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ABSTRACT

This paper discusses U.S. energy policy and the associated evolution of energy supply, energy demand, energy prices and the industrial organization of the domestic energy industries during the period 1991 through 2000. This period covers the last two years of the George H. W. Bush administration and the entire Clinton administration. The paper begins with a background discussion of energy supply, consumption and energy policy *prior* to the 1990s. It then provides an overview of the evolution of energy markets and energy policy during the 1990s. This discussion is followed by a more detailed discussion of supply, demand and public policies affecting the primary sources of energy supply and demand during the 1990s: petroleum, natural gas, electricity, coal, nuclear energy, renewable energy and energy efficiency.

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I. INTRODUCTION³

This essay discusses U.S. energy policy and the associated evolution of energy supply, energy demand, energy prices and the industrial organization of the domestic energy industries during the period 1991 through 2000. This period covers the last two years of the George H. W. Bush administration and the entire Clinton administration. It begins with an “energy crisis” stimulated by the invasion of Kuwait and the subsequent Gulf War and ends with an “energy crisis” caused by significant increases in oil and, especially, natural gas prices, the collapse of California’s new competitive electricity markets and the threat of electricity shortages throughout the Western U.S. Both “energy crises” led the sitting Presidents’ administrations to develop national energy strategies and to try to convince Congress to enact comprehensive energy legislation to implement them. Neither “energy crisis” had the severe economic impact or led to the kinds of dramatic, and often ill-conceived, policy responses observed following the two oil shocks of the 1970s. The 1990-91 “energy crisis” was short-lived and interest in energy policy soon faded. It would not be surprising if the latest “energy crisis” follows a similar course.

Most of the decade between these two “energy crises” was characterized by abundant supplies of energy, stable or falling real energy prices, and relatively little public or political interest in national energy policy issues. Energy demand continued to

¹ This paper was prepared for the conference “American Economic Policy During the 1990s,” sponsored by the John F. Kennedy School of Government, Harvard University, June 27 to June 30, 2001.

² Elizabeth and James Killian Professor of Economics and Management at MIT, Director of the MIT Center for Energy and Environmental Policy Research (CEEPR), and a Research Associate of the National Bureau of Economic Research. I gratefully acknowledge financial support from CEEPR. I have benefited from discussions with Denny Ellerman, John Deutch, Luis Tellez, Ernie Moniz, and comments from Charles Curtis, Daniel Yergin, Bill Hogan, Philip Sharp, and participants in recent CEEPR workshops. Erich Muehlegger provided excellent research assistance.

³**DATA NOTE:** I have relied extensively on data reported in the Energy Information Administration’s (EIA) publications *Annual Energy Review 1999* (July 2000) and *Monthly Energy Review* (April 2001). I have included revisions to some data originally included in the *Annual Review* which subsequently appeared either in the *Monthly Energy Review* or in more recent data distributed by EIA and available on its web site. Unless otherwise indicated, the data utilized and referred to in this essay come from these sources.

grow steadily through the decade, but supply was able to meet it without major increases in prices until the end of the decade. Because energy prices were stable or falling during most of the decade and there were no serious supply disruptions, there was little interest among the voters in energy policy issues and major new energy policy initiatives never rose very high on the policy agendas of either the Clinton administration or Congress during the 1990s. After an early failed effort to get Congress to pass legislation to impose a large BTU tax, the Clinton administration's energy policy initiatives became more modest and less urgent, largely working within the existing statutory framework and budget constraints. No sweeping new energy policy legislation was passed by Congress after 1992 and efforts to get national electricity deregulation and regulatory reform legislation passed in the Administration's final two years were not successful. Overall, the U.S.'s energy consumption portfolio changed very little during the decade. Energy demand continued to grow modestly, energy intensity continued to decline modestly, and the mix of fuels satisfying demand changed remarkably little. This should remind us that the energy supply and consumption infrastructure changes slowly in response to economic forces and public policies as a consequence of sunk investments in long-lived assets on both the supply and demand sides.

The Clinton administration's energy policies were heavily influenced by concerns about the environmental impacts of energy consumption and production, including impacts of greenhouse gas emissions and climate change. In particular, the Administration trumpeted programs to encourage renewable energy, energy efficiency, alternative-fuel vehicles, and increased use of natural gas in electricity generation and vehicles. However, some of these efforts were hampered first by federal budgetary constraints which limited increased R&D expenditures and tax subsidies, then by a Republican Congress that restricted the administration's efforts to tighten vehicle and appliance efficiency standards and provide larger tax incentives for renewable energy, electric fuel cell and hybrid vehicles, and finally by an unexpected acceleration in the pace of electricity sector restructuring and competition programs which undermined the administration's efforts to use regulated monopoly utility "integrated resource planning" programs to subsidize energy efficiency and renewable energy.

While the Clinton administration pursued federal land-use policies that further restricted oil and gas drilling activity on some federal lands in the West, it also quietly supported or acceded to Republican policy initiatives that encouraged oil and gas drilling in deep water in the Gulf of Mexico, tax and royalty relief for small oil and gas wells, opened up additional federal lands in Alaska to drilling, proceeded with the privatization of federal uranium enrichment facilities and the Elk Hills Naval Petroleum Reserves, supported federal funding for development of new technologies to increase oil extraction productivity, continued the slow process of licensing a federal nuclear waste storage facility, supported the re-licensing of operating nuclear power plants and continued research on advanced reactor technology, and initiated a cooperative program with the U.S. automobile industry to develop more fuel-efficient vehicle technology. Foreign policy initiatives endeavored to strengthen relationships with the governments of oil producing states, to diversify the nation's oil imports, and to foster the independence of

oil producing states that were created after the break-up of the Soviet Union from both Iran and Russia.

An important component of energy policy during the 1990s involved the completion of the restructuring and deregulation of natural gas production and transportation begun during the 1980s, and major new initiatives to restructure the electric power sector so that it would rely on competitive wholesale and retail markets for power supplies. The wholesale competition initiatives were undertaken initially by the Federal Energy Regulatory Commission (FERC). The retail competition programs were driven primarily by state rather than federal policy initiatives. Harmonizing diffuse state retail competition programs with federal wholesale market and transmission access and pricing reforms became a major policy challenge. The Clinton administration supported these initiatives by appointing sympathetic individuals to serve as Commissioners at FERC and, belatedly, by proposing comprehensive federal electricity reform legislation in competition with numerous Republican electricity reform bills; none of which made it through Congress.

While the 1990s was a decade of limited major new federal energy policy initiatives, it was also a decade in which the country finally reaped the benefits of the end of many ill considered energy policies of the 1970s and the early 1980s: oil and gas price controls, fuel-use restrictions, protectionist policies for oil refiners, publicly funded mega-projects to promote specific supply sources came to an end. Traditional market forces were given the opportunity to operate with less government intervention in oil, gas, and coal markets, the restructuring of the natural gas pipeline industry was largely completed, and major electricity restructuring and competition initiatives began. Even the controversial privatization of the United States Enrichment Corporation (USEC) reflected broad acceptance of relying primarily on market forces to govern the energy industries. Moreover, the transition to competition in electricity, the spread of performance-based regulation, etc., provided powerful incentives to improve the performance of nuclear and coal-fired generating facilities.

Because much of the regulatory apparatus of the 1970s and early 1980s had been dismantled by 1990, some of the tools for doing mischief in response to energy supply and price shocks were not readily available. As a result, there was little that could be easily done of a regulatory nature in the short run to respond to oil price shocks in 1990-91 and oil and gas price shocks in 2000 and 2001. This was a good thing and made it easier for these sectors to adapt to changes in supply and demand conditions. The 1990s benefited from the legacy of failed regulatory policies of the 1970s and 1980s in another important, though indirect way. The decade began with substantial excess capacity and a variety of inefficiencies on the supply side. They provided significant opportunities for cost reduction and innovation in energy production and distribution. This too contributed to abundant supplies, stable or falling prices, and allowed energy policy issues to fade into the background on the national policy agenda. The legacy of regulatory and energy policies of the 1970s and 1980s also were a major stimulus for electricity restructuring initiatives in California and the Northeast which had inherited high-cost assets and

contracts from the 1970s and 1980s whose costs for regulatory purposes were often far above their 1990s competitive market values.

The Clinton administration embraced and supported increased reliance on market forces to allocate energy resources and continued efforts begun by the previous administration to remove barriers to good market performance. The Clinton administration viewed the proper role of energy policy to be to respond to market imperfections, especially as they related to the environmental impacts of energy production and consumption. However, the favorable performance of the energy sectors during most of the 1990s also led to some complacency on the energy policy front, especially regarding investments in energy supply infrastructure. While the decade began with substantial excess capacity in electricity generation and transmission, natural gas production and transportation, and oil refining capacity, the capacity of these infrastructure facilities were being stressed by the end of the decade. Tight supplies and growing demand led to rising prices for oil, natural gas, and wholesale electricity by the end of the decade, to significant energy price volatility. Regulatory and environmental constraints, as well as continued uncertainty about the future of electricity sector restructuring, contributed to tight supplies, price volatility and some spot shortages of electricity and natural gas during 2000 and 2001.

The essay proceeds in the following way. First, I will discuss a number of reasons why the United States might need a set of sustained national policies specific to the energy sector. Next, I will provide a background discussion of energy supply, consumption and energy policy *prior* to the 1990s. I then turn to an overview of the evolution of energy markets and energy policy during the 1990s. This discussion is followed by a more detailed discussion of supply, demand and public policies affecting the primary sources of energy during the 1990s: petroleum, natural gas, electricity, coal, nuclear energy, renewable energy and energy efficiency. The essay concludes with some reflections about current energy policy challenges.

II. WHY DO WE NEED NATIONAL ENERGY POLICIES?

It is useful to begin with a brief discussion of the reasons why we might need national policies targeted specifically at energy supply, demand, and pricing that go beyond broader public policies (tax, antitrust, environmental, R&D, etc.) affecting American industry generally. Energy policies are derivative policies reflecting a number of higher level policy objectives and considerations.⁴

- a. Important infrastructure sectors essential for economic growth and development: Economical and reliable supplies of energy play an important role in fostering economic growth and development. Energy, like transportation and telecommunications services, is a key intermediate input into most sectors of a developed economy. Distortions in prices,

⁴ The list is not meant to be exhaustive. Clearly, income distribution concerns have played a role in energy policy formation and implementation. So too have market imperfections which may make it difficult for consumers to make rational investments in energy-using structures, equipment and appliances.

consumption, supply, or reliability of energy infrastructure services can lead to large economic and social costs. Moreover, because the short run demand for energy tends to be quite inelastic and dependent on long-lived capital investments, it takes time for consumers to respond fully to long term shifts in price levels by changing consumption patterns. Key segments of the energy system (electricity and natural gas networks) have (or had) natural monopoly characteristics and have been subject to economic regulation for most of this century. The performance of these regulatory institutions has profound implications for broader indices of economic performance.

- b. National Security Concerns: A growing fraction of U.S. energy consumption is supplied by imports of energy, primarily petroleum, from other countries. World petroleum reserves in countries exporting oil are concentrated in the North Africa, the Persian Gulf, Russia, and countries that were formerly part of the Soviet Union.⁵ These regions are politically unstable and have governments that are not always friendly to the United States. Because energy, and in particular petroleum, is an important input supporting economic growth and development, energy market instability is potentially very costly to the U.S. economy and those of our oil-importing allies. Accordingly, enemies of the United States or its allies may use energy supply strategically in an effort to influence other U.S. policies.⁶
- c. Environmental Impacts: The combustion of fossil fuels is the primary source of air pollution targeted by environmental policies aimed at cleaning the air (NO_x, SO₂, CO, etc.) and accounts for most of the production of CO₂, a greenhouse gas generally thought to be a major contributor to global climate change. Energy production and delivery also have significant potential impacts on water quality, water temperature, and land use. Since air and water pollution are generally acknowledged to be “externalities” which require policy intervention, environmental policies will have significant effects on energy supply, demand and prices and vice versa. Environmental policies necessarily affect energy markets and energy policies necessarily have environmental effects. Sensible environmental policy should be matched with compatible energy policies. Moreover, because the U.S. has been reluctant to use the best available instruments to internalize environmental externalities (e.g. environmental taxes and/or property rights-based cap and trade systems), second (third, fourth or more) best policies may involve interventions that work directly on the supply of and demand for the resources that have adverse environmental impacts.
- d. Competition Policy: General U.S. economic policy is oriented toward promoting the development of competitive markets and relying on price and

⁵ Countries in the Middle East and North Africa account for over 70% of world crude oil reserves.

⁶ This is not my area of expertise, but it seems to me that the oil import situation for both the U.S. and other G8 countries in the aggregate is an important consideration in evaluating energy security issues.

entry regulation only when unregulated markets have “natural monopoly” characteristics and are expected to perform poorly absent regulation. Important segments of the U.S. energy sector, in particular electric power and natural gas, have been subject to price and entry regulation for almost a century. As already noted, these regulatory institutions have important implications for the performance of these important infrastructure sectors and, therefore, for the performance of the economy. U.S. competition policies continually reexamine the rationale for and performance of price and entry regulation. Poor sector performance, as well as technological and economic changes that undermine the case for price and entry regulation, can make it desirable to design and implement competition policies that restructure regulated industries to expand opportunities for competition and shrink the expanse of price and entry regulation. Competition (antitrust) policies have not only served as constant pressures on regulated energy industries, but have also played an important role in affecting the structure and behavior of generally “unregulated” energy segments, especially the petroleum sector. However, U.S. antitrust policy alone cannot fully override existing state and federal statutes that create regulated monopoly sectors. Specific changes in state and federal legislation are necessary to do so.

- e. Use of Publicly-owned Resources: A significant fraction of domestic energy resources lie on or under land that is controlled by the federal government (and to a lesser extent state governments) and this fraction has been increasing.⁷ Hydroelectric resources lie on rivers and in locations subject to state or federal jurisdiction. The federal government has no choice but to develop and implement policies which define how these lands can be used for energy exploration and production. Whether and how these public lands are made available for exploration, development and production of energy can have important implications for energy supply and prices. These policies also have impacts on the environment that further complicate the interactions between energy and environmental policies. Sound federal land use policies cannot be developed independent of complementary energy and environmental policies.

- f. Federalism Issues: Responsibility for energy policy involves both the states and the federal government. However, state energy policy decisions can have impacts on other states and on suppliers of energy and energy-using equipment that affect consumers in many states. Conflicts between state policies have emerged in electricity and natural gas industry reform initiatives. Moreover, individual uncoordinated state programs defining appliance efficiency standards, air and water emissions standards, the composition of gasoline, certification of energy facilities, etc., can increase the overall national costs of achieving energy policy and environmental goals. Federal

⁷ Due largely to increased production from Federal offshore tracts, the share of domestic oil production from Federal lands increased from 16.3% in 1989 to 26.9% in 1997; similarly, the federal share of natural gas production increased from 30.2% in 1980 to 39.3% in 1997.

policies may be necessary to harmonize state programs to reduce their costs and to alleviate barriers to interstate commerce created by individual state policies.

III. BACKGROUND: ENERGY SUPPLY AND DEMAND AND ENERGY POLICY BEFORE 1990

Historically, energy has been abundant and relatively inexpensive in the U.S. Americans consume roughly 70% more energy per capita or per dollar of GDP than do people in most other developed countries. [FIGURE 1] We drive bigger cars, drive them further, live in bigger houses, and heat, cool and light them more, and work in buildings that use substantially more energy per square meter than Europeans. The availability of reliable supplies of cheap energy, especially gasoline, is viewed as a birthright by many Americans. Taxes on energy are much lower in the U.S. than in most other developed countries and most politicians have learned that proposing large increases in energy taxes is unlikely to be a career-enhancing decision. Accordingly, consumer prices for all forms of energy in the U.S. are relatively low compared to Western Europe and Japan. Nevertheless, last year Americans spent (directly or indirectly) about \$600 billion on energy of all kinds. About 38% of U.S. energy consumption comes from petroleum, 24% from natural gas, 23% from coal, 8% from nuclear power, and 7% from renewable energy, primarily conventional hydroelectric resources.⁸ This mix is little changed from 1990. [FIGURE 2 and FIGURE 3]. Residential energy consumption in 2000 accounted for 20%, commercial 17%, industrial 36%, and transportation 27% of energy consumed in 2000. The 2000 sector mix is almost identical to that in 1990 as well. [FIGURE 4 and FIGURE 5]

The U.S. has been blessed with large endowments of domestic energy resources -- - petroleum, natural gas, coal, and hydroelectric resources. These endowments are not equally divided among the states, however. Most of the states along the Atlantic and Pacific Oceans have relatively limited fossil fuel resources and are very significant net importers of energy. There are substantial coal resources distributed throughout the Appalachian mountain region in Western Pennsylvania, West Virginia, Kentucky and stretching west into Tennessee, Indiana and Illinois. There are also very substantial coal resources in the far West, especially in Wyoming, Montana, New Mexico, Utah and Arizona. Oil and natural gas production resources are concentrated in Texas, Louisiana, Alaska, Oklahoma, and several western states, including California. Hydroelectric resources are concentrated in the West.

Historically, the U.S. relied relatively little on imports of energy from other countries, though imports of petroleum began to increase rapidly in the early 1970s and, have increase steadily since 1985 to the point where we now import about 60% of our

⁸ This includes primary fuels used to produce electricity.

petroleum is imported from countries around the world.⁹ [FIGURE 6 and FIGURE 7] Many analysts expect U.S. petroleum imports to continue to grow as a fraction of total U.S. petroleum consumption; up to 75% by 2020.¹⁰

Prior to the first oil shock in 1973-74, federal energy policy consisted primarily of uncoordinated industry specific support policies: various tax subsidies for oil and natural gas production, the leasing of federal lands for oil and natural gas exploration and production, quotas on imported oil to protect domestic suppliers from cheap imports, substantial research and development expenditures devoted to promoting the production of electricity using nuclear power --- a legacy of the development of nuclear weapons during WW II ---, the regulation of the prices charged for transportation by interstate natural gas pipelines and, beginning in the early 1960s, a complex system of price controls on natural gas sold in interstate commerce. The states were primarily responsible for regulating prices for electricity and the local distribution of natural gas since these services were provided by state-franchised monopolies. State agencies in Texas, Louisiana and a few other states also played an important role in regulating supplies of oil and natural gas.

In the last 30 years, there have been several bursts of political activity (characterized as responding to an “energy crisis”) focused on developing national policies to increase domestic production of energy and to increase the efficiency with which energy is used in the U.S. in order to reduce the rate of growth in energy consumption in general and the growth in oil imports in particular. These initiatives have generally been stimulated by some kind of energy supply and price “shock,” and associated concerns about energy security and U.S. dependence on imported oil, and the associated impacts on the U.S. economy. After the first oil price shock in 1973-74, President Nixon launched Project Independence, with the goal of achieving U.S. energy-self-sufficiency by 1980. These initiatives included reorganizations of federal agencies involved in energy research and development, new energy price regulations, data collection and policy initiatives. In 1975, President Ford signed the Energy Policy and Conservation Act, extending price controls on oil, establishing automobile fuel efficiency standards, and authorizing the creation of a Strategic Petroleum Reserve.

Almost immediately after becoming President, Jimmy Carter signed the Emergency Natural Gas Act of 1977 in response to growing natural gas shortages

⁹ OPEC countries accounted for 43% of world oil production and 51% of world oil production outside of North America in 2000. The comparable figures for 1990 are 38% and 47%. In 1973, however, OPEC accounted for 56% of world oil production and 69% of production outside of North America.

¹⁰For example, see *Annual Energy Outlook 2001*, Energy Information Administration, December 2000, page 88. The U.S. consumes roughly 19 million barrels of oil per day (including natural gas liquids), of which about 11 million barrels per day is imported. Domestic consumption grew steadily during the 1990s while domestic production fell steadily (more on this below). To put this in perspective, if ANWR is developed it is projected to produce about 600,000 barrels of oil per day. *If* growing petroleum imports is perceived to be a policy problem it is extremely unlikely that increases in domestic petroleum supplies will have a significant impact on petroleum import trends.

resulting from the existing price controls on natural gas supplies sold in interstate commerce. Soon after, President Carter announced a National Energy Plan and called for the creation of a new Department of Energy (DOE, created later that year) to consolidate dispersed federal agencies involved in energy policy, research, and development programs.¹¹ After a contentious political debate lasting more than a year, in late 1978 Congress passed and President Carter signed the National Energy Act, which included the National Energy Policy and Conservation Act (NEPCA), the Power Plant and Industrial Fuel Use Act (FUA), the Public Utilities Regulatory Policy Act (PURPA), the Energy Tax Act (ETA), and the Natural Gas Policy Act (NGPA). NEPCA provided that the DOE was to issue appliance efficiency standards for household appliances and charged the FTC with issuing appliance energy efficiency labeling rules. PURPA required states to determine whether they should and would introduce new pricing mechanisms to encourage energy conservation and obligated electric utilities to purchase power from cogeneration plants and small power production facilities using renewable and waste fuels. The NGPA, began the deregulation of “new gas” supplies while continuing price regulation of “old gas” supplies. The ETA provided tax breaks for domestic energy supplies and energy efficiency improvements. The Fuel Use Act prohibited the use of natural gas and oil, whose prices were kept below market clearing levels by federal price controls, in new power plants and phased out natural gas use in existing power plants by 1990. These regulations reflected an effort to alleviate natural gas shortages and reduce the demand for oil burned “inefficiently” to generate electricity. These regulations pushed utilities to increase their use of coal to generate electricity.

Only two months after President Carter signed the laws making up the National Energy Act, Iran ceased exporting oil following the Shah’s overthrow, leading to worldwide shortages of oil and an explosion in world oil prices. In March 1979, a serious accident occurred at the Three Mile Island (TMI) nuclear power plant in Pennsylvania, reinforcing already significant opposition to nuclear power, leading to a moratorium on the completion of new nuclear plants, and a temporary closure of some operating nuclear plants, pending a review of safety issues raised by the TMI accident. In April 1979, President Carter, responding to growing oil and gas shortages, announced the gradual decontrol of oil prices and proposed a windfall profits tax on producers. In July, he proclaimed a national energy supply shortage, established temperature restrictions in non-residential buildings, and went on television to address the nation to argue that energy shortages had become a major test for the nation requiring sacrifices of various kinds. He also announced an \$88 billion program to produce synthetic fuels from domestic coal and shale oil reserves and a few months later announced proposals to increase domestic energy supplies and reduce consumption. In June, 1980 President Carter signed the Energy Security Act, consisting of six pieces of legislation: U.S. Synthetic Fuels Corporation Act, Biomass Energy and Alcohol Fuels Act, Renewable Energy Resources Act, Solar Energy and Energy Conservation Act, Geothermal Energy Act, and Ocean Thermal Energy Conversion Act. These laws all provided an array of tax subsidies and direct subsidies for alternative energy supplies and to encourage energy efficiency. The

¹¹ The DOE also has extensive responsibilities for the U.S. nuclear weapons program and for the cleanup of weapons research and production sites. I will not discuss these aspects of the DOE’s activities in this essay.

synthetic fuel and shale oil programs were later abandoned as oil and natural gas prices fell during the 1980s.

Oil prices peaked in 1981, fell gradually until 1985 and then fell dramatically in 1986. **[FIGURE 8]** Real oil prices have stayed far below their 1981-85 peak since then. Natural gas prices peaked in 1982-84 and then fell dramatically after 1984. **[FIGURE 18]** During the 1990s real natural gas prices fluctuated between \$1.50 and \$2.50/MCF until May 2000 when they began to increase rapidly, reaching a new post-1973 peak by the end of 2000, before falling back to about \$3/MCF in late July 2001. Real coal prices began to fall in the late 1970s and real electricity prices fell during the post-1985 period. As energy prices fell and the supply shortages disappeared, interest in energy policy seems to have quickly declined as well. There were few significant new federal energy policy initiatives during the Reagan administration or the first years of the George H. W. Bush administration. Presidents Reagan and Bush largely completed the process of deregulating oil and natural gas commodity prices. The Natural Gas Wellhead Decontrol Act of 1989 completely removed the wildly inefficient price controls on wellhead prices of natural gas effective January 1993.

Historically, local gas distribution utilities (LDCs), electric utilities and large industrial consumers of natural gas purchased their gas needs from interstate pipeline companies under long-term contracts. (Smaller consumers in turn purchased gas from LDCs at prices regulated by state regulatory agencies) These supply contracts “bundled” the supply of natural gas itself with the transportation of that gas. The associated prices charged by interstate pipeline companies were subject to regulation by the Federal Energy Regulatory Commission (FERC) using cost-of-service principles.¹² The pipelines in turn entered into long term gas supply contracts with gas producers.¹³ In 1985, FERC began an initiative to open up access to interstate natural gas pipelines to allow gas distribution companies, electric utilities, and large industrial consumers to purchase gas separately from transportation service, allowing them to contract directly with gas producers or marketing intermediaries, purchasing transportation service from interstate pipelines separately from the gas itself. This initiative was a response to the changing market and regulatory framework governing the production of natural gas. As field prices of natural gas declined and supplies increased during the 1980s, pipelines and gas distribution companies found themselves locked into long-term contracts at very high prices. This created enormous incentives for industrial customers to seek ways to bypass high regulated pipeline and gas distribution tariff prices to get at low-priced gas in the field by buying directly from producers and using competing pipelines (including constructing spur lines to get to them) to transport market-priced natural gas. Legislation that went into effect in 1979 created limited opportunities for pipelines to make special arrangements with industrial customers to increase sales of natural gas by offering them

¹² S. Breyer and P. MacAvoy, *Energy Regulation by the Federal Power Commission*, Brookings Institution, 1974, Washington, D.C.

¹³ FERC (under its previous name, the Federal Power Commission) began regulating field prices of natural gas, in addition to pipeline charges, in the early 1960s. Field price controls were not fully removed until 1993, though they were largely eliminated during the 1980s.

transportation service at regulated prices, but allowing them to purchase gas at lower unregulated prices. As field prices fell, the demand for these special arrangements grew, resulting in enormous differences in purchase prices depending on the ability particular buyers had to make special supply arrangements with pipelines. The growing bypass efforts threatened to create serious “stranded cost” problems for pipelines and LDCs locked into long-term contracts.

In 1985, FERC issued Order 436 which established a voluntary program to encourage pipelines to provide “open access” transportation service in order to allow natural gas producers to negotiate directly with local gas distribution utilities, electric utilities and large industrial consumers of natural gas supplies. This was an effort to rationalize a regulatory framework that was rapidly collapsing and to do so in a way that was fair to customers, pipelines and LDCs. Gas transportation rates would continue to be regulated by FERC, but the price of commodity natural gas would be determined through arms-length negotiations. This order began the separation of interstate pipelines’ transportation functions from their “merchant” functions as marketers of natural gas. Although Order 436’s open access rules were voluntary, the order provided financial incentives for pipelines to adopt the open access rules and associated separations of transportation and merchant functions in order to obtain recovery of above-market “take-or-pay” contract costs. Along with the deregulation of wellhead prices for natural gas, these regulations spurred the development of competitive markets for natural gas at a growing number of trading hubs, markets for gas storage, secondary markets for pipeline capacity, the development of a vibrant gas marketing industry, and the creation of financial derivatives markets giving wholesale gas consumers a wide range of contracting and risk management options. These developments later served as the model FERC relied upon to foster competitive wholesale electricity markets and access to the transmission capacity necessary to support them.

Federal policy toward nuclear power during the 1980s was primarily a policy of benign neglect. Legislation was passed in 1982 and 1987 to identify and develop a site for storing waste fuel from civilian nuclear reactors, though the future of nuclear power continued to dim as costs escalated, electricity demand growth slowed and many announced nuclear plants were cancelled. Federal funding for the development of the Clinch River Breeder Reactor was terminated in 1983 and the project cancelled. Federal budget cuts reduced DOE spending on research and development dramatically during the 1980s. The Reagan administration opposed setting appliance efficiency standards required by legislation passed during the Carter administration and eventually promulgated “no-standard standards.” The DOE was then sued for failing to enforce the National Energy and Conservation Act of 1978 and a Court of Appeals ruled against the Reagan administration. However, little progress was made in enacting federal appliance efficiency standards until the late 1980s, when new federal legislation was passed in response to a growing number of states enacting their own appliance efficiency standards and manufacturer concerns about the prospect of manufacturing appliances meeting numerous state-specific energy efficiency standards.

During the 1980s, the states became much more involved in energy policy, largely stimulated by Title II of the Public Utility Regulatory Policy Act (PURPA) and the Reagan administration's perceived indifference to energy policy and environmental issues. Title II of PURPA required electric utilities to purchase electricity supplied by "Qualifying Facilities" (QF) producing electricity using cogeneration technology, renewable and waste fuels.¹⁴ The objective of PURPA was to stimulate electricity production from more thermally efficient cogeneration plants and to encourage the use of renewable and waste fuels in the production of electricity, combining energy security goals with environmental protection goals. The details of implementation, however, were left to the states. The states were required to develop regulations to ensure that electric utilities would stand ready to purchase power from QFs at prices reflecting their "full avoided costs." Several states, including California, New York, all of the New England states, New Jersey and Pennsylvania embraced PURPA with great enthusiasm. In addition to requiring utilities to pay high prices for QF power under 20 to 30 year contracts, the implementation of PURPA was also accompanied by the creation of public "integrated resource planning" (IRP) or "least cost planning" (LCP) processes to determine "appropriate" electric utility investment and contracting strategies which were eventually implemented with competitive bidding programs. These programs were heavily influenced by environmental groups active in these states (NRDC, EDF, CLF). The programs required treating "customer energy efficiency investments and other demand-side programs" as utility "resources" and led to the creation in some states of large utility programs to subsidize customer energy efficiency investments. The rationale for and economic consequences of these programs were controversial.¹⁵ The costs of these subsidies, in turn, were funded through higher regulated electricity prices. These states (California, New York, Massachusetts, Maine, Washington and a few others) led the development of an increasingly close linkage between energy policy and environmental policy. As I will discuss presently, many of these states were also the pioneers in electricity sector restructuring and competition in the mid-1990s, stimulated in part by the high costs and high electricity prices resulting from the PURPA initiatives of the 1980s.

States also began to enact their own appliance efficiency standards. California imposed appliance efficiency standards during 1977-79 and upgraded these standards during the 1980s. Other states followed California's lead during the 1980s, including New York, Florida, Massachusetts, and Connecticut. The proliferation of different individual state standards then led appliance manufacturers to seek uniform national appliance efficiency standards. Manufacturers and energy efficiency advocates (environmental groups) negotiated what became the National Appliance Energy Conservation Act in 1987. This Act contains specific efficiency standards for 12 types of

¹⁴ A more detailed discussion can be found in P. Joskow, "Regulatory Failure, Regulatory Reform and Structural Change In The Electric Power Industry", *Brookings Papers on Economic Activity: Microeconomics*, 1989 and the references cited there.

¹⁵ See for example P. Joskow and D. Marron, "What Does a Negawatt Really Cost? Evidence From Electric Utility Conservation Programs", *The Energy Journal*, 1992 and J. Eto, *et. al* , "Where Did the Money Go? The Cost and Performance of the Largest Commercial Sector DSM Programs," *The Energy Journal*, Vol. 21, No. 1, 2000.

home appliances that are supposed to be updated from time to time by the DOE. The first standards became effective in 1988 and 1990 and the DOE has revised the statutory standards since then. President Clinton approved new standards for air conditioners and other appliances close to the end of his term.

Most of the federal energy policy initiatives during the 1970s and 1980s were portrayed largely as responses to “energy and economic security” concerns associated with excessive dependence on foreign oil, and followed sudden large increases in petroleum prices and temporary oil and gas shortages. As time went on, however, energy policy and environmental policy initiatives became more closely linked as well since fossil fuel combustion accounts for a large fraction of the emissions of most air pollutants (NO_x, SO₂, CO, lead) and carbon dioxide. Energy efficiency and renewable energy slowly rose to more prominent places on the policy agenda. As I will discuss, this linkage became much closer at the federal level with the enactment of the Energy Policy Act of 1992 (EPAct92) at the end of the George H. W. Bush administration and this linkage was strengthened during the Clinton administration. State governments have also played an increasing role in influencing energy policy, largely reflecting the influence of environmental groups in California and the Northeast.

IV. ENERGY POLICY OVERVIEW: 1990 THROUGH 2000

A. Energy Policy 1990-1992

The decade began with the invasion of Kuwait by Iraq, the curtailment of oil exports from the area, and a rapid and significant run-up in oil prices in mid- 1990. This in turn led to the now familiar, though episodic, process of hand ringing by politicians and the media about rising oil prices, dependence on Middle East oil, and the absence of any sustained coherent U.S. energy policy. The Department of Energy developed a “national energy strategy” which presented policy options to President George H.W. Bush.¹⁶ In February 1991, the Bush administration proposed federal energy policy legislation to Congress. It focused on increasing oil, natural gas, and nuclear power production, including oil and gas exploration in the Arctic National Wildlife Refuge (ANWR). The proposals were very controversial and aggressively opposed by Democrats and environmentalists. Congress spent the rest of the year debating the administration’s proposed energy policy measures. The core features of the Bush administration’s bill were finally rejected by the Congress in June 1991.

The debate about energy policy continued in 1992, though the public concern about high oil prices, potential shortages and dependence on imported oil faded quickly away with the end (so to speak) of the Gulf War. Indeed, in retrospect, the oil shock of 1990-91 was much more modest, narrower and short-lived than the previous two oil shocks and it is surprising that it generated so much media attention and legislative activity. Apparently, energy “supply-siders” saw this as an opportunity to promote their

¹⁶ There was a big increase in media coverage of energy policy issues during this period. A Herb Block cartoon (August 12, 1990) depicted the White House staff searching for an energy policy, which was last heard of during the Jimmy Carter administration. Numerous editorials in major newspapers during the rest of 1990 called for a national energy policy.

favorite policy initiatives. They may have regretted doing so. The debate subsequently shifted away from the Bush administration's supply-side initiatives to a very different energy policy program advocated by House Democrats. The Energy Policy Act of 1992 (EPA92) was passed in October 1992. It was the only piece of major energy policy legislation passed during the 1990s. It grew out of legislation proposed by Congressman Phil Sharp entitled "The National Energy Efficiency Act of 1991." It was a very different piece of energy legislation than the Bush administration had proposed in 1991. Rather than being a supply-side program oriented toward conventional fuels it focused on creating tax and direct subsidies for energy efficiency and renewable energy technologies and on encouraging all states to develop and implement "integrated resource planning" programs for their utilities which were to include utility-sponsored energy efficiency programs in their resources planning processes. The associated costs were to be included to regulated retail electricity and gas prices.

EPA92 also made changes in the Federal Power Act (FPA) and the Public Utility Holding Company Act (PUHCA) that helped to make electricity industry restructuring and competition initiatives feasible. Ironically, these restructuring and competition programs in turn eventually undermined the state integrated resource planning and energy efficiency programs which EPA92 promoted since their structure and financing relied heavily on the institution of regulated monopoly to support what were effectively a set of "taxation by regulation" policies.¹⁷

In 1992, FERC also issued Order 636, the culmination of nearly a decade of policy initiatives to open up access to natural gas pipelines by unbundling the sale of transportation service, the sale of gas storage services, and the sale of natural gas itself, allowing buyers and sellers of "commodity" natural gas to negotiate supply contracts directly and then to buy pipeline transportation service to deliver the gas from field to destination. Order 636 supported continued development of competitive natural gas markets, natural gas marketing, natural gas financial derivatives markets, natural gas storage, and secondary markets for natural gas pipeline capacity. It represented the culmination of eight years of efforts by FERC to respond to the consequences if the natural gas regulatory policies of the 1970s and early 1980s and the subsequent collapse of the existing regulatory and contractual framework governing the natural gas industry. As FERC continued to restructure the pipeline industry, states began to extend the "unbundling" concept to Local Gas Distribution Companies (LDCs), allowing industrial and larger commercial consumers to purchase unbundled transportation service from their LDC as well. These state policies further expanded the base of retail customers purchasing in competitive gas commodity markets and working with gas marketers and brokers. These developments have important implications for related changes in the electric power industry that came later in the decade.

¹⁷ See Paul L. Joskow "Emerging Conflicts Between Competition, Conservation, and Environmental Policies in the Electric Power Industry," prepared for the California Foundation on the Environment and the Economy conference on the regulatory compact, April 2-3, 1992. Expenditures on electric utility energy efficiency and demand side management programs peaked in 1994 and have declined significantly since then. See *Annual Energy Review 1999*, Energy Information Administration, July 2000, page 228.

EPAct92 was the only major piece of energy policy legislation enacted during the 1990s. Moreover, it was largely a Democratic energy policy framework inherited by the Clinton administration soon after it was signed by President George W. Bush and was the foundation for much of the Administration's subsequent energy policy efforts. Accordingly, it is useful to summarize its primary provisions.

- a. Energy Efficiency and Renewable Energy: Directs the Secretary of Energy to establish energy efficiency standards for federal buildings, to develop voluntary energy efficiency standards for residential and commercial buildings and to incorporate them in state building codes; Directs the Secretary of HUD to establish an energy efficient mortgage financing program in five states, to develop an affordable housing plan using energy efficient mortgage financing incentives; Specifies parameters and provides funding for R&D on cost effective technologies to improve energy efficiency and increase renewable energy use in buildings; Amends PURPA to require gas and electric utilities to employ integrated resource planning and to adjust prices to encourage energy efficient decisions by consumers and to provide grants to states for DSM programs; Amends EPCA to include energy efficiency labeling for commercial and industrial equipment, to define energy efficiency standards for a specified set of such equipment, to define guidelines for energy efficiency audits and insulation in industrial facilities, to provide grants for efficiency improvements in low-income housing; Establishes various programs to encourage/require improvements in energy efficiency in federal buildings; Requires the Energy Information Administration (EIA) to collect data on renewable energy production and demand-side management programs; Creates tax subsidies to encourage energy efficiency and alternative fuels, including electric vehicles, solar and geothermal energy production, alcohol fuels (thank you Senator Dole!), and (snuck it in) independent oil and gas producers; Establishes a program and authorizes funding for further commercialization of renewable energy technologies, requires various studies and reports on renewable energy and data collection regarding renewable energy and its impacts on reducing greenhouse gas emissions.
- b. Alternative fueled Vehicles: Provides for acquisition of alternative fueled vehicles for the federal fleet, subsidies for an alternative fuels commercial truck program and mass transit, funding for an electric motor vehicle demonstration program and electric motor vehicle refueling infrastructure, various low-interest financing and subsidy programs for alternative fuel vehicles.
- c. Electricity Generation and Use: In addition to above, establishes an R&D program for various specified technologies for the generation of electricity from renewables on-grid and off-grid, fuel cells, heat engines, superconductors and other technologies.
- d. Coal: Authorizes R&D expenditure for specified coal-based technologies, to solicit additional proposals for clean-coal technology, and for technology transfer.

- e. Strategic Petroleum Reserve: Provides for an increase in the size of the SPR to 1 billion barrels and expands the set of circumstances in which a severe supply disruption is deemed to exist.
- f. Global Climate Change: Requires various reports, studies and assessments regarding global climate change and options for reducing greenhouse gas emissions.
- g. Nuclear Energy: Directs the DOE to perform various studies, to develop emissions criteria, and oversight of the Yucca Mountain nuclear waste fuel depository site; Creates the United States Enrichment Corporation (USEC) as a government corporation to take over ownership and responsibility for the federal government's uranium enrichments plants and requires the USEC to transmit to the President and Congress a strategic plan for privatizing the Corporation; Requires the USEC to purchase uranium from domestic suppliers, to "overfeed" it into the uranium enrichment process (i.e. to artificially increase the demand for domestic uranium), and to create a strategic uranium reserve. Provides funds for R&D on advanced nuclear technologies.
- h. Electric Utility Restructuring and Competition: Amends the Federal Power Act to give FERC authority to order utilities to provide interstate transmission service ("wheeling") to any jurisdictional supplier requesting such service, requires that the costs of providing such service be recovered from those requesting service, and expands transmission service obligations to the Bonneville Power Authority and to those portions of Texas (ERCOT) which had previously been exempt from the FPA by virtue of their decision not to interconnect with either the Eastern or Western Interconnections (keeping Texas electrons out of interstate commerce); Amends the Public Utility Holding Company Act (PUHCA) to exempt independent power producers meeting certain criteria (Exempt Wholesale Generators --- EWG) from most of the provisions of PUHCA; Amends PUHCA to exempt foreign utility holding companies from certain provisions of the Act and to allow U.S. utility holding companies to own interests in foreign utilities.

B. Energy Policy 1993-2000

The focus of EPA92 on energy efficiency, renewable energy, and environmental impact mitigation was well matched to the positions that the Clinton-Gore team had advanced during their election campaign. Vice President Gore was a champion of environmental improvement and had expressed deep concerns about CO₂ emissions and their impacts on global climate change. Their appointments to the Department of Energy were consistent with these views. Secretary Hazel O'Leary drew together an energy policy team that was very "green" and had been closely involved with the development of integrated resource planning, renewable energy, and demand-side management programs

in their respective states.¹⁸ This team saw the opportunity to bring the lessons they had learned in New England, New York, and California about the wonders of using electric and gas utilities as instruments for promoting energy efficiency, renewable energy, and related programs to the rest of the country. Promoting improvements in energy efficiency, renewable energy, alternative-fuel vehicles and new technologies for extracting and using conventional energy sources were their highest priorities.

Soon after his inauguration, President Clinton proposed the implementation of a large broad based tax on energy (the “btu tax”). The proposal’s motivation was to raise revenue to reduce the federal budget deficit, to promote energy conservation, and indirectly to reduce pollution associated with the combustion of fossil fuels. The proposal was widely criticized in Congress, was unpopular with industry and individual consumers, and eventually went down in flames. The only remnant of the initial proposal that eventually was passed by Congress was a small increase in the federal gasoline tax to bolster the Highway Trust Fund. No new major energy policy legislation was passed by Congress during the rest of the decade. In April 1999, the Clinton Administration proposed comprehensive electricity industry restructuring and competition legislation, but neither it nor Republican alternatives got very far in Congress.

Energy policy during the rest of the decade relied heavily on the framework and policies embodied in the Energy Policy Act of 1992, associated state initiatives to restructure the electricity industry to promote wholesale and retail competition, the continued implementation of FERC regulations supporting the evolution of the restructured natural gas industry, new state initiatives to expand “customer choice” of natural gas supplier to residential and commercial customers served by local distribution companies (LDC), and the effects of the Clean Air Act of 1990 on coal use in the electric power industry. The major energy policy venues for gas and electricity policies were the Federal Energy Regulatory Commission (natural gas, electricity) and state regulatory commissions.

The Department of Energy’s policies were heavily influenced by the Administration’s environmental policy agenda, including concerns about global climate change. The DOE gradually reallocated R&D funding and policy initiatives away from coal and nuclear R&D programs toward programs focused on promoting energy efficiency and renewable energy supplies, and the development of more efficient vehicles that use fuels other than petroleum. Federal expenditures supporting energy efficiency, renewables, and alternative fuel vehicles increased significantly while funding for coal and nuclear technology declined.¹⁹ The Administration’s efforts in these areas were first hampered by federal budgetary constraints that placed pressure on the DOE’s budget. After 1994, these initiatives were impeded by a Republican Congress that was hostile to

¹⁸ A large fraction of the DOE budget is devoted to nuclear weapons-related programs and the clean-up of radioactive waste on sites associated with these programs. I will not discuss these important aspects of DOE activities in this paper.

¹⁹ There was a significant increase in appropriations for fossil energy and nuclear science and technology programs in FY2001.

the DOE in general and the Clinton administration's favorite energy programs in particular. Congress prohibited federal agencies from even studying tightening the existing vehicle fuel efficiency standards, placed roadblocks in the way of evaluating and tightening appliance efficiency standards as required by EPAAct92, and rejected or cut back Administration proposals for tax subsidies for renewable energy and alternative fuel vehicles. Congress also slowed down efforts by the Administration to shift funds toward renewable energy and energy efficiency programs. In response to budget constraints and a hostile Congress, the Clinton administration began to work with industrial groups on voluntary programs to develop policies to respond to global warming concerns (Climate Change Action Plan) and new motor vehicle technologies that would improved fuel economy and reduce air emissions (Partnership for a New Generation of Vehicles).

Early in the Administration, the DOE was an active cheerleader for spreading the gospel of state "integrated resources planning" (IRP) programs for regulated gas and electricity utilities. However, most of the states that had been leaders in applying IRP were veering quickly toward initiatives to restructure their gas and electric utilities in order to promote wholesale and retail competition or "customers choice." The Clinton DOE team had to play "catch-up" on the electricity competition front as the states (e.g. California, New York, Maine, Massachusetts) that had been the primary test-beds for integrated resource planning and utility Demand Side Management (DSM) programs began to focus primarily on the problem of high electric rates and the potential for industry restructuring and competition to bring them down. The electricity restructuring bandwagon also undermined the Climate Change Action Plan initiative as many of the utilities that had been active on climate change issues became occupied with industry restructuring, stranded cost recovery and competition issues. The Administration did not propose its own federal electricity restructuring legislation until early 1999 and it too had a number of provisions designed to preserve utility energy efficiency and renewable energy programs and to tilt deregulated markets toward renewable energy through "portfolio" standards. Neither the Administration's bill nor several Republican alternatives ever gathered enough political support to come close to being passed. While the Administration's bill was a piece of "something for everyone" legislation, opposition from state officials, some vertically integrated utilities, some consumer groups, and tepid support from interests that supported some, but not all, of the details of the proposed legislation undermined the ability of the Administration to move it to a successful conclusion in Congress.

The Administration also quietly supported or acceded to Republican policy initiatives that encouraged oil and gas drilling in deep water, tax and royalty relief for small relatively inefficient oil and gas wells, opened up additional federal lands in Alaska to drilling, proceeded with the privatization of federal uranium enrichment facilities and the Elk Hills Naval Petroleum Reserve, supported federal funding for development of new technologies to increase oil extraction productivity, continued the slow process of licensing a federal nuclear waste storage facility, supported the re-licensing of operating nuclear power plants and continued research on advanced reactor technology, and initiated a cooperative program with the U.S. automobile industry to develop more fuel-efficient vehicle technology. Foreign policy initiatives endeavored to diversify the

nation's oil supplies and to foster the independence of oil producing states that were created after the break-up of the Soviet Union. The Administration also supported increases in the oil stored in the Strategic Petroleum Reserves (SPR) and the development of policies to use the SPR to respond to oil supply crises.

It is important to recognize that the Clinton administration demonstrated a continued commitment to relying primarily on market forces to allocate energy resources. It did not try to return to the failed price control, rationing and energy allocation policies of the 1970s and early 1980s. The Clinton administration viewed the proper role of energy policy to be to respond to market imperfections, especially as they related to the environmental impacts of energy production and consumption. It believed in using limited financial incentives to encourage consumers and suppliers to change their behavior. It had faith that new technologies could reduce the costs of energy efficiency, renewable energy, alternative-fuel vehicles, and production of conventional fuels. It also viewed increased supply diversity from renewable and alternative fuels as playing an important role in promoting national security interests as well. Thus, the Clinton administration's policies reinforced what has become a bipartisan rejection of the aggressive energy market intervention policies of the 1970s and early 1980s and support for policies focused on allowing energy markets to work, breaking down regulatory barriers restricting markets from working efficiently, and reflecting environmental and national externalities in energy policies through financial incentives and market-based mechanisms.

C. Energy Supply, Demand and Prices During the 1990s

Total U.S. energy consumption grew steadily after 1991, increasing by about 17% between 1990 and 2000. Consumption grew in all sectors (residential, commercial, industrial, transportation) during the decade and the distribution of energy consumption between residential, commercial, industrial and transportation sectors changed little between 1990 and 2000. The economy continued to become more electricity intensive as electricity consumption grew by over 25% during the decade. Energy consumption per real dollar of GDP continued its long historical decline, though the rate of decline was slower than during the 1980-1990 period when energy prices were higher. **[FIGURE 9]** Energy consumption per capita increased steadily after 1991. **[FIGURE 10]**

The overall energy fuel supply mix in 2000 was little different from that in 1990, with a small increase in the share of natural gas and a small decrease in petroleum's share. Aggregate domestic energy production was roughly constant during the decade while oil production continued to decline. Domestic natural gas production increased slightly, as off-shore production and production from non-conventional sources increased more than conventional on-shore production declined. Imports of natural gas from Canada increased significantly as the demand for natural gas increased much more quickly than did domestic supplies. Coal production continued to increase slowly but steadily along with the continuing shift of production from the Eastern producing areas to those in the West. Nuclear energy production increased significantly, despite few new plants being completed and nearly a dozen plants closing. Definitive resolution of a site for permanent storage of nuclear waste continued to elude policymakers, though some

military waste began to move to a site in New Mexico. Renewable energy supplies increased modestly, but accounted for about the same fraction of domestic energy production in 2000 as in 1990.²⁰

Net imports of energy increased by more than 50% during the decade, with all of the increase coming after 1992. The increase in net imports is associated with large increases in imports of petroleum from around the world and a large increase in imports of natural gas from Canada.

Real fossil fuel prices declined 20% (average for decade) from their 1990 peak through 1999, though there is considerable volatility in oil and natural gas prices. By 1998/99 the real price of fossil fuels reached a level about equal to prices prevailing just before the 1973/74 oil embargo. A further dramatic drop in world oil prices in 1998 quickly reversed itself in 1999 as OPEC implemented a supply reduction program, facilitated by Mexico, and oil prices continued to increase during 2000. Wellhead prices of natural gas, which had remained in the \$2 to \$3/MMbtu range through most of the 1990s, increased dramatically beginning in the summer of 2000, with delivered prices rising to as high as \$10/Mcf in most regions by the end of 2000 and (briefly) to as high as \$60/Mcf in Southern California in mid-December 2000, before falling back to \$3/Mcf by July 1, 2001. Real electricity prices fell during the decade, with the first nominal price increases in many years starting to be observed in late 2000 in response to increases in natural gas and wholesale electricity market prices. There was excess electric generating and transmission capacity in all regions of the country at the beginning of the decade. Little new generating or transmission capacity was added after 1992. With growing demand and little new supply, the excess capacity margin gradually disappeared. Rising natural gas prices, tight supplies, and delays in the completion of new generating plants led to dramatic increases in wholesale market prices in 1999 and especially in 2000. Spot shortages of electricity occurred in California in late 2000, January and March 2001.

In summary, most of the decade following Operation Desert Storm was characterized by abundant supplies of energy, a gas pipeline and electric power infrastructure with excess capacity, and stable or modestly falling real prices. Predictions were for more of the same for the first decade of the 21st century. Interest in energy policy largely disappeared, with the exception of electricity restructuring initiatives, which in turn were largely stimulated by cheap natural gas, excess generating capacity, and very low wholesale market prices. The complacency about energy policy and satisfaction with the performance of energy markets changed quickly as oil, gasoline and natural gas prices increased significantly during 1999 and 2000, California's electricity market collapsed, and electricity supply shortages loomed throughout the West. When George W. Bush was inaugurated, he argued that the nation again faced an "energy crisis" driven by higher oil and natural gas prices, higher wholesale electricity prices, and

²⁰ Almost all of the increase in renewable energy is associated with the use of wood, waste, and alcohol fuels. The data for these uses is not very reliable. Solar and wind energy supplies increased by about 50% during the decade, but represented only about 0.1% of total domestic energy production in 2000. More on renewable energy below.

electricity shortages in some areas of the country. In short, the 1990's was a new "golden age" for energy which happened to start and end with energy supply shocks, but largely proceeded without energy policy being high on the national policy agenda.

V. PETROLEUM

The 1990s was a decade in which U.S. policies relied primarily on unregulated market forces to operate to allocate resources to and within the petroleum sector. While there were no major domestic petroleum policy developments during the decade, the Administration supported Republican sponsored legislation to stimulate off-shore drilling in deep water by reducing federal royalty payments,²¹ urged Congress to reauthorize the Strategic Petroleum Reserves, proposed the establishment of regional heating oil reserves, sold the Elk Hills Naval Petroleum Reserve,²² initiated a set of modest technology transfer and support programs to increase productivity from small high cost oil wells, and opened up federal lands for oil and natural gas drilling, including the National Petroleum Reserve in Alaska and additional areas adjacent to existing production areas on the North Slope of Alaska. The Administration also pursued foreign policies to strengthen relationships with governments of oil producing countries and to encourage Caspian Sea countries and U.S. oil companies developing resources in these countries to build a pipeline under the Caspian Sea to Turkey in order to avoid routes through Iran and Russia, reducing dependence on these two countries.

Environmental regulations also affected petroleum supply and demand during the decade. In particular, the implementation of environmental regulations affecting the composition of gasoline burned in automobiles in several cities resulting from the Clean Air Act Amendments of 1990 and growing constraints on domestic refining capacity began to have a visible affect on gasoline supply and prices in some regions by the end of the decade. Environmental regulations also affected petroleum supply and demand during the decade. In particular, the implementation of environmental regulations affecting the composition of gasoline burned in automobiles in several cities resulting from the Clean Air Act Amendments of 1990 and growing constraints on domestic refining capacity began to have a visible affect on gasoline supply and prices in some regions by the end of the decade. Gasoline price spikes in 1999 and 2000 in California and the Midwest led to calls for price controls, which the Administration resisted. In September 2000 President Clinton decided to release oil from the Strategic Petroleum Reserve (SPR) in response to rising world oil prices and concerns that unusually low heating oil inventories would lead to shortages during the following winter.

Petroleum accounted for about 38% of domestic energy consumption in 2000, down from 40% in 1990. Petroleum consumption grew by 15% between 1990 and

²¹ Deep Water Royalty Relief Act, P.L. 104-58, November 28, 1995.

²²The federal government began studying the sale of Naval Petroleum Reserve #1 (Elk Hills in California) and #3 (Teapot Dome in Wyoming) in 1986. The DOE initiated the process of evaluating and selling Elk Hills in 1995. The sale was completed in 1998 for \$3.65 billion. Since the Teapot Dome reserve contained relatively little remaining oil it was decided to produce it out rather than to sell it. The Administration also initiated policies to lease or transfer to the private sector the federal Shale Oil Reserves. The primary motivations for these efforts were to raise funds for the federal government and to increase productivity from these properties.

2000,²³ and in 1998 surpassed the previous peak consumption level reached 20 years earlier. The transportation sector, primarily passenger cars and trucks, accounted for about 68% of U.S. oil consumption in 2000, up from about 64% in 1990. Most of the rest is accounted for by the industrial sector, with little oil being used in the residential and commercial sectors or to generate electricity. Petroleum policies and policies affecting automobile and truck fuel efficiency and utilization are clearly highly interdependent. (Automobile fuel efficiency policies are discussed below.)

Domestic oil production continued to decline steadily during the 1990s as imports increased. By the end of 2000, the U.S. was importing 56% of its petroleum and petroleum imports increased by 40% during the decade. Overall, imported energy increased from 17% of total energy consumption in 1990 to 25% in 2000. In the mid-1990s aggregate energy imports surpassed the previous peak level reached in 1977 and by 2000 had exceeded that import level by 36%. By the end of the decade, the U.S. was far more dependent on imported energy in general and imported petroleum in particular than it had been since the mid-1970s, just before the second oil shock.²⁴ However, it is also important to recognize that the energy intensity of the U.S. economy declined significantly during this period; energy consumption by dollar of real GDP in 2000 was about 60% of what it was in 1977.

Crude oil prices declined from their 1990 peaks during the most of the decade, though there is significant year-to-year price volatility. Crude oil prices plummeted during 1998, apparently as a result of declining imports from Asian countries experiencing an economic contraction and subsequent economic problems in Russia. Gasoline prices followed a similar pattern [FIGURE 11]. Domestic oil and gas drilling activity followed these price trends fairly closely [FIGURE 12 and FIGURE 13]. Falling crude prices had a significant adverse impact on oil exporting countries. In 1999, the Mexican Minister of Energy worked closely with Venezuela and other OPEC countries to curtail supplies in an effort to drive up prices. While these efforts initially met with little success, they eventually led to coordinated supply curtailments. World petroleum demand increased as the economies of countries in Europe and Asia recovered and oil prices began to rise rapidly. Oil prices rose significantly in 1999 and increased further in 2000 as world demand continued to increase as supplies tightened. Oil prices peaked at an average price of about \$31/barrel of crude oil during the fall of 2000 and then fell back to the \$25-\$27 range during the first four months of 2001. The increase in crude oil (and natural gas) prices has stimulated a very significant increase in domestic drilling activity, with the number of oil and gas wells drilled each month doubling from mid-1999 levels by the end of 2000. Despite the significant price increases that occurred after mid-1999, real oil and product prices remained at levels far below their peaks in 1980-81, though higher than the local price peaks reached in 1990.

²³ This is about the same growth rate experience by the OECD countries as a whole and for OECD Europe.

²⁴ Petroleum supplied by OPEC countries increased to 43% of world production in 2000 from 38% in 1990. OPEC accounted for a much smaller proportion of world production in 2000 (43%) than it did in 1973 (56%).

As U.S. petroleum consumption has increased, the availability of domestic capacity to refine crude oil into petroleum products has become a growing problem. The U.S. experienced a steep decline in refining capacity since its peak in 1981, though most of this decline occurred before 1987. [FIGURE 14] About 3 MMBD of refining capacity was closed during the 1980s, after price controls and allocations ended. These regulations had propped up small inefficient refineries and they exited the market as these regulations were repealed. Though the number of refineries has continued to decline, and no new refineries have been built in many years, total refining capacity was roughly constant during the decade, with a significant expansion in capacity after 1994 resulting from expansion of existing refineries.²⁵ Growing demand for refined products and roughly constant refining capacity led to increasing refinery capacity utilization rates around during the 1990s, with capacity utilization reportedly increased to 98.5% by the end of 2000. Future expansions in refining capacity are expected at some existing refineries and outside the U.S., including in Mexico and South America. It is unlikely that major new refinery sites will be developed in the U.S. unless regulatory restrictions on siting new refineries change significantly.

The extremely high levels of refinery capacity utilization mean that refined product supplies and prices are very sensitive to unplanned refinery outages resulting to equipment breakdowns, fires, etc., since there is essentially no reserve capacity in the system. Accordingly, product demand and supply availability fluctuations must be fully absorbed by product inventories, which had also declined in the last few years. This sensitivity of product prices to refinery (and oil pipeline) outages has increased as a consequence of the growing regional differentiation in the composition of gasoline required to meet environmental regulations on a seasonal basis. There are now as many as 40 “micro-breeds” of gasoline (including octane differences) sold in the U.S.

In the last ten years, the refinery industry has had to respond to five sets of new environmental regulations affecting motor gasoline product composition:²⁶

Phase I Summer Volatility Regulation (RVP):	1989
Phase II Summer Volatility Regulation (RVP):	1992
Oxygenated Gasoline Rules	1992
Reformulated Gasoline Phase I (RFG)	1994
Reformulated Gasoline Phase II (RFG)	2000

These regulations have required significant changes in refinery operations and investments in plant and equipment. In total, the regulations have been estimated to have

²⁵ See *Winter Fuels Outlook*, Energy Information Administration, October 2000. Contrary to some conventional wisdom, refining capacity did not decline during the 1990s. It increased slightly overall, with more than 100% of the increase between 1990 and 2000 coming after 1994.

²⁶ See Tancred C.M. Lidderdale “Environmental Regulations and Changes in Petroleum Refining Operations,” Energy Information Administration, <http://www.eia.gov/emeu/steo/pub/special/enviro.html>, March 22, 2001.

increased gasoline prices by amounts in the range of 7 to 10 cents/gallon.²⁷ Perhaps more importantly, because different states have different requirements for gasoline composition, some states and regions have become more dependent on a small number of refineries that can produce gasoline meeting local requirements.²⁸ This means that regional demand or supply side shocks can have larger impacts on prices in particular areas of the country than would be the case if there was more refinery capacity producing approved fuels available to meet supply and demand shocks. The benefits of giving states flexibility in choosing whether and how to restrict gasoline compositions to meet ambient air quality standards may not be worth the growing costs of this flexibility.

The introduction of the EPA's Phase II regulations for summer-blend reformulated gasoline in high ozone urban areas likely contributed to the localized gasoline price spikes experienced in the Midwest during the first half of 2000. As discussed above, crude, gasoline and product prices increased dramatically during the second half of 1999 and during 2000 throughout the U.S. However, the increase in gasoline prices was much more extreme in a few Midwestern cities than it was in most of the rest of the country during this period of time. These regulations went into effect on May 1, 2000 at the wholesale level in both Chicago and Milwaukee. An FTC study found that the new, more-stringent regulations may have contributed to abnormally low inventories for several reasons. They required that winter-blend gasoline be drained from storage tanks before the summer-blend supply could be added, which led to lower inventories than usual. Apparently, summer-blend Phase II RFG also proved to be more difficult to refine than anticipated, causing refinery yields to be less than expected. Moreover, the FTC study suggests that the ethanol-based RFG used in Chicago and Milwaukee was even more difficult to produce. Further, St. Louis entered the RFG program in 2000, and this further increased demand for RFG in the Midwest. The FTC study noted that additional, non-RFG factors, also contributed to the increase in gasoline prices in the Midwest during summer 2000.^{29 30} Finally, the FTC concluded that supplier behavior that caused the Midwestern gasoline price spikes during summer 2000 did not violate the antitrust laws.³¹

²⁷ *Ibid.* and references cited there.

²⁸ Some states have voluntarily adopted restrictions on gasoline composition during different seasons and states retain some flexibility regarding the precise "micro-brew" they rely on to meet environmental regulations.

²⁹ Final Report of the Federal Trade Commission, *Midwest Gasoline Price Investigation*, March 29, 2000. <http://www.ftc.gov/os/2001/03/mwgasrpt.htm>. See also the FTC's Interim Report, <http://www.ftc.gov/os/2000/07/gasprice.htm>.

³⁰ Another possible contributor to the Midwest price increases was the break in the Explorer pipeline in March. Explorer moves refined petroleum products from the Gulf of Mexico through St. Louis to Chicago and other parts of the Midwest. The pipeline break caused a disruption in the supply of gasoline to the already tight Midwest markets. That could have exacerbated an already tight supply situation and contributed to rising prices throughout the region. *Ibid.*

³¹ In May 2001 the FTC closed an investigation of gasoline price spikes in the Western U.S. which it began in 1998, concluding that the prices at issue were not the result of behavior that violated the antitrust laws. <http://www.ftc.gov/opa/2001/05/westerngas.htm>.

As noted earlier, the SPR was created in late 1975 pursuant to the Energy Policy and Conservation Act. (EPCA). EPCA provided for the establishment of a petroleum reserve of up to 1 billion barrels. Salt caverns were subsequently acquired along the Gulf coast to store the oil, and crude oil began to be stored there in 1977. Oil stored in the SPR peaked in 1994 at 592 million barrels and, after some test sales, settled at 570 million barrels by the late 1990s. Under EPCA, the President must determine if a draw down is required by “a severe energy supply disruption or by obligations of the United States” under the International Energy Treaty. EPCA goes on to discuss the characteristics of such a severe supply disruption and these include that the supply disruption be of significant scope and duration, and cause major adverse impact on national safety or the national economy. Prior to September 2000, the SPR had been drawn down for a couple of test sales and during Operation Desert Storm in early 1991.

On September 22, 2000, President Clinton authorized the release of 30 million barrels of oil from the SPR over a 30-day period. The objective was to increase domestic supplies during the prevailing tight supply situation and, in particular, to increase supplies of heating oil which were projected to be in short supply during the coming winter. Heating oil inventories were at unusually low levels during 2000 and oil prices continued to increase as the year progressed. **[FIGURE 15 and 16]** Very low heating oil stocks going into the fall were of particular concern given the lags between crude oil deliveries, refining, and delivery to local oil terminals.

The proposed release from the SPR was very controversial both inside and outside the administration. The release was opposed by Treasury and State. Those opposed were concerned that the federal government was marching down the path of speculating on future oil price movements and that these interventions would be ineffective because private oil inventory and production decisions would simply work in the opposite direction. In the end, the White House decided to release oil to demonstrate that it was doing something to respond to rising prices and potential heating oil shortages. The release was structured as a “swap” rather than a sale of oil, apparently partly to avoid dealing with EPCA’s criteria for selling SPR oil. Under a swap arrangement oil was released from the SPR and would be replaced later by a larger amount of oil, with the terms of the swap determined by competitive bidding. It is hard to know what, if any, effects this modest release had on heating oil stocks or prices. There is no obvious change in the trajectory of heating oil stocks after the release, though crude oil and product prices did fall significantly after November. **[FIGURE 16]**

The “let the market work” approach to petroleum markets did have some potentially adverse consequences. Imports of petroleum increased significantly. During this period, petroleum demand continued to grow, improvements in vehicle efficiency stagnated (more on this presently), domestic production declined, petroleum imports increased to their highest levels in history. U.S. imports of petroleum now exceed 10 million barrels per day. The Energy Information Administration projects a continuing decline in domestic production and increasing imports of petroleum over the next two decades. By 2020, imports are projected to account for roughly 75% of U.S. petroleum

consumption. There is little chance that much can be done to significantly change this trend through domestic “supply side” initiatives, despite the fact that real oil prices are projected to increase significantly over the next 20 years in all EIA cases. As I will discuss presently, the Clinton administration did little to curtail oil demand growth by, for example, tightening vehicle fuel efficiency standards, largely because Congress made it virtually impossible for the Administration even to study changes in fuel economy standards. For those concerned about U.S. dependence on imported oil, the 1990s did not end well. While the U.S. and other oil importing countries are much less dependant on Middle Eastern oil producers than was the case in the 1970s, the share of world production accounted for by Middle Eastern and North African countries has begun to grow once again. Moreover, these countries account for 70% of world petroleum reserves and dependence on them is likely to continue to grow.

The Administration’s primary direct response to the national security implications of rising oil imports was to strengthen relationships with governments of oil producing countries, to encourage Caspian Sea countries and producers to choose an export pipeline route that did not cross Iran or Russia, and to maintain a significant military presence in the Middle East.

VI. NATURAL GAS

During the 1990’s natural gas was widely viewed as “the fossil fuel of choice.” It is relatively clean (its combustion produces less CO₂, SO₂, and NO_x than do coal and oil yielding equivalent useful energy), it was relatively cheap and it could fuel new efficient combined-cycle gas turbine (CCGT) electric generating facilities. The CCGT facilities in turn were ideally suited for supporting the evolving competitive electricity markets since they could be built quickly, at relatively small minimum efficient scale, were less capital intensive, and could be more easily sited than conventional generating plants. The primary policy initiatives related directly to natural gas focused on completing the program begun in the 1980s to open up access to interstate natural gas pipelines to competing marketers and brokers who could then buy gas in the field at unregulated markets. The Administration’s support for the Republican Sponsored Deep Water Royalty Relief Act of 1995 encouraged exploration, development of continued production of natural gas from marginal reserves in the Gulf of Mexico. The Administration also supported legislation to provide limited tax incentives for oil and gas production.³² Several states introduced open access or retail “customer choice” programs to enable residential and small commercial customers to buy unbundled distribution service from their local gas distribution utility (LDC) and buy commodity natural gas separately from an unregulated intermediary. In addition, federal and state policies supporting restructuring and competition in the electricity sector were viewed as an indirect way to encourage increased use of natural gas to generate electricity.

Natural gas accounted for 24% of U.S. energy use in 2000, up from 23% in 1990. U.S. natural gas consumption increased by 22% between 1990 and 2000. [FIGURE 17]

³² The proposals would have allowed oil producers to expense certain geological, geophysical and lease costs.

Electricity produced with natural gas increased by 57% between 1990 and 2000 and almost all new electric generating plants under construction at the end of the decade were fueled by natural gas.³³ Natural gas consumption is projected to continue to grow rapidly in the next two decades, increasing by roughly 50% by 2020.³⁴ Natural gas's share of total energy consumption is projected to grow to 33.1% in 2020. This increase in projected natural gas consumption is dominated by rapidly growing utilization of natural gas to produce electricity, using CCGT generating technology.

Domestic natural gas production increased by only about 8% between 1990 and 2000; domestic production was roughly constant from 1994 to 1999 before increasing again in 2000 in response to significantly higher prices. Production from off-shore wells, unconventional sources, and gas associated with the production of oil all increased during the decade.³⁵ From 1994 to 1997 natural gas reserve additions exceeded actual production, however in 1998 and 1999 reserve additions fell short of actual production, and this is likely to have been true as well during 2000.³⁶ After declining significantly during the 1980s, gas-finding costs appear to have stabilized.³⁷ The decline in gas finding costs may be attributed in part to the opening up of more federal lands for drilling and, in particular, the expansion of drilling in the deep waters of the Gulf of Mexico. With rapidly growing consumption and stagnant domestic production, imports of gas were required to balance supply and demand. Imports from Canada increased by about 50% during the 1990s, new reserves were developed offshore of Eastern Canada, and new pipelines built, providing gas for New England and the Northeast. The deteriorating reserve additions situation, the leveling out of gas finding costs, stagnant domestic production, the "separation" of gas from oil prices due to what was characterized as a "gas bubble," and the growing demand for gas in the electricity sector probably should have been a warning that natural gas prices would soon rise. However, this was not widely predicted by experts at the time.³⁸

Real natural gas prices were roughly constant through most of the decade, though there was considerable year-to-year price variation. **[FIGURE 18]** Wellhead prices of natural gas were generally below the BTU equivalent price of oil during the 1990s.

³³ Based on first quarter 2001 data on generating plants (nearly 50,000 Mw) actually under construction provided to me by Argus. Natural gas used to generate electricity likely increased at a slower rate during the decade as more efficient CCGT capacity was completed. However, the EIA data presently available do not make it possible to derive accurate estimates of natural gas utilization to generate electricity after 1998.

³⁴ *Annual Energy Outlook 2001*, Energy Information Administration, December 2000, pages 82-86.

³⁵ Barbara Mariner-Volpe, "The Evolution of Gas Markets in the United States, May 2000, a presentation made available by the Energy Information Service.

³⁶ *Ibid.* Year 2000 data on reserve additions were not yet available in May 2001.

³⁷ [A discussion of the Deep Water Royalty Relief Act of 1995 will be included here.]

³⁸ Most pre-2000 forecasts were for natural gas prices in the \$2 to \$3 range in 2010.

Natural gas also had superior air pollution emissions attributes.³⁹ As a result, natural gas drove oil out of most boiler fuel uses (e.g. industrial boilers and conventional steam electricity production). However, beginning in mid-2000, natural gas prices began to rise rapidly to levels far above prevailing predictions or historical experience. **[FIGURE 19]** By late summer 2000 natural gas prices had risen to about \$5/mmbtu at Henry Hub and climbed to near \$10 by the end of the year, before declining back to about \$5/mmbtu by late March 2001 and about \$4 by June 1, 2001 and \$3 by July 1, 2001. Prices in California reached much higher levels as pipeline constraints caused prices in California to rise to levels far above those prevailing in the rest of the country.⁴⁰ **[TABLE 1]** The forward price curves in early July 2001 suggest that for the next few years natural gas prices will be in the \$3.00 to \$3.75/Mcf range, significantly higher than most predictions had indicated as recently as March 2000. *If* this increase in the projected level and trajectory of natural gas prices is sustained,⁴¹ it is likely to have significant implications for electricity prices (higher), existing coal plants (run them more and keep them running longer, and for investments in new generating capacity (several new coal generating plants were announced after gas prices exploded in late 2000).

The reasons for the unexpected increases in natural gas prices during 2000 are not yet well understood. Several factors are likely to be at work. First, natural gas demand increased by about 5% during 2000, after several years of stability, and continuing increases in demand are anticipated going forward as many new CCGT plants will be completed in 2001 and 2002. Second, natural gas in short-term underground storage was at unusually low levels in early 2000 and average storage levels for the year were at their lowest levels since 1978. **[FIGURE 20 and FIGURE 21]** Third, oil and gas well drilling activity had declined significantly in 1998 and the first half of 1999 in response to falling prices and net reserves declined in 1998 and 1999 as production exceeded new reserves. Drilling activity began to increase in mid-1999 in response to rising oil prices and increased further in mid-2000 as natural gas prices rose. Finally, with growing demand anticipated and tighter supplies ending a decade long “gas bubble” and “gas to gas” competition period, some analysts have argued that gas prices will rise to levels closer to price per BTU equivalence with oil products once again.⁴² According to this

³⁹ During the early 1980s, a rule of thumb was that wellhead prices of gas would tend to equilibrate at about 90% of the BTU equivalent price of crude oil, with gas and residual fuel oil competing at the burner tip for the boiler fuel market. During the 1990-99 period wellhead prices were generally well below this level, except during periods when oil prices suddenly dropped or during unusually cold winters. It is the low gas prices experienced for almost 15 years, rather than regulatory obstacles, that made the investments in gas pipeline capacity to bring gas from Northern Alaska and Northern Canada to the lower 48 states unattractive.

⁴⁰ Whether the high prices in California were caused by real pipeline and local storage constraints or reflected (at least in part) the market power of those controlling pipeline capacity into Southern California is an issue in dispute and litigation.

⁴¹ Most experts I have consulted are looking for long-term gas prices at much lower levels than prevailed between June 2000 and May 2001; in the \$3 to \$3.50/Mcf range.

⁴² J. Jensen, “North American Natural Gas Markets: The Revenge of the Old Economy,” presentation at the MIT CEEPR Workshop, May 4, 2001.

view, rising oil prices help to explain the unanticipated increase in natural gas prices and oil and gas prices will be more closely linked in the future.⁴³

Putting aside the excitement in gas markets during 2000, natural gas policy during the post-1992 period focused on the continued implementation of the open access and unbundling provisions of Order 636. The natural gas industry reforms begun during the 1980s were largely completed during the 1990s. They have proven to be an important, though sometimes misapplied, model for restructuring the electric power sector.

Since the prices for natural gas pipeline capacity continued to be regulated under Order 636, during the 1990s considerable effort was devoted to reforming interstate pipeline transportation pricing policies --- peak and off peak pipeline transportation prices, firm and interruptible contracts, gas storage services to support competitive markets for gas itself, and associated financial derivative markets upon which buyers and sellers increasingly came to rely upon to hedge gas price volatility. One of the more contentious sets of issues was associated with the resale of transportation capacity “released” by pipelines and other market participants who had purchased firm pipeline capacity. Order 636 required pipelines to establish capacity release programs to make unused capacity available to third parties. FERC also allowed shippers to resell or “release” firm capacity rights that they have acquired. However, the resale arrangements continued to be regulated in various ways, including through prices caps on short-term capacity release transactions based on the original regulated sale price of the firm capacity, without properly reflecting peak and off-peak utilization and cost differences. In February 2000, FERC issued Order 637 to resolve some of these issues. The order waives the price cap on short-term capacity release transactions, implements peak and off-peak rates for firm pipeline capacity, and makes a number of other changes.

The federal interstate pipeline access and unbundling programs have largely been successful in achieving their primary goals.⁴⁴ LDCs and large gas customers can now easily purchase natural gas in a competitive gas market (directly or through intermediaries) and are taking advantage of these opportunities. Competitive liquid markets for futures and options contracts have emerged to facilitate risk management by buyers, sellers and intermediaries. Gas transportation prices have fallen and, prior to mid-2000, natural gas prices were reasonably stable and very competitive with other fuels during the decade.⁴⁵ In 1995, a few states began to extend the unbundling concept to residential gas customers and by March 2000, four states had implemented a customer

⁴³ There appears to be another factor at work in 2000 as well. In “the old days,” a gas price spike like the one experience in 2000 would have led many utility and some industrial boilers to shift from gas to oil very quickly. While some switching did take place in 2000, the magnitude was small. I believe that this reflects environmental restrictions that have been placed on electric generating plants that limit the amount of oil that they can burn and the conditions under which they can burn it.

⁴⁴ The following discussion relies on Barbara Mariner-Volpe, *op. cit.*

⁴⁵ Barbara Mariner-Volpe, *op. cit.*

choice program for all residential customers, 7 more states were in the process of doing so, and 12 states had implemented pilot programs to test out the concept.⁴⁶

The increasing utilization of natural gas to generate electricity has and will require significant increases in interstate gas pipeline capacity and gas storage facilities. There were very significant increases in gas pipeline and gas storage capacity during the 1990s.⁴⁷ Even larger investments are being made in new pipeline capacity that is under construction or planned for completion in the first part of this decade.⁴⁸ The realization of the large expected increases in future natural gas consumption depends critically both on expanding gas reserves and expanding the gas pipeline transportation and storage infrastructure. Future pipeline projects must confront three sets of challenges.

First, investors must expect to get an appropriate risk-adjusted return on their investments in pipeline capacity. There are two important factors that must be taken into consideration to satisfy this constraint. FERC still regulates pipeline charges based on cost-of-service principles. Historically, pipeline projects would go forward after the pipeline had lined up long term firm contracts for a significant amount of the pipeline's capacity and the proponents could demonstrate that the pipeline was "needed" to serve this demand. In a world where pipelines are selling transportation service to serve a growing number of customers who are themselves operating in competitive markets (power generating companies, marketers, LDCs with uncertain future obligations to supply gas along with distribution service), it may be very difficult for pipeline developers to rely on very long term contracts to support financing of their projects. More importantly, FERC's methods for calculating pipeline charges were developed in an era where transportation customers entered into very long term contracts and took on the market risks associated with these obligations. With the new market institutions, some of this market risk will inevitably (optimally) be shifted back to the pipelines. If FERC regulation does not reflect the associated increases in capital costs, it will delay or deter necessary pipeline investments.

The second set of potential problems involves local opposition to new pipeline facilities. While the Natural Gas Act gives FERC substantial siting authority (unlike the situation with electric transmission facilities), state and local authorities are still a force to deal with. While the "Nimby" syndrome has not yet been as significant a problem for gas pipelines as it has been for electric generation and transmission projects, the continued local efforts to block pipeline projects is a continuing concern. During the 1990s, the U.S. was able to more fully exploit a gas and electric infrastructure that had excess supply capability at the beginning of the decade. The excess capacity has been used up (or more than used up). People may have become comfortable with increasing consumption without seeing major new supply projects. That era has come to an end and

⁴⁶ *Status of Natural Gas Residential Choice Programs By State*, Energy Information Administration, http://www.eia.doe.gov/oil_gas/restructure/restructure.html, March 11, 2001.

⁴⁷ Barbara Mariner-Volpe, *op. cit.*.

⁴⁸ *ibid.*

we are entering a period when conflicts over siting of energy supply facilities is likely to intensify once again.

Third, the future evolution of the natural gas industry is closely tied with developments in the electric power industry. The incomplete nature of electricity sector restructuring, competition and regulatory reforms and the turmoil caused by recent events in California increases uncertainty and investment hurdle rates for the development of new gas fields and pipeline facilities.

Despite these potential problems, the natural gas pipeline industry was generally successful in expanding natural gas pipeline capacity (and gas storage capacity) to meet the growing demand for natural gas during the 1990s.

Where is all of the natural gas projected to fuel future electric power generation, commercial and industrial demand over the next decade going to come from? Until May 2000, the general view was that natural gas was abundant and would continue to be very cheap. However, the dramatic increase in gas prices since May 2000, and the upward shift of the forward curve going out two years suggests that these assumptions may need to be revised. Rising natural gas prices have potentially important implications for future gas demand, electricity prices, and demand for coal used to generate electricity. The ultimate price trajectory will depend heavily on the cost of developing new supplies in the U.S., Canada (the sole exporter of non-liquified natural gas to the U.S.) and perhaps other countries which may be able to supply liquefied natural gas to the U.S., on the cost of transporting natural gas from Northern Alaska and Northwestern Canada through Alberta, on federal policies governing drilling on federal lands, and on into the U.S., and the ability to expand domestic pipeline capacity to accommodate rapidly growing demand. Domestic natural gas production has been projected to increase by roughly 50% over the next twenty years, after increasing only 8% during the 1990s, and these projections assume that gas prices will not rise above the average level prevailing in 2000 (after falling in the next few years) by 2020. Imports, primarily from Canada, are projected to increase by about 80%, and would account for nearly 20% of U.S. natural gas consumption by 2002.⁴⁹ These projections reflect the assumption that modestly higher gas prices will lead to significant increases in reserves and production from on-shore, off-shore and non-conventional non-associated sources (not found with oil). Production from the first two of these sources has been roughly constant in the last few years, so the projections reflect the assumption of a significant change in recent historical production trends. The price increases required to realize these production increases are very uncertain and without major improvements in drilling technology, much larger price increases may be necessary to bring forth this level of additional natural gas supplies. The recent renewed interest in expanding imports of liquefied natural gas (LNG) suggests that some investors expect natural gas prices to remain relatively high and that more costly LNG imports will be required to balance supply and demand.

⁴⁹ *Annual Energy Outlook 2001*, Energy Information Administration, December 2000, pages 82-86.

VII. ELECTRICITY

A. Background

Electricity accounts for about 36% of U.S. energy consumption, after taking account of the thermal losses associated with the transformation of fossil fuel into electricity.⁵⁰ In 2000, coal accounted for 52%, nuclear for 20% and natural gas for 16% of the electricity supplied. Conventional hydro (7%), oil (3%) and renewable energy (2%) accounted for the rest of the electricity supplied in 2000. [FIGURE 22 AND FIGURE 23]. The proportions of fuels used to generate electricity changed relatively little between 1990 and 2000, with natural gas accounting for a larger fraction (16% vs. 12%) and conventional hydro (10% vs. 7%) a smaller fraction. [FIGURE 24] Electricity consumption grew by about 28% [FIGURE 25] and peak demand grew by about 25% between 1989 and 1999. The U.S. began the decade with substantially more generating and transmission capacity than “needed” to meet current demand according to standard reserve margin criteria. Relatively little investment in new electric generating facilities was made during the decade, however. Generating capacity available to meet peak demand grew by only about 7% during the 1989 to 1999 period while (non-coincident) peak demand increased by nearly 30% during this time period. [FIGURE 26] Investments in new high voltage transmission lines also increased by only about 7% during this period as well. Accordingly, electricity consumption grew much more rapidly than did generating and transmission capacity during the decade. By the end of the decade the excess capacity had largely disappeared and spot shortages of power began to appear in some regions of the country, especially in the West. The real price of retail electricity continued to fall during the 1990s, reaching real price levels prevailing in 1974 by the end of the decade. [FIGURE 27] However, retail electricity prices began to rise again in a number of areas in 2000, following the increases in natural gas and wholesale power prices.

The electric power sector experienced the most profound structural and regulatory changes of any of the energy sectors during the 1990s. These changes were facilitated by a combination of wholesale market reforms initiated by FERC as it implemented portions of the Energy Policy Act of 1992 and individual state initiatives to restructure their electric utilities to take advantage of competitive wholesale markets and to create competitive retail markets which would allow consumers to choose their power supplier who would use the local utility distribution system to deliver power to them. The Clinton Administration’s role in these developments was modest. The rapid evolution of federal and state restructuring activity surprised the DOE and the administration played catch-up during the last half of the decade.

For most of the 20th century, the U.S. electric power industry was organized primarily around investor-owned electric utilities that had *de facto* exclusive franchises to serve all consumers in designated geographic areas.⁵¹ The prices that the utilities could

⁵⁰ The actual number is somewhat higher when electricity produced by industrial generators and cogenerators is fully taken into account. The measurement of the fuel used by these facilities is buried in commercial and industrial fossil fuel consumption data.

⁵¹ A more detailed discussion of the structure and regulation of the electric utility industry prior to the late 1990s can be found in Joskow, *op. cit.* 1989 and P. Joskow, “Deregulation and Regulatory Reform in the

charge to retail consumers were regulated by state public utility commissions, based on their “cost of service,” including a “fair rate of return” on investment. In return for their exclusive franchises, utilities had an obligation to serve all consumers requesting service at the prices approved by their state regulatory commissions. Utilities met their obligation to serve by investing in distribution, generation and transmission facilities. That is, utilities were vertically integrated into the three primary electricity supply segments and provided “bundled” retail service to their franchise customers. Unlike most other countries, the U.S. had a large number of vertically integrated utilities serving relatively small geographic areas rather than a single dominant enterprise serving most of the country. Over time, however, transmission and generating technology evolved in ways that made the economic supply areas regional rather than local. Rather than encouraging horizontal mergers to create much larger utilities to span economical supply areas, U.S. policies since the 1930s encouraged utilities to interconnect their transmission systems with one another, to build facilities jointly, to coordinate and share operating reserves and to trade power among themselves in wholesale markets when a utility with surplus energy could produce more cheaply than could a proximate utility from its own generating facilities. The prices of third-party transmission service (“wheeling”) and wholesale trades of power between utilities have been regulated by the Federal Energy Regulatory Commission (FERC), formerly the Federal Power Commission, since 1935. However, prior to EPA92 FERC had no authority to order utilities to provide transmission service or to require utilities to build power plants or transmission facilities to provide wholesale power or transmission service. As a result, regulatory authority for utility investments, operating costs and prices lay primarily with individual state regulatory agencies.⁵² In addition, the Public Utility Holding Company Act (PUHCA) of 1935 gave the SEC regulatory jurisdiction over the structure of public utility holding companies, their geographic expanse, internal transfer prices, and the kinds of businesses that they could engage in.⁵³

The Public Utility Regulatory Policies Act of 1978 (PURPA) played an important role in stimulating interest in expanding opportunities for non-utility suppliers to compete to build and operate power plants to supply of electric generation service to utilities for resale and created a powerful interest group to promote it. Title II of PURPA required utilities to purchase power produced by certain “Qualified Facilities” (QFs) using cogeneration and renewable energy technology at a price reflecting the utility’s “avoided costs” of supplying the power from its own facilities. These provisions of PURPA were

U.S. Electric Power Sector,” in *Deregulation of Network Industries: The Next Steps* (S. Peltzman and Clifford Winston, eds.), Brookings Press, 2000.

⁵² IOUs historically accounted for about 80% of industry supplies. The rest is accounted for by municipal, cooperative, and federal power supply and distribution entities. I will not discuss these entities here.

⁵³ A public utility holding company is a company that owns more than one utility operating company. PUHCA placed draconian restrictions on public utility holding companies with utility subsidiaries in more than one state. These restrictions severely limited the geographic areas in which a public utility holding company could operate, the lines of business that it could engage in (only those closely related to its utility operations), foreign investments in utilities in other countries, and investments by foreign utilities in U.S. utility businesses.

motivated by a desire to encourage more efficient electricity production technologies (cogeneration) and non-fossil technologies (renewables) reflect the 1970's goals of reducing dependence on foreign oil (though little oil is used to generate electricity) and reducing emissions of air pollution from fossil fueled power plants. Some states embraced PURPA with gusto, pressed utilities to rely as much as possible of PURPA facilities, and required them to enter into high-priced long term contracts to encourage third-party investment in PURPA generating facilities. These states were primarily those with politically powerful environmental groups and high retail electricity prices such as California, New York, the New England states, and a few others along the east and west coasts. Other states were indifferent and placed little pressure on their utilities to turn to third party suppliers for power. While PURPA was originally conceived primarily as an energy efficiency and environmental program, it soon became a demonstration project for the virtues of relying on competitive supplies from non-utility producers and was the primary vehicle undermining the traditional vertically integrated structure of electricity supply. By 1991, nearly 10% of electricity supplies was coming from non-utility generating facilities, primarily PURPA facilities heavily concentrated in California, the Northeast, Texas, and a few other states. Few utility-owned power plants were built in these states after the mid-1980s. Power supplied from "non-utility" generating plants increased by 400% during the 1990s. **[FIGURE 28]**. Until 1996, the increase in non-utility generation displayed in Figure 25 reflected primarily the completion of PURPA facilities and a few non-PURPA independent power projects. After 1996, the increase reflects primarily the divestiture of generating plants by regulated utilities subject to electricity restructuring programs in California, the Northeast, Illinois, and Montana to independent power suppliers and the entry of new capacity developed by independent power producers in these and other states. We turn to these latter developments now.

The enthusiastic implementation of PURPA by California, New York, the New England states and a few others was heavily influenced by environmental interests and concerns. By the late 1980s it would not be unreasonable to conclude that the regulatory process, especially as it related to electric utility resource planning and acquisition programs, had been captured by environmental interests in these states. In conjunction with the implementation of PURPA, these states adopted complex public planning processes to review utility investments, power purchase arrangements with PURPA suppliers, and to encourage utilities to "invest in customer energy efficiency" as an alternative to acquiring additional power supplies through ownership or contract. They also required utilities to give preference to cogeneration and renewable energy sources by placing "environmental adders" on the direct costs of power supplies. These planning processes were referred to as "integrated resource planning" or "least cost planning." They were a way to use the institution of regulated monopoly to pay for environmentally friendly supply sources and energy efficiency programs which traditional utility planning protocols would not have viewed as being "least cost." Most of these states also experienced significant increases in the regulated retail prices of electricity during the 1970s and 1980s. By the mid-1990s retail prices in many of these states were far above the national average **[TABLE 2 and TABLE 3]**. The high prices reflected the high capital costs and poor operating performance of nuclear power plants commissioned during the 1970s and 1980s, the high prices reflected in PURPA/QF contracts, and the

costs of excess capacity which got rolled into regulated prices. The Massachusetts commission took the view, however, that it was “not the price of electricity that mattered but rather its global societal cost.”

By 1990, least cost planning was the all the rage among state regulatory commissions and was spreading quickly from its origins in California, the Northeast and the Northwest. And it is these policies that are heavily reflected in the Energy Policy Act of 1992 (see above). As outlined earlier, EPAct92 has a large number of provisions to encourage energy efficiency, renewable energy, and integrated resource planning. It also had two important provisions that would come to have profound effects on the structure of the electric power industry. First, it gave FERC the authority to order utilities to provide wholesale transmission service to those requesting it, including the obligation to build new facilities to accommodate such requests. Second, it amended PUHCA to exempt firms building independent power production facilities from its regulatory requirements and also relaxed restrictions on U.S. utility investments in foreign utilities. These provisions allowed any investor to build “Exempt Wholesale Generating” plants to supply utilities with power without running into conflict with PUHCA’s rules and without having to meet PURPA’s cogeneration and renewable energy rules. It also opened up opportunities for U.S. utilities to invest in other countries and vice versa.

Thus, the electricity provisions of the 1992 Act reflected environmental, independent power and energy marketer, and utility interests. Environmental interests got the energy efficiency, renewable energy and integrated resource planning provisions of the Act. Independent power producers and marketers, including utilities that were interested in expanding into these lines of business, got the transmission and PUHCA exemption provisions. Other utilities thought that they got protection from losing their exclusive franchises to provide bundled service to retail consumers because the Act restricted FERC’s ability to order transmission service to support direct sales of power to retail consumers.

B. FERC Takes the Lead

Probably the most important contribution to the development of competitive wholesale and retail electricity markets made by the Administration was the appointment of a new set of FERC Commissioners who were committed to creating well-functioning competitive wholesale electricity markets and providing open non-discriminatory access to interstate transmission facilities to support the development of these markets. It turned out as well that these Commissioners were willing and able to work closely with California and a few other states as they went further than Congress required or the Administration expected to restructure their utilities and to create competitive retail markets as well.

Soon after the new FERC Commissioners were appointed, they proceeded aggressively to implement the wholesale transmission access provisions included in EPAct92. The focus was on providing transmission access to utilities seeking to buy power from independent producers to serve their regulated retail customers franchises and independent producers seeking to sell power to them. The basic model was one of

voluntary “wholesale competition” in which the local distribution company continued to act as the generation “portfolio” manager for retail consumers which the distribution company continued to serve exclusively in defined geographic areas at regulated cost-based rates. Purchasing power under contract from independent producers was now an alternative that utilities had to owning and operating their own power plants. A growing number of state regulators required utilities to seek competitive bids for *new* generating capacity needs and either to buy power under the best contracts offered, rather than building themselves, or to use competitive market prices as a benchmark for determining the compensation they would receive if they did build new plants, rather than relying on traditional rate-base/cost of service regulatory mechanisms. The expectation was that competitive bidding and competitive benchmark prices would provide more power incentives to control costs and increase operating performance than traditional cost of service regulation. The transmission access and pricing rules promulgated by FERC were initially focused on facilitating these developments. However, these early initiatives basically only required utilities to respond to transmission service requests on a case-by-case basis. Utilities were not required to file generic transmission tariffs that specified generally available transmission service offerings and associated maximum prices. Moreover, the nature of the transmission services that transmission owners were obligated to supply, and the associated prices, remained fairly vague, and utilities defined the kinds of transmission services and the pricing principles applicable to them in a variety of different ways. Transmission service requests sometimes became lengthy and contentious negotiations.

Both FERC and transmission service customers became frustrated by the slow pace at which transmission service was being made available to support wholesale market transactions, and FERC continued to receive complaints about discriminatory terms and conditions (real or imagined) being offered by transmission owners. Moreover, California’s electricity restructuring initiatives that began in April 1994 (more below) began to make it clear to FERC that its transmission access and pricing rules might have to support far more radical changes in the structure of the utility industry -- the functional separation of the generation of electricity from distribution service and the opening of retail electric service to competition -- and deal with a variety of new issues regarding state vs. federal jurisdiction over transmission, distribution, wholesale power sales and the treatment of “above market” costs of generating capacity and QF contracts (what came to be called the “stranded cost” problem).

In 1995 these considerations led FERC to initiate rulemakings on transmission service that ultimately served as the basis for two major sets of new rules issued by FERC in 1996. These rules are Order 888 -- “Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Service by Public Utilities; Recovery of Stranded Costs By Public Utilities and Transmitting Utilities,”⁵⁴ and Order 889 -- “Open Access Same-Time Information Systems.”⁵⁵ These rules now serve as the primary

⁵⁴ Final Rule issued April 24, 1999, 75 FERC ¶ 61,080.

⁵⁵ Final Rule issued April 24, 1999, 75 FERC ¶ 61,078.

federal foundation for providing transmission service, ancillary network support services, and information about the availability of these services to support both wholesale and retail competition in the supply of generating services.⁵⁶

Order 888 requires all transmission owners to file with FERC pro-forma open access transmission tariffs that transmission service customers can rely upon to define the terms and conditions of transmission services that will be made available to them. Order 888 specifies the types of transmission services that must be made available, the maximum cost-based prices that can be charged for these services, the definition of available transmission capacity and how it should be allocated when there is excess demand for it, the specification of ancillary services that transmission owners must provide and the associated prices, requirements for reforms to power pooling arrangements to comply with Order 888, and provisions for stranded cost recovery. All transmission owners and power pools have now filed open access transmission tariffs with FERC.

Order 888 recognizes the sanctity of pre-existing commercial, contractual, and regulatory arrangements associated with the historical use of transmission systems and is generally sensitive to providing a smooth transition from the old regime to the new regime. Importantly, Order 888 establishes federal principles governing the recovery of stranded costs, -- which I will discuss in more detail presently. For utility-owned generating plants, stranded or “strandable” costs are defined conceptually as the difference between the net book value of a generating plant used for setting cost-based regulated prices and the market value of that plant if it were required to sell its output in a competitive market. For a QF contract, stranded costs are generally defined as the difference between the present value of the contractual payment obligations and the present value of the competitive market value of the electricity delivered under the contracts. FERC established the public policy case for allowing for stranded cost recovery in light of the long established regulatory rules in effect when the investments and contractual commitments were made and the public policy interest in facilitating restructuring and the creation of competitive wholesale power markets.⁵⁷

While FERC’s position on stranded cost recovery was based primarily on its assessment of its legal obligations and equity considerations, it almost certainly reflected a set of more practical considerations as well. Specifically, a major impediment to incumbent utilities’ going along with more fundamental changes in the competitive environment and cooperating in creating new transmission and wholesale market institutions necessary to support full wholesale and retail competition was their concern about stranded cost exposure. FERC, and ultimately most state commissions that have considered the stranded cost issue, effectively sent utilities with stranded cost problems the following message: “Play ball by opening up your transmission and distribution

⁵⁶ FERC Order 2000 regarding Regional Transmission Organizations issued in December 1999 is likely to become equally important. *Regional Transmission Organizations*, 89 FERC ¶ 61,285 (1999).

⁵⁷ Verifiable stranded costs net of all reasonable mitigation options.

systems and by taking actions necessary to create competitive wholesale and retail markets quickly, and regulatory policy will treat requests for reasonable provisions for stranded cost recovery favorably. Moreover, this deal may not be on the table forever.”

Order 888 did not attempt to resolve the problems created for transmission service customers by the large number of transmission owners, all operating under separate pro forma Order 888 tariffs, which existed in many regions of the country. So, for example to make a trade between Indiana and Pennsylvania, a trader might still have to deal with several transmission owners to get a complete “contract path” from the generator supplying the power to the customer. However, FERC subsequently issued a set of regulations which strongly encourage the creation of large Regional Transmission Organizations (RTO) to resolve problems created by the balkanized control of transmission networks and alleged discriminatory practices of generators and energy traders seeking to use the transmission networks of vertically integrated firms under Order 888 rules.⁵⁸ The implementation details and effects of Order 2000 are yet to be determined.

Order 889, issued at the same time as Order 888, requires each public utility or its agent (e.g. a power pool) that owns, controls, or operates facilities used for the transmission of electric energy in interstate commerce to create or participate in an Open Access Same-time Information System (OASIS). This system must provide information, by electronic means, regarding available transmission capacity, prices, and other information that will enable transmission service customers to obtain open access non-discriminatory transmission service in a time frame necessary to make effective use of the transmission system to support power transactions. Order 889 also required public utilities to implement standards of conduct to functionally separate transmission and unregulated wholesale power merchant functions to ensure that a vertically integrated transmission owner’s wholesale market transactions are not advantaged by virtue of preferential access to information about the transmission network. Utilities must also make the same terms (e.g. service price discounts) available to third parties as they do to their wholesale power marketing affiliates.

C. California Takes Over the Lead

FERC’s initial efforts to implement the transmission provisions of EPCRA92 were based on the wholesale competition/utility-as-portfolio-manager model discussed above. Then something rather unexpected happened. In the midst of the recession of the early 1990s, which hit California and the Northeast especially hard as defense contractors and aerospace firms suffered from federal budget cuts, large industrial consumers revolted against the high electricity prices in these states. The cost of generation service reflected in their regulated prices was 6 to 7 cents/Kwh (exclusive of T&D costs) while the wholesale price was about 2.5 cents/kWh. Industrial customers in these states began to

⁵⁸ *Regional Transmission Organizations*, 89 FERC ¶ 61,285 (1999). Order 2000 technically makes participation in an RTO voluntary, but there are carrots and sticks available to FERC that will create significant pressure for utilities to join RTOs. Order 2000 does not mandate a particular organizational form for an RTO, however.

agitate for the right to buy power directly in the wholesale market and to pay the utilities only for the costs of T&D service. They were supported by independent power producers and energy marketers who emerged and matured with the earlier PURPA QF projects and the transformation of the natural gas industry. The utilities generally opposed “retail competition” because it would “strand” the costs of investments and contracts entered into years ago under the assumption that oil would be \$100/barrel rather than \$20/barrel.

In early 1993, the California Public Utilities Commission (CPUC) launched a comprehensive review of the structure and performance of California’s electricity industry. It was motivated primarily by pressure from industrial consumers to reduce electricity prices that were among the highest in the U.S. High prices in turn were blamed on failures of the existing system of regulated vertically integrated monopolies: the high costs of nuclear power plant investments, expensive long-term contracts with independent power suppliers, excess generating capacity, costly and ineffective regulatory institutions. There was broad agreement that the existing industry structure and regulatory system were seriously broken and needed to be fundamentally reformed.

In April 1994, the CPUC articulated a reform program for the electricity sector. It was built around a new industry structure in which the production of electricity from existing generating plants and the entry of new plants would be deregulated and their power sold in a new competitive wholesale market. Retail consumers would have the choice of using the transmission and distribution wires of their local utility to obtain “direct access” to these new competitive wholesale markets or continuing to receive power from their local utility at prices reflecting the costs the utilities incurred to buy or produce it. This vision for reform was heavily influenced by reforms implemented in Britain in 1990, where several CPUC commissioners and staff visited in early 1994.

California’s well-funded interest groups then spent the next four years arguing about exactly how this reform vision would be implemented. The new industry structure that eventually emerged from this contentious regulatory, legislative, and market design process was the most complicated electricity market ever created with many features that had never been tried before. In an effort to appease various interest groups, the market design incorporated bits and pieces of alternative market models.⁵⁹ The operation of the utilities’ transmission networks was turned over to a newly created non-profit Independent System Operator (ISO) which was responsible for managing the operation of the transmission network efficiently and reliably by relying on hourly spot markets for ancillary services and energy to balance supply and demand in real time. It also relied on a number of annual supply contracts with generators with locational market power to ensure supply availability in transmission-constrained areas like San Francisco and San Diego. A non-profit public Power Exchange (PX) was also created to operate a day-ahead hourly energy market and (ultimately) markets for a number of longer term forward contracts. Utilities were required to divest most of their fossil fueled generating plants and to buy and sell energy in the PX and ISO hourly spot markets. Other load serving entities and power suppliers were free to enter into bilateral contracts and simply

⁵⁹ See Joskow (2000), *op. cit.* for a more detailed discussion of California’s wholesale and retail market institutions.

submit schedules to the ISO. The most complicated set of auction markets for energy and operating reserves ever created was developed to govern spot market trading managed by the PX and the ISO.

It is inaccurate to characterize California's electricity reforms as "deregulation." The reforms are more properly viewed as "regulated competition." Wholesale market prices were deregulated, but retail prices were fixed for up to four years. The utilities were forced to sell their generating plants, in order to facilitate the creation of a truly competitive wholesale market and to value any prudent costs "stranded" by competition. But they also retained the obligation to buy power in the new wholesale market to provide service to retail consumers who did not choose a competitive retail supplier and to resell it to them at a fixed price regardless of its cost. The CPUC rejected utility requests to meet their default retail supply obligations, accounting for 85% of demand, by negotiating fixed-price long-term contracts with power suppliers to hedge wholesale market price risks. As a result, a large fraction of California's electricity demand was being served through the utilities' purchases in a volatile wholesale market; the utilities in turn were selling at a regulated fixed retail price and buying at an unregulated wholesale market price. Several knowledgeable people argued that there were numerous design flaws that would lead to problems once the wholesale markets began to operate.

Importantly, the excess capacity situation that contributed to the pressures for reform in 1993 gradually disappeared as electricity demand grew and no new generating capacity was completed during the four-year period of uncertainty over the new rules of the game. Once these rules were defined, developers quickly applied for permits to build many new power plants, only to confront a time consuming environmental review process and community opposition to power plants located near where they lived or worked. This slowed the pace of investment in and completion of new power plants. The first of these new plants did not be on-line until Summer 2001.

Subsequently, nearly two-dozen states decided to implement wholesale and retail competition reforms, though only about a dozen states have proceeded very far with the restructuring of their electricity industries. These states include five of the six New England states, New York, Pennsylvania, New Jersey and Illinois. Most of these "pioneer states" shared many attributes with California: high retail rates, excess generating capacity, expensive nuclear plants and QF contracts, and angry industrial customers. [TABLE 4] Nearly 100,000 Mw of utility generating capacity was divested to independent power suppliers, primarily affiliates of electric and gas utilities with franchises in other parts of the country, by utilities in these and other states from 1997 though 2000. Note that, so far, the state reform initiatives have proceeded with no new federal mandates or obligations beyond those included in EPCAct92 and FERC wholesale power market and transmission regulations made under its existing legislative authority.

D. The Administration Plays Catch-Up

The DOE largely played catch-up with these developments during much of the decade. Early in the administration the DOE's policies focused on exploiting the institution of regulated monopoly to promote utility funding of renewable energy and

energy conservation options, whose costs were paid for in regulated retail prices. The states that had pioneered these “integrated resource planning” programs also happened to be the pioneers on the restructuring and retail competition front. As the debates about restructuring and retail competition spread across the country, interest in IRP and related programs evaporated. The DOE tried to get back into the action by sponsoring a set of electricity policy forums, but DOE simply was never a major player on the electricity reform front. It was not until April 15, 1999 that the Administration proposed comprehensive electricity restructuring and deregulation legislation.

By trying to accommodate states rights interests, pressures from environmental groups to incorporate energy efficiency and renewable energy programs into federal “deregulation” legislation, pressures from utilities and independent power producers to repeal the Public Utility Holding Company Act (PUHCA) and PURPA, the Administration was slow in proposing comprehensive electricity reform legislation. The legislation that it did propose in April 1999 had something for almost every interest group in it. However, the legislation was opposed by several states, some vertically integrated utilities, and some consumer groups and broad support for the entire package was lacking. It did not get very far in Congress.

The primary features of the Administration’s proposed legislation were:

1. Provided that all retail electricity consumers would be permitted to choose their power supplier (retail wheeling) and that local distribution companies would provide unbundled distribution and transmission service to allow them to do so by January 1, 2003 *except* if a state decided to opt out of this retail competition system.
2. Clarifies FERC’s authority to order utilities to provide wholesale and retail transmission service, enshrines the provisions of Order 888 in federal law, and gives FERC authority to require the creation of independent regional system operators.
3. Established a Public Benefits Fund that would disburse federal matching funds to participating states to provide subsidies to low-income consumers, energy efficiency programs, education and other programs. The Fund would be financed by generators with a fee of up to 0.1 cents/kWh.
4. Established a Federal Renewable Energy Portfolio Standard (RPS) which requires electricity retailers to include specified minimum percentages of designated renewable energy sources in their supply portfolios.
5. Repeals the “must buy from QF” provisions of PURPA, while preserving existing QF contracts.
6. Repeals the Public Utility Holding Company Act while expanding access to books and records of holding companies and affiliates for FERC and state regulatory authorities.
7. Expands FERC’s authority to remedy market power problems in wholesale power markets.

8. Expands FERC's authority to approve and oversee a national Electric Reliability Organization and Affiliated Regional Entities to prescribe and enforce mandatory reliability standards.
9. Clarified the authority of EPA to require an interstate trading system for NOx reductions.
10. Provisions for stranded cost recovery.

Numerous other pieces of proposed restructuring legislation were filed in the House and the Senate during 1999 and 2000.⁶⁰ Several of them included many of the key provisions of the Administration's bill while others focused on a narrower set of issues: e.g. repealing PURPA, repealing PUHCA, transmission access, regional system operators and reliability issues. However, neither the Administration's proposed legislation, nor competing legislation proposed by Republican Senators and Congressmen garnered sufficient support to come close to being passed by the Congress.

E. California Runs into Major Problems⁶¹

The new competitive wholesale and retail electricity markets began operating in April 1998. Within a few months significant problems already began to emerge as a result of wholesale market design flaws and suppliers' ability to exploit them. Flaws were identified in the congestion management system, with the local reliability contracts, the protocols for planning and investment in transmission, with the real time balancing markets, in the ancillary services markets, and in other areas. Within the first two years of operation, the ISO had filed 30 major revisions to its protocols with the Federal Energy Regulatory Commission (FERC). The PX had filed for numerous changes in its operating protocols as well. Responding to a never-ending series of problems and proposed fixes for them, FERC ordered the ISO to seek to identify and implement fundamental reforms rather than just piecemeal fixes to individual problems as they arose. The complex "Noah's Ark" governance arrangements, with all major interest groups represented on the Board of the PX and ISO, made agreement on any sensible reforms very difficult. Moreover, because of California's very difficult and time consuming regulatory process for getting siting and environmental approvals for new power plants, the anticipated flood of new generating capacity was being delayed, while demand continued to grow along with the economy.

Despite these problems, competitive wholesale market prices for power were reasonably close to pre-reform projections, averaging 3 cents/kWh (\$30/Mwh) between

⁶⁰ *Federal Restructuring Legislation 106th Congress*, U.S. Department of Energy, http://www.eia.doe.gov/cnea.../page/restruct_bills/bill_sums_106.html, June 29, 2001.

⁶¹ For a detailed discussion of California's electricity market problems see Paul L. Joskow, "California's Electricity Crisis," July 2001, <http://web.mit.edu/pjoskow/www/>. For an overview of the evolution of electricity restructuring and competition programs in the U.S. see Paul L. Joskow, "Deregulation and Regulatory Reform in the U.S. Electric Power Sector," in *Deregulation of Network Industries: The Next Steps* (S. Peltzman and Clifford Winston, eds.), Brookings Press, 2000.

April 1998 and April 2000. [FIGURE 29]⁶² All things considered, prices were perhaps 10% higher than they would be in a system without these design flaws. In March 2000, the California Energy Commission published projections for wholesale market prices for 2000 and beyond which were in the \$30 to \$35/Mwh range.⁶³ Nevertheless, California's new market arrangements were an accident waiting to happen. And in mid-2000 the flawed wholesale market institutions and the partial deregulation program suddenly confronted a run of very bad luck.

Wholesale prices began to rise above historical levels in May 2000 and stayed at extraordinary high levels for the rest of the Clinton Administration's tenure. As wholesale prices rose above the fixed retail prices that the utilities could charge their retail customers, they began to lose a lot of money. The CPUC refused to raise retail prices to cover rising wholesale power costs until early January 2001, and the 1 cent/kWh surcharge approved was far too little to allow the utilities to cover either their ongoing wholesale power costs let along their past-due bills. By December some suppliers had run up against their credit limits and stopped selling electricity to California electricity. In mid-January the utilities had run out of cash and stopped paying their bills for wholesale power. At the Administration left office, the California electricity reform was in shambles as buyers had no credit and suppliers threatened to stop supplying.

During the Administration's final month in office the Secretary of Energy issued emergency orders to keep the lights from going out in California as credit problems led suppliers to withdraw supplies from the market. The Secretary of the Treasury tried to facilitate a negotiated settlement with the Governor of California, California utilities, and the major independent generators and marketers. His efforts were not successful. The mess would be left for the new Bush Administration to deal with.

The serious problems that emerged with the new market and regulatory arrangements in California during Summer 2000 cast a dark shadow over the electric utility restructuring and competition programs implemented during the Clinton years. These problems were at least partially a consequence of the failure of the federal government to articulate and promote a clear model for electricity sector restructuring and competition initiatives. Instead, it accommodated a wide range of state approaches to restructuring and interest group concerns. This "let a thousand flowers bloom" approach may have been politically convenient, but it led to an uncoordinated and sometimes incompatible and poorly design patchwork of state efforts to respond to interest group views on the appropriate directions for electricity restructuring and competition. It is possible that the passage of the comprehensive federal restructuring legislation proposed by the Administration would have (eventually) improved the situation, largely by expanding and clarifying FERC's authority in a number of important areas. However, I

⁶² The prices reported in Figure 26 are average hourly day-ahead prices in the PX. The PX went out of business at the end of January 2001. The prices listed for February, March and April 2001 are the average prices paid by the ISO for real-time energy during those months.

⁶³ "Market Clearing Prices Under Alternative Resource Scenarios: 200-2010," California Energy Commission, March 2000.

don't think that the passage of the legislation in 1999 would have forestalled the problems in California. The legislation does not specify a particular restructuring framework and does not deal with many important "details" that have led to problems in California and other states. It would have taken FERC some time to develop a more comprehensive framework and to use its new authority to implement it. Moreover, the state opt-out provision would have inevitably given the states a lot of discretion to proceed along their individual paths.

VIII. COAL

There were no major federal energy policies initiatives focused directly on the coal industry during the 1990s. However, environmental policies, especially the Clean Air Act Amendments of 1990, enhanced enforcement of New Source review policies, carbon emissions policies, rail transportation policies, policies affecting the price of natural gas, and electric utility restructuring policies all have had and will continue to have important implications for the coal industry. This is the case because (a) the combustion of coal produces more air pollutants and CO₂ emissions than other fossil fuels per unit of useful energy and (b) coal accounts for over 50% of the electricity produced in the U.S.

In 2000, coal accounted for 23% of the energy consumed in the U.S., slightly less than natural gas, about the same percentage as in 1990. Over 90% of the coal produced in the United States is used to generate electricity. Accordingly, developments in the coal sector are closely related to developments in the electricity sector. During the 1990s, U.S. coal consumption increased slowly but steadily, growing 17% between 1990 and 2000.⁶⁴ [FIGURE 30]. The U.S. exported 5% to 10% of the coal produced each year during the 1990s. (Coal production declined slightly in 1999 and 2000 as exports fell.) Coal production continued to shift to the West of the Mississippi from the East of the Mississippi due to the low-sulfur content of Western coal, declining transportation costs (a benefit of railroad deregulation initiated in the 1980s), and falling real Western coal prices. [FIGURE 31] In 1990, about 38% of U.S. coal was produced West of the Mississippi, while in 1999 nearly 50% was produced in the West. Western coal has penetrated farther and farther to power plants in the East and Southeast as coal prices at the mine and coal transportation costs have declined. The 1990 Clean Air Act provided additional stimulus to this continuing shift to Western Coal, but a lot of it can be accounted for by pure economics.⁶⁵ Indeed, the flexibility provided for by the SO₂ allowance trading system created by the Clean Air Act Amendments of 1990 probably helped to sustain Eastern coal suppliers, especial those producing mid- and low-sulfur coals, more than would have been the case if alternative regulatory mechanisms had been adopted based on plant-specific emissions limits or emissions control technology requirements.

⁶⁴ For a more detailed discussion see Richard Bronkowski, "The U.S. Coal Industry in the 1990s: Low Prices and Record Production," Energy Information Administration (undated).

⁶⁵ Ellerman, Joskow, Schmalensee, Montero and Bailey, *Markets for Clean Air: The U.S. Acid Rain Program*, Cambridge University Press, 2000.

Most of the increase in coal consumption during the decade reflected increased utilization of the existing fleet of coal-fired power plants, many of which are now quite old. Few new coal-fired generating plants were built or commissioned for construction during the 1990s and relatively little additional coal-fired generating capacity is planned for the next decade. However, during the 1990s, coal plant owners learned how to operate older plants more efficiently and reliably and adopted maintenance, monitoring and control technologies that have significantly increased the economic life of these plants. They adapted to the 1990 Clean Air Act Amendments smoothly and efficiently. Barring major and costly new environmental restrictions on coal-fired power plants, most of the existing plants have going-forward costs that are less than the total costs of a new gas-fired CCGT. These plants are likely to be economical to operate for many years into the future even if pre-2000 natural gas-price projections are realized. Moreover, the recent increase in natural gas prices and the associated increases in wholesale electricity prices have led to announcements of several new coal plants, though natural-gas fired plants continue to dominate the fleet of planned new generating plants.⁶⁶

It is difficult to measure coal prices in a meaningful way due to heterogeneity in heat, sulfur and other mineral content, the prevalence of long term contracts negotiated at different points in time, and the continuing shift of coal production from the East to the West. Ellerman, Stoker and Berndt show that real coal prices fell significantly in all producing regions during the 1990s, continuing a trend going back to the late 1970s.⁶⁷ Falling real coal prices reflected continuing increases in labor productivity, increases in total factor productivity, and economies of scale associated with a significant increase average mine size.⁶⁸ Productivity improvements were greater in underground mines in the East, Midwest and West than in surface mines generally.⁶⁹ The Energy Information Administration projects a continuing slow increase in coal consumption, a continuing shift of production to the West, and falling real coal prices for the next twenty years.⁷⁰

It became clear during the 1990s that the earlier assumption that older coal plants would be retired after 30 to 40 years of operation was no longer valid. These plants have remained competitive even while significantly reducing emissions of criteria pollutants.

⁶⁶ As of June 2001, there were only about 10-20 GW of new coal plants “planned” out of over 200 GW of total “planned” electric generating capacity. There are several data bases that report on “planned” generating plants and generating plants under construction. There is significant variation in the numbers reported.

⁶⁷ D.A. Ellerman, T. Stoker, and E. Berndt, “Sources of Productivity Growth in the American Coal Industry,” MIT Center for Energy and Environmental Policy Research, March 1998. Spot coal prices rose significantly beginning in the second half of 2000 and continuing into 2001, apparently in response to rising gas prices and a shift toward coal in electric generating plant dispatch. See Richard F. Bonskowski, “U.S. Coal, Domestic and International Issues, Energy Information Administration, March 27, 2001.

⁶⁸ Ellerman, Stoker and Berndt, *op. cit.*

⁶⁹ Ellerman, Stoker and Berndt, *op. cit.*

⁷⁰ *Annual Energy Outlook 2001*, Energy Information Administration, December 2000, pages 92-95.

This realization appears to have motivated the New Source Review lawsuits brought by the EPA toward the end of the Administration's second term --- an effort to impose costly cleanup requirements on older coal plants and to make these plants uneconomical to continue to operate. Even if the tighter restrictions on criteria pollutants did not make these plants uneconomical, some in the EPA hoped that these restrictions would make it more likely that future CO₂ emissions regulations would than have a bigger impact on coal-unit retirement decisions. These suits and the general policies affecting older coal-fired generating units bring to the fore the need to better harmonize energy, economic, national security and environmental policies.

IX. NUCLEAR ENERGY

Nuclear power accounted for 20% of the electricity generated in the U.S. in 2000, down slightly from 21% in 1990. Electricity supplied by nuclear plants increased by 31%, despite the fact that the number of operating nuclear plants fell from 112 in 1990 to 104 in 2000 and overall nuclear plant capacity declined by about 2% during the decade [FIGURE 32 and FIGURE 33]. The increase in nuclear electricity generation is accounted for entirely by a very significant increase in the availability of nuclear plants and their associated capacity utilization factors.⁷¹ Average plant capacity factors from 66% in 1990 to 88% in 2000. [FIGURE 34]

U.S. policy toward the nuclear power industry during the 1990s was a policy of benign neglect, neither promoting new plant development nor seeking aggressively to close existing plants. Indeed, although the Clinton administration was not a big booster of nuclear power, the industry flourished during the 1990s. A number of "pro-nuclear" actions were taken, including developing and applying re-licensing procedures for nuclear plants reaching the end of their initial license period,⁷² pre-certification of three new prototype plant designs, and support for continuation of a modest research program on advanced reactors. After declining for several years, the FY2001 budget included a big increase for nuclear science.⁷³ The Administration also continued to move the review process along for the future construction of a site for civilian nuclear waste at Yucca Mountain in Nevada, though the President vetoed a bill that would have formally designated this site for development.

At the beginning of the decade, the projections for the future of the U.S. nuclear power industry were gloomy. The last four nuclear plants that entered the construction pipeline in the 1980s were completed during the 1990s (2 in 1990, 1 in 1993, and 1 in 1996). No new nuclear plants have been announced since 1979. Eleven nuclear plants were closed during the decade (all before 1998) because of poor operating performance and going-forward costs that exceeded current and projected wholesale market prices.

⁷¹ When nuclear plants are available to run they are almost always dispatched to supply electricity because their short run operating costs are very low and ramping them up and down is costly.

⁷² The re-licensing of the Calvert-Cliffs plant in Maryland provided an important signal that there would not be insurmountable opposition to re-licensing from opponents of nuclear power.

⁷³ The proposed Bush administration budget for nuclear science and technology is, surprisingly, about 20% lower than the last Clinton administration budget for this line of business.

Early closure of additional nuclear units was predicted. By the end of the decade the picture for the existing fleet of nuclear plants was much rosier. There have been no plant closures since 1997 and several plants have applied for extensions of their original operating licenses. The rosier picture reflects the improved operating performance of the existing nuclear plants and the increase in wholesale market prices for electricity around the country. The improved operating performance is at least partially the result of the restructuring of the electric power industry, facilitated by the Energy Policy Act of 1992, and the expansion of competitive wholesale power markets.

The restructuring of the electric power industry and the gradual deregulation of power production is having significant positive effects on the nuclear power sector. Ownership of nuclear plants is being consolidated through mergers of utilities with several operating nuclear plants (e.g. Philadelphia Electric (Exelon) + Commonwealth Electric (Unicom) in 2000) and through acquisitions of nuclear power plants being divested by their original owners by a small number of utilities with a commitment to assemble large fleets of nuclear plants spread around the country (e.g. Entergy and Dominion Resources). Nuclear plants are increasingly subject to market-based pricing rather than cost plus pricing. The consolidation of ownership of plants within companies with substantial nuclear operating experience and staff-expertise, combined with market-based incentives have and should continue to lead to improvements in technical and economic performance of nuclear plants. Of course, the NRC must continue to be vigilant about nuclear plant safety, but the trends on key safety-related indicators have also been excellent.

The big question today is “will anyone ever build a new nuclear power plant again?” While the existing fleet of nuclear plants is economical to operate based on market revenues and going-forward costs, it is far from clear that it is economical to incur the capital costs associated with *building* new nuclear plants which would sell output in competitive power markets, taking into account both market risks and regulatory/siting risks. For new nuclear plants to be built to supply electricity in competitive wholesale markets, investors are likely to have to turn to new technologies which are less costly to build and are “inherently safe” to operate, as well as to overcome public resistance to the siting of nuclear plants near where they work and live. The economics of investing in new nuclear plants will turn heavily of the future prices of fossil fuels, especially natural gas, and whether the U.S. adopts a policy that places a significant price on carbon emissions as part of a serious policy to control emissions of greenhouse gasses

Proposals for new nuclear plants will also have to confront opposition resulting from the unresolved problem of disposal of high-level nuclear waste.⁷⁴ Controversy on where interim and permanent high-level nuclear waste disposal sites would be located continued during the 1990s. A waste disposal site for high-level nuclear waste has yet to be completed and it does not look like this will happen until after 2010. The Nuclear Waste Policy Act of 1982 (plus 1987 amendments) required the DOE to take possession

⁷⁴ For a good summary of the evolution of civilian nuclear fuel waste storage policies and programs See “National Nuclear Fuel Management Program,” and “National Program Implementation Timetable,” Nuclear Energy Institute, <http://www.nei.org>, November 26, 2000.

of and store spent nuclear fuel by January 1998. Since 1982, electricity consumers have been making payments into a fund to pay for waste storage at the rate of 0.1 cents per nuclear kWh produced. Customer commitments plus interest now come to about \$16 billion. However, the federal government has defaulted on its waste disposal obligations and is potentially subject to financial penalties.

The DOE was supposed to build a permanent deep, mined geological depository for high-level waste, an interim storage facility, and develop a transportation system to move spent fuel from power plants to interim and permanent storage sites. An underground site at Yucca Mountain, about 100 miles from Las Vegas, was identified for study (pursuant to 1987 amendments to the Nuclear Waste Policy Act). While feasibility studies for the site have been completed, there has been continuous opposition to constructing it and moving spent fuel to it for storage. In early 2000, Congress passed legislation that would have formally designated Yucca Mountain as the DOE's official waste storage site with a target completion date of 2007. However, President Clinton vetoed the bill. No interim storage site has been designated either. In 2001, DOE is scheduled to make its final site recommendation on Yucca Mountain. If it recommends moving forward, the President would then decide whether or not to go forward. If the State of Nevada objects to his decision, Congress would have to approve the site if it is to move forward. The earliest date that the site would be completed and ready to accept spent fuel is now about 2010. In the mean time, spent fuel is being stored on-site at nuclear plants (including plants that have been closed) around the country.

In 1995 and 1996, a controversy emerged over the privatization of the United States Enrichment Corporation (USEC), an initiative provided for (but not required) by the Energy Policy Act of 1992.⁷⁵ Nuclear power plants use fuel with "lightly enriched uranium" (LEU). Naturally occurring uranium has too little U₂₃₅ to sustain a nuclear reaction. In order to use uranium as a nuclear fuel, naturally occurring uranium must be "enriched" to a point where it contains 3.5% to 5%. LEU cannot be used directly to make nuclear weapons. Uranium-based nuclear weapons require highly enriched uranium (HEU), containing 90% U₂₃₅.⁷⁶ Historically, the federal government provided uranium enrichment services for civilian nuclear fuel (as well as for nuclear weapons) at plants owned by the Department of Energy. Enrichment services are also provided by state-controlled enterprises in France, Russia and a European consortium, though U.S. utilities still rely on U.S. facilities for 75% of their enrichment services. Utilities would

⁷⁵ This discussion draws on Peter R. Orszag, "Privatization of the U.S. Enrichment Corporation: An Economic Analysis," (undated, but written prior to the privatization of USEC); "Commercial Nuclear Fuel From U.S. and Russian Surplus Defense Inventories: Materials, Policies, and Market Effects," Energy Information Administration, http://www.eia.doe.gov/cneaf/nuclear/com_fuel/, March 11, 2001; "Nuclear Proliferation: Implications of the U.S. Purchase of Russian Highly Enriched Uranium," U.S. General Accounting Office, December 2000; Richard Falkenrath, "Uranium Blues: Economic Interest vs. National Security," *The Milken Institute Review*, 4th Quarter 2000.

⁷⁶ Plutonium produced in nuclear reactors can also be used to create nuclear weapons. The disposition of stocks of plutonium reprocessed from civilian nuclear plants around the world also raises security issues.

deliver un-enriched uranium that they purchased from uranium suppliers⁷⁷ to the DOE's enrichment facilities and the DOE would then enrich the fuel and charge the utility for the enrichment services. Roughly 2/3 of the cost of enriched uranium is for enrichment services and the other third for uranium ore concentrate and conversion to a form that can be enriched by the DOE's gaseous diffusion process.

The Energy Policy Act of 1992 created the USEC as a wholly-owned government corporation to provide and market enrichment services from the DOE's enrichment facilities in Ohio and Kentucky. The DOE's enrichment facilities were leased to USEC for a nominal fee and its stockpile of uranium was transferred to USEC as well. The USEC Privatization Act of 1996 authorized the privatization of USEC. The corporation was privatized in July 1998 through an IPO. The IPO yielded \$1.4 billion in proceeds, or about \$14.50 per share of USEC, Inc. common stock.⁷⁸ USEC competes with three foreign uranium enrichment entities, including a Russian and a French enrichment enterprise. The primary motivations for privatization was to improve the efficiency of the operation of the enrichment program, to pursue the development of a new enrichment technology using lasers (AVLIS) on a commercial basis, and to raise money for the federal government.

The controversy over the privatization focused primarily on conflicts between the USEC's commercial objectives and its responsibility to manage, without government subsidies, the 1993 "Megatons for Megawatts" agreement between the U.S. and Russian governments. Under this agreement, the U.S. agreed to purchase 500 metric tons of Russian HEU that would be extracted from nuclear weapons and convert it to LEU civilian nuclear fuel. Mechanically, the Russians extract the HEU as they dismantled their nuclear weapons and then "blend it down" with un-enriched uranium to create LEU suitable for civilian nuclear fuel. The Russians were to be paid separately for the enrichment service (by USEC) and uranium components (by the ultimate purchasers) of the LEU, and the initial prices agreed to would have yielded about \$12 billion to Russia. The USEC was the U.S. government's exclusive agent for managing this agreement and continued in this role after it was privatized.

A potential conflict of interest arises because the Russian uranium was effectively a substitute source of enrichment services supplied from USEC's plants. There is a world market for enrichment services and the Russian LEU effectively reduced the world demand for enrichment services, further driving down prices in an industry that already had excess capacity. Moreover, if USEC had to pay the Russians a price greater than the marginal cost of supplying enrichment services from their own facilities, it would necessarily have sacrificed profits. Accordingly, USEC benefited commercially by paying lower prices for the enrichment component and was better off taking no Russian

⁷⁷ For simplicity and I skip the interim conversion to UF₆ and the subsequent fuel fabrication steps.

⁷⁸ "Privatization of the United States Enrichment Corporation," Energy Information Administration, <http://www.eia.doe.gov/cneaf/nuclear/>, March 11, 2001. USEC, Inc. also issued \$500 million of bonds and the proceeds of the bond sale were turned over to the federal government as well.

LEU at any price greater than its marginal production cost.⁷⁹ On the other hand, the objective of U.S. national security policy was to induce Russia to convert as much bomb grade HEU to LEU as possible, as quickly as possible, regardless of small changes in prices for enrichment services. Since the commercial terms of the arrangement with the Russians had to be renegotiated from time to time, there was great concern that USEC would find it in its commercial interest either to reduce its purchases of Russian LEU or to undermine Russia's enthusiasm for continuing with deliveries at the agreed upon pace, a result contrary to U.S. security goals.

As a commercial venture USEC has remained profitable, but has not been as successful as many had hoped. Its revenues have declined and its stock has fallen from the IPO price of \$14.50/share to a low of about \$4.50/share, though it had recovered to \$10/share by May 25, 2001. It is closing its enrichment facilities in Ohio (raising concerns about domestic enrichment capabilities) and has abandoned development of the AVLIS technology. USEC's performance as the manager of the Russian HEU/LEU agreement has been the subject of considerable criticism⁸⁰, though the HEU/LEU delivery schedule is not very far off target.⁸¹

It is clearly a mistake to privatize a firm that must operate in a competitive market and expect it successfully to pursue both commercial objectives as a publicly traded company and non-compensatory public interest goals.⁸² As Richard Posner observed many years ago, "taxation by regulation" only works if the firm providing the subsidies and cross subsidies is a regulated monopoly. USEC is not a monopoly, its prices are not regulated, and it must compete with other suppliers to make sales of enrichment services. However, while critics have focused on privatization as being the policy error, it seems to me that the real policy error relates at least as much to the terms and conditions under which USEC managed the Russian program and the broader view that USEC would somehow pursue public policy goals that were not in its commercial interests. The federal government could have structured the financial relationship so that USEC had more powerful incentives to meet or beat the HEU/LEU delivery schedule. I suspect that the decision to keep the net costs of the deal with the Russian's "off budget" led to a situation where USEC's commercial interests and U.S. security interests were more likely to be in conflict.⁸³

⁷⁹ The Russians were not paid for the uranium component of the LEU until a buyer was found and then they received the market price for uranium. Uranium prices were also falling during this period as a result of the Russian uranium sales as well as U.S. government sales of surplus defense HEU which was also to be converted to LEU.

⁸⁰ Orszag, *op.cit.* and Falkenrath *op. cit.*

⁸¹ U.S. General Accounting Office, *op. cit.*

⁸² The "market" that USEC was being privatized into was hardly a typical market for goods and services. There were only three other suppliers and they were all state-owned or controlled.

⁸³ There were other potential conflicts of interest that arose with the privatization of USEC, including conflicts arising with the government's longer term goal of pursuing alternative enrichment technologies and continuing pressure to use USEC to support the U.S. uranium mining and conversion industry. If the

IX. ENERGY EFFICIENCY, RENEWABLE ENERGY, AND ALTERNATIVE ENERGY POLICIES

The term “energy efficiency” generally refers to a measure of the quantity of energy required to produce a unit of intermediate energy services --- heat, light, cooling, transportation, power to drive machinery, etc. --- and/or the quantity of energy services required to produce a unit of non-energy goods and services. Energy efficiency and economic efficiency are not the same thing. Energy efficiency measures focus on one set of productive inputs and rely on technical energy input/output indicia which do not take input costs and the value of output into account directly. Economic efficiency takes all inputs into account along with their associated costs and the economic value of the goods and services they produce. Increases in energy efficiency need not lead to increases in economic efficiency and vice-versa. Advocates of policies to promote energy efficiency, however, typically argue that the programs they favor also improve economic efficiency. Either they lead to lower overall life-cycle costs for energy services taking all relevant private costs into account, or they reduce overall social costs once the costs of environmental externalities are factored into the equation. However, the primary motivation of energy efficiency advocates has typically been improvements in environmental quality and/or reduced dependence on imported petroleum, not consumer protection.

The term “renewable energy” generally refers to energy supplied by hydroelectric, wind, solar, wood, waste, geothermal energy resources, fuel cells, etc. These are energy resources which nature (or humans in the case of waste) can naturally reproduce as they are utilized to produce energy so that the resource base is not depleted (or is depleted very slowly)⁸⁴ if it is managed properly. The term “alternative fuels” is used in a variety of different ways. It incorporates renewable energy, but also refers to policies which lead consumers to switch to fuels that reduce environmental impacts or reduce dependence on imported petroleum. Advocates of policies to promote renewable and alternative energy resources, typically argue that the programs they favor also improve economic efficiency. Again, either they lead to lower overall life-cycle costs for energy services taking all relevant private costs into account, or they reduce overall social costs once the costs of environmental externalities are factored into the equation. However, the primary motivation of renewable energy advocates is improvements in environmental quality and/or reduced dependence on imported petroleum.

The case for government programs to promote energy efficiency, renewable energy and alternative fuels is often based on the argument that energy markets are plagued by a variety of market imperfections: poor consumer information, imperfect capital and rental markets, regulated energy prices that are too low, the failure to internalize fully or properly environmental and national security externalities, and other

proponents of privatization believed that they could get the efficiency benefits from privatization while continuing to rely on USEC to pursue public policies that were not in its interest with no continuing federal budget impacts, they were wrong.

⁸⁴ Or in the case of solid waste, transforming it into useful energy saves on other costs that would be incurred to dispose of it.

market barriers. That is, there is a proper role for government policies to promote energy efficiency, renewable energy and alternative fuels because market imperfections lead to under-investment in them. Needless to say, the existence and importance of such market imperfections is controversial.

A variety of policy instruments have been used to promote energy efficiency, renewable energy and alternative fuels. These include vehicle, appliance and equipment energy efficiency standards, tax subsidies, government R&D expenditures, fuel-use mandates, and subsidies funneled through regulated gas and electric utilities and paid for in the prices they charge to consumers. Federal policies supporting improvements in energy efficiency and expanded supplies of renewable energy are reflected in federal energy legislation beginning in the late 1970s. As noted earlier, the Energy Policy Act of 1992 has numerous provisions aimed at providing tax subsidies, R&D funding, and other forms of encouragement for energy efficiency and renewable energy. Several states in the Northeast and West began to use their regulated monopoly electric utilities to stimulate investments in cogeneration, renewable energy, and energy efficiency during the 1980s.

The Clinton administration's appointments to the DOE in 1993 reflected the Clinton/Gore team's strong interest in promoting renewable energy, energy efficiency, integrated resource planning, and recognizing the close linkages between energy production and use and environmental impacts in energy policy, including the impacts of CO₂ emissions on global climate change. Hazel O'Leary and her team of Assistant and Deputy Assistant Secretaries were a "green team" if there ever was one. The instruments that the Clinton-era DOE had at its disposal from existing laws were limited, however. It could seek authorizations to fund R&D, demonstration, and grant programs for energy efficiency, renewable energy, alternative energy projects. It had opportunities to review and update appliance efficiency standards. It could use moral suasion and federal grants to convince more states to adopt integrated resource planning programs to promote the use of regulated monopoly utilities to support energy efficiency and renewable energy programs.⁸⁵ And within the restrictions imposed by existing laws, the Clinton DOE team tried to use these instruments to their fullest potential. New appliance efficiency standards were eventually promulgated and expenditures on renewable energy and energy conservation programs increased. However, no major new laws to promote energy efficiency, renewable energy or alternative were passed after 1992.

The Clinton team's efforts to move forward aggressively to promote energy efficiency, renewable energy, and alternative fuel vehicles was heavily constrained, however. During the first several years, a significant constraint was the federal budget deficit and Congressional spending limits. The DOE's budget had been reduced during the previous decade and was under pressure at the beginning of the Clinton Administration. Republican Senators continued to propose the DOE's abolitions. After

⁸⁵ However, they had to play catch-up as the policy focus at the states quickly shifted from using the institution of regulated monopoly to subsidize energy efficiency and renewable energy projects to breaking them up and promoting competition.

1994, the Administration's efforts to pursue its agenda were further hampered by the Republican Congress. Beginning in 1995 (FY96), Congress included language in the Department of Transportation's annual appropriations bills, forbidding it to even spend any money studying tightening the Corporate Average Fuel Economy Standards (CAFE). Congress also placed roadblocks in the way of the Administration's efforts to review and tighten appliance efficiency standards as provided for under existing laws.⁸⁶ Although President Clinton vetoed a 1995 DOE appropriations bill that would have prohibited further DOE efforts to change appliance efficiency standards, the DOE proceeded cautiously afterwards, delaying the promulgation of new standards for several appliances until the very end of the second term. State programs to promote energy conservation and renewable energy which are funded through electric and gas utility rates increased significantly from 1990 to 1996 and then declined as state regulators turned their attention toward industry restructuring and competition.⁸⁷ Finally, the Republican Congress rejected most Clinton administration proposals to create or increase tax subsidies for renewable energy technologies and alternative fuel vehicles.

Despite these problems, the DOE gradually shifted funds toward renewable energy, energy efficiency, and alternative vehicle programs and, as budget surpluses appeared total funding expanded. During FY 2001, the DOE received appropriations of about \$2.2 billion for expenditures on "energy resources," of which about \$1.2 billion was allocated to energy efficiency, renewable energy and alternative fuel vehicles programs.⁸⁸ Of this amount about 1/3 went to renewable energy and 2/3 to energy efficiency programs. The FY 2001 budget included \$540 million for fossil energy research and development.⁸⁹ This sum includes \$70 million of funding for fuel cells and carbon sequestration and about \$200 million for research focused on improving thermal efficiency and reducing emissions from fossil fueled power plants. Finally, about \$240 million was budgeted in FY 2001 for nuclear energy science and technology.⁹⁰ Between FY 1996 and FY 2000, energy efficiency and renewable energy resource expenditures increased by about 50%, while expenditures on fossil and nuclear resource development declined by about 20%. There was a significant increase in fossil energy expenditures in

⁸⁶ "House Conservatives Step Up Assault on Regulations," *Washington Post*, July 19, 1995, Section A, page 4.

⁸⁷ *Annual Energy Review 1999*, page 228.

⁸⁸ The Bush administration's budget proposes to cut expenditures in these areas by about 15% in FY 2002.

⁸⁹ I have excluded funds reported in the same line of business for the SPR and the federal power marketing agencies.

⁹⁰ An additional \$34 million was appropriated for advanced particle accelerators in FY 2001. Unpacking the DOE's R&D budget is not easy. In FY2001, the DOE budget included about \$7.7 billion of R&D expenditures. However, this figure includes weapons-related research at the National labs, basic and applied science research funded through the DOE budget (e.g. nuclear physics, human genome research, computer science), and other items. The nuclear science and technology research figure includes some funds that are pure research (e.g. university research reactors, medical research, etc.) Other departments also provide some support for related energy resource and conservation programs, but I have not tried to identify them.

FY 2001 and most of the proposed line item for “clean coal” technology in the proposed FY 2002 budget is a transfer from the FY 2001 fossil research budget.

The Administration also embarked on cooperate programs with industry to develop new technologies. The most important program involved cooperation between the federal government and the automobile industry to develop commercial technologies to increase automobile fuel efficiency, with a goal of commercializing vehicles that could get 80 miles to the gallon of gasoline.

Energy Efficiency

The energy efficiency of the U.S. economy, as measured by energy consumption per dollar of real GDP continued to improve during the decade. Energy consumption per dollar of real GDP declined by nearly 15% between 1990 and 2000. However, it declined by 22% from 1980 to 1990, a period with significantly higher average energy prices. Federal legislation to promote more energy efficient vehicles and appliances began to be passed in the 1970s and were enhanced during the 1980s and in EPAAct92.

There is little systematic objective evidence regarding the costs, benefits, and overall effectiveness of federal and state initiatives designed to improve energy efficiency. No new energy efficiency legislation was passed during the 1990s. DOE continues to review and promulgate appliance efficiency standards pursuant to the National Appliance Energy Conservation Act of 1987 and the National Appliance Energy Conservation Amendments of 1988. DOE claims that its appliance efficiency standards have reduced consumer energy expenditures by \$2 billion per year.⁹¹ Appliances are clearly more energy efficient today than they were prior to 1987. For example, a full size refrigerator uses about half the energy today than it did 20 years ago.⁹² The new efficiency standards proposed at the end of the Clinton administration would require washing machines to be 22% more energy efficient by 2004 and 35% more energy efficient by 2007. Hot water heater efficiency is to increase by 8% for gas units and 4% for electric units by 2004. The proposed rules would have required central air conditioners to be 30% more energy efficient by 2006.⁹³ However, the cost-effectiveness and energy savings estimates attributed to federal appliance efficiency standards and state sponsored utility energy efficiency programs have been the subject of considerable controversy. The costs and benefits associated with these initiatives programs have relied heavily on engineering estimates of costs and energy savings rather than actual field experience, fail to take into account all relevant costs, and ignore behavioral responses by consumers (e.g. purchasing larger refrigerators and air conditioners).⁹⁴

⁹¹ http://www.eren.doe.gov/building/consumer_information/. March 11, 2001.

⁹² However, appliance choices also changed. The fraction of households with central air conditioning increased by 21% and with personal computers 120% between 1990 and 1997.

⁹³ The Bush administration subsequently approved the first two new standards and reduced the central air conditioner standard to a 20% improvement in energy efficiency by 2006.

⁹⁴ Greening, L.A. and D.L. Greene, *Energy Use, Technical Efficiency and the Rebound Effects: A Review of the Literature*,” Report to the Office of Policy Analysis and International Affairs, U.S. Department of

One contributor to the deterioration in the rate of decline in the energy intensity of the economy since the late 1980s is likely to be the relative trends in vehicle fuel economy. Between 1980 and 1990, aggregate (passenger cars, light trucks, and trucks) average vehicle mileage for the then existing stock of vehicles increased by about 20%. Between 1990 and 1999 it increased by less than 4%.⁹⁵ [FIGURE 35] The average fuel economy of *new* passenger cars and *new* light trucks (as measured by the EPA) has been essentially flat for the last 15 years. Due to the shift toward SUVs, which are classified as light trucks and have lower average fuel economy than passenger cars, the average fuel economy of new light vehicles (passenger cars + light trucks) deteriorated by about 7% between 1988 and 2000.⁹⁶ Sales of light trucks (including SUVs) now make up almost half of new vehicle sales, more than double their share 20 years ago.

The Energy Policy and Conservation Act of 1975 established Corporate Average Fuel Economy (CAFE) standards for each automaker, with domestically produced and imported vehicles counted as separate fleets. For passenger cars, the CAFE standards started at 18 miles per gallon with the 1978 model year and gradually increased to 27.5 miles per gallon for the 1985 model year. For light trucks, including SUVs, the CAFE standard began at 17.2 miles per gallon in 1979 and rose to 20.5 miles per gallon by 1987. These standards are based on laboratory tests and have not changed since 1985 and 1987 respectively. Actual vehicle mileage has continued to improve, at a declining rate, since then as new cars replaced older vehicles from model years with lower CAFE standards.

The effects of the CAFE standards on vehicle efficiency and utilization, and the merits compared to alternative instruments (e.g. gasoline taxes), have been the subject of

Energy, Washington, D.C., December 1997; Greene, D.L. *et al.*, "Fuel Economy Rebound Effects for U.S. Household Vehicles," *The Energy Journal*, Vol. 20, No. 3, 1999; J. Eto. *et al.* "Where Did All the Money Go? The Cost and Performance of the Largest Commercial Sector DSM Programs," *The Energy Journal*, Vol. 21, No. 2, 2000; F. Wirl, "Lessons from Utility Conservation Programs," *The Energy Journal*, Vol. 21, No. 1, 2000.

⁹⁵ There are a variety of different data on vehicle fuel economy that are available. The Energy Information Agency produces estimates of actual average mileage achieved by vehicles in operation each year. These are the numbers used for the calculation in this sentence. The Department of Transportation (DOT) and EPA publish estimates of the mileage for new "model year" vehicles in various categories. These data are based on laboratory tests, not actual driving experience. The DOT and EPA numbers also differ slightly from one another because the DOT incorporates other factors (e.g. ethanol credits) into the mileage calculations that are related to the agency's enforcement responsibilities. These mileage numbers are higher than the actual mileage achieved by new vehicles in each model year, the mileage reported on the stickers on the windows of new vehicles, and the actual mileage of the current *stock* of vehicles which includes vehicles from a large number of model years. For example, DOT reported that the average fuel economy for 1999 Model Year passenger cars was 28.3 miles per gallon. EIA reports actual vehicle mileage of 21.4 miles per gallon in 1999 for the entire fleet of operating passenger cars.

⁹⁶ The data in the last two sentences are based on the EPA's "new model" mileage data discussed in the previous footnote. See "Automotive Fuel Economy Program, National Highway Traffic Safety Administration, <http://www.nhtsa.dot.gov/cars/problems/studies/fuelecon/index.html> and *Light-Duty Automotive Technology and Fuel Economy Trends 1975 through 2000*, U.S. EPA, December 2000.

much study and remains a subject of considerable controversy.⁹⁷ Efforts to tighten the CAFE standards have been opposed by domestic automobile manufacturers for the last two decades. Since the standards were phased in during a time of rising gasoline prices, some studies suggest that vehicle mileage would have improved significantly without the standards. Other studies suggest that the shift to light trucks (SUVs) is partially explained by the more lenient mileage standards applicable to these vehicles, though changes in consumer preferences and incomes are a more likely explanation. Still other studies find that the improvements in fuel efficiency has led to an increase in miles driven (the so-called “rebound effect”), reducing the impact of the standards on gasoline consumption. Finally, studies have suggested that when manufacturers reduced vehicle weights to increase mileage, this led to an increase in the severity of accidents and increased accident mortality.⁹⁸

There are several things that are fairly clear about the CAFE standards. First, they have almost certainly been binding constraints on domestic automobile manufacturers since the mid-1980s as gasoline prices fell. Second, the efficiency of the CAFE standards could be substantially improved if manufacturers could trade mileage “credits” among one another and the “two-fleet” average rules were eliminated. Third, special credits for alternative fuel capabilities (i.e. ethanol) are ineffective in promoting use of alternative fuels. Fourth, EPA automobile emissions regulations are constraining the diffusion of diesel-fueled vehicles with higher mileage. Finally, cost effective improvements in automobile mileage appear to be available with new technology, but stimulating consumer interest in fuel economy continues to be a major challenge. The National Academy of Sciences is now conducting a study of the CAFE standards and their effects. That report is expected to be released during the summer of 2001.

Renewable Energy and Alternative Fuel Vehicles

In 2000, renewable energy, *including conventional hydroelectric energy*, accounted for 7% of U.S. energy consumption, about the same fraction as in 1990. Excluding conventional hydro, renewable energy accounted for 3.7% of total U.S. energy consumption in 2000, only slightly higher than in 1990. Most of the non-hydro renewable energy is accounted for by wood, waste, and alcohol fuels. Wind and solar energy accounted for only 0.1% of total U.S. energy consumption in 2000, though wind energy supplies did grow quickly during the decade from (and to) a very low base. **[FIGURE 36]**

⁹⁷ P.K. Goldberg, “The Effects of the Corporate Average Fuel Efficiency Standard in the U.S.,” *The Journal of Industrial Economics*, Vol. XLVI, No. 1, March 1998; R.W. Crandall and J. Graham, “The Effects of Fuel Economy Standards on Automobile Safety,” *Journal of Law and Economics*, Vol. 32, No. 1, 1989; J. Mayo and J. Mathis, “The Effectiveness of Mandatory Fuel Efficiency Standards in Reducing the Demand for Gasoline,” *Applied Economics*, Vol. 20, No. 2, 1988; R.W. Crandall, “The Changing Rationale for Motor Vehicle Fuel-Economy Regulation,” *Regulation*, Vol. 13, No. 3, Fall 1990; T. Bresnahan and D. Yao, “The Non-pecuniary Costs of Automobile Emissions Standards,” *Rand Journal of Economics*, Vol 16, 1985; D. L. Greene, *et. al.*, “Fuel Economy Rebound Effect for U.S. Household Vehicles,” *The Energy Journal*, Vol. 20, No. 3, 1999.

⁹⁸Vehicle performance (e.g. acceleration) probably suffered as well during the first decade of experience with the CAFE standards, as manufacturers responded by reducing engine horsepower.

There were about 400,000 alternative fuel vehicles, mostly light trucks and buses, in operation in 1999. **[FIGURE 37]** Most of these vehicles use liquid petroleum gas or compressed natural gas. There were only about 6,500 electric vehicles in operation in 1999. While alternative fuel vehicles represent a tiny fraction of the vehicles on the road, the number of alternative fuel vehicles nearly doubled during the decade.

Despite all of the rhetoric about energy efficiency and renewable energy, and the efforts of the DOE to shift funds to develop and promote more energy efficiency and renewable energy, these initiatives had little if any effect on trends in energy supply and demand during the 1990s. This should not be surprising. The primary change in policy from the previous decade was to shift fairly modest amounts of DOE money toward development of new energy-using and renewable energy technologies. To the extent that these efforts have any significant effects, they will only be realized over a significant future period of time. The Clinton administration continued to tighten appliance efficiency standards pursuant to existing laws, but the impact of new standards are not applicable to new appliances for several years after they are finalized and once they are in effect the impacts on aggregate energy use are realized only gradually over time as the appliance stock turns over.

X. CONCLUSIONS⁹⁹

Overall, the decade of the 1990s was a period in which energy markets performed reasonably well, federal energy policymakers focused primarily on implementing and completing policy initiatives that began before or at the very beginning of the decade, and the energy supply sectors evolved slowly and relatively smoothly. The overall fuel supply mix that satisfied growing energy demand changed very little between 1990 and 2000. Aside from the “energy crises,” which were not nearly of the magnitude of those of the 1970s, at the very beginning and very end of the period examined here, energy supply was able to expand easily to meet growing demand and to support a rapidly growing economy without triggering significant sustained price increases or supply disruptions. Real energy prices were stable or falling for most of the period and there were significant productivity improvements in several energy sectors. The performance of the nuclear energy and coal sectors was especially impressive in terms of continuous performance improvement. It was simply not a decade where there was much public interest in energy policy issues.

The restructuring of the natural gas industry was largely completed and the restructuring of the electricity sector proceeded at a much faster pace than could have been predicted at the beginning the decade. Until 2000, electricity restructuring initiatives begun in California and the Northeast appeared to be going sufficiently well that similar reforms were diffusing fairly quickly among the states without any federal legislation to push states to consider and adopt major reforms. Responsible federal agencies worked cooperatively with states pursuing diverse electricity policy strategies in an effort to ensure that complementary federal policies on transmission access and wholesale power

⁹⁹ A version of this paper containing energy policy recommendations can be found at <http://web.mit.edu/pjoskow/www/>.

markets supported the state restructuring and retail competition initiatives. However, the meltdown of California's electricity markets during 2000 and 2001 has had a chilling effect on the diffusion of electricity sector restructuring and competition beyond the dozen states which have implemented such programs.

The energy intensity of the economy continued to decrease and there was a gradual increase in the penetration of relatively clean natural gas in the production of electricity during the decade, with a large fleet of CCGTs in the construction and planning pipeline. The federal government slowly continued to tighten appliance efficiency standards and to increase federal funds devoted to the development and deployment of more energy efficient appliances, vehicles, and technologies, as well as renewable energy and alternative fueled vehicles. However, the visible impacts of these programs to date are very small. The energy industries were able to adapt reasonably well to the requirements of the Clean Air Act Amendments of 1990 and the Clinton administration clearly recognized and took account of the close relationships between energy and environmental policies. There was little interest among voters in energy problems until the very end of the decade and this is reflected as well in the very modest amount of legislative activity on the national energy policy front.

I am often asked whether I think that there is an "energy crisis." I do not think that the "crisis" mentality for identifying and dealing with energy policy issues has served the country well. We have a number of energy policy challenges that are likely to take many years to deal with effectively. These challenges may only be visible to the public when there are "crises," but they do not disappear when the short-term crisis inevitably abates. Sound long-term policies that can and are sustained during and between energy market shocks are what we should be looking for. The experience of the last 25 years demonstrates that the best energy policies are those that focus on making markets work better, mitigating serious market imperfections, pursuing competition policies that mitigate market power, and on using flexible market-based mechanisms to internalize environmental and national security externalities. This is the framework that should guide long-term energy policies in the future.

TABLE 1
NATURAL GAS SPOT PRICE BASIS DIFFERENCES
\$/MMBTU¹

<u>DATE</u>	<u>Henry Hub</u>	<u>San Juan</u>	<u>So. Cal Border</u>
June 16,2000	\$ 4.38	\$ 3.90	\$ 4.63
July 17	4.18	3.61	4.70
August 15	4.43	3.40	4.63
October 20	5.04	4.48	5.36
November 17	5.88	5.47	10.00
December 15	7.52	6.85	14.00
December 20	9.12	8.55	17.00
January 18, 2001	7.86	7.36	11.50
May 23	4.04	3.47	13.40
June 1	3.77	3.03	10.00

¹ Data from Megawatt Daily (Financial Times) and Energy Market Report (Economic Insight, Inc.), various issues

TABLE 2
AVERAGE REVENUE PER KWH
RESIDENTIAL CONSUMERS²
(cents/kWh)

<u>STATE</u>	<u>1997</u>	<u>1998</u>
Connecticut	12.13	11.95
Maine	12.75	13.02
Massachusetts	11.59	10.60
Rhode Island	12.12	10.91
New Jersey	12.08	11.39
New York	14.12	13.66
Pennsylvania	9.90	9.93
Delaware	9.22	9.13
Illinois	10.43	9.85
Indiana	6.94	7.01
Ohio	8.63	8.70
Wisconsin	6.88	7.17
Iowa	8.21	8.38
Kansas	7.71	7.65
Missouri	7.09	7.08
North Dakota	6.27	6.49
Florida	8.08	7.89
Georgia	7.74	7.67
South Carolina	7.51	7.51
West Virginia	6.26	6.29
Kentucky	5.58	5.61
Alabama	6.74	6.94
Arkansas	7.80	7.51
Texas	7.82	7.65
Arizona	8.82	8.68
California	11.50	10.60
Montana	6.40	6.50
New Mexico	8.92	8.85
Wyoming	6.22	6.28
Oregon	5.56	5.82
Washington	4.95	5.03
U.S. Average	8.43	8.26

² Source: U.S. Energy Information Administration. *Electric Sales and Revenue*, 1997 and 1998 editions.

TABLE 3
AVERAGE REVENUE PER KWH
INDUSTRIAL CONSUMERS³
(cents/kWh)

<u>STATE</u>	<u>1997</u>	<u>1998</u>
Connecticut	7.76	7.70
Maine	6.36	6.61
Massachusetts	8.78	8.18
Rhode Island	8.52	7.61
New Jersey	8.11	7.94
New York	5.20	4.95
Pennsylvania	5.89	5.63
Delaware	4.82	4.65
Illinois	5.29	5.11
Indiana	3.91	3.95
Ohio	4.16	4.30
Wisconsin	3.72	3.86
Iowa	3.95	3.99
Kansas	4.51	4.46
Missouri	4.46	4.43
North Dakota	4.38	4.30
Florida	5.04	4.81
Georgia	4.13	4.23
South Carolina	4.00	3.69
West Virginia	3.47	3.78
Kentucky	2.80	2.91
Alabama	3.71	3.89
Arkansas	4.45	4.16
Texas	4.05	3.94
Arizona	5.05	5.12
California	6.95	6.59
Montana	3.66	3.19
New Mexico	4.42	4.47
Wyoming	3.46	3.38
Oregon	3.23	3.50
Washington	2.59	2.64
U.S. Average	4.53	4.48

³ Source: U.S. Energy Information Administration. *Electric Sales and Revenue*, 1997 and 1998 editions. See footnote to Table 1A.

TABLE 4

**COMPREHENSIVE STATE RETAIL COMPETITION PROGRAMS
(Start Date /All consumers eligible date)**

<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>
California (1998/1998) NH (1998/1998-Delayed) NY (1998/2001) Pennsylvania (1/99-1-00) Rhode Island (1-98/1-98)	Massachusetts (3-98/3-98) Illinois (10-1999/5-2002) Maine (3-2000/3-2000) Montana (7-98/7-2000)	Arizona(10-99/1-2001) Connecticut (1-2000/7-2000)	New Jersey (11-99/11-99) Arkansas (1-2002/6-2003) Delaware (10-99/10-2000) Maryland (7-2000/7-2002) New Mexico (1-01/1-2002) Ohio (1-2001/12-2005) Oregon (10/01 Except residential) Texas (1-02/1-02) Virginia (1-02/1-04)

Average IOU Electricity Prices (1997):

10.4 cents/kWh

8.3 cents/kWh

9.5 cents/kWh

6.8 cents/kWh

Other States: 5.6 cents/Kwh

FIGURE 1

ENERGY CONSUMPTION PER \$ GDP 1998 (USA = 1)

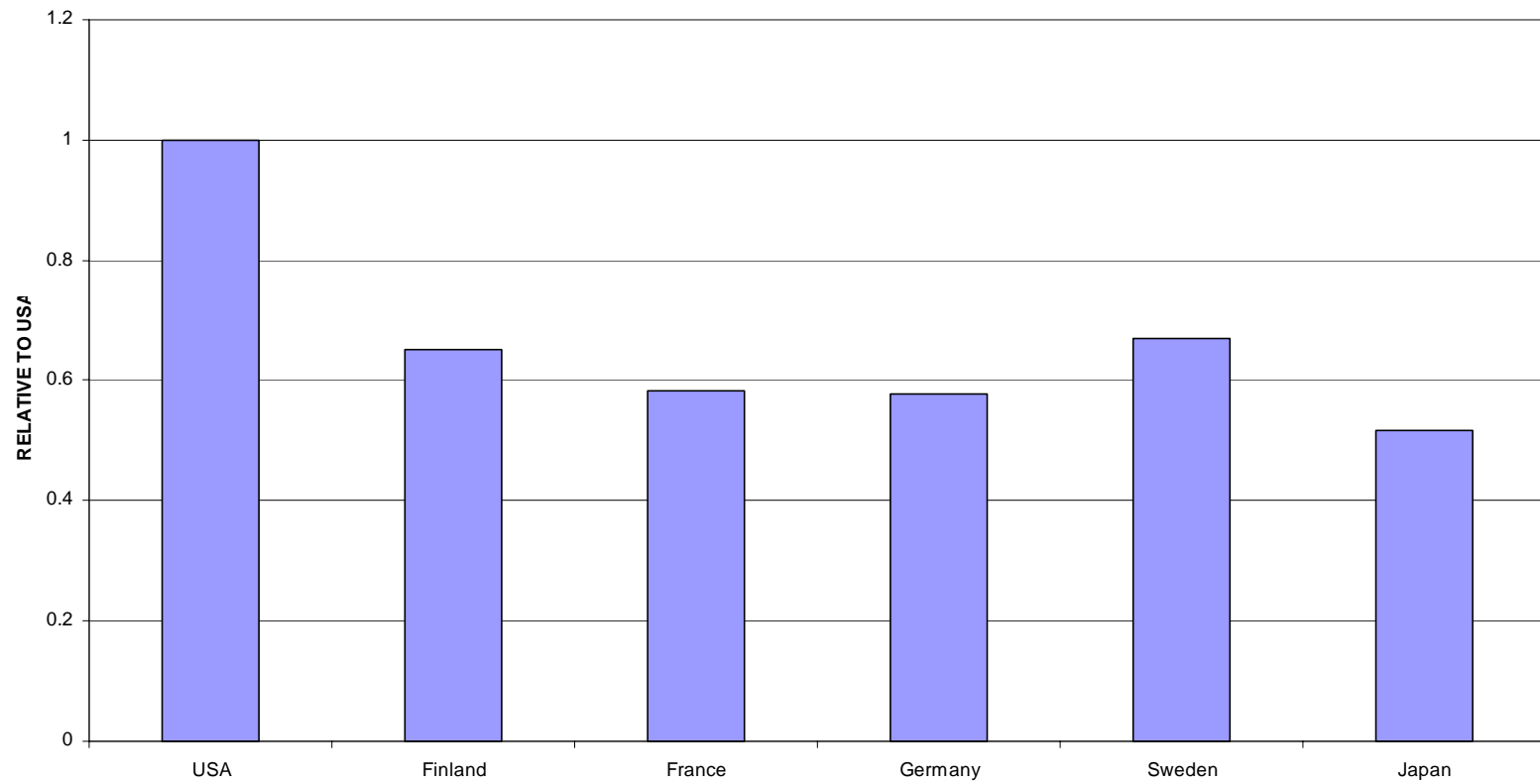


FIGURE 2

ENERGY CONSUMPTION BY FUEL 2000

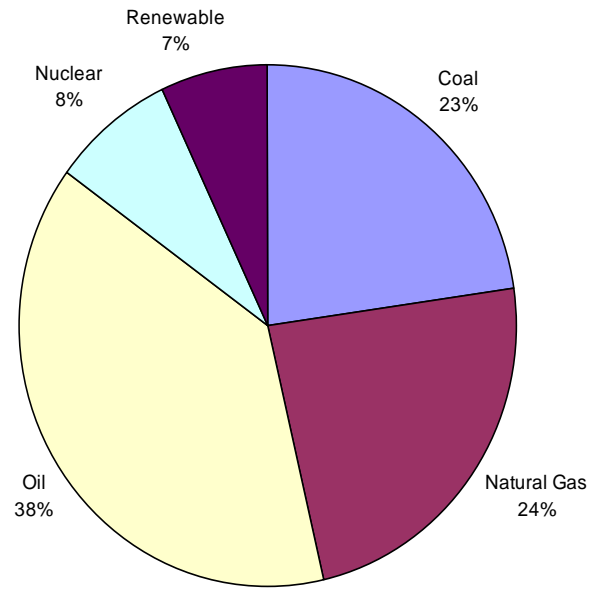


FIGURE 3

ENERGY CONSUMPTION BY FUEL 1990

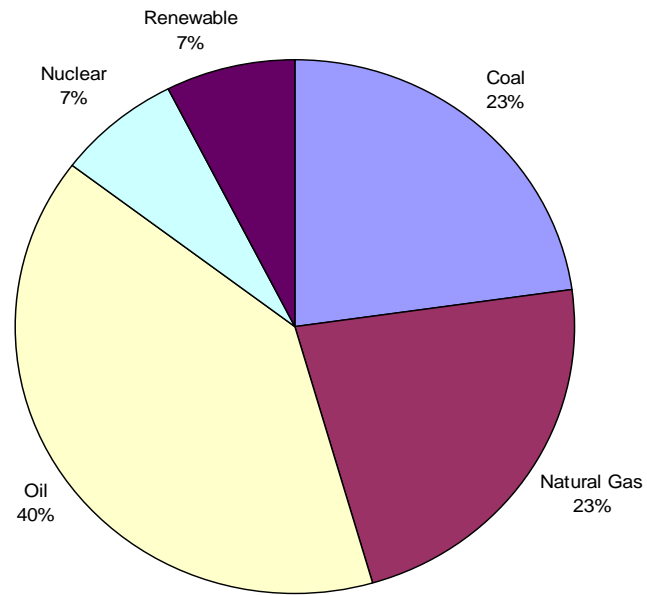


FIGURE 4

U.S. ENERGY CONSUMPTION BY SECTOR 2000

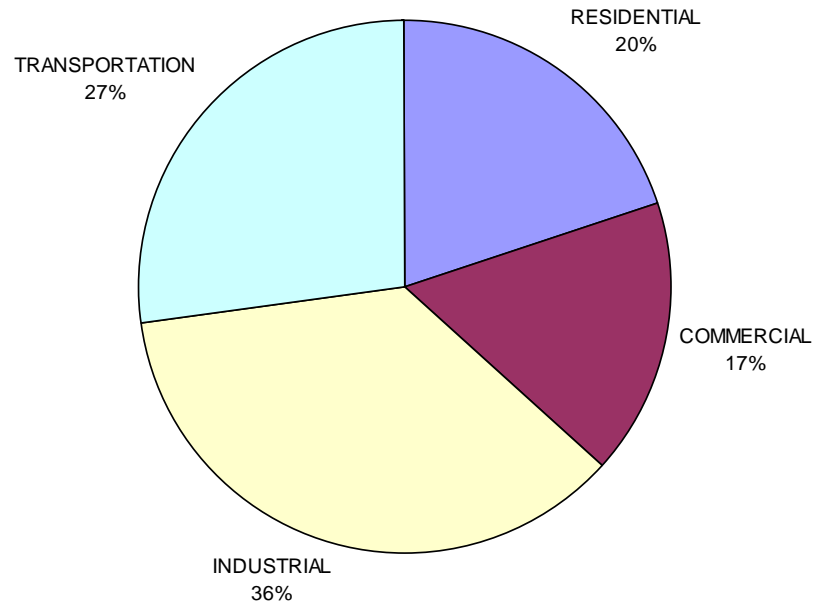


FIGURE 5

U.S. ENERGY CONSUMPTION BY SECTOR 1990

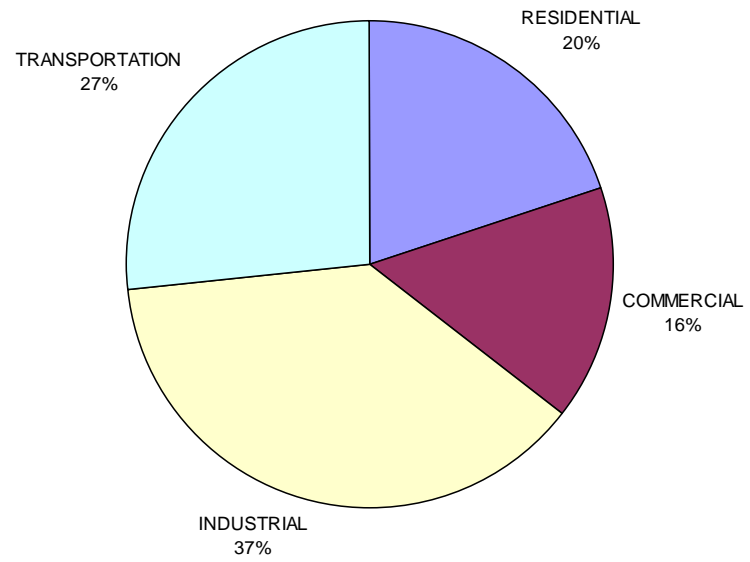


FIGURE 6

ENERGY PRODUCTION, CONSUMPTION AND IMPORTS 1949-99

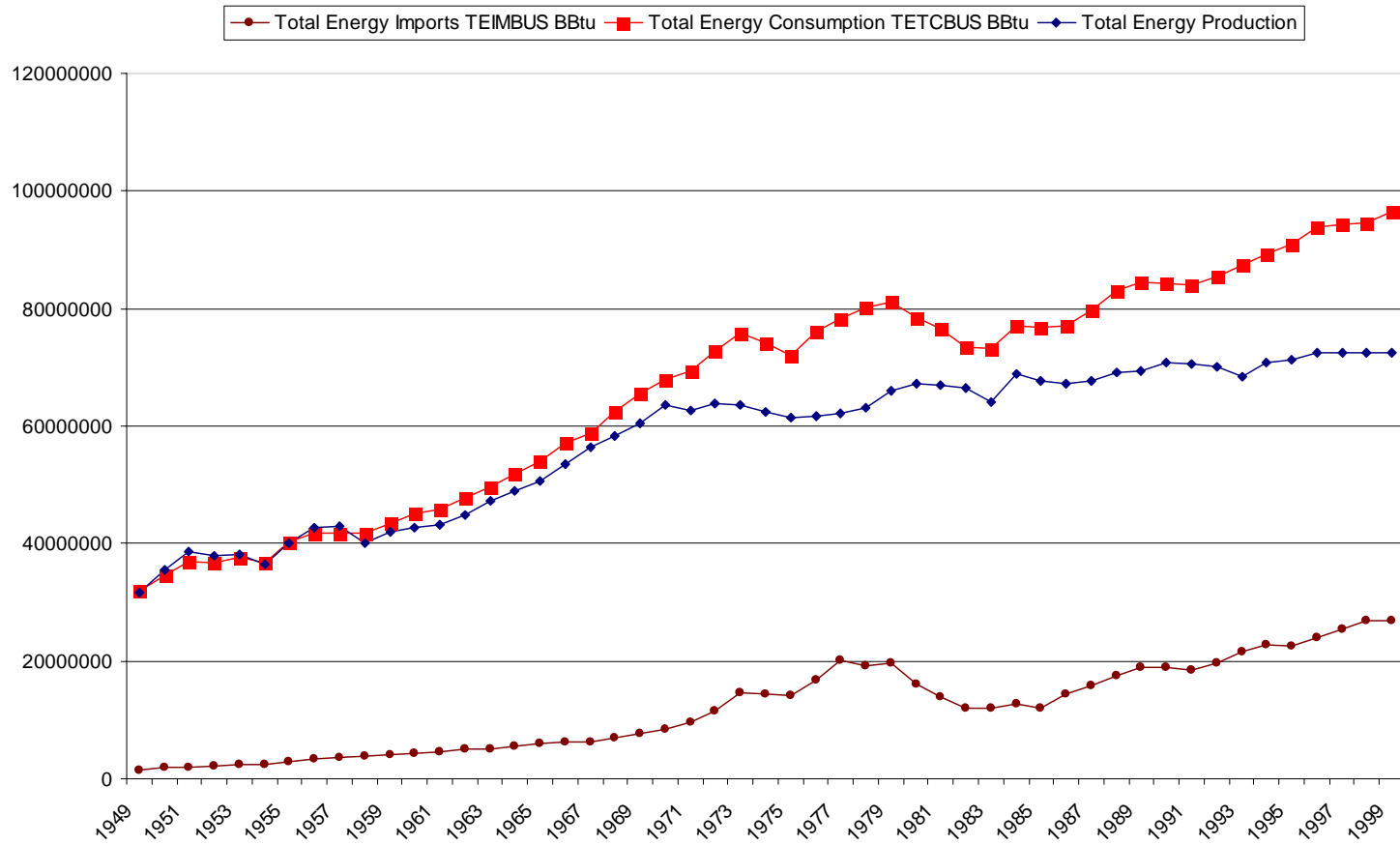


FIGURE 7

U.S. PETROLEUM CONSUMPTION, PRODUCTION AND IMPORTS

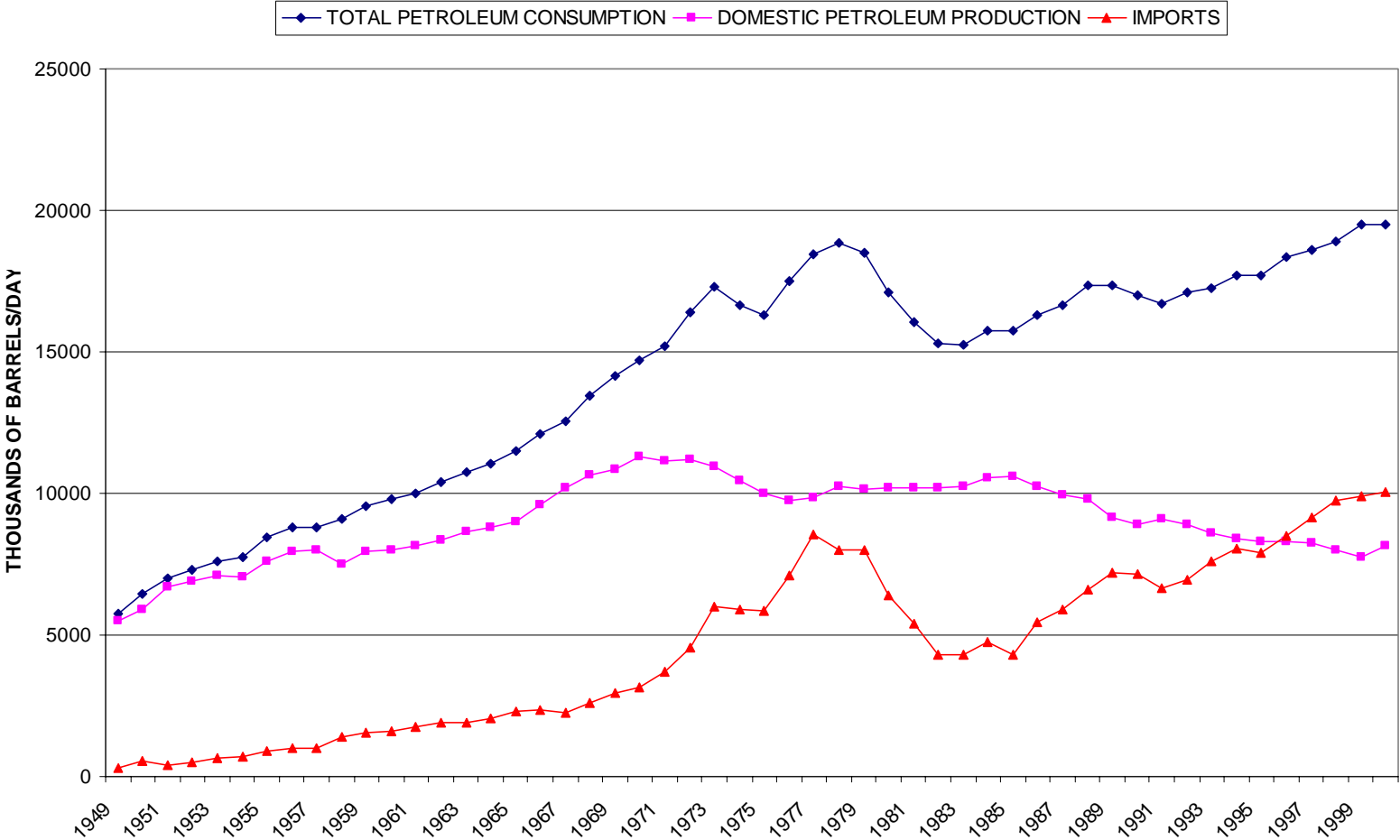


FIGURE 8

REAL FOSSIL FUEL PRODUCTION PRICES

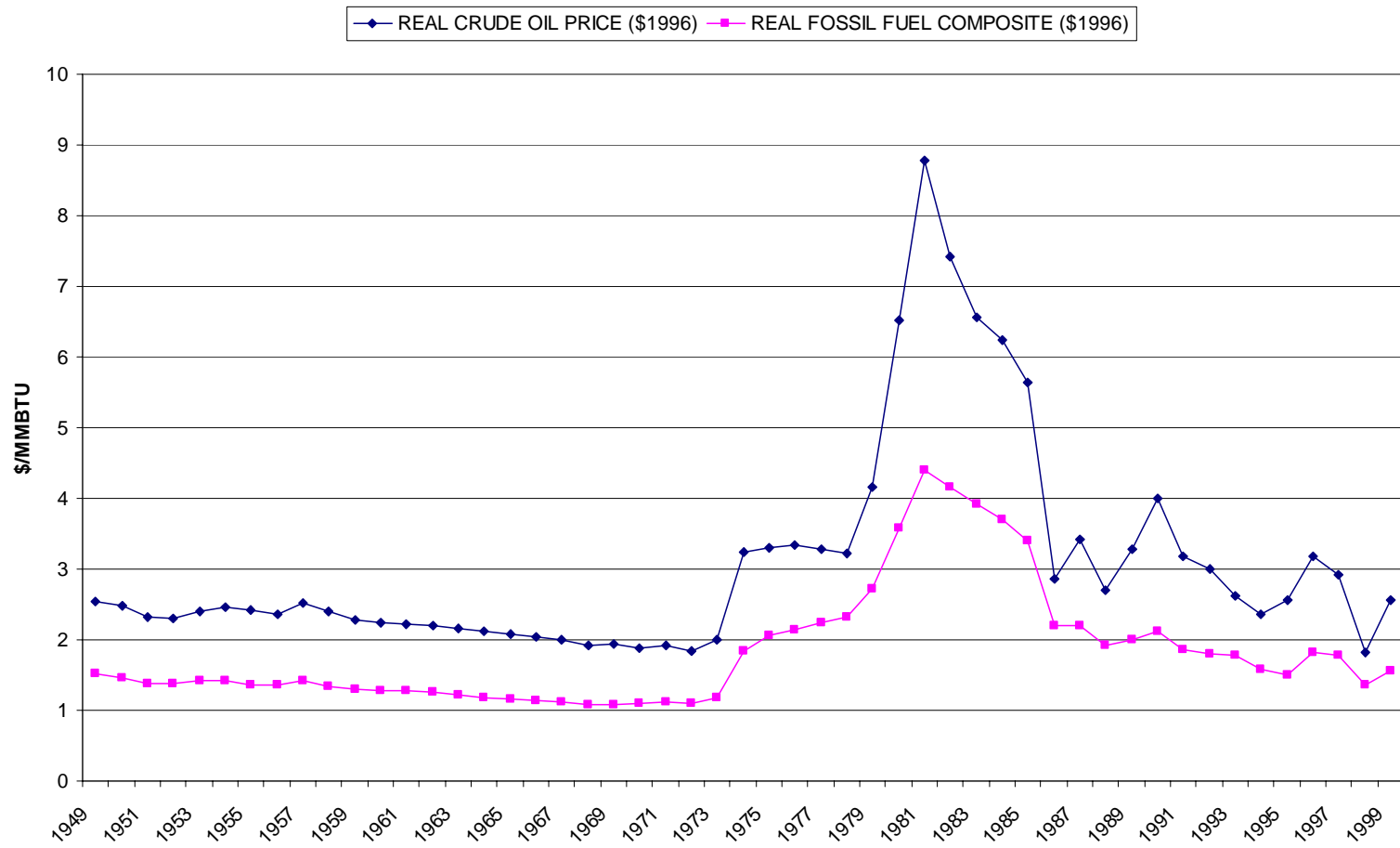


FIGURE 9

Total Energy Consumed per Dollar Real GDP (10Btu/\$1996)

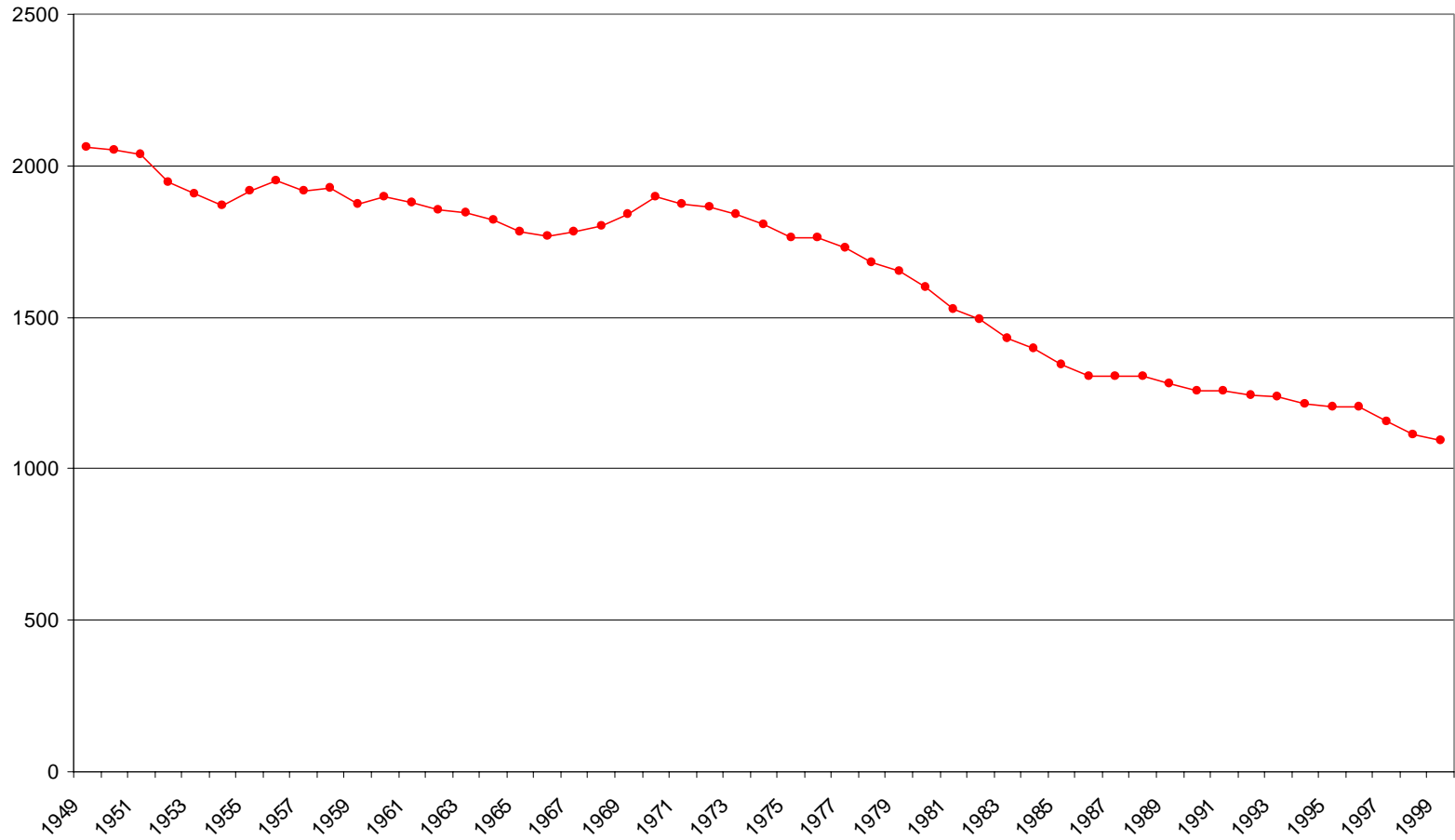


FIGURE 10

Total Energy Consumption per Capita (MMBTU)

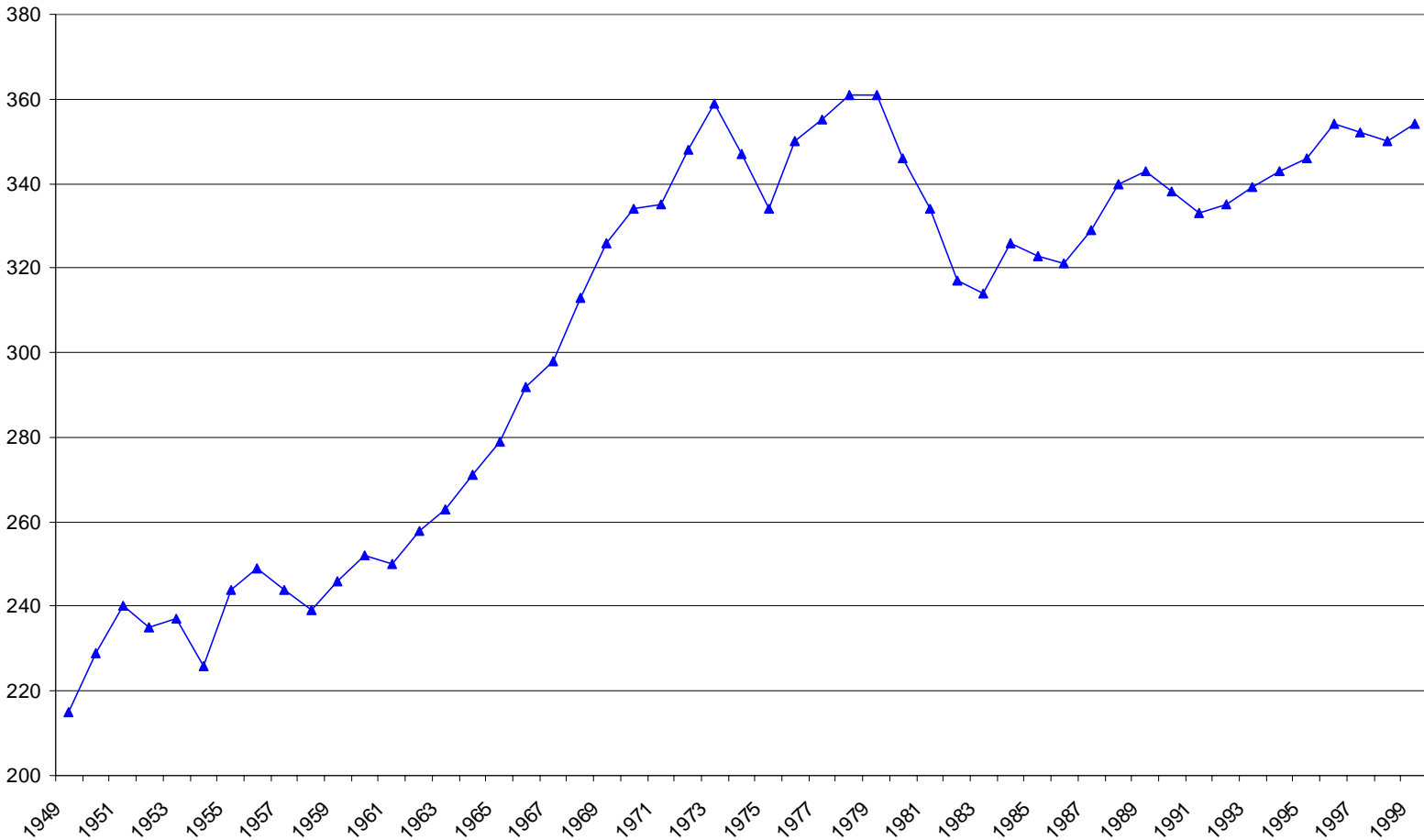


FIGURE 11

REAL PRICE OF REGULAR UNLEADED GASOLINE (\$1996)

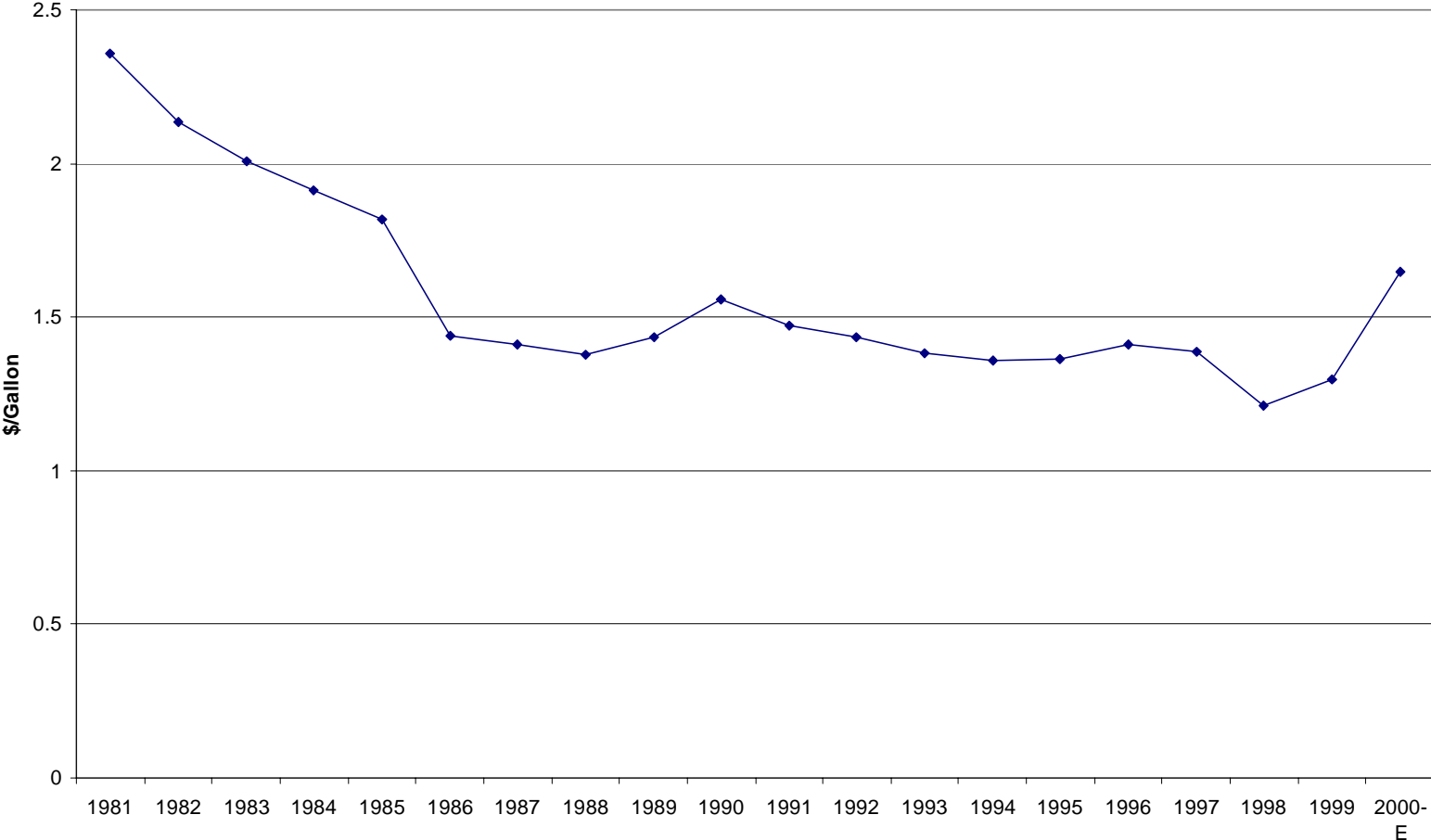


FIGURE 12

Oil and Gas Wells Drilled in U.S.

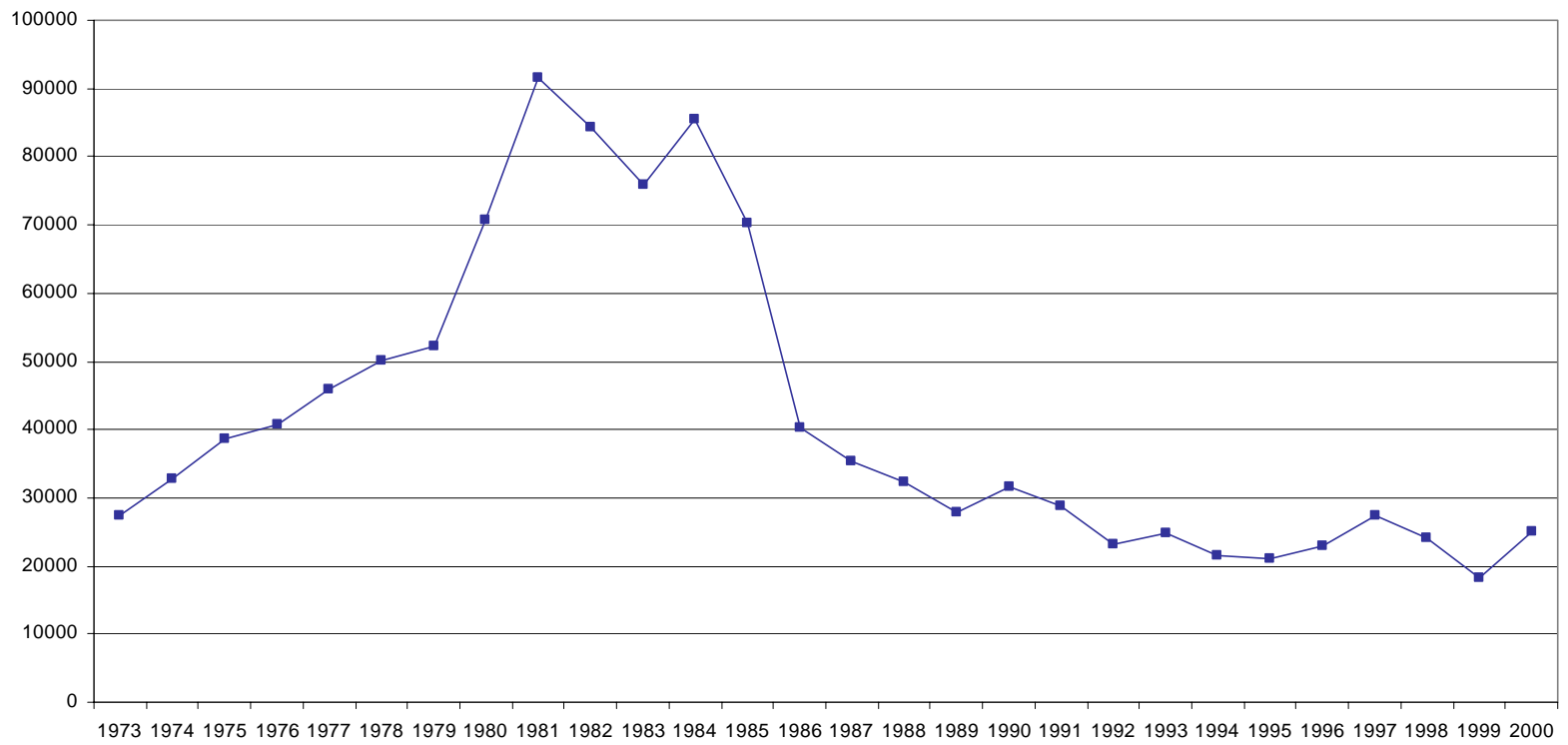


FIGURE 13

MONTHLY OIL AND GAS WELLS DRILLED 1999-2001

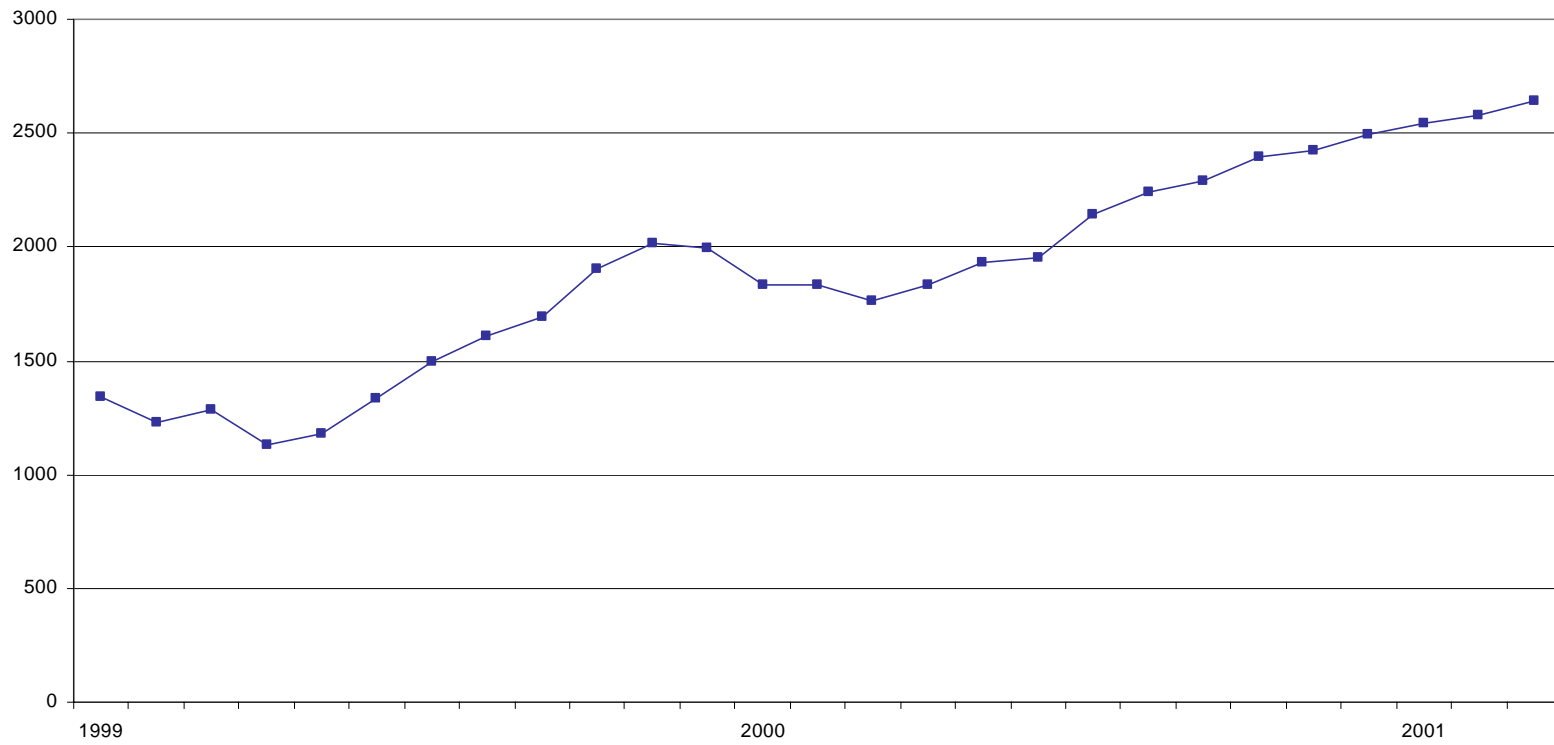


FIGURE 14

U.S. Crude Oil Refining Capacity

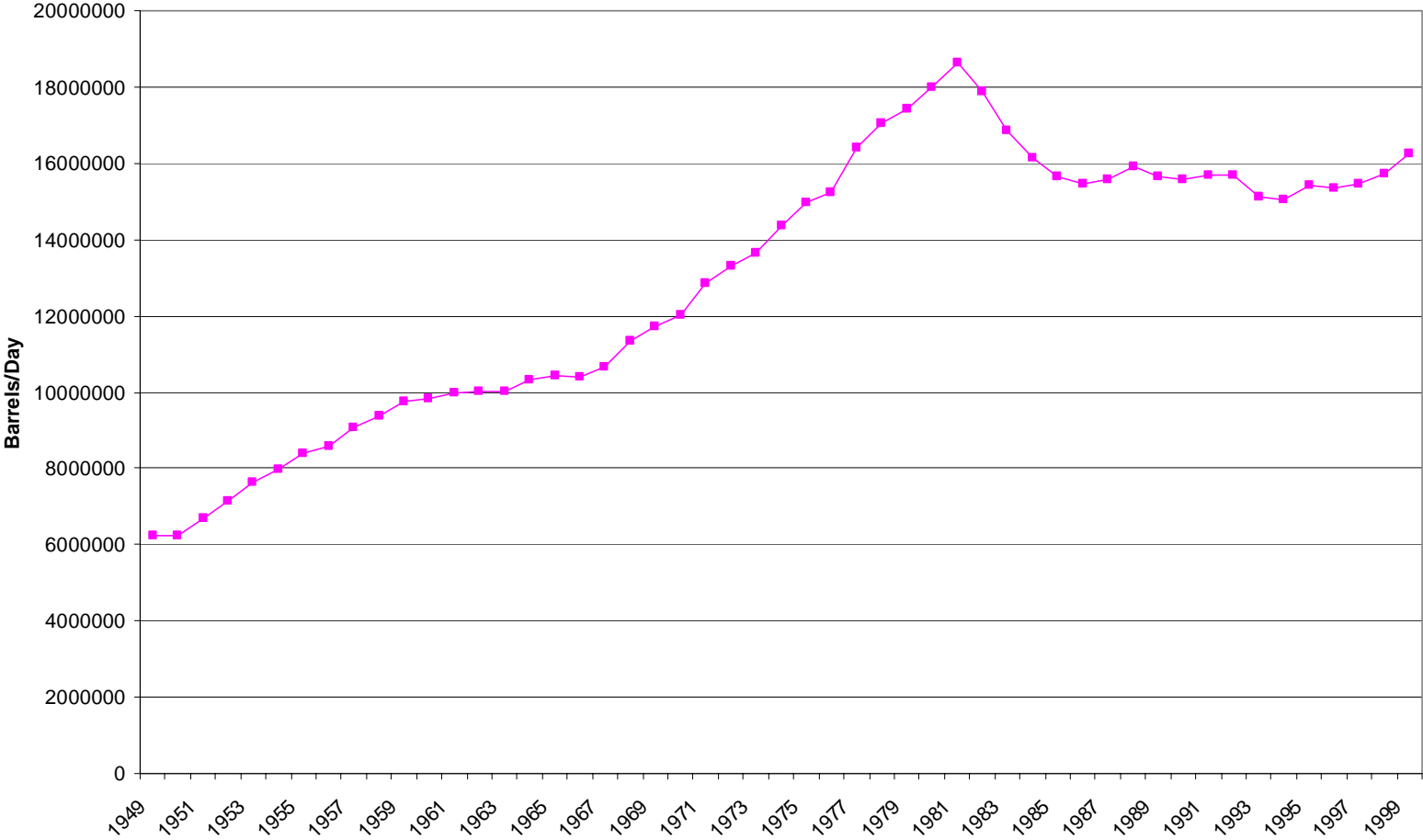


FIGURE 15

Monthly Stocks of Distillate Fuel

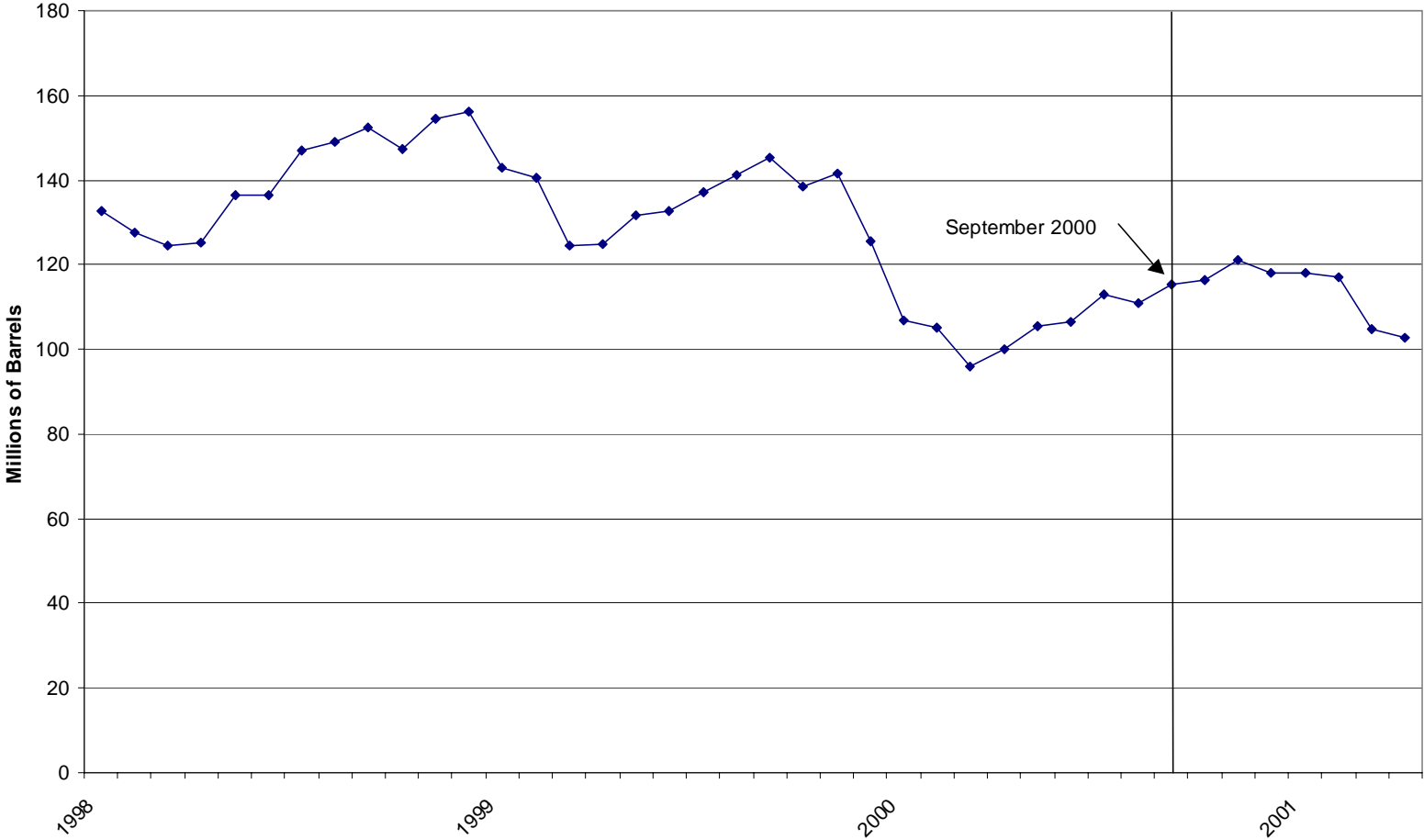


FIGURE 16

Monthly Refiner Price for No. 2 Oil

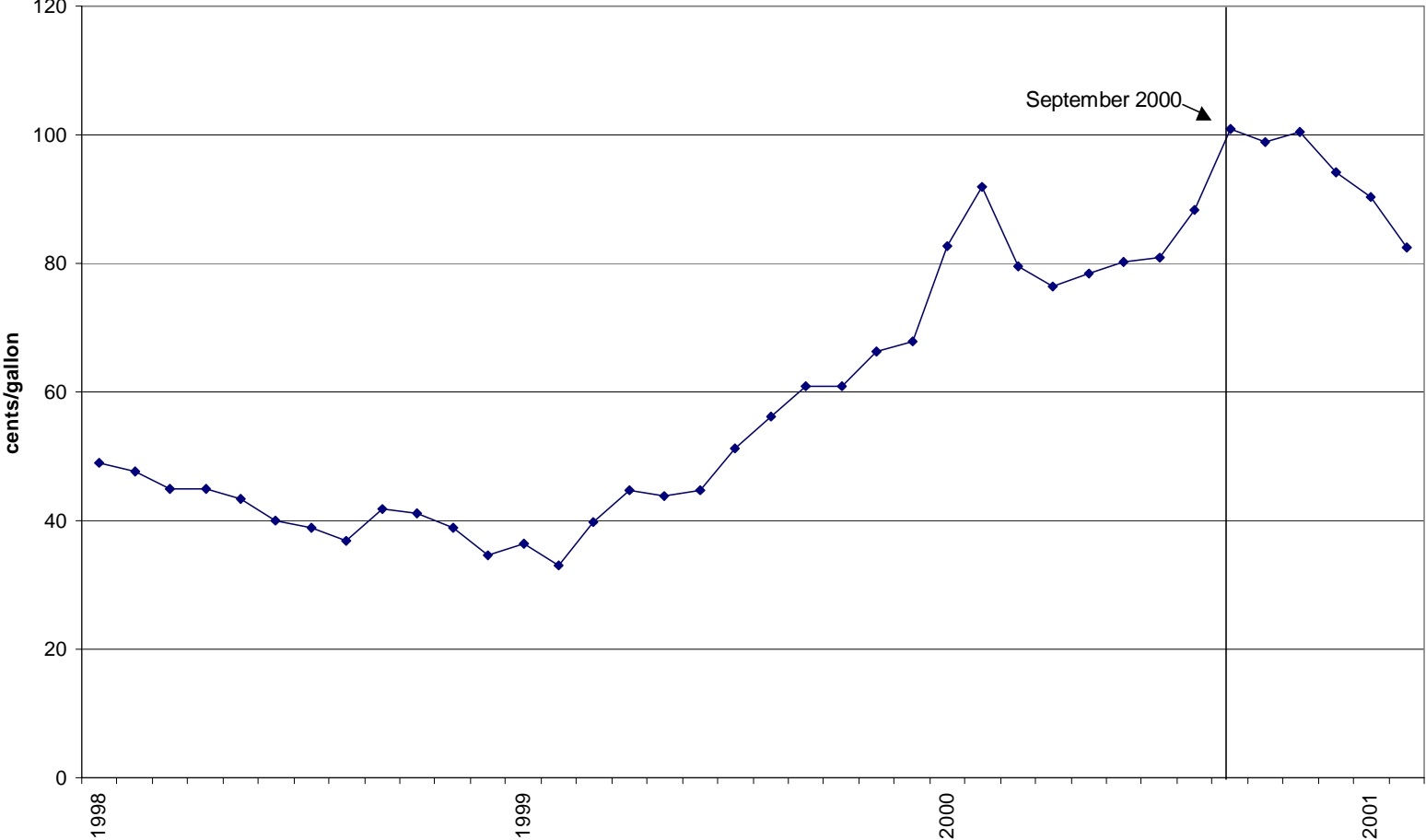


FIGURE 17

Natural Gas Consumption, Production and Net Imports

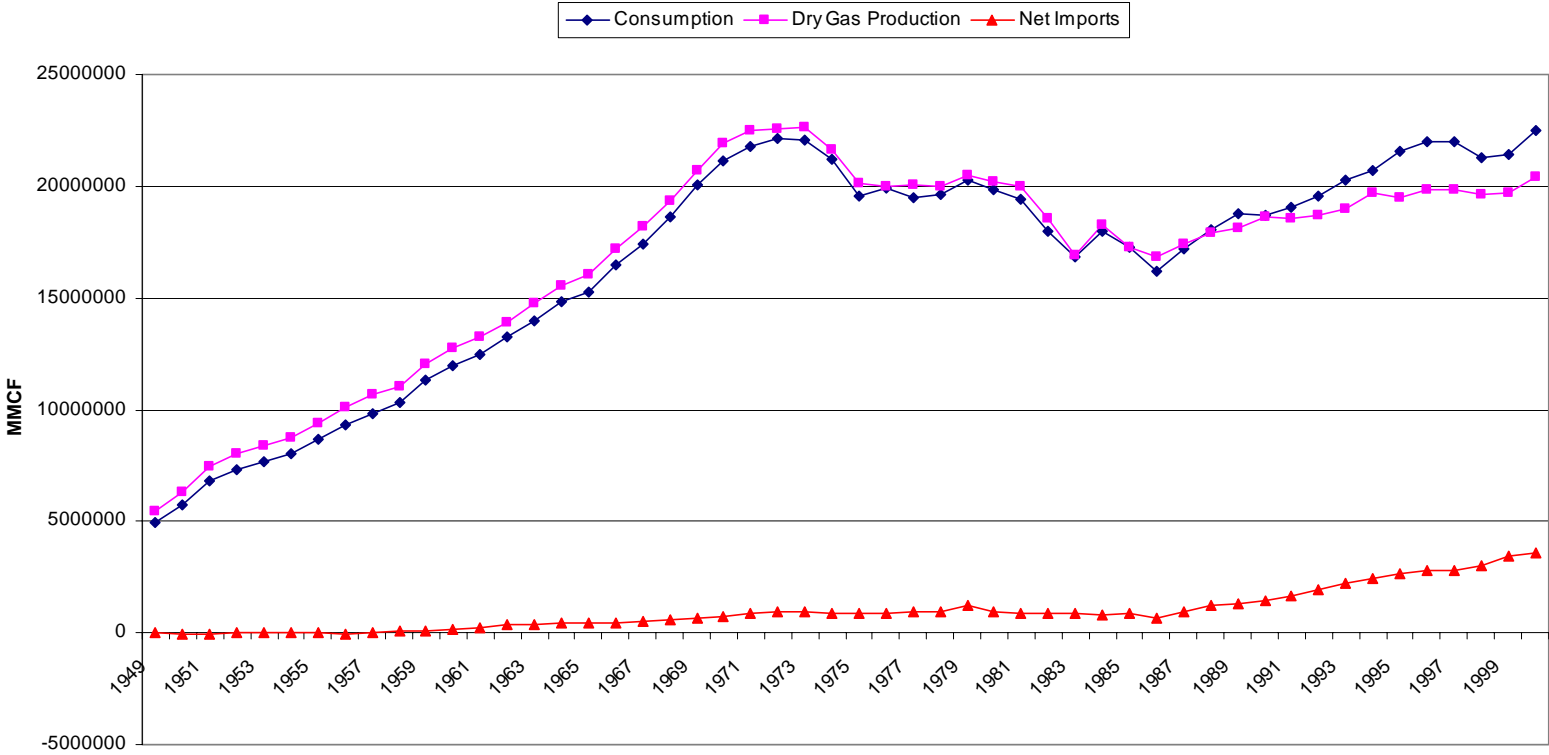


FIGURE 18

REAL WELLHEAD NATURAL GAS PRICES (\$1996)

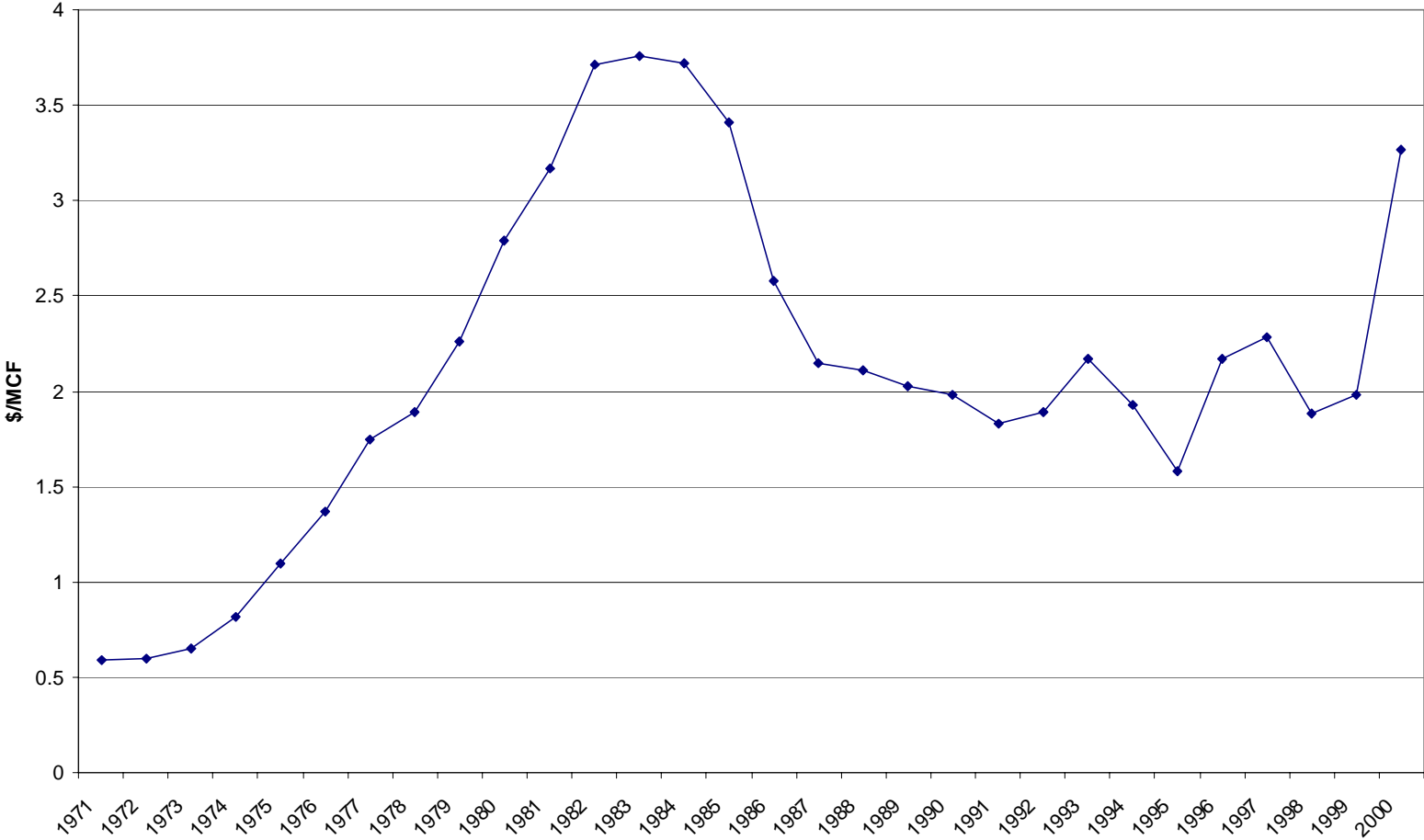


FIGURE 19

Monthly Natural Gas Wellhead Prices 1999-2001

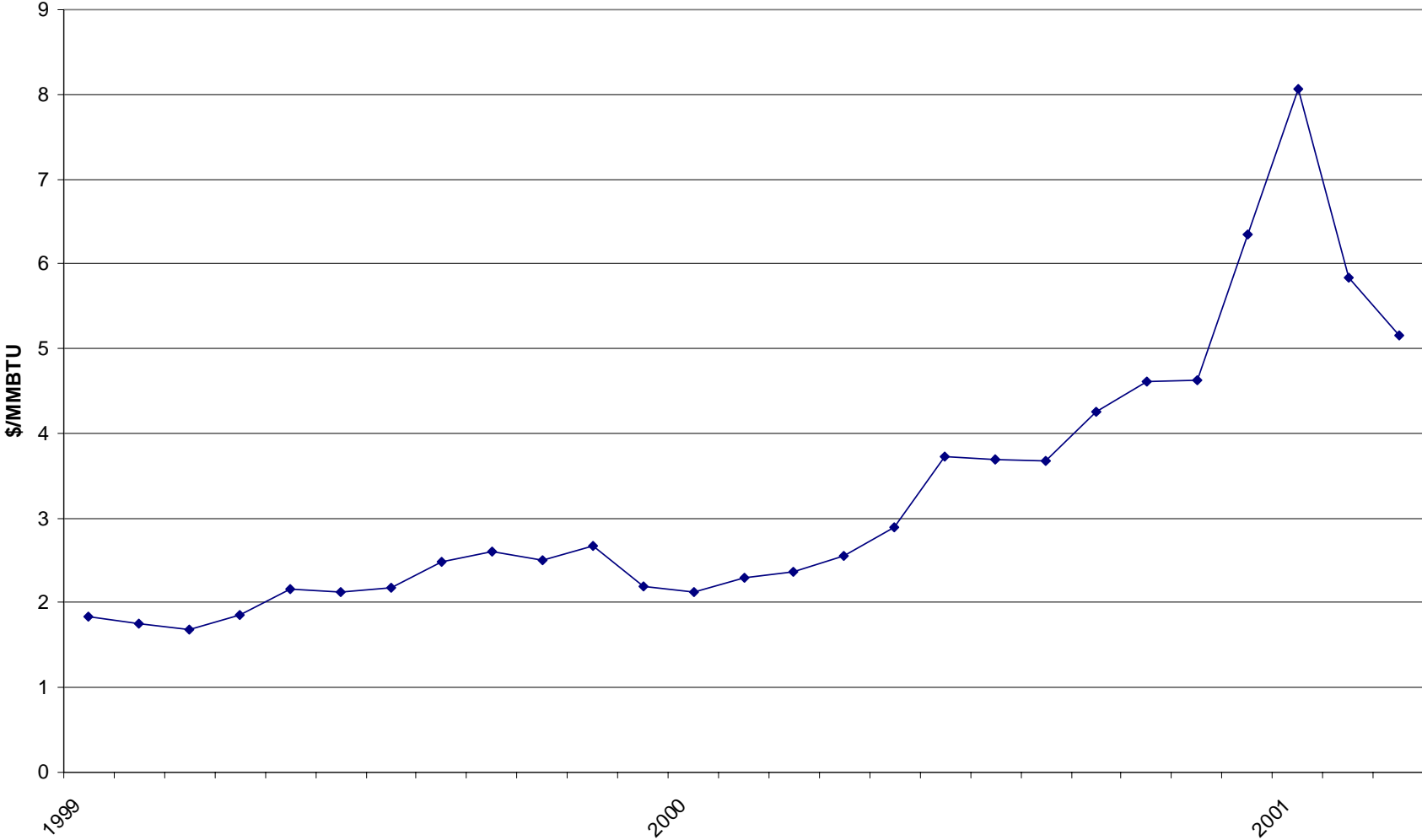


FIGURE 20

NATURAL GAS UNDERGROUND STORAGE

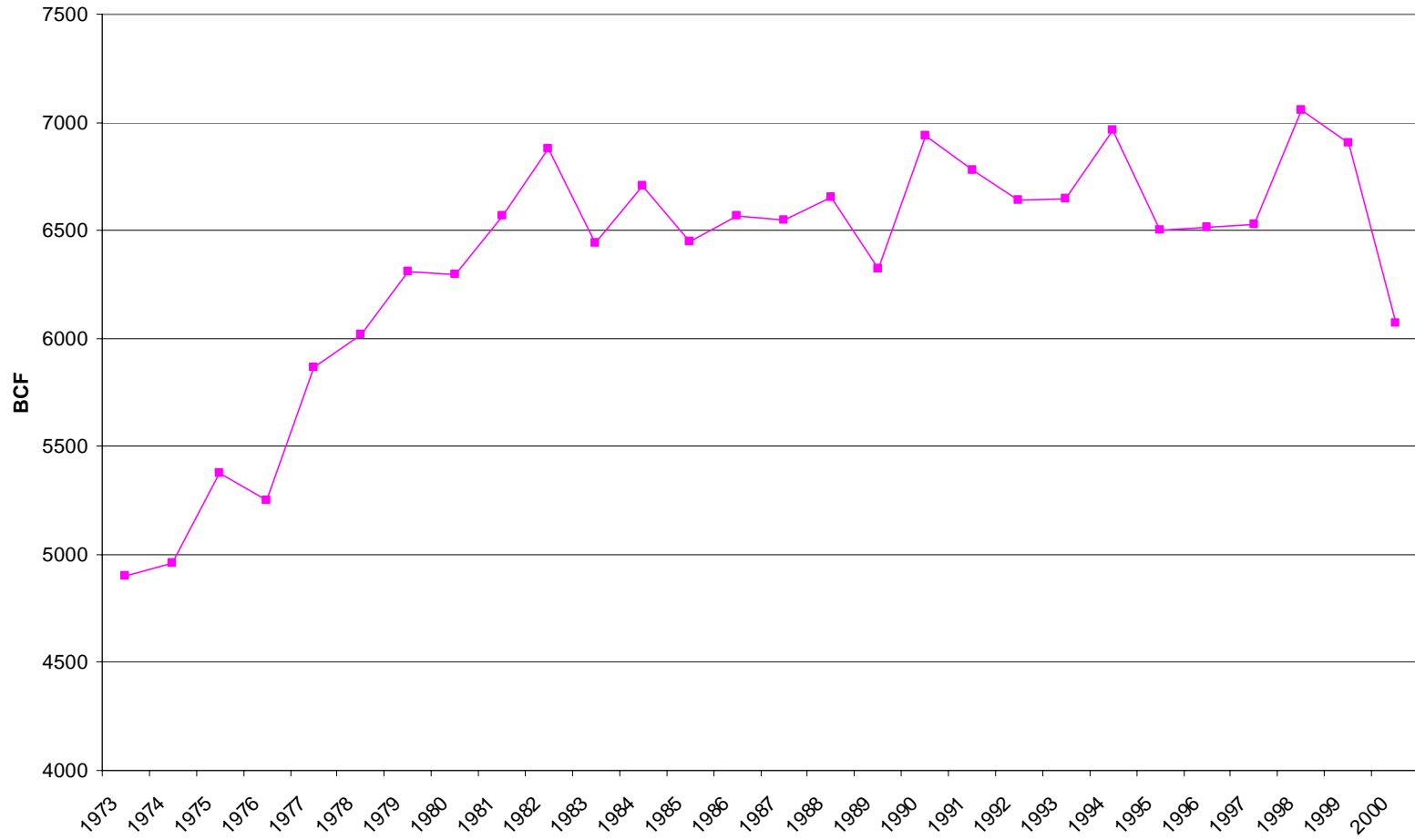


FIGURE 21

MONTHLY NATURAL GAS STORAGE (1999-2001)

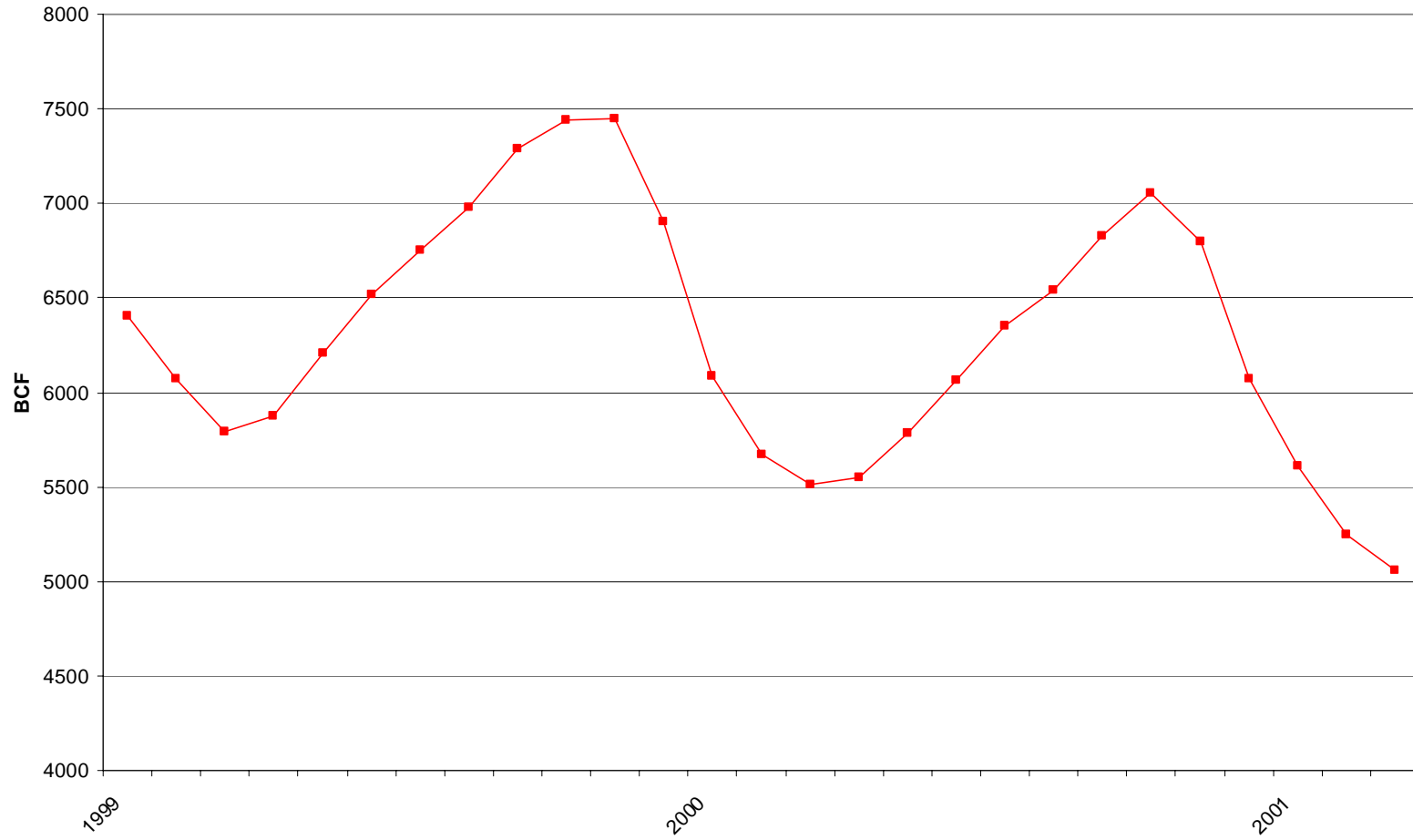


FIGURE 22

FUELS USED TO GENERATE ELECTRICITY 2000

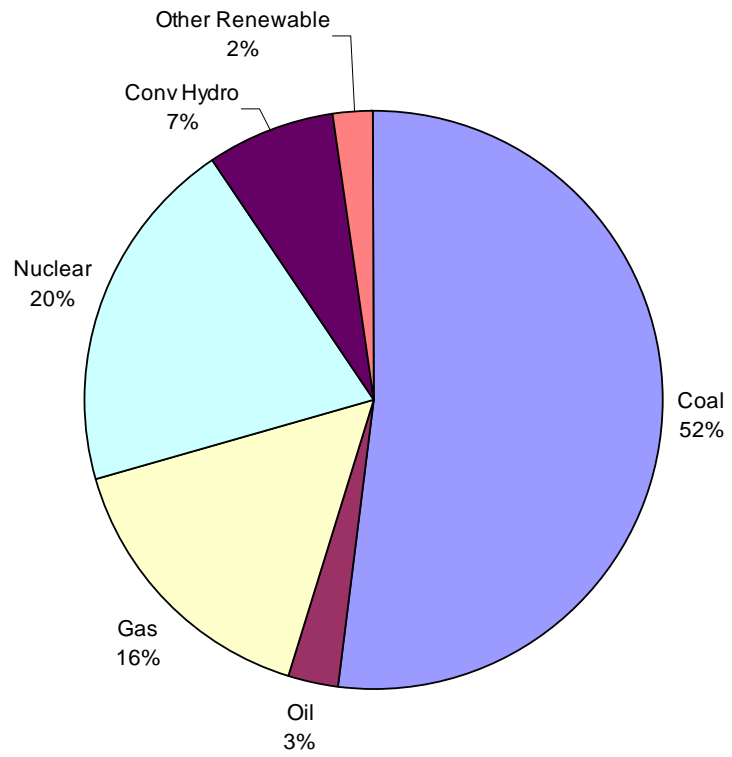


FIGURE 23

Electricity From Renewal Energy (Except Hydro)

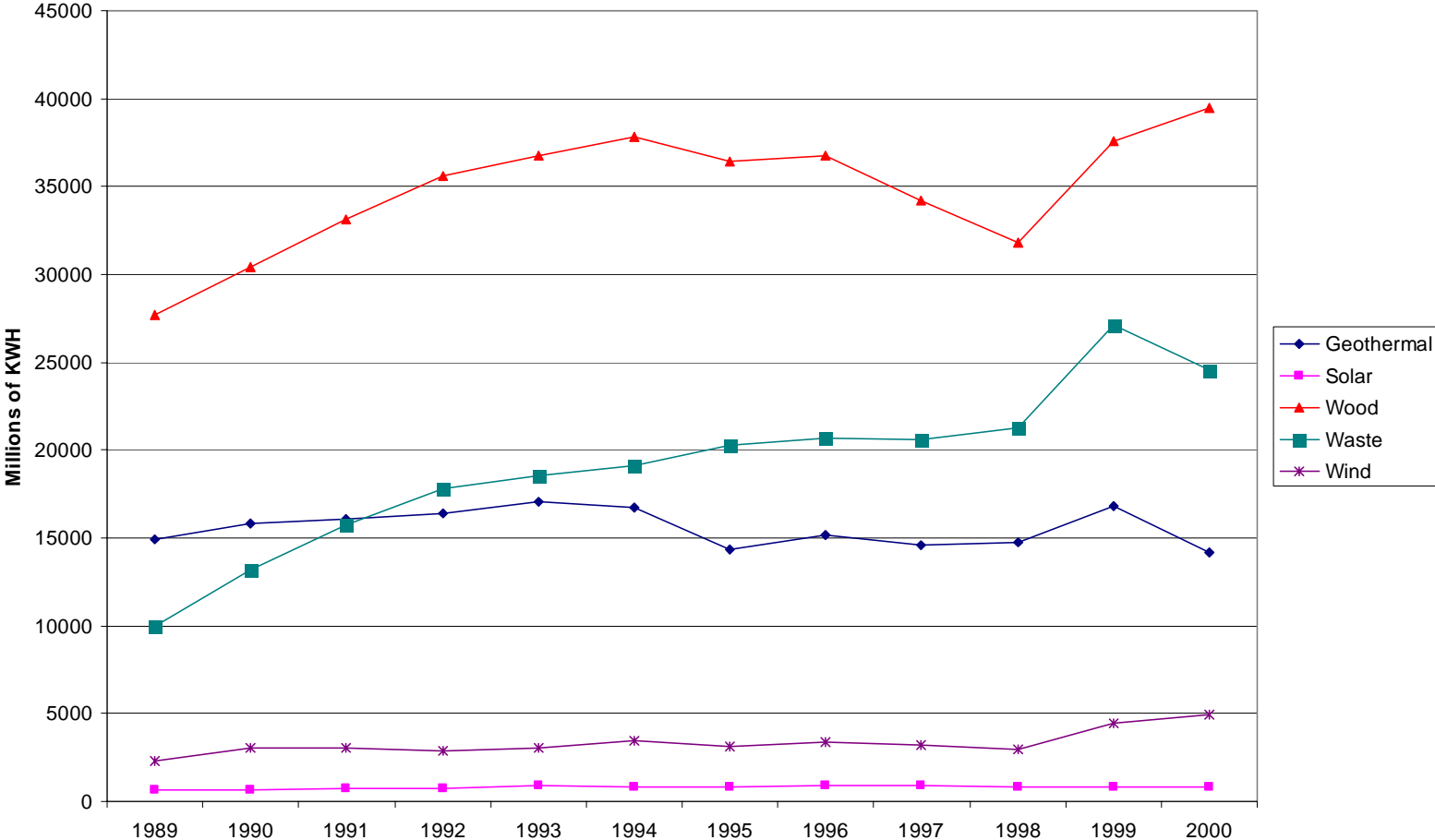


FIGURE 24

FUELS USED TO GENERATE ELECTRICITY 1990

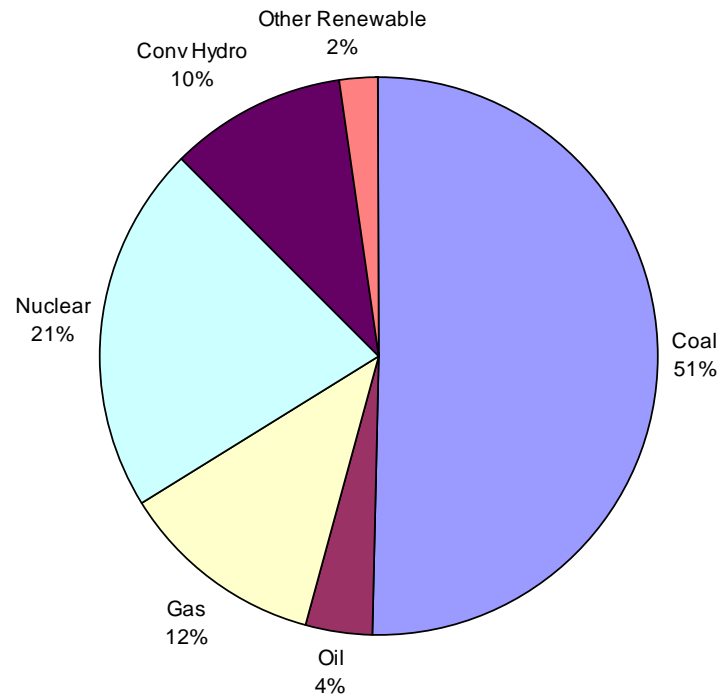


FIGURE 25

Annual U.S. ELECTRICITY GENERATION

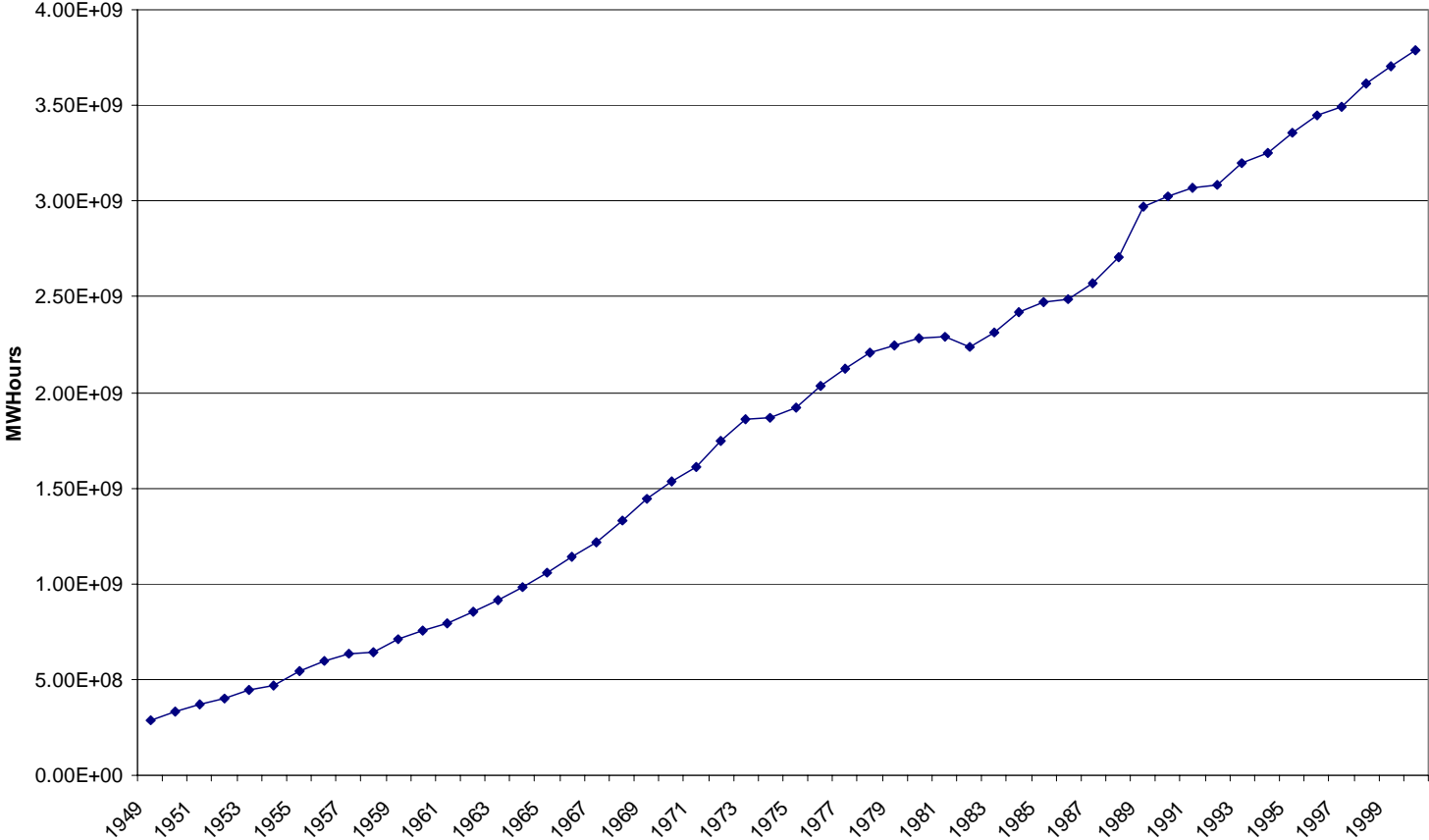


FIGURE 26

PEAK DEMAND AND CAPACITY (GW)

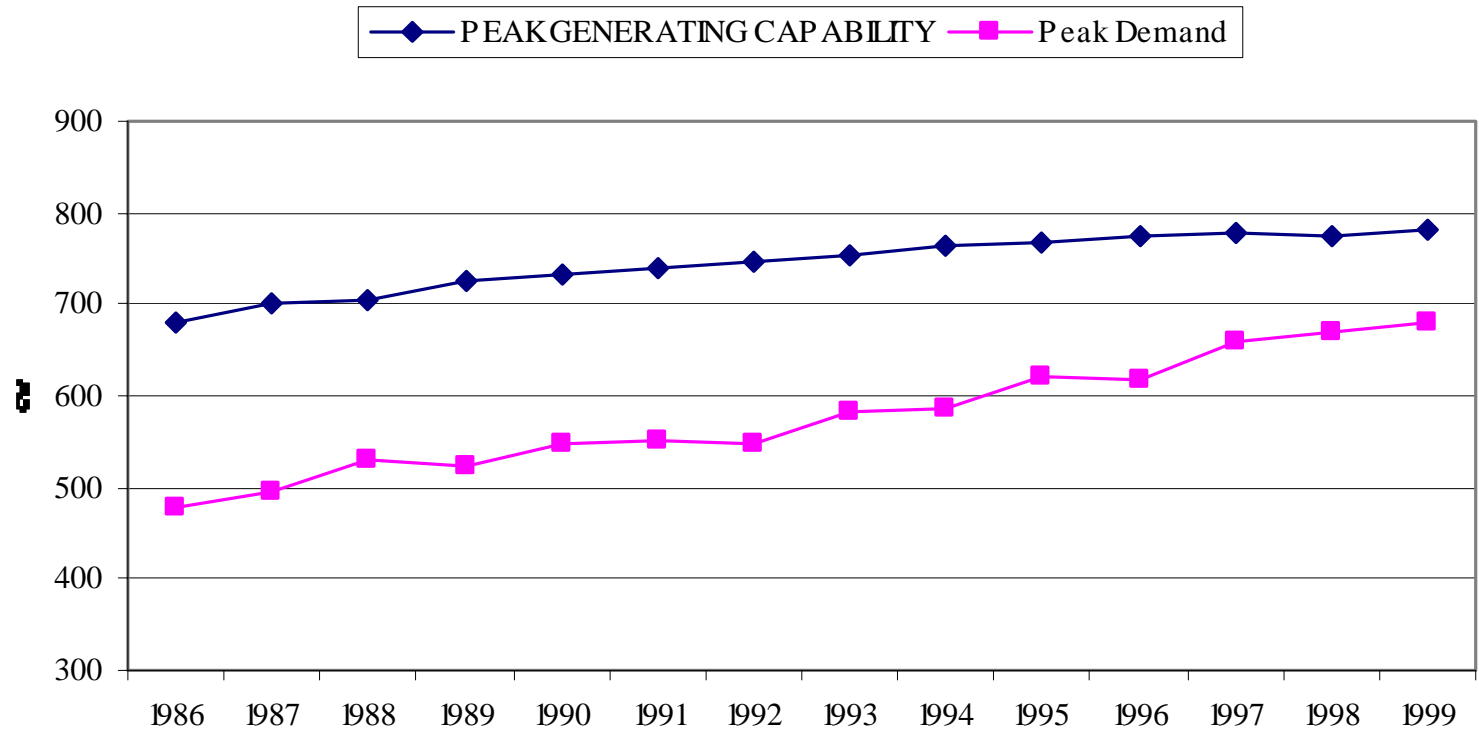


FIGURE 27

Average Electricity Prices (\$1996)

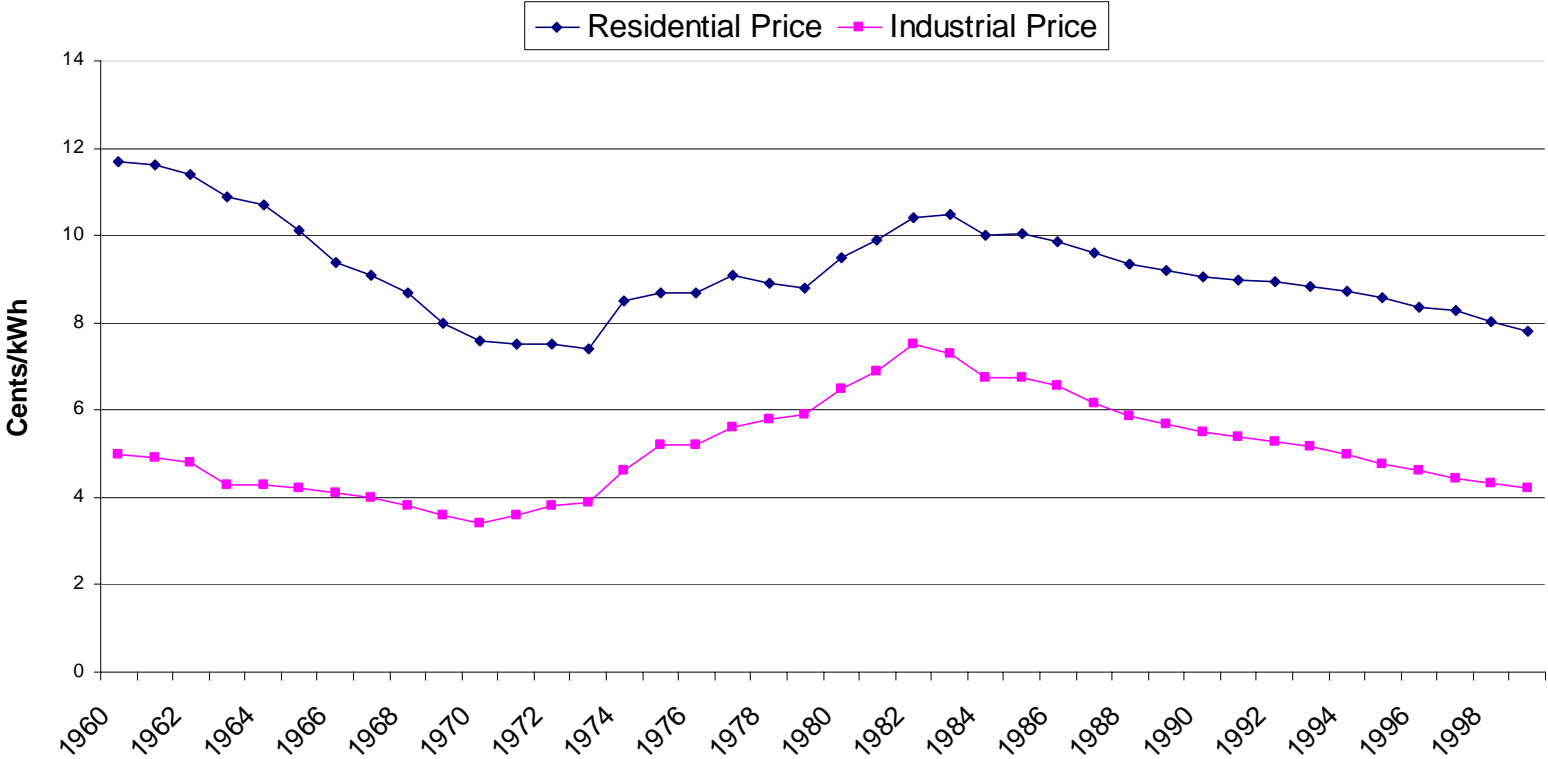


FIGURE 28

NET ELECTRICITY GENERATION FROM NON-UTILITY GENERATORS

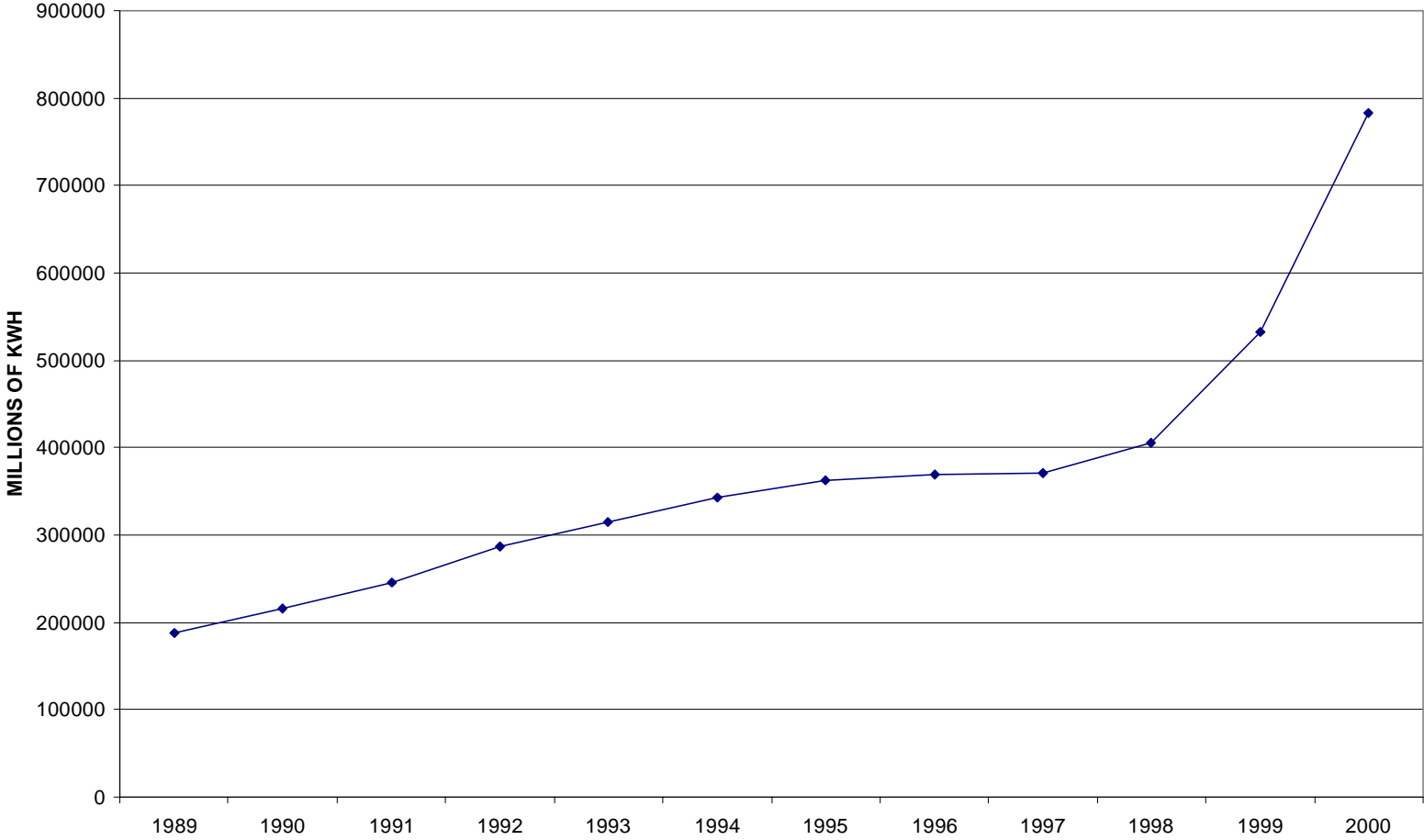


FIGURE 29
CALIFORNIA PX DAY-AHEAD PRICES
 (\$/Mwh: Weighted Averages 7 x 24)

	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>
January	-	21.6	31.8	260.2
February	-	19.6	18.8	363.0 (ISO)
March	-	24.0	29.3	313.5 (ISO)
April	23.3	24.7	27.4	370.0 (ISO)
May	12.5	24.7	50.4	
June	13.3	25.8	132.4	
July	35.6	31.5	115.3	
August	43.4	34.7	175.2	
September	37.0	35.2	119.6	
October	27.3	49.0	103.2	
November	26.5	38.3	179.4	
December	30.0	30.2	385.6	
AVERAGE	30.0	30.0	115.0	

FIGURE 30

COAL CONSUMPTION AND PRODUCTION

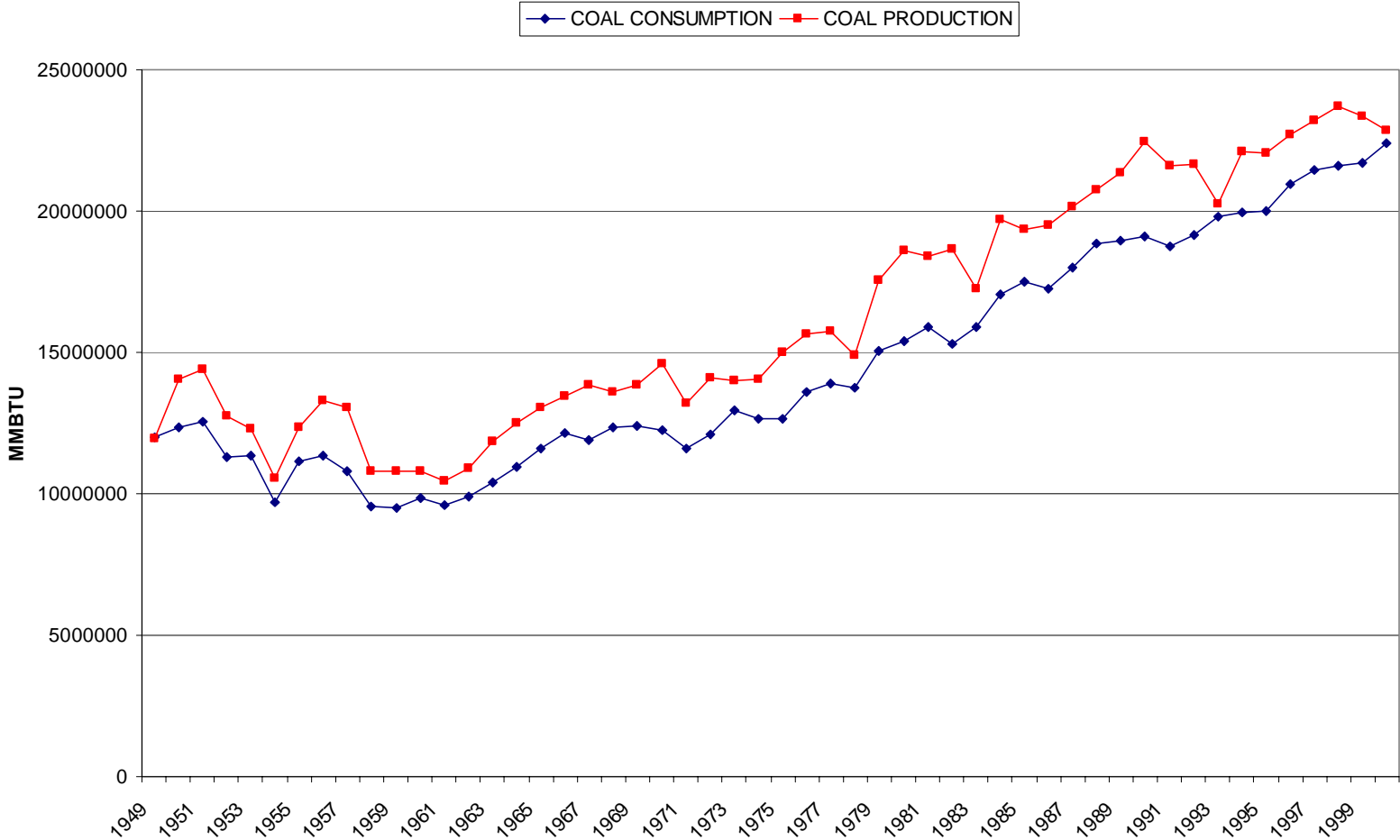


FIGURE 31

U.S. Coal Production

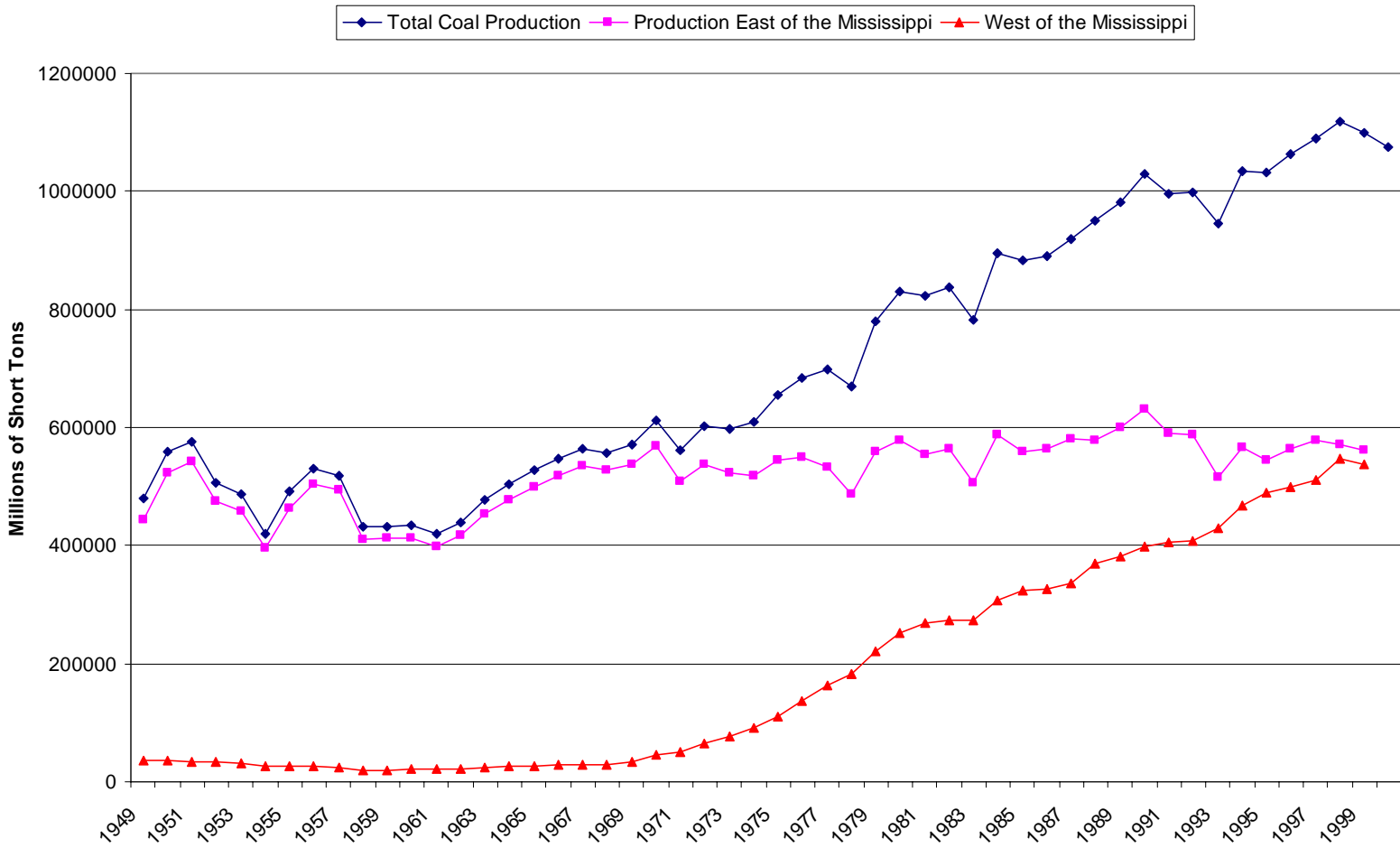


FIGURE 32

NUCLEAR GENERATION

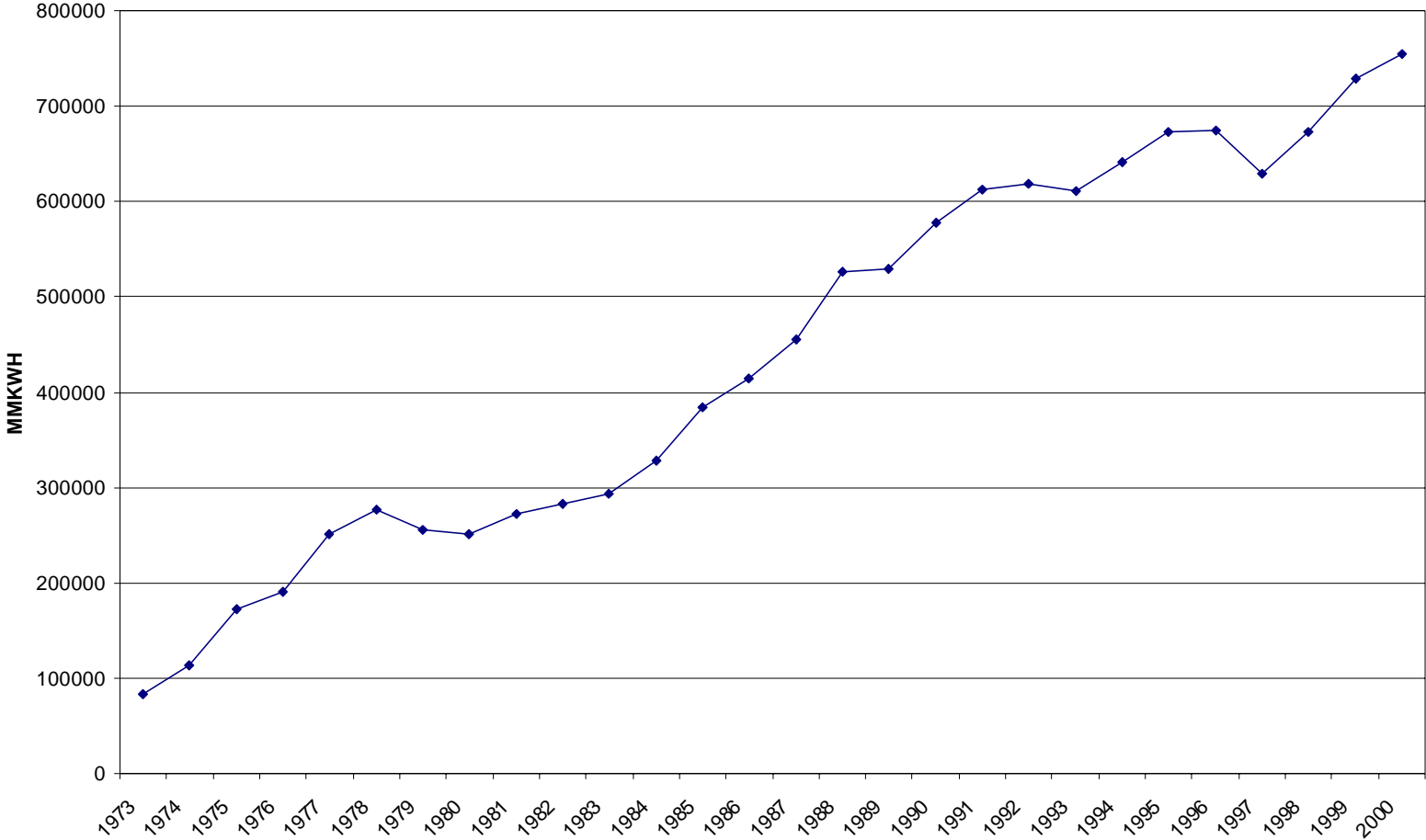


FIGURE 33

NUCLEAR GENERATING CAPACITY

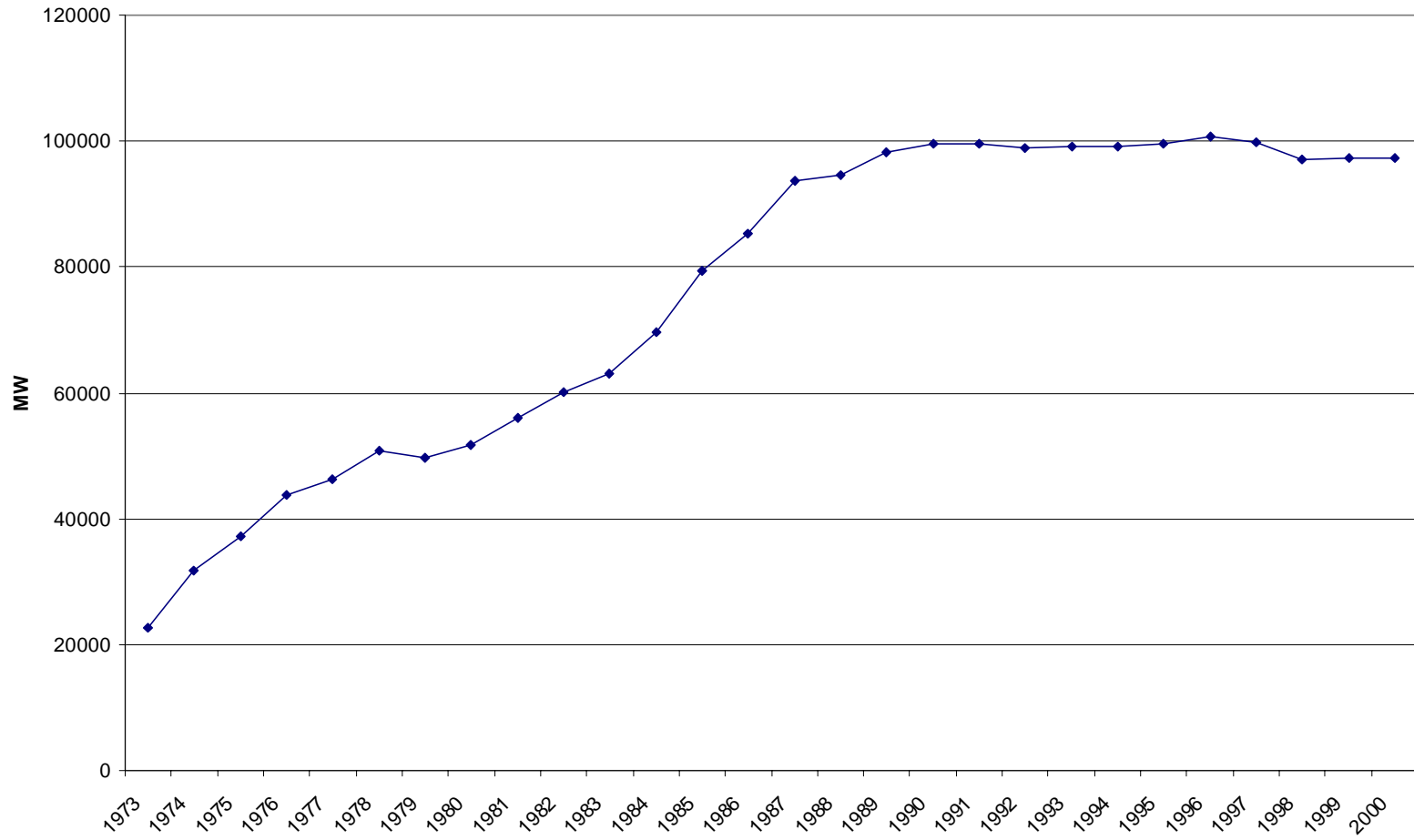


FIGURE 34

Nuclear Plant Capacity Factors

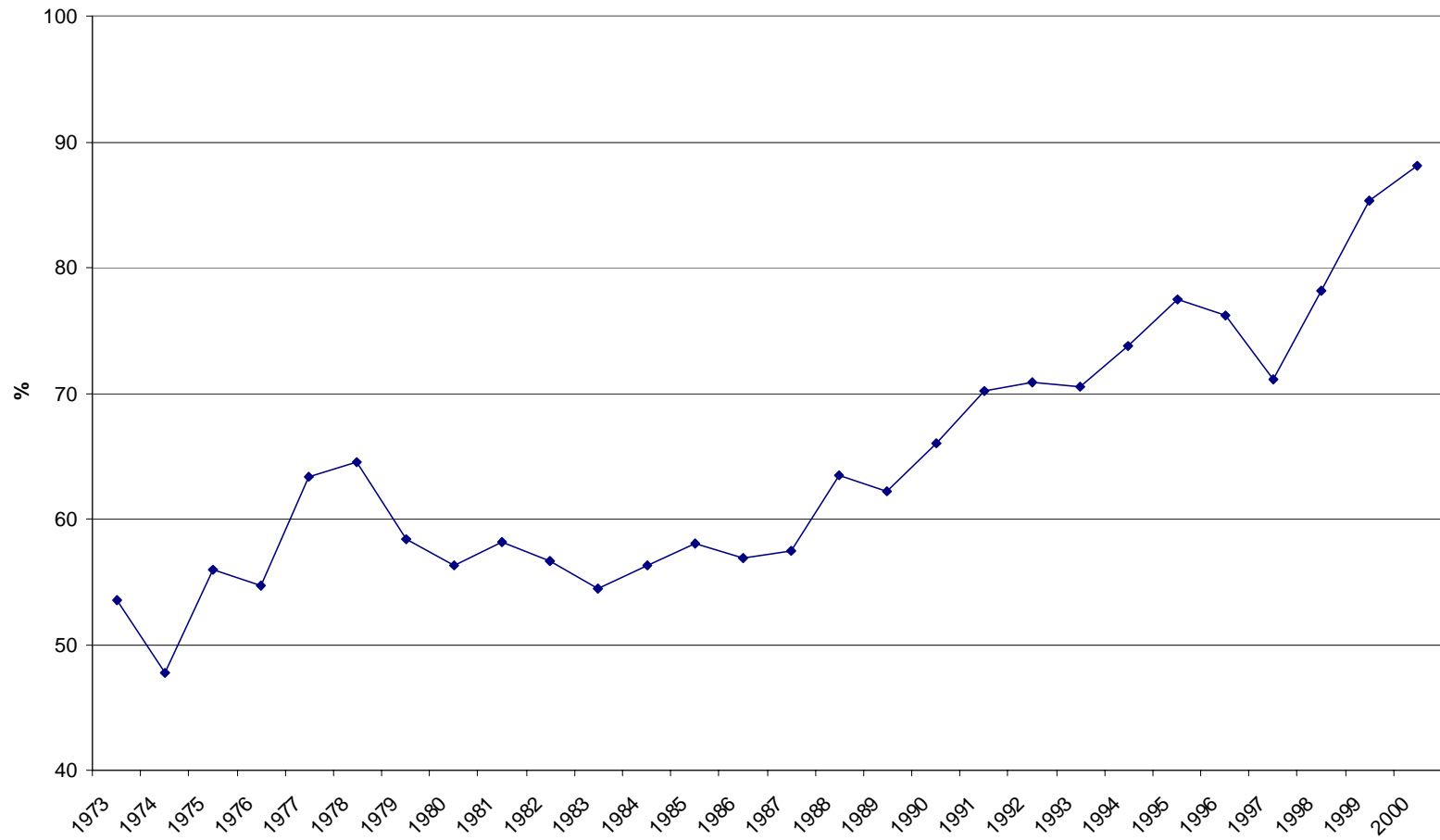


FIGURE 35

MOTOR VEHICLE FUEL EFFICIENCY

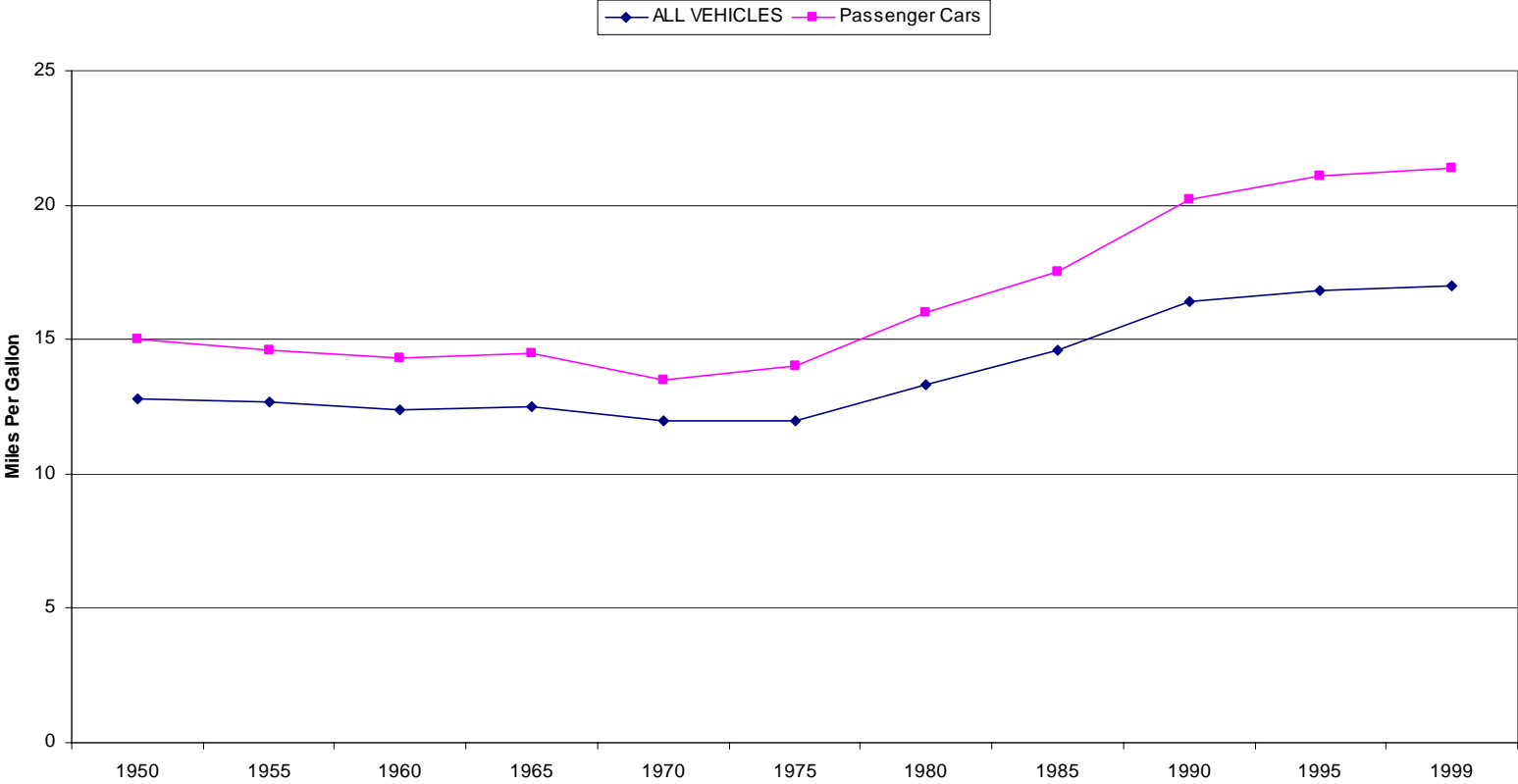


FIGURE 36

RENEWABLE ENERGY CONSUMPTION (BILLION BTU)

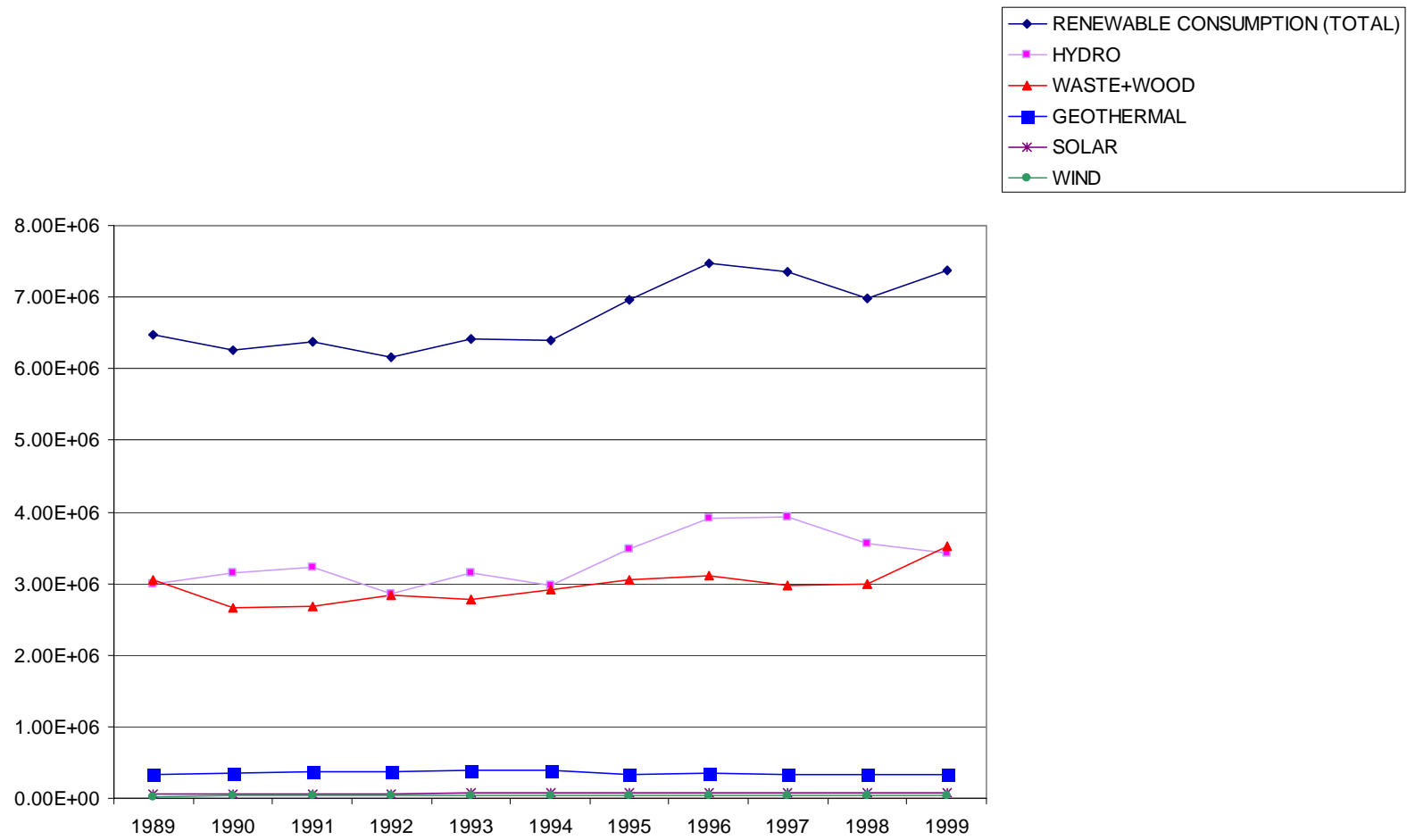


FIGURE 37

ALTERNATIVE FUEL VEHICLES

