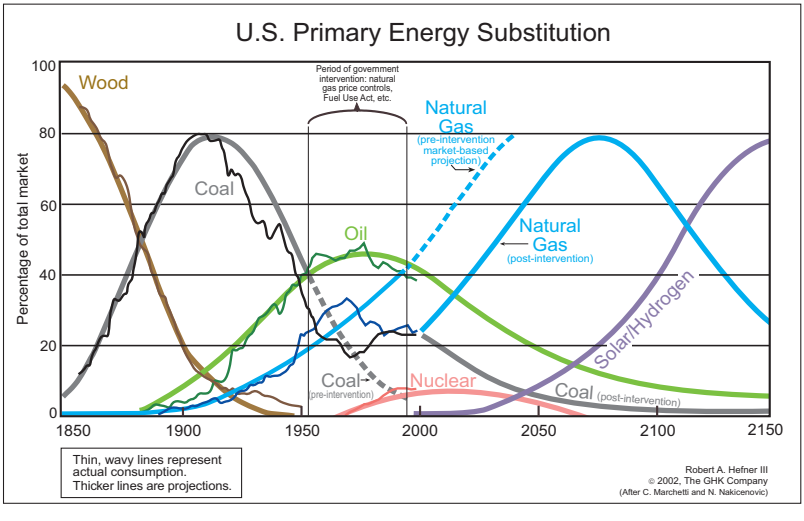
ENERGY AND THE U.S. MARKETPLACE

Toward Environmentally Sustainable Economic Growth

For All Participants in America's Energy Debate

By Robert A. Hefner III
The GHK Company, 2002



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History

History has demonstrated that the best and most efficient path toward environmentally sustainable economic growth occurs when the marketplace is free to choose energy sources. History also reveals that government's correct role in the energy marketplace is to provide resources for promising new technologies, facilitate interstate energy and power transmission and set long-term environmental standards. Government's past direct interventions in the energy marketplace, in the end, set us back decades and became both economically painful and environmentally damaging.

Since the end of the Industrial Revolution, the energy marketplace has been heroic in moving the U.S. and global economies away from large, inefficient, centrally located, capital-intensive, heavily polluting energy systems and toward smaller, less capital-intensive, more highly efficient, progressively cleaner energy systems. This history demonstrates that if American energy policies embrace the marketplace, eliminate subsidies to the established primary sources of energy (coal, oil, natural gas and nuclear) and establish environmental constraints that apply equally to all energy sources, our economy will accelerate toward environmentally sustainable economic growth.

Despite all that has been said about California's energy price flare-up and the collapse of Enron, the United States' energy markets have, by and large, worked well. This paper first examines how America's free market worked to decarbonize our economy for over 75 years and then how direct government intervention from the late 1950's through the late 1970's resulted in the recarbonization of our economy that, because of the long-term nature of energy cycles, remains with us today. And second, based upon this history, the paper recommends three guiding principles upon which to base America's energy policy for the 21st Century.

1950's to 1970's U.S. Market Intervention

The results of natural gas price controls and the Fuel Use Act

Price controls on natural gas production in the 1950's were the first major government intervention in the energy marketplace. These price controls kept natural gas prices at a fraction that of oil, simultaneously stimulating the use of clean natural gas and inhibiting its development, thereby creating a critical shortage of natural gas production despite the abundance of our nation's undeveloped natural gas resources. In 1978, on the heels of this price controlled and artificially created shortage, Congress passed legislation that over time removed price controls on natural gas production. However, fearing continuing economically damaging shortages, Congress also passed the Fuel Use Act[1] that virtually prohibited the use of natural gas in its fastest growing markets: new power generation plants and large industrial use. The Fuel Use Act had the effect of pushing our economy, particularly the electric power sector, away from clean natural gas, toward dirtier, more environmentally polluting coal. This federal legislation for all practical purposes mandated that the power generation industry build large base load coal-fired electric generation plants. Fig. 1, "U.S. Primary Energy Substitution," shows how the government, as a result of price controls and other market intervention

such as the $10 billion Synthetic Fuels Corporation (Synfuels)[2] and the Fuel Use Act, stopped the rapid growth of clean natural gas and created a resurgence of coal-fired electric generation plants. To illustrate, in the early 1970's, coal's percentage share of the energy marketplace was at its historic low – 16.9%, while natural gas's share was 32%[3] and rapidly growing. However, by 1986, coal's share of the marketplace had grown to 23.2% and natural gas had declined to 22.5%[4], and in 2000 coal had 22.7% and natural gas 23.7%[5].

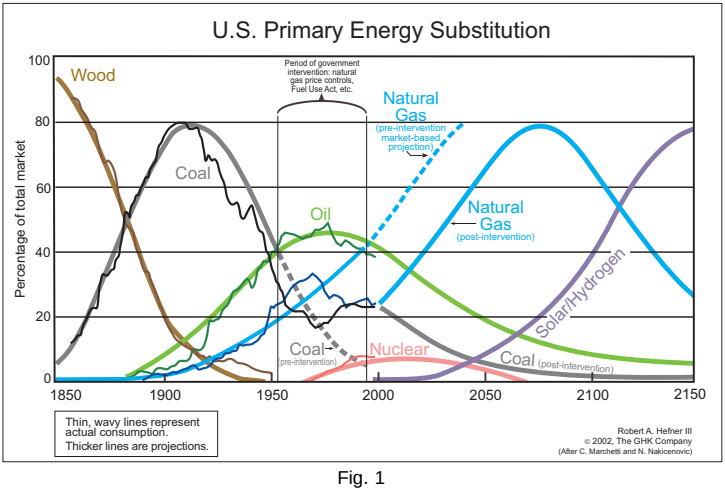

Fig. 1

The cost of added coal generating capacity installed by electric utilities since the enactment of the Fuel Use Act totals about $72 billion[6]. Once built, these capital-intensive power generation plants and their distribution systems must be amortized over their 30 or more year life. And refurbished coal plants often have a life of about 50 years. These circumstances, along with the capital-intensive nature of all energy infrastructure and the rigidness of energy regulatory systems, create the long-term nature of energy cycles (30 to 60 years). As Fig. 1, "U.S. Primary Energy Substitution", shows, the market intervention of the 1970's set back America's market driven transition to clean natural gas by 30 to 50 years. The State of Oklahoma provides a dramatic

example. ***In 1976, Oklahoma generated 95% of its electricity from natural gas and none of its electricity from coal[7]. Today, Oklahoma generates 64% of its electricity from coal[8], largely mined from open pits in Wyoming and shipped to Oklahoma by particulate polluting unit trains.*** The Fuel Use Act pushed Oklahoma's energy infrastructure away from the use of clean natural gas to generate electricity and backward to dirtier coal-produced electricity. Yet in the early and mid-1990's natural gas wells in Oklahoma were shut in for lack of a market.

Coal vs. Natural Gas

From 1979 to 2000, coal continued its relentless and taxpayer subsidized dominance of the electric power market, while natural gas's share of power generation in the U.S. increased only 1% (15% to 16%). Coal now accounts for 51% of U.S. electricity generation[9] (Fig. 2)[10].

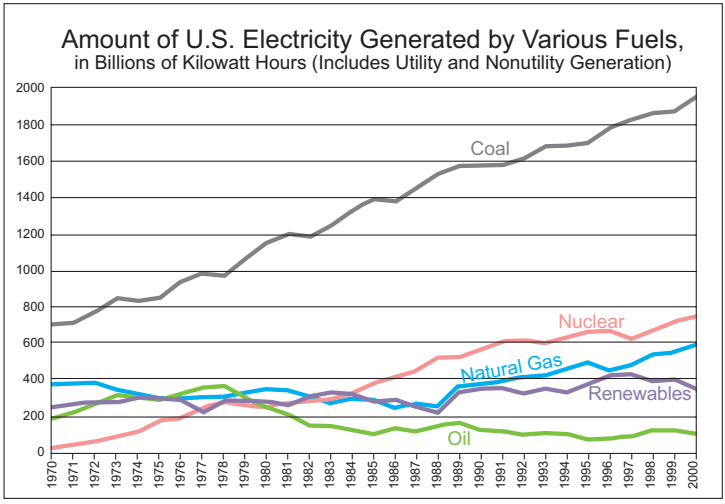

Fig. 2

Coal produces 36% of all U.S. CO_2 emissions[11] and 88% of all CO_2 emissions generated from the electric utility sector[12]. Coal will always emit about twice the CO_2 of natural gas, as well as sulfur dioxide (the principal component of acid rain), and other pollutants not emitted

from natural gas fired plants. ***Coal-fired power plants are the biggest and the only unregulated source of mercury pollution, releasing into our air each year some 40 tons, or roughly one-third of U.S. mercury pollution from all sources***[13]. Additionally, compared to natural gas wells, open pit coalmines require the destruction of large tracts of land and the use of long, particulate polluting railroad trains for transportation. For example, the 35 active coal mining operations in Wyoming average about 9,500 acres each[14]. Producing natural gas wells in the U.S. average only about 3 acres each and natural gas is then delivered to the end user by buried pipelines (see Fig. 3, 4, 5 and 6 on pages 12 and 13).

CO_2 emissions

Fig. 7 (see page 14) shows how coal – largely pure, dirty carbon – fueled the Industrial Revolution and led to the highest carbon emissions per $1000 of gross domestic product (GDP) in American history[15]. Fig. 7 also shows how the modern economy moved away from coal to use increasing quantities of cleaner oil and much cleaner domestically plentiful natural gas to fuel America's more efficient and robust modern economy (oil has about 75% the carbon emissions of coal and natural gas about 50%). As a result of this market driven fuel transition, carbon emissions per $1000 of inflation-adjusted (i.e. *real*)[16] GDP continually fell to lower and lower levels. However, beginning in the 1950's and continuing through the 1970's and 1980's, the net effect of government intervention in the energy market pushed America's energy path away from the cleanest and fastest growing energy source, natural gas (CH_4 – one carbon and four hydrogen atoms), back toward the Industrial Revolution's dirty coal (nearly 100% carbon). However, despite both legislation and multi-billion dollar subsidies that heavily favored coal, carbon emissions per unit of GDP continued to diminish, albeit at a slower rate, as a result of market driven increasing efficiencies. Between 1979 and 1999 CO_2 emissions, per unit of *real* GDP, declined by 27% and since 1920[17] by 75%[18].

Fig. 7 shows that the post Industrial Revolution energy markets, along with private sector and government R&D[19], have worked effectively to continuously reduce carbon emissions per unit of GDP. However, Fig. 7 also reveals that, because of government interventions

Fig. 3: Open pit coal mining operation in West Virginia. Photograph by Mike Smith.

Fig. 4: Open pit coal mine and unit railroad train. © Ian Harwood; Ecoscene/CORBIS.

Fig. 5: Two natural gas wells at a typical site in southeastern Oklahoma.

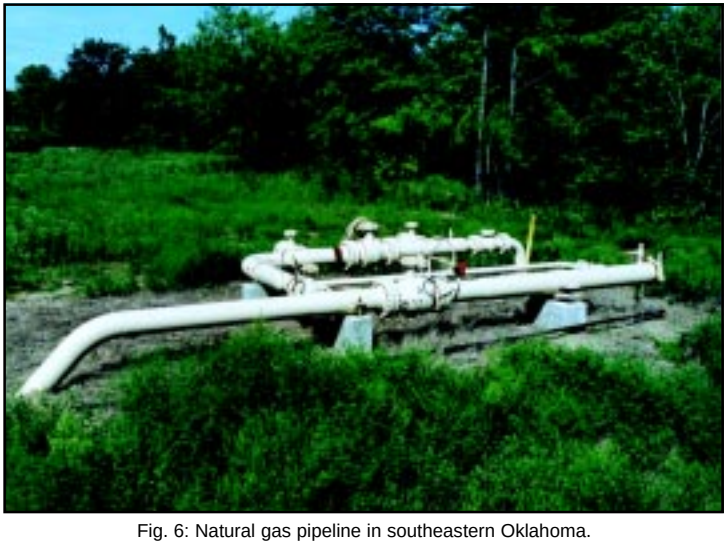

Fig. 6: Natural gas pipeline in southeastern Oklahoma.

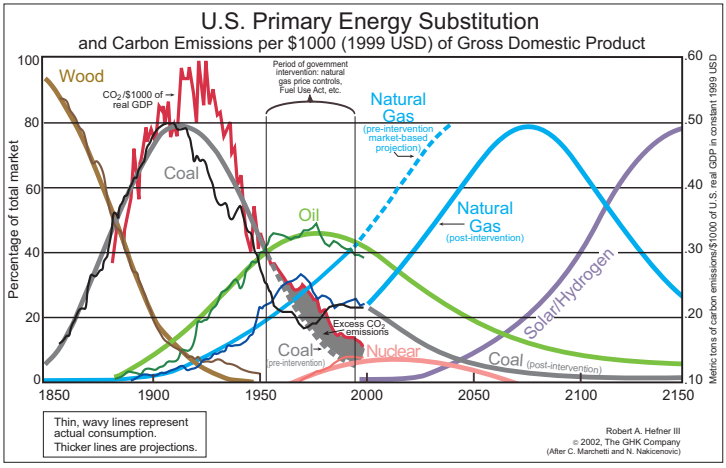

Fig. 7

that caused our return to dirty coal in the late 1970's and 1980's, CO_2 emissions (and coal's other pollutants) are substantially in excess of what they would have been if the Fuel Use Act had not impeded natural gas's growth in power generation and industrial markets. ***Had the Fuel Use Act never existed and two-thirds of the coal-fired electric generating capacity added since 1979 been fueled instead by natural gas (as would have been the case considering natural gas's rapid growth preceding the legislation), U.S. CO_2 emissions would have been reduced by over one billion metric tons. America would be producing about 4% less CO_2 annually and would already be on its way to meeting Kyoto emissions targets.*** And, done so without government intervention, legislation or excessive financial burdens to any sector of our economy.

Natural gas industry severely hurt

Energy cycles in the economy have complex inputs and by nature are long term. The 1978 legislation that over time deregulated natural gas wellhead prices and mandated against natural gas use in the power generation sector (its sector of most rapid growth) created

a natural gas excess supply called the "gas bubble". The gas bubble, along with a declining economy and the fall of oil prices in the mid-1980's, led to the price collapse of natural gas. This crippled the natural gas industry, as well as a large number of banks across the nation that had financed the natural gas industry. ***During the 1980's and 1990's, the 25 largest surviving gas and oil companies cut more than 1 million workers[20]. The number of people in the exploration and production segment of the industry almost halved since 1982.[21]*** The "gas bubble" lasted until 2000, keeping natural gas wellhead prices at relatively non-economic levels of from below $1.00 to just over $2.00, depending on the weather. Under these circumstances, the natural gas exploration and production industry could not grow or even be sustained, and the consequence was over fifteen years of difficult times that led to a relatively weak natural gas industry.

These are the reasons why today we have relatively tight natural gas supply deliverability – even though our nation possesses vast undeveloped domestic natural gas resources that would last between 50 and 100 years at accelerated rates of consumption[22]. Today's tight supplies exist because the natural gas industry continues to suffer from a shortage of both equipment (drilling rigs, drilling bits, pump trucks, etc.) and services. These industrial shortages result in delays in drilling and even longer delays in completion of natural gas wells. Even more important than the equipment shortages, the lack of experienced geologists and geophysicists negatively affects exploration for undeveloped natural gas resources. These people, equipment and service shortages are the long-term result of an unhealthy natural gas exploration and production industry suffering price collapses and spikes due substantially to unstable markets and the "gas bubble" that were the result of former government intervention in the energy marketplace. These are the reasons that natural gas consumers, and many consumers of natural gas generated electricity, were shocked by the 2000/2001 natural gas price spike rather than experiencing a smooth and painless price transition (see Fig. 8 on page 16)[23]. However, now that wellhead natural gas prices may have returned to the average *real* price level of the early 1980's, $3.50 to $4.00 per mcf, the natural gas industry will again begin to drill at levels necessary to provide new supplies for expanding market growth. Wellhead natural gas prices of $3.50 to $4.00

per mcf are certainly justified as compared to U.S. economic growth and inflation. Between 1980 and 2000, the U.S. economy, as measured by *real* GDP, grew by 90%[24], and the Consumer Price Index for a market basket of food increased 93%[25], while the average *real* retail price of natural gas declined. Average *real* commercial and industrial retail natural gas prices dropped over the period from $7.09 to $6.18 per thousand cubic feet (mcf) and from $5.36 to $4.46 per mcf, respectively, and the average *real* residential price remained the same[26]. Fig. 8 shows the average annual price of natural gas at the wellhead from 1960 to 2001 – in inflation adjusted 2001 dollars.

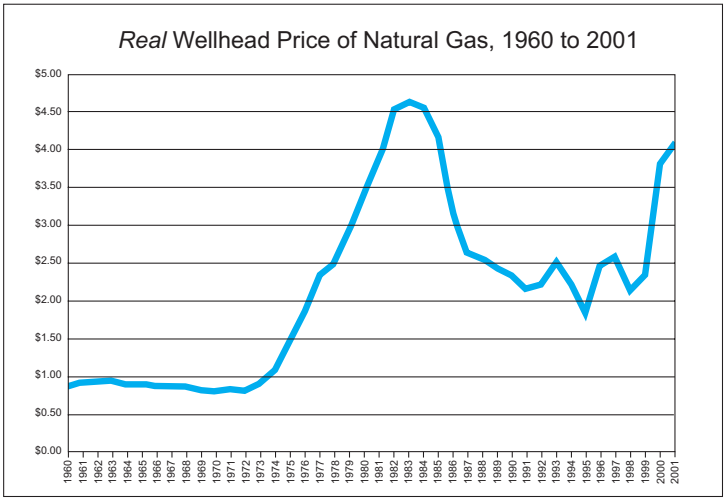

Fig. 8

Power of Coal Politics

In the U.S., coal interests have been influential in politics since the days of John L. Lewis and the powerful United Mine Workers of America. The top ten coal consuming states (Texas, Indiana, Ohio, Pennsylvania, Illinois, Kentucky, West Virginia, Missouri, Michigan

and Alabama) contain 32% of the American population and have 20 votes in the senate and 137 votes in the house. When combined with the top 5 coal producing states (Wyoming, West Virginia, Kentucky, Pennsylvania and Texas)[27], the power the coal industry is able to exercise in energy legislation is extraordinary. Since the 1980's, American taxpayers have spent $4.6 billion on so called "clean coal" technology[28], although it is highly unlikely that there will ever be such a thing as "clean coal" (Fig. 9 below[29]). And now, the Bush administration has proposed the relaxation of the Clean Air Act standards that would extend the life of the old and most polluting coal plants, as well as additional taxpayer subsidies to coal. Should these proposals pass, America will again be set decades behind on its path toward environmentally sustainable growth. On the other hand, were old polluting coal plants required to meet current Clean Air standards, their economic advantage would disappear and the marketplace would quickly replace them with clean, natural gas-fired power plants. New natural gas plants can be on line in about two to five years, as opposed to the larger and more costly coal plants that require about five to ten years from permit application to completion[30].

Emissions from Typical 2000 MW Coal vs. Natural Gas Power Stations			
Pollutant	**Conventional Coal (tonnes per year)**	**"Clean"/Controlled Coal (approximate tonnes per year)**	**Combined-cycle Gas (tonnes per year)**
Carbon dioxide	11 million	10 million	6 million
Sulfur dioxide	150,000	7,500	Negligible
Nitrogen oxides	45,000	20,000	10,000
Solid waste and ash	840,000	250,000	Negligible

Fig. 9

To achieve a better environment and cleaner air quality, American taxpayers must no longer subsidize coal's dominance of the marketplace. In fact, subsidies to any established primary energy source do not make good sense and should be eliminated. Government's roll should not be to choose favored established fuels that have powerful lobbies organized to perpetuate subsidies to this or that energy source, but rather should be to target R&D funds to promising non-established energy sources. In an unsubsidized free market the unquestioned winner for environmentally sustainable economic growth is natural gas. Fig. 9 shows the environmental difference between coal, so called "clean coal" and natural gas fueled electricity-generating plants. As you can see, the coal industry's use of the phrase "clean coal" is environmentally misleading. There is no such thing as clean coal.

The years following the repeal of the Fuel Use Act

The Fuel Use Act was repealed in 1987 and in 1990 the Clean Air Act was passed that set carbon constraints and standards for emissions from power plants. The marketplace once again chose natural gas as America's best, most efficient fuel to generate electric power. In 2000, nearly all new power plants announced were designed to use natural gas. And in 2000, U.S. natural gas use increased 4.3%[31]. But now, largely in response to first, California's energy price flare-up, and more recently the collapse of Enron, we hear calls for price "caps", the unwinding of energy deregulation and proposals for various new regulation of the energy marketplace. Such knee jerk reactions would be a mistake because these are the same mechanisms that, from the 1970's, to the detriment of both consumers and the environment, distorted energy supply and demand and helped stifle natural gas's rapid growth. These are the mechanisms that led to more coal-produced electricity, and thus greater emissions of CO_2 and other pollutants than otherwise would have been the case had electricity been generated with our abundant, clean natural gas. And once again, just as in the 1970's, we hear the call for more production of all energy, regardless of its environmental impact. Once again coal's powerful lobbyists and their large T.V. advertising budgets are singing the virtues of what they misname "clean coal", and are pushing politicians for relaxation of

Clean Air standards and additional coal subsidies. ***Said more bluntly, the coal industry wants to continue to pollute America's air and wants taxpayers to help pay the way.*** However, without new government intervention, the marketplace will continue to choose natural gas, because natural gas is environmentally superior to coal in every way, is economically affordable without taxpayer subsidies, is globally abundant and, unlike oil, is geographically diversified. And equally important, new natural gas plants can be built faster, are less capital intensive and produce cleaner and generally less expensive electricity as compared to new coal plants. In 2000, natural gas was the fastest growing primary energy fuel in the world, growing 4.8%[32].

The Energy Marketplace Works

The market system works for energy, so for federal and state governments to intervene once again because of the mistakes California or other states made in failed attempts to move toward a market-based energy economy would be as wrong today as it was in the past. Government intervention in the marketplace in 2002 would once again produce long-term economic inefficiencies and environmental setbacks. The California energy price flare-up resulted not from an open and deregulated energy market, but rather from laws that at the same time prohibited the utility companies from producing power, and when purchasing power, from using the many mechanisms of the energy markets, while protecting the consumer – for the short term – with price caps. Likewise, Enron's collapse was not because of the deregulated energy market; to the contrary, the energy market worked so well that it barely noticed the absence of Enron. Enron's failure rather was from pushing the limits of security laws and accounting regulations, a partially flawed business plan and the resulting loss of market confidence. So instead of turning away from deregulation in our energy markets, lawmakers need to learn exactly how real deregulation works, and with this knowledge, take American deregulation a step further, perhaps using as a model the experience in the United Kingdom (U.K.), as described next.

U.K. deregulation

Although in the U.S. we talk about energy deregulation and in certain areas believe we have accomplished it, consumers of electricity and natural gas in the United States, particularly households and small businesses, have virtually no choice of suppliers as compared to consumers in the U.K. There, real, competitive choices exist in a system with real deregulation. For example, in the U.K.'s deregulated market, a rapidly growing business known as U-Switch offers an Internet website to assist consumers in reducing electric and natural gas bills. U-Switch helps consumers capture the lowest price offered by allowing them to switch, at no cost to them, to new suppliers of energy as often as they wish via the Internet. U.K customers can choose between 20 electricity suppliers and 24 natural gas suppliers[33]. Since 1998, 6.5 million gas customers and 9.1 million electric customers have switched[34]. Deregulation in the U.K. has brought down consumer prices and has lowered carbon emissions per unit of GDP[35]. From 1990 to 1999 the average annual *real* price of electricity for industrial consumers fell by 25.5%, lower in constant pounds than for any year since records began in 1970. Between 1990 and 1999, electricity prices for domestic consumers fell by 19%. Between 1986 and 1999, average natural gas prices fell, in *real* terms, by 69% for industrial consumers and 35% for domestic consumers. And in the five years from 1994 to 1999, natural gas's share of the U.K's power generation market increased from 15% to over 38%[36].

The Age of Energy Gases

In order to make real progress toward environmentally sustainable economic growth, we must understand the overall, long-term picture of energy substitution. Fig. 10, "The Age of Energy Gases: Global Energy Systems Transition," shows that, over the long term, market driven energy transitions have occurred on a global scale since the 1850's. This Figure reveals a long-term and nearly continuous transition that has moved the global economy from chemically complex, dirty ***solid*** fuels (largely wood and coal) and their centralized, capital-intensive, large scale, inefficient plants, through a ***liquid*** transition (principally oil) toward chemically simple, clean energy

gases (principally natural gas, methane) and their relatively small, decentralized, less capital-intensive, highly efficient infrastructure. The Age of Energy Gases is now just beginning. Throughout the 21st Century natural gas will rise toward predominance of the energy marketplace and for the first time will provide the U.S. and global economies the possibility of environmentally sustainable economic growth. During the latter part of the 21st Century natural gas may also provide a natural transition to the hydrogen economy. Hydrogen (also a gas) is the ultimate sustainable fuel, as it can be made from water and its combustion produces simply water and oxygen. A hydrogen-based economy, for the first time, would provide for totally sustainable, environmentally benign economic growth. Natural gas, with only one carbon atom and four hydrogen atoms, is well on the way to hydrogen, and a hydrogen economy will be able to use much of the natural gas infrastructure.

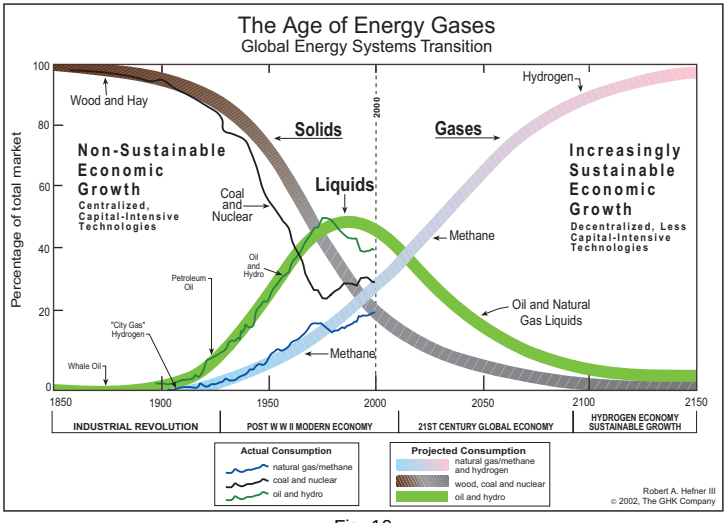

Fig. 10

Conclusion

America's energy history reveals that (1) the cycles of energy transition, by their very nature, are long term; (2) direct intervention by legislation in the form of subsidies to established energy sources, price controls or caps, and restrictive regulations or mandates about fuel choice have not only not worked, but have set us back both environmentally and economically; and (3) what has worked has been the establishment of environmental goals and the provision of funds for R&D in the energy sector.

Three guiding principles for the resolution of today's energy debate

In order to promulgate energy policy that can accelerate market driven trends toward an increasingly cleaner and more efficient energy economy for the 21st Century, our federal and state officials must accept the wisdom of this history and be guided by three fundamental principles emanating therefrom:

(1) eliminate all subsidies to our established primary energy sources of coal, oil, natural gas and nuclear;

(2) continue toward deregulation by removing the many remaining federal and state laws and regulations that impede the energy marketplace;

(3) set environmental standards and carbon constraints that apply equally to all primary fuels.

If these three principles become the foundation of American energy policy, Americans can look forward to a generation or more of increasing energy efficiency and an increasingly cleaner environment.

Endnotes

[1] In 1978, President Jimmy Carter signed into law the Power Plant and Industrial Fuel Use Act. The heart of the Fuel Use Act was Section 102, Part 2, which stated the desire "to conserve natural gas and petroleum for uses other than electric utility or other industrial or commercial generation of steam or electricity, for which there are no feasible alternative fuels or raw material substitutes…(and) to prohibit or, as appropriate, minimize the use of natural gas and petroleum as primary energy sources."

[2] The U.S. Synthetic Fuels Corporation was a program (converting coal to liquids and gases) that was set up by Congress and the Carter administration and had the authority to hand out $88 billion. It was called "Jimmy Carter's $88 billion white elephant" (source: "International Association for Energy Economics Newsletter," Spring 1996, page 13). About $10 billion was actually spent. Synfuels was designed to support various projects such as oil-shale plants, coal-liquefaction plants and coal-to-gasoline plants. The Synthetic Fuels Corporation was terminated in 1987 as uneconomical.

[3] *Energy Statistics Sourcebook*, 12th Edition.

[4] *Energy Statistics Sourcebook*, 12th Edition.

[5] U.S. Department of Energy/Energy Information Administration, *Monthly Energy Review*, April 2001.

[6] Independent research based on various conversations with C.H. Guernsey & Co., OG&E, Oklahoma Corporation Commission documents, "Western Farmers Combined-Cycle Plant – A Success Story," and several U.S. Department of Energy/Energy Information Administration publications including *Inventory of Power Plants in the United States*, various issues of *Historical Plant Cost and Annual Production Expenses for Selected Electric Plants*, various issues of *Electric Plant Cost and Power Production Expenses* and various issues of *Financial Statistics of Major U.S. Investor-Owned Electric Utilities.*

[7] U.S. Department of Energy, Energy Information Administration, *Electric Power Annual*, "Net generation by gas-fired steam units and by gas-fired gas turbine/internal combustion units by census region and

state, 1976-1981," from Federal Power Commission Form 4.

[8] U.S. Department of Energy/Energy Information Administration, *Electric Power Annual 2000*, Volume I, Tables A7, A8 and A10.

[9] U.S. Department of Energy/Energy Information Administration, *Monthly Energy Review*, various issues (for coal's share and natural gas's share of power generation).

[10] U.S. Department of Energy/Energy Information Administration, *Monthly Energy Reviews*, various issues; *Energy Statistics Sourcebook*, 14th Edition.

[11] Carbon Dioxide Information Analysis Center, http://cdiac.esd.ornl.gov/ftp/trends/emissions/usa.dat, 3/18/2002.

[12] U.S. Department of Energy/Energy Information Administration, http://eia.doe.gov/oiaf/1605/ggrpt/tble3.html, 3/12/2002.

[13] "China: A mercury megapolluter," Science News online, July 29, 2000; "Reducing Mercury Emissions by 95 Percent is Critical to Protecting Maternal and Child Health," Environmental Working Group, May 2001.

[14] Based on data sheets from Wyoming Department of Environmental Quality.

[15] As an example of the effects of pollution, 22 people died and 4,200 became ill by a killer smog in 1948 in Donora, Pennsylvania (near Pittsburgh).

[16] Real output, measured in constant prices, is adjusted for inflation. All GDP-related numbers in this article are in 1999 dollars; most other numbers for natural gas and electricity prices from the 1980's are in 2000 dollars.

[17] In 1920, a total of .61 metric tons of carbon emissions were produced per $1000 of real gross domestic product and by 1970 .26 metric tons of carbon emissions were produced per $1000 of real gross domestic product. In 1999, only .16 metric tons of carbon emissions were produced per $1000 of real gross domestic product.

[18] *Historical Statistics of the United States, Colonial Times to 1970, Part 1*, U.S. Department of Commerce, Bureau of the Census; Bureau of Economic Analysis, gross domestic product; Consumer Price In-

dex Conversion Factors to Convert to 1999 Dollars; Carbon Dioxide Information Analysis Center; and U.S. Department of Energy/Energy Information Administration.

[19] Government R&D in turbine engines and computer technology was very effective in increasing the efficiency of energy production and consumption.

[20] *Oil & Gas Journal*, June 12, 2000, "Upstream sector to experience 'severe' personnel crunch."

[21] *New York Times*, July 1, 2001, "A Second Oil Shortage: Experienced Workers."

[22] Estimates of natural gas resources: National Petroleum Council, 1,466 tcf; DOE/EIA, 1,111 tcf; Potential Gas Committee, 1,258 tcf; Gas Technology Institute: 1,805 tcf " current" and 2,058 tcf "advanced"; Robert A. Hefner III, 3,000 to 4,000 tcf.

[23] U.S. Department of Energy/Energy Information Administration, *Monthly Energy Review*, various issues; *Natural Gas Statistics Sourcebook*, 7th Edition; Reliant '02 prices; Federal Reserve CPI calculator.

[24] Gross domestic product data from Bureau of Economic Analysis.

[25] *Statistical Abstract of the United States 2000*; U.S. Census Bureau.

[26] U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, June 2001, Table 9.11; CPI conversion factors.

[27] U.S. Department of Energy, Energy Information Administration, *Coal Industry Annual 1998*; U.S. Census 2000 Congressional Apportionment.

[28] "Clean coal exists in name only for years to come", *Wall Street Journal*, May 18, 2001; "Coal gets cleaner – and better connected," *Business Week*, May 28, 2001.

[29] "International Association for Energy Economics Newsletter," Second Quarter, 2001; *Power Surge: Guide to the Coming Energy Revolution*; "New Directions: Natural Gas, Energy and the Environment"; "China: A mercury megapolluter," Science News online, July 29, 2000; "Reducing Mercury Emissions by 95 Percent is Critical to Protecting

Maternal and Child Health," Environmental Working Group, May 2001.
[30] Conversations, C. H. Guernsey & Co.
[31] U.S. Department of Energy/Energy Information Administration, *Monthly Energy Review*, February 2002.
[32] *BP statistical review of world energy*, June 2001, p. 38.
[33] U.K. Office of Gas and Electricity Markets (Ofgem); http://www.ofgem.gov.uk/customers/suppliers.htm.
[34] U.K. Office of Gas and Electricity Markets (Ofgem); http://www.ofgem.gov.uk/prices/switching.htm.
[35] International Monetary Fund – Real Gross Domestic Product, Constant Prices – United Kingdom; Carbon Dioxide Information Analysis Center; U.S. Department of Energy, Energy Information Administration, http://eia.doe.gov/emeu/iea/tableh1.html, June 7, 2001, "World Carbon Dioxide Emissions…"
[36] U.K. Department of Trade and Industry, "The Energy Report 2000," Chapters 7 and 8.

About the Author

Robert A. Hefner III is Owner and Managing Partner of The GHK Company, a private natural gas exploration and production firm with offices in Oklahoma City. Mr. Hefner appeared 18 times before Congressional committees testifying on energy matters in the 1970's and 1980's and was influential in bringing about constructive changes in Federal policy related to natural gas pricing and deregulation. The GHK Company, founded by Mr. Hefner in 1959, is known for its pioneering deep, high pressure natural gas development in the Anadarko Basin of Oklahoma, where the company led the industry in technological innovation to successfully drill and produce many of the world's deepest and highest pressure natural gas wells and the 1997 discovery of a large natural gas field – the Potato Hills field – in the Ouachita overthrust of southeastern Oklahoma. Additionally, Mr. Hefner is Chairman of the Board and CEO of Seven Seas Petroleum Inc., a publicly traded (AMEX: "SEV") oil and natural gas exploration and production company with offices in Houston, Texas, and international operations in Colombia.

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