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July 1, 1996

HAND DELIVERY

Ms. Blanca S. Bayo, Director
Division of Records and Reporting
Florida Public Service Commission
2540 Shumard Oak Boulevard
Tallahassee, FL 32399-0850

Re: Prudency Review to Determine Regulatory Treatment of Tampa Electric Company's Polk Unit; FPSC Docket No. 960409-EI

Dear Ms. Bayo:

Enclosed for filing in the above docket on behalf of Tampa Electric Company are fifteen (15) copies of each of the following:

1. Rebuttal Testimony of John R. Rowe, Jr. 07017-96
2. Rebuttal Testimony and Exhibits of Hugh W. Smith. 07018-96
3. Rebuttal Testimony and Exhibits of Stephen L. Thumb. 07019-96
4. Rebuttal Testimony and Exhibits of Thomas L. Hernandez. 07021-96
5. Rebuttal Testimony and Exhibits of Charles R. Black. 07020-96

Please acknowledge receipt and filing of the above by stamping the duplicate copy of this letter and returning same to this writer.

Thank you for your assistance in connection with this matter.

Sincerely,

James D. Beasley

JDB/pp
Enclosures

cc: All Parties of Record (w/encls.)

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BEFORE THE

FLORIDA PUBLIC SERVICE COMMISSION

)
) DOCKET NO. 960409 - EI
)

REBUTTAL TESTIMONY

OF

STEPHEN L. THUMB

ON BEHALF OF

TAMPA ELECTRIC COMPANY

JULY 1, 1996

BEFORE THE

FLORIDA PUBLIC SERVICE COMMISSION

)
) DOCKET NO. 960409 - EI
)

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I. QUALIFICATIONS

Q. PLEASE STATE YOUR NAME AND ADDRESS.

A. My name is Stephen L. Thumb. My business address is 1901 North Moore Street, Suite 1200, Arlington, Virginia 22209.

Q. PLEASE STATE THE NAME OF YOUR EMPLOYER AND IN WHAT CAPACITY YOU ARE EMPLOYED.

A. My employer is Energy Ventures Analysis, Inc. ("EVA"). I am a principal with EVA.

Q. WHAT TYPE OF FIRM IS EVA?

A. EVA is a consulting firm which engages in a variety of projects for private and public sector clients. These consulting projects are related to energy and environmental issues. In the energy area, much of our work is related to analysis of the electric utility industry and fuel markets, particularly oil, natural gas and coal. Our clients in these areas include coal, oil, and natural gas producers, electric utility and industrial energy consumers, and gas pipelines and railroads. We also work for a number of public agencies, such as state regulatory commissions, the United States Environmental Protection Agency, and the United States Department of Energy, as well as intervenors in utility rate proceedings, such as consumer counsels and municipalities. Another group of clients include trade and industry associations, such as the Electric Power Research Institute, the Gas Research Institute and the Center for Energy and Economic Development. The firm has provided testimony to nine state public utility commissions, including Florida. Furthermore, the firm has filed testimony in a number of cases in both state and Federal courts, as well as before the Federal Energy Regulatory Commission. My resume is Document 1 of my Exhibit (SLT-1).

Q. PLEASE DESCRIBE YOUR EDUCATIONAL AND BUSINESS BACKGROUND.

A. I received a Bachelor of Science degree in chemical engineering from Northwestern

University and a Masters Degree in Business Administration (concentration in Finance). In addition, I was qualified as a Certified Public Accountant in the state of West Virginia. Prior to joining EVA I spent 15 years in the oil and gas industry working for Ashland Oil, Burlington Northern and Meridian Oil. I am currently a principal at EVA responsible for the firm's oil and gas practice. This work includes a wide range of assignments for a variety of clients, including electric utilities. I have either authored or coauthored ten reports for the Electric Power Research Institute and/or the Gas Research Institute on a variety of topics concerning fossil fuels.

II. PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. EVA was hired by Tampa Electric to provide a broad overview of the fundamentals of supply and demand for natural gas and coal. As part of this effort, EVA will respond to Mr. Breman's assertion that there is a historical differential between coal and gas prices and this differential can be extrapolated to predict future price differentials, as well as comment on the current competitive situation between natural gas and coal.

Q. HAVE YOU PREPARED ON EXHIBIT IN SUPPORT OF YOUR TESTIMONY?

A. Yes. I have prepared an exhibit titled Rebuttal Exhibit of Stephen L. Thumb (SLT-1) which consists of 11 documents prepared under my direction and supervision.

Q. PLEASE OUTLINE THE MAJOR POINTS IN YOUR TESTIMONY.

A. There are four key points I will address in my testimony.

(1) Fundamentals of Coal and Natural Gas.

There are significant differences in the fundamentals of supply and demand for coal and natural gas and this is the major reason that the prices for these two fuels move independently of each other and are not linked. From a demand perspective, the largest portion of demand for each fuel is derived from entirely different categories of customers (electric utility for coal and residential, commercial, and industrial for gas). From a supply perspective the cost structure for the two fuels is radically different. Also, natural gas has been in a period of excess deliverability (i.e., up to 50 percent excess) and this has forced the industry to reduce drilling and use half cycle costs (i.e., excluding exploration costs) to price its product. Now that this excess deliverability has declined, there has been a long-term fundamental shift in the pricing of natural gas and a significant divergence between gas and coal prices has emerged.

There have been a number of recent changes in gas supply trends (e.g., unconventional gas, Canadian imports and Gulf of Mexico production), which have significantly impacted natural gas prices. Forecasting the exact timing of the net impact of all of these supply trends has been very challenging. In the recent past this subject has been so complex and dynamic that earlier or later projections of these changes in gas supply trends and their impact on gas prices would have to be considered reasonable by most industry observers.

(2) Mr. Breman's Analysis.

Mr. Breman's analysis is badly flawed. He has ignored significant events that have occurred in 1996. He has used a smoothing technique that would allow anyone to correlate data for totally unrelated items and develop an apparent constant differential (i.e., examples between coal prices and cattle prices, gold prices, and cooling degree days are provided). In addition, he has, perhaps unknowingly, focused on a period that was dominated by excess deliverability for natural gas and a series of warmer than normal winters, which has suppressed gas prices.

(3) Lack of Empirical Evidence.

Empirical evidence of historical coal and natural gas prices illustrate that there is no linkage between coal and gas prices.

(4) Coal and Gas Competition.

Coal and gas do not compete on a daily dispatch basis. With the exception of one minuscule anomalous event over the last 10 years, there has been no economic fuel switching between coal and gas. Absent a major breakthrough in technology in the future, coal and gas are, for at all practical purposes, the only alternatives for new capacity in the power generation industry and will compete, though not strictly on a price basis, for new capacity decisions.

III. ANALYSIS OF THE FUNDAMENTALS OF NATURAL GAS AND COAL MARKETS

A. BROAD OVERVIEW

Q. ARE THERE FUNDAMENTAL DIFFERENCES IN THE MARKETS FOR NATURAL GAS AND COAL THAT CAUSE THEIR RESPECTIVE PRICES TO MOVE INDEPENDENTLY OF EACH OTHER?

A. Yes. There are very distinct structural differences in the supply and demand for coal and natural gas. These differences in basic fundamentals result in different price determinants for each fuel, which causes the prices of these two fuels to move independently of each other and not be linked. The net result is the price behavior of each fuel is different. There are also other factors that contribute to the differences in price behavior for the two fuels and these include differences in contractual practices and in the case of natural gas, the recent transition of the gas industry.

Q. WHAT ARE THE STRUCTURAL DIFFERENCES IN DEMAND FOR THESE TWO FUELS?

A. As illustrated in my Document 2, domestic coal consumption is approximately 14 percent greater than domestic consumption of natural gas. However, the biggest difference is that majority of demand for each fuel comes from different categories of consumers, which results in the demand determinants of price for each fuel being distinctly different. For coal the dominant share (i.e., approximately 87 percent) of demand occurs from the electric utility sector. For natural gas only 16 percent of demand is derived from the electric utility sector. The remaining 84 percent of natural gas demand comes from the residential, commercial and industrial sectors, which are the major drivers of natural gas demand.

In the case of natural gas, fluctuations in natural gas demand in the residential and commercial sectors can have a significant impact on the annual prices for natural gas.

For example, the difference between peak monthly winter gas consumption and average summer gas consumption for the residential sector is a factor of seven or more. For the commercial sector the difference can be a factor of four. This is a critical factor in that when warmer than normal winter weather occurs, demand is suppressed. This results in excess storage levels, which tend to suppress gas prices throughout a major portion of the year. On the other hand, when colder than normal weather occurs, there is upward pressure on prices. No such comparable phenomenon exists for coal prices, and any fluctuation in coal prices associated with variations from normal weather patterns is relatively minor.

For the particular period presented in Mr. Breman's Exhibit JEB-2 nine of the last 11 winters have been warmer than normal with some years recording 7 to 12 percent warmer than normal winter weather, which is significantly warmer than normal. This along with other factors has served to suppress gas prices during this period.

Q. WHAT ARE THE STRUCTURAL DIFFERENCES IN SUPPLY FOR THESE TWO FUELS?

A. There are several key differences in supply characteristics of the two fuels.

- First, natural gas is basically a fungible commodity, or fuel, whereas coal is not. Due to differences in sulphur content, ash content and grind, among others, different types of coal are not interchangeable. From a supply perspective this leads to a number of submarkets for coal that do not exist for natural gas.
- Secondly, the basic cost structure for developing coal and gas reserves is very different. In most instances, developing coal reserves is a very labor intensive process, whereas developing gas reserves is a very capital intensive process with relatively little labor costs.
- Thirdly, there is considerable exploration risk associated with finding natural gas reserves, whereas there is almost none associated with coal. A significant percentage of the U.S. coal reserves have been mapped and about 474 billion tons are recognized as the "U.S. Demonstrated Reserve Base". This equates to

265 years of production at current consumption levels. On the other hand there is less than nine years of lower-48 natural gas production at present consumption levels. Thus, exploring for new gas reserves, which includes dry hole costs, is a major part of the cost structure of natural gas, but not for coal.

Q. WHAT IS THE IMPACT OF THESE THREE FACTORS?

A. The combination of these factors results in very different supply determinants of price for each of these two fuels and is a major reason that all leading industry analysts foresee a divergence in the price of these two fuels.

Q. OVER THE LAST 10 YEARS THE NATURAL GAS INDUSTRY HAS UNDERGONE A TRANSITION FROM A REGULATED INDUSTRY TO A LARGELY DEREGULATED INDUSTRY. HOW HAS THIS IMPACTED NATURAL GAS PRICES?

A. One of the key developments in this 10 year transitional period was the emergence of the gas bubble, or more technically, excess deliverablility. The emergence of the gas bubble, which was huge, was the result of the significant structural changes that occurred in the industry, when the gas industry was forced to make the transition from a bundled, regulated industry to an unbundled deregulated industry. While some excess deliverability may exist from time to time, it is highly unlikely that any excess of this magnitude will ever occur again. As a result, the gas bubble represents a one time, but very significant, event in the history of the gas industry.

My Document 3 uses Energy Information Administration (EIA) data to graphically depict the gas bubble. During the mid-1980s excess gas deliverability was approximately 25 BCF/D or 50 percent more than the demand for domestic production. This excess deliverability, as a result of a decline in drilling for gas, has gradually declined during the last 10 years. It is currently estimated (i.e., 1996) that excess deliverability is below 5 BCF/D. As a practical matter it will never get to zero as some excess wellhead deliverability is required to maintain the overall system in balance. As a result, after 10 years the industry is just entering a period without any significant excess deliverability and this will have significant impact on natural gas prices.

During this period of excess deliverability, or supply, gas prices in general were suppressed as the excess supply was reduced. As noted by Energy, Mines and Resources Canada[1], industry exploration and production companies during this period were pricing gas supplies based upon half cycle (i.e., excluding exploration cost) rather than full cycle costs, which include both exploration and development costs. This came about because a significant portion of the industry relied heavily upon incremental development of existing reserves, which avoided any exploration costs.

However, over the long-term the industry will have to once again resort to full cycle costs in order to find and develop new reserves. This transition from a half cycle cost structure to a full cycle one will place upward pressure on gas prices. No comparable phenomenon exists for the coal industry.

Q. HAVE PROJECTIONS FOR THE END OF THE GAS BUBBLE CHANGED OVER TIME?

A. Yes. There have been different views by several reasonable forecasters of when the current excess deliverability of domestic gas supply would end. This has been a very difficult element of U.S. gas supply to predict. Part of the reason for this difference in views has been changes, or revisions, in basic data concerning domestic excess deliverability, which is published by the EIA. My Document 3 illustrates the current EIA data concerning domestic excess deliverability. The prior issue of this data by EIA noted a much sharper decline in excess deliverability, as shown in my Document 4. This led many forecasters to project an earlier decline of the gas bubble, which would result in projected gas supply and demand coming into balance earlier and an earlier increase in projected natural gas prices.

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[1]See Energy, Mines and Resources Canada, "An Analysis of North American Natural Gas Supply Trends: A Canadian Perspective" (July 1993).

Q. HOW ARE THE CONTRACTUAL PRACTICES DIFFERENT FOR COAL AND NATURAL GAS?

A. The contractual practices for gas supply are very different from those used to procure coal supplies. For the most part (i.e., approximately 90 percent) of natural gas supplies are purchased on a daily, weekly or monthly index basis for one year or less. Whereas, a significant amount of coal is purchased under a long-term contract (i.e., multiple year contract) for a specific type of coal. Pricing terms for these coal contracts are, in general, for fixed prices, which are escalated to some degree over time.

B. <u>RECENT CHANGES IN NATURAL GAS SUPPLY</u>

Q. IS THERE A REASON FOR THE DIFFERENCE BETWEEN RECENT GAS PRICES AND LONGER TERM PROJECTIONS FOR THESE GAS PRICES?

A. Yes. Several industry observers have been frustrated by the difference between the recent period of relatively low gas prices and numerous projections that longer term gas prices will be higher. The number one cause for this dilemma has been the difficulty in projecting natural gas supply on an annual basis. While changes in natural gas supply trends can be identified, it is very difficult to specify the exact year in which these changes will occur. This dilemma of specifying the timing of such changes for such a dynamic and complex subject has been exacerbated by a series of years with unusually warm winter weather, which suppressed demand and extended the period of excess supply. Another factor that has exacerbated the task of forecasting the precise timing of such changes is tax legislation that has artificially stimulated production.

Q. HAS DOMESTIC NATURAL GAS PRODUCTION BEEN DECLINING?

A. No. Domestic gas production has increased slightly over the last 10 years (i.e., at about 1.3 percent/year), however domestic production capability or capacity, has declined sharply because of the limited amount of gas drilling in the recent past (as a point of reference U.S. gas demand has increased 2.3 percent/year over this period). This decline in domestic production capacity has been in almost every single producing area, as illustrated in my Document 5. The single significant exception has been the development of unconventional gas supplies (i.e., coal-seam, tight sands and shales), which has been artificially stimulated by the Section 29 tax credit, which ranged from $0.50 to over $1.00 per MMBTU, and represents the only type of supply that has grown during the recent period of relatively low gas prices. The Section 29 tax credit was repealed for new wells at the end of 1992. The elimination of this artificially stimulated development of gas supplies represents a major change for gas supply trends.

Q. IS THERE ANY PARTICULAR AREA WHERE THE DECLINE IN U.S. PRODUCTION CAPACITY WAS OF CONCERN TO FORECASTERS?

A. Yes, the Gulf of Mexico. The Gulf of Mexico is the largest producing region in the U.S. and represents 26 percent of U.S. production. Any decline in production in the Gulf represents a significant change in the overall U.S. supply picture and would be an indicator for most forecasters that a period of higher prices would begin.

By the end of 1992, not only had Gulf production capability declined, but actual Gulf production had declined for two consecutive years. Furthermore, Gulf well completions had been in a steady decline since the mid-1980s and Gulf rig count declined to within one rig of the all time low since World War II. Also, proven Gulf reserves were about 20 percent below 1985 levels and had undergone a seven year period of steady decline (see Document 6).

In the early 1990's, most industry observers were genuinely concerned about a declining trend in domestic gas supplies, absent a change in gas prices, and as a consequence were predicting gas prices to rise and the differential between coal and gas prices to increase. Since that time, both gas prices and activity in the Gulf has improved.

Q. IF CONVENTIONAL U.S. PRODUCTION CAPACITY WAS DECLINING, HOW WERE INCREASES IN U.S. DEMAND BEING MET?

A. The incremental increase in U.S. gas demand during the period from 1989 to 1994 was approximately 2 TCF. Approximately 60 percent of the increase in production to meet this incremental increase in demand came from increased Canadian imports. Another 37 percent was met by the increase in production for the tax driven unconventional coal-seam gas with the remaining approximately three percent met by increases in conventional U.S. gas production (see Document 7).

Q. WILL FUTURE INCREASES IN DOMESTIC DEMAND OVER THE NEXT SEVERAL YEARS BE MET IN THE SAME MANNER?

A. No. There have been some dramatic changes in the U.S. gas supply in the recent past, which will result in some significant shifts in the way in which production increases occur to meet incremental increases in demand. Importantly, these changes in supply trends will likely place upward pressure on gas prices and result in an increase in the differential between coal and gas prices.

These changes in supply trends started to become apparent in 1995 and have become more evident in 1996. For example, since for all practical purposes Section 29 tax credit induced drilling for unconventional coal-seam gas has ended, no further increases in coal-seam gas are anticipated. In fact some production declines of unconventional gas may occur. In addition, Canadian imports have reached a plateau in that these imports have almost reached the maximum potential of existing pipeline capacity and there are no significant expansions planned for the next couple of years. As a result, further increases of Canadian imports over the next several years will be very small. As a result of these two factors there will be a greater reliance on conventional U.S. production to meet future demand increases than at any time since the start of the spot market for natural gas (i.e., approximately the last 10 years). Document 7 provides an illustration of this phenomenon over the next several years.

As has been exhibited thus far in 1996, this tightening of supply and demand will place upward pressure on gas prices, in order to stimulate additional drilling since the gas bubble for Eastern markets has ended for all practical purposes. Industry experience over the recent past is that the relatively low gas prices over the last several years are inadequate to stimulate enough drilling to either maintain or increase supplies, absent the existence of excess deliverability. In the future the industry will constantly have to drill for more gas supplies in order to both replace annual declines in gas deliverability due to reserve depletion and to meet increases in the demand for natural gas.

Q. WHAT IS THE NET IMPACT ON GAS PRICES AS A RESULT OF THESE FUNDAMENTAL CHANGES IN GAS SUPPLY TRENDS?

A. The combined impact of (1) the elimination of the gas bubble for Eastern markets, (2) the elimination of the artificially stimulated tax driven drilling for unconventional gas, (3) the sharp reduction in the rate of growth in Canadian imports and (4) the return of the industry to full cycle costs from half cycle costs, among others, has placed upward pressure on gas prices, such that the industry expects long-term increases in gas prices from 1995 levels.

Q. WOULD IT HAVE BEEN REASONABLE TO PREDICT THAT THESE CHANGES IN GAS SUPPLY TRENDS WOULD HAVE OCCURRED EARLIER OR LATER THAN THEY DID?

A. Yes. Forecasting natural gas supply trends is a very complex and dynamic subject, involving a number of imponderables. One of these imponderables is weather. Most forecasts assume the occurrence of normal weather conditions. Yet three of the last five years have been significantly warmer than normal, which has suppressed demand and delayed the decline of the gas bubble, or the reduction of excess deliverability. Additional warmer than normal weather would have delayed some of the changes in gas supply trends, while the occurrence of colder than normal weather during the 1990 through 1995 period would have accelerated them. This acceleration would have resulted in an earlier rise in gas prices and divergence between coal and gas prices. Also, there have been revisions in basic data that impacted projecting the timing of when these changes in gas supply trends would occur. For example, the 1994 EIA data on the amount of excess deliverability in the U.S. was revised upward in 1995. This resulted in forecasts for the duration of the gas bubble to be extended, which had a significant impact on projecting natural gas supply trends.

In addition, changes in legislation have impacted the timing of these changes in gas supply trends. For example, in the early 1990s it was difficult to predict the two year extension of the Section 29 tax credit, which significantly stimulated the production of unconventional gas. Not including such an extension in a forecast would have accelerated some of the changes in gas supply trends and the eventual rise in gas prices. Similarly, once the Section 29 tax credits had been extended, it would not have been unreasonable to include in a forecast further extensions of these tax credits, which artificially stimulate production. This would have delayed some of the changes in the gas supply trends and the subsequent rise in gas prices.

Forecasting the exact timing of the combination of these events is very challenging, even when the impact of the individual events or trends is foreseeable, As a result it has been reasonable for historical forecasts to disagree on timing of projected gas price increases.

IV. CRITIQUE OF MR. BREMAN'S HISTORICAL DIFFERENTIAL BETWEEN NATURAL GAS AND COAL PRICES

Q. WHAT ARE YOUR CONCLUSIONS FROM YOUR REVIEW OF MR. BREMAN'S TESTIMONY?

A. Mr. Breman's testimony asserts that there is a linkage between coal and gas prices. This assertion is flawed from two perspectives. There is empirical data that shows that Mr. Breman's analysis of a constant differential between coal and gas is incorrect. In addition, a review of the fundamentals of supply and demand for both fuels clearly indicates that prices between the two fuels are not linked and that they move independently. Lastly, the data smoothing technique used by Mr. Breman is invalid for correlating relationships between fuel prices.

Q. IS THE ANALYSIS PRESENTED IN MR. BREMAN'S EXHIBIT JEB-2 CORRECT?

A. No, the analysis presented in this exhibit is flawed from several perspectives. Despite the fact that Mr. Breman's testimony was filed in June 1996, Mr. Breman choose not to include any price data for 1996. This is a significant omission as there have been some fundamental changes in the natural gas market, which I discussed earlier in my testimony. For the first six months of 1996 natural gas prices delivered to Florida were approximately 60 percent above 1995 prices for the equivalent period.

Q. HOW WOULD INCLUDING THIS ADDITIONAL DATA AFFECT MR. BREMAN'S ANALYSIS?

A. First, let me note that Mr. Breman's methodology is badly flawed, as I will illustrate later in my testimony. My Document 8 illustrates the seriousness of this omission of recent data. I have redone in Document 8 Mr. Breman's analysis contained in his Exhibit JEB-2 to include data for 1996 and the current NYMEX gas prices for 1997, which is the best indication of the current price for which 1997 gas supplies can be purchased. I have included the NYMEX prices because they are reflective of some important fundamental changes in the natural gas market. The addition of this information results in the differential between coal and gas prices, according to Mr. Breman's methodology, increasing from $0.51 per MMBTU in 1995 to $0.61 per MMBTU in 1996 and $0.64 per MMBTU in 1997. Even though Mr. Breman's methodology is badly flawed, his approach indicates an increasing divergence between coal and gas prices over time.

Q. DO YOU HAVE ANY OTHER COMMENTS ON MR. BREMAN'S ANALYSIS?

A. Yes, I have two additional comments. Mr. Breman's use of FERC 423 data for an analysis of the differential between the market prices for natural gas and coal is flawed. Mr. Hugh Smith's testimony addresses the limitations of using the FERC 423 data for coal and gas prices and I concur with Mr. Smith's observations.

Q. WHAT IS YOUR OTHER COMMENT ON MR. BREMAN'S ANALYSIS?

A. In his analysis, Mr. Breman used a smoothing technique which is invalid for correlating fuel prices. This data smoothing technique, which uses the difference of the cumulative average prices for the two fuels from the start point of the data series,[2] places an enormous weight on prior period prices, which will mask any fundamental change in the price of either fuel.

Mr. Breman's smoothing technique can be used to develop a constant differential for a variety of unrelated data sets. In Documents 9 and 10 Mr. Breman's technique has been used to develop a near constant differential between: (a) coal prices and cooling degree days, (b) coal prices and cattle prices and (c) coal prices and gold prices. EVA does not advocate any of these as a forecasting model.

To further illustrate the severe impact of this technique in Document 11, I have

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[2]For example, the 1995 price differential shown is the difference between the 1986 to 1995 average coal and natural gas price. Similarly, the 1994 price differential uses average prices from 1984 to 1994, and so on until the 1987 price differential used the average of just two years of data.

recalculated the price differentials using a rolling two year average and also using simple annual difference in the fuel prices, which is more indicative of what fuel buyers actually pay for the two fossil fuel prices. These alternatives, and other less distorted approaches, clearly illustrate the dramatic increase in the differential between coal and gas prices in 1996.

Q. HAVE YOU CONDUCTED ANY OTHER ANALYSIS USING MR. BREMAN'S DATA?

A. Yes, I have used some basic statistical tests to determine the correlation between Mr. Breman's coal and gas price data series and whether one data set could be used as a predictor of the other data set. The result of this analysis (see Document 10) are:

(1) The correlation coefficient (i.e., Rho) between Mr. Breman's coal and gas prices was a -0.27. This means that the data sets are weakly <u>inversely</u> correlated, which suggests that when natural gas prices rise coal prices decline.

(2) An Ordinary-Least Squares regression analysis on Mr. Breman's data yields an $R^2 = 0.08$, which means, at most, only 8 percent of the variation in one price can explain the variation in the other price. Typically, analysts look for an R^2 of at least 0.9 when attempting to establish a correlation been two data series.

(3) The t-statistics (i.e., -0.81 and 10 observations) as very low, indicating that there exists no direct linkage between coal prices and natural gas prices.

In order to further highlight the weakness in the correlation of coal and gas prices. The correlations between coal prices and (a) cattle prices, (b) gold prices, and (c) cooling degree days were calculated. It was found that the correlation between coal prices and live cattle prices was superior to the coal prices and natural gas prices correlation. The correlation between coal and gold prices was about the same and there was a very slight positive correlation between coal prices and cooling degree days.

The primary conclusions that can be drawn from the material presented in Document 10 are: (1) there is no statistical significant linkage between coal and natural gas prices, even when using Mr. Breman's data, and (2) use of obviously unrelated data sets can produce better correlations.

Q. WOULD YOU SUMMARIZE YOUR REVIEW OF MR. BREMAN'S ANALYSIS OF THE DIFFERENTIALS BETWEEN COAL AND GAS PRICES?

A. Mr. Breman's analysis is badly flawed and presents an incorrect picture of the relationship between coal and gas prices. The key flaws in Mr. Breman's analysis are:

- Mr. Breman has ignored 1996 data which reflects a fundamental change in the natural gas markets.
- Mr. Breman uses a data smoothing technique which places enormous weight on historical prices which masks changes in the differential between coal and gas prices. Mr. Breman's smoothing technique can be used to develop a nearly constant differential among a variety of data sets.
- The statistical analysis of Mr. Breman's data strongly refutes the alleged link, or constant differential, between coal and natural gas prices.

Q. DO YOU KNOW OF ANY ONE IN THE INDUSTRY WHO USES MR. BREMAN'S SMOOTHING TECHNIQUE TO CORRELATE FOSSIL FUEL PRICES?

A. No I do not.

Q. ARE YOU AWARE OF ANY FORECASTER IN THE INDUSTRY THAT ASSERTS THAT COAL AND GAS PRICES ARE LINKED?

A. As part of our normal business, EVA follows most of the major forecasters of fuel prices. To the best of my knowledge none of these forecasters have ever linked coal and gas prices. This would include the Energy Information Administration, the Gas Research Institute, the American Gas Association, the WEFA Group, Data Resources Inc. and the National Economic Research Association.

V. Competition Between Coal and Gas

Q. WHAT TYPES OF COMPETITION EXIST BETWEEN FOSSIL FUELS?

A. There are two basic types of competition that exist between fossil fuels and they have very different impacts on fuel prices. The first type involves the daily dispatch of fuels and the second involves the decision for new capacity. The first type of competition, which is commonly referred to as fuel switching, is the type of competition that forms a link between fossil fuel prices and, except for one minor anomalous event, it does not exist between coal and natural gas.

Q. PLEASE DESCRIBE FUEL SWITCHING, PARTICULARLY AS IT PERTAINS TO FLORIDA.

A. Some fossil fuel plants are dual fired and capable of burning either of two fossil fuels. Electric utilities have a number of such plants, because it increases the reliability of generation in the event there is an interruption of either fuel. In addition, when the prices of the two fuels are close to each other on a dollar per MMBTU basis, electric utilities can invoke economic fuel switching, which allows them to use the cheaper of the two fuel sources. The same effect can be obtained through dispatch but to a lesser degree. Economic fuel switching can link the price of the two competing fuels by one fuel setting a price ceiling for the other fuel. As a result, as the lower price fuel penetrates the price ceiling, it loses volume to the alternate fuel and with the loss of enough volume, prices of the original fuel will decline over time.

By far the dominant type of economic fuel switching exists between residual fuel oil and natural gas in dual fuel steam generators. Current estimates of naturai gas to residual fuel oil fuel switching capability are approximately 1.9 TCF,[3] this fuel switching capacity

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[3]See Electric Power Research Institute, Fuel Switching On a Dime - Boiler Capabilities of electric Utilities and Industrial Companies, (December 1993) and EPRI, Eraming Scenarios of Electricity Generation and Gas use (Draft report to be published in 1996).

represents 5 to 14 percent of primary natural gas demand depending on the time of year. One of the regions with the greatest amount of oil to gas fuel switching capability is Florida. Furthermore, Florida's oil to gas fuel switching capability is dominated by Florida Power & Light's dual fuel units which can switch between oil and gas or vice-a-versa in a very short period of time.

Importantly, while residual fuel oil can place a ceiling on natural gas prices, the opposite is not true. Natural gas prices can impact residual fuel oil prices in local markets for a short period of time, but have no impact on oil prices, because of the huge size of the overall oil market. Thus, the price linkage associated with oil to gas fuel switching is in one direction with residual fuel oil prices historically setting a ceiling for gas prices.

Q. DOES FUEL SWITCHING EXIST FOR COAL?

A. Basically there is no economic fuel switching between coal and natural gas. Only once since the beginning of the spot market for natural gas (i.e., the last 10 years) have gas prices declined to a level to cause any fuel switching from coal to gas. This anomalous event occurred during a brief period in 1995. The fundamentals driving this decline in 1995 gas prices were the existence of excess deliverability and a very warm winter (i.e., seven percent warmer than normal). The best estimate of the amount of fuel switching that occurred during 1995 was 50 BCF. This represents less than a 0.5 percent of either the coal or the natural gas market. At best it can be noted that coal prices form a floor for gas prices, but coal prices do not bring down gas prices.

Q. DO COAL AND GAS COMPETE FOR NEW CAPACITY DECISIONS?

A. Yes. As a practical matter coal and gas are the only major alternatives for new capacity for power generation. As a result in the future coal and gas will compete for new capacity decisions. However, this competition is not simply based upon fuel prices as was the case for economic fuel switching. Instead this competition for new capacity involves complex tradeoffs between capital costs, performance characteristics (i.e., heat rates), fuel prices and specific utility load requirements and economics, among others.

VI. Summary

Q. WOULD YOU SUMMARIZE YOUR TESTIMONY?

A. There are four key points I would like to make in my summary.

(1) Fundamentals of Coal and Natural Gas.

There are significant differences in the fundamentals of supply and demand for coal and natural gas and this is the major reason that the prices for these two fuels move independently of each other and are not linked. Additionally, predicting the exact timing of changes in gas supply trends has been very difficult for the industry. While 1996 provides evidence of these changes, it would have been reasonable for historical gas supply, demand and price forecasts to predict these gas supply changes to occur at either an earlier or later point than 1996. Furthermore, the combined impact of the numerous changes in gas supply trends addressed in my testimony has placed upward pressure on gas prices, such that the industry expects long-term increases in gas prices from 1995 levels.

(2) Mr. Breman's Analysis.

Mr. Breman's analysis is badly flawed. He has ignored significant events that have occurred in 1996. He has used a smoothing technique that would allow anyone to correlate data for totally unrelated items and develop an apparent constant differential. In addition, he has, perhaps unknowingly, focused on a period that was dominated by excess deliverability for natural gas and a series of warmer than normal winters.

(3) Lack of Empirical Evidence.

Empirical evidence of historical coal and natural gas prices illustrate that there is no linkage between coal and gas prices.

(4) Coal and Gas Competition.

Coal and gas do not compete on a daily dispatch basis. With the exception of one minuscule anomalous event over the last 10 years, there has been no economic fuel switching between coal and gas.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?
A. Yes it does.

TAMPA ELECTRIC COMPANY
DOCKET NO. 960409-EI
WITNESS: THUMB
EXHIBIT NO. _____ (SLT-1)

TAMPA ELECTRIC COMPANY

REBUTTAL EXHIBIT OF STEPHEN L. THUMB

INDEX

RESUME OF

STEPHEN L. THUMB

EDUCATION

C.P.A.	West Virginia, 1977
M.B.A.	Finance, American University, 1972 (cum laude)
B.S.	Chemical Engineering, Northwestern University, 1967

EXPERIENCE

Current Position

Stephen Thumb joined Energy Ventures Analysis in 1988 and became a partner in 1990. Mr. Thumb directs EVA's natural gas and oil practice. Mr. Thumb is also EVA's senior financial analyst. Mr. Thumb is responsible for the FUELCAST Service, which is a multi-client service providing semi-annual forecasts of demand, supply and price for natural gas, coal, oil, and emission allowances. The types of projects in which Mr. Thumb is involved are described below:

Natural Gas Procurement
Evaluates natural gas procurement strategies for consumers taking into account the changing regulatory environment. For example, the procurement must address the mix of long- and short-term supply contracts, the mix of firm and interruptible transportation, and the mix of services.

Natural Gas/Oil Industry Analyses
Evaluates the natural gas and oil industries for clients concerned about supply options and availability. Studies have focused on structural issues such as pipeline capacity.

Forecasting
Provides clients with general or customized forecasts of natural gas and oil prices. Natural gas price forecasts are developed on both a wellhead or burner tip basis. Oil prices are developed for crude and refined oil products.

Financial Analysis
Serves as EVA's senior financial analyst and performs financial analyses as required. Directs the annual COALCAST report entitled Financial Performance of the Publicly-Held Coal Companies. The report analyzes the profitability and cash flow of these firms.

Acquisition and Divestiture Analysis
Performs analyses for companies considering acquisitions or divestitures. One project involved an acquisition analysis of an independent exploration and production firm with substantial natural gas reserves in the northeastern geological provinces. Another involved the acquisition of an affiliate coal mining operation.

Prior Experience

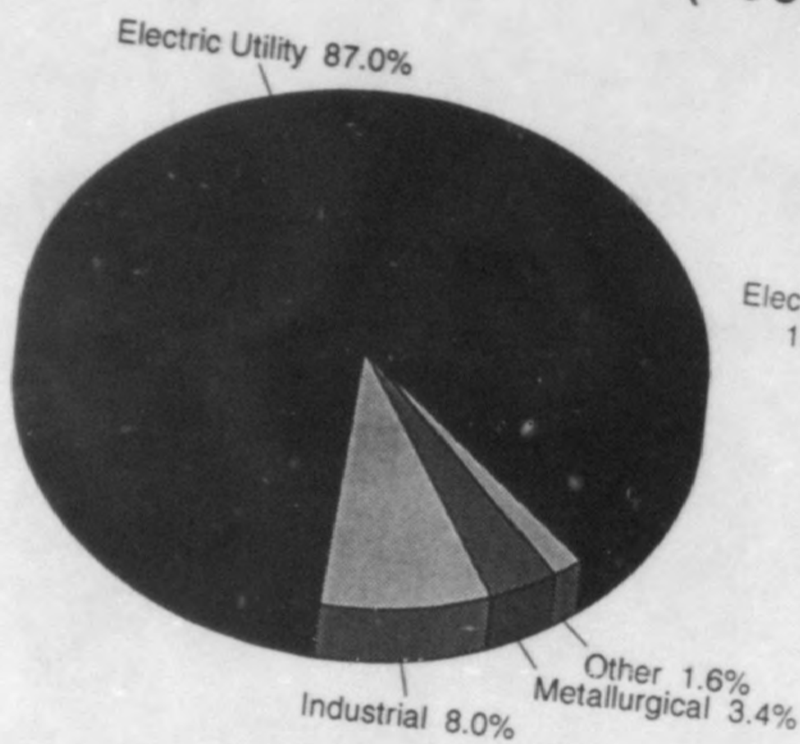
Before joining Energy Ventures Analysis, Mr. Thumb had 15 years of diversified industry experience having worked for three Fortune 100 companies. From 1982 to 1988, Mr. Thumb worked for Burlington Northern, Inc., most recently as Vice President of Planning for Meridian Oil, a wholly-owned subsidiary. Mr. Thumb's responsibilities included acquisitions, economic analysis, strategic plans, annual budgeting. Mr. Thumb's most significant accomplishment was the identification, analysis, and implementation of two major energy-related acquisitions (the El Paso Co. and Southland Royalty).

From 1974 to 1982, Mr. Thumb worked for Ashland Oil, Inc., most recently as Executive Assistant to the Chief Executive Officer. Mr. Thumb managed a number of special projects in the areas of operations and finance such as the development and marketing of a $200 million institutional drilling fund and an analysis of the firm's largest international oil production contract. Mr. Thumb also established a special employee incentive program for an oil and gas subsidiary in consultation with human resources and coordinated the redesign of an exploration and production accounting function.

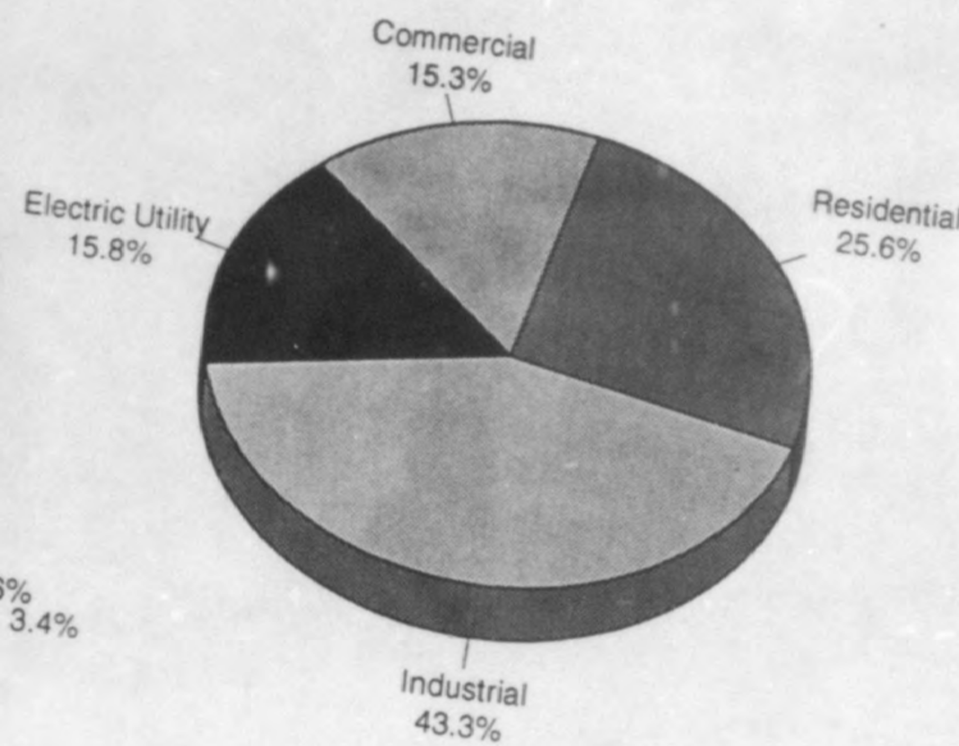
From 1972 to 1974, Mr. Thumb worked for Nuclear Fuel Services, a wholly-owned subsidiary of Getty Oil. Mr. Thumb, as Manager for Financial Planning, was responsible for the preparation of economic analyses and long- and short-term plans. He also assisted the controller in numerous accounting functions.

From 1967 to 1972, Mr. Thumb worked for the Division of Naval Reactors, a joint operation of the Atomic Energy Commission and the U.S. Navy, as an engineer in the fluid design section for surface ships and the radiological and chemical sections. From 1965 to 1967, Mr. Thumb worked at the Naval Ordinance Plant as a chemical and metallurgical technician.

COMPARISON OF DOMESTIC DEMAND FOR COAL AND NATURAL GAS (1994 DATA)



COAL
(22.03 Quads)



Natural Gas
(19.36 Quads)

<u>Source:</u> EIA, Annual Energy Review (July 1995); EIA, Natural Gas Monthly (May 1996); & EIA, Coal Industry Annual 1994, (October 1995).

<u>Footnotes:</u> Primary demand.
Residential and Commercial coal consumption is included within the "other" category. Excludes coal exports.

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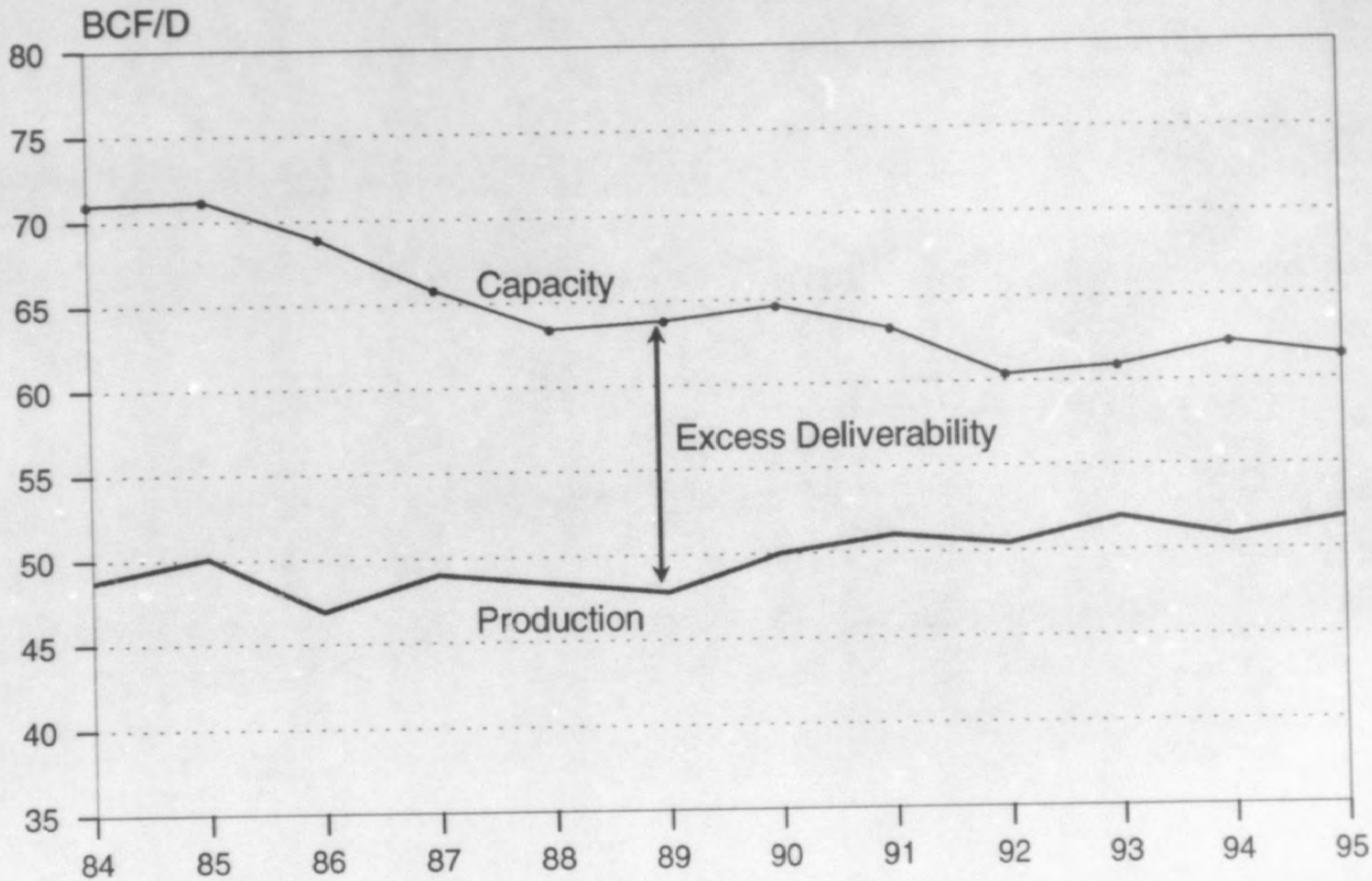
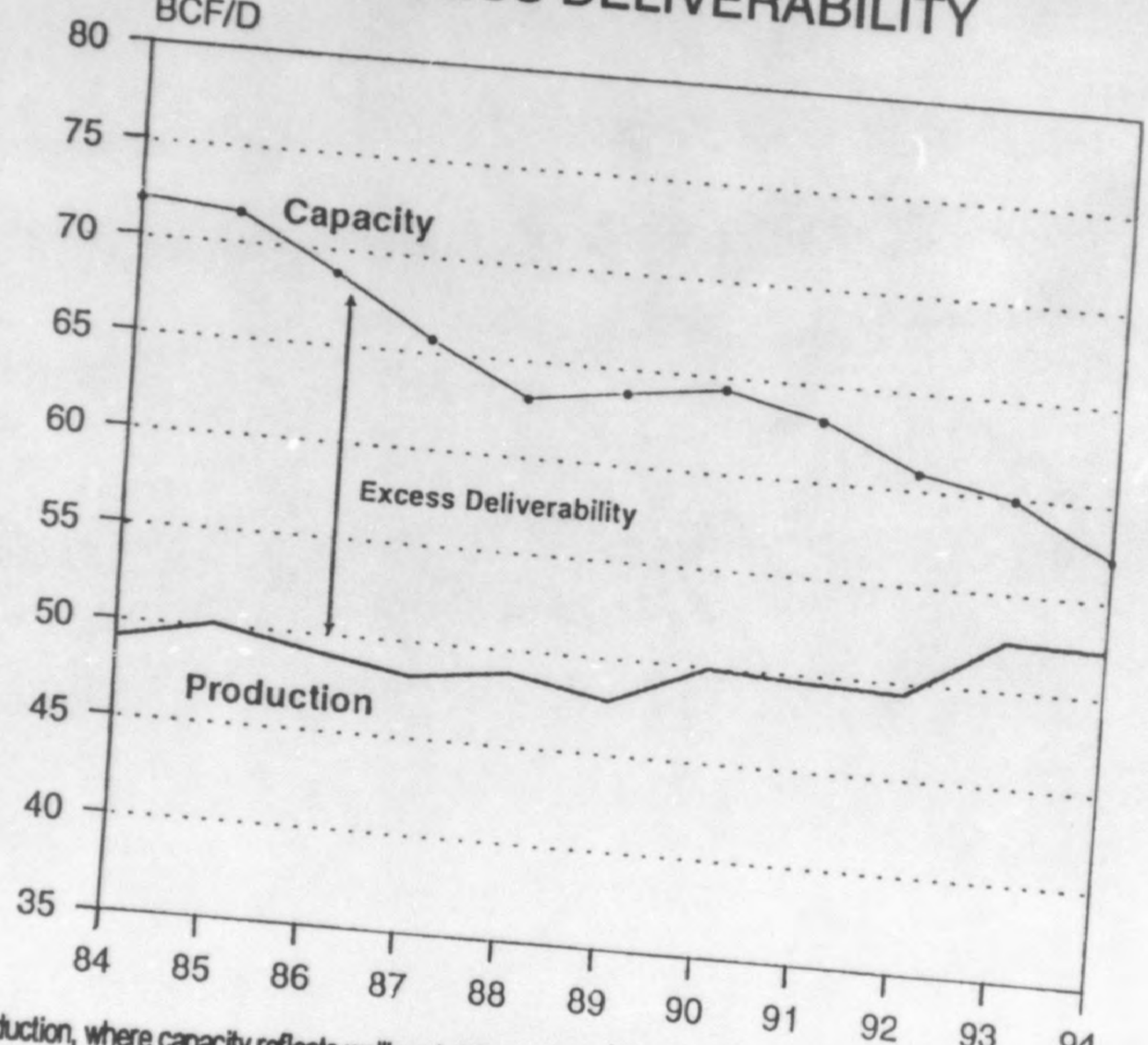
U.S. EXCESS DELIVERABILITY
("The Gas Bubble")



U.S. capacity and production, where capacity reflects wellhead deliverability, excluding Alaska.
Source: EIA, Natural Gas Productive Capacity for Lower 48 States 1984 Through 1996 (February 1996).

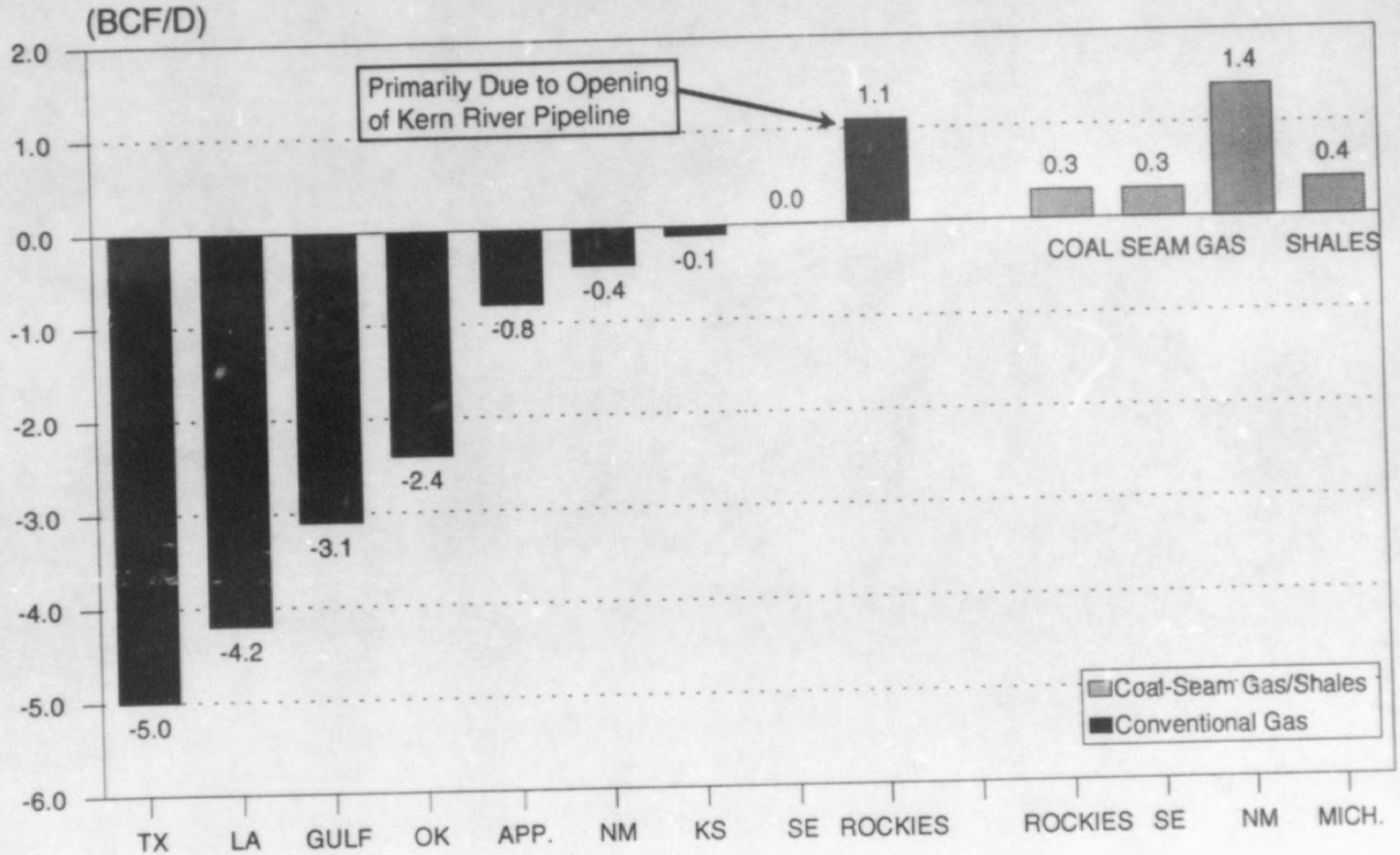
PRIOR EIA DATA ON U.S. EXCESS DELIVERABILITY



U.S. capacity and production, where capacity reflects wellhead deliverability, excludes Alaska.

Source: EIA, Natural Gas Productive Capacity for Lower 48 States 1980 Through 1995 (July 1994).

CHANGES IN U.S. PRODUCTION CAPACITY FOR NATURAL GAS BETWEEN MID 1980'S-1994



Source: EIA & EVA

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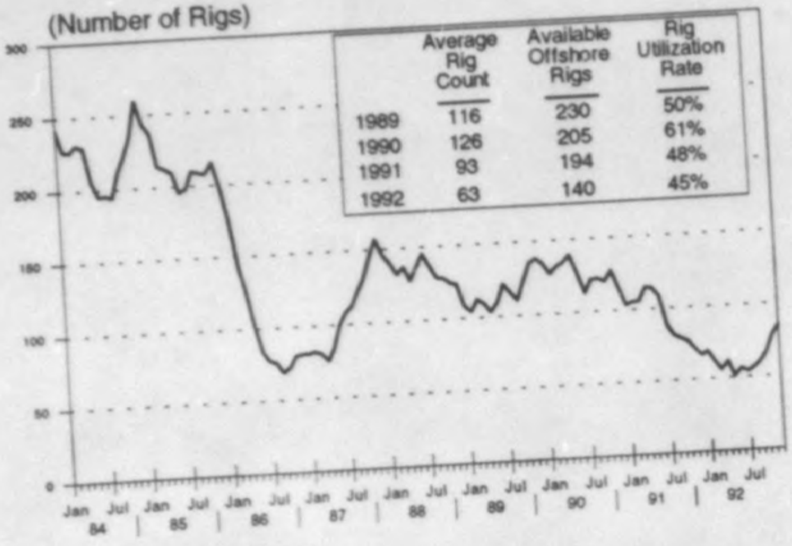
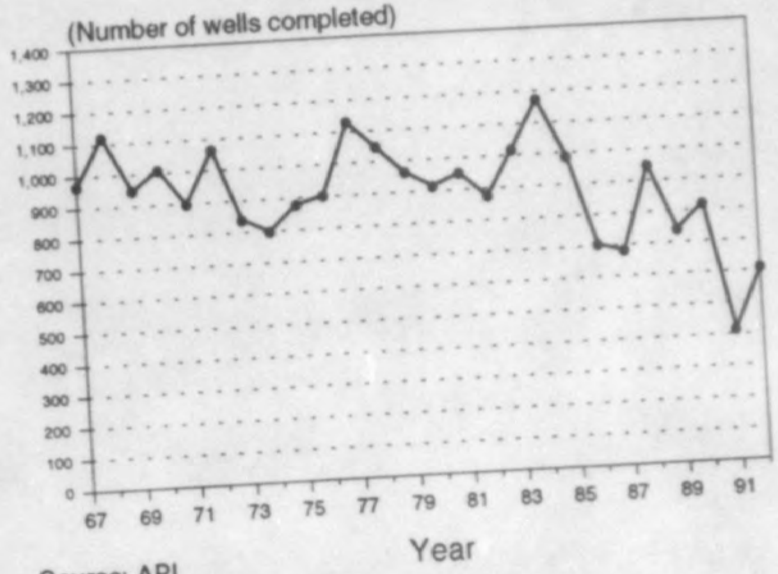
OFFSHORE RIG COUNT



	Average Rig Count	Available Offshore Rigs	Rig Utilization Rate
1989	116	230	50%
1990	126	205	61%
1991	93	194	48%
1992	63	140	45%

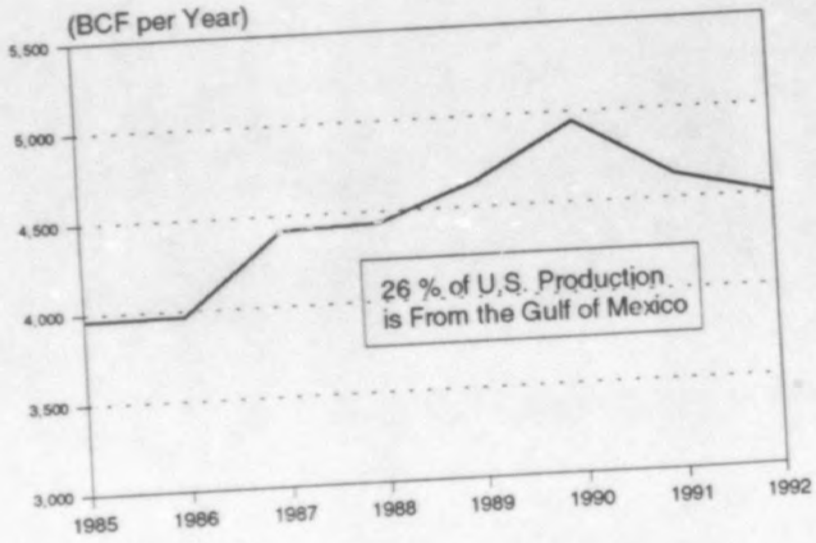
Source: Smith Rig Count

OFFSHORE GULF OF MEXICO WELL COMPLETIONS



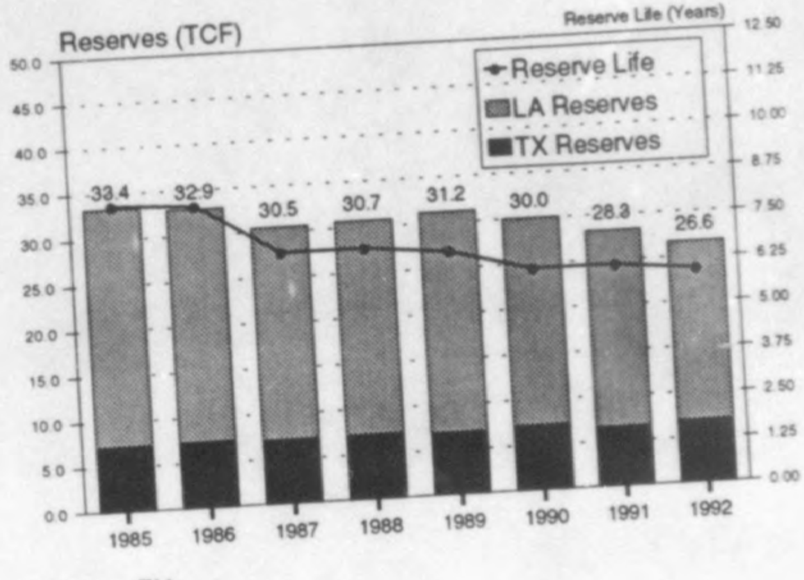
Source: API

GULF OF MEXICO GAS PRODUCTION



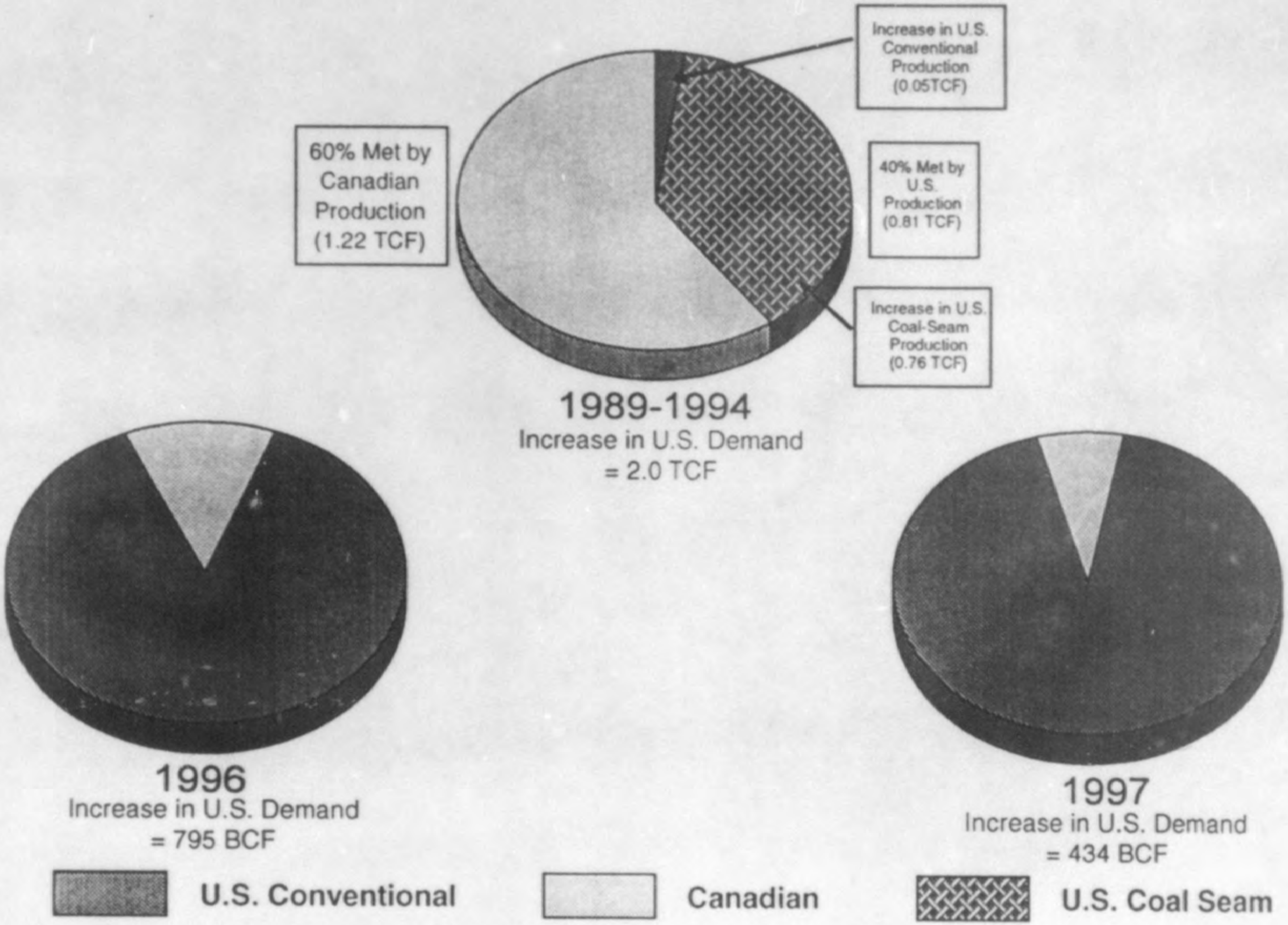
Source: EIA & API

GULF OF MEXICO GAS RESERVES



Source: EIA

OUTLOOK FOR FUTURE PRODUCTION INCREASES TO MEET INCREMENTAL U.S. DEMAND INCREASES



Source: EIA & EVA, Inc

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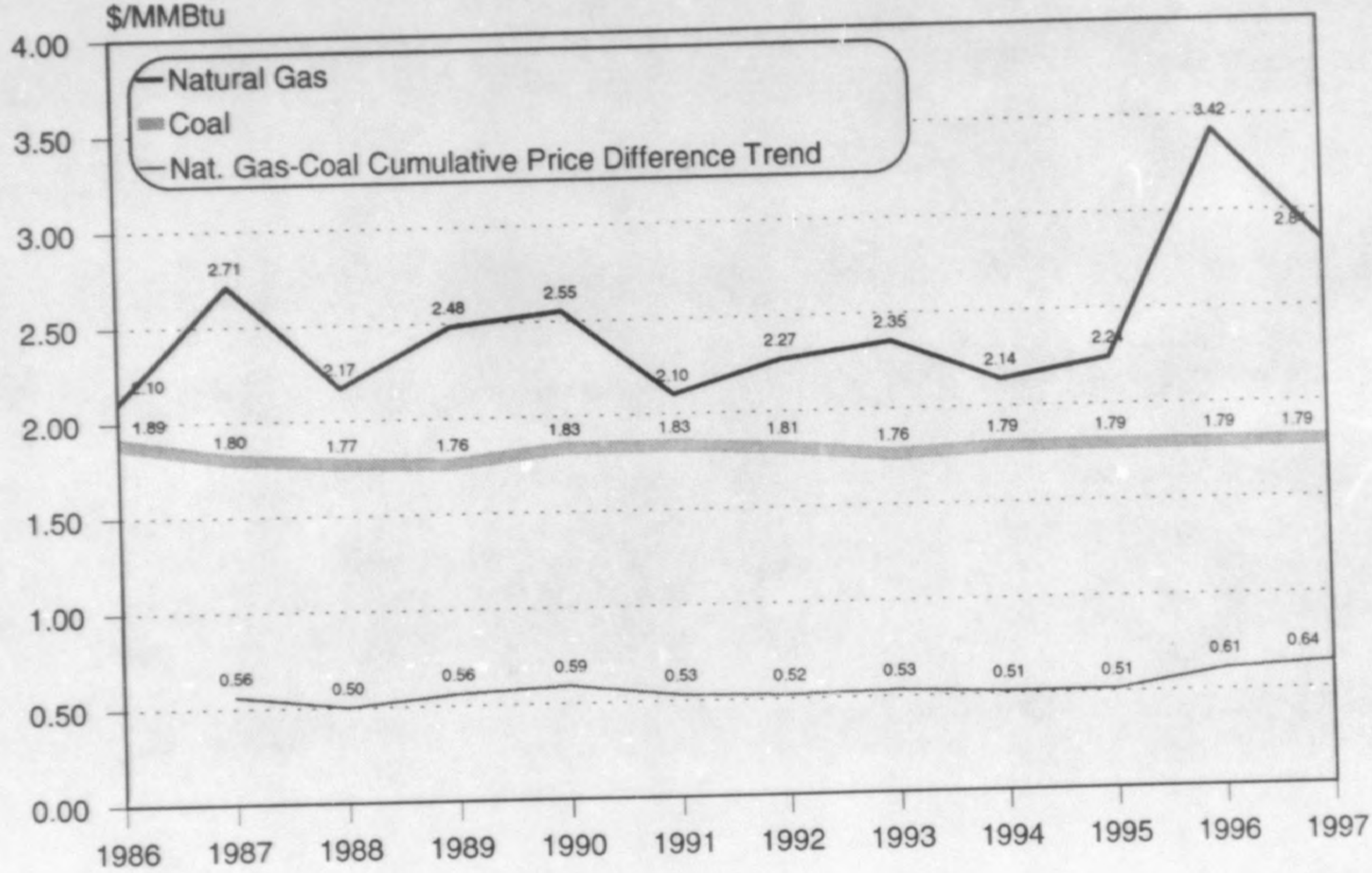
Coal & Natural Gas Prices and Natural Gas-Coal Price Difference Trend



Source: FERC Form 423 and EVA, Inc.

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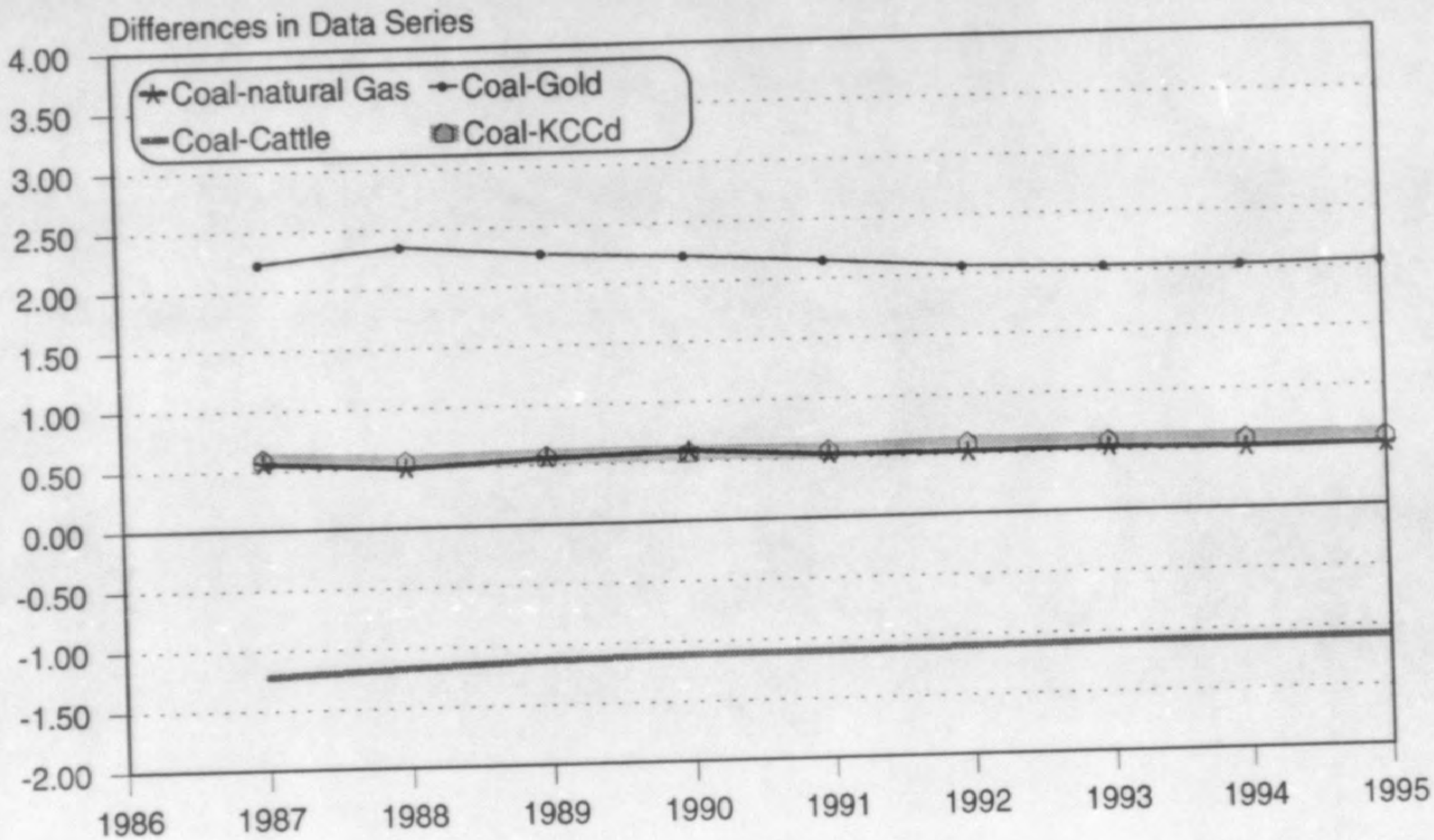
Comparison of Difference Between Coal Prices and Natural Gas, Gold, Cattle, and Cooling-Degree-Days Using Mr. Bremen's Methodology



Source: FERC Form 423

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Differential Between Coal Prices and Natural Gas, Gold, Cattle & Cooling-Degree-Days

	Coal Price $/MMBtu	NG Price $/MMBtu	Ex JEB-2 Price Differential Coal Vs NG	Gold Price (1/100 of One Troy Ounce)	Price Differential Coal Vs Gold	Cattle prices ($/ lb)	Price Differential Coal Vs Cattle	Thousands of Cooling-Degree-Days	Differential Coal Vs KCCD
1986	$1.89	$2.10		$3.68		$0.58		1.25	
1987	$1.80	$2.71	$0.56	$4.46	$2.23	$0.66	-$1.22	1.27	0.59
1988	$1.77	$2.17	$0.50	$4.37	$2.35	$0.71	-$1.17	1.28	0.55
1989	$1.76	$2.48	$0.56	$3.81	$2.27	$0.75	-$1.13	1.16	0.57
1990	$1.83	$2.55	$0.59	$3.84	$2.22	$0.79	-$1.11	1.26	0.57
1991	$1.83	$2.10	$0.53	$3.63	$2.15	$0.75	-$1.11	1.33	0.56
1992	$1.81	$2.27	$0.52	$3.44	$2.07	$0.76	-$1.10	1.04	0.59
1993	$1.76	$2.35	$0.53	$3.59	$2.04	$0.77	-$1.09	1.23	0.58
1994	$1.79	$2.14	$0.51	$3.84	$2.04	$0.70	-$1.09	1.21	0.58
1995	$1.79	$2.24	$0.51	$3.84	$2.05	$0.67	-$1.09	1.28	0.57

Correlation Coefficient			
Coal-Natural Gas	Coal-Gold	Coal-Cattle	Coal-KCCD
-0.27	-0.26	-0.46	0.17

Note: Coal and Natural Gas prices are from Exhibit JEB-2 of J. Breman testimony of June 14, 1996

Source: FERC Form 423, EIA, Chicago Mercantile Exchange, Commodity Exchange (COMEX).

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Poor Correlation and Predictive Power of Coal and Natural Gas Prices

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Correlation Coefficient:

$$\rho_{X,Y} = \frac{Cov(X, Y)}{\sigma_X \sigma_Y}$$

Using data from prior page:

$$\rho_{Coal,NG} = -0.27$$

Ordinary Least Squares (OLS) Analysis (with n=10 observations):

$$Price_{Yt} = \beta_0 + \beta_1 Price_{Xt} + \varepsilon$$

$$Price_{Coal} = 1.85 - 0.21\ Price_{Natural\ Gas} \qquad R^2 = 0.05$$

t-stat: (-0.69)

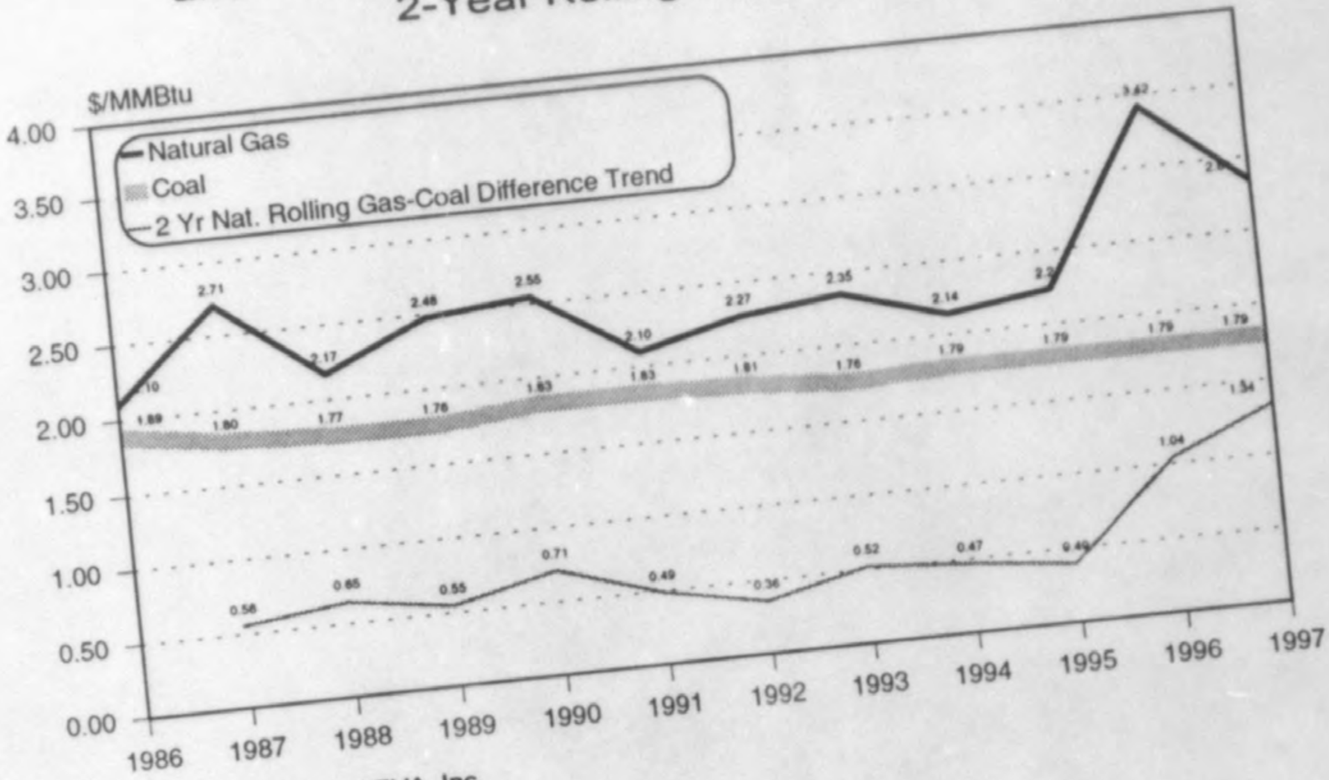
$$Price_{Natural\ Gas} = 4.86 - 1.42\ Price_{Coal} \qquad R^2 = 0.08$$

t-stat: (-0.81)

Conclusions:

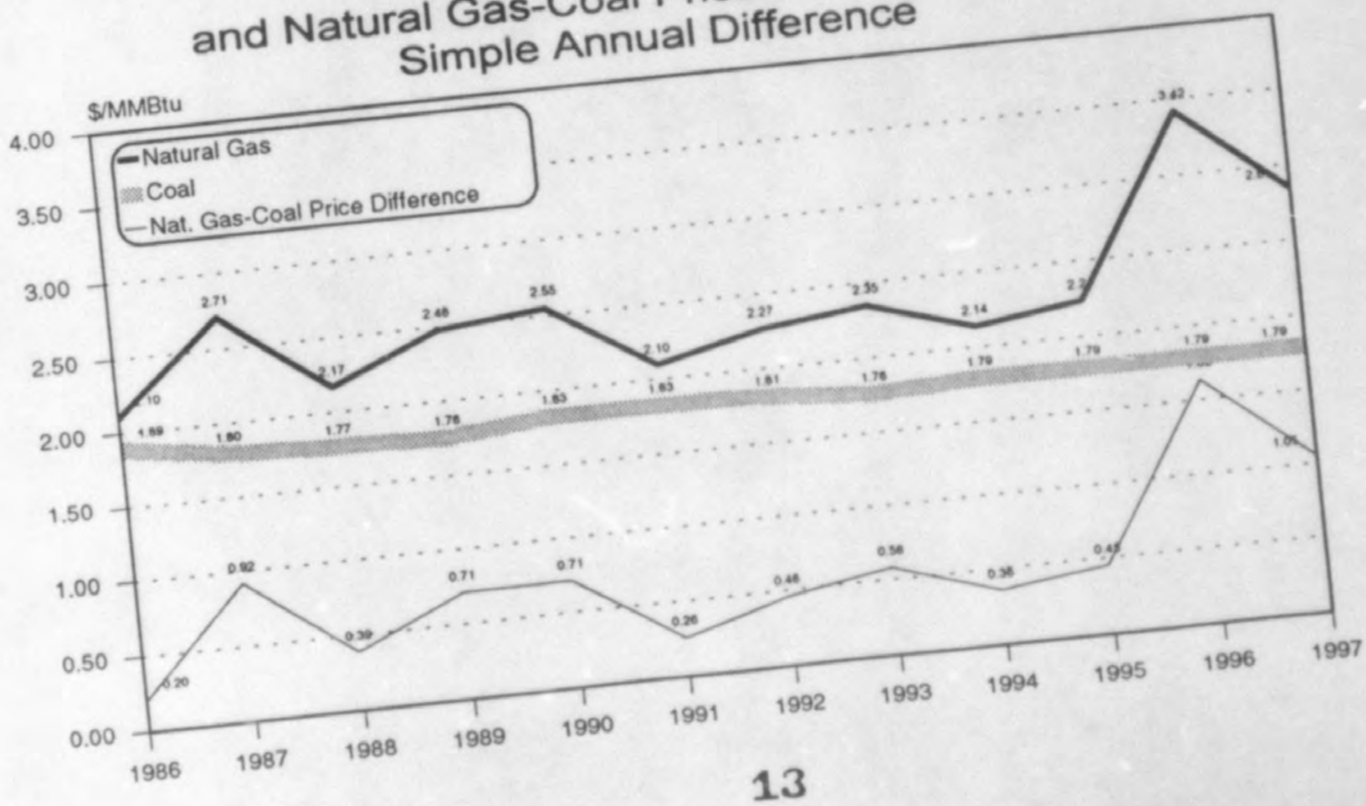
- Coal and natural gas prices are weakly inversely correlated, at best.
- OLS Regression R^2s are very low (0 to 1 scale).
- Coal price is not a statistically significant predictor of natural gas prices, and vice versa (t-stats very low).

Coal & Natural Gas Prices and Natural Gas-Coal Price Difference Trend 2-Year Rolling Average



Source: FERC Form 423, and EVA, Inc.

Coal & Natural Gas Prices and Natural Gas-Coal Price Difference Trend Simple Annual Difference



Source: FERC Form 423, and EVA, Inc.