Energy Use and Facility Siting in Rhode Island

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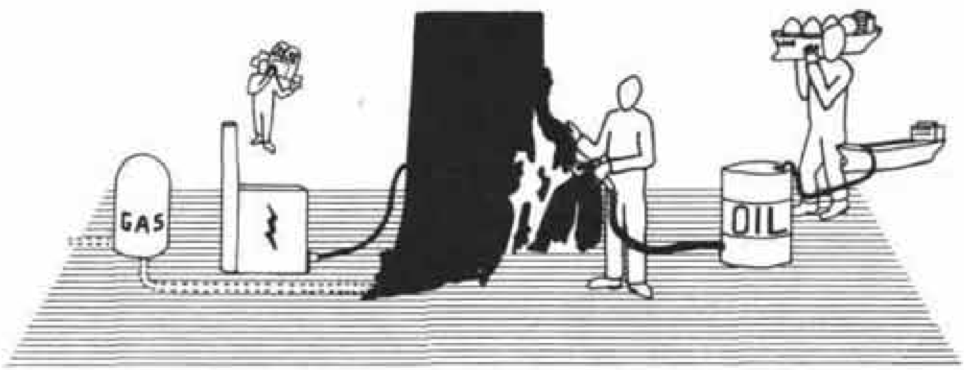

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PROSPECTS FOR CHANGE IN THE AVAILABILITY AND USE OF ENERGY

INTRODUCTION

One thing Rhode Island can count on in the next several years is the advent of a new way of thinking about energy use and fuel supply. The uncertainty which consumers face regarding the price and availability of fuel, the slower growth in energy demand and the shifting costs of competing fuels has raised new questions for public agencies about the role of new energy projects in the state. Traditional assumptions about the economic necessity of increasing our use of fuel and the vital need for every new power plant, oil refinery, fuel storage facility and marine terminal proposed by industry are now being questioned by the public. Public trust in the energy industry and government policy makers is continually challenged by the declining credibility of price and supply forecasts, indecision on basic energy policy and reports of government failure to check industry moves that appear designed to raise prices by creating artificial shortages.

The cause of this change in conventional thinking about energy is complicated but not mysterious. The implications for Rhode Island are not easy to accept, but they are becoming increasingly clear. The first task the state faces is to define its energy problems, which will lead to the identification of causes for which solutions can be developed. Unfortunately, the energy problems we face are being defined in many different ways and attributed to seemingly contradictory causes. The solutions which various people have suggested reflect a wide spectrum of beliefs about the nature of the problem. For example, some people blame oil shortages on the petroleum-exporting countries and the energy industry, while others accuse the federal government of causing shortages and price increases because of too much regulation. A few people have raised the possibility that we ought to blame ourselves for wanting so much fuel in the first place. In fact, Rhode Island's energy difficulties can be attributed to all three causes and others as well.

This report explores the world and national energy situation, which forms the backdrop for state and local siting decisions. The most important conclusion is that energy conservation and use of local energy resources must be the first priority at the business and personal level, since actions which help us to wean ourselves from conventional resources are much less expensive than building new energy facilities to increase production or handle greater demand. Adopting conservation as the primary objective removes a great deal of burden from suppliers of conventional fuels who otherwise would feel compelled to invest in additional supply capacity. By providing information, subsidies, tax credits and technical assistance, government can play an important role in assisting people to accomplish these goals.

The use of oil, gas and electricity will still be important, and the role of state and local government in energy facility siting must not be neglected. The energy situation places new light on the criteria which the state should use in granting or denying permission to an applicant, and raises important questions for major energy users and suppliers regarding the type of equipment and scale of operation which they should select. The need for a proposed facility and an understanding of the nature of its impacts throughout its life cycle have become important considerations in state siting regulations. On the other side, big energy users must consider more appropriate means to accomplish various purposes; for example, by installing a cogeneration plant that provides heating, process steam and electricity, thus making the most use of any fuel consumed.

New energy projects should not be ruled out and deserve a fair hearing. The energy facility siting criteria adopted by the Coastal Resources Management Council in September 1978 provide a framework in which the important questions of need, alternatives to a project, alternative sites, and impacts can be addressed in a public proceeding. The regulations should help to insure a sound decision by state government that is sensitive to some of the new energy facts of life.

THE ENERGY SITUATION

The price of energy is increasing faster than any other industrial or consumer commodity. This higher cost is raising the price of every product and service, and is claiming a bigger share of every family's budget. The effort to develop additional domestic energy resources and our willingness to pay for expensive energy imports have caused energy prices to rise. Energy companies find themselves investing more effort to produce a barrel of domestic oil. The flow of oil to the United States is dependent on the export policies of foreign oil-producing nations.

This situation has come about because the types and quantities of energy the United States has relied upon in industry and at home have changed greatly as ways of using new fuels have been developed and adopted. Until oil and gas became the primary national energy sources in the late 1940s, the United States was self-sufficient in energy and relied primarily upon coal, wood and hydropower. In the fifteen years following World War II, United States dependence on oil and gas grew from 44 to 75 percent of total consumption, while the ability of domestic production to meet demand steadily eroded. In 1950, the nation was almost completely self-sufficient in petroleum, compared to 1975, when domestic production provided only half the oil we consume. The difference is made up by imports of oil from several nations. Unfortunately, the world oil price is much higher now and continues to climb because demand exists for all the oil that can be produced.

The import problem is not new and is not confined to energy. Just as domestic oil resources have been scarce relative to demand for three decades, 23 of 32 major industrial minerals and metals, including chromium, asbestos, nickel, zinc, tin and platinum, are obtained principally through imports. The entire world is now faced with the likelihood that oil producers will be unable to fill projected demand within the next two decades. This fact enables producers to set prices and sell only to the highest bidder. The situation has placed our nation in a serious predicament. Our present economic wealth and power have been created by three centuries of land and mineral exploitation, economic growth and population increases. We have come this far by using up energy resources that were easy to extract and utilize, shifting from wood to coal to oil in the 60 years between 1885 and 1945. Mere maintenance of our present population at current consumption levels for the next 25 years will require about the same amount of energy that we have consumed in the past 50. The development of new, abundant, easy-to-use energy sources has characterized our past; our energy future, however, is one in which scarcity plays a dominant role.

The idea of scarcity must be viewed in relative terms. If we are willing to pay the cost, even the most remote and low-grade fuel can be extracted. A point is reached, however, at which efforts to get a fuel require an investment that cannot be recovered from fuel sales. This point varies depending on the fuel. Consumers are willing to pay more for fuels which are clean and easy to use, even though another fuel may be cheaper per million BTUs (British Thermal Units). For example, gas companies import a percentage of their total annual gas requirements in liquid form. Liquefied Natural Gas (LNG) is much more expensive than pipeline gas. However, in times of peak demand, when the pipeline cannot provide the full amount needed, LNG is viewed as worth it cost because it enables gas utilities to avoid shutting off low-priority customers or imposing temporary curtailments of service. A premium is also placed on low sulphur oil and coal, which is harder to find, because of its low pollutant emissions.

THREE VIEWPOINTS ON THE ENERGY PROBLEM AND ITS SOLUTION

Not everybody agrees that the nation faces an energy shortage. Some people point out a contradiction between publicity about a crisis and the growing wealth and record-breaking profits of the energy companies. Energy companies argue that such profits are not excessive, and are in fact necessary to encourage new investments in exploration and development. The gas industry has been boosting its lagging sales and gaining new customers through aggressive sales campaigns despite the need to curtail supplies during the winters of the mid 1970s, which resulted in a major shortage in the Midwest in 1977. Few disagree, however, that some kind of action is needed to deal with the energy "problem." Just who should be taking the initiative and what steps are necessary have been topics of heated debate since 1973. The many arguments and counterarguments about the energy problem frequently boil down to differing attitudes toward how our society should function.

The prospect of still more and perhaps greater changes in the way we must live in the future brings feelings of uncertainty and fear that we will lose the standard of living the nation has worked for two centuries to obtain. This fear of losing ground has two bases. First, many people believe that in order to maintain and improve our quality of life we must assure that sufficient industrial facilities are in place to develop remaining mineral resources, to process, store and transport fuels, and to generate electricity. The fear that failure to grow in our energy supply and fuel-handling capability, both in terms of domestic production and energy imports, will reduce the United States' ability to provide for its high level of economic activity and prosperity. Other people believe, however, that our country already wastes a great deal of energy and has a long way to go before it can meet the energy efficiency standards of prosperous nations such as Sweden and German. Their fear is that the nation is sacrificing its quality of life and hurting the economy by failing to curtail energy waste.

The California Energy Commission found it useful to identify the different positions on the present energy debate with some well-known figures from history.

The Greelian View

Horace Greeley was a nineteenth-century journalist, activist, political leader and strong proponent of the development of the western frontier. The aphorism "Go west, young man" is wrongly attributed to him yet reflects his basic view. Modern-day Greelians believe that government must promote growth and development by helping to finance very large and sometimes risky energy projects and by simplifying or relaxing environmental and price regulations. Overregulation is perceived as the primary roadblock to the provision of adequate supplies of fuel and electricity at a reasonable cost. Delays in project approval, shifts in environmental standards, and inconsistencies in government policy supporting new technology increase the costs of energy facilities and disrupt industry planning. Government regulation of fuel costs, in the Greelian view, destroys the proper functioning of the free market in setting prices and making resource development and allocation decisions.

The Jeffersonian View

Thomas Jefferson, the third United States President, believed in limiting the centralized power of government and supported individual rights. Applying his views to today's energy problems, it is centralized planning and control by large energy corporations as well as government intervention which has led to our problems of energy shortage, waste and demand for new sites for large-scale energy facilities. People want to be warm, keep food refrigerated and go to work, simple demands which can be met in ways which avoid large, new expensive facilities and technology owned and controlled by a few big companies. Energy conservation will save in two ways, on consumer fuel bills and in avoiding costly new investments to fill already bloated levels of energy demand. Use of solar energy and direct burning of fuels rather than conversion to electricity are examples of the solutions viewed as appropriate to consumers' needs by today's Jeffersonians.

The Periclean Approach

Pericles was a statesman who lived in Athens in the fifth century B.C. during the Golden Age of Athenian democracy. Today, adherents to the Periclean approach would not make any prior claims about the causes or specific solutions to the energy problem. Instead, Pericleans stress that the right answer can be found by following a rational and democratic process. Strong and responsible government leadership can solve our energy problems and provide for both more efficient and less environmentally troublesome resource uses in the future. The desired future must be defined through informed and systematic analysis of specific problems, integrated statewide and regional planning efforts, and broad public participation in determining the direction of energy policy. Problems of wasteful energy investments as well as undesirable regulatory bottlenecks can be avoided if a desired future is chosen from among several well-articulated options.

Criticism Of Each View

All three approaches contain legitimate observations about the energy problems we face. However, each view has important drawbacks that make its approach less than satisfactory. To begin with, Greelians do not see that energy resources are finite and they underestimate the likelihood that a large development project could fail in meeting its financial and energy supply objectives. They also advocate continuous expansion of energy facilities in a program that requires higher consumption levels or energy prices if such projects are to break even as an investment. Greelians ignore the cumulative environmental, social and economic effects of an approach based solely on growth in supply activities, energy consumption and economic development.

Jeffersonians, on the other hand, overestimate the feasibility of a rapid transition from reliance on conventional fuels to heavy use of various renewable alternatives. Some of the choices endorsed by Jeffersonians are not presently available at an acceptable cost or many require changes in life style which many people will not accept without a serious national emergency. Disinterest and suspicion of centralized government and industry planning inhibits the redirection of already substantial subsidies and investment in conventional resources toward acceptable alternatives.

The Periclean approach, in its emphasis on government planning, ignores the enormous difficulties in a society as large and complex as our in achieving consensus on goals, and tends to ignore the danger of centralized planning, which is often dominated by the special interests that are the subject of controls.

PURPOSE OF THIS REPORT

Rhode Islanders are aware in varying degrees of the issues and problems posed to the state by the demand for and supply of energy. This report has been prepared to provide some basic information and ideas about the subject of energy use and facility siting in Rhode Island. The emphasis throughout is upon identification of options and the need for choices for our future, choices which do not depend on national consensus or federal action and which should serve as a buffer for the state from decisions by the energy industry and global fuel suppliers.

The subject of energy contains a number of topics which may not appear to be linked to one another. At first glance, it may be difficult to see how energy conservation, the siting of new facilities and inflation in the economy are tied together. But the experiences of states such as California show that it is possible to tackle the difficult tasks of understanding the different aspects of the energy problem and of undertaking a coordinated effort to select and attain both public and personal goals.

The analysis contained in the following chapters begins with an examination of energy trends in New England and Rhode Island in order to identify issues of major concern. The global and national framework which surrounds state efforts is discussed in terms of the opportunities and constraints it places on state and individual problem-solving efforts. National energy policy and the conflicting roles of the federal government are then explored. Finally, a prospectus for Rhode Island is presented which discusses the difficulties of addressing the future and presents the outline of a pragmatic public and personal energy strategy for Rhode Islanders.

II.

TRENDS IN ENERGY USE AND SUPPLY IN RHODE ISLAND

INTRODUCTION

The continuing worldwide increase in fuel prices, coupled with high domestic energy demand, means that Rhode Islanders must pay more for energy with less money to spend for other purposes. Growth in state energy consumption has slowed in recent years as consumers modified their energy use habits. This has had a general effect in reducing the need for new energy facilities to serve the Rhode Island area. However, proposals to construct such plants in Rhode Island continue to appear. The reason for this is twofold: (1) growth is occurring in some elements of regional energy consumption, and (2) shifts are being made toward greater use of natural gas and electricity. Uncertainty about overall energy use growth rates make assessment of the future energy mix and the identification of necessary new energy facilities difficult.

HISTORICAL PERSPECTIVE ON ENERGY USE

Energy is of central importance in the home, the economy and in the transportation of goods and people. The forms and quantity of energy consumed in America have changed over time as new resources and practical ways of using them have developed. Beginning with native Americans and the early European settlers, Rhode Island's inhabitants have relied on easily utilized natural flows of energy such as the sun, wind, water and wood. Energy resources that are today considered "alternatives for the future" were the primary sources three centuries ago. Native Americans earned their livelihood from subsistence agriculture, hunting and fishing and, later, trading. In addition to using wood for heating and cooking, early farmers cleared large areas of brush and forest with fires. This helped reduce the physical labor needed to prepare the land. All work was done by hand without the assistance of animals. Travel was by foot along paths, some of which became major highways in the twentieth century. Native Americans took advantage of tides and currents when traveling by canoe. The sun provided the basic input of energy into the entire economy, since survival depended on harvesting the plants, fish and animals which nature provided.

European settlers of the seventeenth century brought with them tools and weapons from a relatively high energy society. These tools helped to exploit the natural resources more efficiently. In the early period, the sun was still the primary source of energy, but with a number of important differences. Wood was the primary fuel in the home, accompanied by the use of whale oil for lighting. Agriculture was carried out by large families with the assistance of work animals and, in some cases, slaves.

The use of domestic livestock meant that a great deal of land was required simply for grazing and growing hay. Settlement patterns were determined in part by the primary form of transportation used to move goods and people to other regions: water. Streams were an important geographic factor for transport and simple mill operations, particularly in the late eighteenth and nineteenth centuries. The foundation for vigorous exploitation of the natural resources of New England and for tremendous urban and rural growth rested on the ability of colonists to effectively harness several forms of energy in much larger quantities than the native population had done before them.

Rhode Island played an important role in the transition of New England and the nation from the relatively stable subsistance life style practiced by native Americans to modern patterns of vigorous land resource exploitation and industrialization. The use of water power to operate manufacturing mills began in earnest with the work of Moses Brown and Samuel Slater in Pawtucket in the 1790s. Their success changed the physical and social fabric of New England as the mechanical energy of rivers and streams was harnessed for efficient textile factories, sawmills and numerous manufacturing activities. In the 1800s Rhode Island was a national leader in the development of steam technology, which used wood and coal as fuels. The Corliss Company of Providence designed and sold steam engines worldwide. The Centennial Celebration in Philadelphia in 1876 was powered by one enormous Corliss steam generator. But advanced technology and mineral fuels brought more change to the region. Since abundant and portable coal could be used effectively, manufacturing could be accomplished anywhere. The textile industry began to move south as industrialists took advantage of cheaper human labor. New changes were in store as the nation entered the age of petroleum.

AN ENERGY DEMAND PROFILE OF RHODE ISLAND

Energy Needs

The twentieth century has been an era of widespread and growing consumption of fuels and electricity. Space heating is the single most important reason why New Englanders consume energy, comprising about 42 percent of the energy demand in 1970. In the same year, transportation of goods and people accounted for 27 percent; lighting, machinery and electronics for 16 percent; and loss in the conversion process for 15 percent. This distribution has not changed, with the exception of greater losses of energy to electric power production (Table 1). Rhode Island shares most of the same distinguishing characteristics with New England in its need for energy. Homes and businesses use more energy for space heating than the national average, while less is used in industry and transportation. As a result, total energy use per person is 30 percent less in Rhode Island than in the nation as a whole, as shown in Table 2. In addition, the state accounts for only 7 percent of New England's total energy consumption when the fuel used to generate electricity is excluded.

TABLE 1

END USES OF ENERGY IN NEW ENGLAND
percentage

<table>
<tr><th></th><th colspan="2">1970</th><th>1975</th><th>1976</th></tr>
<tr><td>Space Heating</td><td>41.5</td><td rowspan="2">57.9</td><td rowspan="2">58.7</td><td rowspan="2">53.9</td></tr>
<tr><td>Miscellaneous</td><td>16.4</td></tr>
<tr><td>Transportation</td><td colspan="2">27.0</td><td>28.1</td><td>28.0</td></tr>
<tr><td>Conversion losses</td><td colspan="2">15.1</td><td>18.2</td><td>18.1</td></tr>
<tr><td></td><td colspan="2">100.0</td><td>100.0</td><td>100.0</td></tr>
</table>

From: Chan, Dickinson and Mead, 1975; Bentley, 1978; and New England Energy Congress, 1979.

Table 2

NATIONAL, REGIONAL AND STATE ENERGY CONSUMPTION PER CAPITA, 1976
millions (10^6) of BTUs

	Residential/ Commercial	Industrial	Transportation	Total
Rhode Island	88.2	42.6	64.5	195.3
New England	89.4	45.2	69.9	204.5
United States	75.2	113.6	91.9	280.7

From: Bentley, 1978.

Energy Consumption

Since 1900, per capita use of energy for industry, commerce and households has doubled and the nation's population has tripled, with the result that our energy consumption level has quadrupled since the beginning of the century. More recently, New England's energy use increased 45 percent between 1962 and 1976, while Rhode Island's energy consumption grew 16 percent. As Table 3 indicates, the state has experienced a net decline in total energy consumption from a peak of 206.1 trillion (10^{12}) BTUs in 1971 down to 187.4 trillion BTUs in 1976. Oil continues to be the most important source of energy, contributing 77.3 percent of energy supply in 1962, and 76.5 percent in 1976. Natural gas is currently the second most important fuel, contributing 14.7 percent of total supply in 1976. Electricity remains the smallest source of energy, providing only 8.7 percent in 1976, up from 4.6 percent in 1962.

The overall increase in the levels of energy consumption hides some important facts about the changes which are occurring in the way we use energy. Total energy demand in Rhode Island increased 27.3 percent from 1962 to 1971. This was due to the 20 percent increase in fuel use per capita and the 10 percent increase in population. The decline in total consumption since then has been caused not only by a 3 percent drop in population but a 1 percent drop in per capita consumption as well. The amount of each type of fuel that is used per person has changed considerably since the early 1960s, as the graph in Figure 1 illustrates. Even though the role of oil in filling total demand has remained unchanged, since 1962, use of petroleum dropped from 80.3 to 76.5 percent of total consumption per person between 1971 and 1976. In the meantime, natural gas has increased its role by more than 50 percent, and electricity has doubled its share of per capita use. Coal has disappeared from the energy statistics.

Rhode Island's fuel mix differs sharply from the national picture. Natural gas accounts for about 30 percent of energy use nationwide, compared to only 10 percent for New England and 14.7 percent for the state. One-half of all residential and commercial needs, and close to 40 percent of industrial fuel, is provided by natural gas in the United States. It is no wonder that debate on energy policy at the federal level in 1978 centered on whether price controls on gas should be lifted, rather than on the issues related to the importation of petroleum products. Electricity consumption is also different from the national average. Only 14 percent of residential and commercial energy came from electricity in 1976, compared to 16.8 percent for New England and 24 percent for the nation. Nationally, greater amounts of raw fuels are being converted to electricity rather than being used directly by the consumer. This shows up as a growing loss of energy in the economy due to electric power generation. For example, as recently as 1970, 16 percent of the gross energy consumption of the United States was lost because it was converted to electricity. (It takes 1,000,000 BTUs of oil or coal to make 330,000 BTUs of electricity.) By 1976 this had increased to 19 percent. Current projections show this loss rising to 25 percent in 1985 and 32 percent in the year 2000 if present

TABLE 3

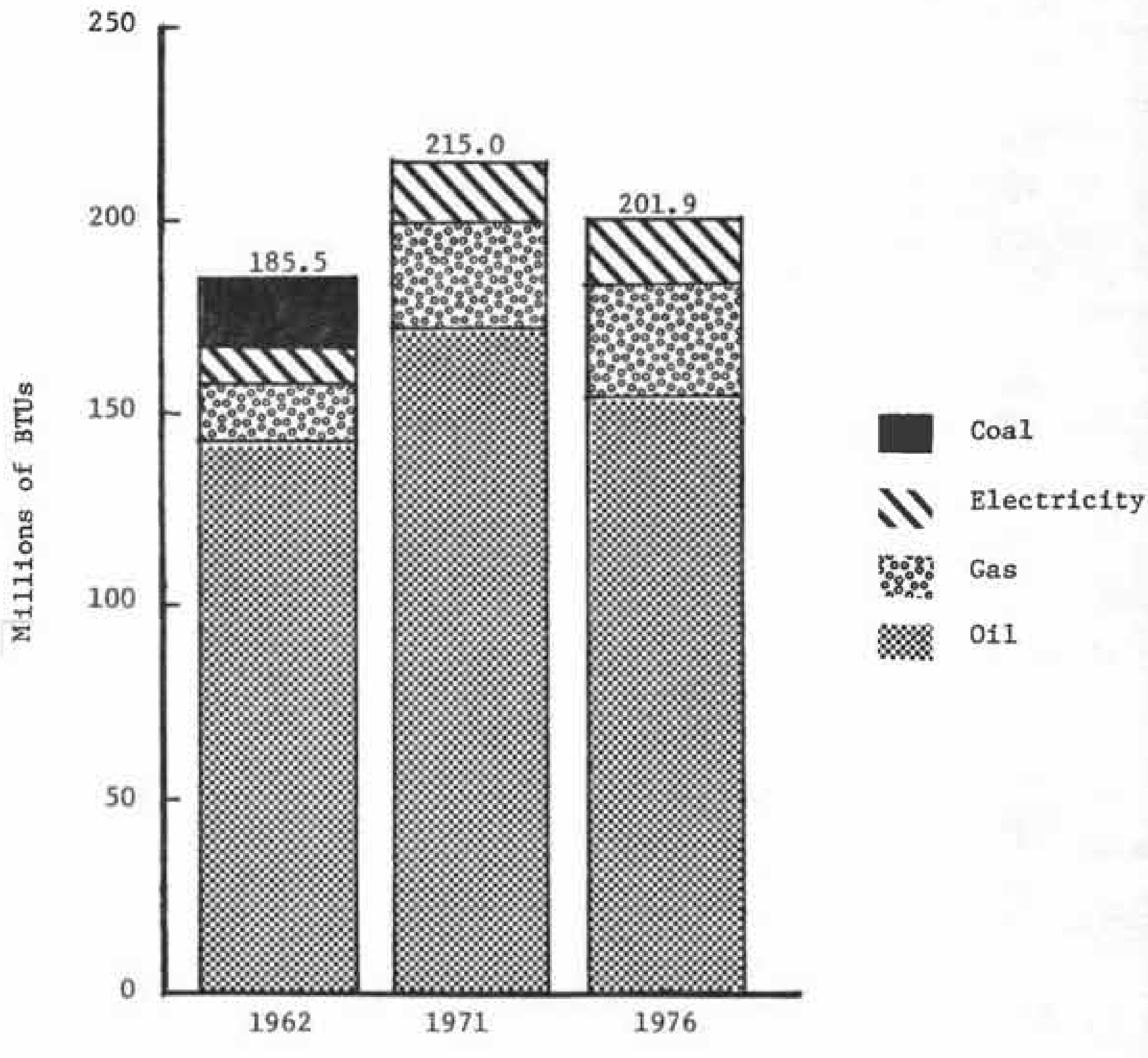
HISTORICAL ENERGY USE IN RHODE ISLAND
trillion (10^{12}) BTUs

	Oil	Gas	Coal	Electricity	Total
1962	124.7	14.1	15.0	7.5	161.3
1965	133.3	10.7	9.0	9.1	162.1
1970	155.0	25.8	0	13.3	194.1
1971	165.4	26.3	0	14.4	205.1
1972	167.7	22.4	0	15.3	205.4
1973	159.1	23.5	0	16.4	199.0
1974	126.1	24.1	0	15.5	165.7
1975	142.8	23.1	0	15.1	181.0
1976	143.3	27.7	0	16.4	187.4
1977	na	na	na	16.4	na

From: A.D. Little, 1974; Bentley, 1978; Electric Council of New England, 1976, 1977; Intermetrics, 1974; R.I. Fuel Allocation Office; R.I. Public Utilities Commission.

FIGURE 1

PER CAPITA CONSUMPTION OF FUELS IN RHODE ISLAND
(Including Utility Sector)



From: Table 3.

trends continue. Not all of this loss is actual waste, since electricity is a high quality form of energy that is essential for lighting, electronics and machinery operation.

Petroleum use per person has grown only 8 percent since 1962, from 143.6 million BTUs per person to 154.5 million BTUs in 1976 (see Figure 1.) Despite this stability, some important changes are occurring. Gasoline and No. 2 (home heating) oil are both increasing in use, while the consumption of No. 6 (heavy) oil by industry and business has declined sharply since the Arab oil embargo of 1973. Coal may soon be replacing even more of the heavy oil. The Brayton Point power plants in Massachusetts will soon be using coal instead of oil as a result of rising prices and the encouragement of the Department of Energy.

Causes of Change in Energy Demand

Explanations can be found for both the decline in per capita fuel use and the net drop in total energy consumption in the state. Rhode Island has been hit harder than other states by outmigration of people. While births continue to balance the migration occurring in other New England states, Rhode Island has suffered a net population reduction. Energy demand has also been dampened by the impact on the state of nationwide recession which occurred between 1973 and 1975. This economic slump was further aggravated by the oil embargo and the shutdown of Navy operations at several bases in 1973. Finally, energy prices have played a role in reducing energy use per capita, since the cost per million BTUs for all forms of energy doubled between 1971 and 1976.

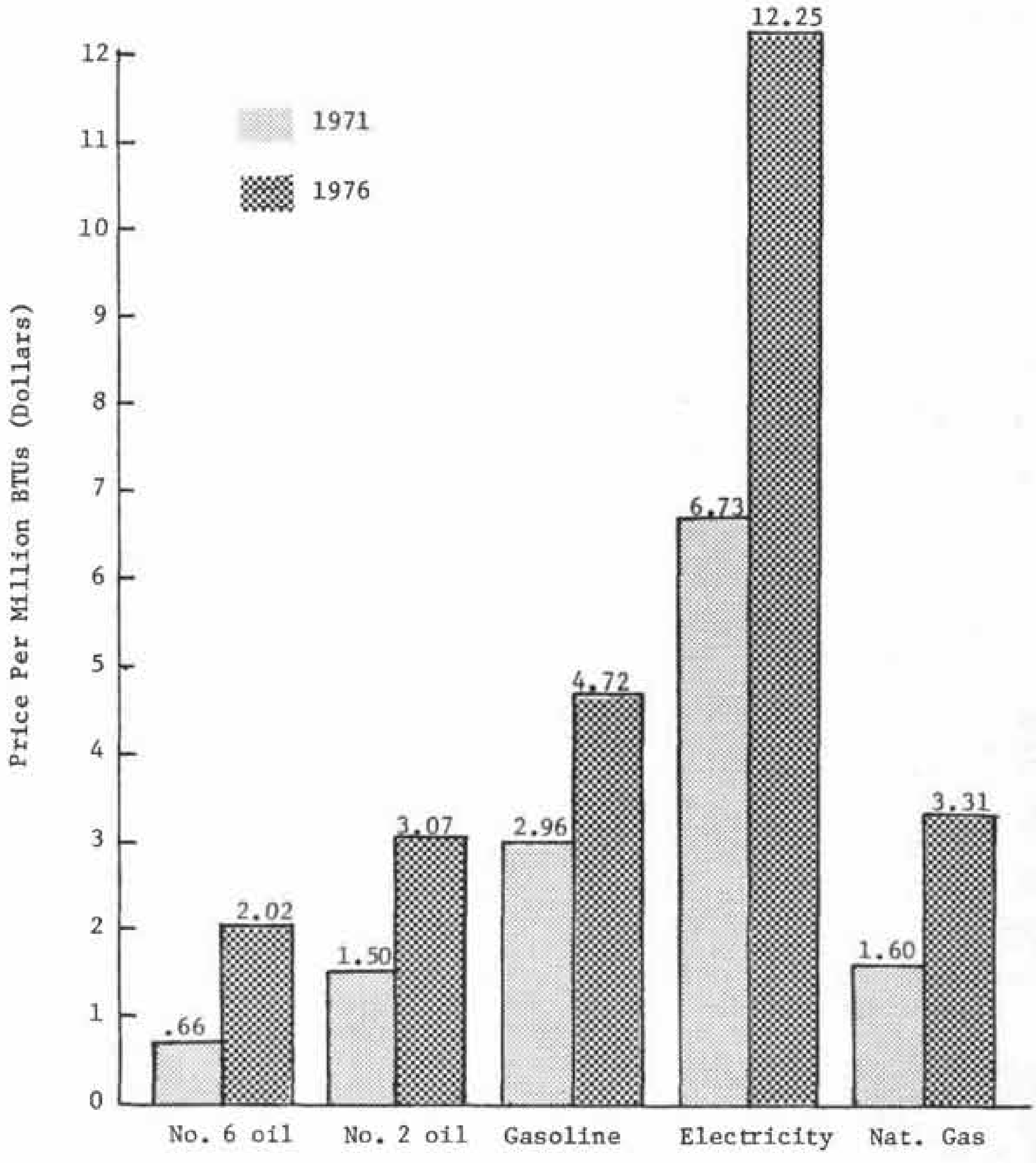
The dramatic change in prices to consumers is shown in Figure 2. While the relative cost of fuels and electricity has remained stable, the actual price has doubled, and in the case of heavy industrial oil it has tripled. Suppliers of substitutes for oil have cashed in on this increase in value of all energy products. For example, following the 1973 embargo, coal prices doubled along with oil prices. The increase in the cost of coal since 1960 has in fact been greater than that of any other fuel. Natural gas prices have not taken the dramatic jump that petroleum prices have, but have increased steadily as domestic production of natural gas has stabilized and declined. Present policy to deregulate the pricing of gas has resulted in more rapid price rises. Finally, electricity consumption in Rhode Island showed no net increase between 1973 and 1977, in part because its price has doubled along with petroleum and other fuels. Electric power is three to four times more expensive per million BTUs than other types of energy because so much energy is used to make it. Its relative price disadvantage ($12.25 per million BTUs versus $3.31 for natural gas in 1976) contributes to its recent slow rate of growth.

Projections Of Future Demand

Projecting future energy demand has become very difficult in recent years due to the uncertainty surrounding future prices and consumer behavior, yet the exercise is important if the energy industry is to plan investments in new energy facilities. Not only is information about the total demand needed,

FIGURE 2

ENERGY PRICES TO RHODE ISLAND CONSUMERS, 1971 AND 1976



From: Bentley, 1978; Electric Council of New England, 1976; Institute of Gas Technology, 1975; R.I. Fuel Allocation Office.

but the share which each type of fuel and electricity will have of that market must also be known. Table 4 presents some historical data and representative projections of New England energy demand. The range of variation increases along with the year for which forecast applies. In 1976, total New England energy consumption was 3.0 quadrillion BTUs. Two forecasts issued in 1975 show a range of 3.2 to 3.8 quadrillion BTUs (quads) for 1980 total demand. The year 1985 is in even more dispute, with projections that vary between 2.9 and 3.8 quadrillion BTUs. The year 1990 is more uncertain yet, with projections of between 4.0 and 5.5 quads.

There are several reasons for such variability in projections of future energy use. The rate of growth in energy use depends upon population change, economic activity, consumer response to prices, and conservation programs. The potential success of energy-saving efforts is not easy to predict. Consumers could merely switch from one type of fuel to another, resulting in actual growth in the use of total energy if electricity is the substitute. On the other hand, there could be strong action to reduce needs and adopt unconventional alternates such as wood, solar energy and wind power. As a result, most reports now use "scenarios" to describe what will happen if no special efforts are taken to reduce demand and then estimate the energy demand reduction possible with a combination of government incentives and consumer awareness. It may appear puzzling that some projections show an actual decline in overall energy consumption from the present. However, many people believe that so much energy is wasted now that efforts to conserve, combined with use of native resources, can avoid the need for any increase in fuel supply or energy facility siting.

RHODE ISLAND ENERGY SUPPLY PATTERNS AND TRENDS

The Distribution Network

Major changes in the consumption of energy have occurred within a regional and local energy marketplace composed of buyers and sellers who have much to gain or lose by the flow of energy supplies and government decisions. The problem for the consumer and citizen is that Rhode Island is served by an energy supply system which ignores state boundaries and sometimes eludes public scrutiny. Transportation methods, geography and business practices have determined how various forms of energy are provided to the state. This has made the role of public officials in planning and regulation difficult, since the companies who sell much of the energy we buy are based in adjacent Massachusetts and subject to federal regulations which are not necessarily responsive to local concerns. For example, only fractions of electricity and gas prices are under the jurisdiction of the Rhode Island Public Utilities Commission. In addition, the state has had little control over the direction of federal policy on import controls and petroleum product pricing, both of which have shifted considerably in the past several years.

Supply Activities

All of Rhode Island's energy is from fuels which are ultimately imported from outside New England, with the exception of a small amount of electricity from hydropower and wood. Figure 3 shows how energy is supplied to

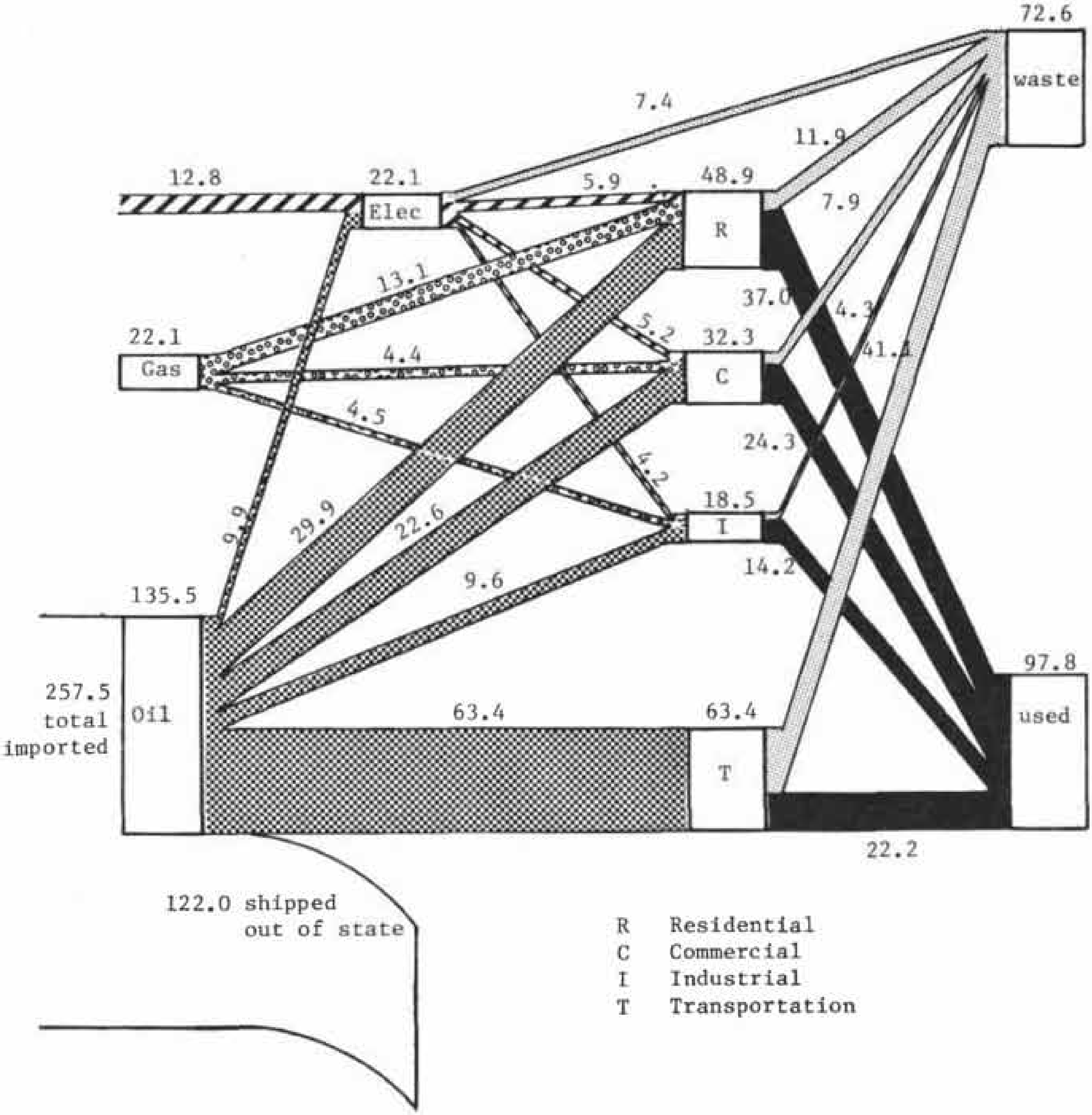
TABLE 4

PAST AND FUTURE ENERGY DEMAND IN NEW ENGLAND, Quadrillions of (10^{15}) BTUs

Source	1962	1963	1970	1975	1976	1980	1985	1990
			Actual				Projected	
AD Little, 1975	2.0	2.1						
DOE, 1975							3.4	
Chan, et al, 1975			2.6			3.8		5.5
New England Energy Congress, 1979				2.7			3.2-3.8	
Bentley, 1978					3.0			
AD Little, 1975						3.2		4.0-4.7
Project Independence 1976							2.9-3.4	

FIGURE 3

FLOW OF ENERGY TO RHODE ISLAND CONSUMERS 1975
trillions of BTUs



From: New England Federal Regional Council, 1977; Army Corps of Engineers, 1975.

the state. The left side of the figure illustrates the amount of energy actually passing through the state. Much of the petroleum landed in Rhode Island has final destinations in Massachusetts and Connecticut. On the other hand, electricity is provided to the state primarily by large out-of-state power plants which feed into the regional power grid. The right side of the figure shows estimates of how much energy is lost due to inefficiencies in fuel conversion. In 1975, this loss amounted to about 50 percent of the gross energy input into Rhode Island. Much of this is unavoidable, because of existing technology and consumption habits. However, it does point out the importance of viewing conservation efforts as a means of creating "new" energy supplies.

Petroleum Products

Gasoline, home heating oil, Liquefied Petroleum Gas (LPG) and heavy fuel oil provide Rhode Island with three-fourths of the energy it uses annually. Oil dominates every consuming sector. Most of this is derived ultimately from foreign production, either as direct product imports or foreign crude refined domestically. The bulk of petroluem products enter Rhode Island by barge or tanker. Forty-three percent of total annual inflow is piped or trucked to retailers and consumers outside the state.

Adequate storage of petroleum products in a region is essential in order to provide a buffer between the irregularities and disruptions of bulk deliveries from refiners and the variations in consumer demand. Rhode Island-based suppliers and Navy storage tanks have a total capability of more than 700 million gallons. The quantity of fuel flowing through the port facilities was about two billion gallons in 1976, which is three times the volume of in-state storage capability.

A gallon of fuel follows a number of routes before reaching the consumer. In general, large regional suppliers receive bulk shipments from refineries, which are unloaded at a marine terminal and stored in large tanks. Tanks may be owned by one of the major oil companies or a regional firm. A distributor, or jobber, transports tanker truck loads to retailers or directly to large consumers. The supply operation varies according to the fuel.

Gasoline is advertised and sold by brand name, which places it in a unique position relative to any other form of energy. Much of the production, refining, and retail sales is vertically integrated. That is, a single company such as Exxon or Mobil produces the crude oil, refines it and then sells it to individual consumers. There are also a number of retail chains which purchase their gasoline from a major supplier but market it under a house name. The result is that 18 suppliers serve about three dozen different distributors as well as hundreds of retail gasoline stations. The small storage capacity of vehicles and retailers, compared to the large volume of consumption makes gasoline distribution the most complex and active fuel distribution system.

Sales of No. 2 fuel oil to homes and businesses, on the other hand, depends on competition only among local heating oil dealers. Price and service in the local market are more important factors than that of brand name. The dealers are supplied by jobbers who transport the oil from marine terminals in the Port of Providence and other small ports. Large commercial, industrial and utility consumers with large on-site storage capacity purchase oil directly from the supplier. Since fuel oil is not taxed, information on the pattern of distribution is not readily available. No. 6 oil is a more specialized fuel, used in large boilers for power generation, space heating of large buildings, or process steam production. Users of this heavy oil purchase it directly from the supplier, or receive tanker deliveries directly, and generally have considerable on-site storage which reduces the need for frequent shipments.

Liquefied petroleum gas, consisting principally of propane, is a petroleum-refining byproduct used in homes and businesses in those areas not served by natural gas pipelines. Distribution practices are similar to those for home heating oil. Suppliers in the region store large quantities of LPG, which is then delivered by pressurized tank truck to retailers, who compete for business in a local market. Small users purchase LPG by the cylinder, while large consumers, such as owners of gas-heated homes, stores and apartment buildings, receive bulk deliveries from pressurized tank trucks. Most propane is imported.

Shortages of petroleum products may occur at several points in this complicated distribution process. Oil companies sometimes place limits on retailers because of production problems or for business reasons (the shortage of a particular grade of fuel, for instance, or the temporary closings of a station). Disruption of crude oil supply, refinery operation difficulties, or surges in demand can affect an entire region, leading to price increases and long lines at service stations.

Natural Gas

Gas is provided to Rhode Island from two gas transmission companies: Tenneco Gas, in the northern part of the state; and Algonquin Gas, which supplies the Providence area and East Bay communities. Until recently, each local company operated many massive floating storage tanks that controlled pressure and provided, in distribution lines, a temporary buffer against sudden surges in demand. Gas service was limited to areas which were connected to the main transmission and distribution pipeline system. In the 1970s, new refrigeration technology, known as cryogenics, has led to two developments. First, natural gas is now imported in a liquefied form, stored in large insulated tanks, and either regassified at the marine terminal or trucked in insulated tankers to local facilities. Demand surges, particularly during the winter months, are handled by using LNG as a supplement to pipeline gas. In some areas, surplus summer gas is liquefied and stored until winter. Secondly, satellite storage tanks provide natural gas to consumers in areas without the need to build pipelines to the major transmission line.

Currently, LNG storage capacity in the state is equal to about 8 percent of Rhode Island's annual gas consumption. Plans to install a second LNG tank on the Providence waterfront, and a proposal to turn the southern tip of Prudence Island into a marine receiving terminal, are not expected to be implemented in the near future due to considerable controversy regarding the proposed sites and questions about the need for the new projects.

Electricity

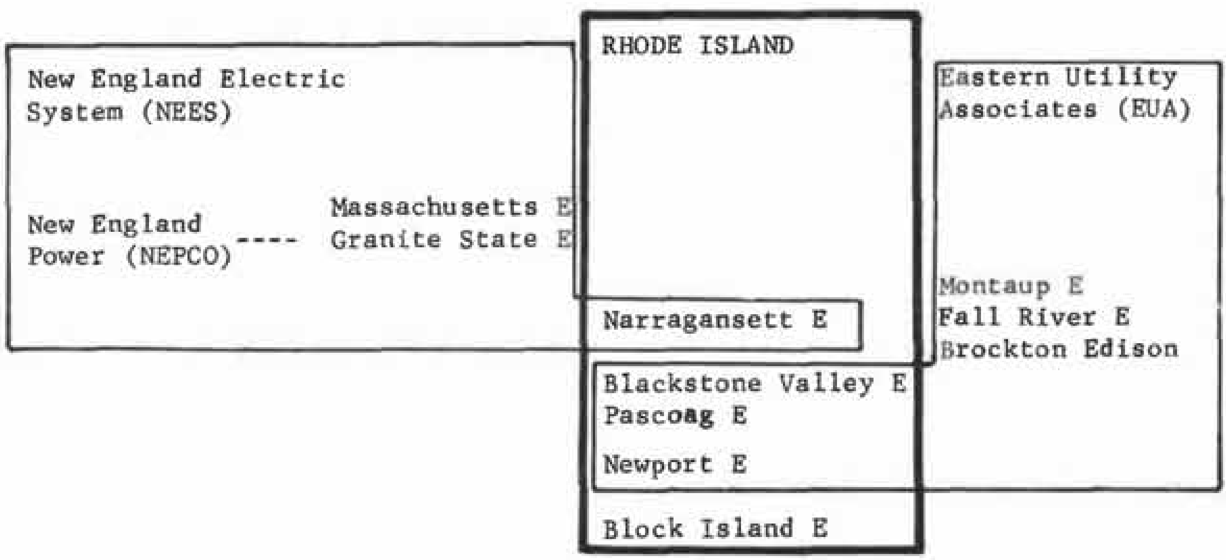
Rhode Island is a small part of the New England power grid, accounting for 7 percent of the region's consumption of electricity. The supply of electricity to the state is provided by investor-owned companies with exclusive franchises over their service areas, which contrasts with the competitive situation in the petroleum marketplace. In return for a franchise in a particular area, the utility is obligated to maintain a reliable service at rates which are controlled in part by the state. Reliability of service is accomplished by the utility in two ways. First, sufficient generating capacity must be operational to meet the instantaneous demand for electricity, with sufficient reserve capacity in the event of a problem with a generating unit or temporary surge in demand. Second, the network of transmission lines must be adequate to deliver the power demanded, and set up in such a manner that alternate routes exist for transmitting the output of a power plant to major demand centers even in the case of breakdown on any one line.

Although each state has a number of power-generating facilities within its borders, the siting of new power stations by utilities is not made on the basis of state lines. The proximity of power plants to consumers and the availability of sites within a multistate service area are the principal criteria. Each utility is responsible first to the consumers in its service area and then to the regional reserve capacity obligation it carries as a member of the New England power pool. The service area for the New England Electric system extends from New Hampshire through Massachusetts to Rhode Island. Eastern Utility Associates provides electricity to southeastern Massachusetts and eastern Rhode Island.

The northeast blackout of 1965 caused a major shift by the New England electric utilities toward a centrally planned and operated power transmission system, the New England Power Exchange, and regional planning in power station construction programs. Electricity transmission is controlled by computerized master and satellite facilities, which instantly match the output of power plants in the region with the load level of an area. Rhode Island receives its electricity in large part from baseload power stations operated by the two major utilities serving the state: the New England Electric System and Eastern Utility Associates (see Figure 4). No continuously operated, or baseload, plant is located within state borders, except for a small unit on Block Island. A number of intermediate and peak load units, such as the stations in Providence, are brought into service during seasonal or daily periods of high demand.

FIGURE 4

DELIVERY OF ELECTRICITY TO RHODE ISLAND



From: Resource Planning Associates, 1976

New Energy Facilities

The uncertainty about future energy demand and fuel mix greatly complicates the task of energy industry planning for new facilities. In the past decade, it would appear that at least one of every kind of major energy facility has been proposed for some site in the state. Liquefied Natural Gas marine terminals and storage facilities have been proposed for siting in Providence and on Prudence Island. One tank has been built on the Providence waterfront. The southern part of Prudence Island has also been studied as a site for a major oil storage depot. Oil refineries have been suggested in several coastal locations. Proposed sites for the construction of a nuclear power station have included Rome Point in North Kingstown, surplus Navy land in Charlestown, and a site in Westerly. A service base to transfer supplies to the offshore oil industry was proposed and is currently operating on surplus Navy property at Quonset-Davisville. Other operations such as constructing production platforms have been suggested for that location. Gas pipelines and processing plants serving possible offshore production on Georges Bank are considered a future possibility in the state, along with a strategic petroleum reserve.

At present, few of these many proposals have been implemented. Many of them were not designed to serve Rhode Island but the entire New England region. The regional energy picture has changed sufficiently to affect the financial success of some of these ventures. In other cases, local objections to the proposed site or federal disapproval of the project has played a role. For those that are pending or will be proposed in the future, new state policies are in place which require greater scrutiny of issues such as need for the project, impacts and reasonable alternatives to a facility or site. This cautious approach to the near-term future of energy demand and supply is warranted by the major change in direction that fuel demand has taken in recent years, and the recognition that our ability to foresee events in the next few years is in considerable doubt.

III.

GLOBAL INFLUENCES ON THE RHODE ISLAND SITUATION

INTRODUCTION

The regional energy distribution system of which Rhode Island is a small part is profoundly affected by the behavior of the global energy marketplace. The source of the fuels we use lies in other regions of the United States and in other parts of the world. Current world energy and political problems are the backdrop against which Rhode Island must identify goals and develop its own approach toward energy use, native energy resource development and energy facility siting. Two basic forces are operating at the global level. Unsatisfied demand for energy means that competition for available production is stiff and price increases inevitable. Continuing depletion of energy supplies means that popular fuels will become more scarce, which is another cause for steady price increases. The United States has already passed its peak oil and gas production levels. Global production could peak by the end of the century; if this happens, we can expect that a great deal of the world's energy demand will not be met. Non-renewable energy and fuels can no longer be relied upon to meet all the energy needs of the United States.

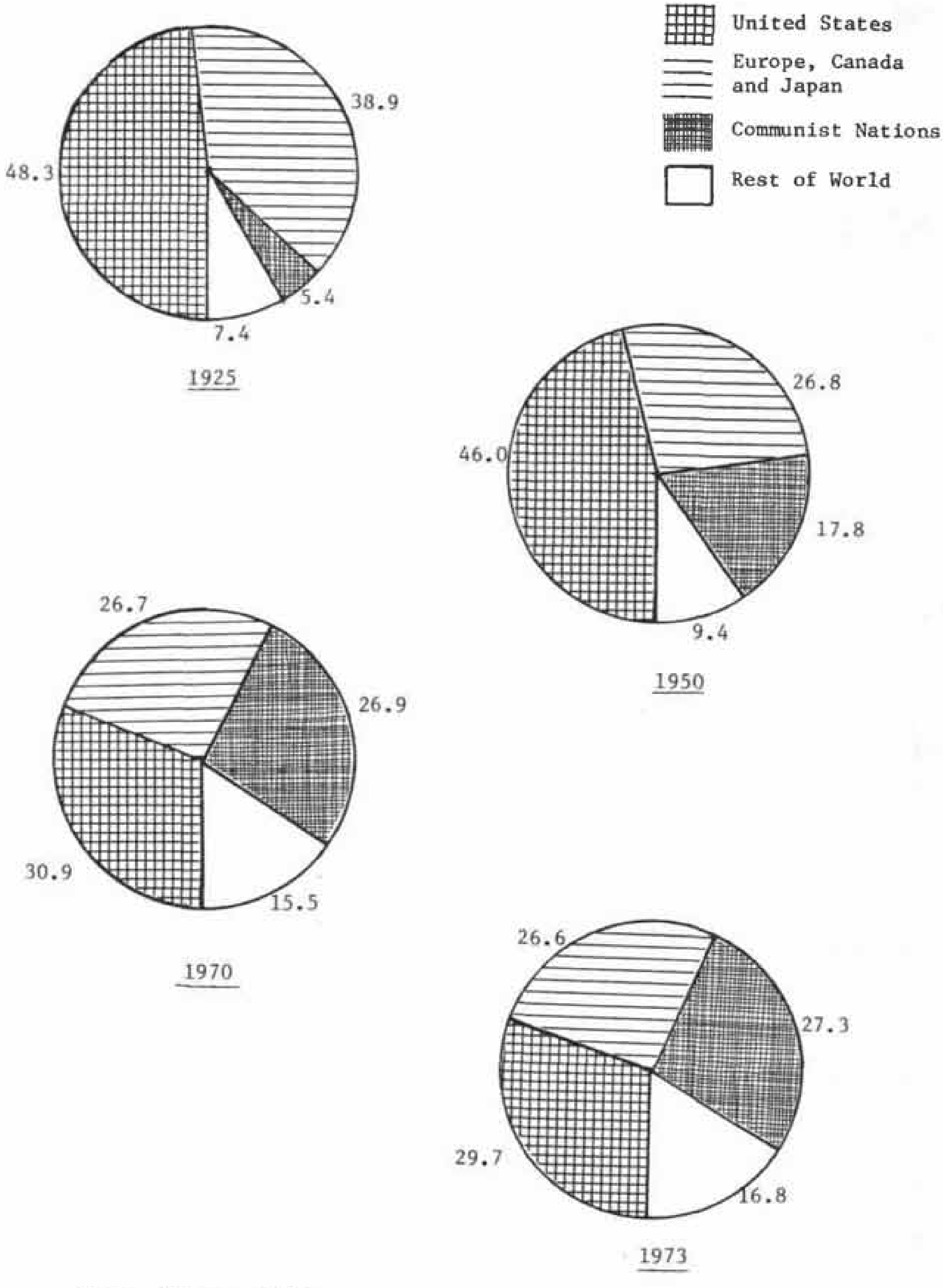
NATIONAL AND WORLD ENERGY DEMAND

Petroleum imports, energy prices, trade deficits and energy consumption have all continued to rise as the value of the dollar has dropped. The United States' position in the world energy market has diminished considerably in the past two decades, as Figure 5 illustrates. As the United States began to demand more energy in the 1940s than its own readily developed energy resources could provide, oil companies became involved in developing the resources of other countries, who at the time had little use for their petroleum resources. In 1950, the United States consumed nearly half of the world's energy production. By 1973 the United States was consuming less than one-third of total world energy demand, which had risen from the equivalent of 41 million barrels of oil per day to 125 million barrels. The United States' consumption is still twice as high as the Soviet Union's, the next largest consumer nation.

The world situation has changed dramatically since the 1950s. Oil has become an essential energy source for both industrialized and developing nations. Industrialized nations depend on petroleum in large quantities to maintain existing populations at current levels of prosperity, and developing nations need petroleum to stimulate economic growth. Oil-producing nations have taken control of their petroleum resources and operate a highly successful price-fixing cartel, the Organization of Petroleum Exporting Countries (OPEC). The growing competition for energy enables OPEC

FIGURE 5

CHANGING ROLE OF U.S. IN WORLD ENERGY MARKETPLACE
(percentage share)



From: Wilson, 1977.

producers to raise prices without suffering a decline in sales. When world oil production reaches a plateau, which may be attained as early as the late 1980s, the resource will be even more precious. This predicament has arisen because of rapid world population growth, pressures for economic development, and a worldwide transition to the fuels advanced nations have used to reach high levels of prosperity. Each of these factors will play an important role in determining how much energy will be available to United States' consumers in the decades ahead.

Population Growth

Energy use has paralleled the tremendous increase in population in this century (Figure 6). World population has more than doubled since 1900, and is increasing at a rate comparable to the creation of a nation the size of the United States every two years. Projections indicate that world population will increase by half again, to 6.2 billion people by 2000. Every new person will be an energy consumer, and will desire a standard of living better than the preceeding generation. This will inevitably require that more energy become available every year.

Economic Development

If energy use was related to population growth only, we would expect current demand to be only twice as high as the levels of 1900. In fact, there has been an elevenfold increase in energy use worldwide. The key factor is that in industrialized nations and in many developing nations per capita energy use has risen substantially as prosperity has increased. Population growth worldwide has been 1.75 percent annually, while energy demand has risen at an annual rate of 3.5 percent. In the United States, energy consumption per person has doubled since the beginning of the century. As Figure 7 indicates, there is a relationship between economic well-being and high levels of energy use. It is to be expected that the People's Republic of China, which used only 6 percent as much energy per capita as the United States in 1975, is deeply interested in modern energy resource development technology and will want to expand its use of oil. At the same time, however, considerable variation in energy use levels exists among mature economies.

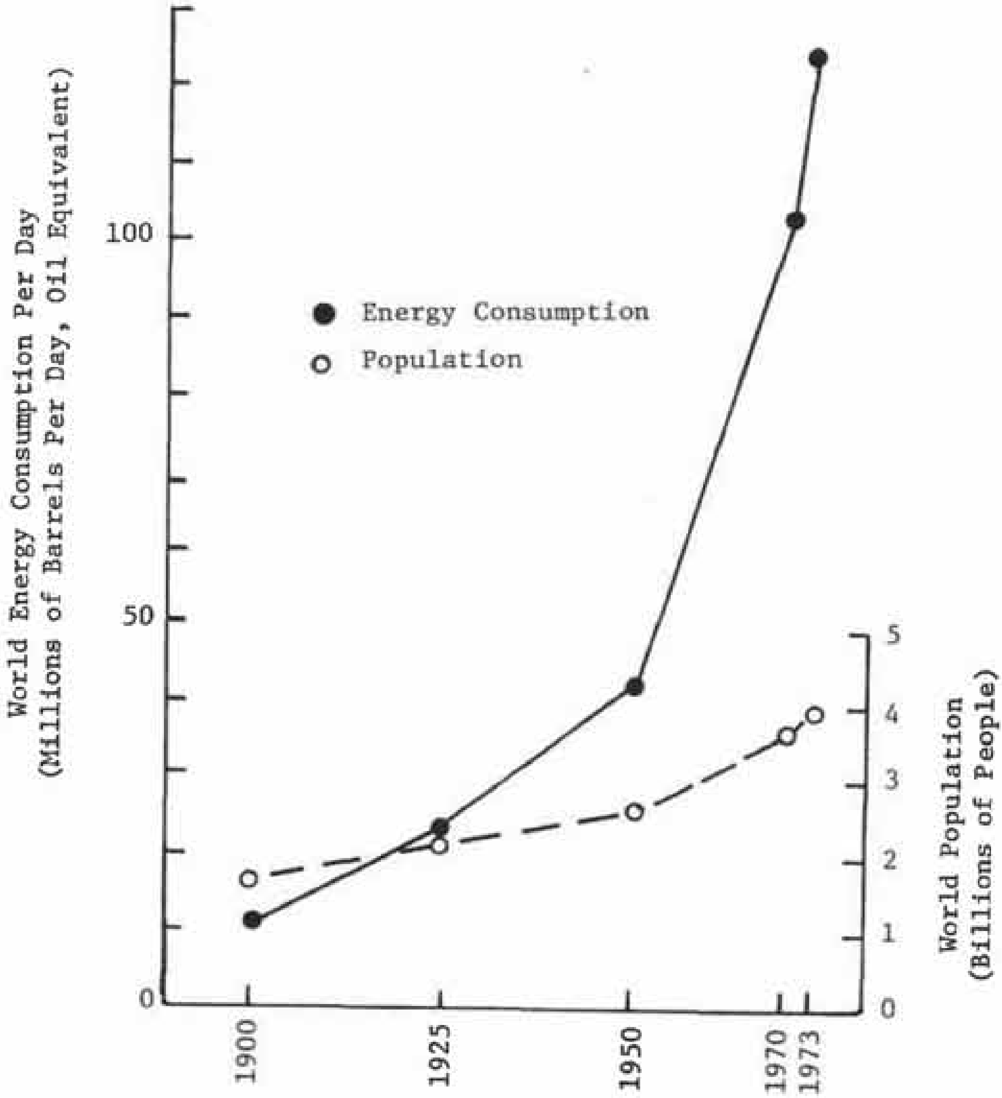
While developing nations strive to achieve the energy use patterns of industrialized nations, the developed world is actively engaged in seeking alternatives to the importation of fuels for which world demand and prices have become unbearably high. Increased efficiency in energy is critical in this effort. Some countries, not including the United States, have achieved considerable success in using energy efficiently, as illustrated by the wide variation in per capita energy consumption among prosperous Western nations shown in Figure 8.

Change In Fuels

Leaders of less developed nations are not interested in undergoing a development process that requires centuries to complete as was true for Europe and the United States. The transition many are seeking is planned in decades, not hundreds of years. The result is the creation of a vast new

FIGURE 6

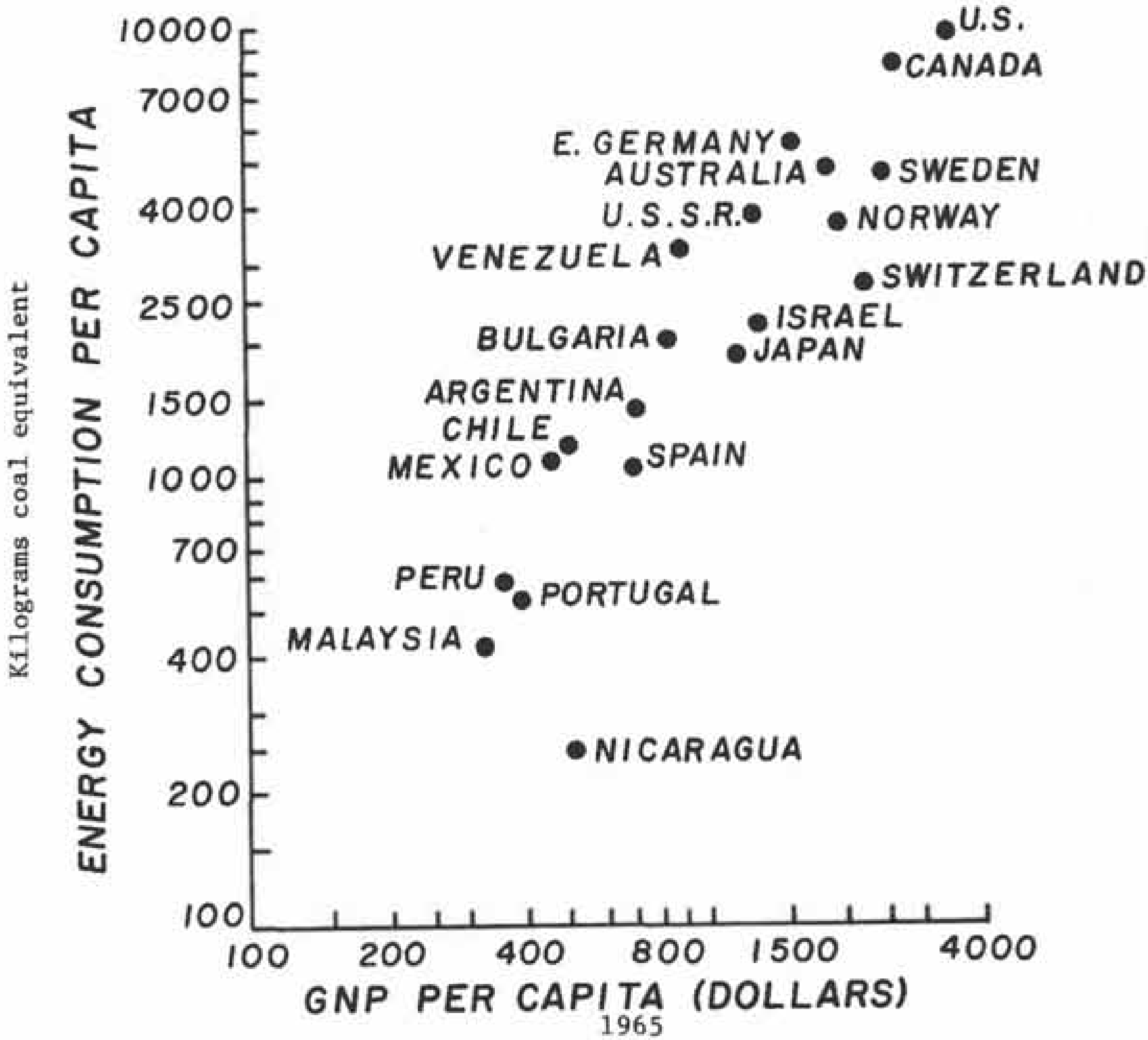
WORLD POPULATION AND ENERGY DEMAND GROWTH IN THE 20TH CENTURY



From: Perry and Landsberg, 1977.

FIGURE 7

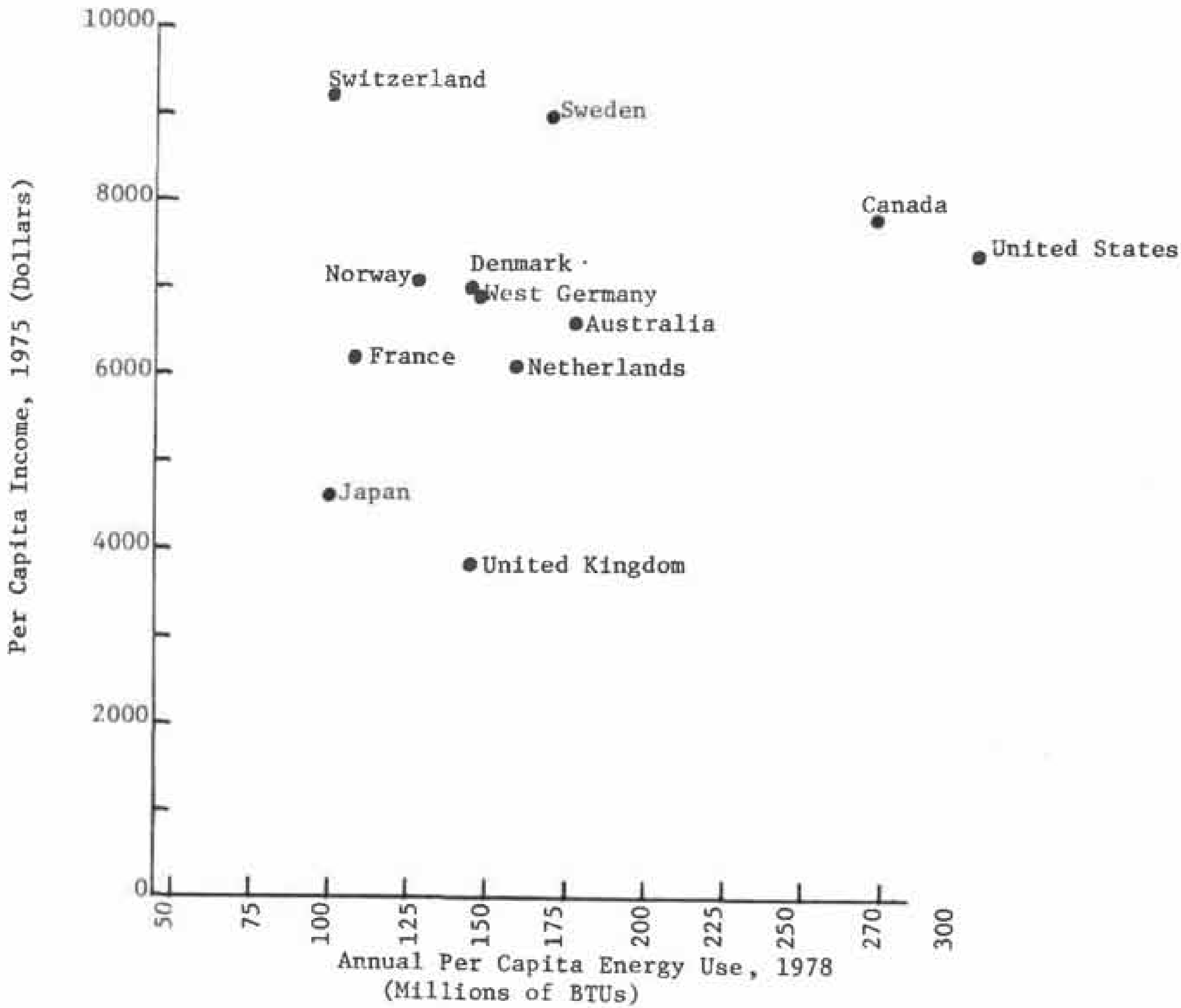
ENERGY USE AND NATIONAL ECONOMIC PROSPERITY



From: Perry and Landsberg, 1977.

FIGURE 8

VARIATIONS IN ENERGY USE AND INCOME AMONG PROSPEROUS WESTERN NATIONS



From: U.S. Department of Commerce, 1978.

market for energy products as people shift from producing energy from firewood and muscle to reliance on petroleum and electricity. Ironically, at the same time that Americans are looking to solar energy and other biological sources for heat, other nations are seeking to abandon them. The Japanese, for example, commonly used hot water heating methods that employed simple but effective solar devices. As part of modernization, however, they are converting to oil-fired or electrically powered hot water systems.

Impacts Of World Demand

These global changes have important effects on international relations and the functioning of the energy market. The first effect is to greatly increase energy demand and raise the price nations are willing to pay for oil. In addition, programs to build an industrial base that includes the importation of technical assistance, equipment and new types of energy create both internal and international tensions. In some cases, the expectations of a developing nation increase faster than progress toward goals can be made, leading to domestic unrest and demands by developing countries for more assistance from the developed world. On the other hand, some prospering nations face political instability as a result of resistance to pressures for continuing modernization. For example, the recent revolution in oil-producing Iran placed its supply policies toward the United States in doubt. Other nations are restricting exports as their own economies grow, and increase their energy requirements.

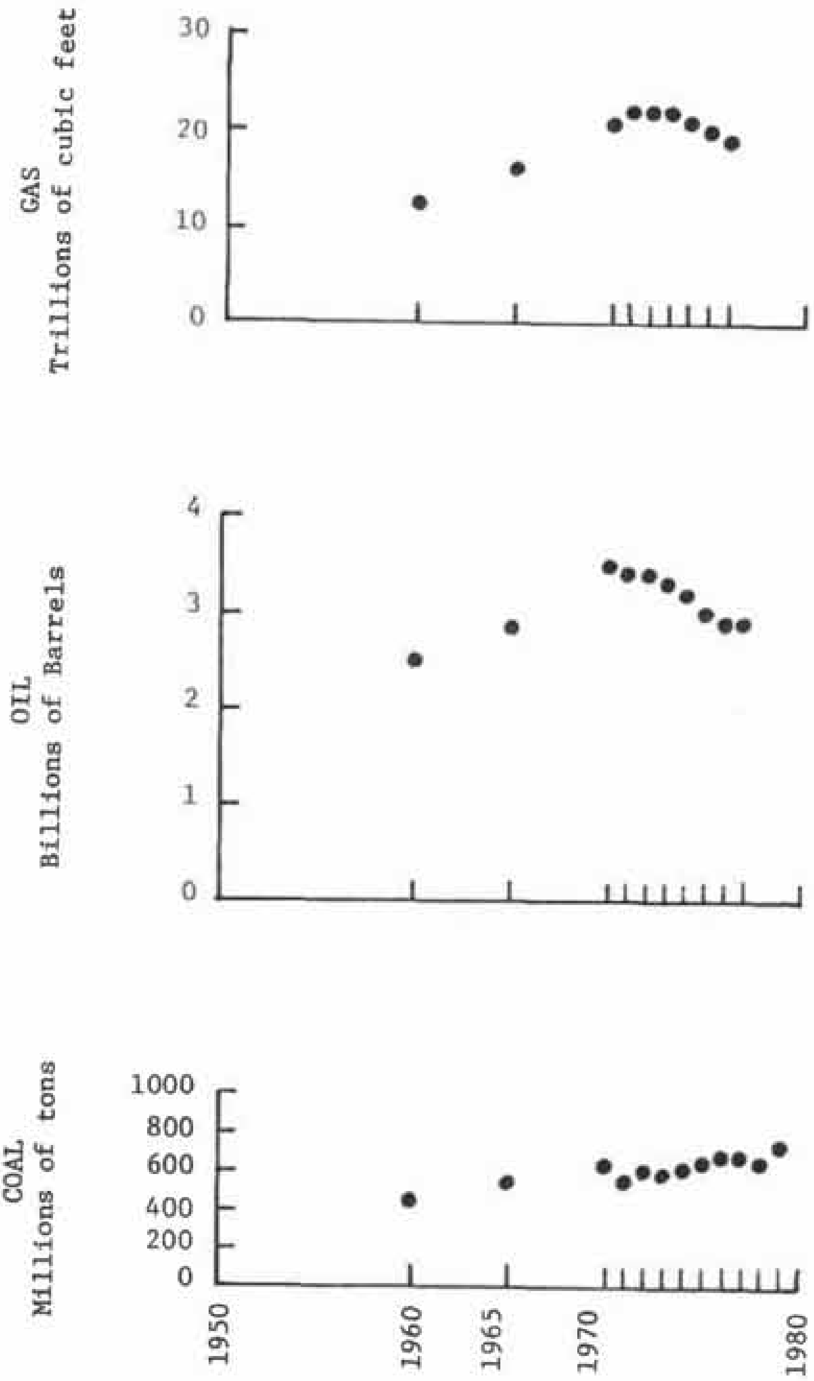
WORLD ENERGY SUPPLY PATTERNS

As the world's largest energy consumer, the United States is inextricably bound to the world energy supply situation. In adopting an economy and life style which operates on petroleum and natural gas, the nation chose a course which led it to depend on imported energy for more than 40 percent of its needs, despite vast domestic reserves of coal. The result of past choices is shown in Figure 9. Both domestic oil and gas production have declined steadily since the early 1970s, despite the growing demand and rising prices of energy worldwide. Coal production, on the other hand, was the same in 1950 and 1971. Since the 1973 oil embargo, the coal industry has broken production records, despite the long coal strike in 1977 and skepticism about industry capabilities. Yet the problem of lagging coal demand continues. In the same month that OPEC announced a 14.5 percent increase in crude oil prices, the Tennessee Valley Authority, the nation's largest coal consumer, reported a glut of coal on the open market. Unwillingness to use domestic resources has sent us into the world oil marketplace. The result is shown in Figure 10. Imports of oil have doubled since 1970, while payments for imports have increased eighteenfold.

Coal is the most plentiful global mineral energy resource, distributed principally in the Northern Hemisphere, where most industrialization has occurred (Table 5). Measured reserves in 1975 were about 1327 billion metric tons, the equivalent of 6,405 billion barrels of oil. Proved reserves of oil in 1975 were 712 billion barrels, only one-tenth of global

FIGURE 9

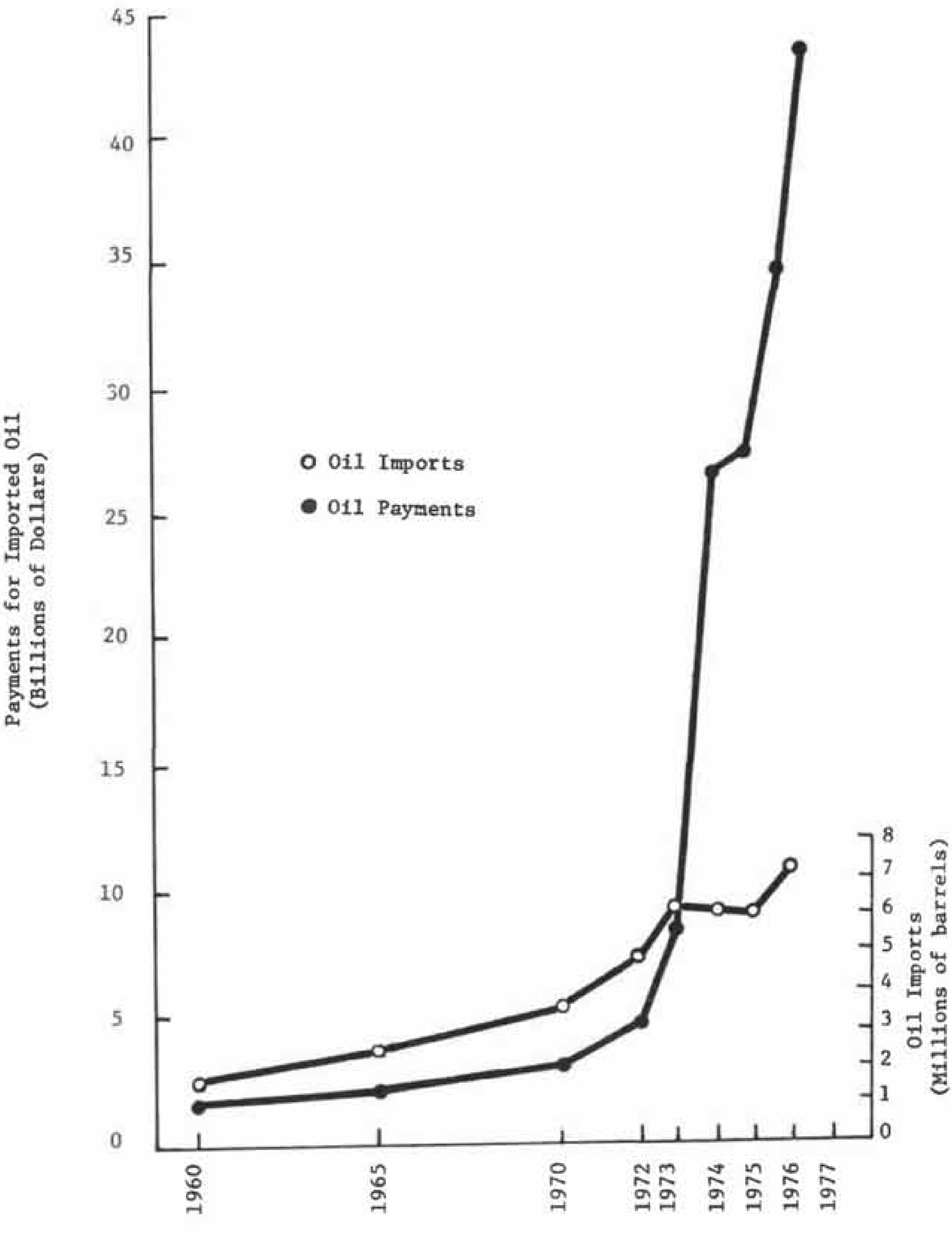
ENERGY PRODUCTION IN THE U.S.



From: U.S. Department of Commerce, 1978.

FIGURE 10

QUANTITY AND COST OF U.S. OIL IMPORTS



From: Energy Users Report, Reference File, Section 81, p. 259.

TABLE 5

WORLD COAL RESERVES AND CONSUMPTION

	Measured Reserves, 1975		Coal Consumption, 1975	
	Billions of Metric Tons			
U.S.	396.	29.8	.58	21.3
Canada	13.	.9	.03	1.3
OECD Europe	225.	170	.39	16.6
Japan	3.	.2	.09	3.8
Rest of non-communist world	140.	10.6	.24	10.2
Communist countries	550.	41.5	1.10	46.8
	1327	100.0	2.35	100.0

From: Wilson, 1977; U.S. Department of Commerce, 1977.

coal equivalent (Table 6). The Middle East controls two-thirds of this oil, along with one-third of natural gas supplies (Table 7). In 1975, the United States consumed nearly one-third of the annual oil production and nearly one-half of all the annual production of natural gas.

The world energy marketplace is composed of business organizations which are capable of handling large projects and complex transactions between producing nations and American consumers. The advanced technology and management skills provided by United States-based multinational companies are used worldwide to explore, produce and transport both petroleum and liquefied natural gas. Of the twenty largest industrial corporations in the United States, ten are principally involved in developing, processing and selling petroleum and gas products. Statistics on the performance of these firms are provided in Table 8. Every aspect of United States' energy supply occurs on a scale where enormous corporations are involved in development and processing of raw fuels, technology development, transportation, wholesale and retail sales, and in the formation of public policy. Many of these are multinational companies who are not under the complete control of any single country. In fact, the 1970s have witnessed the emergence of the "energy company," a corporation with major holdings in coal, petroleum, gas and uranium. Total sales of the ten biggest energy companies exceeded $220 billion in 1978. These firms, which include most major oil companies, exert considerable influence over the price and availability of energy as well as government policy on energy issues.

The success of the oil industry in accumulating profits during the early part of this century made possible the rapid development of petroleum resources throughout the country as profits were reinvested into new production. United States-based multinational oil companies have been involved in developing the world's oil resources through licenses granted by the host government in exchange for the privilege of producing and selling the oil. These costs are passed on to consumers in the price of the product.

The role of the energy companies in the world marketplace will be important for a long time to come if the United States continues to demand vast quantities of oil and gas, and massive investments will be required to exploit harder-to-get petroleum resources. The industry has proven its effectiveness in carrying out this task when consumers were willing to pay the price.

The cost of energy in the future will inevitably increase as companies pursue deposits of petroleum and other fuels which are more difficult to extract than is oil from the Persian Gulf. The extraction costs of some of these new sources are shown in Figure 11. Capital costs refer to the size of investment in facilities needed to produce a barrel of oil or its equivalent from the source. The technical costs represent the component of the fuel price attributed solely to the cost of extracting it, not including royalties, rents or profits. Currently, Persian Gulf crude oil requires very little investment in production facilities, which has a corresponding low effect on the cost of a barrel of oil. The wholesale price of Middle Eastern oil con-

TABLE 6

WORLD OIL RESERVES AND CONSUMPTION

	Estimated Proved Oil Reserves, Jan. 1975		Oil Consumption, 1975	
	billions of barrels (42 gallons)			
U.S.	34.2	4.8	5.9	29.1
Remainder of Western Hemisphere	47.8	6.7	1.9	9.4
Middle East	403.9	56.8	.5	2.5
Africa	68.3	9.6	.4	2.0
Asia	21.0	2.9	2.9	14.2
Western Europe	25.8	3.6	4.9	24.1
Communist Nations	111.4	15.6	3.8	18.7
World Total	712.4	100.0	20.3	100.0

From: American Petroleum Institute, 1977.

TABLE 7

WORLD GAS RESERVES AND CONSUMPTION

	Estimated Proved Gas Reserves, Jan. 1975		Gas Consumption, 1975	
	Trillions of Cubic Ft.			
U.S.	228.2	10.2	20.0	42.6
Remainder of Western Hemisphere	147.5	6.6	5.1	10.8
Middle East	538.6	23.9	2.1	4.5
Africa	207.2	9.2	.5	1.1
Asia	111.6	5.0	.8	1.7
Western Europe	180.8	8.0	6.0	12.8
Communist Nations	835.0	37.1	12.5	26.6
World Total	2248.9	100.0	47.0	100.0

From: American Petroleum Institute, 1977.

TABLE 8

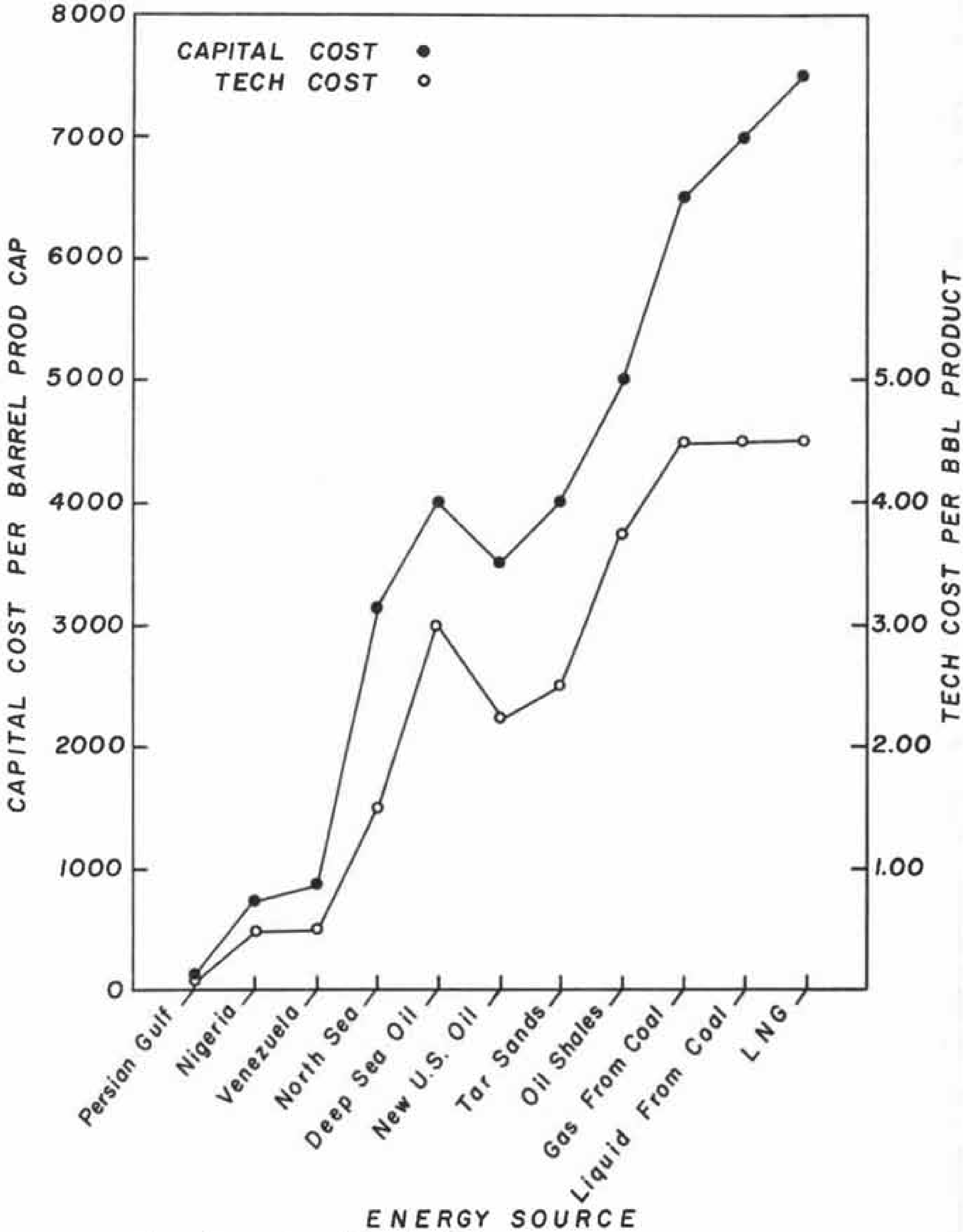
CHARACTERISTICS OF THE TEN LARGEST ENERGY COMPANIES IN 1978

Rank 1978	Company	Sales ($000)	Assets ($000)	Assets Rank	Net Income ($000)	Net Income Rank	Employees Number	Employees Rank
2	Exxon	60,334,527	41,530,804	1	2,763,000	3	130,00	14
4	Mobil	34,736,045	22,611,479	3	1,125,638	6	207,700	6
5	Texaco	28,607,521	20,249,143	6	852,461	10	67,841	43
6	Standard Oil of California	23,232,413	16,761,021	7	1,105,881	7	37,575	114
9	Gulf Oil	18,069,000	15,036,000	9	791,000	13	58,300	57
12	Standard Oil	14,961,489	14,109,264	10	1,076,412	8	47,011	81
13	Atlantic Richfield	12,298,403	12,060,210	12	804,325	12	50,716	71
14	Shell Oil	11,062,883	10,453,358	14	813,623	11	34,974	128
18	Continental Oil	9,455,241	7,445,165	20	451,340	24	42,780	97
19	Tenneco	8,762,000	10,134,000	15	466,000	23	104,000	22

From: Fortune, May 7, 1979.

FIGURE 11

COST OF DEVELOPING VARIOUS ENERGY RESOURCES



From: Mesarovic and Pestel, 1974.

sists almost entirely of profit to the producing nations. This is not the case for North Sea oil and new United States' oil, which is far more expensive to obtain and puts a bigger dent into the profits that oil producers and host nations will make after refining and transportation costs are added. Anticipated sources of liquid and gaseous hydrocarbon fuels, such as oil-bearing shale, and of gas liquids derived from coal are expected to cost twice as much to produce as new United States' oil.

A concrete example of the cause of higher energy prices is the oil industry's interest in potential oil and gas off the Atlantic Coast. An average offshore well costs more than six times as much to drill as an onshore well.

In 1975, it cost an average of $892,000 to drill an oil well, and $1,246,000 to drill a gas well offshore. The total number of wells drilled onshore and offshore increased by 40 percent, from 26,244 in 1974 to 36,960 in 1975. The cost of exploratory drilling doubled in the same period, from $3.0 billion to $6.5 billion. Rhode Island officials hope to expand the offshore oil service activities which have been taking place at Davisville piers so that the state can obtain some of the economic benefits of possible offshore drilling and energy production on Georges Bank area off southeastern New England. Rhode Island consumers would ultimately pay their full share of the costs of obtaining new oil and gas supplies offshore.

IV.

FEDERAL GOVERNMENT POLICY AND REGULATION

INTRODUCTION

Energy use and supply are priority concerns in the federal government's foreign and domestic policy. The economic well-being of the nation depends on an adequate and steady supply of various forms of energy, particularly petroleum, at a price that is fair to suppliers and that consumers can afford. There is a great deal of government intervention in the domestic marketplace in order to maintain the equitable and efficient operation of the energy supply system. In a period when much of our fuel comes from a cartel of producer nations, our national security hinges upon good relationships with oil exporters, political stability in the Middle East, and free shipping lanes in the Persian Gulf. United States involvement in the events of the Middle East have become unavoidable to assure a supply of crude oil. Some analysts carry this concern even further, arguing that "future threats to the security of the nations are more likely to come from failure of ecology and economic systems (including energy) than from military power" (Brown, 1978). Domestic involvement by the federal government includes controlling prices, energy research and technology, development, environmental protection and energy conservation.

THE GEOPOLITICS OF ENERGY

Until the 1950s, energy was not a national security issue, since the nation was large self-sufficient. A voluntary import quota was initiated in 1955, presumably for the purpose of limiting our vulnerability to disruptions in the supply of petroleum. In fact, imported oil was considerably cheaper in the 1950s and 1960s than domestic crude, and came from friendly nations. The mandatory import control program begun in 1959 was a means of protecting and subsidizing domestic oil producers.

During the same period, petroleum-exporting countries were losing revenue from oil sales because they were forced to slash prices to move oil production surpluses. The Organization of Petroleum Exporting Countries formed in 1960 to provide some stability to the fledgling global energy marketplace. But even with the price stability program and rising royalties to producer nations, oil imports continued to be plentiful in supply and cheap relative to domestic crude. The import quota system prevented New England from receiving the full benefits of this cheap oil during the 1960s and early 1970s because it forced East Coast refiners to buy domestic crude at prices that were \$1.50 higher per barrel than imports. Domestic production lagged even at higher prices, sending refiners to the international marketplace.

In the late 1960s, refiners began processing Middle East crude in their efforts to keep up with domestic demand, and the federal quotas were raised by 20 percent per year in the early 1970s, and eliminated entirely in 1973. At the same time, however, the OPEC cartel was increasing in strength. No effort had been made to favor imports from nations that concurred with United States' foreign policy. In 1971, the cartel successfully coerced oil companies to pay much higher taxes on the oil they produced in member nations. By 1974, the cartel had quadrupled its oil prices and established itself as the body which in effect determines the world price of oil. The tremendous flow of cash to oil producers lead to pressure on the United States by other oil-importing nations to develop a stronger domestic energy policy. As poorer nations such as Mexico become important petroleum exporters, American policy will have to change to accommodate the greater stature which these countries will attain.

INTERVENTION IN THE DOMESTIC MARKETPLACE

Domestic energy policy is more difficult to characterize than the international energy situation, despite the fact that the government has considerable power to control it. Since 1973 three Administrations and three Congresses have made attempts to develop a coherent approach to the production, pricing and use of energy. These efforts have been based largely on national security concerns about disruptions to the import of petroleum. The Nixon Administration began the search for a comprehensive energy policy with Project Independence. It was based on the reasoning that:

> Rather than reducing imports per se, our objective should be to reduce our vulnerability to disruptions of imports for this reason, "independence" is better than "self-sufficiency" as a description of our objective (Federal Energy Administration, 1974).

The National Energy Plan put forth by the Carter Administration echoes the phrasing of Project Independence. It seeks:

> as an immediate objective that will become even more important in the future, to reduce dependence on foreign oil and vulnerability to supply interruptions;
> in the medium term, to keep U.S. imports sufficiently low to weather the period when world oil production approaches its capacity limitation; and
> in the long term, to have renewable and essentially inexhaustible sources of energy for sustained economic growth (Executive Office of the President, 1978).

According to the Plan, several principles must be followed in purusing these policy objectives. First of all, continued economic growth must be assured. This is tempered by insistence that environmental protection be incorporated into mineral development and energy facility siting. Abundant energy forms should be substituted for those less available, and energy prices should reflect the replacement cost of a fuel, not its extraction cost. Finally, all groups and regions must be treated fairly by government policy, which is reasonably definite and firm.

Federal energy-related activities and responsibilities fall into four broad categories. Domestic production incentives and price controls have been for several decades the primary concern of government in mineral development on federal lands and interstate sale of natural gas and electricity. Since World War II, research and development has become an important undertaking. The principal interest has been to advance the "state of the art" in generating electricity from radioactive fuel. The environmental and health impacts of energy extraction, processing and use have been the subject of a large portion of federal environmental research and regulatory programs particularly since the 1960s. Finally, energy conservation is in the 1970s being promoted through education, research, tax exemptions, aid to low-income families and product efficiency standards. The emphasis upon conservation and efficiency found in the National Energy plan has not be carried through in legislation and funding by Congress.

Production Incentives and Price Controls

The federal government has power over the conduct of interstate commerce, use of navigable waterways and federal lands, national defense, and the health and safety of the public. These powers have been used to establish federal control over power plants, dams and interstate electricity sales (Federal Power Act of 1920); development of federally owned fuel sources (Mineral Leasing Act of 1920, Outer Continental Shelf Lands Act of 1953); interstate gas and pipelines (Natural Gas Act of 1938); Atomic Energy Act of 1954); and oil prices (Emergency Petroleum Allocation Act of 1973). Since 1973 many of the diverse authorities have been consolidated within the Department of Energy, with the exception of the leasing of mineral rights on federal lands.

The legal structure which imposes controls and incentives on the energy industry and consumers is growing more complex. Consumers are encouraged to reduce demand for fuels and electricity, yet prices are kept below the level charged in unregulated markets. Laws designed to insure fairness to consumers served by companies with service monopolies in effect promote energy consumption. Production levels of domestic oil and gas have declined since 1970 as United States resources are depleted. Outer Continental Shelf leading procedures and recent price incentives approved by Congress are designed to encourage higher production levels which will speed up the use of our remaining reserves.

In basic terms, energy suppliers continually seek the greatest revenue for a unit of product, while consumers seek protection for paying more than a reasonable price for necessary fuel and electricity. Energy companies have unabashedly fought regulations which favor consumers, and vigorously pursued rules which protect and profit the industry. The federal government has played an important role in balancing the relationship between these two groups. All price control policies have undergone change recently, reflecting new concerns over adequate as well as equitable pricing.

Natural Gas Pricing Policies

Since 1938 the federal government has imposed ceilings on the price that natural gas producers and pipeline companies could charge local gas companies to prevent these fuel suppliers from taking advantage of their monopoly status and charging unfair prices. Natural gas is transported in pipelines from wells located principally in the Gulf States region. Liquefied natural gas is imported from foreign suppliers. The Federal Energy Regulatory Commission (FERC, formerly the Federal Power Commission) controls the price of natural gas at the well, and in the interstate pipelines and related facilities. Gas prices are much higher in the intrastate gas market, where federal controls do not apply.

The gas pricing policy approved by Congress in 1978 is a compromise between consumers and producers aimed at increasing the amount of fuel that gas producers make available to the nation. Phased removal of price controls for newly found gas, interstate gas and high-cost gas from deep wells will be completed by 1985. The purpose of this action is to give the gas industry incentives to develop harger-to-get gas resources as an alternative to imported oil. Gas from previously developed wells will increase in cost only at the national inflation rate. Production costs are much lower in these old wells, so it was considered unfair to allow producers to charge the highest price. This compromise was the result of a bitterly fought battle during the 95th Congress. Importation of liquefied natural gas, which is more costly per unit, is now discouraged by the Economic Regulatory Administration (ERA), a branch of the Department of Energy (DOE). It is expected that the new domestic natural gas policies will make a sufficient amount of new gas available to avoid the need for such imports for the next several years.

Petroleum Pricing and Production Incentives

The control of petroleum prices is less direct and more difficult to explain. The reason for imposing controls is based on the fact that not all United States' oil refiners use the same proportion of imported to domestic crude oil. Since domestic crude is now cheaper than imported crude, refineries with access to domestic production are considered to have an unfair advantage over those dependent on foreign crude. East Coast consumers who rely heavily on products made from foreign oil have paid more than residents of other regions. Federal regulation is justified because OPEC prices were raised not only to reap profits but to exert pressure on United States' foreign policy in the Middle East. There is little disagreement in principle to the need for controls to distribute this hardship evenly.

The oil industry has received production incentives for several decades. Beginning in 1926, the oil industry has profited from a subsidy known as the "percentage depletion allowance," as well as other federal policies which favored domestic oil producers. Until 1969 oil companies were deducting 27.5 percent of their gross revenues (to a maximum of 50 percent of profits) from their taxable income, resulting in a tax benefit to them which cost the nation $1.4 billion annually in lost tax revenue and which yielded only an estimated $150 million worth of new oil each year (Mancke, 1974). The stated purpose of the allowance was to encourage the industry to invest in new production efforts by attributing a "cost" to the fact that oil is a depletable resource. It was argued that the producer should be compensated because his source of income was depleted once he sold all the oil. The amount of income that could be deducted for so-called depletion expenses was gradually reduced in the 1960s. Another production subsidy was the import quota, which forced consumers to buy higher-priced domestic oil. Both incentives were eliminated in the early 1970s, when oil demand began to greatly outstrip domestic production capabilities.

The issue of consumer protection and production incentives for the petroleum industry is now far more complicated. The Energy Policy and Conservation Act of 1975 made some important changes to the pricing of crude oil and other products in recognition of the fact that refineries do not have equal access to low-cost crude oil. As in the case of natural gas, different levels or tiers of price controls have been established to reflect the higher expenses associated with new oil production. The lower-tier well price covers older fields whose production costs are relatively low. The upper-tier covers oil developed since 1972, and is several dollars higher. The Department of Energy has postponed or rolled back legislatively scheduled price increases in the upper-tier oil in order to keep the composite domestic oil price at the level required by the act.

To solve the problem of balancing the access of domestic refiners to lower- and upper-tier domestic crude oil, the Department of Energy was empowered to operate a program which transfers the excess profits from those refiners who use cheap crude to those who must handle upper-tier domestic crude or expensive foreign crude. In essence, refiners using more costly crude are entitled to a price subsidy. The DOE determines the percentage and cost of domestic and imported crude oil refined each month for every refiner. It then issues entitlements which have a value based on a formula that determines the lower-tier, upper-tier and uncontrolled (foreign oil and certain "stripper" wells) oil prices. Each refiner gets one entitlement for every barrel of imported crude oil used, and a fraction for each barrel of upper-tier oil used. At the same time, each refiner must purchase at the posted price an entitlement for every barrel of cheap, lower-tier crude used. The effect is to equalize the price each refiner pays for crude oil nationwide.

To pass the savings of refiners along to consumers and to prevent windfall profits to the industry, price controls were imposed on the sale of gasoline, propane, distillate and heavy fuel oils, and other products. Gasoline, propane and aviation fuels are the only products now controlled. Prices have until 1978 run below what the DOE would have permitted to be charged due to competition. The industry favors abandoning product price controls completely. Profits accruing to the industry from the equalization program are in its view necessary to insure sufficient supplies of specific products, so it does not wish to pass its cost savings through to consumers.

Electricity Production and Prices

The Federal Energy Regulatory Commission regulates the construction of hydroelectric power generation in navigable waters and controls the price of electricity sold in interstate commerce in the same fashion that natural gas prices and projects are regulated. It has a special concern for promoting regional planning of power plant construction and for developing a reliable national system for the distribution of electricity. The Commission also makes final decisions on mergers of utilities, project financing and disposal of property. It role in utility regulation is particularly important in Rhode Island, where most power is purchased in the interstate market.

Energy Research and Development

The federal government plays a major role in financing the research, development and demonstration (RD&D) of promising new energy technology which either makes better use of existing resources or brings a new energy source into commercial production or exploitation. More than $4 billion is spent annually for research on nuclear, fossil fuel, solar energy, and conservation technology. Most of this money continues to go for nuclear research in the areas of fission technology including light water and breeder reactors, and fusion. However, nuclear-related programs comprise 70 percent of the fiscal year 1977 budget, compared to about 60 percent of the 1979 budget. This represents both a net decline in dollar amounts as well as the percentage of the allocation.

Research and demonstrations of conservation and renewable energy sources including various solar energy applications are now receiving more attention, rising from one-eighth to one-fifth of the total RD&D budget between 1977 and 1979. Much of the money spent in conservation and solar energy is channeled through the Department of Housing and Urban Development in the form of grants to low-income families for weatherization and for solar energy demonstration programs. One reason for the emphasis on non-research expenditures is simply that the technology currently exists in these areas; therefore, less effort is needed in the form of research. Incentives to persuade energy consumers to adopt conservation practices and renewable energy sources are emphasized instead.

The bulk of federal energy research, when viewed from another perspective, is for the purpose of developing fuels and technology for the generation of electricity. Although electricity accounts for only 7 percent of end use energy consumption nationwide, it consumes about 29 percent of the gross fuel inputs to the economy. Most fossil research is concentrated upon improved extraction and utilization of coal, a fuel which is used principally for electricity power generation. About one-half of the solar energy budget goes to solar electric applications. Nuclear reactors are used exclusively in electric power generating stations. This informal national policy favors the use of electricity over other energy forms.

Activities by the federal government in the civilian nuclear program are necessarily linked to the military weapons program, since the fabrication of weapons-grade uranium is accomplished with the same technology that is used to make reactor fuel. This has led to difficulties in the export of such technology, since reactor technology can provide any nation with an opportunity to develop nuclear weapons, which contradicts the United States' position against the proliferation of such devices.

Environmental Protection

Federal laws and programs to improve environmental quality developed in large measure independently of, and earlier than, national energy policy. However, the two areas are closely related. In fact, many people believe that accomplishing goals in one area precludes progress in the other. Debate over national priorities often pits energy priorities against environmental quality goals. Energy industries and big energy users are often at the forefront of efforts to reduce the stringency of environmental control programs. However, the federal government is committed to implementing some important air and water quality standards.

Federal environmental laws dealing with energy supply and demand fall into three broad categories: (1) air quality standards, (2) water pollution control, and (3) energy facility siting regulations. The Environmental Protection Agency has taken two approaches to the problems of air and water pollution. For existing polluters, performance standards are imposed on air and water pollutant levels, which may result in the need to add on control equipment or modify operations. For new sources, designs must meet even stricter emission standards. New power plants are not permitted to raise the pollution levels of a region or exceed permissible standards for particulates , sulfer dioxide, heated discharge water and radioactivity.

The siting of major energy facilities is not handled in a uniform fashion at the federal level. The federal agency with primary licensing authority is required to prepare an Environmental Impact Statement (EIS), which reviews the entire proposal in light of a variety of environmental concerns. Unfortunately, one of several different agencies could be responsible for preparing an EIS on a power plant, depending on its type and location. The preparation of the environmental impact statement has received most of the attention given to the federal role in energy facility siting and regulation. While it serves a vital role in pulling together a full description of a proposal and its potential impacts, the more appropriate forum for most public concern is at the agencies that make decisions on the substance of a particular proposal.

Some federal agencies preempt local authority over specific matters, such as radiological health and safety, which is handled by the Nuclear Regulatory Commission. However, all states have a great deal of discretion in controlling the use of land and marine resources that may be affected by energy-related operations. The EPA presently encourages states to take over the responsibility for pollution control programs in the areas of air and water quality. States may also adopt a comprehensive facility siting process for all energy developments. Rhode Island's Coastal Resources Management Program is an example of how economic, social and environmental questions are part of a single permit procedure for major energy facilities proposed in the coastal zone.

Unlike the procedures which a federal agency follows in discharging legislatively mandated regulatory responsibilities, no overall standards exist for the preparation of an environmental impact statement. An agency is only obligated to act upon findings in the statement which bear directly upon its own legal authorities. Other agencies which have jurisdiction over an aspect of an energy project may carry out their proceedings independently of the EIS process. Impact statements are often challenged in the federal courts for a determination of their accuracy and completeness. If the EIS meets the basic legal tests for adequacy which have been developed during the course of environmental case law in the past ten years, the lead permitting agency is then free to proceed with its regulatory proceedings and to deny or approve an application. An agency does not have to act on facts in a case which is beyond its jurisdiction.

Conservation and Efficiency of Fuel Use

Energy conservation is recognized in the Carter Administration's National Energy Plan as the simplest, least expensive means of reducing energy use and oil imports. Yet the provisions of the National Energy Act of 1978, passes by the 95th Congress, are estimated to save only between 2.3 to 2.9 million barrels of oil imports per day over projected 1985 demand, compared to 5.1 million barrels per day savings proposed by President Carter. (The United States currently imports 8 million barrels of oil per day). Most of this will not be in the form of reduced energy consumption but simply the result of hoped-for fuel-switching, from imported petroleum to domestic gas, which is expected to be more widely available because of the lifting of price controls.

In the National Energy Plan, energy conservation was to account for a 1.9-million-barrel-per-day actual reduction in energy use beyond what was estimated to occur without federal action. The 1978 Energy Act, however, will yield estimated savings from funded programs of less than 700,000 barrels per day.

According to the National Energy Plan, "Conservation is cheaper than production of new supplies, and is the most effective means for protection of the environment." Nevertheless, the United States uses more energy, more energy per capita, and more energy per dollar of personal income than any other nation. National policy still focuses on price controls, which encourage consumption, and production incentives, which also encourage consumption. The conservation provisions of the 1978 National Energy Act are in large part extensions of previous federal programs. The principle components of the federal energy conservation effort are information, performance standards for some consumer equipment, low-income subsidies for weatherization, and income tax write-offs for renewable energy and conservation investments.

The Department of Energy is responsible for continuing to develop and disseminate information on conservation, adopt appliance efficiency standards, monitor the efforts of large industrial users, and implement the now more stringent automobile mileage standards, which beginning in 1980 will include taxes on cars which fail to meet federal mileage standards. Funding for state energy conservation programs will continue to assure some level of local effort in home energy auditing, conservation information, public building surveys, car and van pooling promotions, and thermal efficiency standards in the building code. The Department of Housing and Urban Development will receive greater support for the low-income weatherization program, which covers insulation, storm windows and other efficiency measures for qualifying households. In Rhode Island, the Governor's Energy Office and the Department of Community Affairs help administer these federal programs. The United States' conservation effort suffers from a lack of specific goals and an assessment of the full potential of conservation for given levels of effort. Most programs are designed to provide savings against some projected level of energy use, rather than fixing on an actual target figure which is less than present consumption. As shown earlier, energy demand projections for the same year can vary widely from both each other and reality. If a forecast is deliberately set too high, a program can be made to appear to have an impact far greater than it actually had.

OUTLOOK FOR NON-RENEWABLE ENERGY SUPPLIES IN THE UNITED STATES

Conditions in the global energy marketplace are focing energy prices to rise. Compared to people in poor nations, Americans have not yet been as seriously harmed by increased spending on energy. The real cost to the United States' economy, however, is much higher than the posted price of OPEC oil. Stobaugh (Stobaugh and Yergin, 1979) estimates that if we increase imports to 14 million barrels of oil per day (5 million barrels per day more than present) by the late 1980s in order to make up for lagging domestic production, the total cost of those imports to the economy will be between \$35 and \$85 per barrel. The effect of an increase in imports will be to push world demand very close to the technical capacity of OPEC production, creating strong pressure on prices that would not exist if imports remained constant. About \$58 billion more would be sent to OPEC by the United States if imports reach the 14 million barrel/day level. Added to this cost is the reduction in Gross National Product caused by the enormous flow of cash to OPEC. This could be between \$10 and \$100 billion annually. Stobaugh observes that "To the extent that any solution at all exists to the problem posed by peaking of United States' oil production and the growth of imports, it will be found in energy sources other than oil." Thus, while many people would readily pay much higher cash prices for oil, the nation as a whole cannot afford to increase petroleum consumption.

Natural gas, coal and uranium are all important domestic energy resources. Yet, it is not realistic to expect that any of these will make a major new near-term contribution sufficient to avoid an increase in oil imports. The availability of each fuel is limited by technical, economic, and institutional problems.

The Natural Gas Act of 1978 was a compromise among producers seeking an uncontrolled market, consumers trying to avoid price increases, and federal concern about providing incentives for exploration and production. Because it is not known whether a specific price increase will actually result in a certain increment in new exploration efforts and gas discoveries, a wide range of outcomes are possible. Production could increase above the present level of 20 trillion cubic feet annually, justifying conversions from oil to gas by many consumers, including electric utilities. More realistically, annual discoveries may range from 10 to 25 trillion cubic feet. This would mean that availability would either continue to decline or remain constant.

Coal is an abundant resource which has some major short-term impediments to its use, and bright although not miraculous prospects for the future. Presently, the system which produces, transports and consumes coal is suffering from various set-backs. Utilities, the major coal user, are experiencing problems in predicting the future demand for electricity. Lack of commitment to new coal power plants prevents railroads from increasing coal handling capacity. Operators are reluctant to open new mines if long-term contracts and transport infrastructure are not in place. Conflicts over the environmental effects of coal mining and coal use are also contributing to the lack of increasing coal production. Progress toward establishing standards and reaching agreements on environmental standards is occurring. Labor relations and management difficulties are preventing the industry from rapidly mobilizing itself to overcome its expansion problems.

In the long run, new technology to make coal easier and cleaner to use will be essential for more widespread reliance on the remaining fossil fuel which the United States possesses in abundance. The conversion of coal into liquids and gas merit greater federal support in light of the true costs of oil imports to the nation and has been strongly advocated to President Carter in his July 1979 energy policy statement. However, haste is likely to cause waste. An expert in synthetic fuels was recently quoted as saying: "People want action, but let's have action that doesn't involve shooting ourselves in the foot. The basic fact of the matter is that we don't know if shale oil costs $15 or $30 a barrel, if coal oils cost $35 or $50. Before you make major commitments you need to know where you are at." (Wade, 1979).

Nuclear fission has been viewed by many as a major contributor to future energy supplies. Nuclear fuels are used only by electric utilities. Like coal, nuclear fuel use is a system which is comprised of several components, beginning with the demand for electricity, nuclear power stations, uranium mining, fuel fabrication, spent fuel reprocessing and radioactive waste disposal. Major problems exist in this system which have diminished the prospects for a major energy contribution from nuclear generated electricity in the near future. Utilities choose between coal and nuclear power plants based on the relative economic advantages of each. This seemingly straightforward comparison has been the subject of considerable controversy in recent years. One observer of this debate concludes, "in the coming years there is little chance of an unbiased scientific consensus on whether nuclear power is cheaper than coal." (I. Bupp in Stobaugh and Yergin, 1979).

Slow growth in demand for electricity has affected the nuclear industry as well as the coal industry. Utilities must be able to justify new construction on the basis of demonstrated future need for power. In addition many power station proposals cause considerable controversy because of environmental quality concerns. With nuclear power plants, safety is an additional issue because of public concern about the release of radiation in an accident. Major accidents were considered possible but very unlikely, until the events which closed Three Mile Island Unit 1 in Harrisburg, Pennsylvania, in early 1979.

In summary, conventional fuels will continue to play a dominant role in the national energy picture. However, consumer-taxpayers can expect to pay the full cost of developing substitutes for imported oil through taxes supporting federal projects and higher fuel prices supporting energy industry initiatives. The question which this prospect raises is whether we have any choice but to produce more fuel to overcome the present energy situation, knowing the difficulties and expense involved. Rhode Island cannot afford to wait for the national resolve on this question. Regardless of any bold federal and industry programs, the state is in no position to produce substantial quantities of low-priced conventional fuels for itself. Since the future will certainly bring us higher costs for oil, gas, coal, and electricity, Rhode Islanders must look to energy conservation and native resources as the primary means of controlling the amount of money we spend for energy.

V.
ENERGY IN RHODE ISLAND'S FUTURE

INTRODUCTION

Rhode Islanders, like all Americans, are caught in a bind between the past and the future. We possess energy use habits and patterns from an era of cheap fuel and declining electric rates, but must make choices in both personal matters and public policy related to energy in a period when the chance of making an error in judgment is high. Furthermore, decisions about energy supplies, price, technology, facility siting and emergency priorities are made at levels beyond our personal influence by governments and corporations that are often competing for control of the situation. No single force can be blamed for the national and regional energy predicament, which means that no single answer will suffice as a solution.

In light of the national and global energy situation, a strong commitment to explore the areas where individuals and local public officials can effectively address energy questions and develop workable strategies is essential. As individuals, we have a great deal of discretion over how we choose to use energy in homes and businesses. These choices include the type of energy used for a particular task, the rate of consumption, and the number of energy-using activities in which we engage. As citizens of a community and state, we can support programs and policies which help individuals and businesses use less energy, create incentives for native energy resource use, and address many of the important questions related to energy use patterns and facility siting. Exercising the power to make personal and public choices is the only way to attain a significant degree of control in our relationship with energy producers and the federal government.

In contrast to the national approach to energy problems, which is embroiled in controversy and political debates, a Rhode Island energy strategy must be directly based on personal and community concerns which are amenable to quick agreement and action. From the individual's perspective, attention should be centered on controlling energy expenditures and choosing appropriate energy sources for various needs. One role of state energy policy must be to help individuals exercise this control, and to emphasize the importance of carefully selecting the equipment, techniques and fuels used to accomplish a particular task. The other important role of state and local government is to provide a means by which issues such as the siting of new energy facilities can be resolved ina manner reflecting public needs and concerns. When viewed in these terms, the energy problems we face are not hopeless and our ability to chart a course for the future less in doubt.

PERSONAL SOLUTIONS

We may not be able to do very much today to influence the course of global events which affect energy prices and supply, but we certainly can make some important decisions about the role of energy in our own lives. Success in handling energy problems at a personal level requires a clear understanding of the nature of the problems that need to be solved and a willingness to seek out and adopt the remedies. The problem can be stated simply: we spend too much money on energy. Even though fuel prices are at their highest, Americans buy far more fuel than people in any other nation. This is because we have traditionally used a smaller share of our income to buy energy than any other group of people. The result is that we are insensitive to how much of our energy use is actually necessary. Rather than exercise restraint in fuel buying, we pay what energy sellers ask and merely complain about the higher prices.

Some of the money we spend on energy is not entirely voluntary. Overspending on fuel is quite literally built into the way we live. Old or malfunctioning heating equipment, poor insulation in walls and attics, cracks and gaps which leak warm air to the outside, and house orientations which fail to take advantage of the winter sun result in higher energy use. People with fixed or limited incomes cannot afford to make needed improvements, or their landlords will not make repairs, and they are forced to sacrifice food and other necessities during the winter to pay heating bills.

Suburban residential and commuting patterns were created in an era of cheap land and energy and are another form of built-in energy waste. Yet the advantages of low-density suburban living and the personal freedom provided by the automobile are important to many people, which helps explain the willingness of consumers to accept fuel price increases rather than change living patterns. In fact, few alternatives exist at the moment for those caught in this life style. The development of new mass transit service for people in suburban areas will require planning and major new investments in an era of public outcry at government spending. Cities could not accommodate a major influx of new residents fleeing from the costs of suburban life.

While waiting for new living and working patterns to emerge which reduce the amount of energy needed for daily activities, attention should be focused on whatever can be accomplished readily at the personal level. This strategy is based primarily upon the adoption of a systematic approach to energy expenditures and energy-consuming capital investments. For many people, this requires a new way of thinking. Many of us are not accustomed to careful planning of home-related spending. Investments that do not offer immediate savings or return have less appeal for a homeowner than might be the case in a business.

There are three basic elements of the personal strategy. First, current energy spending must be controlled by improvements to buildings, machines, energy-consuming behavior and habits. Second, an effort should be made to use locally available or domestically produced energy resources which are less subject to supply disruptions and sudden price increases and which are often lower in price. Finally, there must be careful selection of appropriate techniques, fuels and equipment for accomplishing tasks that require energy in order to avoid incorporating excessive energy use into a building or activity.

East stage of this personal strategy requires an additional amount of initiative, but none are without significant returns in terms of lower or stabilized fuel bills, greater security from fuel supply disruptions, and the broader social benefits of reducing the impact of rising energy costs in the regional economy.

Controlling Energy Spending

A great deal has been written and said about the need to conserve energy. Publishers of do-it-yourself books and magazines, insulation contractors, and government-sponsored information, home auditing and tax credit programs have contributed to awareness by the public of the importance of home weatherizing. The problem for a homeowner or landlord is in selecting priorities and determining how much money to spend on improvements. Conservation efforts should be viewed as an investment which offers a particularly attractive rate of return in the form of family or business income which is no longer directed to pay fuel bills.

One difficulty in conservation efforts is the fact that each structure, business operation and family is unique. Every unit must be examined separately to obtain a true picture of the conservation benefits from a particular level of expenditure. It is useful to examine some general cases to understand the nature of conservation investment. The statistics which are used in this section are based on an average residence in New England and are not to be taken as valid for any specific housing unit.

The first step every homeowner can tak is to initiate a maintenance contract for heating equipment. About half of all New England households fail to have heating equipment serviced each year. An annual outlay of \$25 to \$30 would provide an average fuel savings of about \$60. Heating a house or apartment at 68^{o}F, 60^{o}F at night, and reducing the temperature setting of the hot water heater are other simple means of reducing energy costs with little personal effort or expense.

Further steps to limit energy spending must be viewed as investments that pay for themselves. The energy demand of a building can be greatly reduced by weatherizing and insulation. This includes a range of improvements for adding storm windows to fully insulating ceilings and walls and floors. Another form of conservation involves the upgrading or replacement of equipment such as furnaces and boilers with more efficient units. This is a more costly step. There are of course, numerous opportunities for conservation in all energy consuming sectors. Residential conservation is used here only as a familiar example whose principles can be readily applied to other situations.

Weatherization and insulation should be considered first for several reasons. The period in which these improvements return the cost of materials and installation is usually three years. After that, fuel savings accumulate from the conservation effort at a rate about twice as high as an investment savings account giving 8 percent interest. Also, homeowners have a choice as to how much to spend on conservation, ranging from installation of storm windows and attic insulation to full attic, wall, and floor insulation. Finally, most weatherization can be done by the do-it-yourself individual at a considerable savings. The costs and returns for a particular level of fuel saving investment should be calculated with the help of a contractor, the state program Rhode Islands Saving Energy (RISE), or one of numerous texts available on the subject. It is helpful to examine an average case to see the pay-off from a modest energy conservation effort. The New England Energy Congress has information on the investment needed to achieve various levels of fuel savings based on a computer model of the New England housing stock.

For a New England home in 1978, for example, \$391 spent on storm windows and ceiling insulation would reduce fuel bills by an average of \$122. This average cost and savings per housing unit is used here to illustrate the stream of returns, and reflects only an average value, not the actual savings for specific buildings. Line 1 of Table 9 shows the accumulated value of a \$391 investment returning 8 percent annually. At the end of ten years, the account would be worth \$844. The accumulation of savings are presented in line 3. Line 2 shows the annual fuel savings for a ten-year period, assuming an 8 percent annual rise in fuel prices. (Home heating oil increased 100 percent between 1971 and 1976 and increases greater than this are possible). It is apparent that a much better return can be obtained by spending the \$391 on insulation. At the end of the third year, the initial investment is completely returned. By the tenth year, the total fuel savings is worth twice as much as the 8 percent investment account, or an annual return of 16 percent. If a homeowner put all the money saved on fuel in an 8 percent savings account, the value of the initial \$391 in energy conservation would become \$2431 by the tenth year (shown on line 4), or three times the amount of the 8 percent investment account, representing a 20 percent return on a \$391 investment. Few other opportunities with such high guaranteed returns are available to a family. The faster fuel prices rise, the greater the return on conservation efforts.

It is also worthwhile to borrow money to make building improvements. Assuming a 20 percent down payment, a 10 percent interest rate and a five-year term, fuel savings, on our hypothetical investment in insulation, would become greater than the loan payments by the second year. At the end of the tenth year, the net fuel savings would be half again as large as the value of the 8 percent investment account. Even with the expense of borrowing money, this approach would provide a net savings of \$1284, which is a 23 percent annual return after five years on a cash down payment of \$78. A higher loan rate, say 14 percent, would still result in a positive return of 16.8 percent.

TABLE 9

FLOW OF RETURNS FROM A HYPOTHETICAL ENERGY CONSERVATION INVESTMENT OF $391 (STORM WINDOWS AND ATTIC INSULATION)

	year 1	2	3	4	5	6	7	8	9	10
1 Annual Fuel Savings assuming 8% inflation	122	131	142	153	165	179	193	209	225	243
2 $391 put in a 8% savings account (end of year balance)	422	456	493	532	575	620	670	724	782	844
3 $391 spent on conservation accumulated fuel savings	122	253	395	548	713	892	1085	1294	1519	1962
4 value of fuel savings when invested at 8% (end of year balance)	122	263	426	613	827	1072	1351	1668	2026	2431
5 $391 borrowed for conservation accumulated value of savings (20% down, 10% interest, 5 year period)	-39	9	68	138	220	399	592	801	1026	1269

From: New England Energy Congress, 1979.

The estimated cost and energy savings of replacing one-half of the oil and gas equipment in a home with units capable of up to 80 percent efficiency provide only a 4½ percent annual return after five years, and 12 percent annual return in a ten-year period. For individuals replacing old equipment, the advantage of buying the most efficient units is obvious. However, replacement of equipment regardless of age appears less attractive and should be considered only after a major investment in insulation.

The limits of conservation investments should also be recognized. If all existing buildings were insulated to "ideal" standards, resulting in a 54 percent reduction in energy consumption for space heating, the return on the investment in energy savings would be only 3 percent annually after five years, but 11 percent annually during a ten-year period. After the simplest conservation improvements have been made, it takes more money to save additional amounts of fuel. Yet even an extreme case of conservation pays better interest than a savings account in the long run. In fact, homeowners in New England need wait only until the seventh year to receive fuel savings equivalent to 8.7 percent annual interest on an average initial investment of $1832. (The average cost in 1978 for achieving a 71 percent energy savings in a residential unit).

Returns on conservation investments accrue for a very long period because storm windows and insulation do not deteriorate under ordinary circumstances. The real estate value of property is also improved by reducing the operating costs of a structure. Since a typical homeowner occupies a dwelling for an average of five years, the long-term benefits might not seem to be enough of an incentive. At the end of five years, however, the $391 conservation investment has returned 13 percent annually if the savings are simply pocketed. The new energy tax credit makes the investment even more attractive. It would cover a large share of the down payment if the money was borrowed, and it increases the five-year return to 14.5 percent annually.

Perhaps the best way to make both structural and equipment improvements is to borrow the money to pay for them. A small downpayment would be all the cash necessary to take advantage of the long-term benefits of conservation. Money for loan payments would be available from reductions in fuel bills. In the insulation example mentioned above, savings in fuel exceeds loan payments and down payment in the second or third year, depending upon the latest rate of interest.

Native Energy Resources

The most important energy resource we have is our own ingenuity and labor applied to solving household and business energy problems. Although much of the discussion and debate on energy issues consists of hypothesis and conjecture about national and global trends, the money which can be saved through some initiative and small investment in conservation and use of local resources is quite tangible. The use of renewable resources such as wood, solar energy, wind and flowing water will not answer all questions and put an end to every concern about energy in our future. The impact upon total fuel demand will be small at first, but, from the individual consumer's perspective, use of native resources can provide economical solutions. When added together, the aggregate effect of increased use of many different local energy sources is expected to be significant.

Wood

About 395,000 acres of Rhode Island is forested. Harvesting only the net annual growth of approximately 154,000 cords would provide 4.1 trillion BTUs of energy annually, which is the equivalent of roughly 6 percent of Rhode Island's residential and commercial energy use in 1976. A cord of medium quality hardwood (22.5 million BTUs) could cost as much as $100 ($4.40 per million BTUs) and still be a cheaper source of fuel than No. 2 fuel oil selling for 65¢ per gallon ($4.60 per million BTUs). As the price of oil rises, the cost of a cord of wood could also increase and still be economic. People who cut wood from their own land spend only the price of a saw, fuel and their own time. The full cost of using wood as a supplemental or primary source of heat, as with any fuel, includes not only the price of wood but the cost of a stove or furnace system, equipment efficiency and the energy content of the fuel as well. Cost of equipment can vary from simple home stoves to a complete hydronic or hot air system selling for $2000 to $3000 which can utilize wood and a backup fuel such as oil and gas.

The Sun

Solar energy is another local resource which is gaining greater attention and acceptance. There are two distinct ways in which the sun can be used in building. Passive techniques take advantage of the sun's heat in winter and avoid its influence upon a building in summer through building design and landscaping. Active solar heating involves the circulation of air or water through glass-covered black panels with pumps and special controls.

The passive use of solar energy occurs in any building with windows that face south. Rooms become warm during a sunny winter day. New buildings or additions can be oriented so that rooms have a south-facing wall with large windows in order to let as much light as possible inside during the winter. The heat can be retained at night with the aid of thermal drapes. This can be done at little or no cost. Summer sun can be avoided with the use of overhangs, curtains, deciduous trees and awnings. The benefits of designing structures to take advantage of climate are apparent, but they have not received much attention. Few real estate developers and building contractors consider passive solar heating in planning new projects.

Active solar energy systems are more complex and costly, yet have received most of the attention given to this alternative energy source. For a relatively small cost ($1500 to $2000), a system providing hot water for domestic consumption can be purchased with a solar collector that circulates water through a panel heated by the sun and stored in tanks. A supplemental energy source is used to provide heat during cloudy or cold periods. A much larger expenditure is needed to utilize solar energy for space heating. Many more panels are needed, as well as a large storage reservoir. Water or air can be used as the "fluid" which is heated and circulated in conjunction with a backup system. The piping or ductwork, pumps, fans, controls and collectors can cost \$8 to \$10,000 in a typical home.

Alternatives to spending more money on oil, gas or electricity must at the least be no more expensive and preferably offer significant savings within a reasonable number of years after installation. Although passive solar techniques involve little expense and provide significant benefits, relatively little information is available regarding the economic merit of such design practices in new buildings or in remodeling. Data on active solar energy systems, which by their nature are easier to control and monitor is becoming more available.

Compared to investments in energy-conserving insulation and equipment or the use of wood heating, an active solar energy installation ranks lower as an investment in New England. Active systems can compete with electric hot water heating and electric resistance heat in the Boston area with current federal tax credits for such installation (Bezdek et al., 1979). Table 10 illustrates the number of years required to reach various milestones determining the feasibility of the investment. It was assumed in this example that the money to purchase the system is borrowed as part of the cost of a new home. The criteria used by Bezdek et al., stated that a solar system was competitive against an alternate method if the period when savings exceeded loan payments was three years or less, the down payment was recovered in five years, and the cost of the system returned within ten years. With these qualifications, solar hot water heating is competitive with electric hot water heating, providing positive cash flows and down payment returns in the first year. However, the cost of the system is not returned for 13 years. A solar heating and hot water system was found to be competitive with electric resistance heating, with a positive cash flow in three years, down payment recovery in one year, but a system cost pay back of 17 years. Against all other options, including heat pumps, fuel oil, and natural gas, at current prices, the active solar system was not competitive. The payback period in each case exceeded the anticipated useful life of the system. Included at the bottom of the table are comparable figures for the insulation example cited earlier, which has a positive cash flow and return of down payment in just one year, and a payback of three years.

There are other incentives for choosing to use active solar energy. Prices for electricity and oil will very likely increase at a rate much higher than 7 percent, and natural gas at a rate much higher than 10 percent annually, which were the numbers assumed by Bezdek. For example, OPEC announced a 30 percent hike in crude oil prices just three months after the article was published. Once the investment is made, future supply interruptions of conventional fuels will be of little concern to the owner of such a heating system. Also the solar installation adds to the real

Table 10

Number of Years Needed for Hypothetical Solar Installations in Boston to Provide Savings Over Conventional Heating Equipment (To be competitive, the solar unit must provide in fuel savings a positive cash flow in 3 years or less, return the down payment within 5 years, and pay back the original cash outlay within 10 years).

	Conventional Heating Systems			
Criteria for Judging Performance of Solar Investments	Electric Resistance Heating	Electric Heat Pump	Fuel Oil	Gas
<u>Years to positive cash flow</u> (maximum 3 years)				
Solar Water Heating Alone	1	NA	8	9
Solar Water and Space Heating	3	11	13	12
<u>Years to return down payment</u> (maximum 5 years)				
Solar Water Heating Alone	1	NA	12	14
Solar Water and Space Heating	1	19	21	10
<u>Years to pay back of system</u> (maximum 10 years)				
Solar Water Heating Alone	13	NA	21	20
Solar Water and Space Heating	17	23	25	23

Insulation Program

($391 5 year loan, 20 percent down, 14 percent interest, 15 percent tax credit)

Years to positive cash flow	1
Years to return of down payment	1
Years to pay back of cost	3

Source: Bezdek, Hirshberg, Babcock, 1979; Table 9.

estate value of property, as insulation improvement does. Finally, a homeowner or business may choose a solar installation as part of a belief in the need to shift the energy base of the nation from depletable petroleum and gas to renewable and constant energy sources such as the sun.

Appropriate Technology and Voluntary Simplicity

Most of the discussion of personal solutions has centered on the economic aspects of various fuel consumption-reducing investments. Few people have the habit of carefully examining every decision or purchase on its financial merits alone. There are two basic concepts which provide a common sense guide for making resource use decisions in lieu of complex and time-consuming economic analyses. The first concept is that the means we use to accomplish a particular task -- for example, getting to work or heating a house -- should be appropriate to the task, given the context of national and global energy problems, which are not likely to diminish in the short term. Too often we use energy and waste money to accomplish something that could have been done adequately with less fuel and at lower cost. The second concept is that by voluntarily shifting some of our priorities and habits, we can live full, happy and meaningful lives without consuming large quantities of consumer goods.

Energy conservation practices and utilization of native energy resources are both considered to be examples of appropriate technology. Greater personal effort is required to select the means to accomplish a task which involves the use of fewer resources. In many cases, however, our personal time and energy is in greater abundance and more easily tapped than new reserves of petroleum. Transportation is another area where choices can be made. Walking and bicycling, instead of driving, are effective means of traveling short distances at a much lower cost per mile. Motorcycles, mopeds, buses, trains and car pools are among the options available to many commuters.

The criteria of appropriateness can be applied in other areas around the home. Rather than devoting an entire yard for the cultivation of a lawn, homeowners can divert some of their effort, fertilizer, water and space to growing vegetables. When preparing to plant, a spade is as effective as a rototiller in preparing the soil of a small plot. Cotheslines are a less expensive yet effective means of drying clothes. Bottles, paper, and aluminum cans can be easily separated from household trash and recycled at a growing number of centers throughout the state. Degradable garbage can be added to a compost pile and used to enhance garden productivity. Water-saving shower heads can greatly reduce both the amount of water used and the fuel needed to heat the water. Home appliances such as stoves, freezers and refrigerators vary in their efficiency, and should be selected on the basis of the unit which offers lower costs over its useful life, even if the purchase price is somewhat higher.

The view that tasks should be accomplished in the simplest way in order to reduce unnecessary use of resources can be taken further to include examining the need for particular activities. Energy and resource use can be reduced further through voluntary efforts to modify personal habits and family life styles. This voluntary simplicity should be guided by ideas such as living lightly on the earth, decentralization of the economic base, community cooperation, and willingness to do it yourself. A house should not be a showplace but a homestead which serves as an important base of family well-being. Home arts can become as important to the family's well-being as outside employment. Resources such as garden equipment and labor could be shared with neighbors, and purchasing cooperatives could make lower prices available through bulk purchases. Bartering services for supplies would reduce the need for cash or credit. Recreation and vacations could include bicycling, canoeing, hiking and other fitness activities that combine physical exercise and travel rather than extensive use of the automobile.

The adoption of appropriate techniques and fuels, and a willingness to develop patterns of living which provide satisfaction to individuals while avoiding fuel and resource consumption, can grow out of basic self-interest in money-saving conservation investments. The rising cost of energy combined with growing global energy demand will force such changes in an abrupt and unpleasant manner eventually. A voluntary transition beginning now will make the shift to a period of much higher energy costs easier for individuals as well as serve to relieve some of the pressures of energy demand that are forcing energy prices upward.

PUBLIC RESPONSIBILITIES

Defining the Role of Government

It is not easy to define the aspects of the energy problem which merit government attention, and it is more difficult still to identify solutions which have a chance for acceptance and success. An unfortunate nationwide inertia has been produced by confusion and uncertainty about the answers to important energy questions. Special interest groups battle against each other to influence legislation and policy, making government action on energy issues painfully slow and difficult. Within this national context, state and local governments and citizens are faced with a choice that has profound consequences. The question is whether to tolerate the consequences of both the decisions and the indecision of outside actors such as industry, government and foreign countries or accept responsibility for pursuing personal and public energy solutions in the absence of national resolve on the problem.

Involvement by states and citizens in energy issues requires a broad understanding of national issues and the desire to pursue local solutions. Debates about policy and technology at the national level often seem complicated and far removed from personal concerns, a realm for the experts. However, every policy decision is based on the preferences and values of those making the choices. Failure to participate in these debates means simply that values other than our own will be the basis for important decisions affecting our lives. Likewise, we are in the best position to control our personal spending on energy, encourage the development and use of native energy resources, and make our concerns known about energy facility siting proposals.

At the state level, energy issues touch upon several aspects of government responsibility: income redistribution, economic development, environmental protection, energy policy development and community planning. Aid is provided to individuals with low incomes through emergency loans for fuel, home weatherization, and laws to prevent utility shutoffs in winter. Energy costs and availability are a continuing concern in economic development. Proposed energy facilities are often perceived as a means of increasing the employment levels of state residents. State environmental and health agencies deal with the impact of pollution from energy use and effects of the construction and operation of new energy facilities. Finally, state government has the responsibility to develop policies and plans regarding energy consumption in public buildings, allocation of fuel during emergencies, overall energy conservation, use of native resources and energy facility siting. Developing a state approach in which all these elements work together based on clear goals and objectives is not a simple task.

California's Energy Program

The State of California's venture into energy policy making is an example of the positive results that can come from a willing acceptance of responsibility for the future. California was spurred to action by the 1973 oil embargo. It faced immediate problems in both energy supply and the need to handle proposals to build energy facilities more effectively. Swamped by doubts about the outcome of national debates, clashing viewpoints on what the right approach should be, poor information and siting controversies that would not disappear, California set out to address a full range of concerns about energy in a vigorous manner.

The California legislature created an Energy Commission in the spring of 1974, giving it broad responsibilities for general planning, demand forecasting, energy conservation, petroleum resource management, power facility certification, and energy research and development. Financed by a small tariff on all state utility bills, it has to deal with the concerns of a state with twice the population and three times the land area of New England. Some of the issues it faces, such as leasing offshore oil tracts within state waters, are not of direct concern to Rhode Island. But most of the topics the Commission must deal with, including conservation, facility siting, and impacts of national policy on the state, are identical to those which Rhode Island must address.

The Energy Commission began its energy planning and problem-solving efforts in the face of a great deal of confusion and uncertainty. The 1977 first biennial report, California Energy Trends and Choices, presents some important conclusions. The Commission notes that:

> uncertainty in economic, environmental and political systems necessary to meet our energy future is pervasive and real cause for concern... . The underlying debate which we believe creates the basic confusion (is) the inability of people with competing philosophies to focus on the issue of whether or not resource scarcity is real and inevitable.

The three philosophies discussed in Chapter 1 of this report — Greelian, Jeffersonian and Periclean — were by themselves viewed as unsatisfactory means to a solution. Recognizing further that adoption of any single viewpoint would be met with determined opposition from the other two perspectives, yet faced with the need to act, the Energy Commission concluded that:

> Clearly, we cannot wait until the debate is over and resource scarcity is resolved academically or politically: we require a practical interim energy policy.

Toward this end, several principles were developed to guide Commission work on specific topics. Together, they comprise California's interim strategy, and provide some important insights into the complex topic of energy policy at the state level.

The basic premise of the California approach is that uncertainty, rather than any single technology or program, is the central concern of state energy policy. A lack of consensus on what the state's energy future should be, plus considerable difference of opinion on the correct steps to take to reach any particular goal, demands a special course of action. The strategy California selected has four basic themes: (1) state policy should foster a diversity of ideas and solutions; (2) incorporate flexibility in plans and projects; (3) prefer proven options; and (4) economize on regulation.

Diversity of Ideas and Solutions

California feels that there is an important element of security inherent in the free flow of ideas and technical solutions to problems. All energy supply and conservation efforts are directed toward providing answers to our continuing need for energy, but some solutions may be too expensive, risky or vulnerable to disruption to serve as satisfactory answers for the long term. In pursuing a number of options for energy supply and conservation, there is a greater chance that generally acceptable choices will emerge. In facility siting, smaller supply and processing projects possess the advantage of being resistant to complete disruption due to implementation delays or external events. Smaller projects such as intermediate-sized power stations may be more expensive to construct, but they have fewer impacts, can be sited more easily, and built more quickly than large, centralized facilities. Premature commitment to a single fuel or technology is avoided.

Flexibility in Plans and Projects

Because of uncertainty about whether new facilities will be needed once they are built, or whether a fuel will be readily available after commitments are made to use it, it is necessary to design flexibility into energy projects. Developments with large capital costs relative to fuel costs are economical only if sufficient demand exists to spread these fixed costs over a large volume of sales. If energy conservation programs are successful, they could substantially lower the growth in energy demand. Facilities that are built without full knowledge of the need for them could cause higher energy prices to consumers in order to pay for unused capacity. Another reason for insisting on flexibility is technological. The commitment of 20 to 40 years to a facility which is necessary to obtain a reasonable investment return can foreclose other opportunities that may develop as technical advances are made with energy alternatives. Finally, fuel handling, generating plants, facilities and user equipment such as boilers and furnaces that are adaptable to several fuels can take immediate advantage of changes in fuel availability and price. In an era which offers major uncertainties in the near and long term, flexibility is an essential part of realistic energy policy.

Staying with Proven Options

Innovations that once appeared promising, such as the gasification of coal, are presently more expensive than many intermediate-term options currently available. Premature large-scale commitment to a new idea can result in the neglect or exclusion of less expensive available choices, the problems and performance of which are known. As a result, the California Energy Commission favors concentrating on what is known to work rather than embracing solutions which are too far from reality or are largely untested. While encouraging small-scale experimentation where failure has negligible social impact, the Commission remains skeptical of massive "crash" programs, which are based on largely unproven technologies.

Role of Government

Finally, the Commission, as a government agency, is concerned about avoiding regulation that unnecessarily delays decisions on specific projects or restricts innovative solutions. In its view, environmental controls are necessary but should be straightforward and consistently applied to all proposals so that project developers can predict what is required of them before designs are prepared and expensive commitments made. Confusion and difficulty have been created for both public and private sectors by the roles of the federal and foreign governments in imposing conditions, restrictions and controls over energy prices and project proposals independent of local and regional concerns. The Energy Commission views public and industry involvement in the development of regulations as crucial if uneeded or counterproductive rulemaking is to be avoided.

The results of Energy Commission efforts and changes in the energy situation which occurred in the past two years are reported in the recently prepared 1979 biennial report. While energy problems seemed unmanageable earlier, the Energy Commission has seen improvements occur. Overall demand increase has slowed despite still-increasing gasoline demand and an economic growth rate of 7.8 percent in 1978. Oil and gas supply prospects have improved somewhat. Progress has also been made in developing innovative supply options such as geothermal, solar, wind, biomass and cogeneration of heat and electricity. The potential for the clean use of coal has also increased. The economic ramifications of energy problems are gaining wider recognition not only in terms of balance of trade but in terms of inflation, unemployment and public spending. For electric power generation, new facilities must be "custom-tailored" to available sites and power needs. The important questions now are how much more it will cost and who will carry the burden of making certain that meeting power needs will be consistent with the quality of life Californians want.

ENERGY STRATEGIES FOR RHODE ISLAND

State and local government have important roles to play in helping individuals, assessing local energy needs and resources, and establishing criteria for the siting of energy facilities. For each of these responsibilities, both the substance of state policies and the organizational means of implementing solutions and programs must be developed. Protracted debate about the distribution of jurisdictions and power among agencies and branches of government can impede progress in the identification and analysis of problems and the preparation of policies and strategies. On the other hand, the lack of sufficient legislative authority and organizational difficulties will prevent even the most carefully designed program from achieving success.

The limited funding and staff or state and local government require that the most important elements of an energy strategy be identified and put into action first. Crisis intervention and conservation programs to help individuals save money as well as reduce aggregate demand is the most important step. The second element of a strategy involves a careful look at the types of fuels used in the state and current and potential substitutes for those fuels. Finally, the state must be prepared for the infrequent but important responsibility of evaluating proposals to locate major energy facilities within state borders.

Assistance to Individuals

The most immediate impacts of the current energy situation are upon families and individuals whose physical and financial health are jeopardized by rising fuel prices coupled with little or not extra income. For some, the large bills which occur during the heating season present difficulties that can be overcome by a level payment program which spreads fuel bills evenly over twelve months. Others must choose between having heat or other necessities such as food. Emergency funds are needed to intervene in such crises as well as regulations preventing utility shutoffs in winter to prevent severe hardship or even death because of individuals' inability to pay fuel bills. For the past several years, the Department of Community Affairs has operated an emergency loan fund supported by the federal government to help qualified applicants pay energy bills during the heating season.

In addition to crisis intervention, there is a role for government in helping individuals conserve energy. From the individuals' viewpoint, saving energy is the most important issue. From the state and federal view, energy conservation is necessary now to avoid crisis and allocation problems later on. Some means of energy conservation can be made compulsory, such as thermostat settings in public buildings and building insulation standards. However, much of the effort within the private sector must rely on providing incentives such as information, technical assistance, tax credits, and energy-saving alternatives such as mass transit systems. Conservation merely for the sake of reducing demand some percentage below a projected level is not an adequate goal. Economic recessions have led to declines in Rhode Island's energy use, but nobody desires them. The test for government policy and programs is the extent to which individuals reduce the amount of fuel and electricity they use while maintaining or improving their quality of life.

State government through the Governor's Energy Office (GEO) is currently involved in administering several federal conservation programs. These include a public awareness campaign, technical advice, home audits, and insulation assistance through the Rhode Islanders Saving Energy (RISE) project. Special assistance in weather systems and insulation is provided to low-income households by the Department of Housing and Urban Development (HUD) grants, implemented by local community action programs. Transportation energy use is being addressed by promotion of the Rhode Island Public Transit Authority (RIPTA), enforcement of the 55-mile-per-hour speed limit, and measures such as allowing right turns at red lights.

Some efforts are being made at the state level to encourage individuals to use native energy resources such as solar heat, hydropower and solid waste. The GEO is administering a HUD grant which provides small subsidies to people installing solar-heating equipment. The GEO has also been involved with an Army Corps of Engineers project to assess hydroelectric potential in the state as a first step in promoting development of old and new sites. The Solid Waste Management Corporation is currently moving ahead with plans to construct a facility that will recover heat for generating steam and electricity from some 1200 tons of refuse per day. The tax credits now available for investments in conservation and solar energy from the federal government result in a credit on Rhode Island income taxes, since the state tax is figured as a percentage of federal taxes.

Most of the funds providing assistance to individuals originate from the federal government. The state has relatively little control over the amounts and purpose of this money, aside from taking the initiative to acquire these grants. The question remains whether these funding levels and program goals match the state's needs and priorities.

Assessment of Local Needs and Native Resources

In New England the single most important need for energy is in space heating, the second is transportation. Some data is available describing trends in energy needs for the region, but much less information is available on Rhode Island's energy needs as they apply to specific end uses. Yet without such knowledge it is difficult to establish goals for conservation or the use of native energy resources, and impossible to assess the progress of the state in meeting those goals. Likewise, little information is available regarding the native energy resources of the state, although studies of single resources such as hydropower and wood have been undertaken by various investigators. Without this information it is not possible to know to what extent these fuels can be relied upon to meet energy need now and in the future. In its final report, the New England Energy Congress estimated that alternative energy resources such as wood, wind, hydro, solar and solid waste could provide as much as 25 percent of the region's needs in the year 2000. A vigorous public effort will be necessary to reach that goal.

A fresh approach is needed if there is to be public recognition of the nature of our energy problems and citizen involvement in developing solutions. Although the general public is presumed to benefit from research and energy planning, studies at the federal, regional or state level often fail to include consideration of public interests and opinion. Much of the credibility gap between people and both government and the energy industry may be due to a failure by those analyzing the energy problem to link broad energy concerns with specific local problems and issues.

One approach to energy studies has emerged which deals with energy problems at the local level and is designed to explore local solutions. A guidebook for county-level energy studies has been developed by Alan Okagaki and James Benson of the Institute for Ecological Policies in Washington, D.C. The county unit, although not an important government level in Rhode Island, possesses some valuable characteristics. It is large enough to cover the distribution of several native energy resources, geographic patterns of urban development, and a regional economic picture. The county is also close enought to the local level to foster interest and permit meaningful involvement by people with a concern about their community and a willingness to cooperate with people they know.

The County Energy Plan Guidebook describes how to gather information about the qualities, types, costs and uses of energy and the locally available fuel resources, including solar energy, wind, hydropower and wood. The resulting characterization makes it possible to explore how well resources match needs. The study involves comparing the impacts of two energy paths, one based on conventional fuels and another based on renewable resources. Information gathered in the process is intended to answer the question of how much of the energy needs for all consuming sectors could be provided economically by a combination of local renewable energy sources in the year 2000. The county energy study avoids referring to vague goals such as "energy independence from foreign supplies," "shifting the balance of payments" and "reducing imports." Rather, the approach enables residents of a county to discuss the specific energy needs of local industries and businesses in the future, the effect of energy price increases on families and on the economy, and how the native resources directly available to them can be used to solve local problems. The University of Massachusetts of Amherst has already conducted a county energy study for Franklin County, Massachusetts which concluded that a substantial portion of the energy needs of all sectors could be met from local resources. A county-based energy study program in Rhode Island should help people to:

(1) assess energy use and price trends in consuming sectors and identify important energy users;
(2) prepare an inventory of native energy resources, and assess potential for energy conservation;
(3) analyze effects of pursuing a conventional energy path;
(4) analyze effects of pursuing an energy path relying more heavily upon conservation and native energy resources; and
(5) pursue goals and options that are based on an understanding of future energy supply prospects and local needs.

Each of Rhode Island's five counties is likely to have a different mix of energy needs and resources. The effect of fuel price increases may become a burden only to those living in urban areas as people in rural towns begin to use wood. Those who must commute long distances to work may find, on the other hand, that living in an urban area is far more economical. Some businesses may be adversely affected by rising fuel costs, whereas the economy of other parts of the state may actually benefit. These variations in prospects are only visible in an approach that begins at the local level. Regardless of whether energy shortages and price increases are the result of a government boondoggle, oil company conspiracy, or simple greed on everyone's part, the effects on family budgets and business conditions are the same. Analysis and arguments about the energy situation in Washington or the State House are invisible to most people, so it is not hard to understand why public opinion polls continue to reflect widespread skepticism that fuel shortages are genuine. It is important that all energy consumers see for themselves how decisions about our energy future affects them.

Energy Facility Siting

The most important challenge of the current energy situation lies in modifying energy consumption patterns and exploring the use of native energy resources. However, the energy industry is continuing to design and construct new plants and facilities for supplying conventional fuels and electricity. Proposals to build liquefied natural gas import terminals and storage tanks and electric power-generating stations are pursued by the competing gas and electric industries as the region's energy mix continues to shift away from petroleum. The search for oil and gas resources on the Atlantic Outer Continental Shelf (OCS) has led to an exploration phase service base at Davisville and could lead to proposals for pipelines and plans in the eventuality of a development phase. In the decade of the 1970s, oil refineries, oil storage depots, a strategic petroleum reserve, liquefied natural gas storage, nuclear-fueled power plants and numerous OCS-related facilities have been proposed and in some cases constructed in Rhode Island. Most of the proposers sought coastal sites in a period when the shoreline of the state is already heavily used and valued by often competing activities. Making the best choice among a number of possible uses for a site or resource has become an important public concern. This interest and concern requires a mechanism for expression through a government agency with sufficient jurisdiction and organizational means to make good decisions based on a well-developed body of rules and criteria which will guide the nature of the decision.

Several agencies are likely to be involved in reviewing major energy facility proposals, covering a broad range of public concerns about such large-scale industrial developments. The Governor's Office provides overall energy policy guidance to all state agencies. The Governor's Energy Office, created by executive order in 1975, is responsible for energy policy and research, development of new and alternate energy sources, and energy conservation. It reviews facility siting proposals, and through the federal Coastal Energy Impact Program provides planning assistance to coastal communities where major facilities have been proposed. The Public Utilities Commission and the Division of Public Utilities exercise authority over electric and gas utilities, including controlling the condemnation of land, resolving disputes over local zoning and approving the issuance of bonds for property acquisition. The Department of Environmental Management has the regulatory authority and responsibility for a number of important aspects of energy facility siting, including air quality, water quality, alteration of wetlands, and the disposal of solid and hazardous wastes. The Coastal Resources Management Council, and staff at the Division of Coastal Resources within the Department of Environmental Management develop and enforce regulations governing the alteration and use of a variety of coastal features and areas. The Statewide Planning Program, while not a regulatory body, performs several valuable functions including establishing long-range goals and plans for the physical, economic, and social development of the state in a series of documents known as the Guide Plan. It also coordinates state review of federal actions and license applications. The Rhode Island Port Authority and Economic Development Corporation is a quasi-public organization authorized to assume a financial interest in and promote a wide range of projects for the purpose of improving the state's economy. The General Assembly has reserved to itself the final authority for approving nuclear power plants and oil refineries in which the Port Authority has a financial interest.

The Coastal Resources Management Council (CRMC) has taken a comprehensive approach in implementing its authority over major energy facilities whose construction or operation would affect the coastal zone. Its policies and regulations make the crucial link between the need for a specific facility and an assessment of its impacts. The regulations which it adopted in September 1978 exhibit a recognition of the need to consider both aspects when dealing with the occasional but important cases where a development costing hundreds of millions, or even several billion dollars, is proposed on a coastal site. Uncertainty in the present energy situation and widespread public concern prompted CRMC to adopt strong criteria and standards for applications for coastal siting permits by developers of energy projects under its jurisdiction, including refineries, LNG terminals, petroleum storage, OCS development-related facilities and power plants.

The CRMC's approach is based on extensive study of the overall energy situation and its implications for energy facility siting. They highlight the importance of external factors, including those at the global level, in determining the availability of fuel in the state, which is likely to be constrained in the future. The fact that outside forces play such a significant role introduces considerable uncertainty regarding the availability and cost of conventional fuels and electricity. Consequently, the ability to deal successfully with uncertainty must be a major task of all the state's energy policies, plans and programs. Six energy-related coastal program objectives were identified by the CRMC:

(1) Energy conservation should be promoted as an essential part of the state's effort to plan for future energy supplies.
(2) Diversification should occur in the fuels, technology and energy facilities used to supply state needs. This includes use of native resources, greater fuel source flexibility in energy-consuming equipment, an expansion in the fuel types used to make electricity, and exploration of ways to reduce power station size and decentralize their locations.
(3) Consideration must be made of a reasonable number of alternatives to each proposed project.
(4) Consideration also should be given to alternative sites for a project in order to accommodate both economic and environmental concerns.
(5) Strategies must be developed to mitigate the adverse consequences of the use of energy in the state, for example, by assisting groups involved in Coastal Energy Impact Program projects.
(6) The Coastal Resources Management Council should help in exploring other improvements to the state's ability to handle the siting of energy facilities.

In order to avoid the creation of a regulatory maze for the applicant, the CRMC will review an application concurrently with other regulatory groups and has committed itself to participation in federal, state and local proceedings when appropriate to avoid unnecessary delays. To avoid piecemeal regulations, the CRMC will issue only one permit for an entire project, rather than separate permits for each facet of its jurisdiction. In addition, it will not issue its approval until the applicant has demonstrated that all other federal, state and local permissions have been obtained. The only exceptions are if the applicant appeals a local decision to the Public Utilities Commission and wins, when local permission is not needed, or if the proposal has financial involvement by the Economic Development Corporation, in which case the General Assembly will make the final decision after receiving CRMC recommendations.

The applicant is required to demonstrate that the project fulfills a legitimate energy need; to identify the economic, social and environmental impact throughout the project's life to examine alternate sites for the proposed project; and to assess alternate means of filling the needs which the project is intended to satisfy. The CRMC requires that the proposed project will not conflict with the Coastal Management Program or the State Guide Plan. The Coastal Program contains policies and regulations controlling the use of the shore and marine resources, including physiographic features such as marshes and barrier beaches, biological resources and ecological systems. The Guide Plan is a collection of documents containing plans for housing, transportation, employment, social services, recreation and other needs of statewide concern. The developer must prove that a superior site has not been identified during the course of CRMC proceedings and that a shorefront site is necessary for the project.

The impact assessment requirement is comprehensive yet could be filled by the submission of reports and documents that the applicant has prepared for other regulatory proceedings. The important difference is that the CRMC imposes legal standards regarding the completeness and validity of the statements made in any submission -- which is not entirely the case for the federal Environmental Impact Statement, for example. Unlike agencies or consultants preparing an EIS who must take the work of an applicant at face value, the Council can place any developer or consultant under oath and take testimony from other parties and experts as well. CRMC regulations specify the content of the environmental assessment, which is not true for the federal EIS. Federal environmental statements vary considerably in quality, content and readibility, depending on the agency required to prepare it. The CRMC requires explicit examination of the effects of the proposal throughout its entire life cycle, including plant expansion and decommissioning. The topics to be considered in the assessment of social, economic and environmental impacts are clearly identified. An applicant must discuss at least two alternate sites in sufficient detail to make comparisons with the proposal possible. It must be demonstrated that energy conservation, alternative generating technologies, decentralized facilities and renewable energy resources are incapable of handling the need which the proposed project would otherwise meet.

Although Rhode Island does not possess a single agency with as much authority and funding as the California Energy Commission, neither does it face the enormous problems of that state. The basic tools for effective public decision making on energy facility siting are in place, however, for the occasions when important siting proposals materialize.

The Next Decade

Rhode Island's economic well-being has historically depended upon the ability of entrepreneurs to harness available natural, human and fossil fuel energy flows. Agriculture, maritime trade and manufacturing each involved the use of energy in an increasingly sophisticated manner for financial gain. In this century Rhode Island has been beset by economic problems including loss of industries and periods of high unemployment. There were just as many people employed in manufacturing in 1910 as today. The state's population grew 20 percent between 1950 and 1970, while the number of employed persons increased only 11 percent. In the 1970s both population and employment levels have declined, while other regions are experiencing rapid economic and population growth.

The economic goals set by our state government have recognized the fact that Rhode Island's economy has matured. Employment opportunities are now sought only to satisfy state needs by diversifying the industrial base, fostering the development of existing firms and attracting environmentally "clean" new activities with growth potential. The state would only be frustrated if it used raw growth as the principal criteria for economic development and maintenance or improvement in quality of life. If Rhode Island is to remain competitive, improvement in the efficiency of using energy, labor and native resources is essential. However, rapid growth in energy use, for example, is not necessary for prosperity. A mature forest supports an enormous biomass yet has the same amount of solar energy and rainfall available to it as an open field. Many European nations can squeeze much more national product out of a barrel of oil than we do. Rhode Island must also learn how to take greater advantage of the human and natural resources it posseses.

Failure to improve our energy fitness as a State can only mean further economic decline and deterioration of environmental quality, as the state's ability to afford clean-up and environmental enhancement programs declines. Without action, Rhode Island will be forced to wait for rescue from the federal government in a time when New England is already competing hard to receive its share of federal concern and financial support. It is not possible to confidently predict that national resolve on energy issues will emerge soon and fully address the state's concerns. In the mean time, few people will feel comfortable relying on OPEC to decide our energy fate.

Rhode Island should not be paralyzed by visions of an energy poor, economically-stagnant future. The conditions of a century ago which fostered rapid economic and population growth simply do not apply to the state any longer. No factor of production, materials, capital, labor or energy, is available to the state in such abundance that its low price provides us with a competitive advantage over other regions. When a resource such as energy is needed in the economy or in homes, it is clear that a choice must be made between spending more money on fuel and learning how to prosper using less. Reducing requirements is often the most economical choice.

The belief that the construction of new energy facilities will cure Rhode Island's economic and energy difficulties is seriously mistaken. Recent analyses show that energy conservation measures cost far less per million BTUs saved than do new fuel supplies, and also create more employment. For example, the New England Energy Congress estimated that measures to achieve electricity conservation and conversions to solar energy units would create as much as eleven times more employment, yield considerable savings to families in lower fuel bills, and save more energy than would be supplied by a scenario involving the construction of two power plants.

The 1970s was a decade which vividly pointed out the nature of our energy problems and also provided the basic outline for their solution. The 1980s will be the decade of transition away from old patterns and habits which have left us the victims of energy gluttony to an era of self-control and survival based on careful selection of the means and ends of energy use. This transition has already begun in many homes and businesses, but much more work lies ahead as municipalities and state government learn to use less in their own operations and help to develop an energy consciousness and conservation ethic among all users of fuels and electricity.

REFERENCES

I.

California Energy Commission. 1977. California Energy Trends and Choices, Volume I, Toward a California Energy Strategy. Sacramento, California.

II.

A.D. Little, Inc. 1974. Historical Data on New England's Energy Requirements. Prepared for the New England Regional Commission, Boston, MA.

Army Corps of Engineers, New England Division. Various Years. Waterborne Commerce of the U.S. Government Printing Office. Washington, D.C.

Bentley, G. 1978. New England Energy Factbook. New England Congressional Caucus, Boston, MA.

Chan, D.C.W., L. Dickinson and K. Mead. 1975. A Conventional Energy Demand Projection for New England. New England Regional Commission, Boston, MA.

Electric Council of New England. 1978. Electric Utility Industry in New England, Statistical Bulletin.

Ernst and Ernst. 1975. Analysis of Impacts on New England of Recent Energy Shortages and Price Increases. New England Regional Commission. Boston, MA.

Institute of Gas Technology. 1975. Gas Industry Development in New England: Analysis of Alternatives. New England Regional Commission. Boston, MA.

Intermetrics. 1974. The Petroleum Distribution Network for New England. New England Regional Commission. Boston, MA.

Langlois, R. 1976. Future Natural Gas Supply to the Northeast. Brookhaven National Lab, Upton, NY.

Lee, J. 1976. Future residential and commercial energy demand in the Northeast. Policy Analysis Division, National Center Laboratory, Upton, NY.

McLoughlin, W. 1978. Rhode Island, a History. W. W. Norton Company, New York.

MITRE Corporation. 1974. Base Period Analysis of Gasoline Distribution in New England. New England Regional Commission. Boston, MA.

New England Energy Congress. 1978. New England Statistical Energy Profile. Somerville, MA.

New England Energy Management Information System. 1976. Fuel Storage Capacity in New England. New England Regional Commission. Boston, MA.

New England Federal Regional Council. Energy Resource Development Task Force, Energy Statistics and Projections Work Group. 1977. New England Energy Situation and Alternatives for 1985. New England Federal Regional Council, Boston, MA.

Resource Planning Associates. n.d. Energy Flows in New England, Historical and Projected. New England Regional Commission. Boston, MA.

Resource Planning Associates. 1976. New England Power Pool. New England Regional Commission. Boston, MA.

Rhode Island Division of Public Utilities and Carriers. Various years. Utility Company annual reports on sales and revenues. Providence, RI.

Rhode Island Fuel Allocation Office. Various years. Data on petroleum sales collected for fuel allocation program. Providence, RI.

III.

Energy Users Report. Bureau of National Affairs. Washington, D.C.

Exxon Corporation. 1978. World Energy Outlook. New York, NY.

Hayes, E. 1979. Energy Resources Available to the United States, 1985 to 2000. Science. 203: 233-239.

Mesarovic, M., and E. Pestel. 1974. Mankind at the Turning Point.

Modeling Resource Group. 1978. Energy Modeling for an Uncertain Future. Committee on Nuclear and Alternative Energy Systems. National Research Council. National Academy of Sciences. Washington, D.C.

Perry, H., and H. Landsberg. 1977. Projected World Energy Consumption in Energy and Climate. Geophysics Study Committee, National Research Council. National Academy of Sciences, Washington, D.C.

United States Central Intelligence Agency. 1977. The International Energy Situation: Outlook to 1985. U.S. Government Printing Office, Washington, D.C.

U.S. Department of Commerce. Various years. The Statistical Abstract of the U.S. Government Printing Office, Washington, D.C.

Wilson, C. 1977. Energy: Global Prospects 1985-2000. Report of the Workshop on Alternative Energy Strategies. McGraw-Hill, New York, NY.

Yergin, D. 1978. Oil is the Word. New England. Boston Sunday Globe. November 12, 1978.

Yergin, D. 1978. The Real Meaning of the Energy Crunch. New York Times Magazine. June 4, 1978.

________________."The Fortune Director of the 500 Largest Industrial Companies." Fortune, May 7, 1979.

IV.

Brown, L. 1977. Redefining National Security. Worldwatch Institute. Washington, D.C.

Conant, M. 1977. Geopolitics of Energy. Senate Committee on Interior and Insular Affairs. U.S. Government Printing Office, Washington, D.C.

Congressional Budget Office. 1977. President Carter's Energy Proposals: A Perspective. Staff Working Paper. U.S. Government Printing Office. Washington, D.C. June 1977.

Department of Energy, Office of Pulbic Affairs. 1978. The National Energy Act. Washington, D.C.

Exeutive Office of the President, Energy Policy and Planning. 1977. The National Energy Plan. U.S. Government Printing Office. Washington, D.C.

Federal Energy Administration. 1974. Project Independence. Washington, D.C.

Hirst, E. and J. Carney. 1978. Effects of Federal Residential Energy Conservation Programs. Science. 199: 845-851.

Mancke, R. 1974. The Failure of U.S. Energy Policy. Columbia University Press. New York, NY.

Miller, R. 1976. The Energy Puzzle, Putting the Pieces Together. T. Rowe Price Associates, Inc. Baltimore, MD.

Stobaugh, R. and D. Yergin, eds. 1979. Energy Future. Report of the Energy Project at the Harvard Business School. Random House. NY.

Wade, N. 1979. Synfuels in Haste, Repent at Leisure. Science. 205:4402. 13 July 1979.

V.

Bezdek, R., Hirshberg, A. and W. Babcock. 1979. Economic Feasibility of Solar Water and Space Heating. Science. 203:1214-1220.

California Energy Commission. 1979. Energy Choices for Calfiornia ... Looking Ahead. Sacramento, CA.

Clark, W. 1974. Energy for Survival. Anchor Press/Doubleday. Garden City, NY.

Coastal Resources Management Council. 1978. Findings and Policies, 1978. Amendments: Energy. Providence, RI.

Energy Users Report. 1978. State Creates Non-profit Company as Integral Part of Conservation Plan. Bureau of National Affairs. Washington, D.C. 258: July 20, 1978.

Governor's Commission on Cooperation. 1978. Cogeneration: Its Benefits to New England. The Commonwealth of Massachusetts. Boston, MA.

Governor's Energy Office. 1977. Rhode Island Energy Conservation Plan. Providence, RI.

Hirst, E. and J.C. Moyers. 1973. Efficiency of Energy Use in the United States. Science. 179:1299-1394.

Massachusetts Energy Facilities Council. 1978. An Integrated Regional Approach to Regulating Energy Facility Siting. Final Report. Boston, MA.

New England Energy Congress. 1979. Final Report of the New England Energy Congress: A Blueprint for Energy Action. Somerville, MA.

Okagaki, A. and J. Benson. 1979. County Energy Guidebook Creating a Renewable Energy Plan. Institute for Ecological Policies. Washington, D.C.

Pomerantz, D. n.d. Franklin County Energy Study Overview. University of Massachusetts School of Education Future Studies Program. Amherst, MA.

Reuyl, J. 1977. Energy Futures for Claifornia: A Conference to Explore the Alternatives. Energy Systems Integration Office, California Energy Commission, Sacramento, CA.

Schipper, L. and A.J. Lichtenberg. 1976. Efficient Energy Use and Well-being: The Swedish Example. Science. 194:1001-1013.

White, R. 1978. One County Looks Ahead. New Roots. Amherst, MA. September-October, 1978.