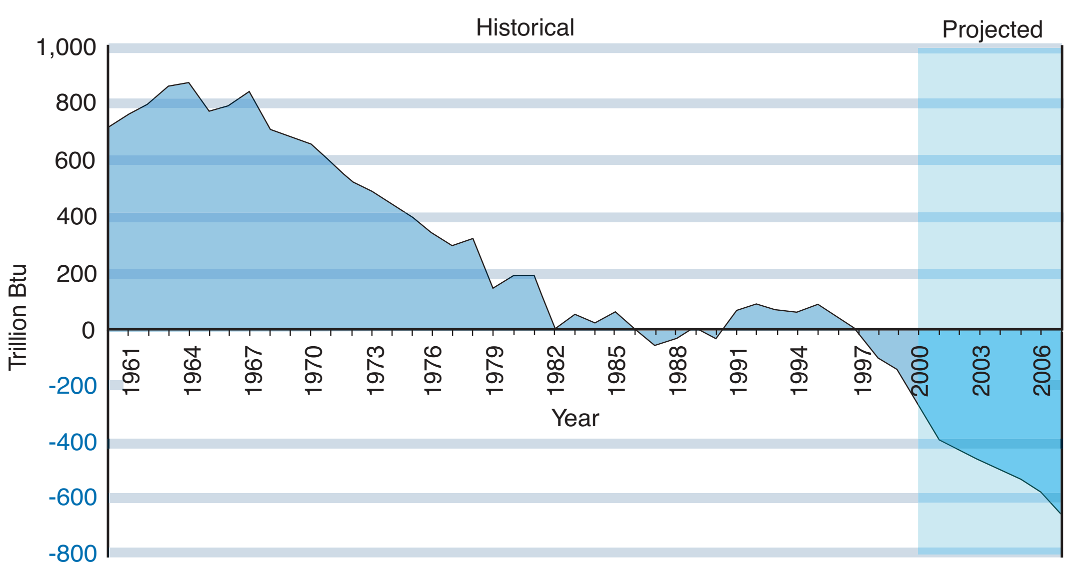


Figure 1—Kansas net energy balance, 1960 to 1999, with projections to 2007. Positive numbers show energy produced in excess of consumption (exports), while negative numbers show energy consumed in excess of production (imports).

Production Forecasts

- Based on expected prices significantly above $20 per barrel of oil (BO), Kansas oil production is forecasted to maintain current monthly rates of 2.9 million BO[1], with a lower limit of 2.8 million BO, 2.7 BO million, and 2.6 million BO per month in December 2003, 2005, and 2007, respectively. Annual production for 2003, 2005, and 2007 would be 33.6 million BO, 32.4 million BO, and 31.2 million BO, respectively.

- Current monthly gas production of approximately 38 billion cubic feet (bcf) is expected to decline to approximately 37.5 bcf, 36 bcf, and 32 bcf per month in December 2003, 2005, and 2007, respectively, using a hyperbolic depletion curve. Annual production for 2003, 2005, and 2007 would be 450 bcf, 432 bcf, and 384 bcf, respectively.

- Electricity generation in Kansas is forecast to increase steadily over the next five years. In 2001, 44,707 million kilowatthours (kWh) were produced in Kansas. For the years 2003, 2005, and 2007, Kansas electricity generation is projected to increase to 47,642 million kWh, 50,252 million kWh, and 52,862 million kWh, respectively. Renewable energy, based primarily on wind, is forecast to nearly triple in production, though it will only produce 2% of the state's electricity by 2007.

Consumption Forecasts

- Annual petroleum consumption is forecasted to increase by 2.25% to 3% annually. In 2003, 2005, and 2007, petroleum consumption is projected to be 85,582 thousand barrels, 89,920 thousand barrels, and 94,874 thousand barrels, respectively. Motor gasoline and distillate (diesel) fuel consumption are projected to increase annually by 0.1% and 0.44%, respectively. Consumption of LPG (liquid petroleum gas) is projected to increase 7.1% annually, while consumption of lubricants is projected to decrease by 0.2% annually.

- Natural gas consumption, which was 321 bcf in 2000 (the most recent data available), is projected to decrease 9.9% in 2002 and then increase by 1% to 1.4% annually through 2007. Gas consumption in 2003, 2005, and 2007 is forecast to be 300.4 bcf, 307.5 bcf, and 315.7 bcf, respectively.

- Total electricity consumption, which was 35,921 million kilowatthours (kWh) in 2001, is projected to increase to 39,068 million kWh, 41,317 million kWh, and 43,697 million kWh in 2003, 2005, and 2007, respectively.

Energy Recommendations

The Council recognizes that the plan presented in this report will not immediately improve Kansas's energy self-sufficiency. The plan was prepared in a short time period with the full realization that State financial investment would not be available in the near term to implement more far-reaching, but potentially costly, strategies. The Council is making modest recommendations this year to start laying the foundation for an expected long-term solution to the State's energy problems.

Recommendations for Council Action

- Establish a Transmission Task Force in Kansas to identify and recommend changes to improve the transmission network to support potential energy resources from wind or other emerging technologies and improve the flow of electricity within and outside Kansas.

- Establish a working group (composed of representatives from key state agencies, research universities, and the private sector) to identify specific research needs and opportunities to increase energy production and efficiency and that could also lead to development of new businesses (e.g., manufacturing wind turbines) in Kansas. Tasks include:

    1. Provide for technical assistance to independent petroleum operators, similar to the technical support given to agriculture, that will improve recovery of existing Kansas energy resources in an environmentally benign manner.

[1] The delay in posting oil and gas production data in Kansas averages about five months. For the purposes of this report, current production would be July 2002.

2. Develop information on the economic potential of coalbed methane in Kansas.

3. Promote opportunities for employment in the oil and gas producing sector by developing curriculum that can be taught in the community colleges and vo-tech schools.

4. Promote enhanced oil recovery (Tertiary) technology to recover residual oil left after water flooding.

5. Explore sources of CO_2 in locations closer to mature producing fields to use in enhanced oil recovery projects, and explore feasibility of State's construction of CO_2 pipeline or financing of CO_2 pipeline owned by investors.

6. Promote irrigation management practices designed to achieve maximum economic yield by reducing pumping costs. Adjusting pumping rates based on frequent monitoring of crop, soil, and weather conditions can provide water and energy savings with limited impact on yield.

7. Expand technical assistance to industry. Existing programs, such as the Energy Extension Service at K-State and the Energy Analysis and Diagnostic Center at the University of Kansas could be enhanced to provide high-quality energy audits and specific technical assistance to Kansas industries seeking to improve energy efficiency. These efforts should be structured to avoid displacing private sector services.

- Establish an annual energy conference to discuss the state's energy issues among researchers, state and local policy decision-makers, industry, utilities, and the public.

- Review energy programs in other states for their effectiveness and potential applicability to Kansas.

- Implement an awards program, providing recognition (and monetary rewards) for important contributions in energy-efficiency achievement based on actual measured performance.

Recommendations for Legislative Action in 2003

- Implement energy performance contracting for existing, state-owned buildings.

- Update 1989 energy efficiency standards with American Society of Heating and Air Conditioning Engineers (ASHRAE) 1999 standards for all new construction.

- Provide legislation that will alleviate punitive financial liabilities upon industry for actions taken to comply with state and federal regulations.

Priority Study Items for 2003

- Analyze all incentives for renewable energy, including, but not limited to, net metering and Renewable Portfolio Standards (RPS), as part of a goal to increase the generation of renewable energy.

- Develop an educational program for the public (consumers and students) about energy issues, environmental impacts, and the initiatives to address those concerns.

- Make a study of the value of the petroleum industry to Kansas as a base for policy decisions.

- Study electric utility demand-side management programs related to time-of-day pricing.

- Investigate the market for low environmental impact "green" energy sales to interested consumers and utilities facing pollution abatement requirements.

- Encourage the state's electric utilities to participate and take a leadership role in all renewable energy groups and discussions.

- Investigate a systems benefit assessment/charge on all energy consumption and use proceeds to fund current energy-related program costs (e.g., weatherization, low-income heating assistance, development of renewable energy).

Energy Issues for Future Consideration

The Council compiled over 175 recommendations from its membership and previous studies. Many were dropped from consideration as being obsolete or were combined with related issues. Some were adopted as part of the current year's State Energy Plan. A complete listing of the remaining recommendations is included as Appendix 2—Energy Recommendations for Future Consideration.

Background

Need for Energy Planning

For much of the 20th century, Kansas was not only an exporter of energy but one of the larger suppliers of natural gas and oil to the midwest region of the nation. Energy, and particularly oil and gas, was widely recognized as one of the three legs of the Kansas economy, along with agriculture and the aerospace industry. By about 1980, a number of factors brought Kansas to a roughly zero balance between energy exports and imports.

Production in the giant Hugoton natural gas field, largest in North America, was on an inexorable decline. Primary oil production (production from natural flow or by pumping) had long since passed its peak. Secondary oil production from waterfloodings had been applied almost everywhere it was feasible. [According to Carr (2002), long-term oil production is declining 2.5% annually, resulting in a 50% reduction in less than 20 years; when prices fall below $15.00 per BO, the decline rate jumps to 4.9%.] Petroleum refineries closed due to obsolescence, increased costs, and tougher environmental restrictions. Kansas coal production decreased because of its relatively higher sulfur content making it less environmentally acceptable and stiffer competition from low cost Wyoming coal. On the consumption side, the demand for gasoline and electricity grew with population and economic growth. Gasoline was increasingly supplied by out of state refineries. Much of the growth in electricity generation came from coal-fired plants using Wyoming coal.

The combination of decreasing production of oil and gas, coupled with increasing gasoline and coal imports, continues to worsen the state's energy supply situation. About 1997, the balance between imports and exports started a dramatic shift that made Kansas a significant net importer of energy. Although energy production is still a major contributor to the Kansas economy, we increasingly send our wealth out of state to pay for energy needs. We can afford to do this if we have other sources of wealth to pay for it. Otherwise, we have to sell assets or reduce our standard of living to pay the energy bills.

Among the possible solutions to this growing problem are to reduce our energy usage through conservation, to slow or reverse the decline of energy production, and to develop new sources of energy in the state. Although renewable energy sources hold promise, Kansas (and the rest of the nation) will continue to rely on fossil fuels in the short term. Research and development of new technologies is key to both long- and short-term solutions.

Formation of the Council

The State Energy Resources Coordination Council (SERCC) was established by Governor Bill Graves by executive order (#2002-04) on July 1, 2002 (Appendix 1). Appointments to the Council were made by the end of September 2002. The impetus for creating the Council came from legislation proposing a similar organization by statute that passed the Kansas House earlier in 2002 but failed in the Senate. The Governor adopted the legislation as an executive order at the urging of the bill's authors.

The Kansas Geological Survey (KGS) at the University of Kansas and the Kansas Corporation Commission (KCC) were tasked with providing staff support to the Council. No funds were allocated for the Council's work.

Goals and Work Plan

The broader impetus of the creation of SERCC was to address the worsening export/import ratio of energy in the state. The goal of the Council is to identify ways to make Kansas more energy self-sufficient and restore the state to its role as an energy exporter. The tasks of the Council cover two areas: (1) forecasts of energy production and consumption and (2) development of a comprehensive state energy plan.

Previous State Activities

In 1991, Governor Joan Finney established the Kansas Energy Policy Committee (KEPC) by proclamation to develop the State's first energy policy. Eighty volunteer members from across the state served on the Committee and Subcommittees. The Fossil Energy Subcommittee had five task forces of oil, gas, economics, environment, and coal. The Non-Fossil Energy Subcommittee had six task forces of efficiency/conservation/environment, transportation, renewables, utilities, state government, and agriculture.

The KEPC published a comprehensive 116-page report (KCC, 1993) that addressed all aspects of Kansas energy, in context with national and global issues. The Fossil Energy Subcommittee made 38 summary recommendations to be included in the Kansas Energy Strategy. The Non-fossil Energy Subcommittee listed unnumbered recommendations throughout the text of their report. SERCC staff combed through this latter list to compile all the recommendations into a spreadsheet that was presented to the current energy council for review.

A Governor's Conference on Kansas Energy Policy was held on October 6, 1993, in Topeka, with a variety of technical presentations on a range of topics that were initially identified in the KEPC report.

The 1993 report was not widely distributed and had little impact on state energy policy. Interestingly, at least two of the participants in the KEPC now serve on SERCC. Other former KEPC members contacted the SERCC chairman to express their concern that the current effort not be in vain as the first seemed to be.

Committee Structure and Membership

The Council set up five committees. Two of these deal with forecasts, a Production Forecast and a Consumption Forecast committee. These committees are composed solely of Council members. Three sector committees were established, composed of both Council members and others from the public: Petroleum, Electricity (informally called the Utilities committee), and Emerging Energy committees, which includes renewable and alternative energy areas. The sector committees were given the task of reviewing existing recommendations, largely compiled from the 1993 energy report—to delete obsolete items, edit or update relevant issues, and add new topics, for consideration by the entire Council.

SERCC Meeting Dates and Locations

- October 24, 2002, Kansas Corporation Commission hearing room, Topeka
- November 20, 2002, Kansas Corporation Commission hearing room, Wichita
- December 18, 2002, Kansas Corporation Commission hearing room, Topeka

Council Strategy

Because the SERCC appointments were made late in the year and the first energy plan and forecasts were due in January, 2003, the SERCC chair proposed that the Council (1) review existing recommendations and proposals rather than emphasizing creating new ones; (2) identify a few action items to include in the initial plan; and (3) make sure that our efforts would be meaningful.

The Council directed staff at the KGS and KCC to compile existing graphs, charts, tables, and databases for a Kansas Energy Abstract (KGS, 2003). Gaps in coverage of topics will be determined, with the intent of generating those data for subsequent volumes of the Abstract.

An online energy atlas is under construction, hosted by the Data Access and Support Center, the state's GIS clearinghouse, which is housed at the KGS. GIS map layers covering locations of orthophotos of the entire state, political and map boundaries, oil and gas fields, power plants, ethanol plants, and numerous other energy-related facilities are posted at http://neutrino.kgs.ku.edu/website/energy_atlas/viewer.htm.

The Kansas Energy Information Network webpage, www.kansasenergy.org, funded by KCC, and managed by the KU Energy Research Center at the KGS, was adopted as the Council's official web site.

Kansas Energy Overview[2]

Introduction

Energy plays a crucial role in the Kansas economy. The direct production and distribution of energy made up approximately 4.3% of the Kansas gross state product in 2000.[3] In addition, energy is an essential input into all industrial, agricultural, commercial, transport, and household activities.

Kansans spend a considerable amount of their income on energy. In 1999 (the latest year for which these data are available), the per capita expenditures for energy were 15th highest in the nation, at $2,273, while prices ranked 28th in the nation (KGS, 2003, Table 44). Clearly, the state's per capita energy expenditures reflect consumption levels more than prices. Per capita consumption in 1999 was the 16th highest in the nation and was significantly higher (12.8%) than the national average (EIA, 1999).

For much of its history, Kansas was among the top oil and gas producing states in the nation, producing more energy than it consumed. Energy production in Kansas peaked in 1967 at 1,573 trillion Btu and declined to approximately 796 trillion Btu by 2001. Since 1997, Kansas has consumed more energy than it produced, largely as a result of declining production of the state's oil and gas fields, especially from the huge Hugoton natural gas area in southwestern Kansas.

At the same time, Kansas, like the rest of the nation, has become increasingly dependent on electricity, and the state's power plants have been importing increasing amounts of coal, mainly western coal from Wyoming, to generate electricity. This further widens the gap between energy production and consumption.

Natural gas and petroleum remain the dominant energy resources in Kansas, accounting for nearly all primary energy produced in the state. In 2001, Kansas produced over 34 million barrels of oil and 483 billion cubic feet of gas. Although production is down, Kansas is ranked 8th in the nation in the production of both oil and natural gas. Emerging energy sources such as wind energy and ethanol have the potential to make significant economic impacts on local communities.

Energy Consumption

Kansas energy consumption has increased 41% since 1960, driven largely by the growth in electricity demand. Since 1960, electricity's share of energy consumption has doubled from 15% to nearly 34% in 1999 (Figure 2). During this period, annual demand for electric power has increased 400%, growing from 24,000 million kilowatt hours (kWh) to 100,000 million kWh.

This dramatic growth in electrical energy consumption is changing the types and quantities of fuels consumed. In 1960, Kansas consumed 633 trillion Btu, consisting of 58% natural gas and 39% petroleum, with coal making up the balance (Table 1). By 2000 (the latest year of complete data from the EIA), energy consumption was at 1,117.2 trillion Btu, consisting of 30% natural gas, 35% petroleum, 27% coal, 8% nuclear power, and 1% biomass and renewable energy.

The growth of electricity was fueled almost entirely by coal and nuclear power (Figure 3). During this period, primary energy consumption grew rapidly through 1980, but slowed after 1980

Table 1— Kansas Energy Consumption by Fuel (trillion Btu).

	1960	1980	2000
Petroleum	253.5	375.6	429.9
Renewables	0.2	0.1	0.5
Natural Gas	373.7	482.0	323.7
Nuclear Power	0	0	94.5
Biomass	3.9	10.8	6*
Coal	15.7	191.6	362.6
Electrical Exports	-14	-31	-100
Total	633.0	1,029.1	1,117.2

* Estimated.

[2] The Kansas Energy Overview is an updated and revised version of the 2000 Kansas Energy Report (KGS Open-file Report 2000-69), by T. R. Carr and S. W. White.

[3] Sum of gross state product (GSP) for fossil fuel production, refining of petroleum products, and electric and gas utilities ($3.660 billion) compared to total Kansas GSP ($85.063 billion). Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Accounts Data for 2000, http://www.bea.doc.gov/bea/regional/gsp/.

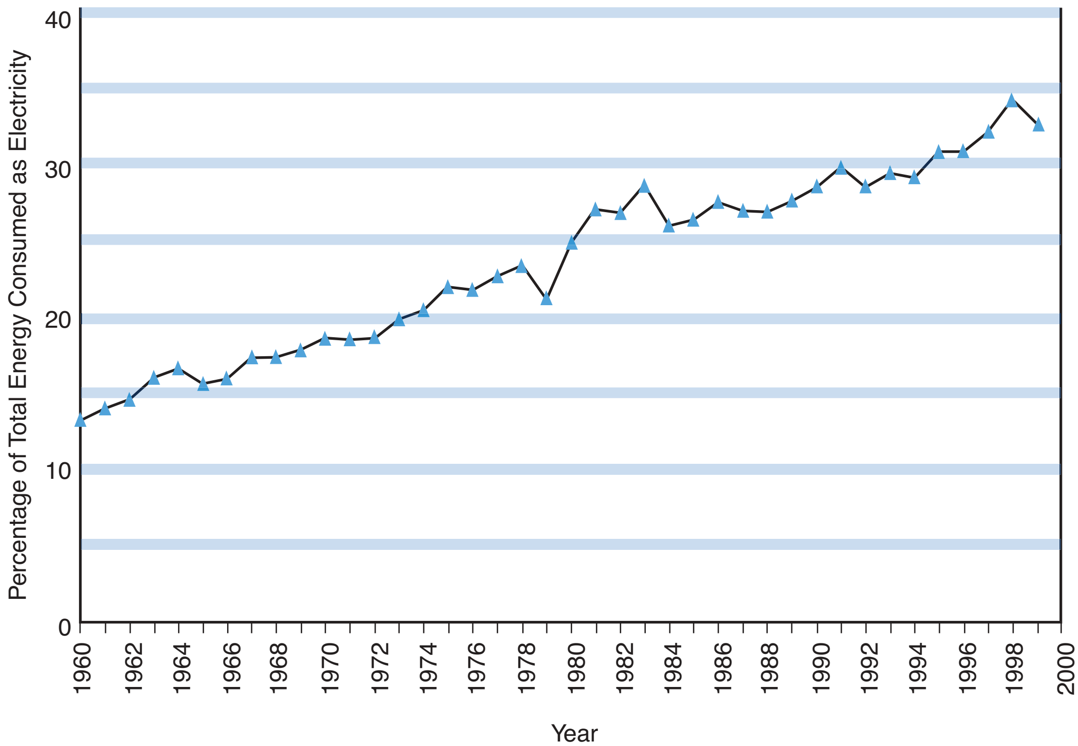


Figure 2—Electricity's share of Kansas energy consumption, 1960–2000. Since 1960, consumption of electricity, as a percentage of total energy consumption, has more than doubled (produced from data found in the EIA, *State Energy Data Report,* DOE/EIA-0214, various years).

(Figure 4). Natural gas consumption was less in 2000 than in 1960, while petroleum use was nearly double the 1960 levels, though it was down slightly from 1999. Coal consumption has increased steadily and nuclear power has been consumed at a consistent level since the mid-1980's.

The change in the mixture of fuels consumed 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 the state. Nearly all the coal consumed in Kansas is transported by rail from Wyoming and Montana, uranium is mined elsewhere, Kansas oil production has not kept pace with consumption, and refined petroleum products increasingly come from out of state.

Electricity Consumption

The increase (more than double) of electricity's share of Kansas energy use is indicative of the emerging importance of electricity to Kansas in the past 40 years (Figure 2). Kansas electricity consumption has increased fivefold since 1960 from 7,000 million kWh to 35,900 million kWh in 2000 (Figure 5). This increase in electricity demand was met almost entirely by coal and nuclear power. From 1971 to 1980, several large coal plants came on-line to meet demand (Table 2), increasing the consumption of coal from 12% in 1970 to 20% by 1980 of total energy consumed. The Wolf Creek Generating Station came on-line in 1985 and now supplies 8% of the state's energy, or 20% of its electricity.

Table 2—Historical summary of large-scale growth in Kansas electric utility infrastructure.

1971	403 MW coal plant at Lawrence Energy Center, Douglas County
1973–1977	1,578 MW coal plant at LaCygne, Linn County
1978–1983	2,160 MW coal plant at Jeffrey Energy Center, Pottawatomie County
1980	388 MW coal plant at Holcomb, Finney County
1985	1,235 MW nuclear plant at Wolf Creek Generating Station, Coffey County

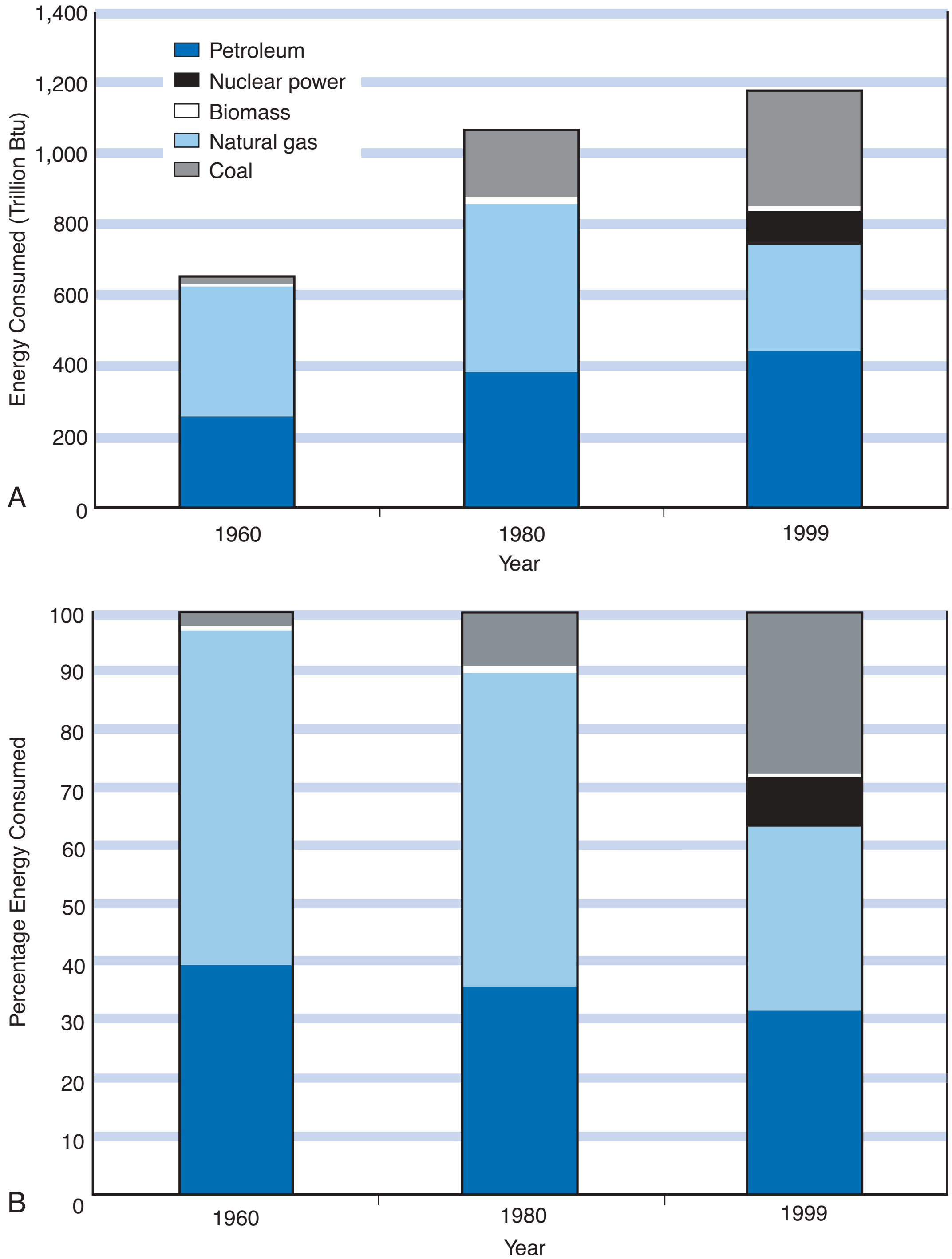


Figure 3a,b—Since 1960, consumption of coal in Kansas has increased dramatically, from 2% to nearly 30% of total energy consumption. During the same period, the state's consumption of natural gas has declined from almost 60% to 30% (EIA, *State Energy Data Report*, DOE/EIA-0214, various years).

With the construction of these new power plants, the mix of fuels used to generate electricity shifted from mostly oil and natural gas in 1960 to 73% coal and 20% nuclear today (Figure 6). The last 40 years also saw an improvement in the overall energy efficiency of electricity generation (Figure 7), with the conversion efficiency improving from less than 29% to nearly 34%. Possible reasons for this improvement include higher capacity factors (percentage of time operating at maximum) and the

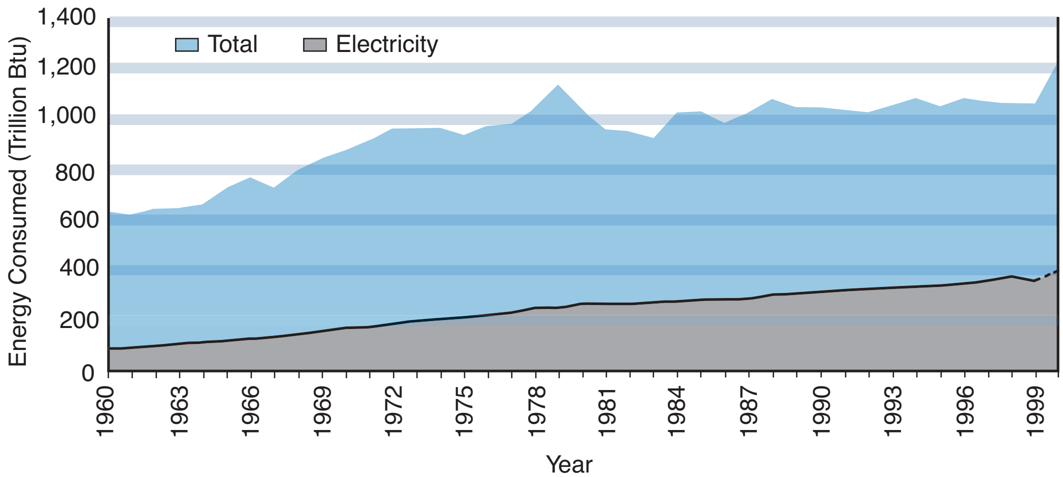


Figure 4—Electricity consumption as part of Kansas total energy consumption, 1960–2000. While overall consumption has remained relatively constant in the past 20 years, electricity consumption continues to grow. Note: electricity consumption for 2000 is estimated (EIA, *State Energy Data Report*, DOE/EIA-0214, various years).

replacement of small, less-efficient oil and natural gas power plants. In addition, improvement in power plant control systems and other performance enhancements in the 1980's and 1990's have improved the operating efficiency of the state's power plants.

Primary Energy Consumption

Kansas primary energy consumption increased 66% from 1960 to 1999. As Figure 4 illustrates, most of this growth took place from 1960 to 1980. Coal and nuclear energy filled most of the new demand, with coal consumption increasing from

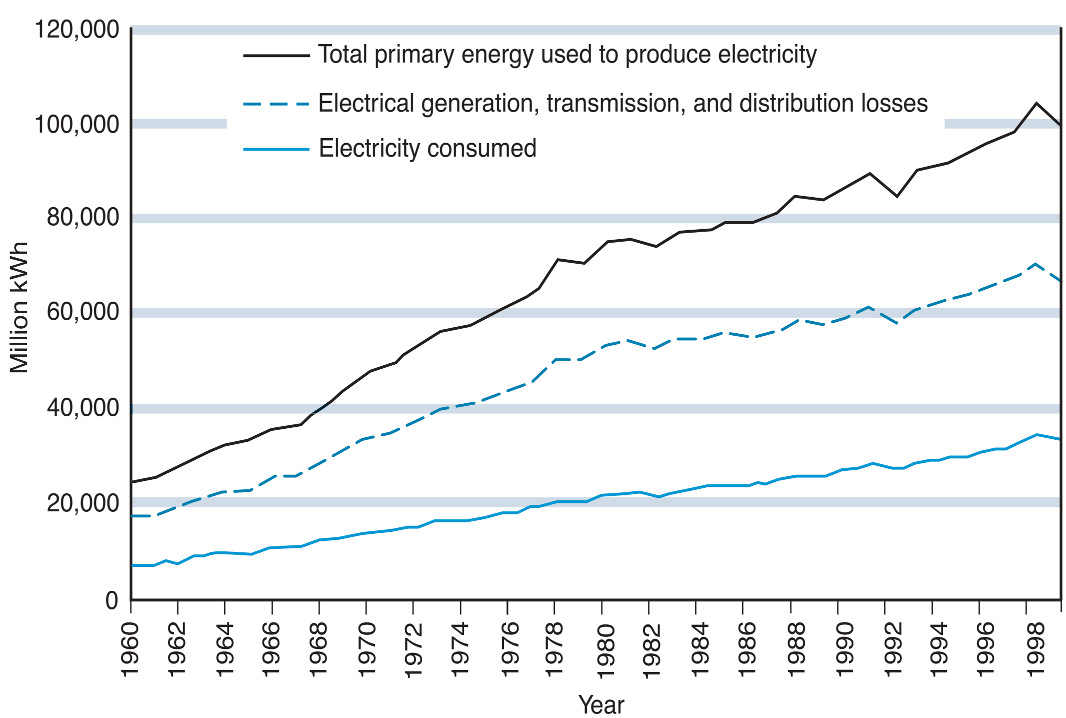


Figure 5—Kansas electricity consumption, system losses, and total primary energy used to produce electricity, 1960–1999. System losses include the energy lost in converting primary energy to electricity, as well as transmission and distribution losses (EIA, *State Energy Data Report*, DOE/EIA-0214, various years).

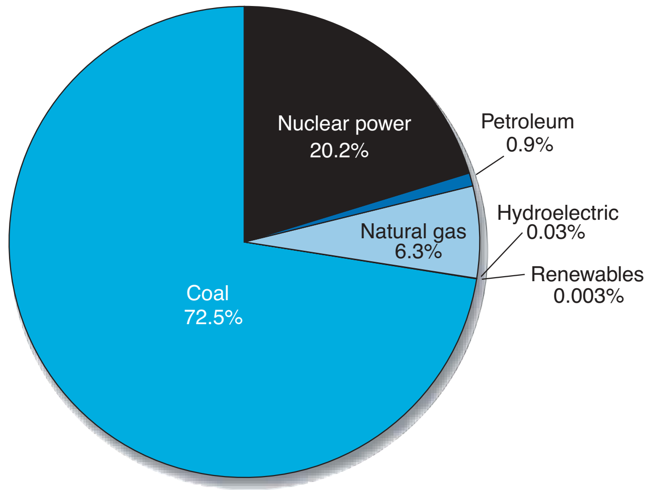


Figure 6—Kansas electricity production by fuel source, 2000 (EIA, *Electric Power Annual 2000*, vol.1, DOE/ EIA-0348(2001/1), August 2001).

675,000 short tons in 1960 to nearly 21 million short tons in 2000, an increase of 3,000%,[4] and nuclear power emerging in 1985 (Figure 8). Natural gas consumption grew rapidly in the 1960's and remained steady until the early 1980's when Federal law restricted the use of natural gas for electricity generation, causing consumption to drop off sharply. Petroleum consumption, as a percentage of total energy 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 35%, 219%, and 211% respectively since 1960, while residual fuel and kerosene use declined (EIA, 1999).

In 2000, Kansans consumed around 1,117 trillion Btu of energy. In 1999, the average use of energy per Kansan was 396 million Btu, 12.8% above the U.S. average rate of 351 million Btu (EIA, 1999). Fossil fuels accounted for over 90% of the energy consumed. Petroleum accounted for 37% of this energy with coal providing 28% and natural gas 25% (Figure 9). Nuclear power, which fuels the Wolf Creek nuclear generating station, accounted for 8% of the total, while biomass was 0.6%. Hydroelectric and other sources of energy (e.g., wind and solar) comprised less than 1% of the state's energy consumption during 1999.

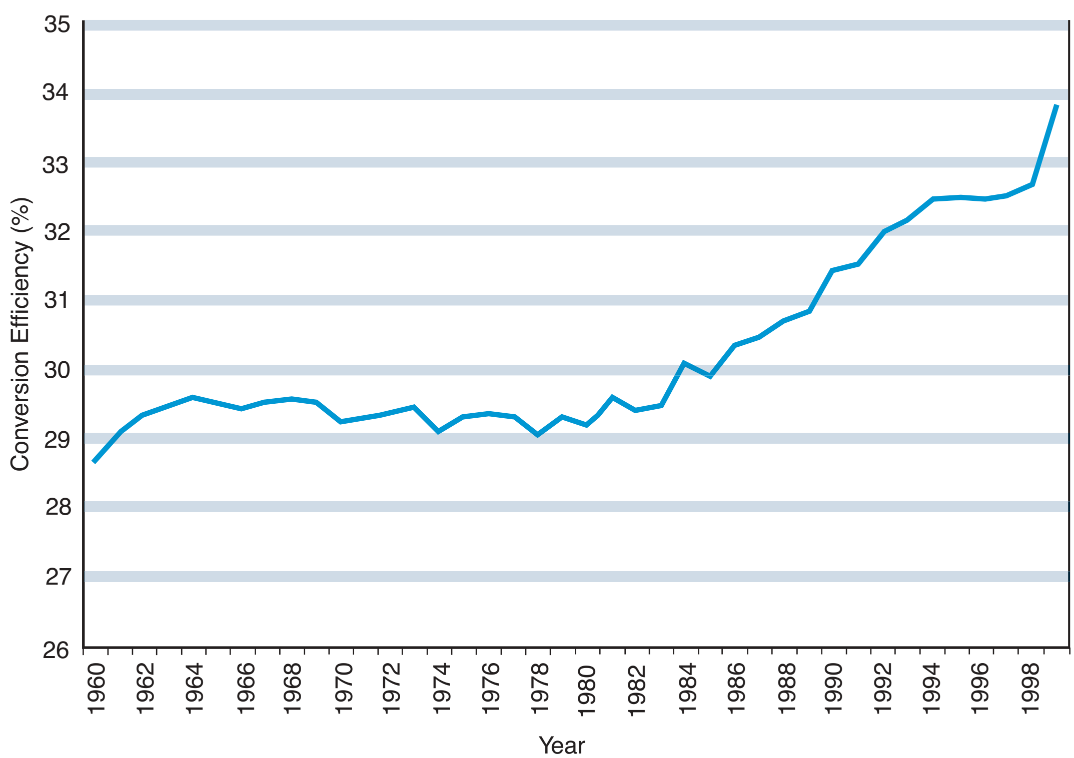


Figure 7—Conversion efficiency of Kansas electricity (the ratio of electricity produced to primary energy used), 1960 to 1999. Note: in this figure, the years fall between the hatch marks (based on data from EIA, *State Energy Data Report*, DOE/EIA-0214, various years).

[4] The energy value of coal's growth, as measured in Btu, was slightly less dramatic at 2,094% during this period. The growth came in the form of lower Btu subbituminous coal primarily from Wyoming.

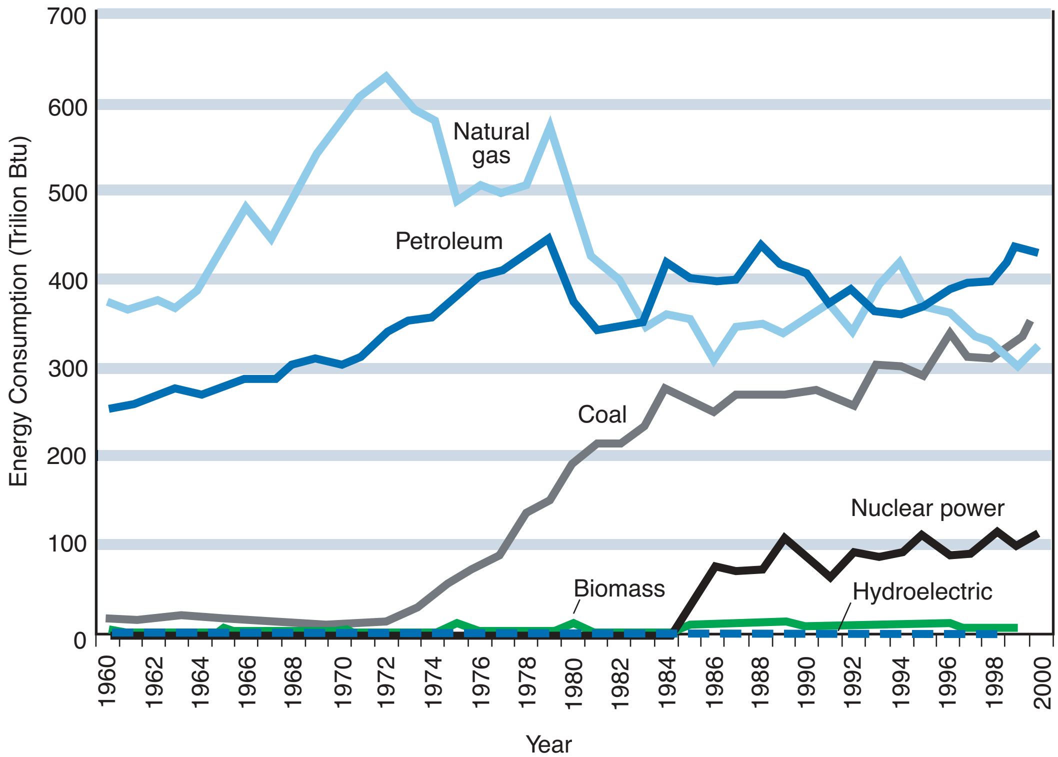


Figure 8—Consumption of energy in Kansas by fuel source, 1960–1999. Since 1960, natural gas consumption has fluctuated and the consumption of coal has increased dramatically. Since Wolf Creek Generating Station came on-line in 1985, it has powered a significant part of the state's electricity. Note: in this figure, the years fall between the hatch marks (EIA, *State Energy Data Report*, DOE/EIA-0214, various years).

In 2000, total petroleum consumption in Kansas was at 228,350 barrels per day, down slightly from 237,000 barrels per day in 1999 (KGS, 2003, Table 16). More than half of this total petroleum consumption (about 57%) was for transportation fuels, with gasoline and distillate (diesel) having the largest shares (Figure 10). Liquid petroleum gases (LPG), primarily propane used extensively for rural heating and industrial purposes, accounted for another 25% of the total consumption. As Figure 10 shows, the industrial and transportation sectors are the two biggest consumers of petroleum products in the state.

As of 2000, Kansas produced only 45% of the energy it consumed. All of the uranium, 99% of the coal and 66% of the petroleum consumed in the state is produced in other states (assuming Kansas first consumes the energy produced here) (Figure 12). The single largest source of imported energy is coal from Wyoming, which is burned in the state's power plants. Some of the energy imported into Kansas is offset by the export of natural gas, though this amount decreases each year. In 1997, Kansas

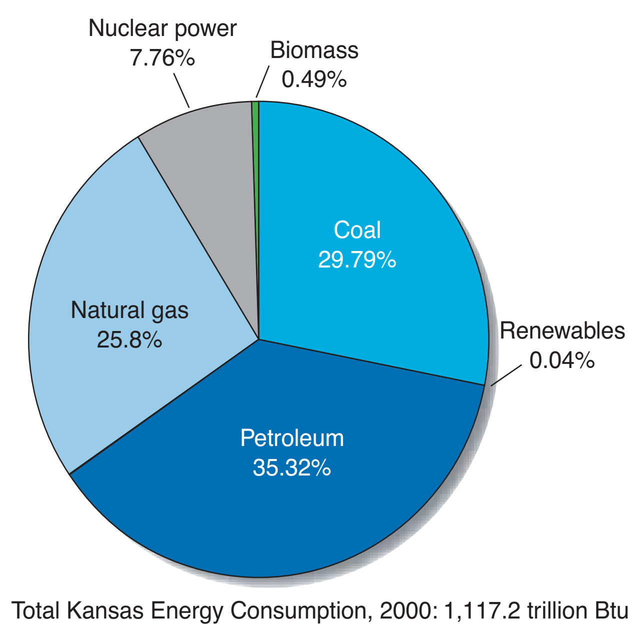


Figure 9—Energy consumption in Kansas, by fuel source, 2000 (data comes from EIA, *State Energy Data 2000*, which was not fully available at press time; estimated consumption data for individual fuels was available in various tables at http://www.eia.doe.gov/emeu/states/_multi_states.html).

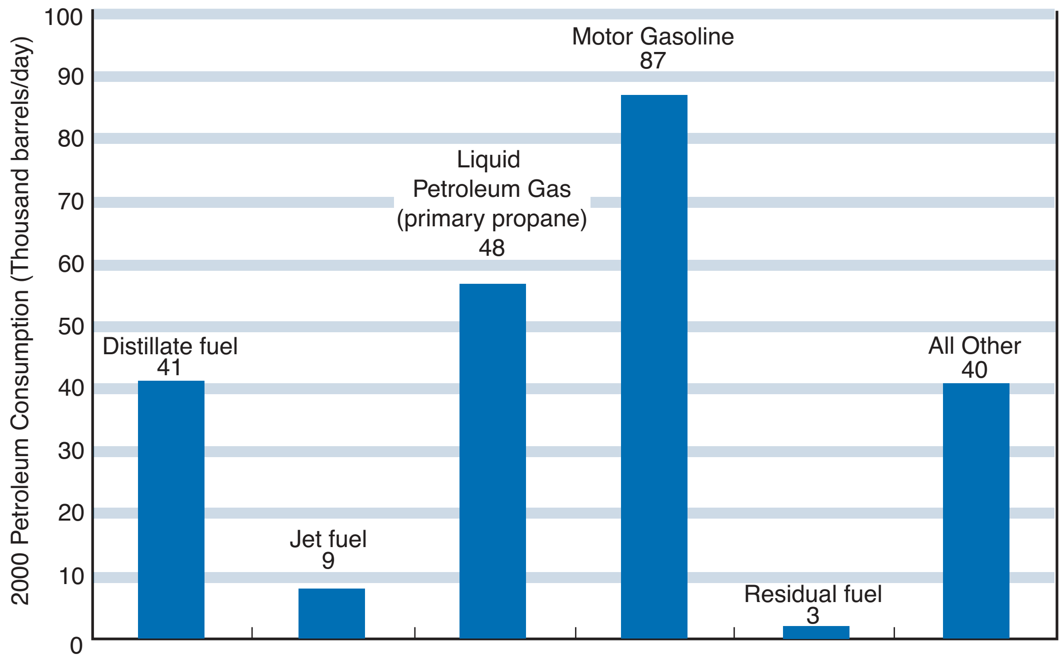
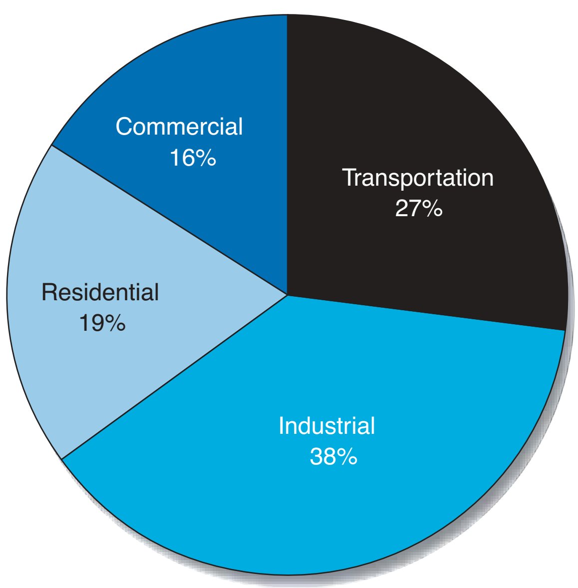


Figure 10—Overview of petroleum consumption in Kansas, 2000. Transportation fuels (motor gasoline and distillate fuel, or diesel) account for the vast majority of the state's consumption (EIA, *State Energy Data Report*, DOE/EIA-0214).

exported 60% of the natural gas produced in the state (and consumed the rest, assuming all the natural gas consumed in Kansas was produced here). As of 2000, only 40% of the natural gas produced here was available for export (again assuming the state consumed its own first). While consumption continues to increase, Kansas has become more energy efficient in the last 20 years in terms of the State economy (Figure 13). For example, in 1998 it took 70% less energy to generate one dollar of gross state product than in 1977.

Energy Production

As mentioned above, natural gas and petroleum account for nearly all the primary energy produced in the state. Energy production in Kansas peaked in



Total Kansas Energy Consumption, 1999: 1,050 trillion Btu

Figure 11—Kansas energy consumption by sector, 1999. The transportation and industrial sectors are the largest consumers in Kansas (EIA, State Energy Data Report, 1999, most recent data available).

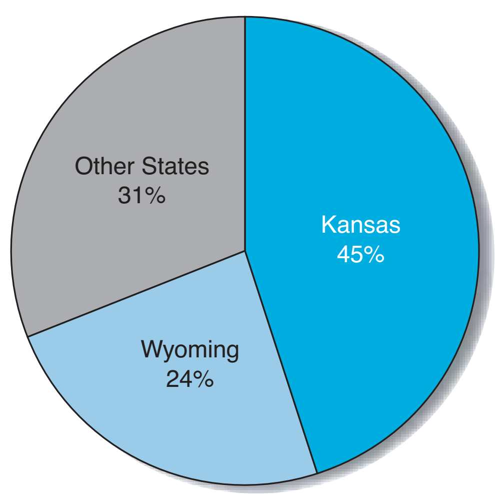


Figure 12—Sources of energy consumed in Kansas, 2000. Over 55% of the energy consumed in Kansas comes from other states (based on various EIA data).

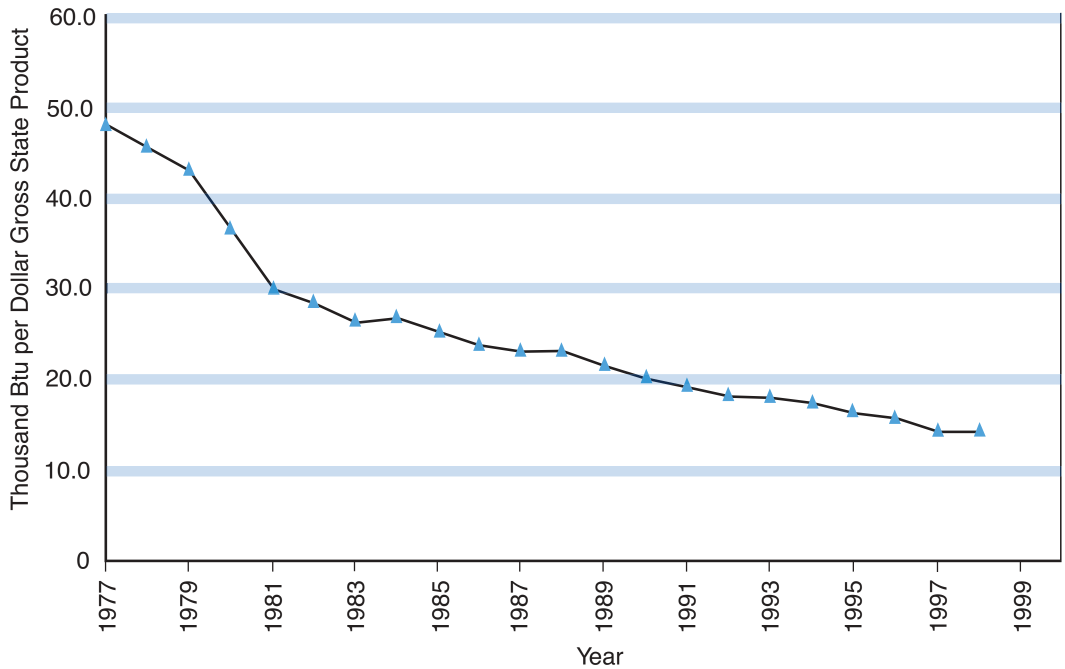


Figure 13—Energy needed to fuel the Kansas economy, 1977 to 1998. The Kansas economy has become more efficient in its use of energy since the late 1970's.

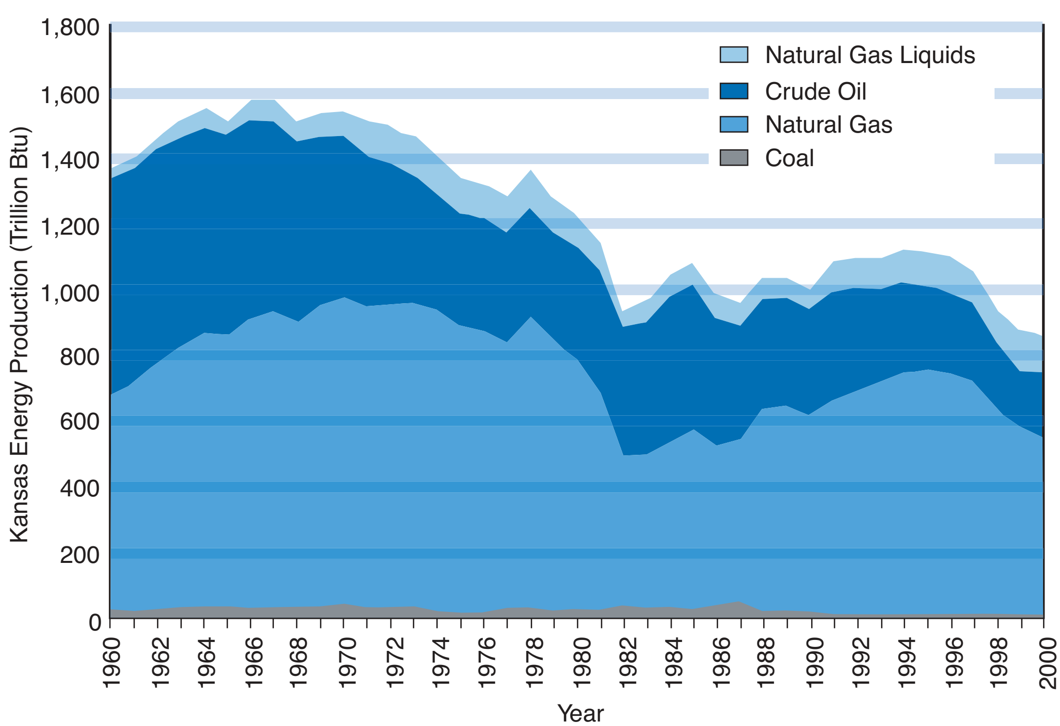


Figure 14—Kansas energy production, 1960 to 2000. Kansas total energy production peaked in 1967. The biggest decline in energy production has been in crude oil (based on EIA and KGS publications, various years).

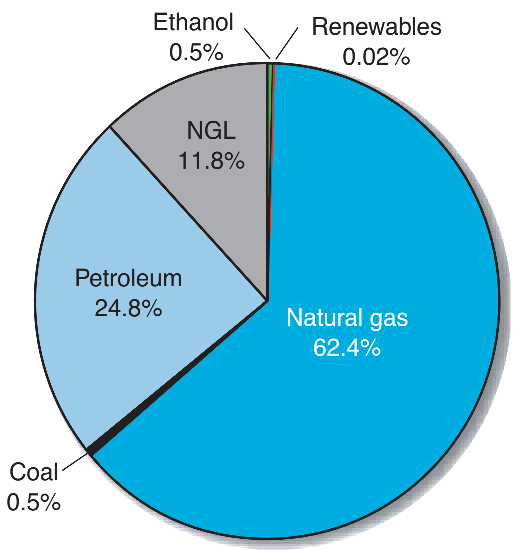


Figure 15—Kansas primary energy production, 2001. Total energy production was approximately 796 trillion Btu (based on 2002 EIA and KGS data).

1967 at 1,573 trillion Btu and had declined to roughly half that amount by 2000 (Figure 14). Natural gas production peaked in 1970 at 900 billion cubic feet (bcf).[5] Petroleum production peaked in 1956 at 124 million barrels. As of 2000, Kansas ranked 8th in the U.S. in both natural gas and oil production (EIA, 2002).

In 2001, Kansas produced 796 trillion Btu of energy. Of this, 62% was from natural gas (484 bcf), 25% was from petroleum (34 million barrels), and 12% was from natural gas liquids (NGL) (26 million barrels). Coal (176,000 short tons), ethanol (43 million gallons), and renewable energy (29 million kWh), combined, accounted for about 1% (Figure 15). Since 1960, total energy production in Kansas has dropped by over 40%. The majority of this decrease in energy production can be attributed to decreased oil production, which in 2001 was less than a third of 1960's production. In 2000, natural gas production was also down 17% from 1960 (and down 42% from the 1970 peak of 904 billion cubic feet). Oil's share of the total energy produced in the state has dropped from nearly 50% in 1960 to 25% in 2001 (Figure 15).

In 2001 Kansas produced over 34.1 million barrels of oil and 483 billion cubic feet of gas (Figure 16), which is less than was produced in 2000 (35.1 million barrels of oil and 533 billion cubic feet of gas). Although the data for 2002 oil and gas production are not complete (at the time of this report), from 1999 to 2001, oil production is estimated to have increased slightly, while gas production has decreased. Using estimated 2000 average monthly wellhead prices for oil and gas in Kansas, the value of the oil and gas produced in the

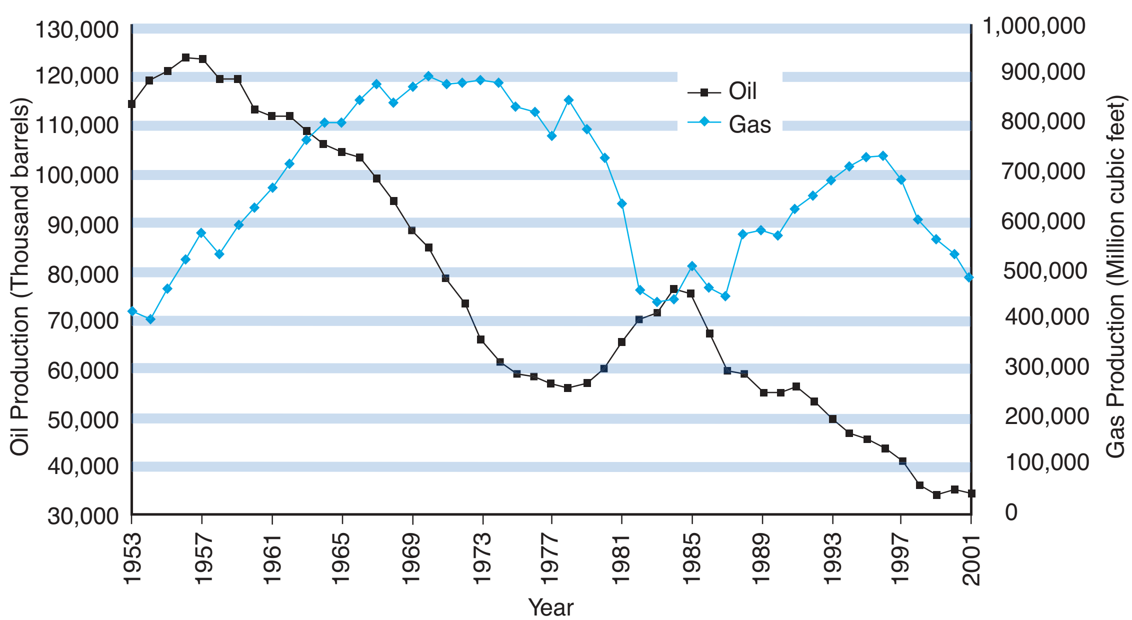


Figure 16—Kansas oil and gas production, 1953 to 2001 (based on KGS data).

[5] Unless otherwise noted, all oil and gas production data are from the databases of the Kansas Geological Survey (http://www.kgs.ku.edu).

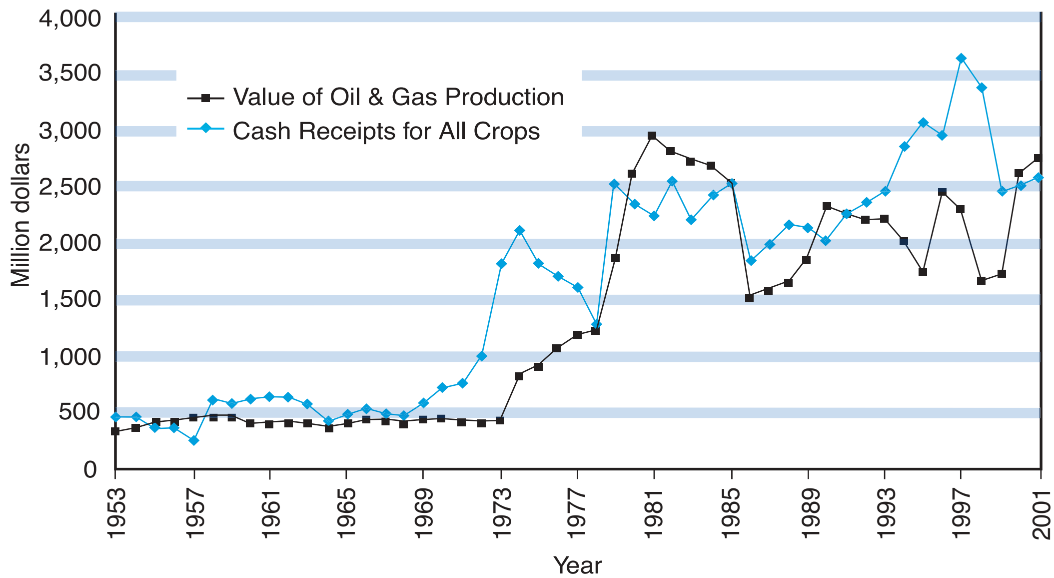


Figure 17—Wellhead value of Kansas hydrocarbon production compared to cash receipts for all Kansas crops, 1953 to 2001.

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 ($0.754 billion). Over the past 40 years, the value of Kansas oil and gas production has been comparable to the value of total statewide crop production as measured by the cash receipts for all the crops produced in the state (Figure 17).

Oil

Oil currently provides 25% of the energy produced in Kansas (by Btu), a smaller share than in the past. In 1960 it accounted for 48% of the total production (by Btu). Nonetheless, Kansas remains one of the top 10 oil-producing states, as it has for many decades (the state currently ranks 8th in the

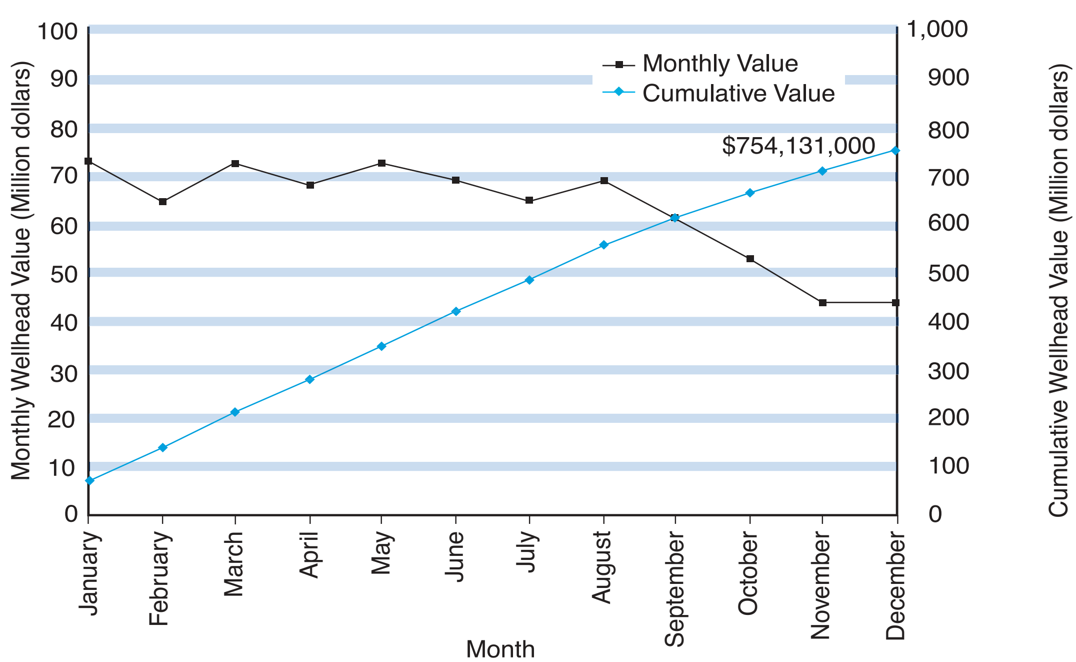


Figure 18—2001 cumulative and monthly wellhead values (in millions of dollars) for Kansas oil production.

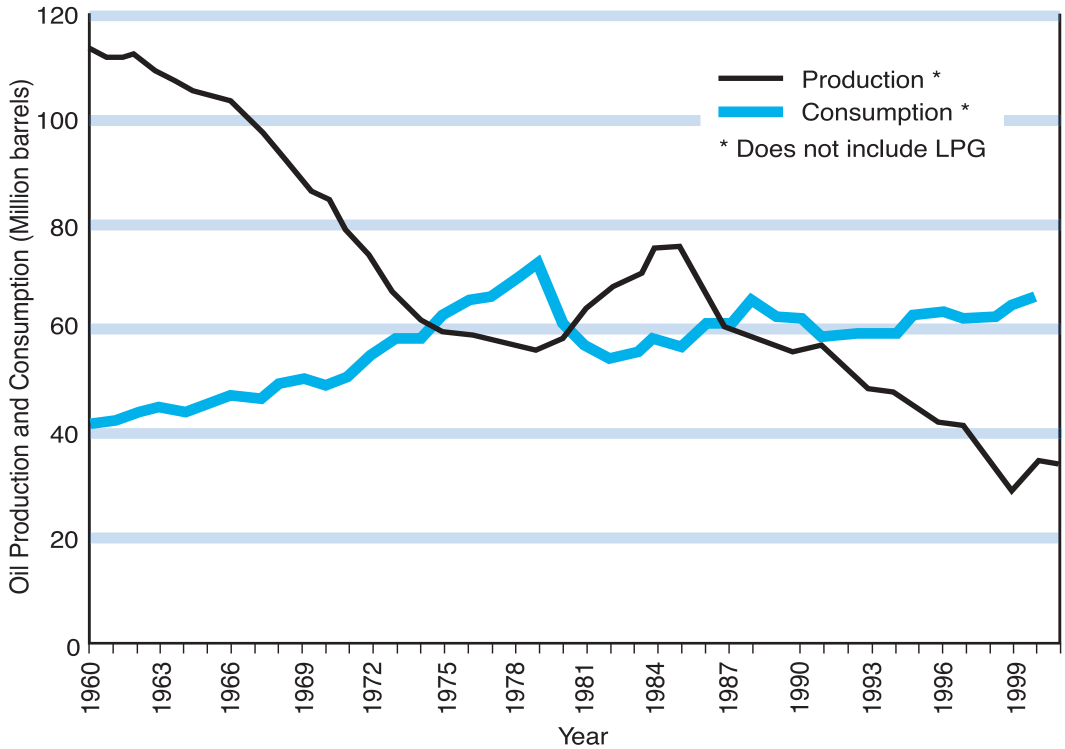


Figure 19—Kansas oil production and consumption, 1960 to 2001. Note: consumption numbers for 2001 not available at time of this report (based on 2002 KGS data and EIA, *State Energy Reports*, various years).

nation). In 2001, oil production in Kansas was valued at $ 754 million at the wellhead (Figure 18).

Until the 1973 Arab oil embargo, Kansas produced more oil than it consumed (Figure 19). Production peaked at 124.5 million barrels in 1956 and was followed by a steady decline to 56 million barrels 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 barrels 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 19). With exceptions 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 19, 20). Although production and consumption have both decreased since 1980, the gap between them has widened. In 2001, Kansas crude oil production was approximately 34 million barrels, while consumption was around 65 million barrels in 2000. The significant increase in oil prices in 2000 resulted in a slow increase in oil production (Figure 20).

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. In general, oil wells that produce, on average, between 5 and 15 barrels per day are called stripper wells. In 2001, a total of 36,885 wells representing over 98% of the producing oil wells in Kansas averaged less than 15 barrels per day and would be classified as stripper production (Carr, 2000). These stripper wells produce approximately 75% of the state’s oil, and each represents a 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

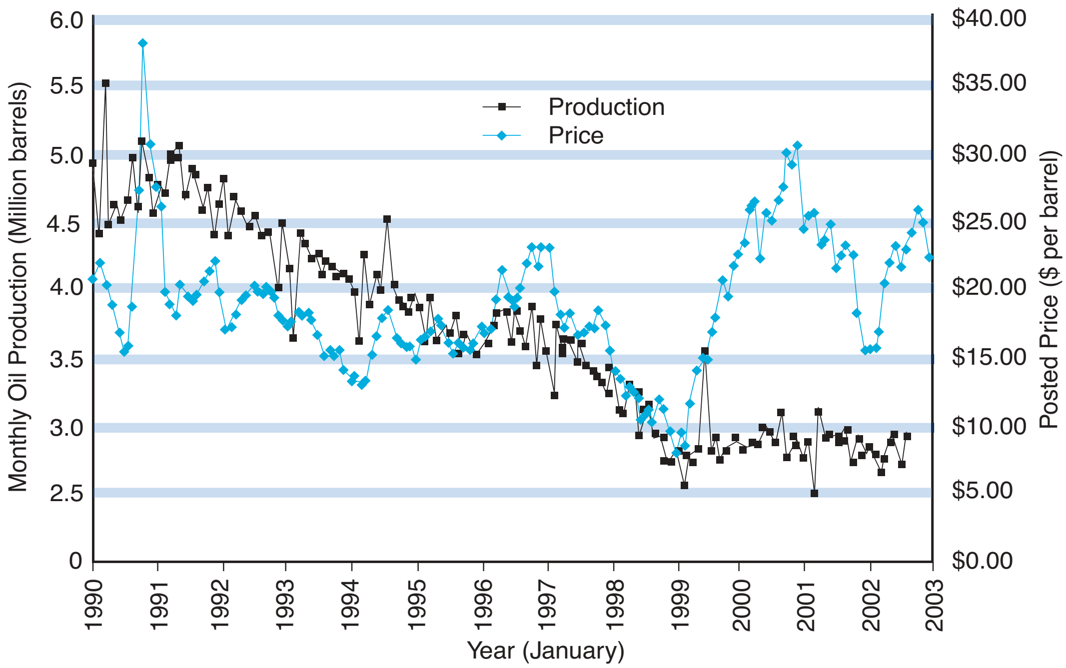


Figure 20—Monthly Kansas oil production and average wellhead price, 1990 to 2003. Prices (in nominal dollars) are average monthly posted prices from Koch Petroleum Group for central Kansas crude (http://www.kochoil.com/).

positive correlation to current wellhead prices (Figure 20).

In 1999, 2,273 different operators reported oil production. The average Kansas independent operator produced just over 15,000 barrels of oil in 1999. The top ten producing companies produced approximately 25% of the oil in 1999.[6] All ten top producing companies are independents, and five of them are headquartered and primarily operate in Kansas. Independent operators dominate Kansas oil production. Large integrated petroleum companies, such as BP, ExxonMobil, or Chevron-Texaco, are estimated to produce less than 5% of the state's oil.

Natural Gas

Natural gas accounts for over 60% of current energy production in Kansas. 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 2000, Kansas produced approximately 200 bcf more gas than it consumed.

Gas production is concentrated in southwest Kansas, where the Hugoton and other fields 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. Since then, production has declined annually despite higher average wellhead prices during 2000 (Figure 23).

Economic conditions and government policies have affected Kansas gas production (e.g., the 1973 Energy Petroleum Allocation Act, the 1975 Energy Policy and Conservation Act , the 1978 Power Plant and Industrial Fuel Use Act, the 1979 Kansas Natural Gas Price Protection Act, the 1981 Price and Allocation Decontrol, and the 1983 Kansas Natural Gas Price Control Act). 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

[6] 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.

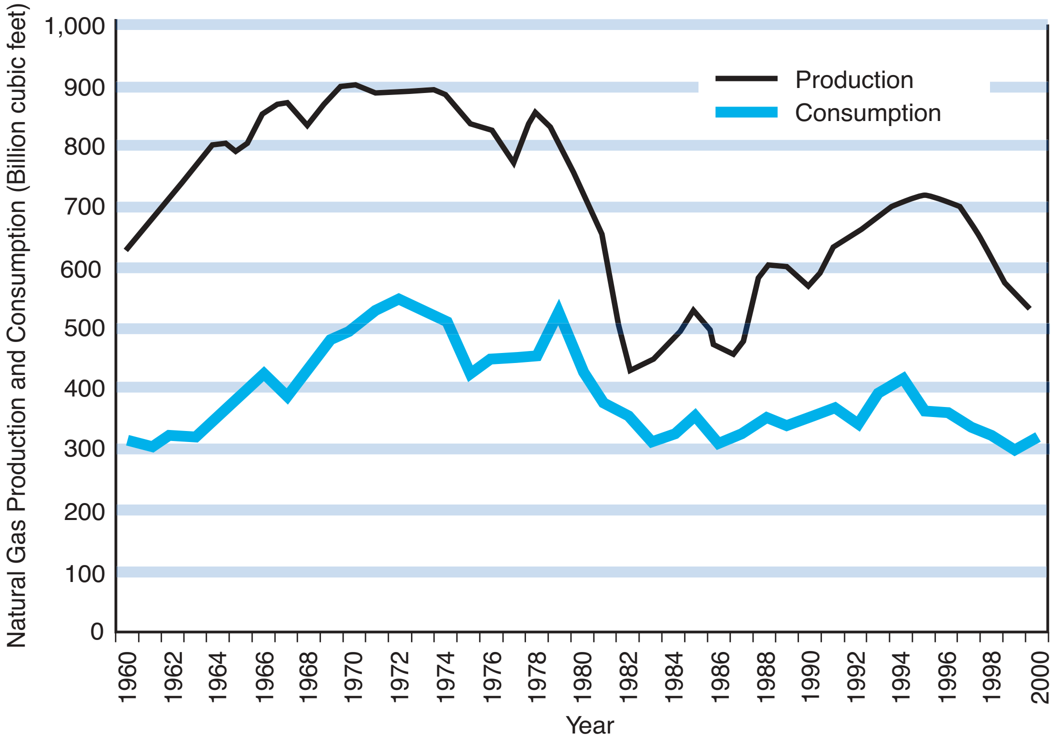


Figure 21—Kansas natural gas production and consumption, 1960 to 2000. Note: in this figure, the years fall between the hatch marks (based on 2002 KGS data and EIA, *State Energy Reports*, various years).

of prices, allocations, and uses of fuels, and the 1986 Kansas Corporation Commission's modified spacing rules in the Hugoton Field contributed to a second production peak of just over 700 bcf in 1996 (Figures 16, 21). Since 1996, the Hugoton field has declined at an average annual rate of 8%. 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[7]. As reservoir pressures continue to decline, intelli-

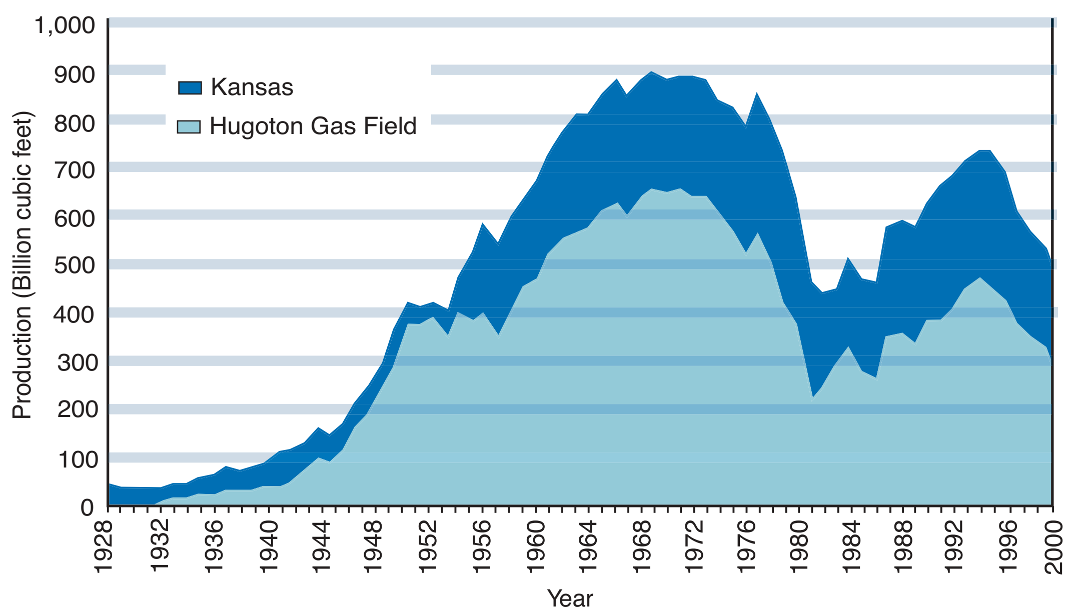


Figure 22—Kansas natural gas production from the Hugoton field and the state as a whole, 1928 to 2000.

[7] 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.

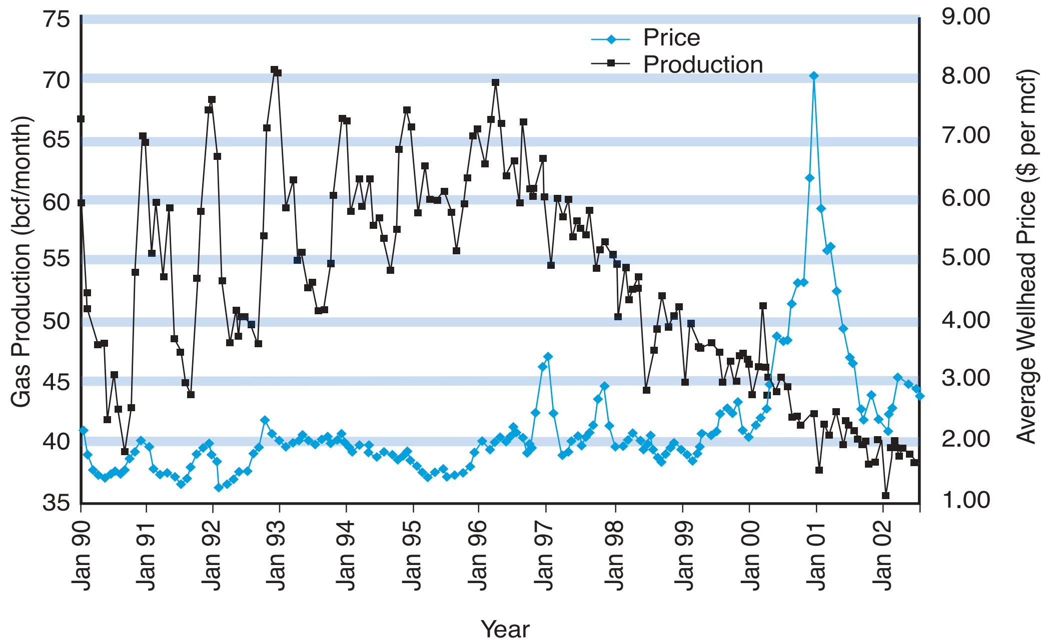


Figure 23—Monthly Kansas natural gas production and average monthly wellhead price, 1990 to 2002. Gas production data (in billion cubic feet per month) was obtained from online databases at the Kansas Geological Survey (http://www.kgs.ku.edu/PRS/petroDB.html). The production data are sales volumes reported to the Kansas Department of Revenue (as a result of additional late production updates, the current month's production is usually revised upwards). Price in nominal dollars is the monthly average wellhead price for thousand cubic feet, reported by the U.S. Department of Energy, Energy Information Agency (http://www.eia.doe.gov/pub/oil_gas/natural_gas/data_publications/natural_gas_monthly/current/pdf/table_04.pdf, accessed 12/23/02).

gent energy policies, significant investment capital, and new technologies must be developed to assure continued production.

Kansas gas production is dominated by the Hugoton and related fields of southwest Kansas (e.g., 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 (mcf) per day. In 1999, 63% of the 17,146 producing gas wells averaged less than 90 mcf per day and produced 24.1% of the gas (Carr, 2000). As with oil, stripper gas production is sensitive to changes in the wellhead gas 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 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., ExxonMobil, BP) and independent companies (e.g., Anadarko, Helmerich & Payne).[8]

The seasonal nature of natural gas production changed significantly in the late 1990's. Prior to 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 generally disappeared. As a result, during the summer a cheap and plentiful supply of natural gas is no longer available to power irrigation pumps in southwest Kansas.

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

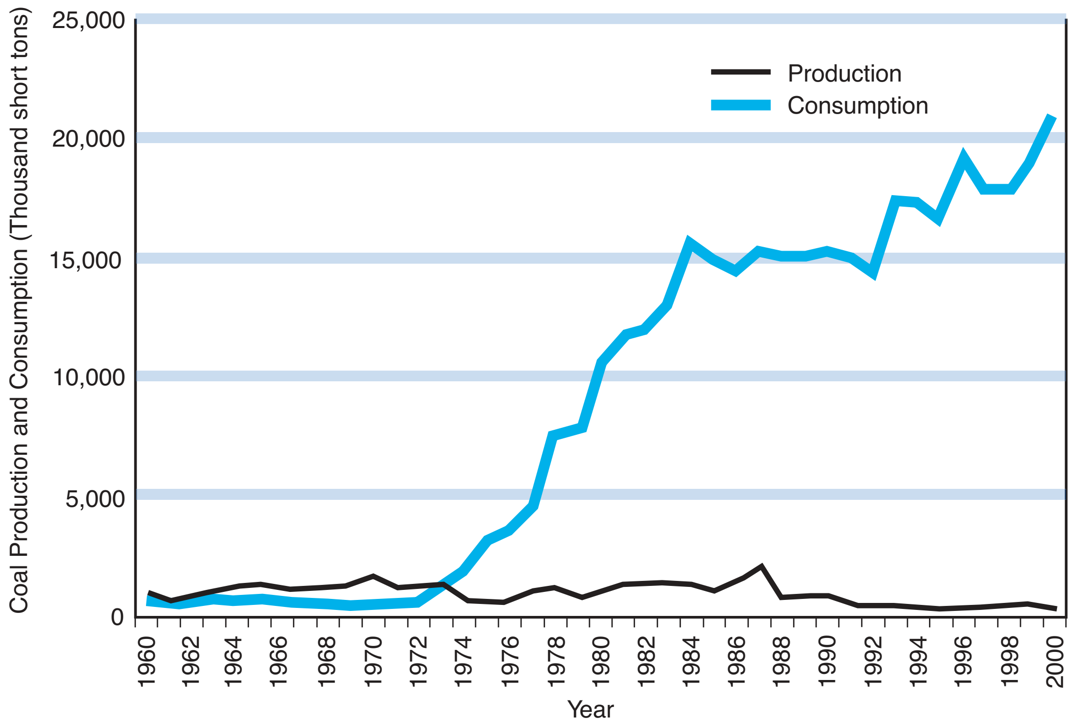


Figure 24—Kansas coal production and consumption, 1960 to 2000. Note: in this figure, the years fall between the hatch marks (based on EIA, *State Energy Reports*, various years, and EIA *Weekly Coal Production,* various issues).

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 24). Coal production, on the other hand, exceeded 1.5 million tons annually only once in that period. For the past decade, coal production has been less than a million tons in any given year, while consumption has increased to nearly 21 million short tons annually. Coal for Kansas electric generation is imported primarily from Wyoming (Figure 12). The deficit between consumption and production continues to be in contrast to the United States as a whole, which produces and consumes coal in nearly equal amounts. In 2000, the U.S. consumed 1.08 billion tons of coal, while producing 1.07 billion tons.

Renewable Energy

Wind Power

A 1993 study by Pacific Northwest Laboratory 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 (Elliot and Schwartz, 1993). A more recent study by the U.S. Public Interest Groups has rated Kansas's wind potential as top in the U.S. when transmission access and other factors were taken into account (Morrison and Cassidy, 2002). Both studies attest to the potential Kansas has as a producer of electricity from the wind, though to this point, that potential has just barely been tapped as the state's installed capacity of 114 MW only ranks 8th of U.S. states (AWEA, 2002).

Interest in wind energy development in Kansas has exploded in the past several years. Kansas Wind Energy conferences have been held annually in 2000, 2001, and 2002, and were each well attended. The first utility-sized wind farm was constructed near Montezuma in Gray County in 2001 by FPL

Energy, a subsidiary of Florida Power and Light. This wind farm consists of 170 wind turbines each of which has an installed capacity of 660 kW.

Currently, wind farm projects are in various stages of development in several counties. Butler County has had two proposals introduced to the County Planning Commission and at least a third on the docket. Both Wichita and Decatur counties in western Kansas have had news accounts reporting wind-developer interest in those areas.[9]

The interest in wind farms is something like the gold rushes of old with wind developers seeking the best and windiest areas and signing landowners to leases that will pay should a project come to fruition. At the same time, these same companies are being contacted by landowners who hope to benefit from the placement of wind turbines on their property. Landowner income per wind turbine starts at around $2000 per year.

The Federal production tax credit on renewable energy sources, which pays 1.5¢ per kWh (1993 dollars and indexed for inflation) for the first 10 years of a project's life, has driven most new wind developments (Guey-Lee, 2001). This policy came out of the Energy Policy Act of 1992 and has been renewed since then. A similar program exists for non-taxpaying entities, the Renewable Energy Production Incentive, with qualifying facilities receiving a direct cash payment subject to availability of annual appropriations. Continued renewal of these policies will have a strong effect on future developments. At the same time, a property tax abatement for renewable energy systems in Kansas, made possible through KSA 79-201 in 1999, has also provided incentive to future wind power developments in this state. While local communities do not receive the tax benefits of having these projects sited in their jurisdiction, some companies, including FPL Energy have made contributions to various county entities, including school districts, in lieu of these taxes.

Impediments to wind energy development include inadequate transmission capacity, scarce markets for the power, and even local opposition to the wind farms. While Western Kansas has excellent wind resources and apparent local support for the siting of these projects, there is a lack of sufficient transmission capacity to move the electricity to market. At the same time, local utilities are not required to accept this power on their transmission lines. Markets for wind power vary across the U.S. due to green pricing programs, renewable portfolio standards (RPS) of individual states, and the ability to deal with the intermittent nature of this energy source. Several areas in the U.S., including the Flint Hills of Kansas, are also experiencing opposition to siting these projects due to environmental and aesthetic concerns.

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, especially for local communities and individual land owners. 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% or more of the land to still be used for farming or ranching. The development of this energy source, however, may require innovative actions by the State to spur development rather than waiting for large utilities to do it themselves.

Biomass

The biomass resource base in Kansas is extremely diverse and includes the following resources: (1) forestry, and primary and secondary wood-processing wastes; (2) agricultural crop residues that remain after harvest, such as corn stover and wheat straw; (3) oilseed crops, animal fats, waste greases, and food-processing wastes; (4) herbaceous energy crops, such as big bluestem and switchgrass; and (5) animal manures. Each of these resources has been demonstrated to produce bioethanol, biodiesel, or can be used as a replacement for coal or natural gas for thermal heating or electricity generation purposes.

Energy and environmental benefits attributable to implementing biomass energy resources have been shown to result in energy savings/gain ranging from 3 to 1 (oilseeds and fats) to 20 to 1 (energy crops).

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[9] For these and additional news stories relating to Kansas energy, see Kansas Energy Information Network (http://www.kansasenergy.org/energynews.htm).

Ethanol

The production of ethanol merges two of Kansas's most important industries: agriculture and energy. Ethanol is produced by fermenting starches, which are present in many Kansas grains, such as corn, milo, oats, barley, and wheat. Ethanol capacity in Kansas is currently 73.5 million gallons per year. U.S. ethanol production has increased from 175 million gallons in 1980 to 2.7 billion gallons in 2002, due to state and federal tax subsidies and mandates to use high-oxygen gasolines. (DiPardo, 2000; RFA, 2003)

Tax subsidies have played an important part in the growth of the ethanol industry, though it is the value added to by-products that keeps ethanol plants vital. These by-products include wet and dry distillers grains (the remaining protein, fiber, and fat from the grain after ethanol production that are used as a high-protein supplement for beef cattle); carbon dioxide (CO_2), a by-product of fermentation that can be captured and used for food-grade processes (carbonation in soda or dry ice) or enhanced oil recovery in mature oil fields; and waste water that is used to grow fish for human consumption.

A main benefit of ethanol is in oxidizing fuel in internal combustion engines, which reduces carbon monoxide emissions. In cities with air pollution problems, fuel-oxidizers are required during cold weather months. With the leading oxidizer, MTBE, being phased out of use in several markets because of concerns about ground-water contamination, ethanol production is poised to grow. With the Denver market being so close and other western U.S. markets being within reach, Kansas is well located to increase production in this area. Kansas also has potential markets for CO_2 in enhanced oil recovery processes. With good cropland situated directly over oil fields that are candidates for CO_2-enhanced oil recovery, CO_2 from ethanol is an attractive alternative to hauling CO_2 from out of state in the absence of CO_2 pipelines.

As fuel cells become the engines of future vehicles, ethanol, along with gasoline and natural gas, may provide the hydrogen necessary for the first generation of vehicles. These fuels contain the hydrogen atoms necessary to be used in fuel cells and can utilize the existing liquid fuel distribution system.

Summary

Demand for energy continues to grow in Kansas, while total energy production is declining. The state's energy production peaked in 1967 at 1,573 trillion Btu, but it had declined to approximately 796 trillion Btu by 2001. Since 1997, Kansas has consumed more energy than it produced, largely as a result of the declining production from the huge Hugoton natural gas area in southwestern Kansas. Kansas, like the rest of the nation, is increasingly dependent on electricity. The state's power plants have been importing increasing amounts of coal, primarily from Wyoming, to generate this electricity, further widening the gap between the energy production and consumption in Kansas.

Kansas oil and gas fields are entering a third phase of production that will require increased technology and capital investment to implement enhanced recovery techniques. Renewable energy sources such as wind energy and ethanol have the potential to make significant economic impacts on local communities. In the short term, however, Kansas (and U.S.) energy supply will continue to be dominated by fossil fuels.

Until the energy price collapse in mid-1980's, Kansas was a net exporter of energy (Figure 1). Without a significant increase in primary energy supply, Kansas has become a significant net importer of energy. Kansas will need to sell more products 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.

Production and Consumption Forecasts

Net Energy Balance

In 1963 Kansas produced almost 900 trillion Btu more energy than it consumed, allowing much of the energy to be exported to other states and generating considerable wealth for the state (Figure 1). By 2002, however, it is estimated that Kansas consumed at least 400 trillion Btu more than it produced, buying that energy from out of state. By compiling the production and consumption forecasts for different energy segments, we estimate that by 2007, the net energy balance will be approximately -650 trillion Btu—that is, Kansas energy consumption will be 650 trillion Btu greater than production.

Using an average cost of $4 per million Btu, we calculate that Kansas spent $1.6 billion in 2002 importing energy to meet demands. By 2007, using the same price, we estimate Kansans could spend over $2.5 billion to make up the energy shortfall.

Production Forecasts

Based on expected prices significantly above $20 per barrel of oil (BO), Kansas oil production is forecasted to maintain current monthly rates of 2.9 million BO, with a lower limit of 2.8, 2.7, and 2.6 million BO per month in December 2003, 2005 and 2007, respectively. Annual production for 2003, 2005, and 2007 would be 33.6 million BO, 32.4 million BO, and 31.2 million BO, respectively (Figure 25).

Current monthly gas production of approximately 38 billion cubic feet (bcf) is expected to decline to approximately 37.5 bcf, 36 bcf, and 32 bcf per month in December 2003, 2005, and 2007, using a hyperbolic depletion curve. Annual production for 2003, 2005, and 2007 would be 450 bcf, 432 bcf, and 384 bcf, respectively (Figure 26). The production forecasts for oil and natural gas assumed that oil and natural gas production would decline hyperbolically as stated in Carr's (2002) projections (see Appendix 3).

As for renewable energy, ethanol production has been forecast to increase fivefold by the end of 2007, per the projections of the Kansas Corn Growers Association (Figure 27). Energy from wind power has been forecast to nearly triple in the next five years, per KCC forecasts, from 385 million kWh to 1,084 million kWh. Hydropower is expected to stay the same as in recent years (12 million kWh = 0.04 trillion Btu).

Electricity generation in Kansas is forecast to increase steadily over the next five years. In 2001, 44,707 million kWh were produced in Kansas. For the years 2003, 2005, and 2007, Kansas electricity

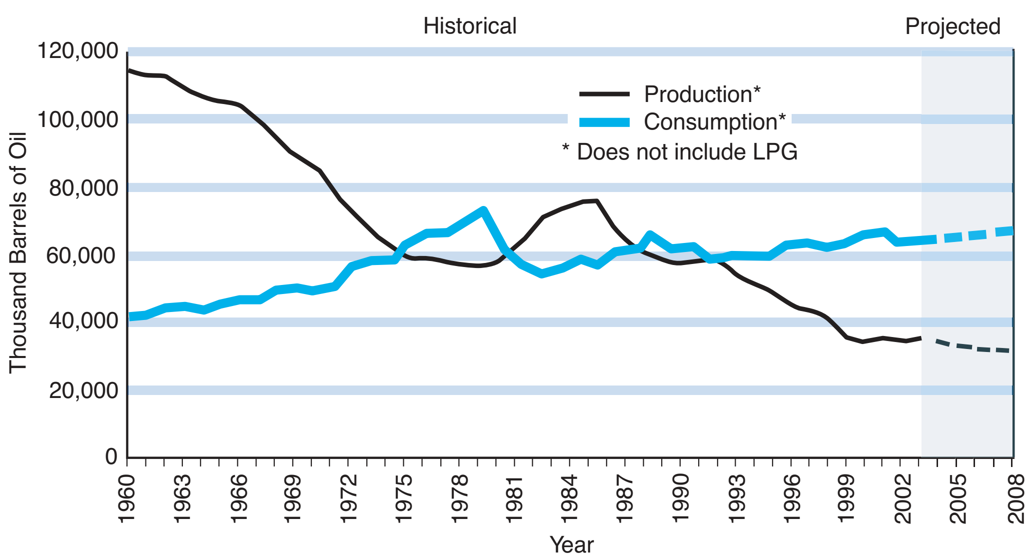

Figure 25—Kansas oil production and consumption, 1960 to 2008. Production estimates begin with 2002; consumption estimates begin with 2001.

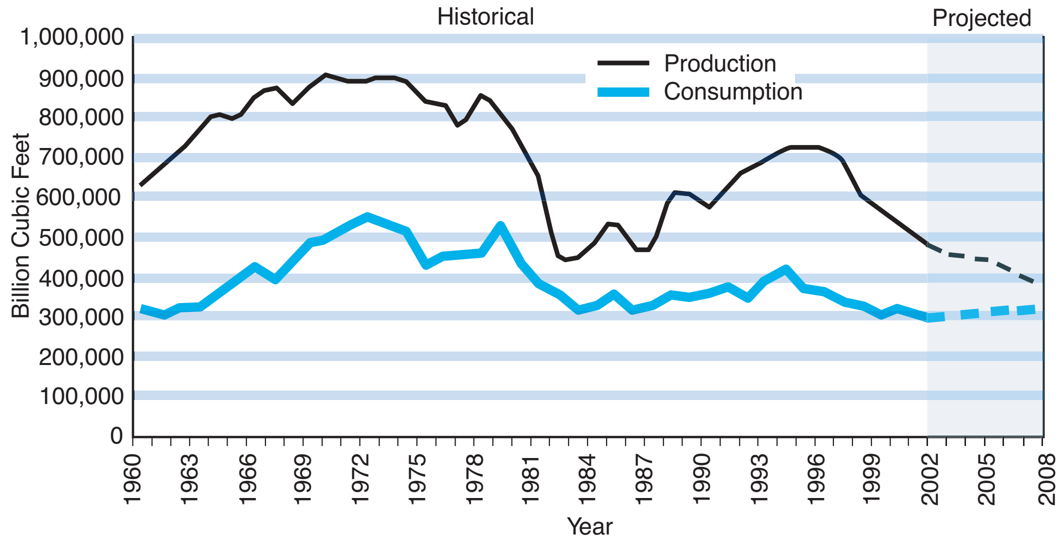

Figure 26—Kansas natural gas production and consumption, 1960 to 2008. Production estimates begin with 2002; consumption estimates begin with 2001.

generation is projected to increase to 47,642 million kWh, 50,252 million kWh, and 52,862 million kWh, respectively. These forecasts assume that generation from nuclear power will not change during this period. Electricity from coal is assumed to increase by 2.4% to 2.2% per year, though no new capacity is projected to come on-line during this period. Natural gas is expected to pick up the slack not provided by other fuels. Oil use for electrical generation is projected to increase substantially, primarily in co-firing coal plants. Renewable energy, based primarily on wind, is forecast to nearly triple in production, though it will only produce 2% of the state's electricity by 2007 (Figure 28).

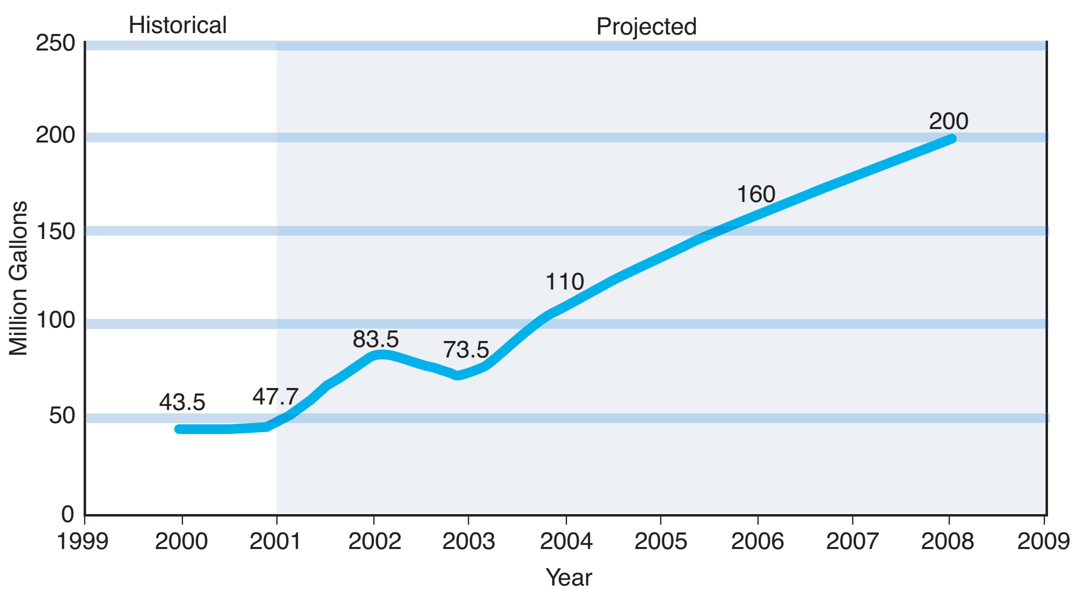

Figure 27—Kansas ethanol production, 2000 to 2008 (in million gallons per year). Based on Renewable Fuels Association web site (http://www.rfa.org) and Kansas Corn Growers Association (personal communication, 2002).

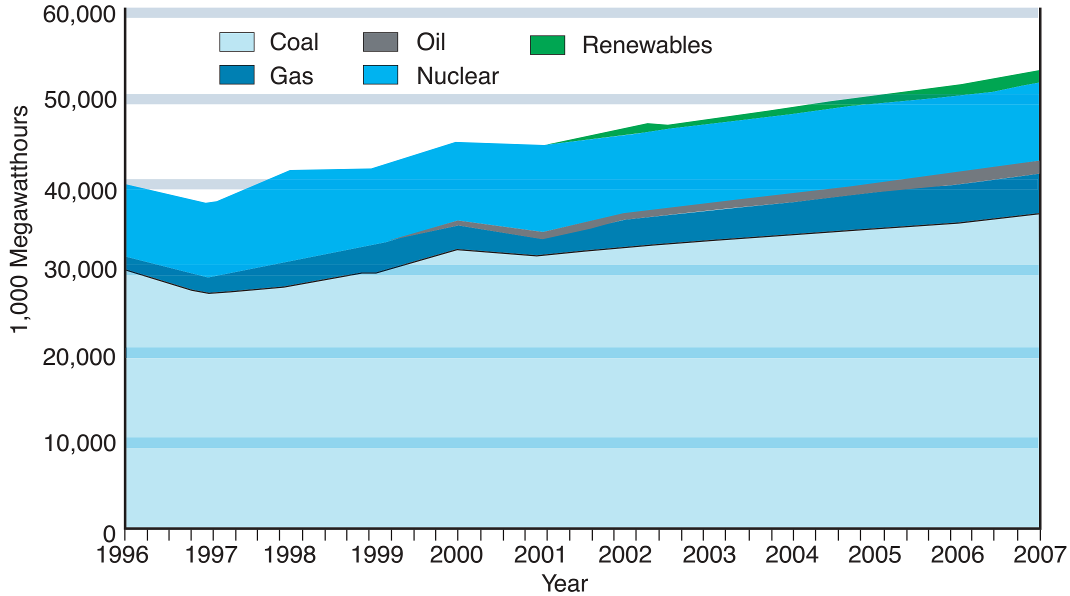

Figure 28—Kansas electricity production, 1996 to 2007. Numbers through 2001 are based on historical data from the EIA; numbers after 2001 are estimates.

Consumption Forecasts

In general, Kansas energy consumption is forecasted to continue to grow, but at a slower rate. Based on history, with more recent history assumed to be a better indicator of future growth, the forecasts incorporate a number of trends that are expected to continue over the forecast periods: (1) economic growth will return to a more normal level, as experienced on average through the prior decade; (2) slower population growth will continue to have an impact on consumption growth, and (3) technological and regulatory impacts will affect consumption. Such technological and regulatory impacts can be seen in the continued growth in natural gas consumption for electricity generation (by far the greatest area of growth), which is driven by the more friendly environmental aspects of gas-fired generation and by technological developments that have dramatically improved conversion efficiencies and lowered capital costs of gas fired generation. See Appendix 4 for further information and supporting tables for the consumption forecasts.

Total petroleum consumption is forecasted to increase by 2.25% to 3% annually. In 2003, 2005, and 2007, petroleum consumption is projected to be 85,582 thousand barrels, 89,920 thousand barrels, and 94,874 thousand barrels, respectively. Motor gasoline and distillate (diesel) fuel consumption were projected to increase annually by 0.1% and 0.44%, respectively. Consumption of LPG (liquid petroleum gas) is projected to increase 7.1% annually, while consumption of lubricants is projected to decrease by 0.2% annually.

Natural gas consumption, which was 321 bcf in 2000 (the most recent data available), is projected to decrease 9.9% in 2002 and then increase by 1% to 1.4% annually through 2007. Gas consumption in 2003, 2005, and 2007 is forecast to be 300.4 bcf, 307.5bcf, and 315.7 bcf, respectively.

Electricity consumption forecasts were broken down by sectors (residential, commercial, and industrial sectors). Residential consumption was projected to increase annually by 2.7%, commercial consumption by 3.0%, and industrial consumption by 2.8%. Total electricity consumption, which was 35,921 million kilowatthours (kWh) in 2001, is projected to increase to 39,068 million kWh, 41,317 million kWh, and 43,697 million kWh in 2003, 2005, and 2007, respectively (Figure 29).

Coal consumption for 2003, 2005, and 2007 is forecast to be 21,300, 22,3000, and 23,300 short tons, respectively. The coal consumption forecast is based on KCC's forecast for electric utility con-

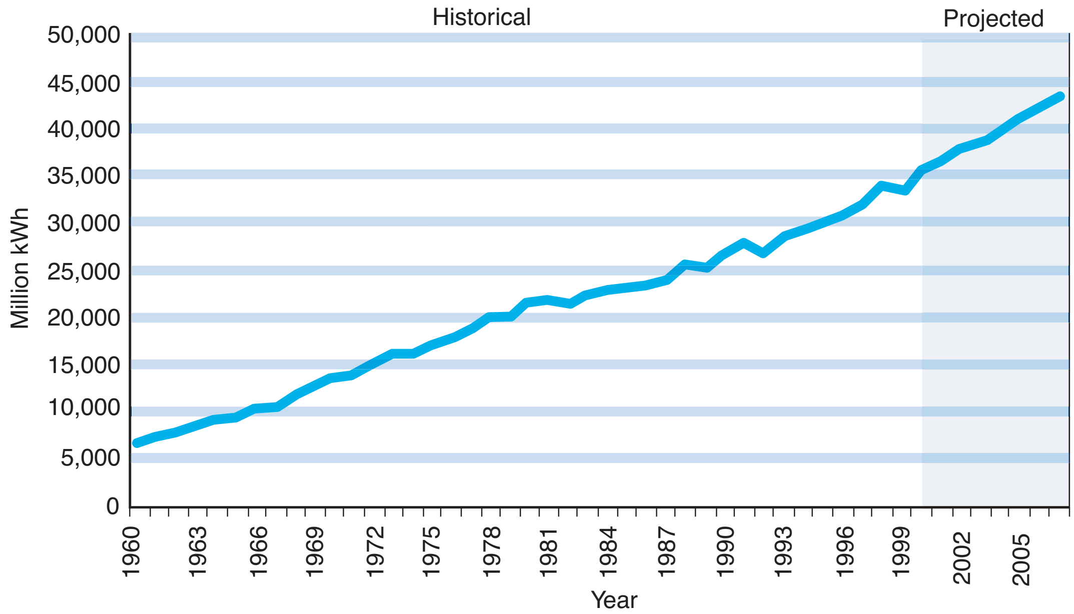

Figure 29—Kansas electricity consumption, 1960 to 2007. Note: in this figure, the years fall between the hatch marks (based on EIA *State Energy Data Reports*, various years, and consumption forecasts, Appendix 4).

sumption plus a 1% adjustment. Based on historical consumption data, it was assumed that utility coal consumption accounted for 99% of Kansas coal consumption. Therefore, forecast data are 1.01 times that of the KCC forecast.

Council Recommendations and Priorities

The SERCC Sector committees reviewed a spreadsheet of more than 175 recommendations compiled largely from the Kansas Energy Policy Committee report (KEPC, 1993). Many of the recommendations are generalized goals or strategies without a specific recommended action or tactic to accomplish them. Each committee deleted items, added their own, and then prioritized them for the consideration of the entire Council at the December 2002 meeting. Every prioritized item was approved by a majority vote of the Council. Priority items without a specific implementation action are proposed for further analysis during 2003 with the intent of developing appropriate actions and identifying the responsible parties for implementing them.

The spreadsheet of recommendations prepared by staff for the Council collected the recommendations into a number of more broadly defined themes:

- Identify policy and tax issues that adversely impact self-reliance
- Identify potential energy resources
- Ensure reliability of energy supply at reasonable price
- Increase efficiency in use of resources
- Affect national policy or state planning
- Environment
- Education
- Research and development

Within each theme are a number of goals. A major reason for creating this hierarchical classification was to clarify the recommendations from the KEPC 1993 report. In it, recommendations, goals, and themes are intermingled together under the general rubric of recommendations. By re-categorizing the issues this way, the Council could more easily and quickly delineate those measures that were more fully realized and ready to implement.

The Council voted to approve inclusion in the energy plan of 23 separate recommendations brought forward by committees. The Chair characterized them in three categories: those for adoption by the Council, those appropriate for Legislative action, and those that needed further study or discussion to develop specific tactics or actions for implementation.

Energy Recommendations

Recommendations for Council Action

The Council recognized that it is well suited to carry out some of the recommendations itself and will undertake to:

1. Establish a Transmission Task Force in Kansas to identify and recommend changes to improve the transmission network to support potential energy resources from wind or other emerging technologies and improve flow of electricity within and outside Kansas.

2. Establish a working group (composed of representatives from key state agencies, research universities, and the private sector) to identify specific research needs and opportunities to increase energy production and efficiency and that could lead to development of new businesses (e.g., wind manufacturing capability) in Kansas.

3. Establish an annual energy conference to discuss Kansas' energy issues among researchers, state and local policy decision-makers, industry, utilities, and the public. Tasks include:
   - Provide for technical assistance to independent operators, similar to the technical support given to agriculture, that will improve recovery of existing Kansas energy resources in an environmentally benign manner
   - Develop information on the economic potential of coalbed methane in Kansas.
   - Promote opportunities for employment in the oil and gas-producing sector by developing curriculum that can be taught in the community colleges and vocational technology schools.
   - Promote Enhanced Oil Recovery (Tertiary) technology to recover residual oil left after water flooding.
   - Explore sources of CO_2 in locations closer to mature producing fields to use in enhanced oil recovery projects.
   - Promote irrigation management practices designed to achieve maximum economic yield by reducing pumping costs. Adjusting pumping rates based on frequent monitoring of crop, soil, and weather conditions can provide water and energy savings with limited impact on yield.
   - Expand technical assistance to industry. Existing programs, such as the Energy Extension Service at K-State and the Energy Analysis and Diagnostic Center at Kansas University could be enhanced to provide high-quality energy audits and specific technical assistance to Kansas industries seeking to improve energy efficiency. Efforts to provide technical assistance should be structured to avoid displacing private sector services.

4. Review energy programs in other states for their effectiveness and potential applicability to Kansas.

5. Implement an awards program, providing recognition (and monetary rewards) for important contributions in energy-efficiency achievement based on actual measured performance.

Recommendations for Legislative Action in 2003

The Council approved three specific recommendations that need to be acted on by the Legislature. Two fall under the goal of Increasing Energy Efficiency:

1. Implement energy performance contracting for existing, state-owned buildings.

The KEPC report stated that, "If improved energy efficiency is to be a cornerstone of state energy policy, state government must lead the way by implementing an organized program to reduce energy use in government operations" (KEPC, 1993, p. 70). In 1990, energy expenditures accounted for slightly less than two and one-half percent of state general fund expenditures. The KEPC noted that since energy savings were generally returned to the state general fund but increased costs to maintain more efficient energy systems were borne by the agencies, there were actually disincentives to implementing energy efficiency improvements.

2. Update 1989 energy efficiency standards with ASHRAE 1999 standards for all new construction (ASHRAE = American Society of Heating, Refrigerating and Air Conditioning Engineers).

The third recommendation falls under the goal of Encouraging Investment in the Energy Industry:

3. Provide legislation that will alleviate the financial liabilities upon industry for actions taken under regulatory control.

The KEPC report stated that, "At present, even if operators follow regulations to the letter, they remain liable for damages resulting from their regulated activities. Prescribed actions by regulatory standard practice should not be liable for punitive damages. Other mitigation costs should be shared or paid by the regulatory agency. Such legislation would not only lighten the insurance and bonding burdens of operators, it would encourage adoption of best possible technology by regulatory agencies, and strongly encourage operators to carefully obey all regulations, so as to avoid exposure to major liability. Thus, the industry would be free of liability for actions taken in response to requirements from regulatory agencies, but very much inclined to adhere closely to the letter of all regulations in order to obtain that relief. The state wins, and the regulated industry wins. No one loses" (KEPC, 1993, p. 45–46).

Priority Study Items for 2003

The approved recommendations without specific actions for implementation are:

- Analyze all incentives for renewable energy, including but not limited to, net metering and Renewable Portfolio Standards (RPS), as part of a goal to increase the generation of renewable energy.
- Develop an educational program for the public (consumers and students) about energy issues, environmental impacts, and the initiatives to address those concerns.
- Make a study of the value of the petroleum industry to Kansas as a base for policy decisions.
- Study electric utility demand-side management programs related to time-of-day pricing.
- Investigate the market for low environmental impact "green" energy sales to interested consumers and utilities facing pollution abatement requirements.
- Encourage the state's electric utilities to participate and take a leadership role in all renewable energy groups and discussions.
- Investigate a systems benefit assessment/charge on all energy consumption and use proceeds to fund current energy-related program costs (e.g., weatherization, low-income heating assistance, development of renewable energy).

Energy Issues for Future Consideration

The remaining recommendations were combined or edited from the working spreadsheets into a summary list (Appendix 2) by staff with Council committees guidance. Many of the original 175+ recommendations were eliminated as obsolete or as having been achieved. Many that were similar were combined. A few were modified to clarify intent or update them to changed situations.

Implementation Strategy

The Council understands well the budget situation of state government in this and the next fiscal year. Raney Gilliland, Legislative Analyst, briefed the Council on the realities of the upcoming legislative session and discussed ways for the Council to be effective. His assessment was that proposals with costs to them were unlikely to pass or even, in some cases, to be considered at all in the 2003 session.

Therefore, the Council decided not to recommend to the Legislature and Governor any proposals this year that would have significant costs or the potential to reduce State revenues.

Some of the recommendations reviewed by the Council are best handled by other groups, including industry, trade and professional groups, and research universities. The Council tried to identify the appropriate implementation path for each proposed action. In a number of cases, the Council is taking on the responsibility itself.

Plans and Recommendations for Continued Council Activities

The Council is a volunteer effort with staff support provided by KGS and KCC being redirected from other activities. Salary for one staff member, who is normally paid by grants funds, was provided by KGS. No additional funds were provided for the Council's operations. The level of staff effort directed to the Council's activities in 2002 cannot likely be continued much into 2003 without additional resources. Many of the involved staff were temporarily pulled off other duties to help get the Council started and an initial report submitted. One of the goals for 2003 will be to identify resources to support some of the Council's activities.

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Appendix I: Executive Order 2002-4

EXECUTIVE ORDER NO. 2002-04

Establishing the State Energy Resources Coordination Council

WHEREAS, Article 1 § 3 of the Constitution of the State of Kansas vests the supreme executive power of the state in the Governor; and

WHEREAS, Energy production is one of the core foundations of our state's economy; and

WHEREAS, The production of energy benefits the long term economic and employment health of the state; and

WHEREAS, The formation of public policy is dependent upon accurate and timely information being made available to Kansas policy makers; and

WHEREAS, Improved coordination of the State's energy resources is an essential element in improving the quality of services provided to the people of Kansas;

NOW THEREFORE, pursuant to the authority vested in me as Governor of the State of Kansas, I hereby establish the State Energy Resources Coordination Council.

(1) The State Energy Resources Coordination Council shall:

(a) Collect and compile information pertaining to the availability, production and use of energy in the state;

(b) Based on such data, formulate an initial comprehensive state plan for the coordination of the management, conservation, and development of energy resources;

(c) Such a state plan shall include sections corresponding with;

(i) Estimates of energy consumption by Kansas residents for the next 12, 36 and 60 months by energy category;

(ii) Estimates of energy production by energy source for the next 12, 36 and 60 months by energy category;

(iii) Estimates of energy purchased by retail marketers in excess of domestic production for the next 12, 36 and 60 months by energy category;

(d) The Council shall annually review and modify as necessary the state energy plan.

(e) The Council shall advise of trends identified in relation to energy production, consumption and any tax or revenue implications;

(f) The Council shall recommend:

(i) Appropriate means to increase the productive life of Kansas energy resources;

(ii) Appropriate means to increase the state's self reliance on its own energy sources through;
- · Increased efficiency in the use of its resources,
- · Identification of potential energy resources, and
- · Identification of policy and tax issues that adversely impact self- reliance.

(iii) Ways to avoid loss of tax revenues and employment opportunities related to energy resource management;

(iv) Policies to increase the export of energy from Kansas; and

(v) Other policies or actions related to energy resource management as they may evolve.

(g) The Council shall annually report their findings and recommendations. The first annual report of the Council shall be provided to the Kansas Corporation Commission, the Governor and the Legislature by January 13, 2003.

(2) The Council shall consist of 13 members as follows:

(a) The State Geologist, or designee;

(b) The Chairperson of the Kansas Corporation Commission, or designee;

(c) The Consumer Counsel of the Citizens' Utility Ratepayer Board, or designee;

(d) 10 members appointed by the Governor including:

(i) An energy economist serving on the faculty of a state educational institution;

(ii) An individual knowledgeable in tax and revenue issues related to energy use or production;

(iii) A representative of oil producers;

(iv) A representative of natural gas producers;

(v) A representative of investor-owned generators of electricity;

(vi) A representative of rural electric cooperative;

(vii) A representative of municipally owned or operated electric utilities;

(viii) A representative of generators of electricity from renewable energy resources;

(ix) A representative of refiners of petroleum products;

(x) A representative of marketers of petroleum products.

(e) Of the members first appointed by the Governor subsequent to this Executive Order, four shall serve terms of four years, four shall serve terms of three years, and two shall serve terms of two years, and thereafter terms shall be for four years.

(f) All other members shall serve terms consistent with their terms of office, employment or appointment.

(3) The Governor shall annually select a Chairperson and Vice-Chairperson from among the members. The Council may elect other officers among its members and may establish any committees deemed necessary to discharge its responsibilities.

(4) The Council shall meet as frequently as necessary to discharge its responsibilities.

(5) Members of the Council shall not receive compensation, subsistence allowance, mileage or associated expenses. Officers or employees of state agencies who are appointed to the Council shall be authorized to participate on the Council as part of their duties and may claim subsistence allowance, mileage or associated expenses as permitted by law.

This document shall be filed with the Secretary of State as Executive Order No. 2002-04 and shall become effective immediately.

Appendix 2—Energy Recommendations for Future Consideration

The Council compiled over 175 recommendations from its membership and previous studies, especially the 1993 Kansas Energy Policy Report (KEPC, 1993). Many were dropped from consideration as being obsolete or were combined with related issues. The items listed below are those the Council retained for future discussion and consideration. The order of listing does not indicate any ranking of the topics.

1. To encourage investment in energy businesses, institute a capital gains tax reduction in the Kansas income tax.

2. To encourage risk capital formation in Kansas, institute investment tax credits for new ventures and high-risk investment.

3. Require a cost/benefit review of all new regulations.

4. The State should work with local distribution companies and pipelines to improve rate and operating flexibility necessary to support the unique needs of the electric generating industry.

5. The State of Kansas should support the expedited treatment of incremental or expansion pipeline projects at the FERC, and before state and local governments.

6. Continue to implement effective and responsible state environmental regulations that are consistent with federal law, maintaining continued emphasis on the necessity of state-managed programs, but require more federal funding to support federal-mandated programs.

7. To resolve conflicting resource issues (such as ground-water protection concerns versus produced fluid disposal needs), create a forum to discuss.

8. Take leadership from the federal establishment.

9. Assist existing efforts to develop and apply technology that will improve recovery of existing Kansas energy resources in an environmentally benign manner.

10. Support research to develop techniques to prevent environmental damage from oil and gas activities through the University of Kansas Energy Research Center and other entities.

11. To encourage more cost-effective implementation of energy efficiency in state buildings:
    (a) provide agencies and institutions with incentives to achieve better energy performance in the operation of their facilities;
    (b) develop and implement purchasing procedures that allow institutions to use a common vendor for building energy management systems.

12. To encourage cost-effective adoption of energy-efficient technology:
    (a) encourage utilities to develop and implement integrated resource planning programs, including steps to provide utilities with an opportunity to profit from efficiency investments;
    (b) develop programs to provide financing for energy-efficiency investments in all energy-consuming sectors;
    (c) provide tax incentives for energy efficiency investments;
    (d) broaden existing public information programs to provide credible information on energy-efficient technologies to help overcome public uncertainty about performance;
    (e) expand the range and sophistication of training programs for individuals providing services affecting energy use, from boiler maintenance technicians to plant engineers and building architects;
    (f) investigate the merits of certification and continuing-education programs for individuals providing services with a significant impact on the efficiency of energy-consuming systems;
    (g) use state building projects to showcase energy-efficient building technology.

13. To encourage energy efficiency in existing residential buildings:
    (a) adopt residential building energy standards

(see p. 83-4, KEPC, 1993, for more details and cautions);
- (b) establish a training program for home builders, trades people, home lenders, and utilities (see p. 84, KEPC, 1993, for more details);
- (c) encourage utility investment in residential energy efficiency;
- (d) encourage lending institutions to provide mortgages which recognize the financial value of improved energy efficiency;
- (e) adopt a standard method of rating the energy performance of homes;
- (f) exempt labor and material for residential energy efficiency investments from sales tax or remove the sales tax exemption from residential utility bills in order to create an incentive to conserve rather than to consume;
- (g) require energy cost disclosure at time of sale or at time of leasing of rental property;
- (h) develop strategies for replacement of low-efficiency furnaces, air conditioners, heat pumps, and refrigerators as part of utility demand-side management programs.

14. Encourage greater industrial energy efficiency. As with all other sectors, cost-effective energy efficiency improvements in industry often go unimplemented for lack of financing.

15. Require utilities to acquire a specified portion of their energy requirements from renewables by a specified date.

16. Investigate the potential for "green utility rates" in which the customer agrees to pay a higher price to ensure the utility acquires a portion of their energy requirements from renewable resources (note: the wind energy program at Jeffrey has had poor consumer participation).

17. To encourage development of Kansas's renewable energy resources:
    - (a) provide financial incentives for utilities to invest in renewable energy research and development and demonstration;
    - (b) provide financial incentives (such as sales tax exemptions, property tax abatements, and income tax credits, based on actual metered energy production) for individuals and businesses that own and use renewable energy systems;
    - (c) provide financial incentives for utilities and developers to invest in renewable energy research and development and demonstration;
    - (d) establish a coordinated effort to conduct research into the expanded development of Kansas's renewable resources.

18. To encourage use of solar energy in Kansas buildings:
    - (a) implement building lighting standards that encourage the cost-effective use of daylighting;
    - (b) implement building codes that encourage cost-effective use of passive solar building design.

19. To encourage alternative energy development in Kansas:
    - (a) investigate the potential for "co-fired" generating systems using wind turbines, backed up by natural-gas-fired turbines for capacity;
    - (b) incorporate the external cost of energy production in making regulatory decisions regarding long-term energy supply planning;
    - (c) rekindle expertise in wind resource assessment and wind technology within one or more of Kansas's universities.

20. Ensure that the industry is not adversely affected by the State's fiscal condition by maintaining adequate funding for the appropriate regulatory agencies.

21. To ensure that existing oil and gas fields are not prematurely abandoned during periods of low prices, raise trigger points for ad valorem tax and severance tax exemptions to reflect higher costs of operations.

22. Provide gas producers economical access to gas markets. Explore whether current "complaint" system provides such access or whether gas gatherers should be regulated in the same manner as other natural monopolies.

23. Make oil and gas exploration a more attractive opportunity for capital investment. Explore ways

that the state can reduce risk for employed capital through more certain regulatory and tax structure.

24. Improve the inadequate infrastructure of service companies to accommodate an increase in drilling activity.

25. Simplify the state's structure of taxation of oil & gas. Consider combining the ad valorem tax with the severance tax & rebating money to the affected counties.

26. Develop energy resources where Kansas has a comparative advantage. Place a renewable energy incentive adder on electricity consumption at no more than 1.0 mil per kWh and use proceeds to encourage appropriate development of grid and new technology development.

27. Minimize risk of investment in expensive extraction technologies. Tax oil production by 25% on all production for the incremental revenue received over $20 per bbl as defined by the Index for Kansas Common Crude. Utilize the long-term proceeds to provide 25% credits when oil price dips below $20 per bbl for Kansas Common Crude.

28. Minimize risk of investment in expensive extraction technologies. Provide a price stabilization method that taxes natural gas recovery for wellhead prices over $3.00 per MMBtu and lifts revenues when prices are below that amount.

Appendix 3—Additional Information on Oil and Gas Production Forecasts[1]

Overview

Oil and gas production in Kansas is very mature and has declined significantly from peak rates in the 1950's and 1970's. Over the last decade of the 20th century petroleum production rates in Kansas have exhibited the influence of price on supply. At prices less than $15 per barrel of oil (BO) and $2.00 per thousand cubic feet (mcf) of natural gas, petroleum production declined exponentially (approximately 4.9 percent for oil and 7.1 percent for gas). When the prices exceed $20 per BO and $2.50 per mcf, the "natural" exponential depletion curve no longer provides an adequate fit. If the price signal is significant and prolonged, Kansas petroleum supply does respond (e.g., the 1.1% rate increase in oil production from September 1995 to November 1996 and January 1999 to July 2002).

While supply disruptions, political actions or the crisis of the moment will affect near-term price trends, mid-term energy price forecasts suggest that Kansas oil, and possibly gas, production will hold more or less steady through 2007. Given expected prices significantly above $20 per BO, Kansas oil production is forecasted to maintain current monthly rates of 2.9 million BO[2], with a lower limit of 2.8, 2.7, and 2.6 million BO per month in December 2003, 2005, and 2007, respectively.

Due to price-forecast uncertainties and the dominating effect of the Hugoton Field, forecasting natural gas production is more problematic. However, based on a hyperbolic depletion curve, the current monthly gas production of approximately 38 billion cubic feet (bcf) is expected to decline to approximately 37.5 bcf in December 2003, 36 bcf in December 2005, and 32 bcf per month in December 2007. If the decline of the giant Hugoton Field continues to slow and new gas production from coalbed methane continues to increase, the decline in natural gas production rates may be less severe over the next five years.

Forecasting Prices

In the near-term, prices are influenced by supply disruptions, political actions, or the crisis of the moment. Long-term fundamentals affecting energy demand and prices include the availability of energy resources, developments in U.S. electricity markets, technology improvement, and the impact of economic growth. All of these long-term fundamentals point to adequate energy supply and stable prices through 2025 (Energy Information Administration, U.S. Department of Energy—Annual Energy Outlook 2003, early release: http://www.eia.doe.gov/oiaf/aeo/index.html).

Short-term Prices

Oil prices have been pushed up by fears that a war in Iraq could coincide with an extended stoppage in Venezuelan supplies, pushing the world's spare output capacity to the limit. Futures prices are above $30 BO through April 2003, and above $25 per BO through December 2003. Based on futures prices, the forecast by the Energy Information Agency of the U.S. Department of Energy (EIA) for average prices in 2003 of $25.83 per barrel appear to be reasonable (Table A1, Figure A1).

Table A1—Forecasted world prices of oil (per barrel) and natural gas (per mcf) in 2001 dollars (Energy Information Agency, U.S. Department of Energy, Annual Energy Review 2001, DOE/EIA-0384, http://www.eia.doe.gov/oiaf/aeo/aeotab_12.htm, and http://www.eia.doe.gov/oiaf/aeo/aeotab_14.htm, revised 12/14/02).

	2002	2003	2004	2005	2006	2007
Oil	$23.33	25.83	24.05	23.27	23.43	23.57
Gas	2.75	3.13	2.92	2.88	2.82	2.91

[1] This appendix is excerpted from KGS Open-file Report 2002-57 (Carr, 2002).
[2] The delay in posting oil and gas production data in Kansas averages about five months. For the purposes of this report current production would be July 2002.

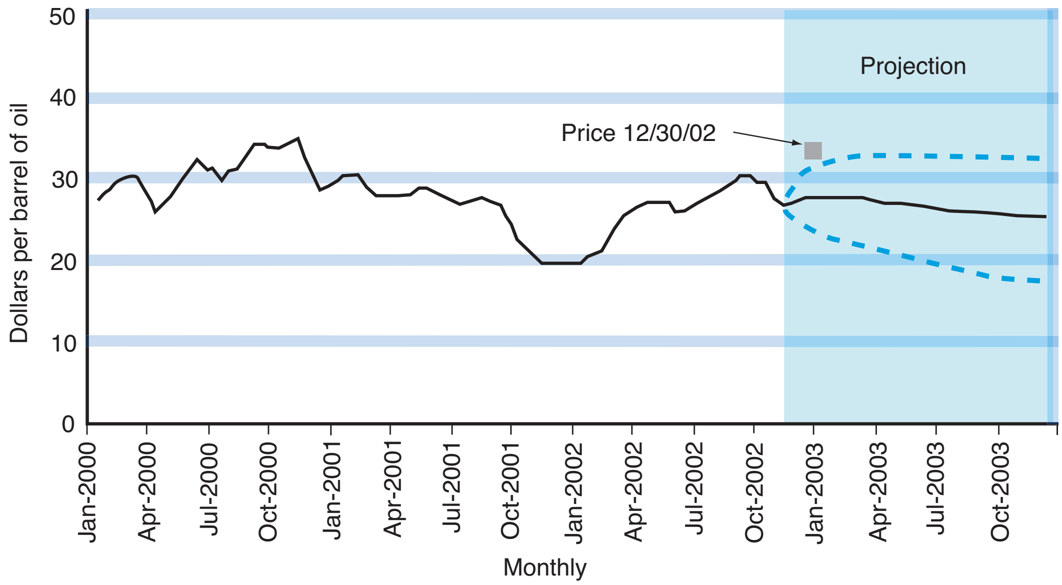

Figure A1—Short-term EIA forecast of posted price of benchmark West Texas Intermediate (WTI) Crude in nominal dollars (base case and 95% confidence interval). Due to current political unrest, the current price for WTI Crude (December 30, 2002) is higher than the predicted range ($33.28 NYMEX—February Delivery). (EIA, 2002).

In December 2002, natural gas prices rose to above $5.00 per mcf, and the average price for the year should be well above the $2.75 per mcf forecasted by the EIA-DOE (Table A1). Futures for 2003 on the New York Mercantile ($/mcf at Henry Hub) are running from $4.37 to $5.20. On average, Henry Hub spot prices are 32 cents per mcf (10.8%) higher than wellhead prices (U.S. Natural Gas Markets: Relationship Between Henry Hub Spot Prices and U.S. Wellhead Prices, EIA 2002, http://www.eia.doe.gov/oiaf/analysispaper/henryhub/index.html). The forecasted wellhead price of $3.13 per mcf is very conservative, and an average price for 2003 above $4.00/mcf appears more reasonable (Table 1).

Medium and Long-Term Prices

The EIA provides price forecasts through 2025 in an early release of the 2003 Annual Energy Outlook (http://www.eia.doe.gov/oiaf/aeo/index.html). The EIA projects the average world oil price to increase from $22.01 per barrel (2001 dollars) in 2001 to $25.83 per barrel in 2003, then to decline to $23.27 per barrel in 2005. Rising prices are projected for the longer term, to roughly $25.50 in 2020 and roughly $26.50 in 2025, largely due to higher projected world oil demand.

The EIA projects that after 2002 average natural gas prices (including spot purchases and contracts) will increase, as technology improvements prove inadequate to offset the impacts of resource depletion and increased demand. Natural gas prices are projected to increase in an uneven fashion, as higher prices allow the introduction of major new, large-volume natural gas projects that temporarily depress prices when initially brought on-line. Prices are projected to reach about $3.70 per mcf by 2020 and $3.90 per mcf by 2025.

Kansas Oil Production Rate Trends and Forecast

Oil production in Kansas is dominated by low-volume, economically marginal wells that are extremely sensitive to changes in wellhead price (Figure A2; see also Figure 20). The majority of oil wells in Kansas average less than 15 barrels of oil per day (BOPD) and can be classified as stripper production. In 2001, approximately 36,885 wells in Kansas met the criteria for stripper production (96% of the number of wells) and produced 74.8% of our state's oil. With the exception of a few months in1991 during the Gulf War, the early 1990's were characterized by nominal price of oil averaging less than $20 per barrel and as low as $8.10 per barrel (December 1998). The periods of September 1996 to November 1996 and January 1999 to July 2002 were periods where nominal oil prices increased and averaged above $20 per BO. As both the nominal and constant dollar price of oil declined to below $10 per barrel, production collapsed to a low of 2.5 million barrels per month (February 1999). During both periods of rising price above $20 per barrel the production has increased. Our current production rate is just over 2.9 million barrels per month (July 2002).

Kansas oil production can be projected using a simple straight line extrapolation (Figures A3, A4). Such standard methods as exponential or hyperbolic provide a range of results. For example, an exponential decline appears to follow production from 1990 until 1999, but seriously underestimates current production in Kansas (Figure A3). The exponential extrapolation provides a monthly production estimate for July 2002 of 2.2 million BO, compared to reported production of 2.91 million BO. In addition, the difference between observed and extrapolated production trends appears to be growing.

Exponential extrapolation is the standard method used by conservative petroleum engineers and the "Hubbert-Curve" proponents.[3] This extrapolation form would fit the Kansas long-term production trend, but it would have to ignore recent production trends as noise. The expectation under this scenario would be a fairly rapid return to a constant annual decline rate of approximately 4.9% (Figure A3).

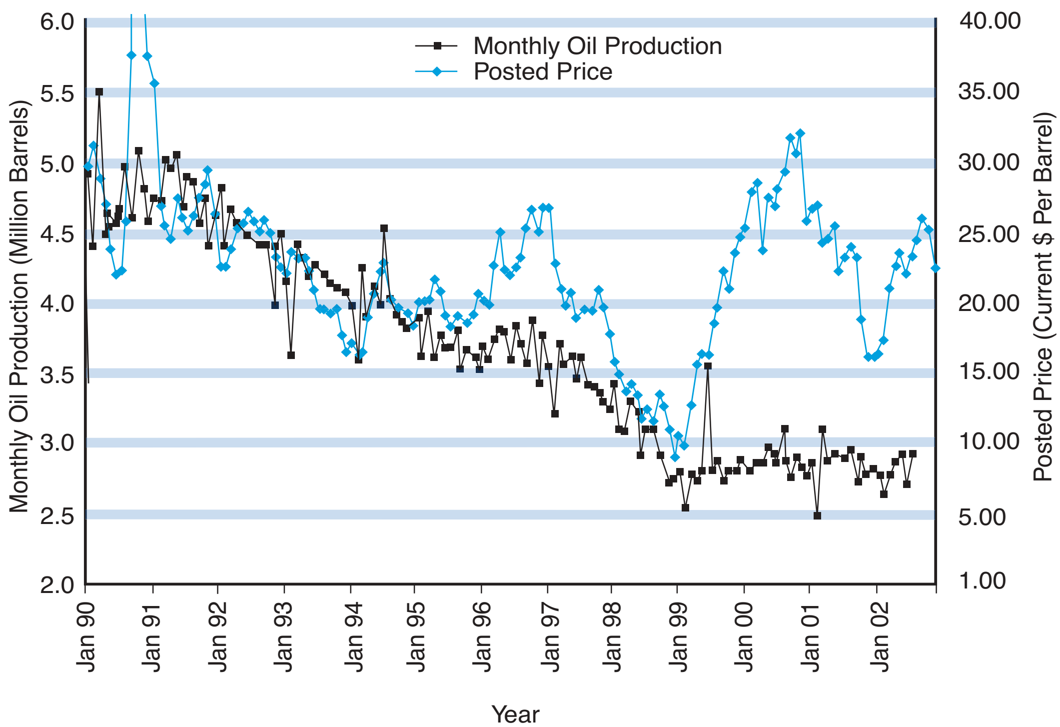

Figure A2—Kansas monthly oil production and monthly posted price (in constant current dollars) from January 1990 through current date (Production 7/02, price 11/02). Oil production is in thousand barrels per month and is from online databases at the Kansas Geological Survey (http://www.kgs.ku.edu/PRS/petroDB.html). The production data are sales volumes reported to the Kansas Department of Revenue. Price in current dollars is the adjusted monthly average price per barrel of 42 U.S. gallons for merchantable crude oil purchased and delivered into pipelines or facilities authorized by Koch Supply & Trading, L.P. in the area of central Kansas (http://www.kochoil.com/). Nominal dollars were adjusted to constant current dollars using the monthly Consumer Price Index—All Urban Consumers. Data was extracted from the U.S. Department of Labor, Bureau of Labor Statistics (www.bls.gov, accessed 12/23/02). Note: As a result of additional late production updates to the Kansas Department of Revenue, the current month's production is usually revised upwards.

[3] In 1971, M. King Hubbert used a logistic equation (bell curve) to predict that world-oil production would peak in about 2000 and decline thereafter. Numerous proponents have used this approach over the last thirty years to argue for the immediate decline of oil production. One problem with this approach is using a static estimate of total resources instead of a dynamic variable resource, growing with technology change, infrastructure improvements, etc. For a review and critical evaluation of this method of extrapolation see Lynch (1998, Crying Wolf, 1998, http://sepwww.stanford.edu/sep/jon/world-oil.dir/lynch/worldoil.html or Forecasting Oil Supply: Theory and Practice, 2002, The Quarterly Review of Economics and Finance.

The exponential decline is often interpreted to reflect the natural decline of petroleum reservoirs (constant percentage). If Kansas returned to the constant 4.9 percent decline, monthly production rates at the end of 2003, 2005, and 2007 would be estimated at 2.7 million BO, 2.35 million BO, and 2.1 million BO, respectively (Figure A4).

However, if oil production rates in Kansas respond to price signals, and if prices are sufficient to attract investment and technology dollars, then the exponential decline will underestimate production. This situation is typical in very mature production settings or economically or technologically marginal resources.[4]

Another approach to extrapolation is hyperbolic decline (Figure 29). A hyperbolic decline assumes that the decline in production per unit time is proportional to a fractional power of the production rate (i.e, production rate declines decrease over time and approaches some asymptotic value). The inverse hyperbolic situation is typical of growth in very mature industries (i.e., slow, negligible, and tied to

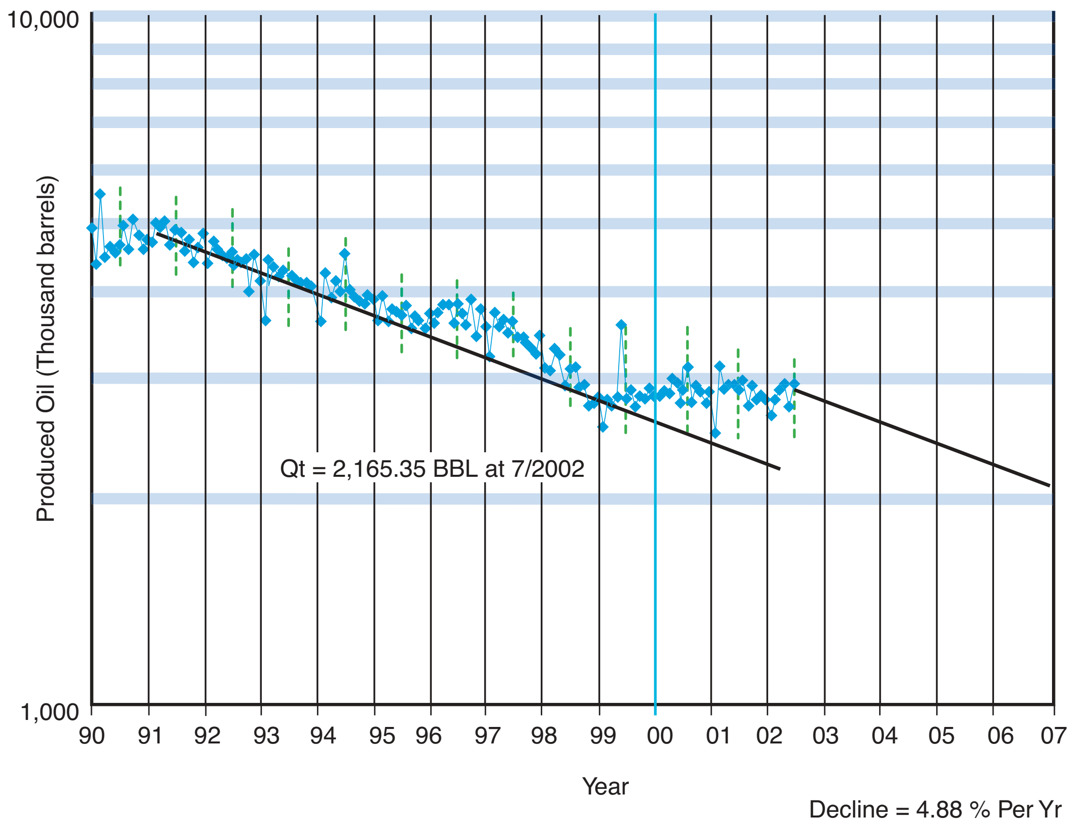

Figure A3— Exponential decline analysis and forecast for Kansas oil production using a decline rate of 4.88% per year observed from 1991 until 1999. If this decline were extrapolated from 1999 until July 2002, production would be estimated at 2.16 million barrels per month. Production in July 2002 was reported at 2.91 million barrels (subject to upward revision). Simple exponential extrapolation underestimated current production by approximately 750,000 per month. Extrapolating from current production would result in estimated oil production of 2.1 million barrels per month at the end of 2007. Production in 2003 and 2005 would be estimated at 2.7 and 2.35 million barrels per month, respectively. Bars show the range and average annual production.

[4] A discussion of the complex relationship among price, technology and natural resource availability is well beyond the scope of this report. However, available petroleum resource (labeled reserves) increases as price for the resource increases. Technology appears to moderate the cost of changing resources into reserves that can be produced and reducing price to the consumer. For a readable discussion that addresses this complex relationship see: McCabe, P. J., 1998, Energy resources—Cornucopia or empty barrel?: American Association of Petroleum Geologists Bulletin, v. 82, no. 11, p. 2110–2134.

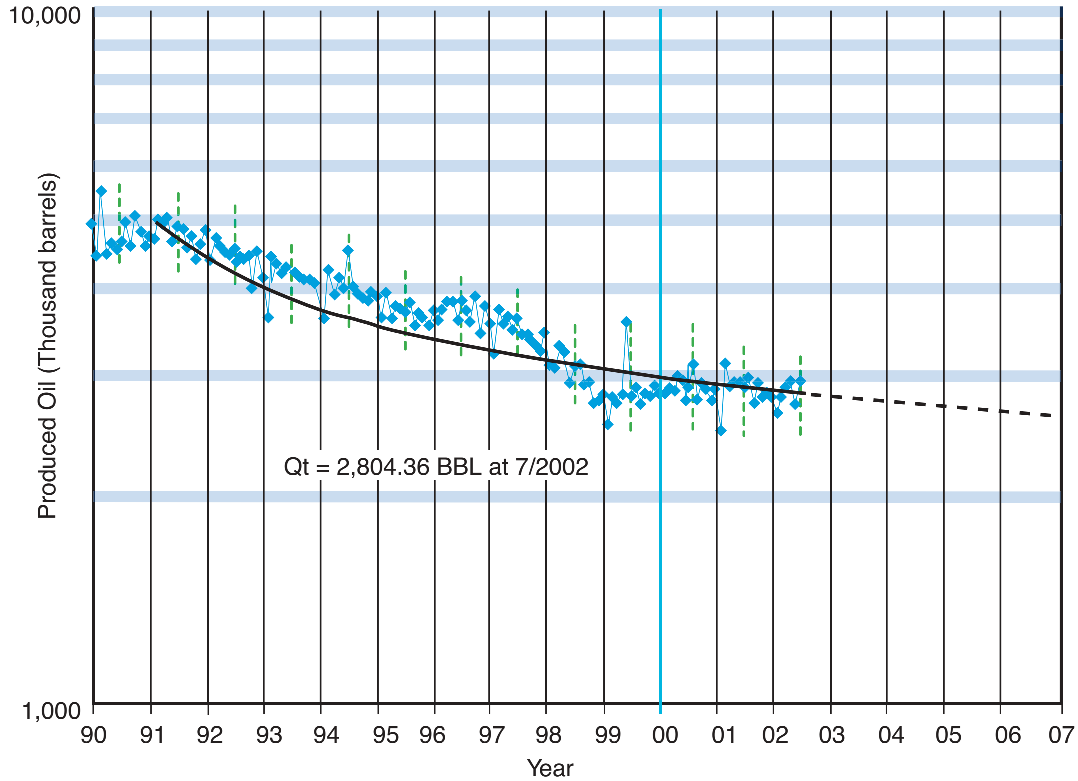

Figure A4— Hyperbolic decline analysis and forecast for Kansas oil production. If this decline was extrapolated from 1999 until present (7/02) production would be estimated at 2.8 million barrels per month. Production in July 2002 was reported at 2.91 million barrels (subject to upward revision). Hyperbolic extrapolation underestimated current production by approximately 100,000 barrels per month. Extrapolating the curve would result in estimated oil production of 2.6 million barrels per month at the end of 2007. Production in 2003 and 2005 would be estimated at 2.8 and 2.7 million barrels per month, respectively. Bars show the range and average annual production.

predictable external variables such as population). Reservoirs in the later stages of depletion, and possibly very mature hydrocarbon provinces such as those in Kansas, follow some form of hyperbolic decline when hydrocarbon prices are above a threshold value. If price is stable and sufficient, continued capital and technology investment can maintain hydrocarbon production for long periods of time at some constant level or at a negligible decline rate (Figure A4). Application of a hyperbolic decline to Kansas production predicts current production within a reasonable margin. The fit of the curve is somewhat arbitrary and departures appear to be related to significant changes in price trends. The predicted oil production in December 2007 using an exponential decline from current production (July 2002 production was 2.91 million barrels per month) would be 2.35 million barrels and using a hyperbolic decline would be 2.7 million barrels per month.

Predicting Kansas oil production requires knowledge of future oil prices. Assuming that EIA oil price scenario is correct and price remains well above $20 per barrel (Table A1), Kansas production in 2007 is estimated using a hyperbolic decline curve at well above 2.7 million barrels per month (Figure A4). Given favorable application of technology, monthly oil production could exceed current rates of 2.9 million barrels per month. However, if oil price forecasts are incorrect and fall below $20 per barrel for significant time periods, Kansas production rates will quickly decline. If oil prices collapsed immediately, production in 2007 is estimated using an exponential decline at somewhere in the vicinity of 2.4 million barrels per month (Figure A3). These estimates provide a range of expected monthly oil production rates for Kansas through 2007.

Kansas Gas Production Rate Trends and Forecast

In contrast to oil production, natural gas production in Kansas is dominated by the Hugoton field, one of the largest natural gas fields in North America and the world. It produces almost 60% of the state's total annual natural gas production. The Hugoton reached an initial peak in 1970. Following significant new capital investment and policy changes that permitted infill drilling and compression, it reached a second peak in 1996. Since 1996, the Hugoton field has been declining at an average annual rate of 8%. Kansas gas production dominated by the Hugoton has also declined a similar rate since 1996 (Figure A5; see also Figure 23).

Exponential depletion curve analysis and decline forecast for Kansas gas production indicates a decline rate of 7.10% per year from 1996 until 2001 (Figure A6). If this decline were extrapolated from 1996 until July 2002, production would be estimated at 36.35 billion cubic feet (bcf) per month. Production in July 2002 was reported at 38.15 bcf per month (subject to upward revision). Thus, simple exponential extrapolation underestimated current production rate by a small amount (2 bcf per month). Extrapolating from the current production rate would result in estimated gas production of 26 bcf per month at the end of 2007. Production in 2003 and 2005 would be estimated at 35 bcf and 30.5 bcf per month, respectively (Figure A6).

Hyperbolic decline curve analysis and forecast for Kansas gas production indicates a slightly lower

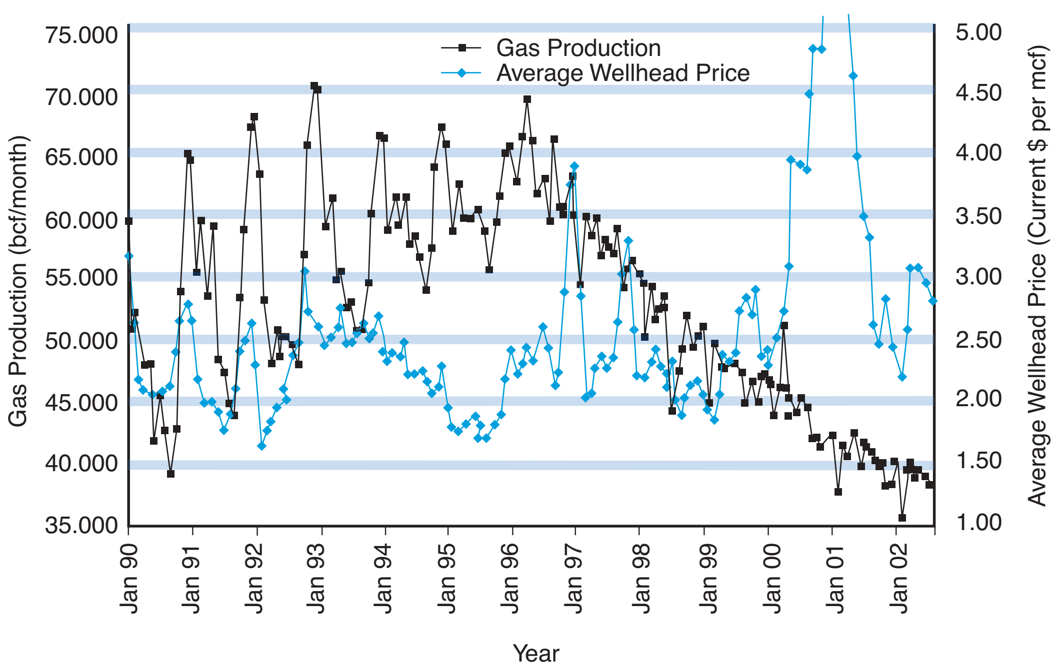

Figure A5— Kansas monthly gas production and monthly posted price from January 1990 through current date (Production 7/02, price 11/02). Gas production is in billion cubic feet per month and is obtained from online databases at the Kansas Geological Survey (http://www.kgs.ku.edu/PRS/petroDB.html). The production data are sales volumes reported to the Kansas Department of Revenue. Price in current dollars is the adjusted monthly average wellhead price for thousand cubic feet as reported by the Energy Information Agency of the US Department of Energy (http://www.eia.doe.gov/pub/oil_gas/natural_gas/data_publications/natural_gas_monthly/current/pdf/table_04.pdf - accessed on 12/23/02). Nominal dollars were adjusted to constant current dollars using the monthly Consumer Price Index - All Urban Consumers. Data was extracted from the U.S. Department of Labor, Bureau of Labor Statistics (www.bls.gov - 12/23/02). Note: As a result of additional late production updates to the Kansas Department of Revenue the current month's production is usually revised upwards.

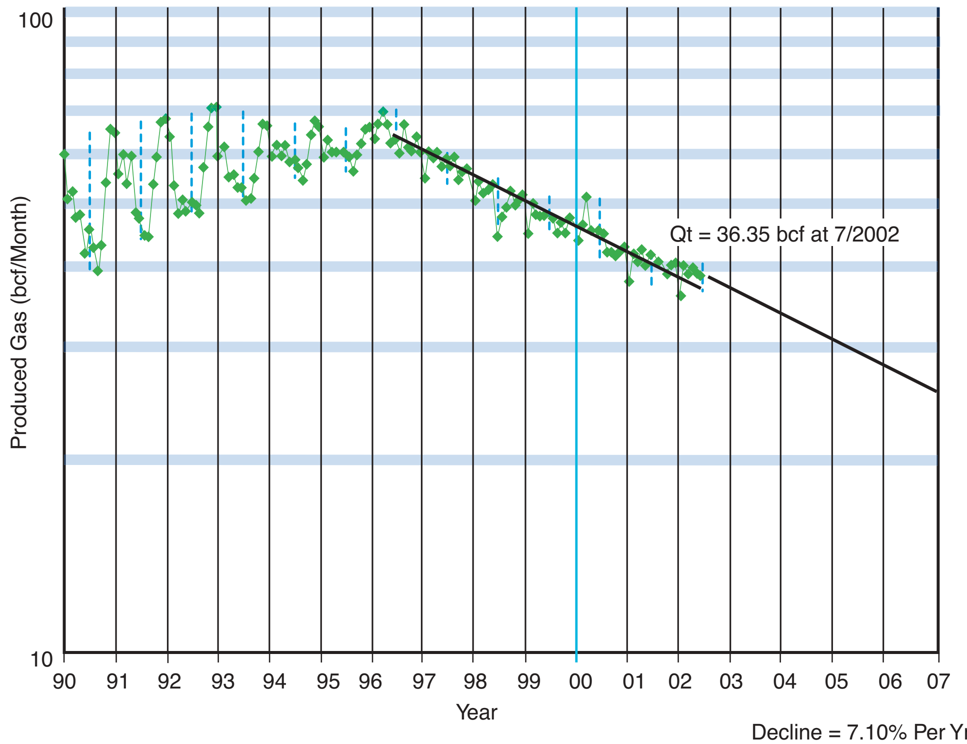

Figure A6— Exponential curve analysis and decline forecast for Kansas gas production using a decline rate of 7.10% per year observed from 1996 until 2001.

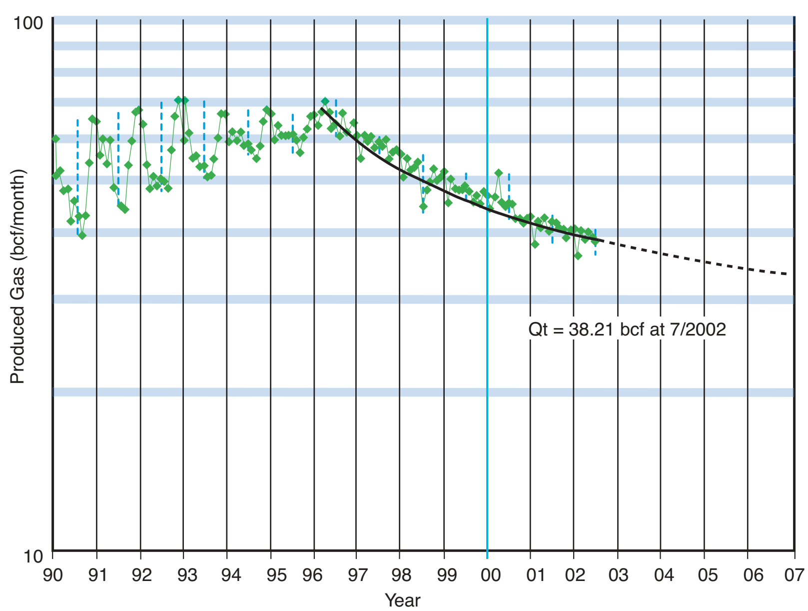

Figure A7— Hyperbolic decline analysis and forecast for Kansas gas production.

decline rate in recent time periods (Figure A7). If this decline were extrapolated from 1996 until July 2002, production would be estimated at 38.21 billion cubic feet (bcf) per month. Production in July 2002 was reported at 38.15 bcf per month (subject to upward revision). Hyperbolic extrapolation slightly overestimates current production rate by approximately 0.06 bcfper month. Extrapolating the curve would result in estimated gas production rates of 32 bcf per month at the end of 2007. Production in 2003 and 2005 would be estimated at 37.5 bcf and 36 bcf per month, respectively (Figure A7).

Appendix 4—Additional Information on Consumption Forecasts

The consumption forecasts were developed in a three-step process. First, the historical annual growth rate of the energy consumption was calculated. To ensure stability in historical growth rates, outliers (anomalies in the data) were deleted throughout the data filtering process. Second, the historical data was divided into two different sizes, a full sample and a truncated sample. The full sample incorporates all available historical data, whereas the truncated sample utilizes only the recent consumption data. As noted above, more recent history is considered a better barometer for the future, especially considering some of the structural changes that have occurred recently in the energy markets. Finally, the historical data was modeled and projected into the future. A number of statistical techniques were utilized, including both static (actual values) and dynamic (previously forecasted) models.

Natural gas consumption forecasts did not include fuel delivery losses, which include lease fuel, pipeline fuel, and plant fuel. The EIA defines these losses as follows: lease fuel includes gas used in well, field, and lease operations such as gas used in drilling operations, heaters, dehydrators, and field compressors; pipeline fuel includes gas consumed in the operation of pipelines, primarily for compression; and plant fuel is natural gas used as fuel in natural gas processing plants. It was assumed for the forecast period of this report, that the percentage of losses for these activities would equal the average percentage of losses for the period 1985–2000. This was 29.1% of fuel delivered to customers.

Table A2—Summary of Kansas petroleum products consumption forecast (thousands of barrels).

Year	Total Petroleum Products Consumption Forecast	Percent Change	LPG Consumption Forecast	Percent Change	Kerosene Consumption Forecast	Percent Change	Distillate Consumption Forecast	Percent Change	Gasoline Consumption Forecast	Percent Change	Residual Fuel Consumption Forecast	Percent Change
1990	77,567		15,565		27.00		16,561		28,626		232	
1991	71,240	-8.2%	13,293	-14.6%	24.00	-11.1%	15,714	0.44%	28,041	-2.0%	128	-44.8%
1992	75,564	6.1%	16,816	26.5%	33.00	37.5%	15,154	0.44%	27,821	-0.8%	180	40.6%
1993	67,354	-10.9%	8,269	-50.8%	36.00	9.1%	16,268	0.44%	28,480	2.4%	373	107.2%
1994	66,810	-0.8%	7,754	-6.2%	17.00	-52.8%	15,770	0.44%	29,073	2.1%	190	-49.1%
1995	67,162	0.5%	4,924	-36.5%	28.00	64.7%	19,446	0.44%	29,402	1.1%	31	-83.7%
1996	73,329	9.2%	10,442	112.1%	37.00	32.1%	16,964	0.44%	30,927	5.2%	292	841.9%
1997	76,336	4.1%	14,557	39.4%	58.00	56.8%	17,142	0.44%	30,695	-0.8%	260	-11.0%
1998	76,132	-0.3%	14,121	-3.0%	50.00	-13.8%	16,215	0.44%	32,001	4.3%	286	10.0%
1999	86,511	13.6%	21,741	54.0%	360.00	620.0%	15,514	0.44%	33,550	4.8%	616	115.4%
2000	83,349	-3.7%	17,401	-20.0%	32.00	-91.1%	15,113	0.44%	31,894	-4.9%	1,025	66.4%
2001	77,983	-6.4%	18,636	7.1%	30.11	-5.9%	15,179	0.44%	31,912	0.1%	1,058	3.2%
2002	79,509	2.0%	19,960	7.1%	28.34	-5.9%	15,246	0.44%	31,931	0.1%	1,092	3.2%
2003	81,132	2.0%	21,377	7.1%	26.66	-5.9%	15,313	0.44%	31,949	0.1%	1,127	3.2%
2004	82,859	2.1%	22,895	7.1%	25.09	-5.9%	15,381	0.44%	31,968	0.1%	1,163	3.2%
2005	84,696	2.2%	24,520	7.1%	23.61	-5.9%	15,448	0.44%	31,986	0.1%	1,201	3.2%
2006	86,652	2.3%	26,261	7.1%	22.22	-5.9%	15,516	0.44%	32,005	0.1%	1,239	3.2%
2007	88,735	2.4%	28,126	7.1%	20.91	-5.9%	15,585	0.44%	32,023	0.1%	1,279	3.2%
2008	90,954	2.5%	30,122	7.1%	19.67	-5.9%	15,653	0.44%	32,042	0.1%	1,320	3.2%
2009	93,317	2.6%	32,261	7.1%	18.51	-5.9%	15,722	0.44%	32,060	0.1%	1,362	3.2%
2010	95,836	2.7%	34,552	7.1%	17.42	-5.9%	15,791	0.44%	32,079	0.1%	1,406	3.2%
2011	98,521	2.8%	37,005	7.1%	16.39	-5.9%	15,861	0.44%	32,097	0.1%	1,451	3.2%
2012	101,383	2.9%	39,632	7.1%	15.43	-5.9%	15,931	0.44%	32,116	0.1%	1,498	3.2%
2013	104,436	3.0%	42,446	7.1%	14.51	-6.0%	16,001	0.44%	32,134	0.1%	1,546	3.2%
2014	107,692	3.1%	45,460	7.1%	13.66	-5.9%	16,071	0.44%	32,153	0.1%	1,596	3.2%
2015	111,167	3.2%	48,687	7.1%	12.85	-5.9%	16,142	0.44%	32,171	0.1%	1,647	3.2%

Table A2, continued.

Year	Petroleum Lubricants Consumption Forecast	Percent Change	Asphalt Consumption Forecast	Percent Change	Gasoline Consumption Forecast	Percent Change	Aviation Jet Fuel Consumption Forecast	Percent Change	Other Pet Prods Consumption Forecast	Percent Change
1990	1,035		3,875		136		3,701		7,809	
1991	926	-10.5%	3,721	-4.0%	124	-8.8%	3,296	-10.9%	5,973	-23.5%
1992	944	1.9%	3,715	-0.2%	142	14.5%	4,164	26.3%	6,595	10.4%
1993	962	1.9%	3,635	-2.2%	151	6.3%	3,617	-13.1%	5,563	-15.6%
1994	1,005	4.5%	4,741	30.4%	142	-6.0%	1,981	-45.2%	6,137	10.3%
1995	988	-1.7%	3,911	-17.5%	146	2.8%	2,414	21.9%	5,872	-4.3%
1996	959	-2.9%	3,581	-8.4%	177	21.2%	2,009	-16.8%	7,941	35.2%
1997	1,013	5.6%	2,115	-40.9%	247	39.5%	2,130	6.0%	8,119	2.2%
1998	1,060	4.6%	2,699	27.6%	199	-19.4%	2,157	1.3%	7,344	-9.5%
1999	1,071	1.0%	2,358	-12.6%	240	20.6%	3,476	61.1%	7,585	3.3%
2000	1,055	-1.5%	2,470	4.7%	215	-10.4%	3,234	-7.0%	10,910	43.8%
2001	1,053	-0.2%	2,468	-0.1%	217.58	1.2%	3,519	8.8%	7,646	-29.9%
2002	1,051	-0.2%	2,524	2.3%	220.19	1.2%	3,828	8.8%	7,676	0.4%
2003	1,050	-0.2%	2,583	2.3%	222.83	1.2%	4,165	8.8%	7,707	0.4%
2004	1,048	-0.2%	2,642	2.3%	225.51	1.2%	4,532	8.8%	7,738	0.4%
2005	1,046	-0.2%	2,703	2.3%	228.21	1.2%	4,930	8.8%	7,769	0.4%
2006	1,044	-0.2%	2,765	2.3%	230.95	1.2%	5,364	8.8%	7,800	0.4%
2007	1,042	-0.2%	2,828	2.3%	233.72	1.2%	5,836	8.8%	7,831	0.4%
2008	1,041	-0.2%	2,894	2.3%	236.53	1.2%	6,350	8.8%	7,862	0.4%
2009	1,039	-0.2%	2,960	2.3%	239.37	1.2%	6,909	8.8%	7,894	0.4%
2010	1,037	-0.2%	3,028	2.3%	242.24	1.2%	7,517	8.8%	7,925	0.4%
2011	1,035	-0.2%	3,098	2.3%	245.15	1.2%	8,178	8.8%	7,957	0.4%
2012	1,033	-0.2%	3,169	2.3%	248.09	1.2%	8,898	8.8%	7,989	0.4%
2013	1,032	-0.2%	3,242	2.3%	251.06	1.2%	9,681	8.8%	8,021	0.4%
2014	1,030	-0.2%	3,316	2.3%	254.08	1.2%	10,533	8.8%	8,053	0.4%
2015	1,028	-0.2%	3,393	2.3%	257.13	1.2%	11,460	8.8%	8,085	0.4%

Table A3—Summary of Kansas natural gas consumption forecast (in million cubic feet (Mmcf). *Fuel delivery includes lease fuel, pipeline fuel, and plant fuel, per EIA. Source: EIA, Natural Gas Annual, Volume I, EIA/DOE-0131, various years.

Year	Residential Consumption Forecast	Percent Change	Commercial Consumption Forecast	Percent Change	Industrial Consumption Forecast	Percent Change	Utility Consumption Forecast	Percent Change	Kansas Total Consumption Forecast	Percent Change	Fuel Delivery (Losses)*	Loss Percentage	Kansas Total Consumption w/ losses)
1990	71,327		56,045		116,915		26,978		271,265		81,514	30.0%	352,779
1991	74,825	4.9%	58,571	4.5%	123,517	5.6%	36,122	33.9%	293,035	8.0%	77,522	26.5%	370,557
1992	71,522	-4.4%	53,973	-7.9%	130,807	5.9%	13,981	-61.3%	270,283	-7.8%	72,934	27.0%	343,217
1993	84,896	18.7%	56,023	3.8%	139,032	6.3%	21,636	54.8%	301,587	11.6%	90,018	29.8%	391,605
1994	74,156	-12.7%	52,253	-6.7%	187,979	35.2%	27,279	26.1%	341,667	13.3%	76,350	22.3%	418,017
1995	75,846	2.3%	53,122	1.7%	129,515	-31.1%	27,945	2.4%	286,428	-16.2%	81,913	28.6%	368,341
1996	85,376	12.6%	57,229	7.7%	110,294	-14.8%	22,607	-19.1%	275,506	-3.8%	87,458	31.7%	362,964
1997	69,415	-18.7%	41,482	-27.5%	116,522	5.6%	25,822	14.2%	253,241	-8.1%	85,955	33.9%	339,196
1998	70,217	1.2%	41,788	0.7%	111,143	-4.6%	36,896	42.9%	260,044	2.7%	66,891	25.7%	326,935
1999	68,146	-2.9%	38,952	-6.8%	97,469	-12.3%	35,857	-2.8%	240,424	-7.5%	62,685	26.1%	303,109
2000	70,589	3.6%	39,647	1.8%	108,903	11.7%	33,509	-6.5%	252,648	5.1%	68,507	27.1%	321,155
2001	70,546	-0.1%	38,930	-1.8%	95,009	-12.8%	23,269	-30.6%	227,755	-9.9%	66,277	29.1%	294,031
2002	70,441	-0.1%	38,696	-0.6%	95,883	0.9%	25,107	7.9%	230,128	1.0%	66,967	29.1%	297,095
2003	70,335	-0.2%	38,464	-0.6%	96,766	0.9%	27,091	7.9%	232,656	1.1%	67,703	29.1%	300,358
2004	70,229	-0.1%	38,233	-0.6%	97,656	0.9%	29,231	7.9%	235,350	1.2%	68,487	29.1%	303,836
2005	70,124	-0.1%	38,004	-0.6%	98,554	0.9%	31,540	7.9%	238,223	1.2%	69,323	29.1%	307,545
2006	70,019	-0.1%	37,776	-0.6%	99,461	0.9%	34,032	7.9%	241,288	1.3%	70,215	29.1%	311,503
2007	69,914	-0.1%	37,549	-0.6%	100,376	0.9%	36,720	7.9%	244,560	1.4%	71,167	29.1%	315,727
2008	69,809	-0.2%	37,324	-0.6%	101,299	0.9%	39,621	7.9%	248,054	1.4%	72,184	29.1%	320,238
2009	69,704	-0.2%	37,100	-0.6%	102,231	0.9%	42,751	7.9%	251,787	1.5%	73,270	29.1%	325,057
2010	69,600	-0.1%	36,877	-0.6%	103,172	0.9%	46,129	7.9%	255,778	1.6%	74,431	29.1%	330,209
2011	69,495	-0.1%	36,656	-0.6%	104,121	0.9%	49,773	7.9%	260,046	1.7%	75,673	29.1%	335,719
2012	69,391	-0.1%	36,436	-0.6%	105,079	0.9%	53,705	7.9%	264,611	1.7%	77,002	29.1%	341,613
2013	69,287	-0.1%	36,218	-0.6%	106,046	0.9%	57,948	7.9%	269,498	1.7%	78,424	29.1%	347,922
2014	69,183	-0.1%	36,000	-0.6%	107,021	0.9%	62,526	7.9%	274,730	1.7%	79,947	29.1%	354,677
2015	69,079	-0.1%	35,784	-0.6%	108,006	0.9%	67,465	7.9%	280,335	1.7%	81,577	29.1%	361,912

Table A4—Summary of Kansas electricity consumption forecast (millions of kilowatthours).

Year	Residential Consumption Forecast	Percent Change	Commercial Consumption Forecast	Percent Change	Industrial Consumption Forecast	Percent Change	Kansas Total Consumption Forecast	Percent Change
1990	9,515		9,547		8,087		27,149	
1991	9,933	4.4%	9,935	4.1%	8,284	2.4%	28,152	3.7%
1992	8,873	-10.7%	9,746	-1.9%	8,451	2.0%	27,070	-3.8%
1993	9,986	12.5%	10,120	3.8%	8,702	3.0%	28,808	6.4%
1994	10,131	1.5%	10,482	3.6%	9,001	3.4%	29,614	2.8%
1995	10,356	2.2%	10,645	1.6%	9,356	3.9%	30,357	2.5%
1996	10,672	3.1%	11,388	7.0%	9,231	-1.3%	31,291	3.1%
1997	10,862	1.8%	12,043	5.8%	9,365	1.5%	32,270	3.1%
1998	11,832	8.9%	12,546	4.2%	9,762	4.2%	34,140	5.8%
1999	11,347	-4.1%	12,258	-2.3%	10,215	4.6%	33,820	-0.9%
2000	12,528	10.4%	13,171	7.4%	10,222	0.1%	35,921	6.2%
2001	12,866	2.7%	13,566	3.0%	10,508	2.8%	36,941	2.8%
2002	13,214	2.7%	13,973	3.0%	10,802	2.8%	37,989	2.8%
2003	13,570	2.7%	14,392	3.0%	11,105	2.8%	39,068	2.8%
2004	13,937	2.7%	14,824	3.0%	11,416	2.8%	40,177	2.8%
2005	14,313	2.7%	15,269	3.0%	11,735	2.8%	41,317	2.8%
2006	14,700	2.7%	15,727	3.0%	12,064	2.8%	42,491	2.8%
2007	15,096	2.7%	16,199	3.0%	12,402	2.8%	43,697	2.8%
2008	15,504	2.7%	16,685	3.0%	12,749	2.8%	44,938	2.8%
2009	15,923	2.7%	17,185	3.0%	13,106	2.8%	46,214	2.8%
2010	16,353	2.7%	17,701	3.0%	13,473	2.8%	47,526	2.8%
2011	16,794	2.7%	18,232	3.0%	13,850	2.8%	48,876	2.8%
2012	17,248	2.7%	18,779	3.0%	14,238	2.8%	50,264	2.8%
2013	17,713	2.7%	19,342	3.0%	14,637	2.8%	51,692	2.8%
2014	18,191	2.7%	19,922	3.0%	15,047	2.8%	53,160	2.8%
2015	18,683	2.7%	20,520	3.0%	15,468	2.8%	54,671	2.8%