Kansas Oil and Gas Production Forecasts

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"Those who cannot remember the past are condemned to repeat it." George Santayana, (The Life of Reason, 1906)

"The future seems to me no unified dream but a mince pie long in the baking and never quite done." E. B. White (One Man's Meat, 1944).

Executive Summary

Responding to a request for mid-term forecasts of Kansas monthly oil and gas production, historical production patterns were evaluated in relation to commodity prices. Kansas oil and gas production rates are estimated for December 2003, 2005 and 2007. While supply disruptions, political actions or the crisis of the moment will affect near-term price trends and political chatter, mid-term energy price forecasts are expected to remain at levels that investment and technology should maintain Kansas oil and possibly gas production volumes near present levels through 2007. 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 20^{th} 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) petroleum production rate decline 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 production the "natural" exponential depletion curve no longer provides an adequate fits. If the price signal is significant and prolonged, Kansas petroleum supply does respond (e.g., the 1.1 percent rate increase in oil production from 9/95 to 11/96 and 1/99 to 7/02). Given expected prices significantly above $20 per BO, Kansas oil production is forecasted to maintain current monthly rates of 2.9 million BO[1] 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, natural gas production rate forecasts are more problematic. However, using a hyperbolic depletion curve current monthly gas production of approximately 38 billion cubic feet (BCF) is expected to decline to approximately 37.5 and 36, 32 BCF per month in December 2003, 2005 and 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.

[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.

Introduction

I remember and was directly affected by the solid predictions and strongly held beliefs in the 1970's and 80's. These included:

- $100 per barrel oil and the end of the petroleum era,
- catastrophic decline of gas production from the Hugoton Field[2]; and
- immediate ascension that was actively promoted by poorly designed government policies of the latest fashionable form of clean limitless energy[3]
  (e.g., nuclear, oil shale, deep gas or various forms of renewable energy).

With each new supply disruption or political action over the last quarter century, the predictions of the 1970's have been repeated. However, if anything has come to pass, it is that nothing changes. I cannot predict the future of energy supply or energy prices, but most long-term industrial and governmental forecasts call for adequate supply and moderate prices for the next quarter century. Example reports from governmental sources include:

- Annual Energy Outlook – 2003 from the Energy Information Administration, US Department of Energy with a supply, demand and price forecast through 2025 (http://www.eia.doe.gov/oiaf/aeo/index.html), and the
- World Energy Outlook 2002 from the International Energy Agency with a forecast through 2030 (http://www/worldenergyoutlook/weo/pubs/weo2002.asp).

These reports and similar reports from private sector organizations unequivocally state that fossil energy will be the primary source to meet increased energy demand and that world energy supplies are adequate to meet anticipated increases in energy consumption. I may be wrong, but I am not alone in guessing that our world will be running on fossil-fuel in 2025, and that we will be wrestling with how to wean ourselves from fossil-fuel dependence while responding to the latest short-term crisis in the energy market. Based on the published energy price forecasts and production trends, I believe that the primary forms of energy produced in Kansas in 2025 will remain oil and gas. I also believe that the primary form of electrical generation will be from fossil fuel (i.e., coal and natural gas). Again, the energy outlooks cited above support this speculation.

Kansas should work to achieve an economically reasonable, environmentally sensitive and diverse energy-supply portfolio that enhances carbon-based fuels as the foundation of our prosperity. Kansas should invest in the latest technology to enhance our current energy supplies, develop new methods of energy generation and distribution and continue to maximize both the qualities of our environment and our economy. Technologies such as enhanced oil and gas recovery technologies, integrated energy systems, and new generation and distribution technology can provide the new tools to improve our state's energy system through the first quarter of the 21st century.

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[2] An example would be the cover story in the Kansas City Star Magazine, entitled Out of Gas (April 3, 1988) that predicted the immediate and catastrophic decline of the Hugoton Field.

[3] Our federal and state government attempts at an ambitious energy policy in the 1970's largely failed. Since that time, it could be said that U.S. energy policy has largely been a non-policy that has been frozen by the law of "first do no harm".

Forecasting Prices

Supply disruptions, political actions or the crisis of the moment, not long-term fundamentals of energy markets, influence near-term price trends and political chatter. 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, US Department of Energy – Annual Energy Outlook 2003 early release http://www.eia.doe.gov/oiaf/aeo/index.html)

Short- Term – (All short-term forecasts are subject to rapid change and this discussion will probably be out-of-date and the crises history before the laser printer cools). Average crude oil prices fell by about $2.50 per barrel (BO) between October and November 2002 in response to continued high production levels from OPEC countries (Figure 1). However, by the end of November and into December oil prices had risen as concerns over the situations in Iraq and Venezuela pushed prices up. As a strike crippled petroleum exports from Venezuela refiners were forced to seek alternative supplies in order to ensure having enough crude oil to keep their refineries running in January and February. According to press reports, Venezuela's oil production has been has been cut by more than 90 percent by the strike. Production of less than 300,000 barrels per day is being maintained to provide basic services. The Western hemisphere's largest refining complex, PDVSA's 940,000 barrels per day Amuay-Cardon plant, has been virtually stopped by the strike, and CITGO, PDVSA's US refining and distribution subsidiary is having trouble locating crude supply. Prices have been further 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. West Texas Intermediate (WTI) front month (February) crude oil futures prices on the New York Mercantile Exchange (NYMEX) rose to a 23-month high and settled at $31.75 per barrel on Monday, December 23, up $1.45 per barrel from Friday's close. Futures prices are above $30 per BO through April 2003, and above $25 per BO through December 2003 (http://quotes.ino.com/exchanges/?c=energy). Based on futures prices, the forecast by the Energy Information Agency of the US Department of Energy (EIA) for average prices in 2003 of $25.83 per BO appear to be reasonable (Table 1 and Figure 1).

In December natural gas prices rose to above $5.00 per thousand cubic feet (mcf), and the average price for the year should be well above the $2.75 per mcf forecasted by the EIA-DOE (Table 1). Futures for 2003 on the New York Mercantile ($/mcf at Henry Hub) are running from $4.37 to $5.20 (http://quotes.ino.com/exchanges/?c=energy). On average, Henry Hub spot prices are 32 cents per thousand cubic feet (10.8 percent) 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 (Table1).

Medium and Long-Term – The Energy Information Agency (EIA) of the US Department of Energy provides prices forecasts through year 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) are projected to move higher 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 thousand cubic feet by 2020 and $3.90 per thousand cubic feet 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 (Figures 1 & 2). The majority of oil wells in Kansas average less than 15 BOPD and would be classified as stripper production. In 2001, approximately 36,885 wells in Kansas meet 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 1991 during the Gulf War the early 1990's were characterized by nominal price of oil averaging less than $20 per BO and as low as $8.10 per BO (12/1998). The periods of September 1996 to November 1996 and January 1999 to present (7/02) were periods where nominal oil prices increased and averaged above $20 per BO. As displayed in figure 1 and 2 there appears to be a very strong relationship of price to Kansas oil production rates. As the 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).

One can approach prediction of Kansas oil production from an exercise in simple-minded extrapolation (Figures 4 & 5). The standard methods such as exponential or hyperbolic provide a range of results. An exponential decline appears to follow production from 1990 until 1999, but seriously underestimates current production in Kansas (Figure 4). 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 diverging. Exponential extrapolation is the standard method used by conservative petroleum engineers and the "Hubbert-Curve" proponents[4]. This extrapolation form would "fit" the Kansas long-term production trend, but 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 percent (Figure 4). 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 and 2.35 and 2.1 million BO, respectively (Figure 4).

[4] 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.

However, if oil production rates in Kansas respond to price signals and prices are sufficient to attract investment and technology dollars the exponential decline will underestimate production. This situation is typical in very mature production settings or economically or technologically marginal resources[5].

Examples of the influence of price on marginal resources outside of Kansas include:

- heavy-oil production in California's San Joaquin Valley, which is now exceeding peak production rates established in the early part of the 20th century,
- heavy tar sands of Alberta, Canada, which requires technologies such as SAGD (Steam Assisted Gravity Drainage) that could not be developed and deployed until the recent robust oil prices, and
- expensive high technology required for production of the numerous giant oil and gas fields in the water depths in excess of 10,000 feet from the Gulf of Mexico and elsewhere in the world's oceans.

Another approach to extrapolation includes hyperbolic decline (Figure 5). 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 predictable external variables such as population). Reservoirs in the later stages of depletion and I would postulate very mature hydrocarbon provinces such as 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 5). 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.

[5]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.

An econometric approach to estimating future Kansas oil production rates is to evaluate the price elasticity of oil supply. Using the data of Figure 3 one can plot oil supply for the period 1990 through present as a function of constant dollar price (Figure 6). The result provides interesting estimates for the point elasticity of the Kansas supply function and insight into the nature of Kansas oil production. The data in Figure 6 plots in three major clusters with exclusion of the five-month price spike resulting from the Gulf War (9/90 – 1/91).

- Group1 – Low nominal prices (less than $20 per BO) and declining prices in constant dollars including the periods January 1990 through October 1995, and February 1997 through February 1999. Highlighted in red.
- Group 2 – Relatively high nominal prices (greater than $20 per BO) or increasing prices in constant dollars including the period from November 1995 through January 1997. Highlighted in olive.
- Group 3 – R Relatively high nominal prices (greater than $20 per BO) or increasing prices in constant dollars including the period from March 1999 through present (July 2002). Highlighted in bright green.

The instantaneous elasticity of the Kansas oil supply curve during periods of "poor" prices (Group 1) is an order of magnitude larger than the instantaneous elasticity of Kansas oil supply curve during periods of "good" prices (Groups 2 and 3). This asymmetry is interpreted as the result of the presence of "natural" reservoir depletion. When capital and technology investment is no longer economically viable, exponential production declines quickly reduce production rates. In contrast, when new capital and technology investment is economic the "natural" depletion remains. Given sufficient prices decline in Kansas production rates can be slowly mitigated and even enhanced (lagged supply curve). The supply elasticities for both periods of "good" prices are nearly identical (i.e., slopes are equal). However, the intercepts of the two curves vary by more than 800,000 BO per month. I would interpret this parallel shift in supply curves to represent the structural damage to the Kansas petroleum industry during the oilfield depression of 1997 through early 1999. The large-scale loss of producing wells, drilling and workover rigs, suppliers and technical personnel seriously damaged the Kansas petroleum industry. Our present petroleum industry responds to the same price signals, but it is very much smaller than in the early 1990's[6].

Predicting Kansas oil production in the future requires knowledge of future oil prices. Assuming that EIA oil price scenario is correct and price remains well above $20 per barrel (Table 1), Kansas production in 2007 is estimated using either a hyperbolic decline curve or price elasticities at well above 2.7 million barrels per month (Figures 5 and 6). 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

[6] This shift of supply curves between the early 1990's and the present, suggests that serious consideration should be given to policy, which protects our Kansas petroleum infrastructure from periods of extremely poor prices. The February 1999 price of $8.79 per BO was unprecedented and had a major long-term impact on the industry. Similar relatively short-term price fluctuations in the future could have serious detrimental impact on our petroleum industry infrastructure.

vicinity of 2.4 million barrels per month (Figure 4). 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, a single field dominates natural gas production in Kansas. The Hugoton Field is one of the largest natural gas fields in North America and the world. It produces almost 60 percent of our total annual natural gas production in the state. The field reached an initial peak in 1970. Following significant new capital investment and policy changes that permitted infill drilling and compression reached a second peak in 1996. Since 1996, the Hugoton field has been declining at an average annual rate of 8 percent. Kansas gas production dominated by the Hugoton has also declined a similar rate since 1996 (Figures 7 and 8).

Exponential depletion curve analysis and decline forecast for Kansas gas production rated indicates a decline rate of 7.10% per year from 1996 until 2001 (Figure 9). If this decline was extrapolated from 1996 until present (7/02) 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). 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 and 30.5 BCF per month, respectively (Figure 9).

Hyperbolic decline curve analysis and forecast for Kansas gas production indicates a slightly lower decline rate in recent time periods (Figure 10). If this decline was extrapolated from 1996 until present (7/02) 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 BCF per 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 and 36 BCF per month, respectively (Figure 10).

An econometric approach to estimating future Kansas gas production rates indicates that gas supply may be price inelastic (Figure 11). This would indicate that gas supply in Kansas is controlled by non-economic factors (e.g., geology and policy). However, a very weak and premature case can be made for the influence of price. If gas rates are beginning to respond to higher prices the decline in Kansas gas production may slow with the higher forecasted gas prices in the time period through 2007 (Table 1)[7].

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

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[7] There is evidence of increased activity in gas exploration and development in Kansas. For example, coalbed methane activity in eastern Kansas has accelerated and may become a significant new gas-producing province.

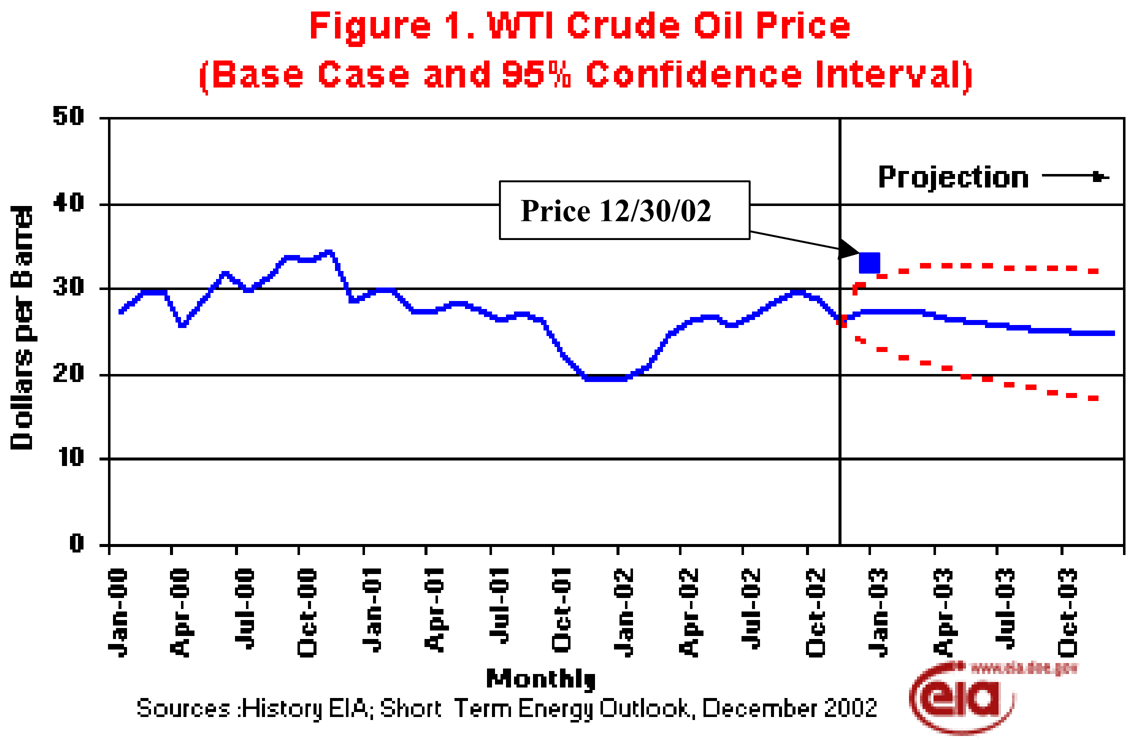

Figure 1 – Short-term forecast of posted price of benchmark West Texas Intermediate Crude in nominal dollars from the Energy Information Agency, US Department of Energy (EIA, Short-Term Energy Outlook – December 2002, http://www.eia.doe.gov/emeu/steo/pub/contents.html). Due to current political unrest, the current price for West Texas Intermediate (December 30, 2002) is above the top of the predicted range ($33.28 NYMEX – February Delivery).

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

Table 1 - Forecasted world prices of oil per barrel and natural gas per mcf in 2001 dollars from the Energy Information Agency, US Department of Energy (EIA, 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).

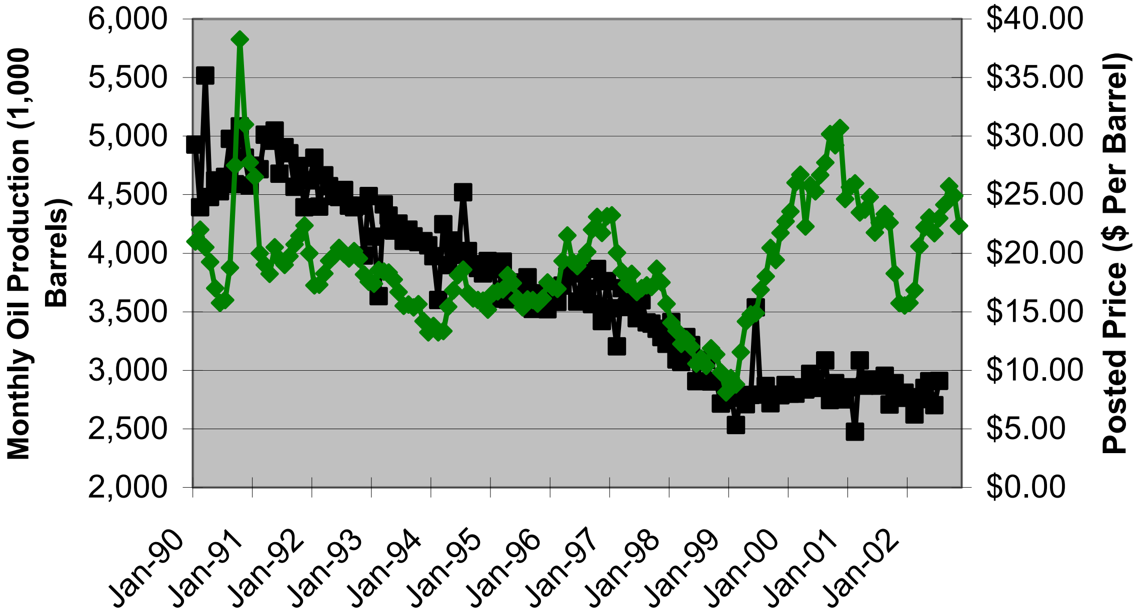

Figure 2 – Kansas monthly oil production and monthly posted price from January 1990 through current date (Production 7/02, price 11/02). Oil production is in thousand barrels per month and is obtained from online databases at the Kansas Geological Survey (http://www.kgs.ku.edu/PRS/petroDB.html). The production data are sales volumes reported to the Kansas Department of Revenue. Price in nominal dollars is the 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/). Note: As a result of additional late production updates to the Kansas Department of Revenue the current month's production is usually revised upwards.

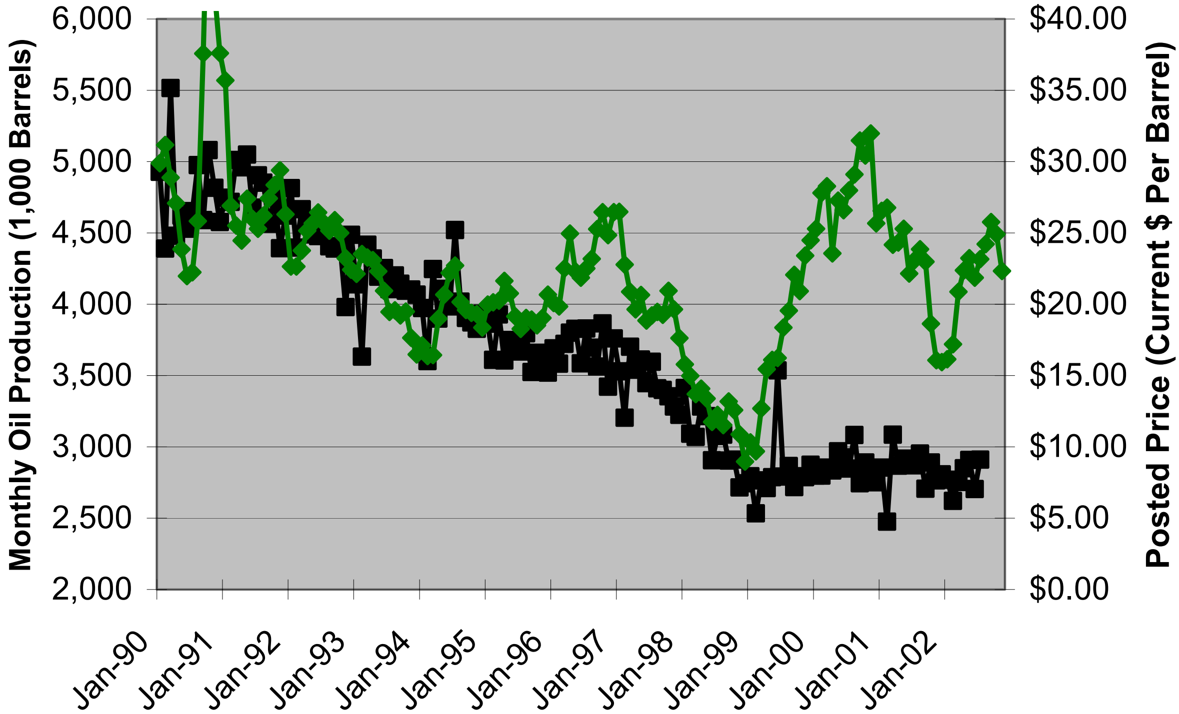

Figure 3 – Kansas monthly oil production and monthly posted price from January 1990 through current date (Production 7/02, price 11/02). Oil production is in thousand barrels per month and is from online databases at the Kansas Geological Survey (http://www.kgs.ku.edu/PRS/petroDB.html). The production 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 - 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.

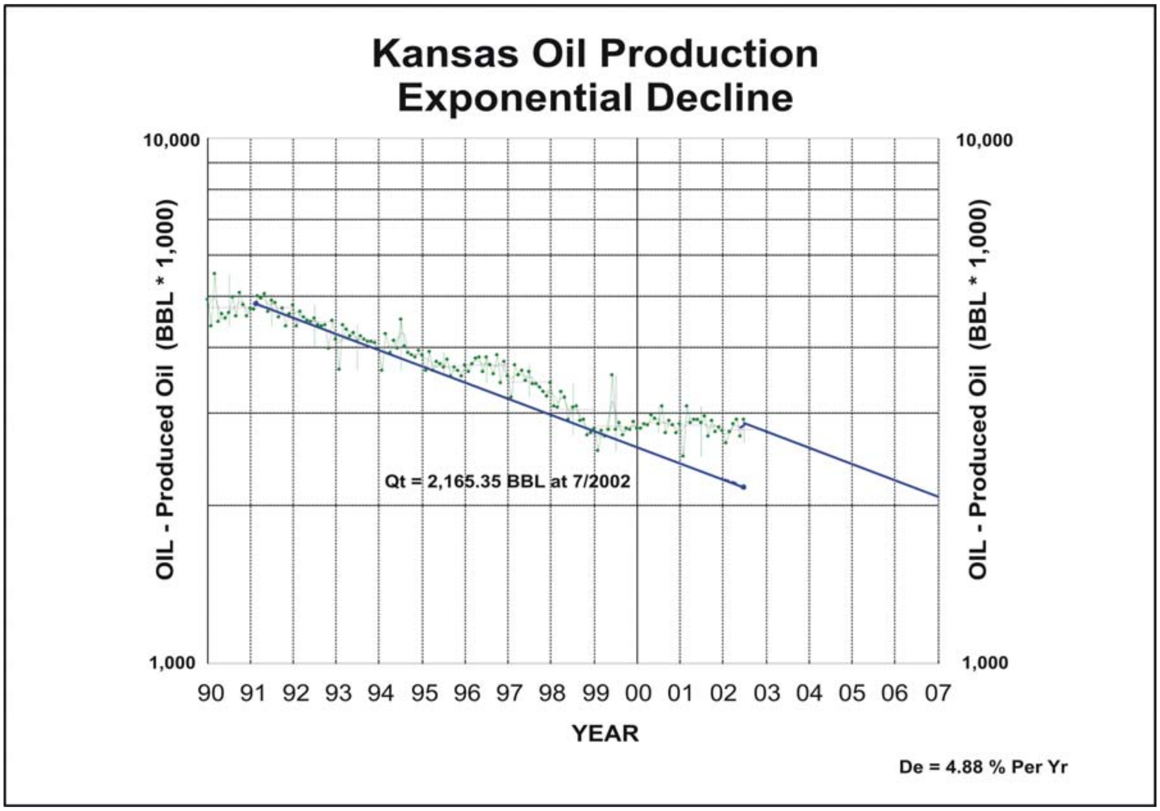

Figure 4 – Exponential decline analysis and forecast for Kansas oil production using a decline rate of 4.88% per year observed from 1991 until 1999. If this decline was extrapolated from 1999 until present (7/02) production would be estimated at 2.16 million barrels per month. Production in July 2002 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.

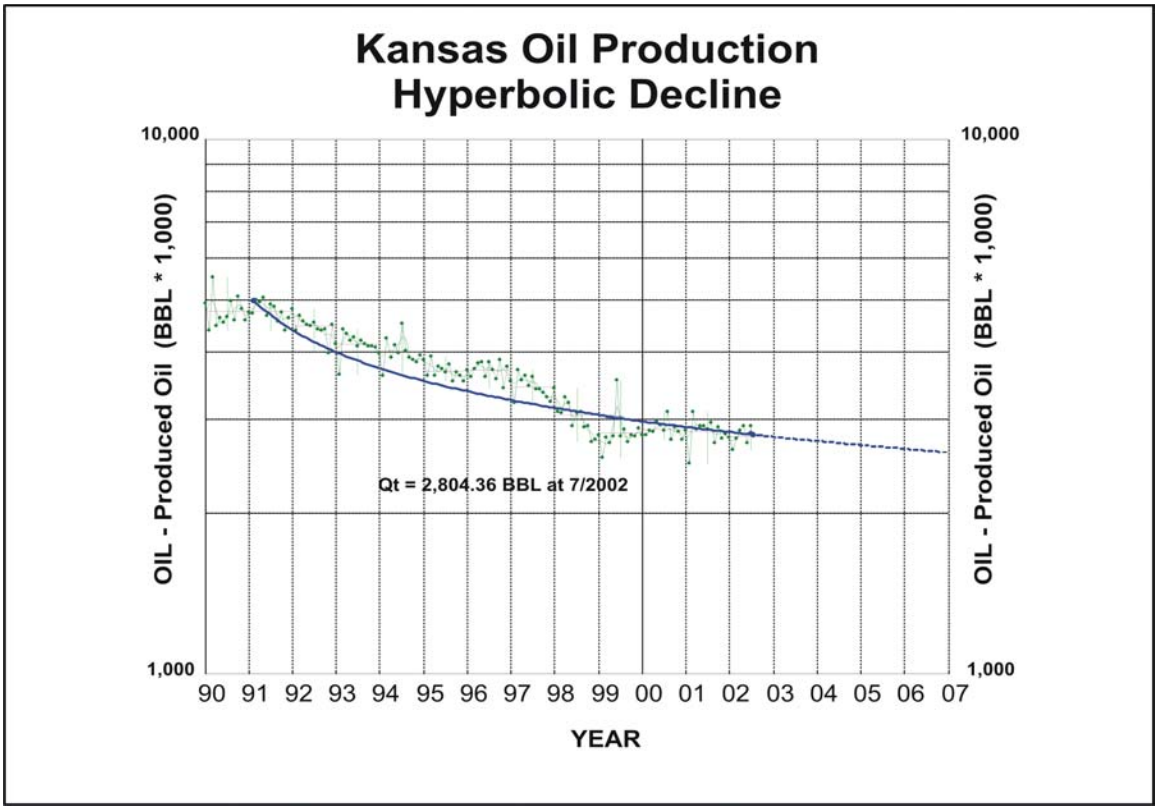

Figure 5 – Hyperbolic decline analysis and forecast for Kansas oil production. If this decline was extrapolated from 1999 until present (7/02) production would be estimated at 2.8 million barrels per month. Production in July 2002 was reported at 2.91 million barrels (subject to upward revision). Hyperbolic 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.

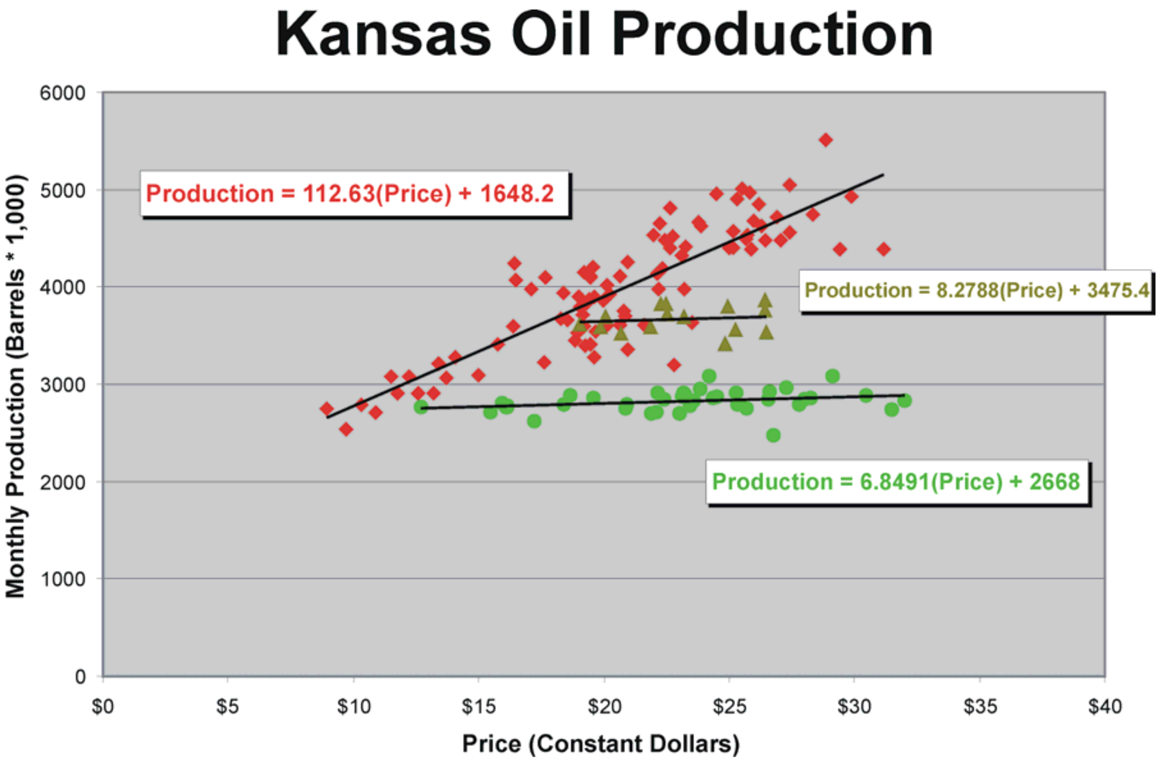

Figure 6 –The price elasticity of Kansas oil production is shown using the monthly production and constant dollar price data (Figure 3). Data plots in three major clusters. **Group1 –** Low nominal prices (less than $20 per BO) and declining prices in constant dollars includes the periods January 1990 through October 1995 and February 1997 through February 1999 (Highlighted in red). **Group 2** – Relatively high nominal prices (greater than $20 per BO) or increasing prices in constant dollars includes the period from November 1995 through January 1997 (Highlighted in olive). **Group 3 –** Relatively high nominal prices (greater than $20 per BO) or increasing prices in constant dollars includes the period from March 1999 through present (Highlighted in bright green). Using the supply curve for Group 3 and the EIA price forecast of constant dollar prices of $23 to $25 per BO for 2003 through 2007 (Table 1), monthly Kansas oil production during the immediate future is estimated at 2.8 million BO.

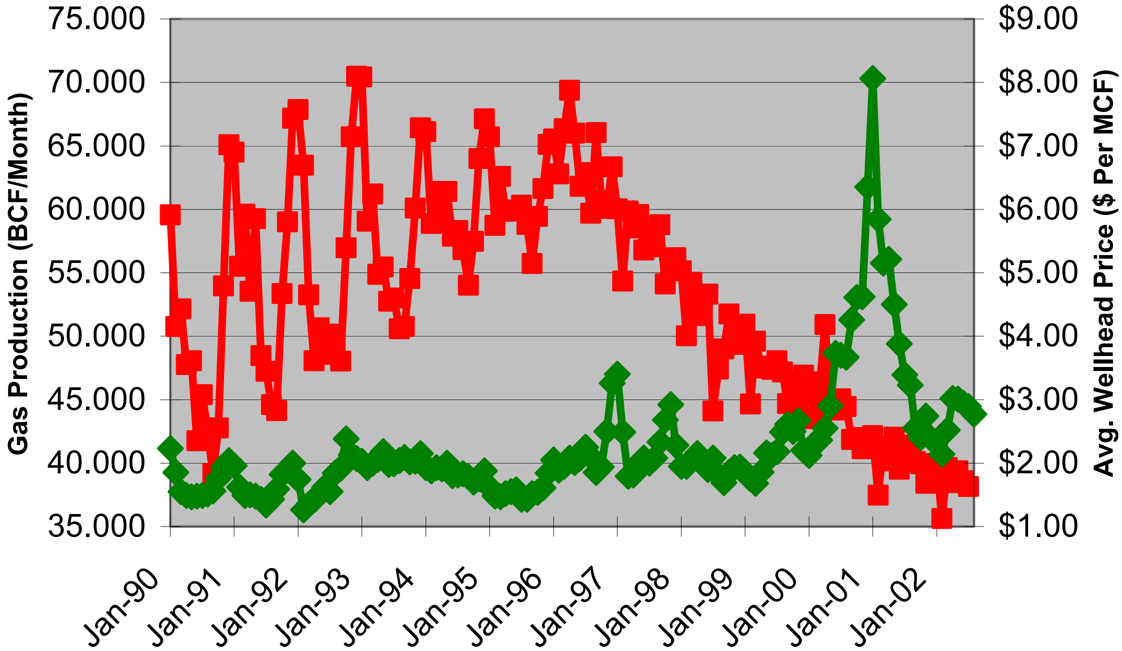

Figure 7 – Kansas monthly gas production and monthly posted price from January 1990 through current date (Production 7/02, price 11/02). Gas production is in billion cubic feet per month and is obtained from online databases at the Kansas Geological Survey (http://www.kgs.ku.edu/PRS/petroDB.html). The production data are sales volumes reported to the Kansas Department of Revenue. Price in nominal dollars is the 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). Note: As a result of additional late production updates to the Kansas Department of Revenue the current month's production is usually revised upwards.

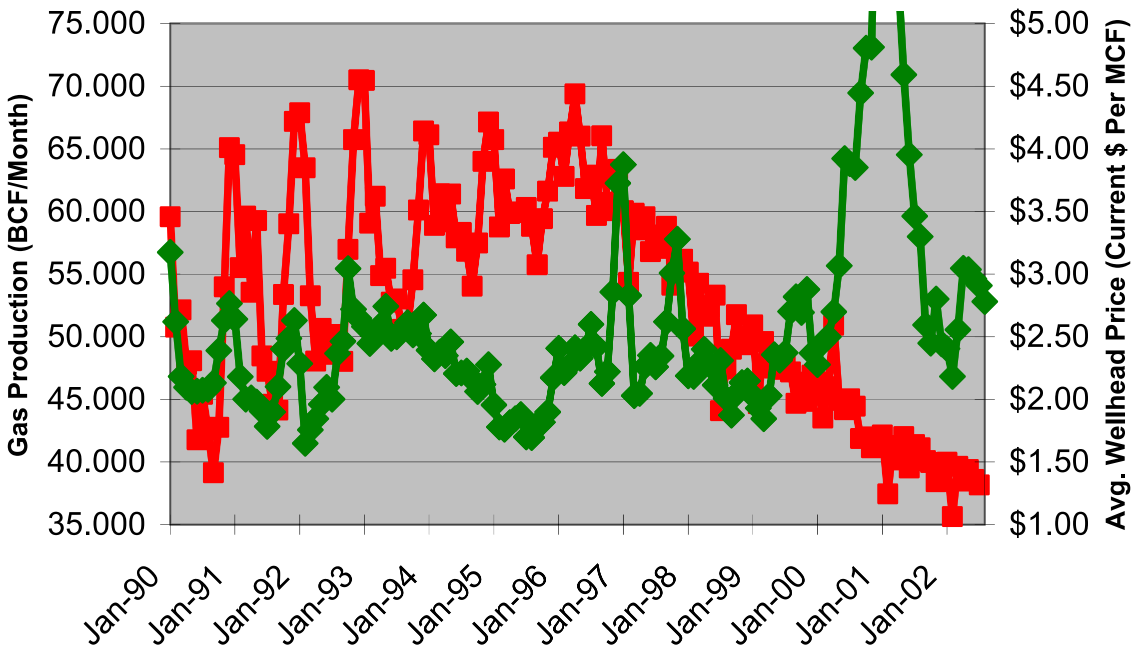

Figure 8 – Kansas monthly gas production and monthly posted price from January 1990 through current date (Production 7/02, price 11/02). Gas production is in billion cubic feet per month and is obtained from online databases at the Kansas Geological Survey (http://www.kgs.ku.edu/PRS/petroDB.html). The 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.

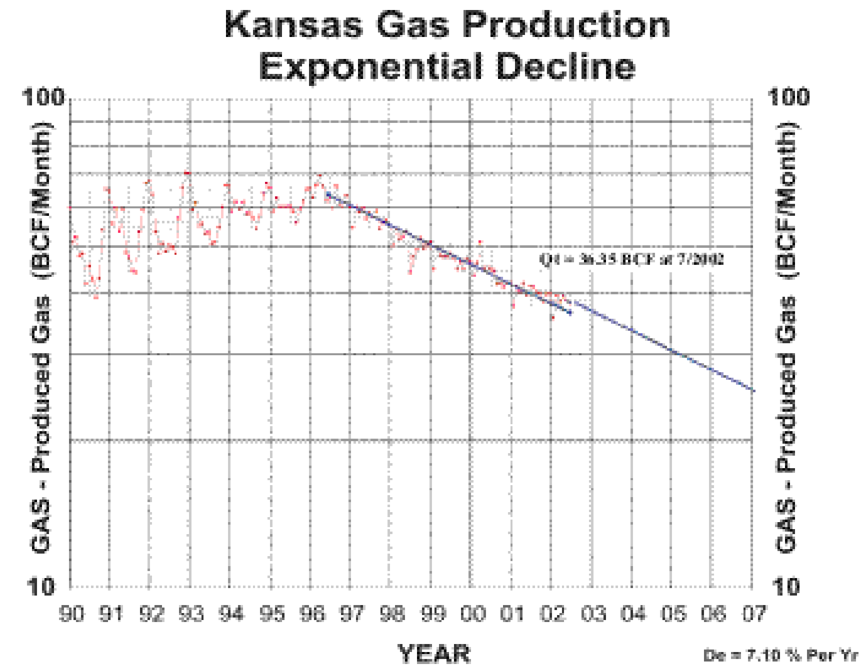

Figure 9 – Exponential curve analysis and decline forecast for Kansas gas production using a decline rate of 7.10% per year observed from 1996 until 2001. If this decline was extrapolated from 1996 until present (7/02) production would be estimated at 36.35 billion cubic feet (BCF) per month. Production in July 2002 was reported at 38.15 BCF per month (subject to upward revision). Simple exponential extrapolation underestimates current production rates by a small amount (2 BCF per month). Extrapolating from current production rates 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 and 30.5 BCF per month, respectively. Bars show the range and average annual production.

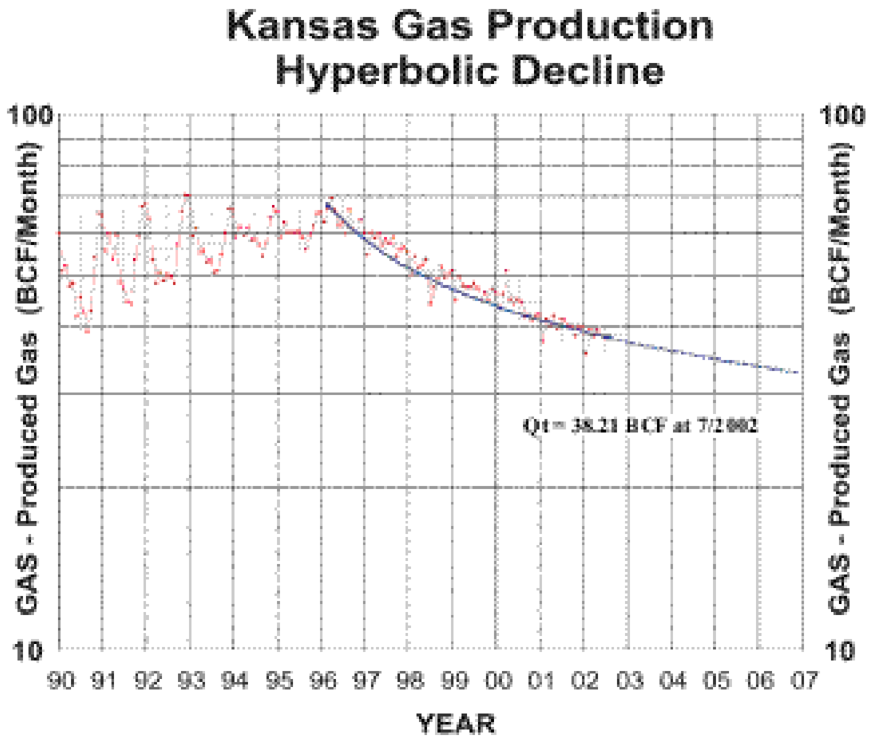

Figure 10 – Hyperbolic decline analysis and forecast for Kansas gas production. If this decline was extrapolated from 1996 until present (7/02) production would be estimated at 38.21 billion cubic feet (BCF) per month. Production in July 2002 was reported at 38.15 BCF per month (subject to upward revision). Hyperbolic extrapolation slightly overestimated current production rates by approximately 0.06 BCF per month. Extrapolating the curve would result in estimated gas production of 32 BCF per month at the end of 2007. Production in 2003 and 2005 would be estimated at 37.5 and 36 BCF per month, respectively. Bars show the range and average annual production.

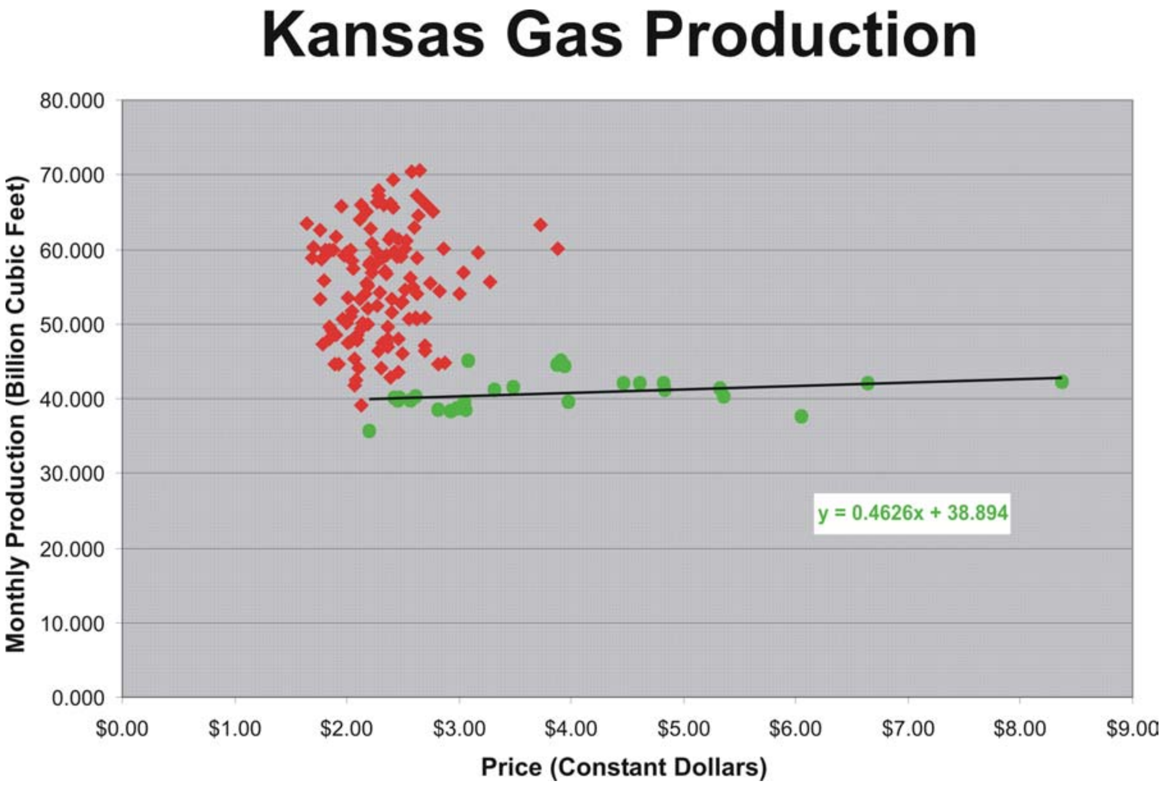

Figure 11 –The price elasticity of Kansas gas production is evaluated using the monthly production and constant dollar price data (Figure 8). Data plots in two major clusters. **Group1 –** Stable low nominal prices (averaging $2.00 or less per mcf) includes the period January 1990 through April 2000 (Highlighted in red). **Group 2 –** Persistent high nominal prices (greater than $2.00 per mcf) May 2000 through present (Highlighted in bright green). The slope of the Group 2 supply curve is very low and if prices were in the historical range of $2.00 per mcf, Group 2 data points would project into lower part of the Group 1 cluster. This would indicate that gas supply in Kansas is inelastic to price and controlled by non-economic factors (e.g., geology and policy). However, a very weak and premature case can be made for the influence of price. If correct, the decline in Kansas gas production may slow with the higher forecasted gas prices (Table 1).