ALASKA LEGISLATURE COMMITTEE FILES, 1989-1990 8672 475

6071 HOUSE RESOURCES

TABLE 1

1987 U.S. ENERGY CONSUMPTION

	Quadrillion Btu	Percent
Petroleum Products	32.63	41
Coal	18.00	23
Natural Gas	17.18	22
Nuclear	4.92	6
Hydropower	3.04	4
Other	2.85	4
Total	78.62	100

Source: DOE-EIA, South/West Energy Council

In terms of crafting an energy policy, the last two decades has provided a wealth of experience upon which to draw. Some of it has been unfortunate, like the last national policy which in 1985, declared the U. S. to be in good energy health immediately prior to the world price collapse that halved domestic exploration.

Some of the experience has been extremely hopeful, like the conservation strides of the 1970s that have allowed the national economy to grow by 2.5 percent a year while consumption of oil has remained at its 1973 level; or the production of this country's greatest oil field at Prudhoe Bay. Despite this experience, crude oil dependency and dogmatically exclusive proposals for energy security still face policy makers.

The dependency is clear. Examine for example, the transportation sector. The U.S. is 97 percent dependent on oil for transportation. Without oil, this nation does not move.

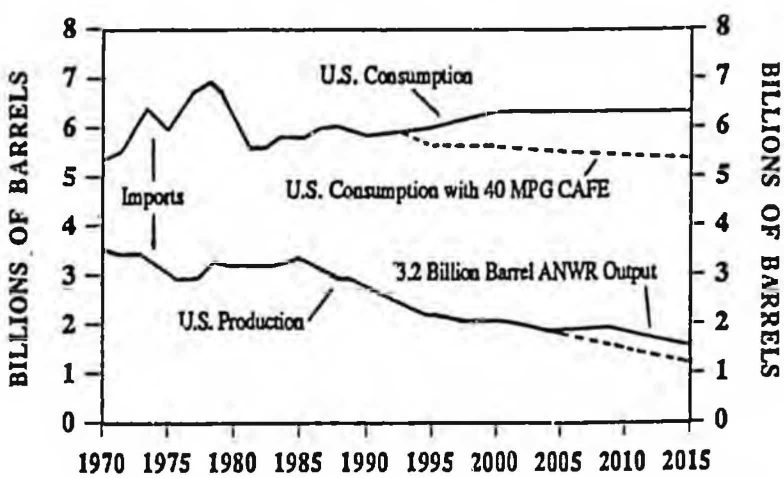
Exclusive policy proposals are perhaps best characterized by the most recent federal approach -- let the market take care of the problem. With 76 percent of the free world's supply of oil belonging to OPEC nations, it is clear that the world oil market is not guided by an invisible hand but rather by some very real foreign governments.

Battles rage nationally over domestic production policies. A policy that would rely solely on domestic reserves simply can't live up to its promise. A policy that vilifies oil companies for "draining America first" may in fact lead to draining America of needed capital, as even now the U. S. sends four billion dollars a month abroad for foreign oil.

In fact, Figure 2 demonstrates the need to add to domestic production as national consumption levels are decreased. Clearly, despite conservation and domestic production efforts, imports will continue to be a critical component of America's energy mix over the short to medium term.

FIGURE 2

PRODUCTION, CONSERVATION AND IMPORTS SCENARIO



CAFE refers to corporate automobile fleet efficiency (federal mileage standards) and ANWR refers to potential production from oil and gas development of the Arctic National Wildlife Refuge.

Source: Yeager, p. 20.

Over the last decade, a degree of comfort has been afforded the U.S. as significant non-OPEC sources of oil were brought on line. Diversifying the sources of supply of imports is one way to manage the import situation. However, many of these producing nations are in supply positions similar to that of the U.S.; Canada has a smaller crude oil reserve base than does the U.S. and reserves in the United Kingdom are being fast depleted, just as are American reserves.

This is not to say that non-Middle Eastern sources of oil will not be available. In the Western Hemisphere, Mexico holds promise for the long term (in this case 12 years or more is long term) and new discoveries are being made, e.g. Brazil's largely unquantified strikes. The largest reserves, conventional and nonconventional, in this hemisphere are in Venezuela which, although a member of OPEC, supplied the U.S. during embargoes in the 1970s.

But the bulk of the world's conventional reserves rest in the Middle Eastern OPEC nations. If indeed this part of the world will be such important suppliers, then the U. S. should start a dialogue to find the common ground that no doubt exists between the world's largest consumer and its largest suppliers.

However much experience past energy policies have granted the nation, it has not been matched by security. In fact, as a nation the U. S. is in an unenviable position of having almost all of its indicators pointing away from a secure energy and economic position. The only bright spot is the Strategic Petroleum Reserve (SPR) which has become this nation's primary energy insurance policy. Consider the factors addressed in Table 2.

The goal of the nation's energy policy is clear; to provide a stable supply of reasonably-priced energy in an efficient and environmentally sound manner to meet the needs of its citizens, economy and national security interests. Energy independence should be the long term goal of the United States.

Over the short term the nation's energy management plan must provide for economic growth while testing the flexibility of supply and demand constraints; that is, how to maximize recovery of both domestic resources and energy from those resources through improved efficiency and conservation measures. Equally important, how can the U. S. best manage its oil imports as an essential component of the national energy mix.

TABLE 2

INDICATORS AND TRENDS RELATED TO ENERGY AND ECONOMIC SECURITY

U. S. Energy Consumption	↑	Consumption is once again increasing, after leveling off as a result of conservation efforts,
U. S. Production	↓	Decreasing, reflecting declining reserves and depressed world price,
Imports of Foreign Oil	↑	Predicted to break 50 percent by 1990,
Conservation	↓	Conservation incentives have been weakened,
Development of Renewable Fuels	↓	Federal research and development budgets gutted,
Strategic Petroleum Reserve	↑	Slowly increasing,
Trade Deficit	↑	In 1987, the U.S. trade deficit increased for the sixth year in a row, and
Environmental Concerns	↑	Greenhouse effect, ozone nonattainment and acid rain head the list of growing concerns.

Source: South/West Energy Council

Environmental concerns, available domestic supplies and the possibility of backing out some imported oil, point to natural gas as a near-term link to the nation's energy future. Finally, national security, international considerations and regional impacts must be addressed.

An energy strategv must look beyond a four year term or even eight years. It must be a continuum of policy measures addressing weak points immediately and strengthening the very basis of the economy over the long term by shifting to a less dependent position. It must not of itself be the cause of economic dislocations by mandating drastic changes in energy supply or demand parameters. Ultimately it must reach for energy independence.

GOAL

It shall be the goal of the United States' energy strategy to provide a stable, reasonably-priced supply of energy in an efficient and environmentally-sound manner to meet the needs of its citizens, economy and national security interests. Energy independence shall be a long term goal of the United States.

CONSERVATION

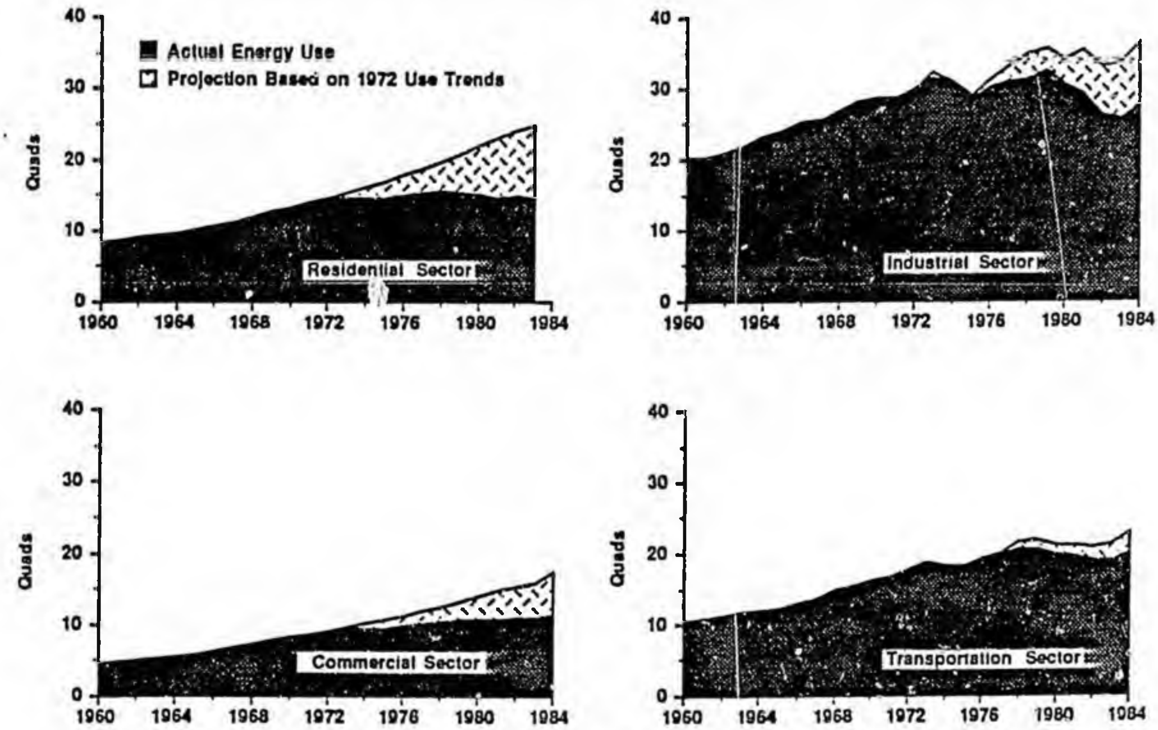
The future of productive and secure energy in our society rests not on how big our supply is but rather on how intelligent we are in using what we have.

Peter Bishop

The 1970s brought a new element to the nation's energy picture -- conservation. Driven by high energy prices. the oil embargo and federal policy, energy conservation efforts were undertaken in all sectors; residential/commercial, transportation, industrial and electric power generation. The result of those efforts is that the U. S. uses roughly the same amount of energy it did in 1973, although the economy has grown 30 percent in the intervening 15 years. Figure 1 demonstrates energy efficiency gains by sector.

FIGURE 1

All Sectors of U.S. Economy Now Use Energy More Efficiently

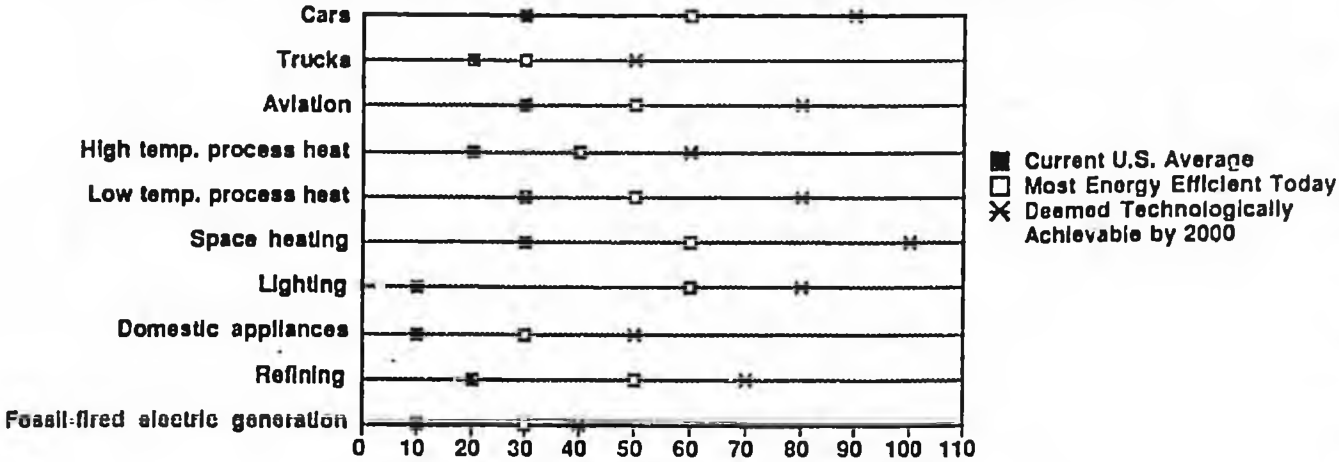


Source: U. S. Department of Energy (DOE/S 0057), p. 97.

However, there are still conservation gains to be made, based on existing technology. Americans use 2.4 times the energy per capita as the Japanese use. For instance, half the electricity used for lighting in the U. S. could be saved by energy efficiency strategies without sacrificing productivity.[1] Figure 2 illustrates end use efficiencies beyond 1973 averages.

FIGURE 2

Percentage Improvement In End-Use Efficiencies (Beyond 1973 Averages)*



Source: U. S. Department of Energy (DOE/S 0057), p. 106

Conservation, often referred to as energy productivity, means decreasing the amount of energy required to sustain a given level of goods and services.[2] Increasing the efficiency of our energy resources makes dollars invested more productive and eliminates certain environmental costs related to energy production.

In this regard, recycling and waste reduction programs are also energy conservation programs. Recycled paper requires 36 percent of the energy required to produce "new" paper and recycled aluminum 4 percent of such energy.[3]

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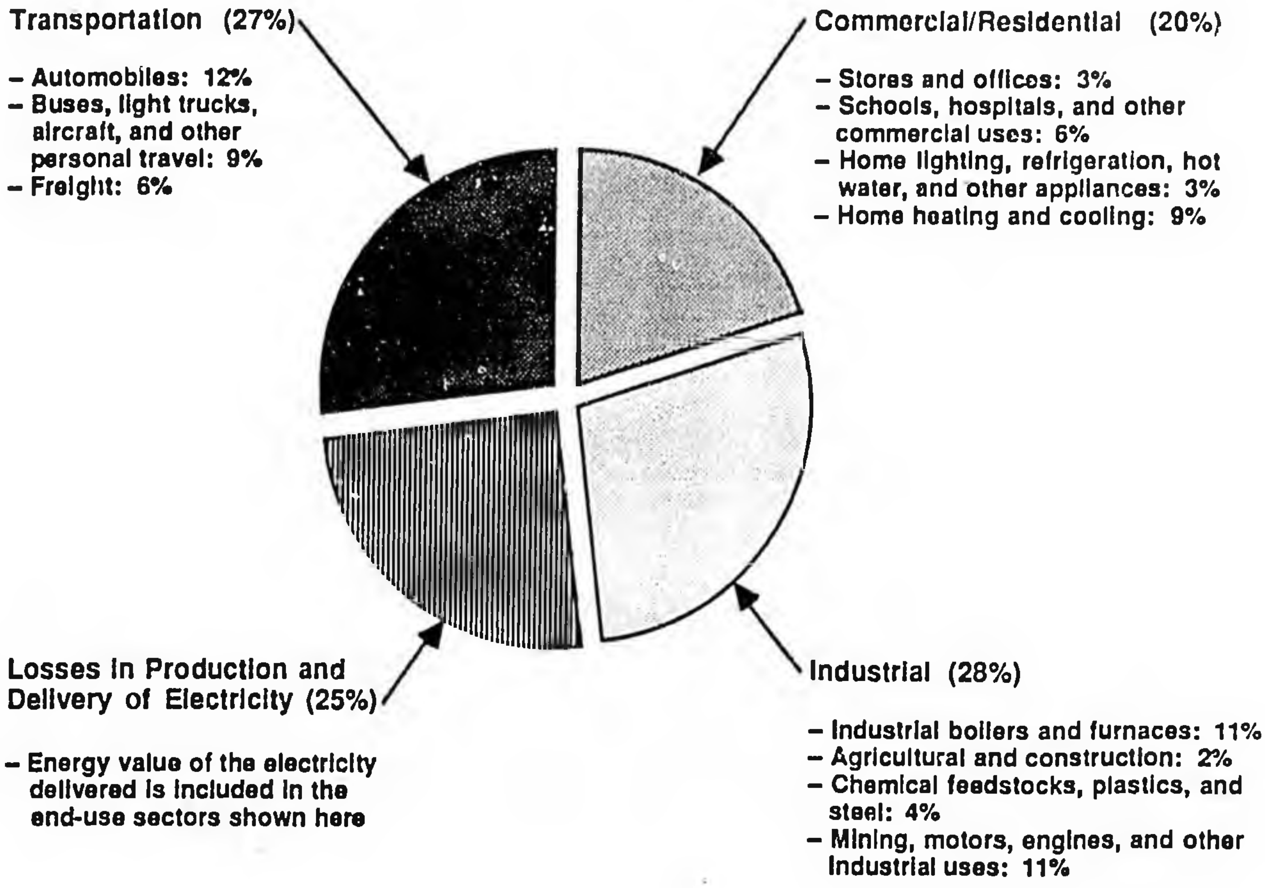
1 Gibbons, p. 11
2 Gibbons, p. 11
3 Scull, p. 1

All energy consumers may benefit from conservation. As Figure 3 indicates, consumption of U.S. primary energy in 1985 was fairly evenly distributed among transportation, commercial and residential use, industrial consumption and losses in electricity production and transmission.

FIGURE 3

Consumption of all U.S. primary energy broke down like this in 1985:



Source: U. S. Department of Energy (DOE/S-0057), p. 100

Transportation represents over a quarter of our energy consumptio·· Fully 97 percent of our transportation runs on petroleum. The lack of alternative fuels tnat might replace gasoline and the strategic importance of crude to the U. S., make automobile fuel efficiency standards an essential component of any energy conservation policy.

In the area of commercial and residential consumption, building codes and appliance standards can have a real impact on energy savings. Refrigerator efficiency standards, part of a federal household appliance statute passed last year, are expected to reduce the need for power generation for household refrigeration by 1995 from as much as 107,000 Megawatts, as would have been indicated by earlier growth tre ds, to 21,000 Megawatts.[4]

About 73 percent of the fuel used by the industrial sector is petroleum and natural gas, strategically important fuels. Industrial conservation gains, primarily savings in oil and gas, have been noteworthy since the 1970s; energy use per unit of production has decreased about 20 percent.[5]

Future conservation in the industrial sector is expected to be derived mainly from new processes or process technology improvements. Recent studies have shown that industrial energy efficiency improvements are simply a matter of investment choice by large corporations and depend primarily on return on the dollar.[6] However, federal research on improving the economic efficiency of industrial processes may promote industrial conservation.

Electricity losses in production and delivery account for one quarter of the nation's primary energy consumption. Research into ways to eliminate these losses includes work on superconductivity, which would represent a major conservation breakthrough.

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[4] Cavanagh, p. 17
[5] U.S. Congress, OTA; p. xi
[6] Ibid.

CONSERVATION STRATEGY STATEMENT

It shall be the energy strategy of the United States to promote energy conservation, improving efficiency, in a variety of ways by setting or strengthening: Corporate Average Fuel Efficiency Standards for automobiles; energy efficiency provisions in building codes (including lighting efficiency standards); home appliance, heating and cooling unit efficiency standards; and waste recycling or reduction standards for industrial manufacturing.

Also, the federal government shall promote energy conservation education and fund research into conservation technologies. Basic energy conservation research funded by the government shall include superconductivity studies.

CRUDE OIL

Over the last 15 years, there have been three worldwide oil price crises. Two of those saw prices double or triple while the third saw the price of oil fall to one-third of its previous level. Economic dislocation in the U.S. as a result of those price swings was severe. Each of the price increases caused nationwide recessions while the price decrease meant severely depressed economic conditions in the oil producing states of the U.S.

In order to define an energy policy that would avoid such economic havoc, nationally and regionally, it is important to review the status of the U.S. with regard to crude oil. Table 1 illustrates U.S. reserve, production, import and consumption levels since 1970.

This nation has not seen a major increase in reserves since the addition of Prudhoe Bay and the North Slope fields in the early 1970s. The oil price crash of late 1985 decreased domestic exploration by half (48 percent) in 1986. Exploratory drilling fell still further in 1987, boding ill for U.S. reserve replacement.

Production in the U.S. has generally declined over the last 20 years with the exception of production increases for a period during the late 1970s and early 1980s. According to the U.S. Department of Energy, conventional U.S. oil production will begin a permanent decline by 1990.

In 1987 oil imports were up for the second year in a row. However, these imports were marked by a diversity of source. Indeed, the world oil price collapse in 1985 - 86 was import-related, as OPEC attempted to regain the world market share it had lost to new international producers. In the late 1970s OPEC supplied 77 percent of U.S. imports. In 1987, OPEC supplied 52 percent of oil imports to the U.S.

TABLE 1

U.S. RESERVES, PRODUCTION, IMPORTS, AND CONSUMPTION

1970 - 1987

	'70	'71	'72	'73	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87
RESERVES (Crude Oil)																		
(Billion Bls)	39.0	38.1	36.3	35.3	34.2	32.7	30.9	31.8	31.4	29.8	29.8	29.4	27.9	27.7	28.4	28.4	26.9	24.6
PRODUCTION (Crude Oil and Condensate)																		
(MMbl/d)	9.63	9.46	9.44	9.20	8.77	8.37	8.13	8.24	8.70	8.55	8.59	8.57	8.64	8.68	8.87	8.97	8.68	8.31
NET IMPORTS (Crude Oil and Petroleum Products)																		
(MMbl/d)	3.16	3.70	4.51	6.02	5.89	5.84	7.09	8.56	8.00	7.98	6.36	5.40	4.29	4.31	5.71	4.28	5.43	5.76
CONSUMPTION (Crude Oil and Natural Gas Liquids)																		
(MMbl/d)	14.70	15.21	16.37	17.31	16.25	16.32	17.46	18.43	18.85	18.51	17.06	16.06	15.30	15.23	15.73	15.73	16.28	16.56

Source: DOE-EIA, Arthur Anderson & Co. and Cambridge Energy Research Associates, South/West Energy Council

Oil consumption levels in the U.S. reflect the impact of conservation efforts begun during the 1970s. Although oil consumption has risen for the last two years, it is still more than 15 percent below the nation's high consumption mark of 1978. While national economic output has grown at an average rate of 2.5 percent, the U.S. uses no more energy now than was consumed in 1973. In fact, U. S. oil consumption in 1987 was below 1973 levels.

As domestic oil and gas fields mature, interest is turning to the maintenance of stripper wells and enhanced recovery to maximize recovery from known reserves. Primary production methods may leave as much as 60 percent of oil and gas reserves in place. Once a well is shut down ("plugged and abandoned"), it is unlikely that a new well will be drilled to recover remaining reserves.

Enhanced production techniques, now generally expensive, recover some of the remaining increments of oil and gas. Research and development is needed to reduce the cost of enhanced recovery of identified reserves.

In addition to "conventional" crude oil, this nation has a wealth of nonconventional oil resources. For instance, oil shale deposits are found in sedimentary rocks, principally in the western U.S. Kerogen is extracted as a liquid oil and hydrocarbon gases when the rock is heated.

The U.S. leads the world in oil shale reserves. Deposits in Colorado, Utah and Wyoming may exceed 1000 feet. The total extent of the resource is estimated at over 2.5 trillion barrels of oil.

Although shale oil can be substituted for refinery feedstock, it is currently expensive, relative to conventional crude oil. Estimates of the cost of production range from $30 to $60 per barrel. Environmental, as well as economic, factors concerning oil shale require further research, development, demonstration and commercialization projects.

Related to domestic production is the matter of multiple use of federal lands. There are 727.1 million acres of federally owned land in the United States. That is approximately one in three acres or 32 percent of the nation's land mass.

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Related to domestic production is the matter of multiple use of federal lands. There are 727.1 million acres of federally owned land in the United States. That is approximately one in three acres or 32 percent of the nation's land mass.

The vast majority of the federal lands is managed by either the Department of Interior or the Department of Agriculture. The Department of Interior (e.g. the Bureau of Land Management, the National Parks Service, and the United States Fish and Wildlife Service) manages half a billion acres while Agriculture (e.g. the National Forest Service) administers about 190 million acres.

Each administrative agency is authorized to manage public lands under different statutory grants of authority. Consequently each has developed a separate set of standards or regulations for addressing issues of multiple use or access.

Almost half (44 percent) of all federal lands are found in Alaska. In fact, 87 percent of the state of Alaska is owned by the federal or state government.

Referred to as this nation's most significant federal conservation measure, the Alaska National Interest Lands Conservation Act (the Alaska Lands Act), passed in 1980, added 104 million acres to federal ownership.[1] The area set aside by the Alaska Lands Act for public ownership is equivalent to the entire Northeastern part of the country; equal to the total land areas of the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Pennsylvania.

Importantly, it is in Alaska that about one-quarter of this nation's proved crude oil reserves are known to exist and 17 percent of the nation's natural gas is found. There are also large coal deposits in Alaska.

Those reserves are this nation's energy "ace in the hole." The oil will be needed shortly, the natural gas may well be needed over the next few decades, and the coal represents a long term energy asset. The preservation of multiple use rights with regard to federal lands, especially those in Alaska, is essential if the United States is to develop our energy resources in an environmentally sound-manner.

The outlook for crude oil has been summarized by the Department of Energy in Table 2. According to DOE, in less than 25 years, even if consumption is held relatively constant, the U.S. will depend on foreign imports for almost two-thirds of our supply of crude oil.

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[1] Quarles and Lundquist.

TABLE 2

1988
DOE CRUDE OIL OUTLOOK
(Quadrillion Btu's per Year)

	1986	1990	1995	2000	2010
Domestic Production	20	18.9	15.9	14.2	12.3
Imports	11.3	14.8	17.9	19.7	21.3
Consumption (Petroleum Liquids)	30.6	32.1	32.2	32.5	32.6

Source: DOE; South/West Energy Council

The U.S. balance of trade is even now suffering from oil imports. In 1987, the U.S. external trade deficit increased for the sixth year in a row. Oil represents about 10 percent by value of total U.S. imports Increased oil imports will only put a greater burden on the trade deficit by sending capital abroad. The current rate of imports is costing the U.S. almost four billion dollars a month.

One means of mitigating the balance of trade problem may be to lift restrictions on the export of Alaskan crude oil. Sold on the world market, to nations like Japan, Alaskan oil will net-back a higher price and encourage the continued development of Alaskan resources, while offsetting some of the U.S. balance of trade deficit. Under the current regulatory scheme, Alaskan oil sells to domestic markets at a low, distorted price, discouraging development of resources in both Alaska and California.

Another national concern is this country's vulnerability based on oil dependency. The U.S. transportation sector is 97 percent dependent on oil. In fact, 62 percent of our oil is consumed by the transportation sector, the bulk of it for personal transportation.

There is no substitute for oil for the transportation sector. Oil dependence, as defined by DOE, is the short term inability to use fuel substitutes, due to either a lack of access to alternative fuels or limitations that make oil the only technically suitable fuel.

Interestingly, with one notable exception, the residential sector is not generally dependent on oil. The northeastern part of the country has limited access to natural gas and is the only region of the nation heavily dependent on fuel oil for home heating.

In addition to national security interests in a secure supply, this nation has a real interest in the exploration, production, downstream activities, jobs and investments in domestic producing regions. The producing states have been gutted by world oil price declines since 1985 resulting in high unemployment, a severe loss of state revenues, bankruptcies and bank failures. Unemployment approached twice the national average in many oil producing states.

A national energy policy based on economic stability can not tolerate severe regional disruption in spite of national prosperity. The economic health of producing regions of the nation must be considered in any national energy policy just as must the residential oil dependency of the Northeast. A national policy seeking economic stability must extend such stability to all regions.

In sorting through the trends that define this country's energy status, the Strategic Petroleum Reserve (SPR) is a bright spot of stability. The goal of the government is to fill the SPR to 750 million barrels. The SPR held 540 million barrels at the end of 1987. This is equivalent to 94 days of net petroleum imports, derived by dividing the end-of-year SPR stocks by the annual average daily net imports of all petroleum.

This measure may be somewhat misleading. In the event of an embargo, the U.S. Department of Defense would require a substantial portion of the SPR. Additionally, the U.S. is committed to supplying the needs of its allies in an embargo situation.

Beyond concerns relative to the size of reserve, there are questions about the rate at which crude oil could be distributed from the SPR to U.S. refiners. Recent tests indicate a maximum draw-down rate would not replace the amount currently supplied by foreign imports. Although it is highly unlikely that an oil embargo would completely cut off foreign supplies, economic and national security interests in avoiding supply disruption require that questions of supply and distribution capacity relative to the SPR be answered.

In addition to the SPR, there are privately held reserves belonging to energy companies. However, it appears that as the government-owned SPR continues to fill, private reserves are being limited to "minimum operating inventory" levels (MOI). The MOI levels are currently only slightly above the level necessary to maintain normal day-to-day operations. Thus the privately owned reserves, about 350 million barrels, would be of limited value in a shortage situation.

Related to the SPR is the U.S. commitment to the International Energy Program (IEP). The U.S. entered into the IEP in 1974. The IEP creates an International Energy Agency (IEA) within the Organization for Economic Cooperation and Development (OECD).

According to the agreement, a seven percent shortage situation authorizes a member country to ask the IEA to consider a sharing arrangement whereby member nations would draw down reserves to assist other members. The IEA's 21 members include the OECD members, basically our European allies, as well as Japan and Australia.

Of governmental reserves held by IEA nations, the U.S. has the greatest amount stockpiled. Japan has 160 million barrels or about 30 percent of the U.S. SPR, West Germany has 180 million barrels (about one-third of the U.S. reserve) and all other nations have 50 million barrels in reserve. The IEA arrangement would rely on private oil companies, 17 of whom are also signatories to the IEA agreement, to affect transfers of crude oil in emergency shortages.

In 1988, the U.S. House of Representatives passed a bill authorizing the extension of the IEA, and calling for a study by DOE on ways to improve cooperation between the United States and Western Hemisphere nations on energy and natural resource policies. This was an important step toward recognizing a Pan American Energy Alliance as proposed by the South/West Energy Council the previous year.

At a joint meeting in New Orleans in April, 1987, the South/West Energy Council and the Louisiana Energy Development Commission brought together representatives of the Canadian and U.S. governments and officials of Petroleos de Mexico and Petroleos de Venezuela to explore the mutual benefits of a Pan American Energy Alliance. Also attending the conference was a delegation of more than 15 Organization of American States ambassadors.

In requesting the DOE study as part of IEA reauthorization, the House Committee on Energy and Commerce cited the points that make a Pan American Energy Alliance attractive, points discussed nationally by the South/West Energy Council over the last two years --

- the global and interdependent nature of energy markets;
- the extent of the Western Hemisphere crude oil resource;
- the increasing frequency of international joint ventures relative to energy;
- international cooperation like the IEA or other trade agreements that limit the danger of oil supply disruption;
- the variety of measures that might raise the productive potential of Western Hemisphere nations including increasing the security of capital investments;
- mutual benefits for consumers, producers and creditors in Western Hemisphere nations; and
- the history of political and economic cooperation and stability enjoyed among Western Hemisphere neighbors.

Finally, any long-term view of oil policy has to return to the facts that three quarters of the free world's reserves are owned by OPEC nations, that U.S. reserves represent four percent of the free world's supply and that the U.S. represents 30 percent of the free world's demand (consumption). Given U.S. dependence on oil, economic vulnerability to oil price shocks and inability to produce a sufficient supply of oil, it is evident that this country, as part of an energy management plan to assure economic stability through energy security, must reach out and open a dialogue with world oil suppliers.

CRUDE OIL STRATEGY STATEMENT

It shall be the strategy of the United States to promote the environmentally-sound production of domestic energy resources, the conservation and efficient use of energy resources, and the management of energy imports.

It shall be the policy of the United States to promote and encourage domestic production of crude oil in an environmentally-sound manner in order to supply U.S. consumers with a secure source of petroleum, and provide a stabilizing influence to the world price of crude oil. In this regard the federal government shall provide tax and tax accounting incentives to oil producers for domestic exploration and development efforts with specific investment tax credits for research and development and enhanced oil and gas recovery.

It shall be the policy of the United States to assure that energy resources are utilized in a manner that recovers the most energy value possible. Similarly, it is the strategy of the United States to alleviate oil dependency by funding research and development to perfect alternative fuels, particularly for the transportation sector and primary modes of personal transportation. Enhanced oil and gas recovery from known reserves shall be promoted, and a research, development, demonstration and commercialization program for unconventional sources of crude oil shall be pursued through a cooperative effort among industry, higher education and national laboratories.

It shall be the policy of the federal government to manage U. S. imports by diversifying import suppliers, allowing the exportation of Alaskan crude oil, pursuing a Pan American Energy Alliance with Western Hemisphere producing nations, considering technological barriers to the use of vast reserves of unconventional crude oil in the Western Hemisphere and opening a dialogue with suppliers worldwide. It shall also be the policy of the United States to continue filling the Strategic Petroleum Reserve, at least to its present goal of 750 million barrels.

It shall be the strategy of the United States to support active management of federal lands and Outer Continental Shelf areas in accordance with principles of multiple use and to recognize the potential that public lands hold, particularly in Alaska, for environmentally-sound development of energy resources.

COAL

In terms of reserves, coal is America's leading fuel. Indeed, one-fourth of the world's coal is in the United States. It is a ubiquitous fuel in this country. Coal is found in 38 states and mined in 27.

Primary coal regions are Appalachia, the Midwest, and the Rocky Mountain area. As a general rule, coal from northern Appalachia and the Midwest has higher energy (Btu) values than does coal from central Appalachia, the Rockies and the Northern Great Plains, but higher sulfur contents as well.

The U.S. produced about 900 million tons of coal in 1984 and has recoverable reserves of 239 billion tons. At the present rate of consumption, our coal reserves would provide fuel for more than 250 years. Coal is consumed in all fifty states. Ten percent of U.S. coal production is exported to 50 countries around the world.

Coal has been mined commercially in this nation since 1748. At the beginning of this century, it supplied 90 percent of the country's power. By 1975, coal had slipped to supplying 18 percent of our energy demand. The 1970s oil embargos benefitted U.S. coal producers and by 1987, coal supplied 24 percent or about one-fourth of our nation's energy.

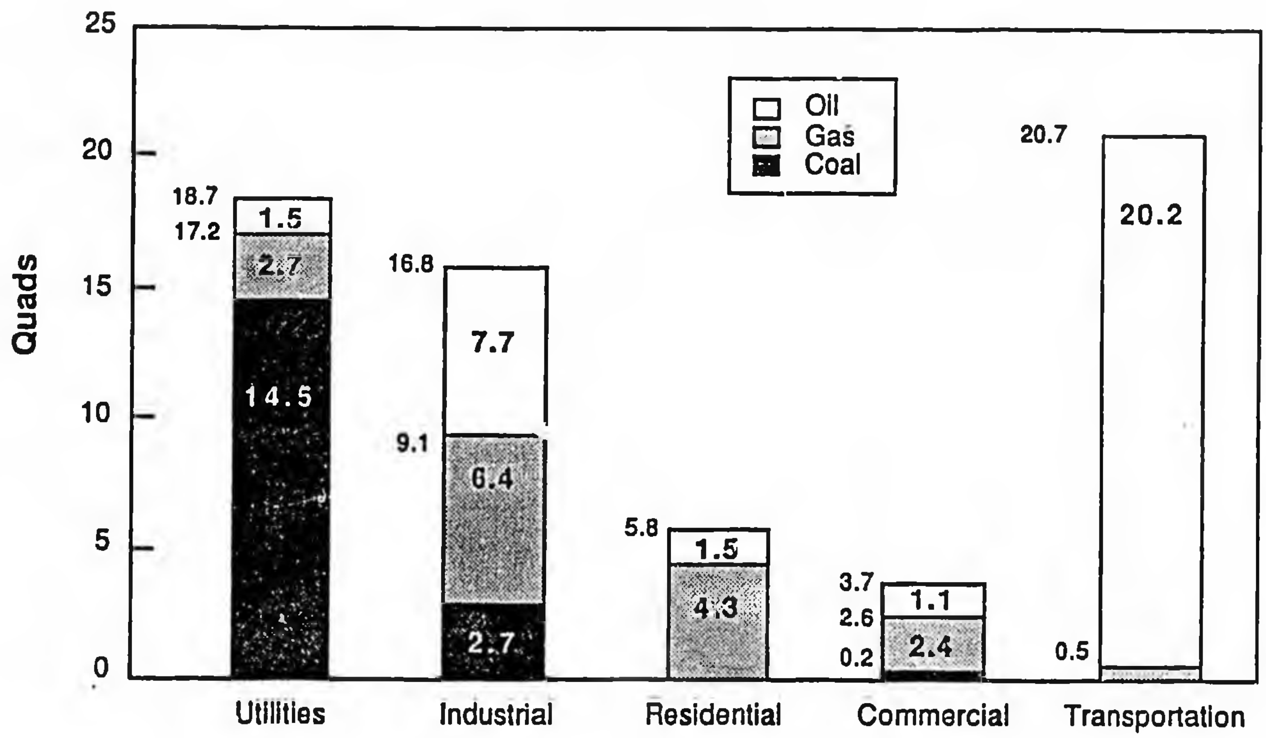
Most coal (60 percent) is transported by rail in the U.S. Coal is the major revenue source for U.S. railroads. Barges, ships and trucks also deliver coal to market. Large coal-carrying ships called colliers transport coal for export from Norfolk, Virginia and other ports.

Some powerplants are located at the edge of the mine. These so-called "mine-mouth" plants are supplied by trucks, rail or conveyor belts. There is one coal slurry pipeline in the nation, which runs 273 miles from Arizona to a powerplant in Nevada.

In many cases though rail is the sole means of transporting coal to consumers. Congress and the coal and railroad industries continue to explore means of alleviating impacts on captive shippers.

Coal is primarily used to fire utility powerplants, producing over half (55 percent) the electricity generated in the U.S. Aside from a very small amount (1 percent) used by the commercial sector, coal is consumed in industrial boilers and processes (16 percent) and utility powerplants (83 percent). Fossil fuel consumption by sector is illustrated in Figure 1.

FIGURE 1
U.S. FOSSIL FUEL CONSUMPTION BY USE SECTOR
(1986)



Source: DOE/FE-0102, p. 5.

Coal consumption is expected to increase slowly in the U.S., primarily in the utility (electricity) sector. Increased use of coal by industrials is expected to be slight because of maturing markets for down-stream products most important to coal (chemicals, cement, paper, primary metals and food processing) and a shift in industry to small scale cogenerating units (producing both process steam and electricity). Coal faces strong competition from natural gas in cogeneration units.[1]

[1]Resource Data, Inc., p. 5.

On the world market, the U.S. is often a high-priced exporter because of higher labor and transportation costs. Western Europe will probably remain this country's principal coal export market, as Pacific Rim importers seek lower cost coal from Australia, South Africa and China. Despite higher prices, the U.S. will remain a swing exporter because of its ability to provide large amounts of quality coal on short notice.

Since significant increases in industrial consumption and exports are not predicted, the future of coal consumption rests with electric utilities. Environmental concerns and aged technology are two hurdles facing expanded coal usage by utilities. Primary among environmental concerns is acid rain. However, the "greenhouse effect" is emerging as an environmental concern linked to coal and other fossil fuel combustion.

Scientists are presently researching what effect acid rain or acid precipitation may have upon agricultural crops, forests, aquatic systems (including fish, streams, and lakes), materials, and human health and visibility. Acid rain precursor emissions are sulfur dioxide, nitrogen oxide and volatile organic compounds.

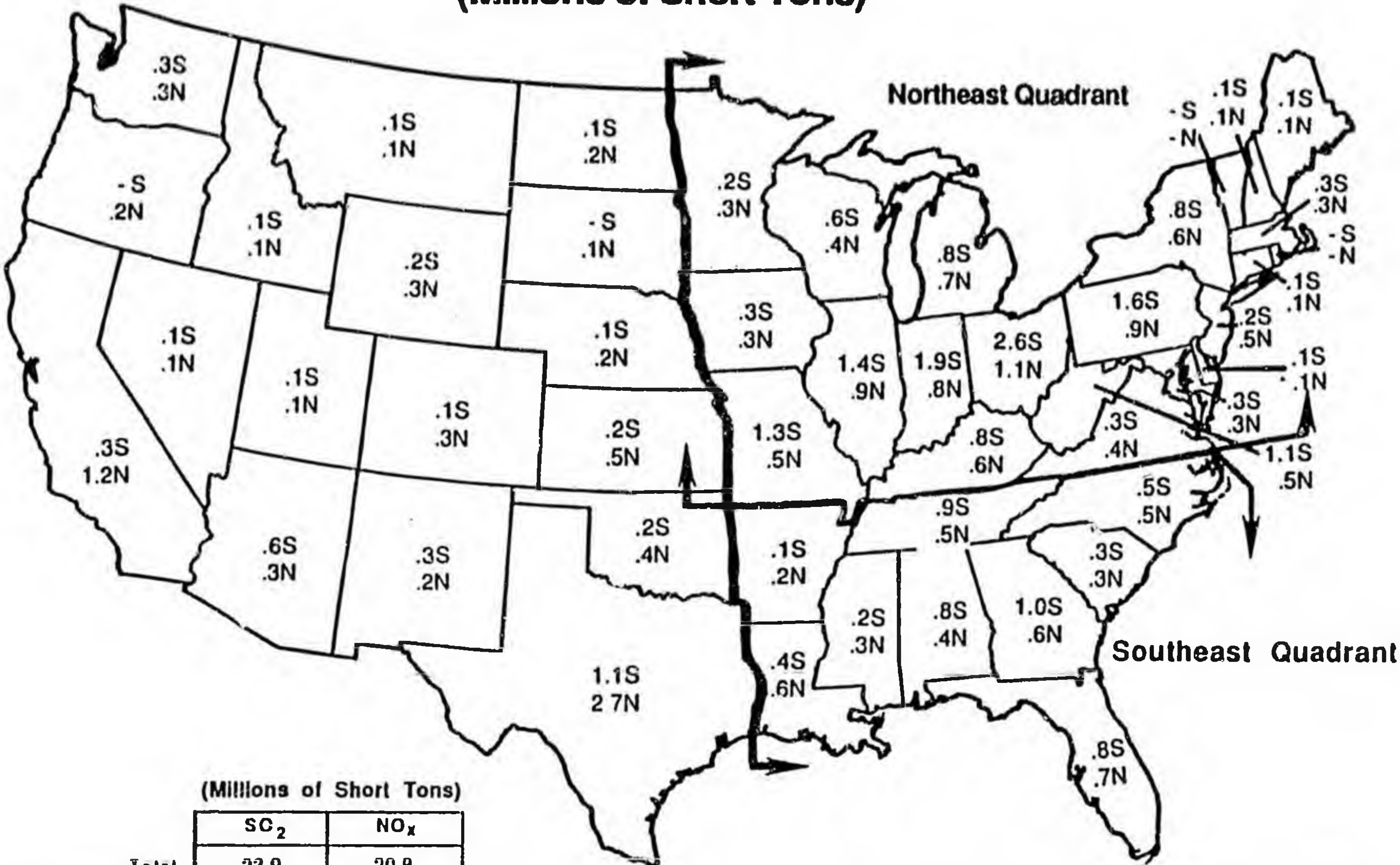
Sulfur dioxide (SO_2), nitrogen oxide (NOx) emissions and volatile organic compounds (VOC) are found in every state. Different emissions are thought to be responsible for different effects. Sulfur dioxide is the "precursor of interest" with regard to chronic lake acidification. Relative to crop damage, nitrogen oxide is the primary precursor.

Acid rain precursor emissions, SO_2, NOx, and VOC, are of natural origin as well as man-made. Man-made acid rain has been present in the Northeast since the turn of the century. Rain is considered acidic when it has a ph of 5 or less.

In 1985, 25 million tons of SO_2 was emitted into the air in the U.S. -- that is approximately the same amount of SO_2 emissions released in the 1920s. As Figure 2 indicates, in 1984 about 83 percent of SO_2 emissions were in the Eastern U.S. Almost half (48 percent) of all SO_2 emissions in the U.S. were from Northeastern utility plants. Figure 3 details sources of SO_2 emissions.

FIGURE 2

Emissions of SO_2 and NO_x in Continental U.S. (1984)
(Millions of Short Tons)



(Millions of Short Tons)

	SO_2		NO_x	
Total	23.9		20.8	
N.E. Quadrant	14.9	62.3%	9.5	45.5%
S.E. Quadrant	4.9	20.5%	4.1	19.6%

Source: DOE/FE - 0083, p. 21

S = Sulfur dioxide
N = Nitrogen oxides

Reference: "Estimated Monthly Emissions of Sulfur Dioxide and Oxides of Nitrogen for the 48 Contiguous States, 1975-1984." ANL/ERS-TM-318; December 1986. (Dividing Metric Value by 0.9072)

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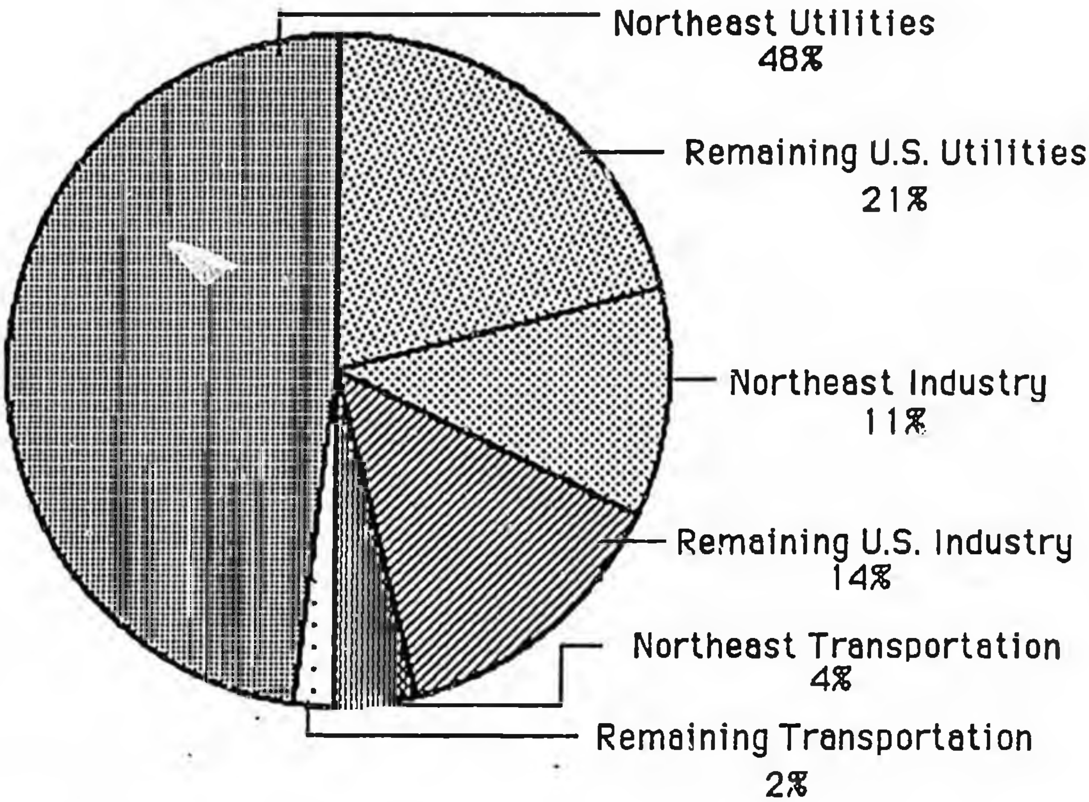
FIGURE 3
1986
Sources of U.S Sulfur Dioxide Emissions



Source: DOE/FE-0083 p. 23.

In the period 1975 to 1985, EPA estimates that utilities have spent $60 billion to capture SO_2 emissions. The impetus behind declining SO_2 emissions was the 1970 Clean Air Act and its 1977 amendments.

The three optio utilized in this effort were flue gas scrubbing, coal cleaning, and coal switching (the substitution of higher priced low sulfur coal for high sulfur coal). The investment has paid off. From 1973 to 1985, the use of coal by utilities increased by 78 percent while SO_2 emissions decreased by 23 percent.

By contrast, emissions of NOx in the U.S. have remained fairly constant since the 1970s. As Figure 2 indicates, of the 20 million tons of NOx released in 1984, 65 percent originated in the Eastern part of the country. Forty-five percent of NOx emissions originated in the Northeast quadrant of the nation, where fully half the country's population resides.

Nationally, NOx emissions are less concentrated by source than are SO_2 emissions. A little less than one-third (32 percent) is attributable to utilities, and a little more than one-third (33 percent) is attributable to the transportation sector. Of the remaining third, 19 percent is generated by industry and 13 percent is attributable to "other sources," like forest fires and open burning.

In North America, natural sources are estimated to contribute six percent of total SO_2 emissions and up to 12 percent of NOx emissions. However, natural emissions of volatile organic compounds (35 million tons) in the U.S. exceeds man-made emissions (21 million tons). Ninety percent of the natural volatile organic compounds are attributable to forests.

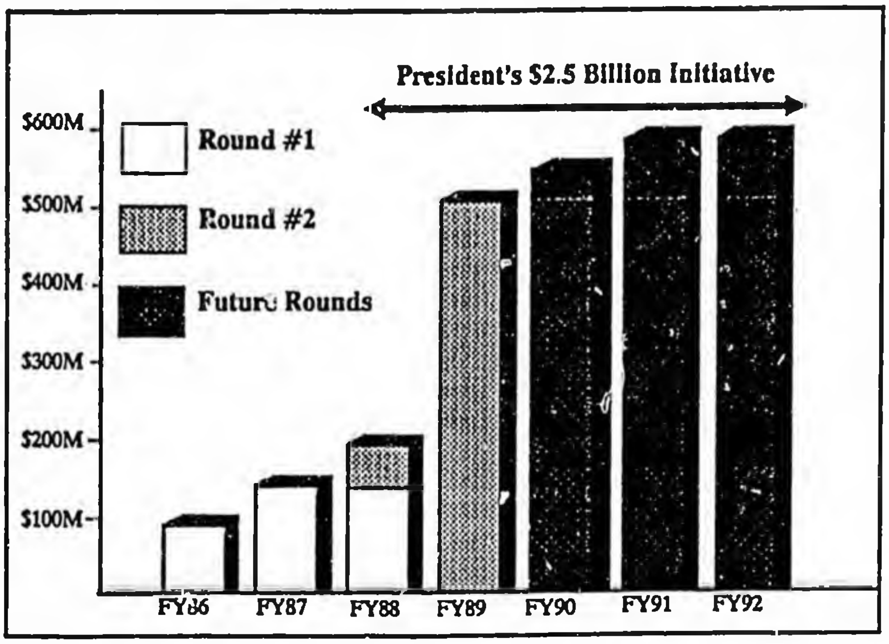
Thirty-eight percent of VOCs released are attributable to the transportation sector. Due largely to federal regulations, vehicles currently being produced emit 90 percent fewer volatile organic compounds than did vehicles manufactured in the 1970s.

In 1980, Congress passed the Acid Precipitation Act which created the National Acid Precipitation Assessment Program (NAPAP), a comprehensive 10 year research plan. The NAPAP has released more than a thousand papers to date and will issue its final report in 1990. The purpose of the NAPAP is to increase general understanding of acid deposition while testing several specific hypothesis relating to environmental damage and acid rain.

In 1985, the U.S. and Canadian governments each appointed a Special Envoy to study the acid rain problem and suggest means of resolving the transboundary pollution problem. In 1986, the Special Envoys' report recommended that the U.S. undertake a five year, five billion dollar effort, jointly funded by industry and government, to demonstrate an expanded menu of environmentally-clean coal base technologies.

Subsequently, in 1986, President Reagan unveiled the Clean Coal Technology Program, administered by DOE. It is proposed that the Clean Coal Technology Program be funded as illustrated in Figure 4.

FIGURE 4
Proposed Funding For DOE's Clean Coal Technology Program



Source: DOE - FE, Fossil Energy Review, January - February 1988, p. 5.

The federal government's proposed $2.5 billion funds will be used to share in the financing of demonstration projects to prove commercial feasibility of new clean coal technologies. There are three categories of projects: retrofitting, repowering and conversion.

Retrofitting (e.g. adding pollution reduction equipment to older plants) impacts older coal fired power units for the remainder of their useful plant life. Because many of the newer plants were built subject to Clean Air Act amendments, the bulk of acid rain precursor emissions are attributable to older plants. Examples of retrofitting technologies are listed in Table 1.

TABLE 1

Retrofit Technologies

Pre-Combustion Cleaning	Combustion Modification	Post-Combustion
Physical	**Combustor/Burner Types**	**In-Duct Injection**
• Fine Grinding (micronization)	• Slagging Combustors	• Sorbent Injection
• Advanced Froth Flotation	• Rotary Cascading Bed Combustors	• Catalytic Reduction
• Heavy Media Cyclones	• Entrained Combustors	
• Micronization w/Limestone	• Limestone Injection Multistage Burners	**Post-Combustion Devices**
• Microbubble Flotation	• Gas Reburning	• Vanadium Pentoxide Afterburners
		• Ternary Boiler w/Pollutant Capture
Physiochemical	**Fuel Types**	• Furnace Injection w/Water Activation Reactor
• Molten Caustic Leaching	• Coal-Water Slurries	• Post-Combustion Oxidation w/Fluid Bed Lime Reactor
• Organic Solvent	• Coal-Gas Co-Firing	• Fluid Bed Absorption
	• Coal-Water-Gas Co-Firing	
Microbial		**Advanced Scrubbers/FGD Devices**
• Bioleaching		• Spray Dryers
		• Regenerable Scrubbers
		• Dual Alkali Scrubbers
		• Electron Beam Scrubbers
		• Ion Exchange Membrane FGD
		• Magnesium Enhancements
		• NO_x Specific Scrubbers
		• Electrode Precharger Enhancements to Precipitators
		• High-Temperature Baghouses

Source: DOE/FE - 0107, p. 11.

Repowering means replacing parts of the original plant with units that will limit emissions while increasing the efficiency of the plant. Much of the technology used in existing plants dates back to the 1940s. Repowering can improve electric power output by 150 - 170 percent, while reducing SO_2 emissions by 99 percent and extending plant life by 30 years according to DOE officials.[2] Repowering technologies are listed in Table 2.

[2]Siegel, p. 5.

TABLE 2

Repowering Technologies

Fluidized Bed Combustion	Gasification-Based	Advanced Options
Atmospheric	**Gasifier Types**	**Gasification w/Fuel Cell**
• Circulating Bed	• Fixed Bed	
• Bubbling Bed	• Fluid Bed	**Magnetohydrodynamics**
	• Entrained Flow	
Pressurized	• Rotary Kiln-type	**Direct Coal-Fired Turbines**
• Circulating Bed		
• Bubbling Bed	**Gas Cleanup systems**	
	• Conventional "Cool" Gas Cleanup	
Hybrid Designs		
• Bubbling-Circulating Bed	• Zinc Ferrite Hot Gas Cleanup	
• Coal Pyrolyzer/Fluid Bed		
	• Ceramic Filter Cleanup	
	• In-situ Desulfurization	

Source: DOE/FE - 0107, p. 12.

Conversion techniques produce liquid and gaseous fuels from coal. This makes coal readily available for use by industrial, commercial, residential and transportation sectors. In the case of the transportation sector, it could have a positive impact on U.S. dependence on crude oil. Conversion technologies are listed in Table 3.

TABLE 3

Conversion Technologies

- Mild Gasification
- Gasification with Once-Through Methanol Production
- Under[illegible]al Gasification
- Gasification in Indirect Liquefaction
- Liquefaction
- Coal/Oil Coprocessing

Source: DOE/FE - 0107, p. 13.

Round One of the Clean Coal Technologies Program funded seven projects, valued at $750 million, of which $225 million will be contributed by the federal government. The Second Round Solicitation drew 54 proposals from 20 states. DOE selected 16 projects located in 12 states for funding under Round Two. Investments in the Second Round projects are expected to total about $1.3 billion, of which over 60 percent ($800 million) will be private sector monies.

In addition to cleaning up this nation's environment, the Clean Coal Technologies Program gives the United States an opportunity to gain technological leadership and export not only coal, but clean, efficient coal-burning technologies abroad as well. It also meets U.S. commitments to Canada to address this issue of mutual concern.

Just as concerns about the acid rain problem transcend the U.S. - Canadian border, the possibility of global warming transcends national boundaries as well. The U.S. Environmental Protection Agency (EPA) points out that "greenhouse gases" such as carbon dioxide, nitrous oxide, methane and others occur naturally in the atmosphere, serving as a thermal blanket for the planet. EPA states that there is scientific consensus that an increase in greenhouse gas emissions will result in climate change, popularly referred to as the Greenhouse Effect.[3]

Environmentalists are pushing for tougher acid rain precursor emission standards, maintaining that there is no reason to delay strengthening such standards since demonstrated technologies exist to reduce acid rain precursor emissions. The Administration has urged delay of new standards until the NAPAP report is final and the Clean Coal Technology demonstration projects results are available. Moreover, DOE officials cite problems with current major control technologies.

Pointing to flue gas scrubbing expense and energy loss (five to eight percent of the powerplant's energy is spent to power the clean up process) and the economic dislocation (loss of jobs and revenues in high sulfur coal areas) of switching to low sulfur coal, DOE claims, "additional sulfur emission reductions pose severe difficulties for conventional controls."[4] The Reagan Administration has looked to the early to mid 1990s as the critical time for decision making, both in terms of continuing reliable electric service and meeting environmental objectives.

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[3]EPA, p. 1.
[4]DOE/FE - 0083, p. 4.

COAL STRATEGY STATEMENT

Coal is America's leading fuel in terms of reserves. It holds the promise of long-term energy security for this nation. However, its current use is constrained by aged technology and environmental concerns.

The Clean Coal Technology Program addresses both these constraints and offers additional benefits as well. The Program commits 5 billion dollars, half federal government funding and half private sector monies, to demonstrate improved technology.

These projects not only burn coal in an environmentally-safe manner, but more efficiently as well. Many environmental concerns can be satisfied through the aggressive development and implementation of clean coal technologies which will allow the use of all types of coal reserves economically and cleanly without environmentally significant by-products or waste materials.

The Program will make the U.S. a technological leader, with the ability to export not only coal but clean, efficient coal technology to other nations of the world. The program also fulfills this nation's promise to its neighbor, Canada, to forcefully address transboundary environmental problems.

It shall be the strategy of the United States that the Clean Coal Technology Program be continued for its environmental, conservation and export potential.

NATURAL GAS

The United States is at a policy crossroad of environmental protection and energy security. One fuel promises to deliver the country into the next century in a cleaner, more efficient manner, while offering a degree of independence from imported oil, thereby increasing domestic energy security. That fuel is natural gas.

Natural gas is not a long-term energy panacea, but a link between the nation's current energy situation, with its attendant environmental and security problems, and a more secure energy future that maximizes energy conservation, renewable energy use, and consumption of other energy resources in a clean, efficient manner.

Today natural gas accounts for roughly one-quarter of the energy used in this country; 16.5 trillion cubic feet (Tcf) of gas was produced in 1987 and 17 Tcf was consumed. That same year the U.S. had about 187 Tcf in proven domestic reserves of natural gas (including Alaska's).

However, as Table 1 indicates, geologists calculate that the U.S. has upwards of 600 Tcf of recoverable gas at a price of less than $3 per thousand cubic feet (mcf). Additionally, Canada, the major importer of natural gas to the U.S., has reserves of 73 Tcf, and a reserves/production ratio of 27 years. Potential reserves of up to 500 Tcf are estimated for Canada. Under the Free Trade Agreement, Canadian export restrictions will be removed, making Canadian reserves readily available for purchase and consumption in the U.S.

Mexico also has natural gas reserves, but is not now exporting production. Liquified natural gas, relatively expensive because of processing and handling costs, is available on the world market.

TABLE 1. TOTAL UNITED STATES GAS RESERVES AND RESOURCES ASSESSED

LOWER 48 (Conventional)	TECHNICALLY RECOVERABLE GAS, Tcf*	RECOVERABLE GAS BY PRICE** <$3./Mcf	$3.-5./Mcf
PROVED RESERVES, 12/31/86, ONSHORE AND OFFSHORE	159	159	...
INFERRED RESERVES/ PROBABLE RESOURCES, 12/31/86, ONSHORE	85	85	...
INFERRED RESERVES, 12/31/86, OFFSHORE	23	23	...
EXTENDED RESERVE GROWTH IN NONASSOCIATED FIELDS, ONSHORE	119	56	18
GAS RESOURCES ASSOCIATED WITH OIL RESERVE GROWTH***	61	30	11
UNDISCOVERED ONSHORE RESOURCES	219	88	59
UNDISCOVERED OFFSHORE RESOURCES****	134	54	28
SUBTOTAL	800	495	116
LOWER 48 (Unconventional)			
GAS IN LOW-PERMEABILITY RESERVOIRS	180	70	49
COALBED METHANE	48	8	4
SHALE GAS	31	10	5
SUBTOTAL	1,059	583	174
ALASKA			
ALASKA: RESERVES	33	7#	0
ALASKA INFERRED RESERVES (COOK INLET AREA)	3	3	0
ALASKA UNDISCOVERED, ONSHORE AND OFFSHORE	93	2#	2#
SUBTOTAL	1,188	595	176
TOTAL	1,188	595	176

*Volumes of gas judged recoverable with existing technology

**Volumes of gas (Tcf) judged recoverable with existing technology by Review Panel at wellhead prices shown (1987$)

***Judged at oil prices of <$24./bbl and $24.-40./bbl

****Outer Continental Shelf

#Component in southern Alaska

Source: DOE/W/31109-H1, p. 2.

Natural gas is produced in 32 states and in federal Outer Continental Shelf (OCS) areas. Over three-quarters of domestic production comes from Texas, Louisiana, Oklahoma, and the federal OCS. Imports from Canada augment domestic production, averaging about 5 percent of U.S. consumption.

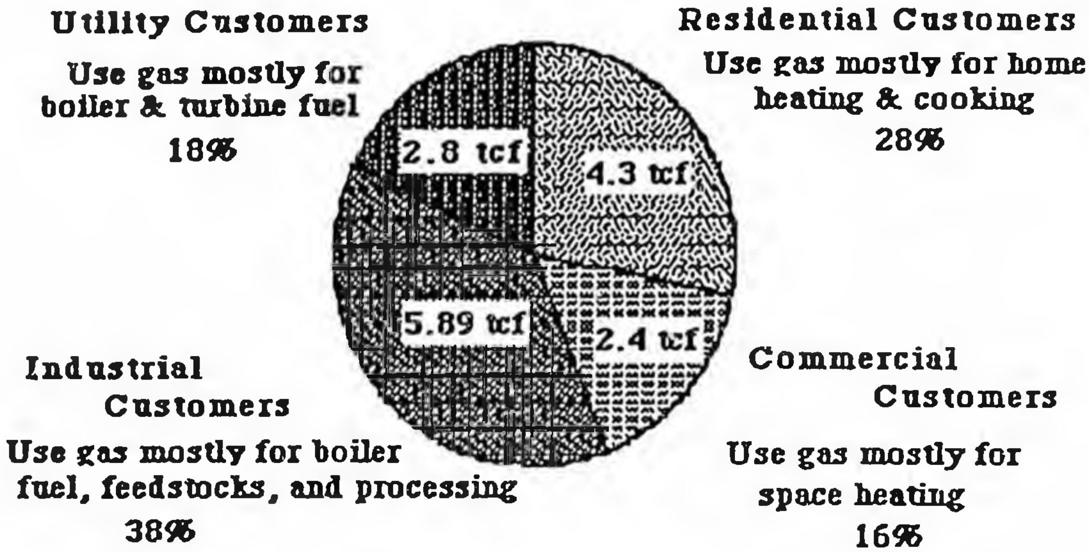
Natural gas pipelines connect every state in the Lower 48 except Vermont, which is supplied by a pipeline from Canada. Gas is transported to the major pipelines from the wellhead by a gas gathering system. From the transmission pipeline, it is generally bought at the "city gate" and distributed by local distribution companies (LDCs).

Major producing states like Texas, Louisiana, and Oklahoma have developed intrastate pipeline systems that operate only within the state. Historically, these pipelines have sold to LDCs, as well as directly to industrials. Intrastate lines and LDCs are subject to state regulation, while interstate transactions, and until relatively recently, all wellhead prices, are subject to federal regulation by the Federal Energy Regulatory Commission (FERC).

Almost a tenth (9 percent) of U.S. natural gas production is consumed in production and transmission activities related to delivering the gas to the end user (as lease, plant and pipeline fuel). End-users include electric utilities, residentials, commercials and industrials. Figure 1 illustrates end-use consumption by sector.

FIGURE 1

NATURAL GAS CONSUMPTION BY END-USE SECTOR, 1987



Source: DOE/S-0057, p.118, updated with DOE data.

Federal regulation has played a major role in the history of the U.S. natural gas industry. Shortages, now widely attributed to market distortions caused by regulation, shut down schools and factories in 1977. The American public was left with the impression that this country had run out of natural gas.

In fact, natural gas was available on intrastate systems where price was not regulated. Left to function as a market, the price rose somewhat on intrastate systems, but demand was met. Interstate natural gas shortages occurred in the same decade as did foreign oil embargoes, setting the political stage for the National Energy Act of 1978.

Actually five separate bills in one, the National Energy Act package included the Fuel Use Act which prohibited new natural gas boilers for electric utilities, and required a phase-out of natural gas use in existing boilers. Gas was also prohibited for use in larger new industrial boilers. The use of coal was encouraged with tax credits, while tax breaks were withheld from oil and gas boilers.

Energy conservation and efficiency were promoted with tax credits for industry and loan programs for residentials, schools, and hospitals. The Natural Gas Policy Act (NGPA) initiated the deregulation of wellhead pricing of natural gas.

On the heels of NGPA natural gas wellhead price deregulation, FERC began the deregulation of the natural gas transmission industry. FERC Order 436, issued in 1986, adopted an open access policy for interstate gas pipelines.[1]

Traditionally, producers sold their gas, under long term contract, to the pipeline located closest to the wellhead. The pipeline then ran pipe to an LDC, and sold gas owned by the pipeline, known as "system supply gas". FERC reasoned that neither the producer nor the LDC had competitive options and that market efficiency and price were suffering. FERC declared that, in the name of competition, producers and LDCs deserved open access to the nation's interstate natural gas pipeline system.

In Order 436 FERC turned the traditional scheme upside down. It essentially forced interstate pipelines to transport natural gas for others. Theoretically producers could sell their gas to whomever they cared to deal with and force the pipeline to act as a transporter. LDCs could shop around for the best deal and then line up transportation for gas they had purchased.

As FERC began transmission deregulation the natural gas market was a troubled one. By 1986, both price and demand for natural gas had plummeted. The price of natural gas fell by more than 25 percent between 1984 and 1986, from a U.S. wellhead average of $2.66 to $1.94 per Mcf. It continued its downward trend to a national wellhead average of $1.67 per Mcf in 1987.

Demand suffered under the cumulative effects of industrial conservation and natural gas prohibitions imposed by the National Energy Act of 1978. Declining demand was aggravated as industrials installed fuel-switching capacity.

[1]See Arthur Andersen and Cambridge Energy Research Associates, p. 10-13.

It is estimated that as many as 80 percent of industrial boilers now have dual capacity to burn either natural gas or residual fuel oil.[2] Industrials with dual capacity may shop between the two fuels for a price advantage that may amount to pennies per thousand Btu's. Dual capacity also eliminates dependence on one type of fuel and offers some protection against shortages like the one in the 1970s on the interstate natural gas market. The proliferation of dual capacity industrial consumers has tied the price of natural gas to the price of residual fuel oil.

From a peak in the early 1970s, industrial and electric utility demand for natural gas had fallen by 35 percent in 1986. Surplus deliverability, also known as the gas "bubble," further depressed prices. Disappearing markets, price instability, and regulatory revisions sent an industry that had traditionally dealt in 20 and 30 year contracts into a month-to-month spot market.

The situation was complicated by obligations incurred by pipelines when supply looked short. In the bullish natural gas market of the early 1980s, pipelines had routinely signed take-or-pay contracts to assure adequate system gas supplies. Take-or-pay provisions require the purchaser to take the gas or pay for it (even if not taken). Pipeline take-or-pay liabilities mounted into the billions of dollars.

In a 1987 decision, a U.S. Court of Appeals upheld FERC's authority to encourage competition but asked the regulators to revisit a few issues not addressed in Order 436, particularly resolution of take-or-pay problems. Subsequently, FERC's Order 500 provided a mechanism for crediting gas transported for producers against take-or-pay balances. Settlement guidelines were also approved for take-or-pay obligations, assisting open access pipelines in the spreading take-or-pay settlement losses.

The FERC orders changed the primary business function of interstate pipelines from marketing (which included moving gas owned by the pipeline to buyers) to transporting (simply moving gas owned by others). During the period 1982 to 1987, the percentage of gas transported for others by interstate pipelines increased from 3 percent to 56 percent; the percentage of natural gas throughout sold by interstate pipelines fell from 97 percent to 44 percent.[3]

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[2]Crosby.
[3]Interstate Natural Gas Association of America.

In the world of open access and competition as defined by FERC, there remains a regulated sector of the industry. LDCs are regulated by the state rather than FERC.

Industrial customers, many of whom have installed dual-fired capacity in order to gain a competitive price advantage, are equally as aggressive in their gas purchasing practices. Many are seeking gas from sources other than their traditional supplier, the LDC. Termed the "by pass issue" because of industrials' attempts to by-pass the LDCs and purchase gas on the open market, it pits producers, pipelines and industrials against LDCs and state regulators against their federal counterparts.

LDCs point to their statutory obligation to serve all customers and the substantial capital investment which that obligation requires. LDCs argue that if industrial customers leave the system, fixed costs may shift to those customers without the option to leave -- principally residentials.

Industrials and pipelines respond that it is futile to stand in the way of economic efficiency, that the producer and pipeline sectors of the industry have emerged alive, if somewhat battered, from their regulatory transformation to a competitive system. Prices have decreased, the industry has survived, and the LDCs have no claim to special treatment.

Producers and pipelines fear that industrials, frustrated in attempts to reduce their purchase price of gas, will simply switch to residual fuel oil, thereby further eroding the natural gas market. Producers maintain everyone loses in that case; producers, pipelines, and LDCs lose markets while residentials may be stuck assuming fixed costs.

A second regulatory concern of LDCs relates to balancing security of supply (longer term, more expensive gas contracts, if available) with economy considerations (i.e. price to residentials). LDCs are uncertain how state regulators will weigh competing interests.

These questions and others resulting from the interface between federal and state regulatory schemes have prompted some LDCs to call for a designation of state regulatory primacy or, alternatively, concurrent, shared state-federal regulation. The resolution of such questions will face legislators and Congress alike over the next few years.

Although the price is low, the supply secure, the distribution system well developed, and the technology efficient, a primary impetus behind increasing use of natural gas is concem for the environment. Importantly, gas is also viewed as a means of backing out imported oil.

Environmental concems, particularly related to air quality, acid rain and global warming, are steering policy makers towards increase use of gas. Burning natural gas produces significantly less sulfur dioxide (SO_2), nitrogen oxides (NOx), small particles, carbon monoxide (CO), and carbon dioxide (CO_2) than does oil or coal combustion. Virtually no reactive hydrocarbons are emitted from natural gas combustion.[4] In contrast to oil - or coal-fired units, natural gas consumption at stationery sources creates no ash or sludge.[5]

Increased use of natural gas, in the industrial, electric utilities, and transportation sectors would reduce air pollution problems. Industrials and electric utilities alike are attracted to combined cycle gas turbine technology. When used in efficient cogeneration units, the exhaust gases from the natural gas-fired turbine are hot enough to power a steam generator, providing two types of power from the single energy source.

Turnkey cogeneration units are available for industrials, and utilities are looking at combined cycle generation for smaller additions of power capacity. Both sectors are concemed about air quality standards.

Natural gas is a candidate for fuel substitution on an environmental basis. For instance, in warm summer months, when ozone and acid precipitation is most likely to be formed, natural gas might be substituted for oil. Further, co-firing natural gas with other fossil fuels actually "scavenges" pollutants like NOx which usually result from combustion of such other fuels.[6] Thus, co-firing may reduce harmful emissions dramatically.

[4]Campbell and Martin, p.30.
[5]Dring and Aboud, p.6.
[6]Campbell and Martin, p. 31.

Air quality considerations are also behind the most significant movement in the nation to implement alternate fuel vehicles -- California's methanol fuel vehicle program. Populous California has significant air quality problems. In its 1987 Biennial Energy Report, the California Energy Commission made three recommendations relative to alternate fuel vehicles:

- California's governmental agencies in nonattainment air basins should adopt programs by 1989 to substitute methanol for 50 percent of their use of motor fuels by the year 2000;

- The federal government should provide Corporate Average Fuel Economy (CAFE) credits for methanol as an incentive to auto manufacturers to produce vehicles capable of using methanol fuels; and

- To provide consumers with transportation fuel use options, California should support the introduction of flexible fuel vehicles into the transportation market.

Of all alternate fuels for vehicles now under consideration, a DOE report recently identified methanol as the preliminary choice for substitution on the basis of technical acceptability, economic competitiveness, environmental acceptability, as well as availability and accessibility.[7]

Although methanol may be produced from a variety of renewable (biomass) and non-renewable (coal) feedstocks, over two-thirds of the methanol produced in this country is from steam reforming of natural gas. Table 2 compares the four leading alternate fuels for replacement of gasoline in vehicles.

In addition to addressing environmental concerns, the use of natural gas for vehicular power would be a first, albeit small, step to reducing U.S. dependence on crude oil in the transportation sector, thus improving U.S. energy security.

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[7]DOE/PE-0080, p. 22.

Despite these apparent benefits questions are being raised about methanol. The first question is whether the domestic natural gas resource base is large enough to provide natural gas feedstock for methanol fuel or would a large scale conversion to methanol fuel only increase dependency on foreign energy sources.

A second concern relates to the cost of retrofitting present transportation, storage and distribution systems or developing new systems to handle methanol. Some metals, elastomers and plastics in existing terminals, tank trucks and service stations may be incompatible with methanol.

A third concern relates to air quality arguments. If "flexible fuel vehicles" (those which use gasoline, methanol or a blend of the two) are promoted, the emission control benefits of methanol may be lost to less than optimal engine operation levels.

Dependence on crude oil is not limited to the transportation sector. The Northeast residential sector, which has limited access to natural gas, is also oil dependent. Interstate natural gas pipelines proposed to serve the region are under consideration at FERC.

Some of the competing projects would interconnect only with Canadian gas pipelines. Domestic producers have urged federal regulators to assure that any new markets opened by interstate pipelines, have, at a minimum, interconnects that would allow domestic producers, as well as Canadian gas, access to new markets. In the new deregulated, extremely competitive natural gas business, access to markets is tantamount to assuring viability of producing regions.

Natural gas is the link to America's energy future. In that future, energy savings and environmental concerns must be as important as power considerations. Natural gas gives the U.S. an opportunity to move closer to environmental goals, while enhancing energy security as well.

Table 2 — Summary of Fuel and Vehicle Characteristics When Alternative Energy Sources Replace Gasoline

	Ethanol	Methanol	CNG	Electricity
Near-Term Technical Acceptability	Proven	Proven	Satisfactory for some uses	Close to commercial
Economic Competitiveness (for energy output)	Much more expensive	Near equivalent	The same or better[a]	More expensive; wide range[b]
Availability	Limited	Limited; good future potential	Limited	Limited by generation constraints
Fuel Volume, Compared With Gasoline[d]	1.5x	2x	5x	2x - 3x[c]
Refueling Procedure	No different from gasoline	No different from gasoline	More complex and lengthy	Recharging takes hours; battery replacement cumbersome
Fuel Storage Container Weight[d]	1.3x	1.6x	100-140x (steel); 50-70x (aluminum)	Heavy; depends on technology
Fuel Storage Tank Cost[d]	Nominal	Nominal	$850-1,000	Battery type determines equivalence
Current State of Fuel System Technology Development	Production technology in Brazil	Pre-production stage	Commercial, but requires updating	Being used in niche markets
Representative Type of Vehicle	Light and heavy duty	Light and heavy duty	Niche fleets; light and heavy duty	Short range, light duty
Engine Performance Characteristics	Power gain, but less than methanol	Approximately 8% power gain[e]	Approximately 10% power loss	Comparable, at expense of range
Exhaust Emissions: HC, CO, NO_x and HC reactivity	Same or better; lower NO_x and HC reactivity	Same or better; lower NO_x & HC reactivity; potential for lower CO[g]	NO_x: same or higher HC: same or higher[f] CO: lower	Only emissions from generating plants (variable with facilities)
Energy Content (Net)				
Compared with about 18,500-19,000 BTU/1b for gasoline and diesel	11,500	8,600	21,300[f]	N.A.
Compared with 112,000-128,000 BTU/gal for gasoline and diesel	75,700	56,600	22,800[f]	N.A.

[a] Depends on vehicle operational characteristics and refueling costs, which are linked to the natural gas rates assigned to transport uses by regulatory bodies.
[b] Depends on battery technology and electricity costs (which have a wide range, based on variations in produc tion technology and local regulation).
[c] Based on equivalent driving range.
[d] Twenty-gallon gasoline tank equivalent.
[e] Based on engines optimized to use gasoline (methanol optimization yields higher gains).
[f] Pure methane. Other minor constituents (such as ethane and propane) boil at higher temperatures.
[g] Under "lean-burn" conditions.

Source: DOE/PE-0080, p. 19.

NATURAL GAS STRATEGY STATEMENT

It shall be part of the strategy of the United States to promote the use of clean, efficient natural gas in residential, commercial, industrial, utility and transportation applications. Such use shall include the co-firing of natural gas with other fuels for efficiency or environmental purposes.

The United States shall promote and encourage domestic production of natural gas in an environmentally-sound manner by providing tax and tax accounting incentives to producers of natural gas. Further, the federal government shall complete price deregulation as existing contracts expire.

The Federal Energy Regulatory Commission shall expedite approval of pipeline construction serving new markets, particularly the oil-dependent residential market of the Northeast, and shall assure that all such projects provide access by interconnecting pipelines to producing areas of this nation.

The federal government shall fund continuing research and development relative to the environmentally-sound production and use of natural gas, in order to conserve energy by improving efficiency and shall promote development of methanol and natural gas-fueled vehicles.

RENEWABLE ENERGY

In terms of the long range energy goals of this nation, i.e. energy independence, alternative or renewable energy sources constitute a key energy option. Over the near term, commercial or near-commercial renewable energy technologies will continue to supplement conventional energy supply, offering diversification and relief from environmental pressures associated with fossil fuels.

Renewable energy resources are broadly defined as indigenous resources with relatively inexhaustible supply. Resources include solar energy, biomass energy (wood and other waste products), geothermal energy, hydropower, wind energy, and ocean energy sources. Renewable energy technologies are used to produce industrial applications, and liquid fuels for transportation. They range in technological status from fully commercial wood combustion, hydropower, wind and solar thermal facilities to research-oriented ocean energy experiments.

While fossil fuels are limited by finite supply, renewable energy sources are limited by comparative economics and conversion efficiencies. Progress in renewable energy technology development has continued throughout the period of low world oil prices and reduced federal support.

The U.S. Department of Energy has estimated that in excess of 80 quadrillion Btu's (quads) of renewable energy could be economically extracted within 25 years as a result of research, development and demonstration work. This would provide more than 70 percent of the nation's total energy consumption projected over this period.

Today renewable energy sources contribute over nine percent of the energy consumed in the U.S. Hydropower accounts for about 4 percent, while wood and wood/agricultural wastes contribute roughly 5 percent. All other renewable energy sources account for less than one percent of the U.S. energy consumption. Table 1 provides the current and additional renewable energy supplies expected to be available by the end of the century.

TABLE 1

RENEWABLE ENERGY CONTRIBUTION TO U.S. ENERGY SUPPLY: CURRENT, ADDITIONAL AND TOTALS PROJECTED FOR 1995-2000

In Quadrillion Btu's (Quads)

Source	Current	Additional	Totals Projected For 1995-2000
Wind	0.0174	0.01	0.03
Photovoltaics	0.0003	0.02	0.02
Biomass	3.80	4.20	8.00
Geothermal	0.1744	0.21	0.38
Hydropower	2.60	1.40	4.00
Solar thermal	0.0059	0.02	0.03
Active solar	0.017	0.08	0.10
Passive solar	0.0350	1.70	1.73

Source: Public Citizen, (Updated with U.S. Department of Energy and industry estimates.)

The most notable renewable energy contribution can be found in the electric utility sector. Table 2 illustrates renewable energy electric generating capacity in the U.S., listing the number of states involved. California is the most diversified state with nine different renewable energy resources under development.

TABLE 2

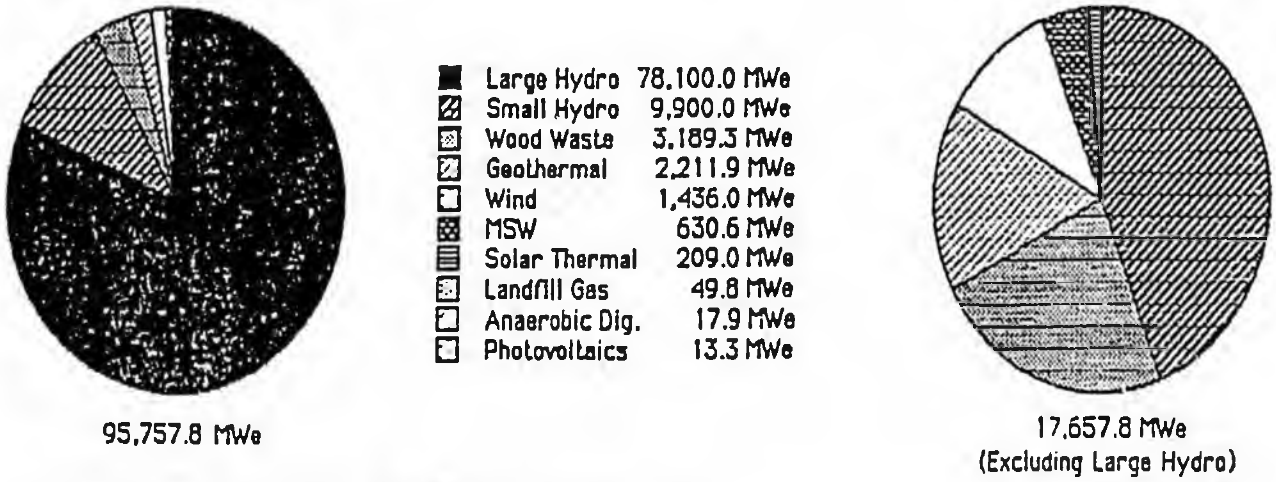
RENEWABLE ENERGY ELECTRIC GENERATION

Energy Source	No. of States	Generating Capacity(MWe)	% of Total
Large hydropower	37	78,100.0	83%
Small hydropower	46	9900.0	7
Wood/ag. waste	31	3189.3	4
Geothermal	4	2211.9	3
Wind	21	1436.0	2
Municipal solid waste	16	630.6	<1
Solar thermal	3	209.0	<1
Landfill gas	7	49.8	<1
Anaerobic digestion	6	17.9	<1
Photovoltaics	16	13.3	<1
TOTAL		82,186.2	

Source: U.S. Export Council for Renewable Energy (with updated industry estimates).

As Figure 1 indicates that large scale hydropower provides the bulk of the generating capacity. However, in addition to large hydropower, renewable energy electric generating capacity includes significant contributions from resources that have largely been developed in the past decade.

FIGURE 1
RENEWABLE ENERGY ELECTRIC GENERATION



Source: Council for Renewable Energy Education

Hydropower is a very well developed technology for generating electricity. It provides much of the electricity generated in the Pacific Northwest and other Western states; Tennessee, North and South Carolina in the South; and New York and Pennsylvania in the Northeast. In fact, more electricity is generated by hydropower in the U.S. than by oil or natural gas.

Most U.S. hydropower electricity generation is by large units sited at major dams. In addition, the U.S. Army Corps of Engineers (Corps) has estimated that up to 10,000 MW capacity exists for small scale, "low head" hydro. The number of small, privately-owned hydro facilities operating in the U.S. has grown during most of the 1980s, due in part to tax and regulatory incentives.

As of 1986, there were 579 privately-owned small hydroplants in the U.S. with a total capacity of 1,309 megawatts. Another 651 projects were licensed or under construction, representing an additional 1,056 megawatts.

U.S. hydroelectric power development, both large and small, has recently come under increasing regulation. Conducting highly site-specific environmental impact assessments and meeting conflicting jurisdictional requirements of federal and state agencies can significantly increase project costs and add several years to the time needed for a facility to be planned and built. Consequently, some small hydrodevelopers in the U.S. have built plants mostly at the sites of existing but non-operating dams, where questions about environmental impacts have been resolved.

Solar energy includes three main categories: solar thermal, photovoltaics, and solar for building applications. Solar thermal technologies concentrate sunlight for thermal or electric applications. Government-sponsored research has been conducted on central receiver, parabolic dish and parabolic trough systems. Of these, parabolic troughs have experienced the greatest commercial activity.

The most notable solar thermal contribution to U.S. energy supply is the Solar Electric Generating Systems (SEGS) developed and operated by California-based LUZ International. By the end of 1988, LUZ will be operating a total of 194 MW of parabolic trough systems and has contracts with the local utility to triple that capacity over the next 5 years. SEGS successfully supplements solar energy with natural gas to provide a close match with peak electricity demand in southern California.

Solar thermal is being used commercially in a number of industrial process heat applications such as metal plating, and copper foil manufacturing. Concentrated high temperature solar thermal processes also hold potential for the destruction of toxic wastes (e.g., dioxins and chlorofluorocarbons).

Photovoltaics (PV) covert sunlight directly to electricity. Photovoltaic systems range in size from power sources for hand-held calculators to multi-megawatt installations employing concentrators and solar tracking systems. While the domestic market for photovoltaics has grown slowly, the market in developing countries has emerged much more rapidly. U.S. photovoltaic products are used to provide power in remote locations for health, communication and small domestic applications.

Although 16 states have developed photovoltaic projects, the principal activities have been in California, Arizona and Texas. Electric utilities have shown increasing interest in photovoltaics. In 1987, a consortium of utilities created PVUSA (photovoltaic utility scale applications) to investigate the operation of utility-owned photovoltaic installations.

Passive solar systems employ building designs to directly tap or regulate the sun's rays for heating, cooling or lighting. These designs can be incorporated into both new and existing residential, commercial and office buildings. A well-designed passive solar home can reduce energy bills by 75 percent. Added construction costs ranges from 5 to 10 percent.

Active solar systems are used primarily for domestic water heating. As of 1987, there were an estimated 800,000 water heating systems and 100,000 active space heating systems in use in the U.S. The majority of active solar installations are in Southern and Western states, most notably California, Arizona, Florida, and Hawaii.

Biomass energy involves the conversion of organic feedstocks into useful forms of energy such as heat (thermal energy), electricity, or liquid fuels for transportation. Wood and wood waste account for 90 percent of the total biomass energy produced. Lumber companies and pulp and paper companies are the greatest users of biomass energy, meeting more than 65 percent of their energy needs with biomass.[1] Fuelwood provides about 10 percent of the energy used in households; 5.6 million homes are heated exclusively with fuelwood and 21 million homes are heated partially with wood.

Pressures on refuse landfills has increased the attractiveness of municipal solid waste (MSW) as an energy source. The U.S. Department of Energy estimates that about 80 percent of the 160 million tons of MSW produced each year in the U.S. is combustible, with an energy equivalent of 1.2 Quads. An additional 0.3 Quads could be extracted from the methane produced by the decomposition of wastes at existing landfills. Direct combustion of MSW has raised concerns over the dioxin, lead and cadmium found in the resultant ash, issues that must be addressed before this technology can reach its full potential.

Domestic fuel ethanol production capacity has increased from 180 million gallons of anhydrous (99.9 percent pure) ethanol in 1980 to 1,364 million gallons in 1988. During that same time, ethanol sales to the transportation sector have increased from 80 million gallons to an estimated 824 million gallons.[2] There are over 100 ethanol production facilities operating in 32 states.

In 1987, ethanol-gasoline blends accounted for 8 percent of the total motor fuel used and the ethanol in these fuels reduced oil consumption by 29.8 million barrels. It is likely than ethanol will be increasingly used to replace lead as an octane enhancer to meet EPA lead reduction standards in gasoline.

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[1]National Wood Energy Association
[2]Information Resources, Inc.

The Department of Energy Biofuels Program includes regional biomass centers, providing technical assistance corresponding to the geographic diversity of biomass energy needs. Western Area Power Authority maintains the Western regional program and Tennessee Valley Authority, the Southeastern program.

The primary use of wind energy in the U.S. is for the production of electricity. Wind turbines are often developed as "wind farms". Although wind is used to generate electricity in 21 states, fully 94 percent of the U.S. wind generation is in California. Other favorable wind regimes are found in the Rocky and Appalachian Mountain states, Northern Plains states, Alaska and Hawaii.

Over 16,000 wind turbines have been installed in California by the end of 1987, with a total generating capacity of 1,300 megawatts. California wind farms generated 1.7 billion kilowatt-hours of electricity in 1987, with an energy equivalent of approximately 2.6 million barrels of oil.[3]

Installed costs of wind turbines have dropped from $3,000 per kilowatt in 1981 to $900 per kilowatt in 1987. This is due, in part, to the introduction of foreign subsidized wind turbine sales. In 1987, imports of foreign wind machines accounted for 58 percent of the U.S. market.

Geothermal energy converts the earth's natural heat to useful forms of energy. Concentrated in the Western U.S., geothermal electric generating capacity reached 2211.85 megawatts by mid-1988.[4] The Geysers in northern California account for 1918 megawatts, or 86 percent of the nation's total.

Direct use of geothermal energy development include space conditioning of buildings, district heating, groundwater heat pumps, greenhouse heating, industrial processing, aquaculture, and swimming pool heating. Forty-four states have experienced geothermal direct use development in the last ten years. The total installed capacity is 5.7 billion Btu/hr., with an annual energy capacity of 17,000 billion Btu/yr. (4.5 million barrels of oil energy equivalent).[5]

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[3]American Wind Energy Association.
[4]DiPippo.
[5]Geo-Heat Center.

Ocean thermal energy conversion can be utilized to generate electricity by exploiting ocean temperature gradients between surface to deep waters. This process is called Ocean Thermal Energy Conversion (OTEC). It holds promise for island areas and the Gulf of Mexico. Not surprisingly, U.S. OTEC projects to date have been demonstrated off the coast of Hawaii.

Ocean thermal energy provides additional benefits when considered as an energy system. Desalination processes may be integrated into OTEC technology. Also, the colder water brought from the deep ocean is free of micro-organisms and rich in nutrients making it an attractive resource for aquaculture projects.[6] Ocean energy is also available in the form of wave energy and tidal power. Table 3 summarizes major renewable energy sources with end-uses.

TABLE 3

MATCHING UP MAJOR RENEWABLE ENERGY SOURCES WITH END-USES

RESOURCE	TECHNOLOGY	ENERGY TYPE
HYDRO	HYDROPOWER	ELECTRICITY
SOLAR RADIATION	BUILDINGS: ACTIVE, PASSIVE	HEATING, LIGHTING, COOLING
	SOLAR THERMAL: CENTRAL RECEIVER, DISHES, TROUGH	ELECTRICITY, HEAT
	PHOTOVOLTAICS: THIN FILM, CRYSTALLINE MULTI-JUNCTION, CONCENTRATORS	ELECTRICITY
BIOMASS	DIRECT COMBUSTION, BIOCHEMICAL THERMOCHEMICAL	HEAT, ELECTRICITY, FUELS
WIND	HORIZONTAL, AND VERTICAL AXIS TURBINES	ELECTRICITY
OCEAN	OCEAN THERMAL ENERGY CONVERSION (OPEN CYCLE)	ELECTRICITY
GEOTHERMAL	DIRECT DRY STEAM, SINGLE- AND MULTI-STATE FLASH BINARY HYBRID BINARY	ELECTRICITY, HEAT GASEOUS FUELS

Source: From U.S. DOE/S - 0057, p. 199

[6]Takahashi, p. 2.

Various lists of renewable energy sources often include technologies that may make renewable energy resources more efficient and, therefore, cost effective. Cogeneration, energy storage systems (e.g. batteries, molten salt), and superconductivity are all frequently mentioned. These technologies would also help integrate renewable energy systems into present, "conventional" energy systems.

Renewable energy captured the imagination of the U.S. after the oil crisis of the mid-1970s. Touted as a group of resources that would help wean America off oil, government support for renewable energy was largely abandoned in the face of lower oil prices and the mounting federal deficit. Despite the inconsistent treatment under federal energy policy, renewable energy systems made remarkable strides in the past decade and a half.

Because of the broad range of renewable energy technologies, federal support requirements vary widely. Some technologies need basic research and development to make a renewable resource feasible, others need demonstration efforts, while some need commercialization incentives to promote market acceptance.

The renewable energy research commitment since the late 1970s has contributed to great efficiency and cost improvements. DOE cites the reduction, over 10 years, of the cost of photovoltaics from more than $600 per peak watt to less than $5 per peak watt, with doubled efficiencies. Likewise the cost of ethanol processes have been reduced from $4 per gallon to less than $1.50 per gallon.[7]

Wind energy cost have dropped from $3000 to $900 per installed kilowatt. Solar thermal generated electricity costs have fallen from 45 cents/kilowatt-hour for a demonstration central receiver plant in 1978 (Solar One) to less than 12 cents/kwh for The LUZ Solar Electric Generation Systems (SEGS IV and V), a commercial parabolic trough system installed in 1988.

However, during the 1980s, concern about the federal budget deficit and a change in DOE's research and development policies led to a dramatic decline in federal research and development funding. The DOE's policy has restricted federal funding to long-term, high risk areas, cutting or removing support for demonstratio[illegible]d commercialization projects. Consequently, renewable energy received substantially less federal support in 1988 than it had in the mid-1970s.

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[7]Martin, p. 4.

Figure 2 illustrates federal research and development commitments to renewable energy from 1976 to 1988. The federal budget for renewable energy research and development has fallen 87 percent since 1960.

FIGURE 2

TOTAL FEDERAL RENEWABLE ENERGY BUDGET
1977 - 1988

Source: Potter, p. 180.

Other events have hindered development of renewable energy as well. Most notably, low world oil prices have made alternatives less attractive economically. In addition to directly affecting the market for ethanol fuel, low oil prices have dissipated consumer interest in solar and other technologies. Finally, the low price of oil has affected the price utilities are willing to pay for renewable energy generated electricity.

In 1978, Congress passed the Public Utility Regulatory Policies Act (PURPA), as part of the National Energy Act. It provided that utilities must interconnect with independent cogenerators and small power production facilities. PURPA required utilities to buy surplus electricity from the cogenerators and small power producers at the utility's marginal or avoided cost and to sell the facilities back-up power.

PURPA has been a very important legislative incentive for renewable energy small power facilities. However, the low price of oil, which in turn influences the price of other fossil fuels, has kept utilities' avoided costs down as well, reducing the price paid to independent renewable energy projects.

Renewable energy received another set back in the Tax Reform Act of 1986 which phased out all renewable energy tax credits by December 31, 1988. Solar, geothermal, ocean thermal and biomass energy investments had all been subject to investment tax credits ranging from 10 to 15 percent. Wind energy investment tax credits and residential solar tax credits, which had originally been enacted in the National Energy Act of 1978, were not extended in the Tax Reform Act.

One positive development for renewable energy in the 1980s was formation of the Committee on Renewable Energy Commerce and Trade (CORECT). An interagency committee including the Departments of State, Commerce, Energy, Defense, the Agency for International Development, the U.S. Trade representative and others, was formed as part of the Renewable Energy Industry Development Act of 1983. The purpose of CORECT is to facilitate exports of U.S. renewable energy equipment. CORECT plays an important role in assisting small renewable energy firms and in coordinating the development efforts of various government agencies.

In the mid-1980s the American share of the world photovoltaic market fell, in three years time, to less than 50 percent. Other nations are vigorously pursuing technological research, development, demonstration and commercialization strategies in photovoltaics and other alternative energy areas. Although nations like Japan and those in Europe build on U.S. technology, American researchers and entrepreneurs are limited by language and information distribution constraints from benefitting from foreign advancements.

Current federal support for renewable energy is insufficient to allow renewable resources to reach their potential in the long term. As the Congressional Office of Technology Assessment points out, the low price of oil has provided the nation with a window of opportunity to bring these technologies to the market place. The nation has benefitted from low oil prices, "buying" time for development of renewable energy, a luxury that would disappear with another world oil crisis.[8]

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[8]Blair, p. 2.

The government's goal of lessening dependence on imported oil and relieving environmental pressures cannot be assumed to be the concerns of the private sector. Those concerns, basic to development of renewable energy, are national ones.

RENEWABLE ENERGY STRATEGY STATEMENT

Renewable energy sources are characterized by a broad range of technologies, costs, efficiencies and environmental concerns. Recognizing this spectrum of resources, it shall be the strategy of the U. S. to institute a long range, stable Renewable Energy Development Program which identifies and assists renewable energy sources from research and development through demonstration projects and commercialization in a cooperative effort among industry, higher education and national laboratories.

Renewable energy resource development must be ranked and funded on the basis of factors including energy efficiency, economic competitiveness, environmental impacts and technological adaptability. Part of this program, and critical to its success, is federal development of alternative technologies that improve renewable energy efficiencies, cut costs and assist in integrating renewable energy into existing energy systems. Also needed is a translation and distribution system for international technical and marketing papers on renewable energy.

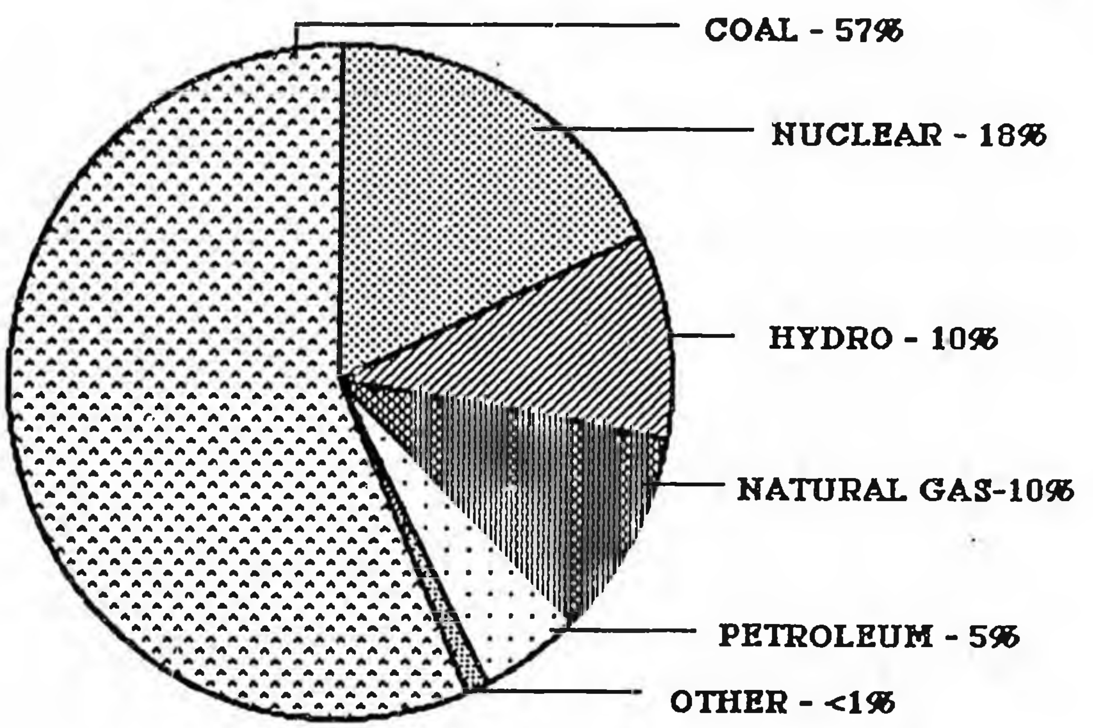
ELECTRICITY

There are three phases to the U.S. electricity industry: generation, transmission and distribution. Traditionally, electric utilities have been integrated and involved in all three phases of the industry. However, transmission and distribution functions may be separated from generation in some cases.

Electricity generation in the U.S. is quite diversified. Powerplants are fueled by coal, nuclear, hydropower, natural gas, petroleum and other energy sources. However, coal fired more utility powerplants in 1987 than all other fuels combined. Figure 1 shows U.S. electric generation by utilities by fuel source for 1987.

FIGURE 1

1987 ELECTRICITY GENERATION BY UTILITIES BY FUEL SOURCE



Source: South/West Energy Council From DOE-EIA - 0348 (87) p. 13.

Not surprisingly, coal is the most important generating fuel to states in the Eastern coal belt -- Ohio, Pennsylvania, West Virginia and Indiana. Texas also uses a lot of coal, much of it lignite mined in the state. There are 108 nuclear units in the U.S. and more than fifty percent of the electricity in New Jersey, Connecticut, South Carolina, Maine and Vermont is supplied by nuclear powerplants.

Hydropower is a significant source of generation on the West Coast (Washington, Oregon and California) as well as in New York State and Arizona. Over 85 percent of the natural gas used for electricity generation is burned in Texas, California, Louisiana, Oklahoma and Florida.

Petroleum is a significant source of power generation for areas of New England (Massachusetts and Connecticut), certain Middle Atlantic states (New York and Pennsylvania) and Florida. Almost 90 percent of U.S. generation from "other fuels" (including geothermal, wood, waste and solar) is located in California.

A utility has a responsibility to provide reliable power. Thus it must stand ready to supply the peak power requirements of its customers. This means having enough power available to meet the highest demand level, or the "peak demand," of the year.

Unlike other forms of energy or fuel, electricity cannot be stored. Consequently, it must be produced as needed. "Baseload" plants run continuously to meet average electricity needs. However, daily peak demands on a utility system may be met by "peaking" plants. Such plants are often more expensive to run and smaller than baseload plants but their electricity production levels may be increased quickly to meet rising demand.

Utilities employ computerized economic dispatch programs which constantly monitor electric power demand on the system. The dispatch program calls up additional generation on the basis of plant efficiency, power economics and transmission limitations.

Capacity to produce electricity beyond that required in peak usage periods is called the reserve margin. Reserve margins of 15 to 25 percent are considered an industry norm. Reserve margins cover contingencies such as having a generating unit down for emergency repairs during a peak demand period.

Peak demand varies by consumption sector. Cost of service also varies by sector. Residential consumers have well-defined daily and seasonal peaking patterns. Daily peaks occur in the late afternoon when consumers come home from work, watch the news and prepare supper.

The second distinguishing characteristic of residential consumers is the high cost of service per consumer. The peaking nature of residential demand is expensive since it requires additional generation units for brief periods of excessive demand. Also, residentials are expensive to serve since each unit must be connected, metered and billed separately.

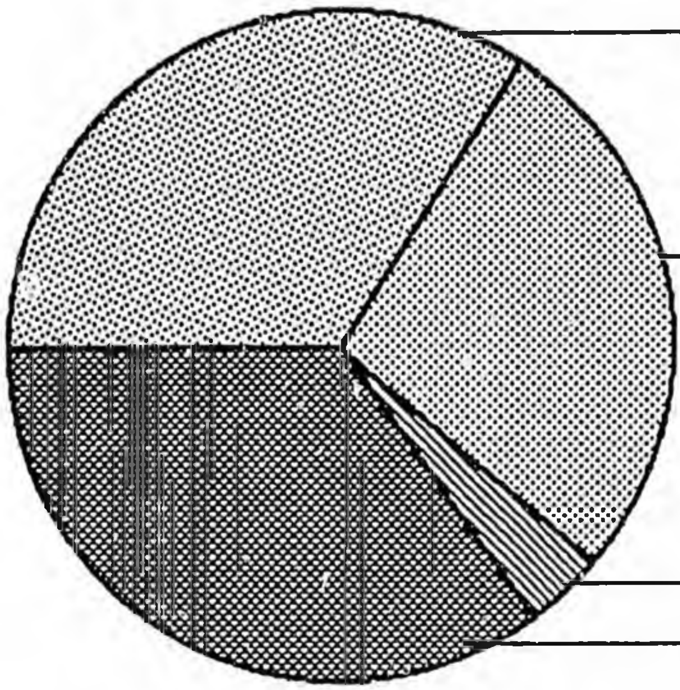
Industrial consumers represent a relatively constant load (demand) for electricity since many industrial processes run continuously, 24 hours a day, 365 days a year. Many industrials use large amounts of electric power at high voltage levels. They require a limited number of connections to the system and often represent a single or limited number of metering and billing operations. All these factors make industry less expensive, on a per kilowatt/hour basis, for an electric utility to supply.

The third consumer group is the commercial sector which includes businesses, hospitals, schools, government buildings and such large electricity consumers as shopping malls. Although system reliability is obviously critical to institutional consumers like hospitals, it is becoming increasingly important to the business sector in general. The pervasive integration of electronic data processing and computers into office operations underscores the need for a reliable supply of electricity.

Electricity consumption by sector for 1987 is illustrated in Figure 2. The "other" category is defined by DOE as including street lighting and sales to public authorities, railroads and interdepartmental sales by utilities.

FIGURE 2

1987 ELECTRICITY CONSUMPTION BY SECTOR



Source: South/West Energy Council From DOE-EIA - 0348 (87).

Transmission systems tie the source of electric power, the generation sector, to the consuming sector. The transmission systems of individual companies are usually linked together at points called interconnects. The transmission systems of a region may be connected in a "pool". This permits companies to buy and sell power to assure reliability and economy, as well as to share power in emergency situations.

Distribution systems "deliver" electricity to consumers. There are three main types of utilities providing generation, transmission and distribution services in the U.S. today. They are investor-owned utilities serving over three-quarters of the consumers; municipally-owned utilities serving 13 percent; and the electric co-operatives, known as co-ops, serving 11 percent of the nation's consumers. Additionally, there are federal power authorities like the Tennessee Valley Authority, Bonneville Power Authority and others which sell wholesale power to utilities for distribution.

Largely on the basis of completion or abandonment of major generating projects during this decade, generating capacity varies greatly from region to region in the U. S. Some regions, like the Northeast, experienced brown-outs (power reductions) during the summer of 1988. In other areas, where large generating units came on line at roughly the same time demand slacked off, reserve margins may exceed 50 percent.

Regions with excess capacity have been particularly affected by the requirement to purchase PURPA power, which has been enforced even though additional capacity was clearly not needed. This means further increases to utility bills which had recently been increased to pay for new generating capacity.

Regional regulation, in light of the regional nature of electricity markets, has been suggested by policy makers like the National Governors Association. Such efforts have proved unsuccessful largely because of a fear of adding another regulatory layer to an already complex regulatory system.

Improved interconnects and transmission technology, as well as regional capacity differences, have led to tremendous growth in bulk power sales between utilities. Other bulk power sales have come from independent power producers and Canadian imports. Increases in long term contract sales, spot power exchanges, contract power pooling, shared facility ownership, and economic dispatch are all related, at least in part, to the growth in the bulk power market.

Canadian electricity imports, primarily generated by Canada's vast hydro-resources, provide up to 10 percent of New York's and New England's electricity consumption. Proponents of Canadian electricity imports point to cheaper rates for U.S. consumers, a reduction of air pollutants by backing out coal-powered generation and a decrease in imported oil for generation. Opponents cite increased trade deficits and question reliability, dependence on foreign power, and subsidies granted Canadian utilities by that government.

Additions to utility capacity have definitely decreased from their peak in the early 1970s. Figure 4 shows capacity additions made and planned.

Construction schedules were disrupted when regulatory agencies responded to the Three Mile Island Nuclear Plant accident with revised safety requirements. Further, nuclear plants were built on an unprecedented scale and often ran into construction problems and delays because of unforeseen technical difficulties. Finally, organized legal challenges slowed many projects significantly.

In the political arena, the oil embargoes of the seventies provided the impetus for the National Energy Act (NEA) which included the Fuel Use Act (FUA) and the Public Utility Regulatory Policies Act (PURPA). In an effort to temper U.S. dependence on what was perceived to be limited domestic oil and natural gas resources, the FUA prohibited the construction of new oil and gas utility powerplants and industrial boilers. Those prohibitions were removed in 1988, but by that time a number of coal-fired generating units had been built in lieu of natural gas plants.

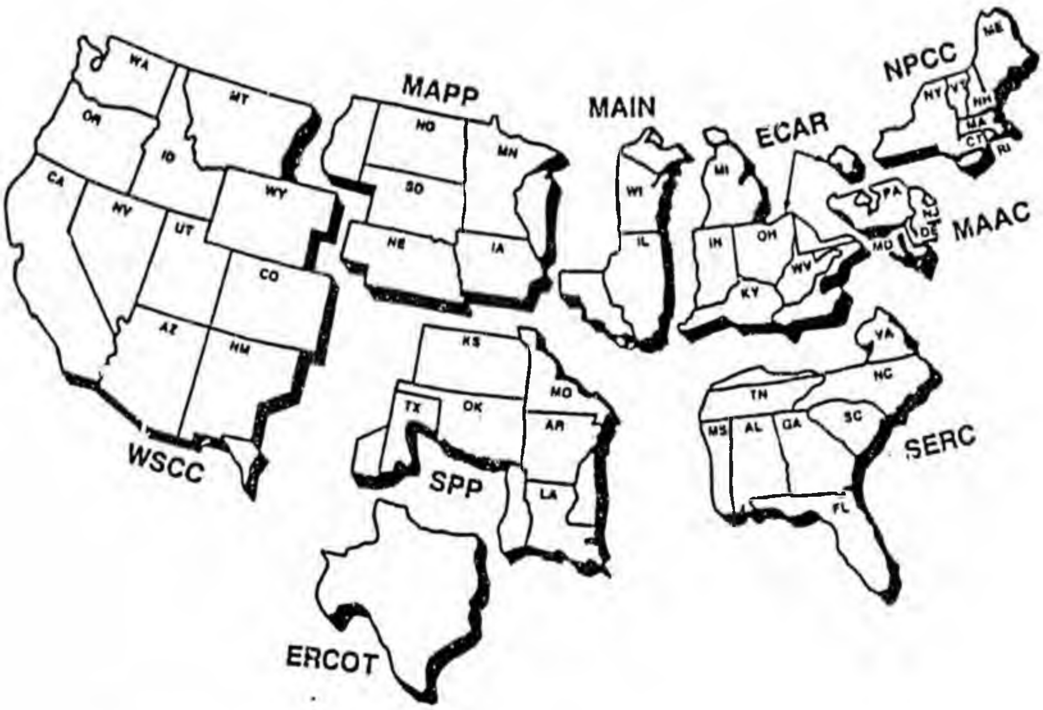
PURPA attempted to conserve energy by encouraging small alternative fuel generation and cogeneration units. Cogeneration, practiced by industry since early this century, is the simultaneous generation of electric power and heat for industrial processes. PURPA directed that utilities must buy power if offered for sale by small power producers and cogenerators at rates no higher than the purchasing utility's avoided cost.

During the upheaval of the late seventies and early eighties, the public became politicized as utility rates climbed with higher fuel costs and plant construction overruns. Unfortunately, during this same period, demand growth which had averaged 10 percent per year, dropped precipitously and settled at an annual rate of two to five percent.

Once under construction, large-scale power generation stations afforded utilities little flexibility in completion or financing (e.g. utilities were faced with completing plants no longer needed or abandoning their sunk investments). Prudence reviews, alternatively viewed as witch hunts or management accountability tools, were conducted by PUCs facing rate increase requests from cash-strapped utilities.

FIGURE 3

NORTH AMERICAN ELECTRIC RELIABILITY COUNCIL REGION MAP



Regional Electric Reliability Council Areas

ECAR—East Central Area Reliability Coordination Agreement
MAIN—Mid-American Interpool Network
MAAC—Mid-Atlantic Area Council
MAPP—Mid-Continent Area Power Pool
NPCC—Northeast Power Coordinating Council
SERC—Southeastern Electric Reliability Council
SPP—Southwest Power Pool
ERCOT—Electric Reliability Council of Texas
WSCC—Western Systems Coordinating Council

Source: DOE-EIA, Electric Power Annual, 1986

The post-war period of utility growth and prosperity came to an end in the 1970s. Foreign oil embargoes caused energy costs to rise in an unprecedented manner. Since fuel costs average 50 percent of a utility's operating and maintenance costs, PUCs allowed automatic fuel adjustments to consumer's bills.

Secondly, utility construction programs, based on previous demand growth rates, ran into cost-of-capital problems with high inflation. Many of these new construction projects were large nuclear plants.

Utilities are generally either publicly regulated or publicly-owned. Regulation at the federal level is by the Federal Energy Regulatory Commission (FERC). FERC's authority extends to all sales for resale, whether intrastate or interstate, and all transmission transactions except most in the state of Texas.

State regulation usually includes the regulation of most or all retail sales to consumers of electricity. Much of state regulation is related to the monopolistic status granted the utility by the state.

The traditional regulatory compact grants utilities a geographical service franchise in exchange for meeting the obligation to provide service on reasonable terms to all those who request it. Further, earnings are limited on opportunity to earn a "fair" return on invested capital, as set by the regulatory body.

Most states have utility regulatory bodies, commonly called public utility commissions (PUCs) or public service commissions (PSCs). Their members may be elected by the public or appointed by the governor. State PUCs or PSCs normally regulate rate schedules, security offerings and certain contractual relationships, as well as other matters, under state statutory or constitutional grants of authority.

In some cases such authority may be withheld in favor of local government regulation. Local regulation normally takes one of two forms; the granting of franchises to locate distribution facilities (poles and wires) on public right-of-ways, and the regulation (or actual operation) of a municipal utility.

In retrospect, the period from the close of World War II to the mid-1970s was a golden one for electric utilities in the United States. Technological improvements meant declining costs while demand grew steadily at rates as high as 10 percent per year.

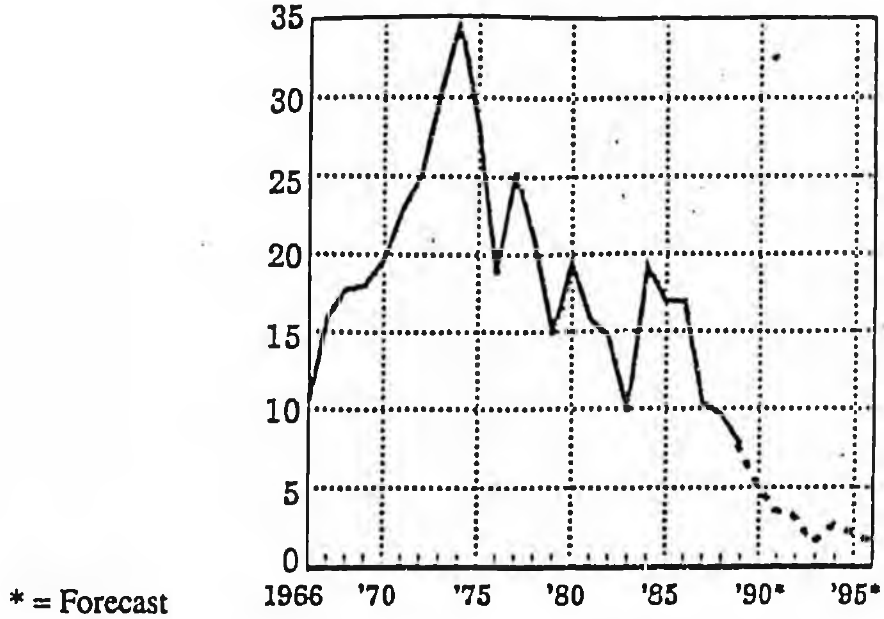
One exception to this generally trouble-free era was the so-called "New York City Black-Out" which occurred in November, 1965 and plunged 30 million people on the Eastern seaboard into darkness. That incident lead to the formation of the National Electric Reliability Council, composed of 10 Regional Reliability Councils as illustrated in Figure 3. Interconnects and pooling arrangements within the regional reliability councils improved system reliability and the ability to make bulk (wholesale) power sales between utilities.

FIGURE 4

ELECTRIC GENERATING CAPACITY ADDITIONS BY U.S. UTILITIES

MADE AND PLANNED, 1966 - 1996

(Thousands of Megawatts)



Source: Wall Street Journal from Utility Data Institute

Finally, the residential electricity consumer movement, born of the rate battles waged earlier this decade, is promoting "least-cost alternatives" to new generating construction. Least-cost planning is recommended by its advocates as a process to assure that electric utilities meet future load growth with reliable and adequate energy services by employing demand management, as well as supply-side options.

Least cost proponents want a voice in the utility's planning process. They say that if state PUCs and public advocates become involved in front-end "management decisions" relative to new generation, they will share responsibility for the decision with the utility after the powerplant is built.

One least-cost approach, called integrated resource planning,[1] has been outlined for PUCs. It would consider a number of factors including utility protection from prudence reviews, standardized means of evaluating demand-side programs, expensing of utility conservation program costs and a review of automatic adjustment rates to account for lost revenues associated with conservation programs. Integrated resource planning would also require the development of appropriate funding and staffing levels at state PUCs to properly review utility plans.

Ordered to buy PURPA power and able to buy bulk power, many utilities are looking at new generation construction long and hard. Powerplant conversion (e.g. conversion of incomplete nuclear plants to natural gas) and refurbishing existing powerplants also look less risky than construction. However, all these alternatives raise questions of system reliability.

Regardless of who builds the next generation of power stations, environmental factors will play a significant role in the type of facility selected. The so-called "greenhouse effect" may impact future power production decisions in two regards. First, it may influence the choice of fuel and secondly, an increase in the earth's temperature might increase electric utility capacity needs.

Coal and fossil fuel combustion has also been linked to acid rain. Regional differences arise when utility generators using "compliance coal" (low sulfur coal), low sulfur oil, natural gas or nuclear power are threatened with paying for the clean up of older, high sulfur coal facilities. Many recent coal-burning utilities, forced off of indigenous oil and gas by the FUA, built more expensive compliance coal generation units. Such utilities fear double jeopardy now with regard to the cost of cleaning up acid rain problems.

Although there are over a hundred nuclear generating plants in this country, it is unlikely that new plants will be considered until matters of licensing reform, uniform design and disposal of spent nuclear fuel are settled. Regulation of nuclear plant construction has been greatly simplified by European nations relying on an approved, standardized plant design.

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[1] Hurst.

Another nuclear concern relates to the disposal of spent nuclear powerplant fuel, presently being stored on the plant site. Finalization of federal policy regulating disposal of spent fuel is a pressing energy policy need.

Industries, seeking to buy power from generators other than the franchised utility, have long sought wheeling (transmission) privileges in the name of economy and efficiency. Utilities generally oppose wheeling on the grounds that transmission systems, designed to handle power generated by the utility, are unable to move specific blocks of power from point to point but rather must be balanced systematically and could become overloaded with wheeling demands. Further, according to utilities, wheeling-off system power to the utility's industrial consumers would mean a loss of baseload consumption, and consequently, higher rates to the utility's remaining customers.

Utilities feel beleaguered by increasing competition from PURPA power generators, pressure to wheel from industrials, regional capacity problems which pit utilities against one another (under excess or shortage conditions), and least-cost planning processes enforced by state PUCs. They voice grave concerns over the status of their service obligation, loss of control of transmission systems and system failure due to unreliable generation.

It is in this environment that FERC has issued Notices of Proposed Rulemaking (NOPRs) which in the words of electricity industry analysts, "Could change forever both the structure of the utility industry and the regulatory framework within which it operates."[2]

In an effort to reform electric power regulation, FERC's notices label traditional cost-based regulation as flawed because it provides insufficient incentives to utilities to minimize costs to consumers. FERC also feels that the present regulatory scheme holds utilities accountable for failures, but fails to reward utility successes proportionately. As a result, utilities may minimize capital expenditures. This may also result in a bias toward less fuel diversity and a reduction in technological innovation.

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2 Smartt.

Citing the terms of PURPA, the first phase of FERC's efforts are to target near term decisions in meeting new capacity needs. Subsequent phases of reform regulation will focus on pricing for bulk power markets, utility wholesale sales and transmission.

The current NOPRs, issued in March, 1988, clarify federal rules relative to state PUC administrative determinations of "full avoided cost" for PURPA power purchased by utilities. They also eliminate unnecessary capacity purchases. The second part of the NOPRs provides for a bidding program as an alternative to administrative determinations of full avoided cost. Coincidentally, PUCs in states like New York are pursuing bidding programs as well.

The third set of NOPRs establishes a framework free of regulation for Independent Power Producers (IPPs) who do not qualify for benefits under PURPA and also do not have market power sufficient to fix or maintain prices. Utilities charge that this NOPR would create an unregulated class of generators with an unfair competitive advantage. This proposal will no doubt be challenged in court as exceeding FERC's authority under the Federal Power Act and PURPA.

Although FERC's policy changes may be considered dramatic, the NOPRs are no match for the excitement generated by physicists pursuing superconductivity as the subject of private, as well as public, research efforts. Fully 25 percent of the primary energy consumed in the United States is attributable to electricity generation and transmission losses; superconductivity has the potential to greatly reduce those losses and provide storage technology to levelize electricity demand peaks.

Although now largely limited to the laboratory, concerted research on superconductivity may be expected to impact power generation, transmission and storage, shortly after the turn of the century. Other energy, or specifically, electricity storage systems, are also under development. The potential for electricity conservation is tremendous.

ELECTRICITY STRATEGY STATEMENT

It shall be the strategy of the United States to promote the development of sources of electric energy that are sufficient to meet national needs, secure from external threat, reliable in availability and delivery, safe relative to people and the environment and efficient for use in homes, businesses and industries.

The electricity sector today is marked by tremendous regional diversity, especially with regard to capacity. Fuel usage also varies widely. Implementation of federal legislation that fails to recognize this diversity inevitably penalizes one region or another.

State regulatory bodies are close to consumers, utilities, industries, and concerned for state economic well-being. State regulatory bodies are in the best position to evaluate consumer needs, questions relative to fuel choice, economic development implications, and system reliability.

A federal government program for storage and disposal of spent nuclear fuel shall be finalized as quickly as is safely possible. Federally-acceptable, standardized nuclear powerplant designs must also be established.

Electricity research and development efforts shall be intensified with regard to energy efficiency, superconductivity, advanced and reasonable environmental controls in power generation, and development of cost-effective renewable supply technologies. The development of electric vehicles shall also be pursued.

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South / West
Energy Council

Rep Bill K. Brewster (Ok)
Chairman
South/West Energy Council

Rep John W. Ramsey (Ar)
Chairman
South/West Energy Research Foundation

Alabama:
Sen Earl Goodwin
Sen Earl Hilliard
Rep Taylor F. Harper
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Louisiana:
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Alaska:
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Sen Drue Pearce
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Colorado:
Sen Tilman M. Bishop
Sen Ted L. Strickland
Rep Carl B. Bledsoe
Rep Scott McInnis

Texas:
Sen Grant Jones
Rep Jim McWilliams
Rep Rick Perry
Rep Dan Shelley

Patrick J. Raffaniello
Executive Director

290 E. Carpenter Freeway
Suite 114
Irving, Texas 75062
214-541-1991
Fax 214-717-0647