BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

New England Can Reduce Its Oil Dependence Through Conservation And Renewable Resource Development

Volume 1 Of Two Volumes

New England is unusually dependent on oil as a fuel source, resulting in high utility rates, susceptibility to supply disruptions, and a financial drain on the local economy. New Englanders have reduced their use of oil since the 1973-74 embargo, but given current energy demand forecasts and supply plans, the region will continue to depend heavily on oil through the 1990s.

Steps could be taken to significantly reduce future oil demand through increased conservation and the use of more indigenous renewable sources of energy, such as wind, hydropower, and wood.

GAO points out why such steps have not been taken and offers several suggestions and recommendations at the State, local, and Federal level that could help New England address its most critical energy problem--reliance on others for its energy needs.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the severity of New England's dependence on imported oil for electrical generation and other uses. The report offers suggestions on how New England can alleviate its problem through use of more conservation and alternative energy sources and points out that a more effective effort by the Department of Energy and appropriate regional bodies will be required, along with the possible need for future Federal actions.

We made this review to see whether existing and potential Federal programs are needed to reduce New England's dependence on imported oil through use of conservation and renewable resources. This is the fourth in our series of reports dealing with energy alternatives in various regions of the country.

Copies of this report are being sent to the various State governments and other local entities in New England; the Director, Office of Management and Budget; the Secretary of Energy; and interested members and Committees of the Congress.

Sincerely yours,

Milton J. Socolar

Acting Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

NEW ENGLAND CAN REDUCE ITS OIL DEPENDENCE THROUGH CONSERVATION AND RENEWABLE RESOURCE DEVELOPMENT

DIGEST

About 80 percent of New England's energy needs are met by oil, primarily foreign imports. As a result, electric rates and heating bills in the area are among the highest in the Nation. The region is vulnerable to oil supply disruptions and its economy is drained of dollars to pay for foreign oil. (See pp. 1-2.)

New England has made significant strides since the 1973-74 oil embargo in its efforts to reduce oil consumption and has other actions planned or underway. It is using about 12 percent less oil now for heating and generating electricity than it did before the embargo. This is due to increased use of nuclear power and conservation measures spurred by rising oil prices. The New England Power Pool, an association of electric utility companies in New England, has other actions planned that it forecasts will more than double present nuclear power generation and significantly increase the use of coal by the year 2000. (See pp. 7-10.)

New England must face some hard decisions in the future and be prepared to take even more stringent measures if its dependence on uncertain and increasingly expensive supplies of oil is to be reduced. (See p. 37.)

ARE FURTHER REDUCTIONS ACHIEVABLE?

To assist in determining the potential for further oil use reductions, GAO employed the services of an energy consulting firm. The consultants concentrated on further use of conservation and alternative supply sources, and concluded that substantial oil savings can be achieved by policies which emphasize conservation and renewable resources. The consultants projected a considerably lower demand for electrical energy in the year 2000 than did the New England

Power Pool, but even with this lower demand concluded that by the year 2000:

--Alternative supplies of energy could reduce oil consumption for electricity generation by 49 percent or 29 million barrels. (See p. 22.)

--Increased conservation could reduce oil consumption by 57 million barrels (156,000 barrels a day) for electricity generation (42 million barrels) and heating (15 million barrels). (See p. 20.)

If the New England Power Pool demand forecasts are used, the potential for oil savings would presumably be even greater (as would the need).

The types of actions considered in achieving these reductions include such things as appliance and lighting efficiency standards, electric space heat regulation, voltage regulation, passive solar energy requirements in new construction, increased use of wood, tidal power, solid wastes, etc. (See pp. 17 et seq.)

WHY AREN'T THESE MEASURES BEING IMPLEMENTED?

Many of these actions admittedly require hard decisions; others apparently require a more unified regional approach than presently exists. (See p. 35.)

Further reductions of oil consumption will probably require a more effective regional effort by the Department of Energy, the New England States, utilities, and appropriate regulatory bodies. (See p. 36.)

The Federal Government has no direct involvement in electric power planning, generation, transmission, or regulation in New England as it does in the Tennessee Valley or Pacific Northwest. Also New England's regional organizations have no authority in these areas and the region's utilities generally have not been aggressive in promoting conservation and/or alternative supply options because they have little economic or regulatory incentive to do so. Therefore, the New England States, through their public utility commissions, must play the primary role in working with the utilities to increase conservation and the use of renewable resources. (See pp. 35-36.)

OBSERVATIONS

Many of the actions to be taken to achieve oil savings can be achieved through actions by the New England State legislatures, regulatory commissions, regional utilities and energy suppliers. Accordingly, GAO offers the following observations:

--New England State legislatures should consider laws to continually improve energy efficiency in such areas as appliances, buildings, and lighting. In addition, the merits and impacts of controlling the installation of electric resistance space heating must be assessed.

--Electric utility plans need to reflect the potential from conservation and alternative supplies.

--States, through regulatory commissions, siting councils, and State energy offices, need to assure that utilities' plans include potential conservation and alternative supply options.

--State Public Utilities Commissions (PUCs) need to develop economic and regulatory incentives that will motivate utilities to pursue conservation and alternative supply options.

--Each State PUC needs to identify the energy, regulatory, and economic policies that are shaping utility policies and determine whether appropriate emphasis is being placed on policy options such as conservation and cost-effective renewable energy resources.

--State PUCs, energy offices, and siting councils need to work with regional energy planners to maximize development of indigenous resources that can help reduce reliance on imported oil.

--States need to establish a responsibility center with the goal of reducing oil used for heating. (See pp. 37-38.)

RECOMMENDATIONS

At present, the problem is a matter for State and local rather than Federal resolution. However, some Federal action may be needed. GAO recommends that the Secretary of Energy establish a responsibility center in the New England regional office to assist the New England States by:

--Monitoring utility plans and State oversight of those plans and helping to assure that conservation and alternative supply options have been considered in utility forecasts.

--Working with State utilities commissions and regional utilities to identify the energy, regulatory, and economic policies that influence utility policies and determine possible changes which would better assure that all options are included in formulating those policies.

--Assessing utility forecasting methods and providing advice and input in power supply/demand alternatives.

--Preparing a plan for regulatory intervention to be used when DOE's oversight of electric power planning--at State utility commission or utility company level--indicates that all options are not being given adequate consideration.

--Providing technical assistance and other support, as necessary, to State regulatory commissions to help improve the quality of electric power planning. (See p. 39.)

MATTERS FOR CONSIDERATION OF THE CONGRESS

Our recommendations above are based on the premise that the Federal role should be one of supportive oversight to improve the quality of electricity planning and the regulatory review process. The utility industry should continue to have primary responsibility for planning and operating the regional power system.

In view of the long-term nature of the demand and supply projections, DOE should keep abreast of New England's progress in reducing oil consumption and determine whether stronger measures are required. If DOE determines that sufficient progress is not being made, then it should request that the Congress consider stronger measures. These measures could include the establishment of a regional power planning board or a regional power authority.

It should be stressed that the preferred method of achieving the conservation and alternative energy options is to work with the existing institutions and regulatory infrastructure. The Federal Government has not traditionally played a direct role in electricity planning or regulatory review and has left this up to the States and utilities. Accordingly, we are not recommending, at this time, that this be changed. (See p. 39.)

AGENCY AND UTILITY COMMENTS

Comments on GAO's draft report were obtained from the New England Power Pool, State offices, and involved branches of the Federal Government.

The comments varied considerably as to opinions on the adequacy of past and planned efforts to reduce oil consumption, the extent of future reductions achievable, and how best to achieve such reductions. These comments in themselves tend to demonstrate the need for a more dynamic and cohesive regional approach to the problem.

The Department of Energy, for example, pointed out the need to consider additional use of coal and nuclear power beyond that now planned, and the potential for savings in the transportation sector. The Rhode Island Public Utilities Commission pointed out the potential of imported hydropower and natural gas from Canada. The State of Maine was supportive of the objective of increased conservation and alternative sources, but expressed reservations about localized appliance efficiency standards. The New England Power Pool seemed to suggest that the utilities were already doing as much as could reasonably be expected, and it challenged many aspects of the GAO forecasts.

Most respondents opposed the idea of more legislation, increased Federal involvement, or a possible regional power authority, but the Rhode Island Public Utilities Commission felt a regional board or authority was needed now. The Department of Energy felt that a Federal role should be limited to technical assistance to the New England States and utilities.

GAO believes the diversity of these comments demonstrates the disparity of viewpoints on how best to solve New England's oil dependency problem. They also go far in explaining why many actions have not been taken, and show the need for a cohesive regional approach.

The variety of actions proposed in addition to those considered by GAO also suggests that considerable potential exists for additional reductions in the use of imported oil. (See pp. 41-47.)

Contents

VOLUME I

ABBREVIATIONS

Btu	British thermal unit
DOE	Department of Energy
FRC	Federal Regional Council
GAO	General Accounting Office
GWH	gigawatt-hours
KWh	kilowatt-hour
MMB	million barrels
MW	megawatts
NEEC	New England Energy Congress
NEPOOL	New England Power Pool
NERC	New England Regional Commission
PUC	Public Utility Commission

VOLUME II

<u>GLOSSARY</u>

alternative electricity sources	Generating and generation-displacing options to coal-fired and nuclear electricity generating facilities. Options include conservation, cogeneration, wind energy systems, and hydropower.
baseload	The minimum load in a power system over a given period of time.
capacity	Maximum power output, expressed in kilowatts or megawatts. Equivalent terms: peak capability, peak generation, firm peakload, and carrying capability.
cogeneration	The simultaneous production of electricity and useful heat.
conservation	Improving the efficiency of energy use; using less energy to produce the same product.
degree-day (heating)	A measure of the coldness of the weather experienced based on the extent to which the daily mean temperature falls below a reference temperature usually 65 degrees F. Degree-days are accumulated during a predetermined heating season for annual comparisons to assist in delivering fuels.
demand	In an economic context, the quantity of a product that will be purchased at a given price at a particular point in time.
demand forecast	Projection of the future demand for electricity. Various types of demand forecasting models include trending, econometric, and engineering or end-use.
econometric model	A forecasting model based on assumed relationships between electricity consumption and general demographic

	and economic variables such as gross national or State product, prices of electricity and competing fuels, prior year's electricity sales, and population.
electricity planning	Procedures used to develop electricity plans. Procedures address forecasting, analyzing options, and public participation.
electricity plans	Determination of supply sources (e.g., nuclear, coal, alternatives) which will satisfy projected electricity demand.
end-use (engineering) model	A forecasting model relying on a detailed enumeration of all energy-using equipment that is expected to be functioning during the forecast period. A use rate is applied to each type of equipment to forecast total energy consumption.
energy	The ability to do work, the average power production over a stated interval of time; expressed in kilowatt-hours, megawatt-hours, average kilowatts, or average megawatts. Equivalent terms: energy capability, average generation, and firm-energy-load-carrying capability.
gigawatt	The electrical unit of power which equals 1 billion watts.
hydropower	A term used to identify a type of generating station, or power, or energy output in which the prime mover is driven by water power.
investor-owned	A utility which is organized under State laws as a corporation for the purpose of earning a profit for its stockholders.
kilowatt	The electrical unit of power which equals 1,000 watts.

load	The amount of electric power delivered to a given point on a system.
load management	Influencing the level and state of the demand for electrical energy so that demand conforms to individual present supply situations and long-run objectives and constraints.
megawatt	The electrical unit of power which equals 1,000,000 watts or 1,000 kilowatts.
municipal utility	A utility owned and operated by a city.
offpeak	A period of relatively low system demand for electrical energy as specified by the supplier, such as in the middle of the night.
peaking	Operation of generating facilities to meet maximum instantaneous electrical demands.
peaking capacity	Generating equipment normally operated only during the hours of highest daily, weekly, or seasonal loads. Some generating equipment may be operated at certain times as peaking capacity and at other times to serve loads on a round-the-clock basis.
peakload	The maximum electrical load consumed or produced in a stated period of time. It may be the maximum instantaneous load (or the maximum average load) within a designated interval of the stated period of time.
power	The time rate of transferring or transforming energy; for electricity, expressed in watts. Power, in contrast to energy, always designates a definite quantity at a given time.

reliability	Generally the ability of an item to perform a required function under stated conditions for a stated period of time. In a power system, the ability of the system to continue operation while some lines or generators are out of service.
reserve capacity	Extra generating capacity available to meet unanticipated demands for power or to generate power in the event of loss of generation resulting from scheduled or unscheduled outages of regularly used generating capacity. Reserve capacity provided to meet the latter is also known as forced outage reserve.
time-of-day pricing	Rates imposing higher charges during those periods of the day when the higher costs to the utility are incurred.
trend forecast	The forecast that relies heavily on historical consumption patterns to project future consumption.

CHAPTER 1

INTRODUCTION

New Englanders' 1/ electric rates are about 33 percent higher than the national average and their heating bills are among the highest in the Nation. The main reason for this is that the region's primary fuel is oil--accounting for about 79 percent of all energy needs. Also, since about 87 percent of New England's oil is foreign imports and the other 13 percent comes from domestic sources outside the region:

--The region is highly vulnerable to international oil supply disruptions and escalating world oil prices.

--The region's economy is drained as dollars leave New England to pay for oil.

Dependence on foreign oil is a national problem; however, it is especially acute in New England. This report discusses the potential for increased conservation and the use of renewable resources, two approaches emphasized by the National Energy Act of 1978. These two options are available in New England and would tend to keep energy dollars in the region. Increased use of coal, nuclear power, domestic oil, and domestic gas should also be considered.

There are problems associated with every available option--environmental, health, safety, transportation, and availability problems--and some difficult choices will have to be made. However, the solutions found in New England may well point the way for other parts of the country in years to come.

NEW ENGLAND'S ENERGY MIX

New England depends heavily on distillate oil to heat homes and residual oil to generate electricity. This is reflected in the following comparison of total energy sources for

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1/New England is a six-state region including Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

New England and the United States for 1978, the most recent year for which we have complete statistics. 1/

Table 1

Total Energy Consumption by Source

	New England	United States
Distillate fuel oil	22%	9%
Residual fuel oil	27	9
Motor gas	23	19
Other oil	7	12
Coal	1	18
Natural gas	9	25
Hydro	1	4
Nuclear	10	4
Total	100%	100%

Factors which contributed to New England's current oil dependence

New England's oil dependence resulted from fuel-use decisions made during the 1960s when oil had economic and environmental advantages over other fuels.

Distillate oil cornered the region's market for space heating because it was cleaner and more convenient than coal and more available than natural gas. For electrical generation, residual oil offered utilities economic advantages over coal in meeting the Federal and State clean air standards and in transportation costs. Also, while the rest of the country was subject to an oil import quota from 1959 to 1973, New England gained an exemption from this quota for residual fuel oil, which allowed the region ready access to foreign oil.

The following comparison of the region's generating fuel mix for the years 1965 and 1979 shows how the use of residual oil to generate electricity has increased in New England.

1/Data for 1979 was not available from the Department of Energy (DOE) at the time of our field work because of a delay in finalizing DOE's Annual Fuel Oil Sales Report (DOE/EIA-0113).

Table 2

Thousands of Gigawatt-hours (GWH) Produced by Generating Source

	1965	1979
Oil	11.2	43.4
Coal	23.2	2.9
Natural gas	1.2	.7
Nuclear	.8	26.8
Hydro	3.6	4.5
Total	40.0	78.3

In other words, residual oil generated nearly four times more electricity in 1979 than it did in 1965. About 72 million barrels of oil were burned by New England utilities in 1979.

OBJECTIVES, SCOPE, AND METHODOLOGY

This is the fourth in our series of reports dealing with various regions of the country. We have previously issued reports on the Pacific Northwest, the Pacific Southwest, and the Tennessee Valley. Two important factors which set New England apart from the other three regions are:

- --New England does not have a large Federal power marketing agency such as the Bonneville Power Administration, the Western Area Power Administration, or the Tennessee Valley Authority. It has a utility industry made up of about 112 investor-owned, cooperative, and municipal electric companies which have regionalized their operation through membership in the New England Power Pool.

- --Only a small percentage of New England's homes (about 10 percent) are heated by electricity, while over 65 percent are heated by oil. Therefore, a heating oil shortage could place a severe strain on the region's electric system.

There are many reasons for treating New England's energy situation on a regional scale:

- --Many previous studies of the energy situation have treated New England as a distinct region.

--There are a number of regional organizations dealing with energy in New England, including the New England Regional Commission (NERC), Federal Regional Council, (FRC), New England Energy Congress (NEEC), and the New England River Basins Commission among others.

--New England's electric utility companies have regionalized their generating and transmission operations through membership in the New England Power Pool (NEPOOL).

The objective of this report is to discuss and analyze how greater use of cost-effective conservation and renewable resource options can help New England reduce its dependence on imported oil for heating and electrical generation. We chose to emphasize these two options because by promoting conservation and indigenous renewable energy sources, New England can directly address its most critical energy problem: reliance on others for its energy needs.

This study assumes that the April 1980 capacity expansion plans of the New England utility industry will be accomplished as scheduled. These plans include 4,600 megawatts (MW) of nuclear power (four units), 1,970 MW of coal-fired capacity (three units), 510 MW of oil-fired capacity (two units), and 150 MW of solid waste capacity (two units), all scheduled to be completed before the year 2000. It is possible that the utility industry could bring additional nuclear or coal capacity on line to decrease its oil use. However, it was not our objective in this study to evaluate additional non-oil supply options other than conservation and renewables.

Likewise, it was not our objective to address the region's use of petroleum for transportation. The transportation sector obviously has a great influence on oil consumption and has sufficient importance to be a study in itself.

We discussed New England's energy situation with officials at all levels of government, utility companies, and others listed in appendix I. We found many different opinions and points of view regarding the region's energy demand forecasts, the potential of conservation and alternative sources, and the strategies available to help solve New England's energy problem. Because of the variety of these opinions and points of view, we wanted to obtain some measurement of the impacts that applying various conservation and renewable resource policy options could have on the region's oil consumption.

To measure these impacts, we employed the services of an energy consulting firm 1/ which has this capability as well as recognized expertise in a wide variety of related energy matters.

The consultants used an end-use energy forecasting model to develop projections of New England's energy needs through the year 2000 under three policy options:

--A base case, or "business as usual" option, was developed to determine New England's long-range energy demand forecast. This case is based on current technical, economic, and policy trends and provides a benchmark for energy demand which can be used to measure the impact of other options on oil consumption.

--A conservation case which assumes vigorous promotion of cost-effective conservation measures which are not likely to occur without additional policy action. This case determines how much oil can be saved by applying conservation measures that are technically feasible, that do not increase overall social costs, and that may require additional public actions. This case assumes that electricity savings from conservation would first displace oil-fired generation. This assumption is valid through the year 2000 unless (1) the utilities are able to bring more coal and/or nuclear power on-line than is currently planned or (2) electrical demand in the region drops unexpectedly.

--An alternative supply case which examines the potential for using six renewable energy sources for generating electricity as a substitute for oil. The six renewable resources were selected for both technical feasibility and cost effectiveness over the 20-year period.

In addition, the consultants analyzed the impact which the conservation case would have on New England's economy.

The conservation and supply scenarios are designed to identify how much oil could be saved by pursuing technologi-

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1/Energy Systems Research Group, Inc., 120 Milk Street, Boston, Mass.

cally feasible and cost-effective alternatives to the base case. The scenarios represent reasonable targets to encourage the development of policies and programs to save oil. Our scenarios did not maximize the technological potential attainable under the conservation and alternative supply options. On the contrary, we quantified the potentials which appear to be cost-effective according to fairly conservative criteria.

The scenario analysis was not designed to represent an alternative capacity expansion plan for the New England utilities, or a detailed conservation plan for the regional utilities or other organizations. However, it was necessary to make certain analytical decisions; for example, NEPOOL's projected capacity expansion program was included in order to conduct the rest of our analysis in an effective and useful fashion. Another decision was to conduct a benchmark base case forecast of electricity use and of certain kinds of oil use in New England for a 20-year period, in order to be able to make systematic computations in the conservation case relative to some definite point of departure. Our intent was not to introduce this forecast as a capacity planning tool for the New England utility system. Had it been, much more time would have been spent on the actual forecasting process and less time analyzing the conservation and alternative supply potential relative to the forecast.

This report should be useful to the committees of Congress and regional and State policymakers in making informed choices about the role of conservation and renewable resources in New England's energy future.

The complete text of the consulting firm's analysis is available from GAO as Volume II (EMD-81-58A) of this report.

CHAPTER 2

NEW ENGLAND HAS REDUCED ITS OIL USE, BUT MORE OPPORTUNITIES EXIST

The Arab oil embargo of 1973-74 clearly demonstrated New England's vulnerability to international oil supply disruptions and the subsequent increasing oil prices have hit New England especially hard. By 1978 New England was using less oil than in 1972, but the amount of imported oil used in the region actually increased. Energy forecasts show that oil consumption may still be high in New England in the year 2000 in spite of past and planned oil reduction efforts. This chapter examines past reductions in oil use and looks at the potential ways to achieve further reductions.

OIL USE HAS CHANGED SINCE THE EMBARGO

New England's annual consumption of residual and distillate oil decreased between the pre-embargo year 1972 and 1978, the most current year for which we have complete data. 1/

Table 3

New England Oil Consumption
(million barrels)

	1972	1978	Percent decrease
Heating			
Home heating oil (no. 2)	97.8	91.2	6.8
Other distillates	9.1	7.7	15.4
Residual	45.9	29.3	36.2
Total heating	152.8	128.2	16.1
Electrical generation			
Residual	84.7	75.0	11.5
Total oil use	237.5	203.2	14.4

1/1979 data was not available from DOE at the time of our field work due to a delay in finalizing DOE's Annual Fuel Oil Sales Report (DOE/EIA-0113).

These 2 years provide a good comparison of oil consumption for heating because the number of degree-days in each was very close, 1978 being 1 percent colder (6,933 degree-days in 1972, 7,003 in 1978).

Oil for heating

There are two main reasons why New England's use of home heating oil declined during 1972-78: People who heated their homes with oil started using less, and some switched fuels--about 45,000 oil customers switched to natural gas, and there was a greater use of wood.

Using New England Fuel Institute and Department of Energy (DOE) data, we determined that the average home heating oil customer in 1978 used about 13.3 percent less oil (weather adjusted) than the average 1972 customer used. This decreased use was spurred by rising oil prices which went from about 20 cents per gallon in 1972 to 54 cents in 1978. By June of 1980 the price was almost $1.00. Oil customers turned back thermostats, added weather stripping and insulation, and started substituting other fuels, especially wood, in order to reduce their oil use.

Homeowners also started to burn more wood to meet their space heating needs, and this trend has continued in recent years. The Department of Agriculture conducted a New England Fuelwood Survey and in March of 1980 reported that during the winter of 1978-79,

--33 percent of all households in New England burned some wood,

--2.85 million cords of wood were burned,

--such burning represents a 9-percent increase over the previous winter (1977-78) and a 32-percent increase over the winter of 1976-77, and

--the 2.85 million cords equate to about 5.4 million barrels of home heating oil.

As for the 45,000 oil customers who switched to natural gas, they would have used about 1.7 million barrels of oil in 1978 if they had not switched.

Oil for electrical generation

The primary reasons for the 9.7-million-barrel decrease in residual oil burned to generate electricity in 1978 versus 1972 were the reduction in the electricity demand growth rate in New England and the increased use of nuclear power. From March of 1971 to December of 1975, five nuclear generating plants were opened in New England with a total capacity of about 3,500 MW. The operation of these nuclear plants helped reduce oil-generated electricty by about 5,000 GWH and changed the region's generating mix as follows:

	Thousands of GWH generated		Percentage of mix	
	1972	1978	1972	1978
Oil	52.1	47.3	76%	59%
Nuclear	9.5	28.0	14	35
Other	6.5	4.4	10	6
Total	68.1	79.7	100%	100%

In addition, conservation has slowed electricity demand growth, thereby having an impact on the amount of oil used. From 1966 to 1971, when electricity prices remained relatively constant at about 2.2 cents per kilowatt-hour (kWh), demand for electricity in New England rose at a rate of about 8 percent per year. From 1972 to 1979, as prices steadily rose to 5.1 cents per kWh, this growth rate slowed to a 2.9-percent average annual rate. One reason for this decline was a decline in the growth rate of industrial customers from about 1.8 percent a year to about 1.1 percent annually. Also, we found many examples which indicate that conservation has had a role in reducing the rate of electricity growth. For example:

--A large Connecticut company reduced the electricity demand at its headquarters offices by 9.4 million kWh per year by reducing lighting to adequate levels, using more efficient lighting fixtures, and changing operating procedures.

--Each State in the region has implemented lighting standards for public buildings which have reduced electricity use.

--More consumers are considering making their own electricity through cogeneration or developing small hydropower sites.

If the growth rate for electricity had continued at 8 percent from 1972 through 1978, demand in that year would have been some 28 billion kWh higher and this demand would have been met by burning an additional 47 million barrels of residual oil, making the oil dependency problem much worse than it is now.

OPPORTUNITIES TO FURTHER REDUCE OIL IMPORTS

While past efforts to reduce oil consumption have helped New England's oil situation, and more are planned, indications are that more needs to be done. Using New England Power Pool projections, New England's use of oil to generate electricity may increase by the year 2000, despite significant increases in its use of coal and nuclear power. Obviously, every facet of energy supply needs to be examined to find more ways to assure a real decline in oil use. Following is a discussion of several supply options, including conservation, increased availability of natural gas, conversions of oil-fired plants to coal, nuclear plants, and renewable resources such as wood, wind, hydropower, solid wastes, and tidal power.

Conservation

Studies of New England's energy situation have estimated varying amounts of energy which could be saved through both residential and industrial conservation. In fact, the New England Energy Congress calls conservation "the most sensible and effective strategy for facilitating our transition to a more desirable energy mix." For example, it projects potential savings for residential conservation through various levels of investment in weatherization and increasing heating system efficiencies beyond what is already being done as follows:

Level of investment $, billions (note a)	Potential Savings			
	Trillion British thermal units (Btus)	Percent	Oil equivalent (note b) MMB	Oil equivalent (note b) ($, billions)
$ .95	128	18	22.0	$ .77
4.00	276	38	47.4	1.66
7.30	386	54	66.3	2.32
12.40	515	71	88.4	3.09

a/Of which $50 million represents increased heating system service costs which must be spent each year, and remainder is a one-time investment.

b/Assumes 5.825 million Btu's and $35 per barrel of oil.

Since some houses are heated by gas, wood, or electricity, actual oil savings would be about 75 percent of oil equivalent figures. Considerable energy savings potential also exists in the commercial and industrial sectors. For example, the Massachusetts Governor's Commission on Cogeneration estimated the potential capacity for cogeneration in New England at 1,700 MW by the mid-1980s which could result in saving 10 million barrels of oil per year. Also, energy experts 1/ point out that while conservation is proceeding more rapidly in the industrial sector than the rest of the economy, there is still considerable energy savings potential in this sector.

Potential savings, however, will only be achieved through the actions of many parties. The savings ultimately achieved will depend on the policies mandated at the Federal, State, and local level; policies practiced by the utilities; the rate of return that consumers will require for their voluntary conservation investments; and the quality of work performed on conservation measures. So while there may be disagreement over potential savings available in the region, it seems safe to say the region has a great opportunity to reduce oil consumption through conservation.

Alternative energy sources

Prospects of future oil shortages are making the technologically feasible alternatives of wood, hydropower, wind, solid waste and tidal power attractive in New England. Rising oil prices are also improving the economic feasibility of these alternatives to a point where the number of profitable sites is increasing and so is the probability that they will

1/R. Stobaugh and D. Yergin, Energy Future, New York: Random House, 1979, p. 155.

be developed between now and the year 2000. 1/ Also, government incentives, such as offering small developers attractive rates for their power or providing funding or financing for alternative energy development, could increase the number of economically feasible sites. There are other alternatives being developed, such as photovoltaics, ocean power, and district heating. However, we feel their chances of commercialization are not as good as the alternatives discussed in this report.

Each of these alternative supply sources has barriers and trade-offs associated with it, and these must be considered and dealt with in developing them into any future supply mix.

Wood

Wood is an abundant resource in New England, totaling about 31 million acres, or 80 percent of New England's land area. It has potential energy use for space heating, steam, electrical generation, and alcohol, as well as its other uses for building materials, pulp, paper, and furniture.

Increasing amounts of wood are being burned for residential space heating. Also, utilities are evaluating its use to generate electricity with one 7-MW plant already operating and a 50-MW wood-fired plant being planned.

Wood is a renewable resource but woodlands must be properly managed to guarantee reliable supplies over a period of time. For example, a 50-MW electrical plant requires the managed sustainable yield from large areas of woodlands--the Northeast Solar Energy Center estimates as much as 250,000 acres. Also, since there is not an established wood supply network in the region, there is concern that the uncontrolled harvesting of cord wood will result in a depletion of wood resources and degradation of the land. Competing uses for wood and the lack of equipment to harvest, transport, and process wood economically are other factors which affect wood's chances of reaching its energy potential.

Hydropower

New England's hydropower potential lies in the rehabilitation of some 1,700 existing small dam sites, an undetermined number of new small dam sites, the 944-MW Dickey-Lincoln hydropower project, and 17 other conventional hydropower sites with potential of 975 MW. Rising electricity prices are improving the economics of developing the small dam sites, but high interest rates are having a negative impact on their economic feasibility and development potential.

1/ More details on the cost-effectiveness of these options are presented in app. II.

Barriers to developing existing dam sites include competing uses for rivers (navigation, recreation, etc.), complicated water rights issues, ownership of the dam sites, and environmental concerns.

Wind

New England offers good potential for wind power. For example, one study prepared for the National Service Foundation found that the region's highest wind potential is during summer afternoons. Since this corresponds to the summer peak electric demand period, wind power could have an impact on reducing the oil used to meet the summer peak.

The cost-effectiveness of wind systems depends primarily on the initial cost of the system and the average wind speed at the particular site. Small wind energy systems (100 kilowatts or less) are already economically feasible for certain applications. The cost-effectiveness of large-scale wind systems is uncertain at this time. Other factors which will have an impact on the development of wind systems are

--interconnection and sale of wind-generated electricity to utilities;

--environmental concerns (mainly, aesthetics and interference with communications signals), and

--legal and regulatory problems such as siting, zoning, and building codes.

Solid Waste

Solid waste can be burned directly to produce steam or it can be converted to a dry powder and mixed with oil or coal. Large solid waste to energy systems (i.e., over 1,000 tons per day) are economically feasible in metropolitan areas where large amounts of wastes are available with relatively low transportation costs and there are nearby customers willing to buy the steam or electricity produced. Smaller (100-450 tons per day) plants may also be feasible if there is a steady supply of wastes and a market for the resultant energy.

There has been a growing interest in solid waste facilities as they represent a way for New England to dispose of its solid waste while also contributing to the region's energy needs. Early in 1980, New England had 7 solid waste to energy facilities operating or under construction and 23 others in the planning stage. These facilities generally range in size from 100 to over 2,000 tons per day.

Solid waste projects will impact on New England's future energy mix. However, cooperation from the region's utility industry and regulatory agencies is necessary to facilitate the development of solid waste projects.

Tidal power

The technology is available for using the tides to generate electricity, and tidal electric generating plants are operating in France, the Soviet Union, and China. The upper Maine coast (Passamaquoddy Bay area) offers the greatest potential for tidal in New England, but studies conducted by the Army Corps of Engineers on these sites so far have concluded that development of Passamaquoddy is not economically feasible.

Some constraints to the development of tidal power are the high capital cost of construction and equipment, the concurrence between the tidal changes and the need for the electrical demand, and environmental concerns.

COAL, NUCLEAR, NATURAL GAS, AND DOMESTIC OIL

Construction of nuclear capacity, conversion of oil plants to coal, and switching from oil to natural gas for heating have all made a contribution to oil reductions in the region, and aditional use of these fuels should have the same effect in the future. While the major emphasis of this report is on conservation and renewable resources, a number of activities are taking place in coal, nuclear, natural gas, and domestic oil, and these are briefly discussed below.

Coal

Most of New England's coal potential lies in conversion of oil-fired generating plants to coal and a new coal-fired generating plant proposed at Sears Island in Maine.

DOE has 33 New England generating plants on its coal conversion "hit list," but of these only 3 units at Brayton Point have been converted, representing 1,152 MW of capacity. The 33 plants on the list have a total capacity of 5,445 MW. It seems unlikely that all 33 plants will be converted given current State air quality standards and the high costs of conversion. Legislation was introduced to the Congress in 1980 which would provide grants to utilities to help defray the costs of conversion. While this legislation was not passed in 1980, similar legislation has already been re-introduced in the current session and vigorous implementation of coal conversion in New England could significantly reduce the region's oil use.

In 1979, the State of Maine turned down the proposed 570-MW Sears Island plant. An official at Maine's Office of Energy Resources told us that the plant was turned down at this time because additional capacity was not needed and that another location should be found to take advantage of the plant's waste heat. However, the utility is expected to re-submit its application for the new coal plant.

Nuclear

Presently, New England utilities have plans to construct four new nuclear powerplants by 1990, adding about 4,600 MW of capacity to the approximate 4,200 MW of present nuclear capacity. Earlier utility plans called for the construction of 10 nuclear plants with total additional capacity of about 11,700 MW. However, because of reduced demand, rising costs, environmental, health, operational safety, and other problems, the utilities' plans for growth in nuclear generating capacity have been slowed. Nevertheless, additional nuclear power does represent a non-oil alternative to the region.

Natural gas

Increased conversions to natural gas could reduce oil use, but this would be switching from one expensive fossil fuel to another which would also have to be imported from outside the region. However, increased use of natural gas does represent an alternative to the program. Deregulation of natural gas prices is expected to increase availability of domestic gas in New England and there are preliminary plans to import an additional 335 million cubic feet of gas per day from Canada.

Potential oil/gas on
Outer Continental Shelf

Additional oil and natural gas may be available off the New England coast on Georges Bank. The Department of the Interior has been trying to lease this area for exploration; however, there has been considerable litigation which has delayed exploratary drilling because of environmental concerns.

This exploratory drilling may now begin as early as the summer of 1981. Estimates of the potential oil and gas reserves vary, but it should be noted that Outer Continental Shelf oil and gas may be available by the year 2000 and could directly benefit New England.

CONCLUSIONS

While New England's past efforts to reduce oil consumption are commendable and have accomplished much, more must be done if a significant reduction in the region's dependence on expensive and uncertain supplies of imported oil is to be achieved.

All the options discussed above have some potential and should also be examined. We concentrated our analysis on two options--increased conservation and greater use of renewable resources because these options can directly reduce New England's reliance on others for its energy needs. The following chapter presents our analysis of these two options.

CHAPTER 3

ANALYSIS OF THREE ALTERNATIVE ENERGY POLICIES FOR NEW ENGLAND

As shown in chapter 2, New England has many opportunities to diminish oil consumption through conservation and alternative supply sources. We examined the potential oil savings available through pursuit of a number of different conservation policies and alternative energy supply options through the year 2000. We used a model to analyze three alternative policy sets: a business-as-usual case (base case), assuming continuation of present regional plans; a conservation case which addresses the region's oil consumption for electricity generation and heating, assuming vigorous conservation; and an alternative supply case which addresses various non-oil supply options for electricity generation. These cases are printed in volume 2 of this report, and a summary report appears in appendix II of volume I. The consultants also determined the employment impact of implementing the conservation case, since these impacts are not as apparent as the employment impacts of constructing large powerplants.

For purposes of comparison, we have also included in this chapter the electrical forecast and construction plans of New England's utilities as published by the New England Power Pool. NEPOOL is a regional utility entity which coordinates and dispatches virtually all electrical power from the region's generating stations. NEPOOL also forecasts peakloads and electrical demand for the region through the year 1995.

ALTERNATIVE POLICY SETS

Base case

Our purpose in developing a base case is to determine what New England's oil consumption would be if the region followed its current plans in a "business as usual" manner. It includes energy use trends, policies, and regulations which are presently in effect and projects their impact through the year 2000. It provides a benchmark for energy demand which can be used to measure the impact of the conservation and alternative supply cases.

The forecasting model breaks down energy use into various components within the three major energy-consuming sectors--residential, commercial, and industrial. The residential sector provides data for 14 end-uses including major appliances, lighting, heating, and cooling. The commercial sector provides for four end-uses within five different building types--retail, hospitals, schools, office, and other. The industrial sector includes data for each of 19 standard industrial classifications. The study also assumes all generating plants now under construction or planned by the utilities 1/ are developed on schedule.

Our base case forecast is really an average of a high and a low forecast which were constructed to reflect the forecast uncertainty which is present under "business as usual" conditions. The high/low forecasts use different assumptions for such inputs as population, income, electricity prices, and oil and gas prices, appliance saturations, heating penetration, and production and employment growth. (All assumptions are explained in detail in technical appendix I, pp. 61-106). For example, the high case forecast assumes that incomes in the region will rise at annual real growth rate of 1.5 percent and the price of electricity at 1.0 percent. The low case forecast assumes incomes will rise at 0.5 percent and electricity prices at 2.5 percent.

It may be noted that our base case shows somewhat lower growth in demand than the NEPOOL forecast. NEPOOL's forecasting model and the one we used are similar in that they both incorporate a considerable degree of end-use detail. However, there are a number of possible reasons for the difference in the forecasts. For example, our consultants stated that the models use different demographic and economic assumptions and the NEPOOL model is more sensitive to price changes and historic trends than the model we used.

We found the base case would:

--Result in an electricity growth rate of 1.64 percent to the year 2000, compared to NEPOOL's 2.6 percent growth rate through 1995.

--Require about 59 million barrels of oil for electrical generation by the year 2000, compared to about 76 million used in 1978. If NEPOOL's growth rate is used, about 112 million barrels would be required by the year 2000, unless additional non-oil capacity is brought on line between 1995 and 2000.

1/

Plant	Units	Fuel	Capacity (MW)
Stony Brook	2	Oil	510
Seabrook	2	Nuclear	2,300
Pilgrim	1	Nuclear	1,150
Millstone	1	Nuclear	1,150
Sears Island	1	Coal	570
Edgar	1	Coal	800
Canal	1	Coal	600
Mass. Municipal Wholesale Electric Companies	2	Refuse	150

--Require about 96 million barrels of oil for heating in the year 2000, compared to about 116 million used in 1978.

Conservation case

The purpose of our conservation case is to see how much oil could be saved by vigorously implementing feasible, socially acceptable, cost-effective measures which are not likely to be implemented without additional government action. The conservation case includes conservation criteria such as:

--The conservation measures are technically feasible.

--The measures do not increase the overall social costs for energy services.

--The measures require the stimulus of additional public actions for implementation.

The conservation case modifies the base case model by injecting assumptions for specific policy measures in the following elements, while leaving the other base case assumptions unchanged:

Residential Sector

Appliance Efficiency Standards
Lighting Efficiency Improvements
Building Envelope Standards
Plumbing Fixture Efficiency Standards
Electric Space Heat Regulation
Voltage Regulation

Commercial Sector

Building Envelope Standards
Passive Solar Energy Requirement in New Construction
Heating, Ventilation and Air Conditioning System Equipment Efficiency Regulations
Heating, Ventilation and Air Conditioning Operations Requirements
Internal Load Requirements (lighting levels and ventilation rates)
Electric Space Heat Regulation
Voltage Regulation

Industrial Sector

Cogneration Regulation and Incentives (utility ownership mandate, utility directives, back-up rate review)
Industrial Conservation Program (services, audits, outreach)
Building Envelope Standards

For example, the conservation case assumes a policy of minimum efficiency standards for nine appliances to be implemented in two places in 1983 and 1988. (The specific assumptions regarding these minimum efficiencies may be found in Volume II, Technical Report II, pages 16-25). We feel these minimum efficiencies are somewhat cautious because our 1988 standards are less efficient than the proposed DOE standards announced in June 1980 and scheduled to be implemented in 1986. Like the base case forecast, our conservation case forecast is also an average of a high and a low forecast.

The conservation case also assumes that electricity savings from conservation would first displace oil-fired generation. This assumption is valid today as New England utilities burn oil every minute of the day to generate electricity and oil is the marginal fuel. This assumption is valid for the future given our base case projection and the April 1980 utility expansion plans. However, if our base case projection proves to be accurate and the utilities are able to bring more nuclear and/or coal capacity on line than shown in their April 1980 plans, then it is possible that at some time our conservation measures would displace coal or nuclear-generated electricity and projected oil savings would be overstated.

Other measures in our conservation case, such as the ban on electric resistance space heating, may be somewhat controversial but are justified on several grounds--energy conservation, social cost reduction, and scarce fuel management.

We found that by the year 2000, the conservation case would make the region more self-sufficient by:

--Reducing the region's annual oil consumption by about 57 million barrels (37 percent), as compared to the base case. This represents a savings of about 156,000 barrels per day.

--Requiring 42 million barrels (72 percent) less oil to generate electricity, as compared to the base case and about 95 million barrels less than NEPOOL's projections.

--Requiring about 15 million barrels (15 percent) less oil for space and water heating, as compared to the base case.

--Creating a net cumulative increase of about 335,000 new jobs region-wide, as compared with the base case. A kilowatt-hour of electricity saved would create more employment than producing a kilowatt-hour of electricity.

--Reducing the average annual growth rate of electricity to 0.4 percent, as compared to the base case of 1.64 percent and NEPOOL's 2.6 percent.

--Reducing the annual use of oil for heating from 1978's 116.5 million barrels to 81.4 million barrels (a 30-percent reduction) by the year 2000.

We also found that in the conservation case:

--The reductions in electricity demand are evenly distributed percentage-wise among the three market sectors--residential, commercial, and industrial.

--The implementation of appliance efficiency, lighting, and plumbing standards could account for electricity savings of about 4,440 GWH (or 20,300 barrels of oil per day) in the residential sector in the year 2000, or about one-half of electricity savings in the residential sector.

Alternative supply case

This case examines the alternative energy sources for generating electricity as a substitute for oil. The options were selected for both technical feasibility and cost effectiveness over the 1978 to 2000 period. However, no consideration has been given to institutional or environmental constraints which might limit the realization of the potentials. The alternative sources of energy are added to the regional electricity capacity expansion plan included in the base case. Furthermore, the alternative supply case options are assumed to displace oil-fired generation.

The contributions of each option are included in the alternative supply case as shown in table 4.

Table 4

Alternative Electric Generation Potential in New England Beyond Base Case Quantities

	1990		2000	
	Capacity (note a) (MW)	Annual electric generation (note b) (GWH)	Capacity (note a) (MW)	Annual electric generation (note b) (GWH)
Wind	500	1,300	2,900	7,600
Municipal solid waste (MSW)	480	2,310	850	4,100
Hydropower				
Small Hydro	510	1,790	510	1,790
Conventional Hydro	195	420	580	1,300
Tidal	12.5	40	710	1,800
Wood	30	180	80	490
Total	1727.5	6,040	5,630	17,080

a/Potentials are based on technical feasibility and cost effectiveness with no consideration of institutional or environmental constraints which might limit the realization of these potentials.

b/Calculations reflect capacity for each source times appropriate capacity factors.

The table of supply sources shown above presents the contribution of these resources only for centralized on-grid electricity generation.

We found the alternative supply case would:

--Reduce oil consumption for electricity generation by about 49 percent (29 million barrels per year) in the year 2000, compared to the base case for that year.

--Make the region more self-sufficient by relying more on indigenous resources and less on imported oil.

COMPARISON OF THE IMPACTS OF THE THREE POLICY SETS

Oil for heating--base and conservation cases

About 67 percent of New England's homes are heated by oil. Therefore, we wanted to see how much of this oil usage, along with oil being used for water heating and commercial and industrial space heating, could be saved. We found that oil use for space and water heating can be reduced in New England by implementing the conservation case. Figure 1 summarizes the conservation case impact on oil consumption for space and water heating as compared to the base case. By the year 2000, New Englanders would use about 15 percent less oil for space and water heating under the conservation case.

Oil for electricity generation--base, conservation, and alternative supply cases

The conservation case and alternative supply case have a significant result in changing the electricity demand and supply picture for New England. We first compare the impacts of our conservation case to the base case and then compare what the generation supply mix would be under the alternative supply case and the base case.

NEPOOL's forecasts and construction program are also displayed to show the utilities' current plans through the year 1995. We extrapolated the NEPOOL forecast to the year 2000 using their long-range growth rate of 2.6 percent.

Figure 2 estimates the amount of oil that will be needed to generate electricity in the years 1990 and 2000 under the present NEPOOL forecast, and our base case, conservation case, and alternative supply case projections. These estimates assume the present utility construction program in New England. However, if the NEPOOL forecast proves to be accurate, it seems likely that the utilities would bring additional non-oil capacity on line before the year 2000 or else be faced with using 48 percent more oil than was used in 1978.

Figure 3 demonstrates the decline in the electricity demand growth rate from NEPOOL's forecast to our base case and the conservation case. The conservation case shows a drop in electrical demand starting in 1983 because of the introduction of many of our conservation policies in 1983.

FIGURE 1

OIL CONSUMPTION FOR HEATING UNDER BASE AND CONSERVATION CASES

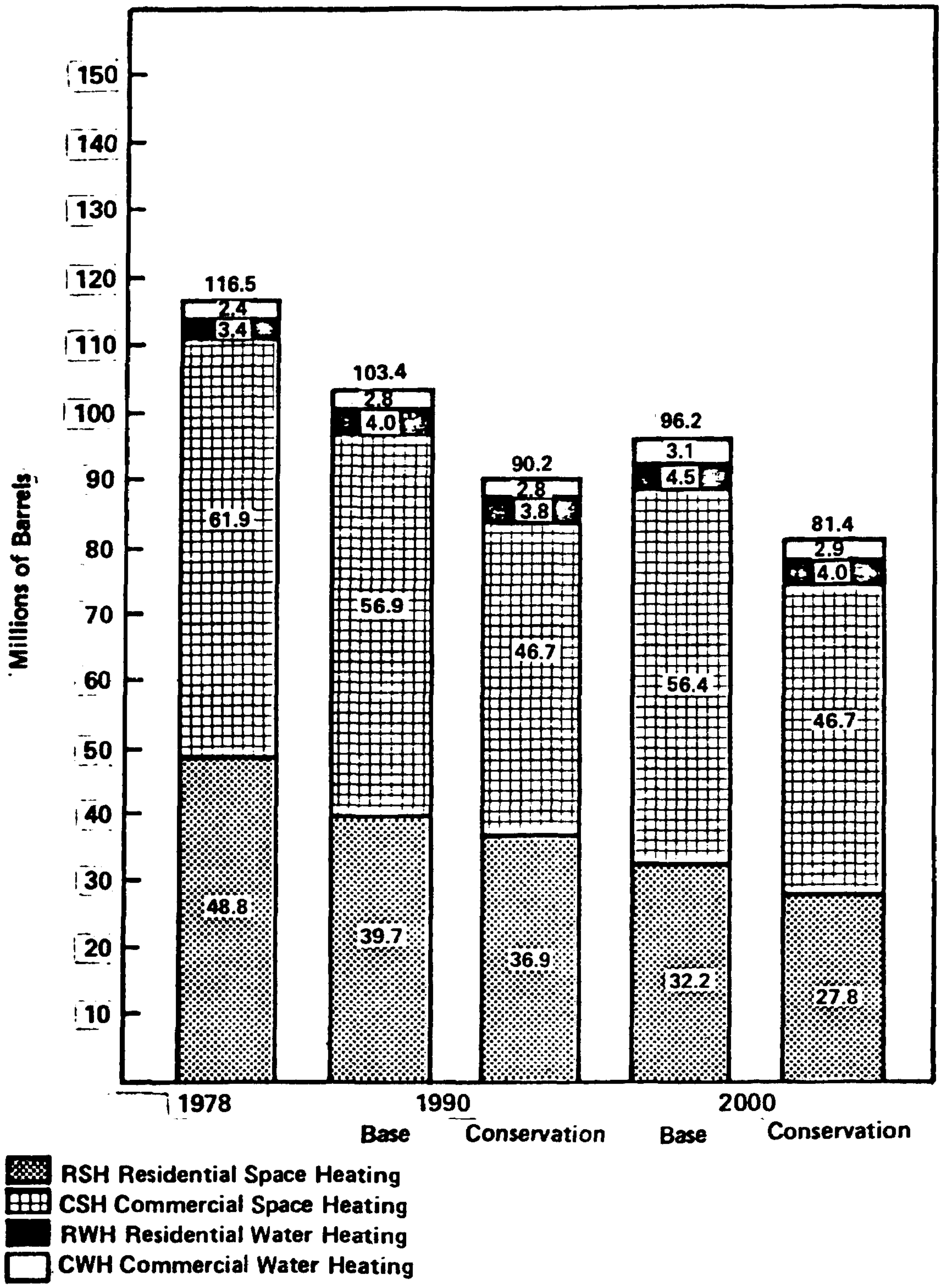
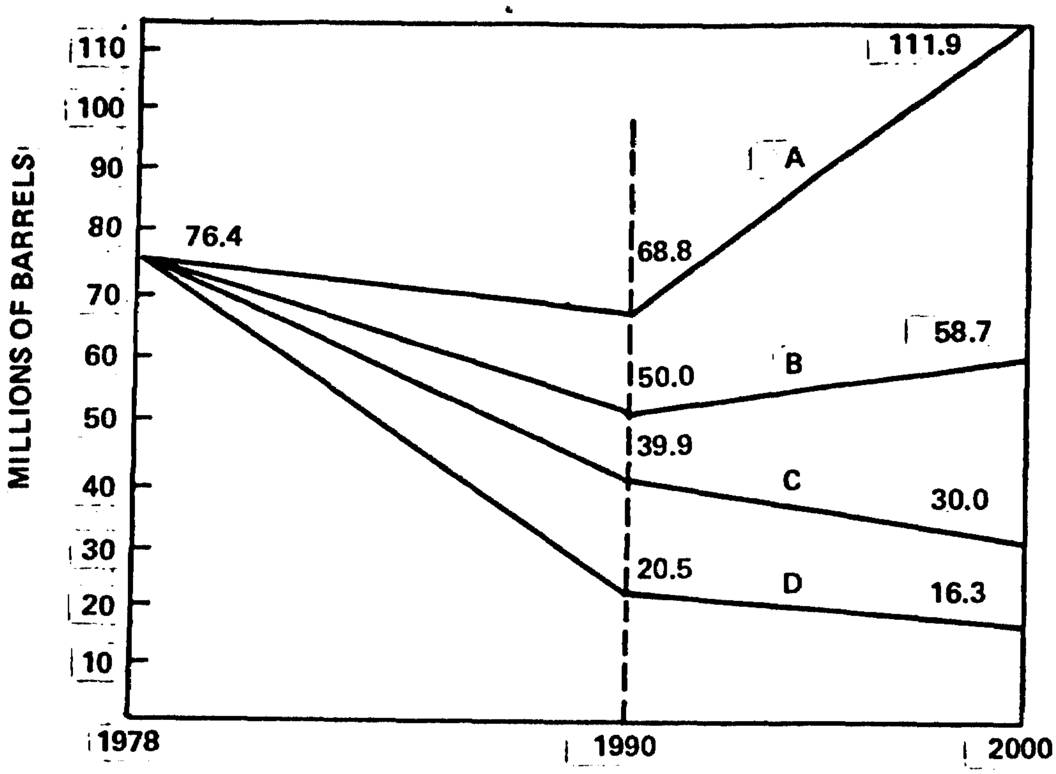


FIGURE 2

NEW ENGLAND OIL CONSUMPTION FOR ELECTRICAL GENERATION, 1978, 1990, AND 2000, UNDER VARIOUS POLICY SETS



A NEPOOL Forecast to 1900 and projected out to 2000 assuming 2.6-percent annual demand growth rate and no additions to non-oil capacity from 1995 to 2000.

B Base case forecast

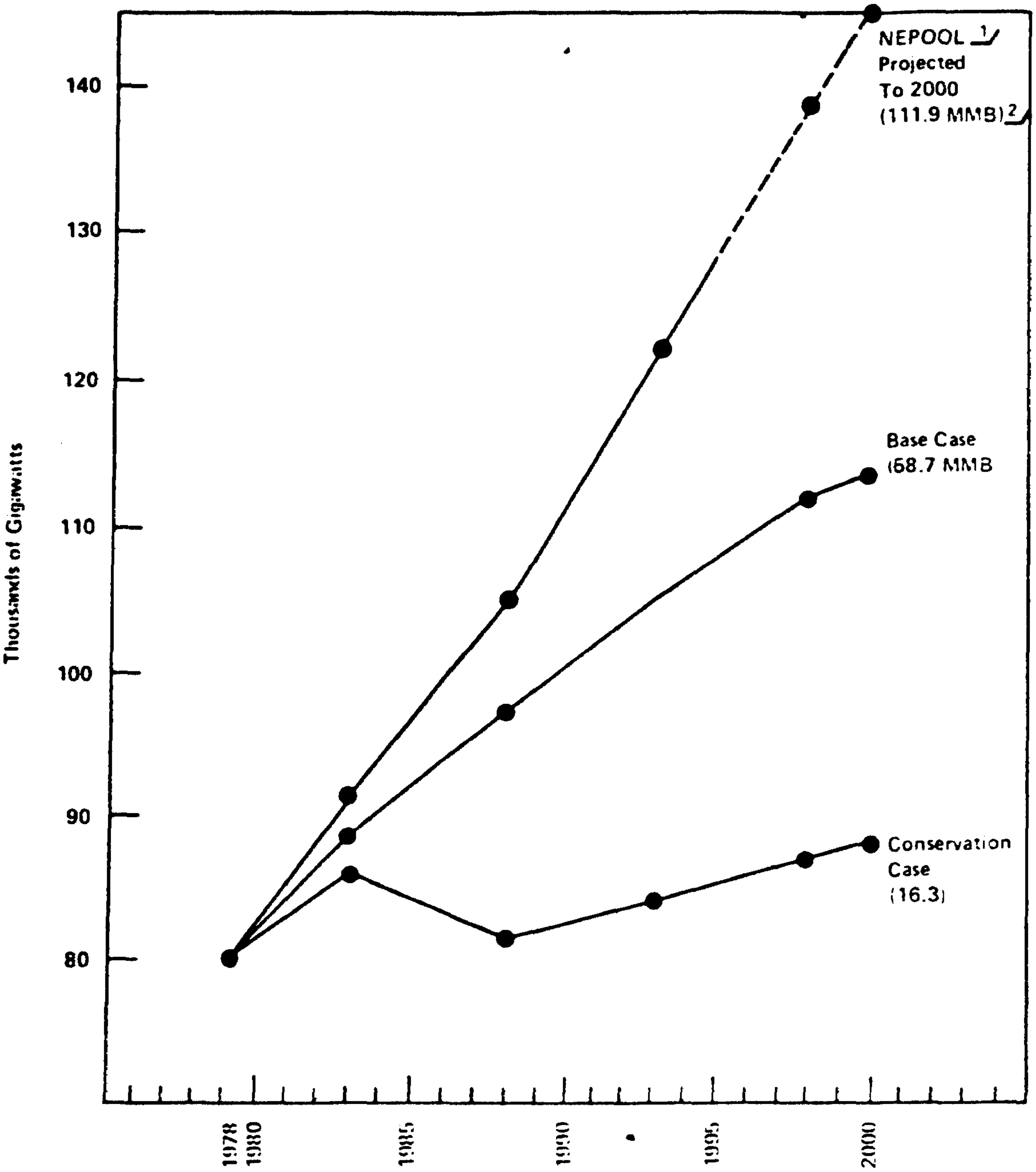
C Base case forecast and implementation of alternative supply potential.

D Conservation case forecast.

* All cases assume the NEPOOL construction program and the conversion of two generating stations from oil to coal.

FIGURE 3

COMPARISON OF ELECTRIC ENERGY GENERATED UNDER VARIOUS PROJECTIONS



1/ NEPOOL Forecast from 1995 to 2000 Extrapolated Using NEPOOL's Forecasted 2.6-percent Annual Demand Growth Rate.

2/ MMB Millions of Barrels per Year.

The conservation case results in advantages the region would find attractive--about 42 million barrels less oil to generate electricity and a more self-sufficient position. Of equal importance, our conservation measures are all less costly than the energy they displace on a life cycle basis and are therefore less burdensome to the public in the long run.

In addition to pursuing the policies supporting the conservation case to reduce oil use, the region can also reduce oil by pursuing alternative generating sources. Our alternative supply case shows that oil use for electricity generation can be reduced by 10 million barrels in 1990 and by almost 29 million in 2000 beyond the base case. When compared with NEPOOL's plans, oil use would be reduced by about 29 million barrels, or 42 percent, in 1990.

Figure 4 graphically demonstrates the potential oil needed for electrical generation under the base, conservation, and alternative supply cases and NEPOOL's forecast for the years 1990 and 2000. As the bar graph shows, nuclear power and coal are the same in all cases for both 1990 and 2000. Also, hydro is the same in all cases--4,400 GWH, but additional hydro is included as an "alternative" in the alternative supply case.

The oil savings between NEPOOL's projection and the conservation case is the most dramatic. Under NEPOOL's projection oil would be needed to generate 67,000 GWH (or about 112 million barrels) of electricity in the year 2000 while under the conservation case 9,700 GWH would be generated by burning oil (or about 16.3 million barrels). This means that the conservation case could save about 96 million barrels of oil.

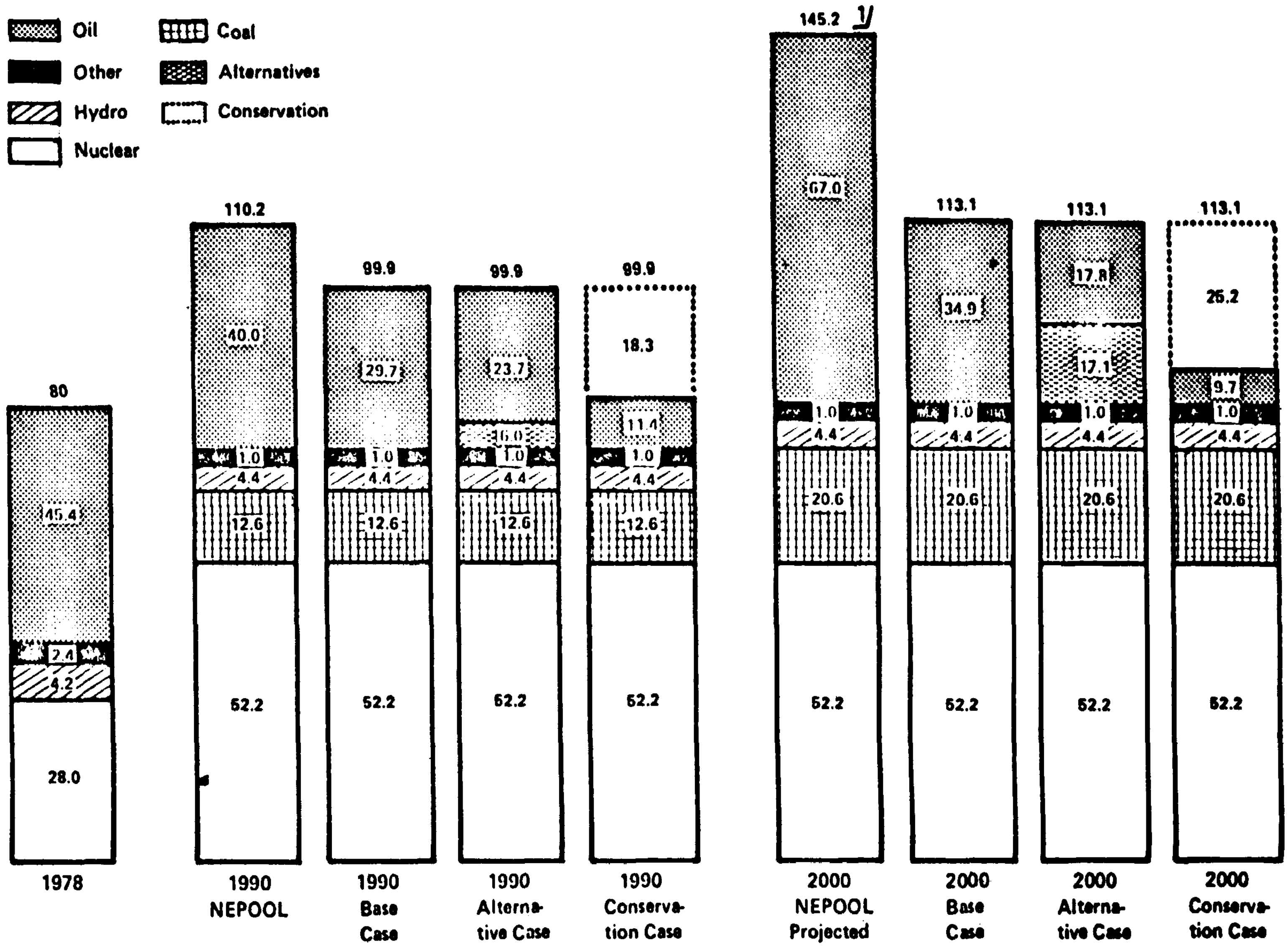
Economic impacts--base and conservation cases

Energy costs have escalated and most of the money spent on energy has flowed out of New England to other regions and countries. Because of the impacts energy supply options can have on the economy, we believed an economic comparison of the base and conservation case was an essential part of this study.

We found that the conservation case would produce greater benefits to New England's employment picture than the base case. The conservation case produces an annual average of about 15,200 jobs above the base case throughout the region, or a total of 335,000 jobs through the year 2000. This 335,000 is a

FIGURE 4

ELECTRICAL GENERATION FORECASTS BY FUEL TYPE
(thousands of GWH)



1/ This column is shown for comparison purposes only. NEPOOL forecasts demand through 1995, and we have extrapolated through 2000 using NEPOOL's 2.6-percent growth rate. If NEPOOL's growth projections are correct, the industry will either bring more non-oil capacity on-line before the year 2000 or use 48 percent more oil than was used in 1978.

net figure which includes decreased employment in those sectors involved in oil and gas marketing, distribution, and handling and the employment at oil-fired electric generating plants that would no longer be needed. Offsetting these losses are increased employment resulting from increased activity in the local economy through 1) increased demand for conservation materials produced locally (indirect employment), (2) increased demand for installation of the materials (onsite employment), and (3) increased spending in the local economy as people have more spendable income due to decreased spending on energy. Employment gains from conservation occur because conservation measures pay for themselves rapidly, result in less energy costs, and thus increase disposable income for non-energy items. This leads to increased purchases by consumers and, hence, increased employment.

CONCLUSIONS

In spite of increased use of coal and nuclear power, projections suggest that New England's oil consumption for electrical generation will still be significant in the year 2000, and could possibly increase over that of 1978. However, our analysis shows that additional actions could be taken in the areas of conservation and renewable resources to reduce oil consumption significantly.

Conservation measures that are feasible, socially acceptable, and cost-effective could be taken to reduce the region's oil consumption by 37 percent. Technically feasible and cost-effective alternative supply options could be exercised that would reduce oil consumption for electrical generation by 49 percent. These options would also reduce the flow of energy dollars out of the region and have a positive impact on the region's economy.

The following chapter examines some of the problems in implementing these measures.

CHAPTER 4

CURRENT REGIONAL ACTIVITIES WILL NOT ACHIEVE FULL POTENTIAL

The savings that can be achieved through the conservation and alternative supply cases described in chapter 3 are substantial and they would have a positive economic impact on New England. To implement either case to any degree, however, would require a closely coordinated regional effort. The present organizations and programs in the region give little assurance that these savings will ever be achieved. Several regional organizations--the New England Regional Commission, the Federal Regional Council, and the New England Energy Congress--have studied the region's oil dependency and done an excellent job of identifying the problems and proposing ways to help solve it. These organizations, however, have no authority to implement or follow up on their recommendations. In addition, the entities in the region having authority to take action have been slow to react. The efforts of a few of the organizations, along with Federal and State efforts, are discussed below.

REGIONAL ENTITIES' EFFORTS TO REDUCE OIL USE

The groups which have studied New England's oil dependency problem include:

New England Regional Commission

NERC is comprised of the six New England Governors and a Federal Co-Chairman. In 1973 NERC set up an energy program to help the New England States develop and implement regionally advantageous energy policies and programs.

In November of 1975, the New England Governors, through NERC, approved a New England Energy Policy. This policy recognizes the region's dependence on oil and states that "New England is prepared to commit itself to the development of a more nearly balanced mix of energy production capabilities." This policy also states an objective of reducing "the region's dependence upon oil by one fifth" in the next decade. However, there is no systematic action plan to implement the agreement and accomplish its stated goals.

New England Federal Regional Council

The FRC is an inter-agency, intergovernmental coordination group which formed an Energy Resouce Development Task Force which published a series of studies during 1976-77. At that time the FRC membership included the heads of 11 Federal agencies 1/ and several other members with backgrounds in energy, economic development, and State and local government. One of their studies was an overview of the region's energy situation and there are individual reports on topics such as emergency petroleum storage, wood, hydropower, indigenous coal, nuclear, and natural gas.

The FRC studies contained numerous conclusions and recommendations which are advisory in nature and not specifically addressed to anyone. The FRC depends on the cooperation of its member agencies to carry out their recommendations. Some recommendations have been acted upon--such as compiling an inventory of small hydropower dams and studying the Narragansett Coal Basin--but much more could be done to implement the task force recommendations.

New England Energy Congress

A recent and probably the most comprehensive regional effort to address the energy problem is the work of the New England Energy Congress. The congress was funded by the Department of Energy and sponsored by the New England Congressional Caucus and Tufts University. It began in May of 1978 with the "objectives of reducing the region's overwhelming dependence on foreign oil and its cost disadvantage compared to the rest of the country." This effort involved various regional interests and included government, utilities, environmentalists, business, and consumers.

1/Community Services Administration
Department of Commerce
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Labor
Department of Transportation
Environmental Protection Agency
Federal Energy Administration
Farmers Home Administration
Law Enforcement Assistance Administration

This study culminated in the Final Report of the New England Energy Congress: A Blueprint for Energy Action, dated in May 1979. This report contains hundreds of recommendations to the New England Congressional Caucus and State and local officials in hopes that they will use their authority to legislate and implement appropriate recommendations.

Since the report was issued, the Energy Congress has been at work trying to encourage implementation of its recommendations and has released several strategy papers on topics such as conservation, electricity issues, renewable sources, and fossil fuels. While some of the Congress' recommendations have been enacted, a great deal remains to be addressed.

New England Conference of Public Utility Commissioners

This organization provides a forum through which the New England State Public Utility Commissions (PUCs) can provide coordinated regional regulatory assistance without infringing on State Commission jurisdiction. The conference employs a staff, the New England Regulatory Coordination staff, which provides the PUCs with numerous regulatory support activities. For example, the staff coordinated an analysis of the New England Power Pool's forecasting model which concluded that the model is a sophisticated approach to long-range forecasting, yet pointed out some aspects of the model which could affect its reliability.

STATE EFFORTS TO REDUCE OIL USE

State and local governments have taken initiatives and developed programs to conserve oil, but most of their efforts have centered on administration of federally mandated programs. However, State actions taken thus far have not addressed the policy changes needed to achieve the potential in our conservation case. For example, efficiency standards for appliances have not been established by any of the New England States and none of the States has prohibited electric space heating as recommended by the NEEC.

Mandated programs

A DOE regional official told us that the New England States have complied with the programs mandated by the Energy Policy and Conservation Act of 1975 and the Energy Conservation and Production Act of 1976.

Through these mandated programs, each New England State has a goal to reduce its energy use in 1980 by 5 percent of its projected 1980 energy requirements. The States report their estimated energy savings to the DOE regional office. We did not review these mandated programs in New England on this assignment, but one of our previous reports has concluded that State goals will probably not be reached and State-reported savings are generally not accurate. 1/

All of the States have been involved with residential energy audit programs, but there has been no follow up to determine if audit recommendations were implemented or the extent of energy savings resulting from the audit programs in the States we visited. However, these programs may have heightened public awareness and provided residents with information on conservation measures.

State programs

Activities developed and implemented by the States include:

--Maine's Schools Program--a State-financed program started in 1977, it provides for energy audits of some 700 schools and for financing 90 percent of any resulting energy projects which have a payback period of 10 years or less. The goal is to cut energy use by 50 percent in Maine's schools. Nearly all the audits had been completed by the end of 1979 and the initial $5 million in State funds had been obligated to projects with an average payback period of 1.25 years (assuming oil at 90 cents per gallon).

--Connecticut's Low Interest Loan Program--provides households with adjusted gross incomes up to $30,000 the opportunity to borrow up to $3,000 at 6-1/2 percent interest to finance conservation measures and certain renewable energy systems. The State appropriated $6 million for this program and in the first 10 months about 1,650 loan applications were received and 687 loans were approved totaling about $1.5 million.

1/"Evaluation of Four Energy Conservation Programs--Fiscal Year 1977," EMD-78-81, Nov. 21, 1978.

--New Hampshire has passed legislation which should encourage development of the State's low head hydro-power sites. These measures (1) allow these small electric producers to sell their power at retail to private customers, (2) require utilities to purchase and transport power from small producers, and (3) do not require that small producers be regulated as a utility.

--Rhode Island's energy office played a key role in establishing a non-profit energy conservation corporation known as RISE (Rhode Islanders Saving Energy). RISE's services include a free energy audit to determine conservation potential, arranging for certified contractors and low-interest financing, and follow-up inspection of the contractor's work prior to payment. RISE's activities are funded by monthly contributions from the State's gas and electric utilities and by taking a percentage of the cost of each weatherization project.

ELECTRIC UTILITY EFFORTS TO REDUCE OIL USE

The individual electric utilities are responsible for balancing electricity demand/supply for their respective service areas. They project electrical demand and determine how they will meet that demand. In addition, electric power forecasting is done by the New England Power Pool.

All of the utilities we visited were engaged in a number of conservation activities. They all had conservation literature available to customers which they distributed with monthly bills or by other means, some offered energy audits, some mailed shower head water flow controls to customers, and at least one participated in the Edison Electric Institute's National Energy Watch program which leads to certification that a home meets the program's energy efficiency standards.

These efforts are commendable, but only produce a small amount of energy savings, when compared to the potential of our conservation case. A look at some figures in chapter 3 highlights this. As shown in figure 4, NEPOOL's projected growth rate will result in considerably more oil use than either our base, conservation, or alternative supply case. The question then arises, what should be the utilities role in contributing toward achieving this potential? Many of the policies assumed in the conservation and alternative supply case would seem to be a proper role for the utilities to carry out. For example, when weatherization of electric customers' homes is a more cost-effective investment than adding generating capacity, then the utility should pursue the cost-effective investment.

However, the region's utilities have not been involved in financing conservation measures, wide-scale use of conservation devices, or more aggressive conservation activities. This is understandable since the utilities do not seem to have any economic incentive to get involved with vigorous conservation programs. They point out they would not participate in these more aggressive conservation programs until the States' public utility regulators permit them to recover the costs of these investments.

In a related study 1/, we sent a questionnaire to all of the States asking questions about their involvement in balancing electricity supply and demand. Responses from the New England States showed that:

--The States are generally not pleased with the progress of utilities in conservation and/or alternative energy sources.

--The utilities' plans for balancing electricity demand/supply do not recognize significant contributions from conservation and alternative supply sources.

--The States are not taking an active role in working with the utilities to change this picture.

CONCLUSIONS

The present institutional framework in New England is such that the increased use of conservation and alternative energy services we identified in Chapter 3 cannot be assured.

Many of the actions which must be taken admittedly require hard decisions and a more unified regional approach to the problem than presently exists. Regional entities have been largely unsuccessful in implementing their proposals. State efforts have concentrated on federally mandated programs. The region's utilities have had little economic or regulatory incentive to bring about these kinds of changes. In addition,

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1/"Electricity Planning--Today's Improvements Can Alter Tomorrow's Investment Decision," EMD-80-112, September 30, 1980.

the Federal Government has no direct involvement in electric power planning, generation, transmission, or regulation in New England as it does in the Tennessee Valley or Pacific Northwest.

Further reductions of oil consumption will probably require a more effective regional effort by the DOE, and the New England States, utilities, and regulatory bodies to implement the plans and actions needed to take these steps.

Oil savings can be achieved, but no entity in the region is in a position to take full command of the situation. Instead, the savings will only be achieved through the actions of many people. Actions that will need to be taken are discussed in the following chapter.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

New England is heavily dependent on oil as a fuel source. It has done much to reduce oil consumption through consumer conservation and greater use of coal and nuclear power.

We found that New England has many additional opportunities to reduce residential, commercial, and industrial oil consumption through conservation and alternative supply options:

--By the year 2000, aggressive conservation could reduce the region's annual oil consumption by 38 percent, or a total of 57 million barrels of oil, as compared to "business as usual" trends assumed in our base case (see ch. 3). This is comprised of 42 million barrels, or 72 percent, less oil to generate electricity and 15 million barrels, or 15 percent, less oil to heat homes. Also, implementation of the conservation case would have a positive economic impact on New England and provide a total of 335,000 jobs through the year 2000.

--By the year 2000, the alternative supply case could reduce oil consumption for electricity generation by 49 percent or 29 million barrels, compared to the base for that year (see ch. 3).

However, additional efforts must be made if New England is to achieve these oil reductions and the region's decision-makers will have some difficult choices to make. The present organizational framework has inhibited the implementation of more aggressive conservation measures and renewable resource development. Several organizations have studied the oil dependency problem and have proposed ways to help solve it. However, they have lacked the authority to implement their recommendations. Initiatives have been made at the State and local level, but these have centered mainly around federally mandated programs. Utilities have not taken aggressive conservation initiatives because they have little economic or regulatory incentive to do so.

We believe, therefore, that a more unified regional effort is needed to achieve the further oil reductions which we identified through increased conservation and use of renewables.

Many of the actions to be taken to achieve the oil savings included in the conservation and alternative supply cases can be achieved through actions by the New England State legislatures, regulatory commissions, regional utilities, and energy suppliers. Accordingly, we offer the following observations for their consideration:

--New England State legislatures should consider laws to continually improve energy efficiency in such areas as appliances, buildings, and lighting. In addition the merits and impacts of controlling the installation of electric resistance space heating must be assessed.

--Electric utility plans need to reflect the potential from conservation and alternative supplies.

--States, through regulatory commissions, siting councils, and State energy offices need to assure that utilities' plans include potential conservation and alternative supply options.

--State Public Utility Commissions need to develop economic and regulatory incentives that will motivate utilities to pursue conservation and alternative supply options.

--Each State PUC needs to identify the energy, regulatory and economic policies that are shaping utility policies and determine whether appropriate emphasis is being placed on policy options such as conservation and cost-effective renewable energy resources.

--State PUCs, energy offices, and siting councils need to work with regional energy planners to maximize development of indigenous resources that can help reduce reliance on imported oil.

--States need to establish a responsibility center with the goal of reducing oil used for heating.

RECOMMENDATIONS

The Federal Government can also provide assistance to New England in reducing its heavy reliance on imported oil. We recommend that the Secretary of Energy establish a responsibility center in the New England regional office to coordinate regional efforts to reduce oil consumption. This responsibility should include:

- --Monitoring utility plans and State oversight of those plans and helping to assure that conservation and alternative supply options have been considered in utility forecasts.
- --Working with State utility commissions and regional utilities to identify the energy, regulatory, and economic policies that influence utility policies and determine possible changes which would better assure that all options are included in formulating those policies.
- --Assessing utility forecasting methods and providing advice and input in power supply/demand alternatives.
- --Preparing a plan for regulatory intervention to be used when DOE's oversight of electric power planning--at State utility commission or utility company level--indicates that all options are not being given adequate consideration.
- --Providing technical assistance and other support, as necessary, to State regulatory commissions to help improve the quality of electric power planning.

MATTERS FOR CONSIDERATION OF THE CONGRESS

Our recommendations above are based on the premise that the Federal role should be one of assistance and supportive oversight to improve the quality of electricity planning and the regulatory review process. The utility industry should continue to have responsibility for planning and operating the regional power system.

However, in view of the long-term nature of the demand and supply projections, DOE should keep abreast of New England's progress in reducing oil consumption and determine whether stronger measures are required. If DOE determines that sufficient progress is not being made, then it should request that the Congress consider stronger measures. These measures could include the establishment of a regional power planning board or a regional power authority. It should be stressed that the preferred method of achieving the conservation and alternative energy options is to work with the existing institutions and regulatory infrastructure. The Federal Government has not traditionally played a direct role in electricity planning or regulatory review and has left this up to the States and utilities. Accordingly, we are not recommending, at this time, that this be changed.

CHAPTER 6

AGENCY, UTILITY, AND STATE COMMENTS

AND OUR EVALUATION

Comments on our draft report were solicited from the various utilities and State and Federal offices involved in the matters discussed in this report. Many constructive comments were offered and incorporated into the final report. Copies of the responses we received are reprinted as appendixes III through IX of this report. The comments varied considerably as to opinions on the adequacy of past and planned efforts to reduce oil consumption, the extent of future reductions achievable, and how best to achieve such reductions. We believe these comments in themselves tend to demonstrate the need for a more dynamic and cohesive regional approach to the problem.

DOE, for example, agreed that conservation and renewable resources can play a significant role in reducing New England's dependence on oil, and felt that DOE could play a useful role in enhancing regional efforts by providing technical assistance.

The Rhode Island PUC stated that our recommendations showed a good understanding of New England's power problems, and stated that a regional power authority is needed now. Conversely, the New England Regional Commission thought our report showed a lack of understanding of New England's situation, but did endorse some of the recommendations. The Governor of Maine expressed some reservations about a regional authority, but did suggest active DOE involvement in obtaining Canadian energy.

The New England Power Pool also did not favor the possibility of a regionl power authority. Several of those responding to our draft report felt that additional use of coal and nuclear power presented a more viable option than conservation or renewable resources, or pointed out other options, such as increased energy imports from Canada and the passage of oil backout legislation. Some suggested that not including these options in our analysis limited the value of our report as a planning document.

We believe the diversity of these comments demonstrates the disparity of viewpoints on how best to solve New

England's oil dependency problem. They also go far in explaining why many actions have not been taken, and show the need for a more cohesive regional approach. Also, the variety of these proposed actions beyond those we considered further suggests that there is considerable potential for greatly reducing oil imports.

It was not our intention to exhaustively examine every possible option open to New England to reduce its oil import dependency, or to develop a new plan for future construction and other actions. We wanted only to determine if more could be done, and we concentrated our efforts on conservation and renewable resources, as explained on page 4. We agree that other sources of energy exist which have potential, but these would require a separate analysis. We still believe we have demonstrated that the New England region needs to do more to reduce its oil consumption, and that the options we offer are viable and worth pursuing. It should also be pointed out that DOE and others agreed with us that conservation and renewable resources have significant potential to reduce oil consumption.

It should also be pointed out that we are not advocating a regional power authority now. We offered suggestions to the local utilities, State legislatures, and DOE on how enhanced regional planning and emphasis on conservation and renewable resources could improve the oil dependence situation within present institutional frameworks. The regional power authority was offered only as a possible alternative should our other recommendations or suggestions not materialize.

Following is a more detailed analysis of the comments we received.

DEPARTMENT OF ENERGY

DOE agreed that conservation and alternative energy sources can play a significant role in reducing New England's dependence on oil, although it felt our estimate of their potential was overstated because of institutional and other barriers that might inhibit their achievement. DOE also pointed out that our analysis downplayed additional coal and nuclear potential, as well as petroleum consumption in the transportation sector, which in their view limited its usefulness as a planning document.

DOE felt that it should not take an active role in planning and regulatory review but instead should provide technical assistance to local utilities and commissions. It said implementing our recommendations would have budget and personnel implications which must be considered. DOE also felt that a ban on electric resistance heating would not result in oil savings once coal and nuclear have become the primary utility energy sources. Lastly, DOE stated that our model was not valid, although DOE officials later retracted this statement and clarified their position for us. They stated that while our model is valid, some of our assumptions differ from those which DOE uses in their projections. Therefore, their estimate of the amount of oil that can be saved through conservation is somewhat less than ours.

We did select conservation and renewable resources as our area of concentration, and we agree that there may be factors that impede their achievement, but that is the basis for our suggestions and recommendations--that a more concerted effort, particularly from a regional viewpoint, would enhance the likelihood of overcoming barriers in the present planning approach.

We acknowledge that there is potential for additional use of coal and nuclear energy beyond that now planned; however such options were outside the scope of our review. We have clarified this in our final report. Further, our report, and the analyses done by the consultant we employed, were not intended to serve as a new planning document. Our objectives were to show the need for actions beyond those now contemplated if oil consumption is to be significantly reduced, to determine if conservation and renewable resources could make a significant contribution to this end, and to identify means by which its achievement might be enhanced. We believe the model we employed adequately serves this purpose, regardless of whether every factor we considered is implemented in total, and DOE agrees there is considerable potential in these alternate energy sources. While electric space heating restrictions, as an example, may not save oil in a predominantly non-oil utility industry, it can be seen on page 28 that oil will still be a major source of New England electricity in the year 2000.

Finally, we were not suggesting that DOE usurp any responsibilities of the local utilities and governments, only that it work with them and monitor the extent that progress is achieved.

NEW ENGLAND POWER POOL (NEPOOL)

NEPOOL stated that any additional legal or institutional action would better be applied to more rapidly bringing nuclear and coal technologies on line, assisting in rate relief to finance planned projects, and providing funding for coal conversion rather than unconventional technologies which it felt were not cost-effective and not always available.

NEPOOL said existing (Public Utility Regulatory Policies Act of 1978) and proposed (oil backout) legislation and market reaction to price would significantly reduce the oil reduction potential cited in our report. It cited additional oil reductions apparently not included in its April 1980 capacity expansion plan, and cited past efforts toward conservation and use of renewable resources. It also pointed out that implementation of our proposals would require rate increases to finance the projects.

NEPOOL also felt that the main text of our draft report did not support the possible need for a regional power authority, and it offered a lengthy appendix challenging many aspects of our consultant's model.

As we stated previously, any further potential for coal and nuclear energy was outside the scope of our study, and our projections were based on firm plans of NEPOOL. While additional coal conversions may indeed take place by the year 2000, we were unaware of any plans firm enough on which to base projections.

We reiterate that any challenges to the preciseness of numbers generated by our consultant may be based on a misreading of their purpose.

It was not our intention to precisely quantify the oil savings available from each option considered or to formulate a specific plan of action, but instead to determine if there were socially acceptable, cost-effective options available that are not being achieved.

Any modeling effort is probably subject to further refinement and cannot be proven precisely accurate; NEPOOL, in our opinion, did not disprove the additional potential of conservation and renewable resources. Others providing comments agreed with the potential of these sources. We are not recommending that all possible actions considered in the model be implemented, only that actions be taken to adequately consider their potential. We believe that available data still supports our contention that this is an appropriate action.

NEPOOL's detailed appendix questioned many aspects of the model and the assumptions used; however, the comments were such that we felt they did not disprove our contention that conservation and renewable resources offered considerable potential to reduce oil consumption. Nevertheless, we did ask our consultant to prepare a response to the technical matters raised by NEPOOL. The consultant pointed out, as we also feel, that forecast modeling was not the issue in the study. The consultant's specific responses to the technical issues are presented along with NEPOOL's comments in Appendix 10.

STATE OF MAINE

The Governor of the State of Maine generally agreed with our report and the role that the State would play in decreasing the region's oil dependency problem. Commenting on two of the report's recommendations, the Governor agreed that adopting appliance efficiency standards was desirable but pointed out that a multi-State or even a national effort would be much more effective than any single-State effort. A second comment addressed the possibility of establishing a regional power authority or planning board. The implication is made that this is not needed and the downward trend in regional oil consumption will continue in response to general market forces and other State and regional actions. It was suggested that the region might be better served if the Federal Government assisted New England in its efforts to improve energy exchanges with Canada.

We agree that a unified regional approach to adopting appliance efficiency standards is more effective than a single-State approach. This is an underlying premise to our study--a regional effort versus a State effort. Moreover, since the New England electric power system is a regional system, the States would be more effective if they dealt with the utility companies on a regional basis.

Regarding the second point--the need for establishing a Power Authority or Planning Board--the assertion that oil consumption and growth rate of electricity consumption have declined is misleading. While this is true--oil consumption has declined in recent years--imported oil consumption has risen.

We agree that Canada does represent a possible supply source and energy could be exchanged with Canadian utilities. However, this was outside the scope of the study and would require a specific cost-benefit analysis and other relevant factors and considerations before an estimate of this potential could be made.

RHODE ISLAND PUBLIC UTILITIES COMMISSION

The Chairman of the Rhode Island Public Utilities Commission agreed with our observations and recommendations and stated that the report showed a good understanding of the peculiar problems faced by New England. Unlike the Governor of Maine the Chairman favored immediately establishing a regional power planning board. He pointed out that the only regions in the continental United States without some type of Federal Power Marketing Authority are the Northeast and the upper Midwest--and cited these as having the highest energy prices.

Other comments made by the Chairman included the possibility of obtaining hydropower and natural gas from Canada and stressed the need for the oil backout legislation now before the Congress. These comments have also been raised by others and where applicable have been considered in making revisions to the draft report.

NEW ENGLAND REGIONAL COMMISSION

The New England Regional Commission stated that many of our recommendations were worthwhile, but felt that many of our proposed actions were already underway and that others were too general to be of value. It stated that prior studies done by others such as the New England Energy Congress were more comprehensive and useful and that a large measure of the report was outdated, misdirected in emphasis, or in error. The Commission said that coal conversion represents the most immediate opportunity for reducing the utility sector's oil consumption. In summary, the Commission expressed a general disagreement with many aspects of the report, but nothing specific enough for us to respond to, through either report modification or rebuttal.

FEDERAL ENERGY REGULATORY COMMISSION (FERC)

FERC offered several suggestions to clarify certain matters discussed, which were incorporated as appropriate. It also suggested that we more clearly explain the differences between our consultant's model and NEPOOL's model, and our rationale for choosing one over the other. It asked whether there would be costs associated with our proposed legislation, and whether New England consumers would not seek further conservation on their own initiative in response to price increases.

We did not actually "choose" one model over the other. Our consultant developed the "base case" simply to have a consistent set of assumptions against which to compare its projections of oil savings from conservation and alternative sources. We could have applied these projections to the NEPOOL model, which from all appearances would have shown an even greater potential for savings. We also feel that so long as oil consumption forecasts remain as high as indicated on page 28, it is reasonable to assume the energy reductions will be applied to oil.

There may be some costs involved in implementing appliance efficiency standards or other recommendations, but as we indicated, there appear to be no easy ways to achieve significant reductions in oil consumption. As to future conservation efforts on the part of the consumer in response to price increases, these were built into the model that was used.

ORGANIZATIONS CONTACTED DURING REVIEW

UTILITY COMPANIES

Boston Edison Company
Central Maine Power Company
New England Electric System
Northeast Utilities

STATE AGENCIES

Connecticut Division of Public Utility Control
Connecticut Energy Division, Office of Policy Management
Maine Public Utilities Commission
Maine Office of Energy Resources
Massachusetts Building Code Commission
Massachusetts Department of Public Utilities
Massachusetts Energy Facilities Siting Council
Massachusetts Office of Energy Resources
New Hampshire Governor's Council on Energy

FEDERAL AGENCIES

Department of Energy, Region I, Boston, Massachusetts
U.S. Army Corps of Engineers, Waltham, Massachusetts
Federal Energy Regulatory Commission

OTHER ORGANIZATIONS

Atlantic Gelatin Company, Woburn, Massachusetts
Blue Cross/Blue Shield of Connecticut, North Haven, Connecticut
Connecticut General Life Insurance Company, Bloomfield, Connecticut
Franklin County Energy Office, Greenfield, Massachusetts
New England Fuel Institute, Watertown, Massachusetts
New England Power Pool, Springfield, Massachusetts
New England Regional Commission, Boston, Massachusetts
New England River Basins Commission, Boston, Massachusetts
Northeast Solar Energy Corporation, Cambridge, Massachusetts
Rhode Island Citizens Energy Conservation Corporation, Providence, Rhode Island
Sloane School, Massachusetts Institute of Technology, Cambridge, Massachusetts
New England Regulatory Coordination Staff
New England Energy Congress

APPENDIX II

REDUCING NEW ENGLAND'S OIL DEPENDENCE THROUGH CONSERVATION AND ALTERNATIVE ENERGY 1978-2000

SUMMARY BRIEF OF THE ANALYSIS AND RESULTS CONTAINED IN TECHNICAL REPORTS I THROUGH V

Final Revision
September, 1980

Energy Systems Research Group, Inc.
Boston, Massachusetts 02109

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1. SCOPE AND ORGANIZATION OF THE STUDY

1.1 Scope of the Study

This report is an assessment of the extent to which energy conservation measures and alternative supply options that are technically feasible and economically attractive could affect the long-range consumption of oil in New England in the 1978-2000 period. In identifying a set of promising conservation measures and supply options, the attempt has been to point to areas where additional public action appears to be required in order to realize the potential benefits available to the region during the next twenty years. Our objective is to quantify the conservation and alternative supply potentials which could be attained through new institutional initiatives.

On the demand side, the study offers quantitative estimates of the reduction in electricity consumption that will occur should the measures contained in a conservation scenario be implemented. The conservation measures and levels incorporated in the scenario satisfy three criteria. They are technically feasible; their incremental costs to electricity consumers as a group will be less than the costs of additional electricity; and they appear to require the stimulus of additional public action if they are to be implemented. The quantification of the conservation scenario's potential impact was performed using the ESRG long-range load forecasting model. A "Base Case" forecast based on present trends and policies was made and compared with a "Conservation Case" forecast based on the conservation scenario. The Conservation Case forecast was used to quantify (a) utility sector oil savings and (b) buildings sector oil savings.

The additional development of the model that was used in making the forecasts that would have been required in order to quantify possible oil savings in the industry sector was not undertaken for this study. Thus, this conservation potential, which by all indications is a very real one, is not analyzed or quantified within the present report. In addition, the transportation sector was entirely outside the scope of the study.

On the supply side, the study identifies the alternative supply sources that hold most promise as technically feasible and economically attractive options for displacing a portion of the presently planned generation mix and quantifies their potential contribution during the planned period 1980-2000. Because of the study's focus on saving oil and because of the community's evident interest in avoiding environmentally problematic resources, the report focues on those alternative supply options that use renewable resources rather than fossil fuels.

With respect to oil use for heating buildings, our purpose was to quantify the reduction that could be achieved through additional conservation initiatives of the oil/gas mix in heating fuel use remained constant. While this was an analytical assumption, it is not unrealistic. At the present time, gas enjoys a price advantage, but its relative price is expected to increase in the mid-1980s. Deliberately inducing shifts from oil heat to gas heat through policy represents an option for reducing oil use that has not been analyzed in this study.

1.2 Organization of the Research

The research performed to provide input to the G.A.O. New England study is presented in a series of five technical reports. The five volumes and their contents are as follows:

Technical Report I. In this report the structure of a long-range model for forecasting electric energy consumption (and peak power requirements) is described in detail. Based on a "business-as-usual" scenario incorporating present technical, economic, and policy trends, a long-range forecast for the New England states was performed. The data inputs and forecast results are described in detail in Report I.

Technical Report II. Here, a conservation scenario is constructed to explicitly modify several of the input assumptions contained in the "business-as-usual" scenario embodied in Report I. The scenario was designed to permit quantification of economically and technically attractive conservation potential that is not likely to be realized without additional policy action. A second forecast was run based on this scenario, and the results for long-range electrical energy are presented in detail in this Report. The forecast in Report I is denoted the Base Case forecast, and that in Report II, the Conservation Case forecast.

Technical Report III. In this report the impact of implementation of the conservation scenario developed in Report II upon New England oil consumption is quantified. The quantification was limited to two types of savings: (a) oil savings from reduced electricity consumption, and (b) oil savings from reduced heating demand in buildings. Oil savings from conservation of energy in manufacturing are not quantified (except via the electricity reduction for that sector), and the transportation sector is outside the scope of the study.

Technical Report IV. In this report an alternative supply potential is identified. Available literature and data on non-conventional generating sources using non-fossil fuels was reviewed and the options that are more technically and economically attractive were identified. Quantitative estimates of the electric capacity and energy potential from windpower, solid waste, hydro and tidal power, and wood were developed. Finally, the oil savings that would be realized were these alternative sources to substitute for oil-fired generation were estimated.

Technical Report V. In this report the economic ramifications of the conservation measures embodied in the conservation scenario of Reports II and III are assessed. Specifically, an input-output approach to the analysis of the New England regional economy is used to quantify the impacts of the residential sector conservation scenario. Particular emphasis is placed upon the positive net employment changes that would ensue in New England were the residential conservation scenario fully implemented.

2. PRINCIPAL FINDINGS

2.1 Impacts of the Conservation Scenario

Oil consumed for electricity generation and buildings sector heating constituted over half of petroleum products consumed as fuel in New England in 1978 measured in terms of Btu content.* Implementation of the conservation strategy scenario developed for this study would have profound implications for utility and buildings sector oil consumption. The oil savings are quantified in the following table.

TABLE 1

OIL CONSUMPTION BY THE UTILITY AND BUILDINGS SECTORS IN 1978, 1990, AND 2000, BASE CASE AND CONSERVATION CASE WITH PERCENTAGE REDUCTIONS DUE TO CONSERVATION

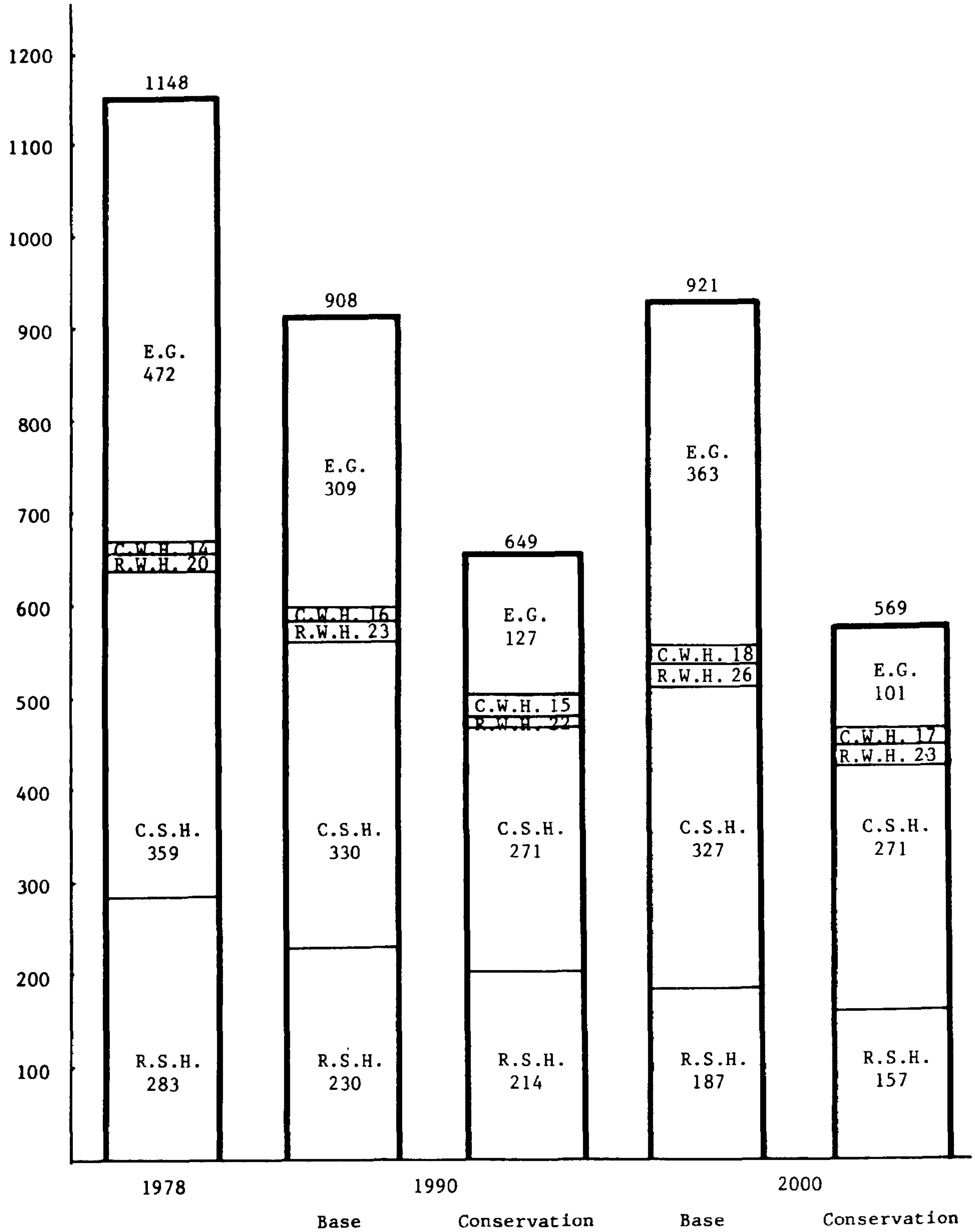
	1978 Historic	1990 Forecast	2000 Forecast
Base Case (10^{12}Btu)	1148	908	921
Conservation Case (10^{12} Btu)	-	649	569
Reduction from Base to Conservation (Percent)	-	28	38

The potential for saving oil through conservation is dramatically evident from the above table. Twenty-eight percent less oil is consumed by 1990 and thirty-eight percent less by 2000, than without a push for achieving the additional conservation potential quantified in the conservation scenario. If anything like the base year sectoral breakdown holds throughout the century, these utility and buildings sector savings could in themselves represent savings of a fifth of the oil that the region would otherwise consume. (Forecasts of transportation and industry consumption were not made.)

* United States Department of Energy, State Energy Data Report, Report DOE/EIA-0214(78), April 1980. The components were residential and commercial oil consumption at seventeen percent each and oil consumption for electricity generation at nineteen percent. Other uses of oil were industry, fourteen percent, and transportation, thirty-three percent. Energy Information Administration consumption data were not used to calculate base year (1978) consumption in this study. Had they been, the absolute numbers would have differed but the trends and the order of magnitude of conservation's impact would have been the same. (See Report III, Sec. 2.3).

FIGURE 1

NEW ENGLAND OIL CONSUMPTION FOR HEATING, AND ELECTRICITY GENERATION
1978, 1990, AND 2000, BASE CASE AND CONSERVATION CASE



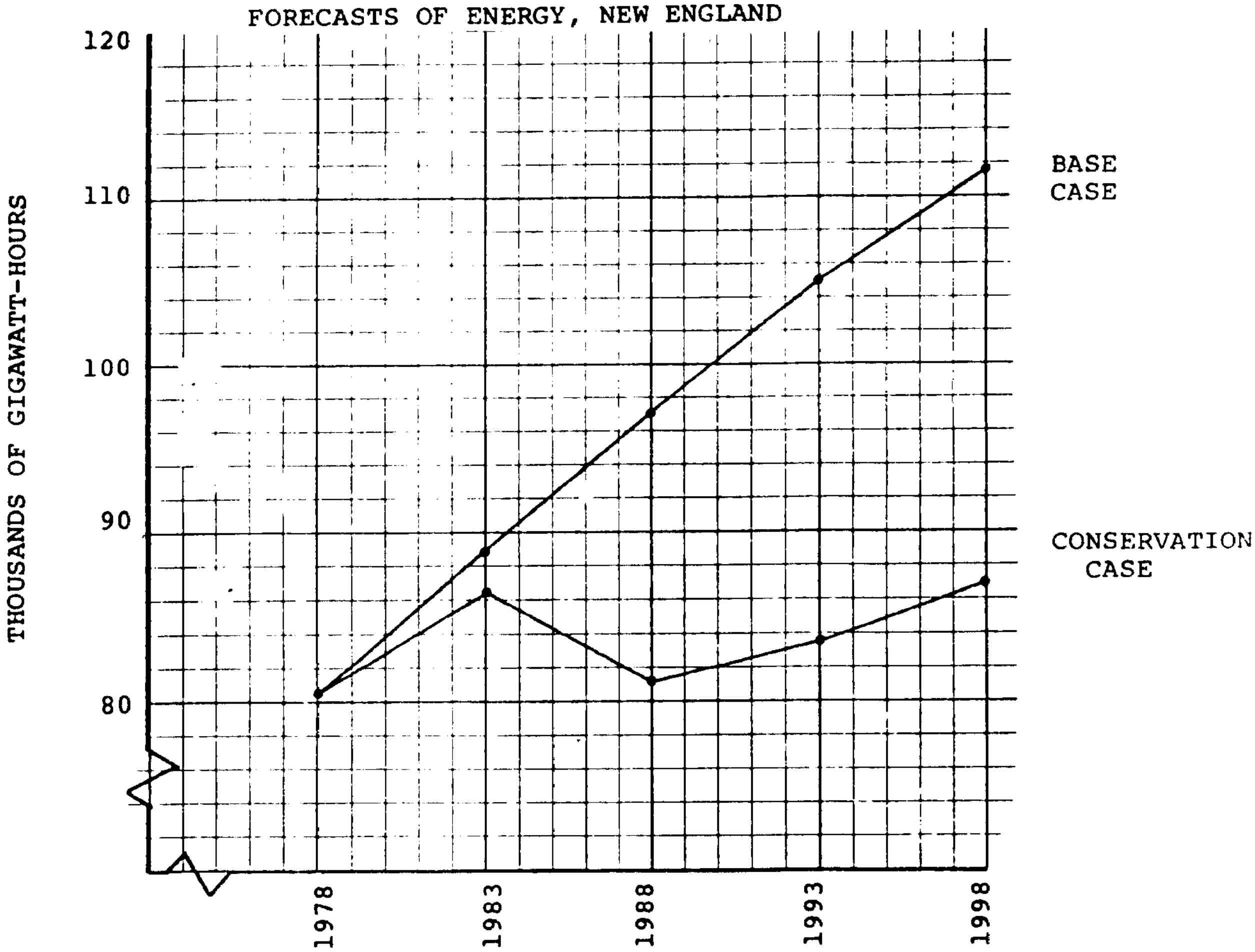
R.S.H. Residential space heating
C.S.H. Commercial-institutional space heating
E.G. Electricity generation
R.W.H. Residential water heating
C.W.H. Commercial-institutional water heating

Oil savings potentially attainable through additional conservation amount to sixteen percent of forecasted Base Case consumption of oil for heating by the year 2000. For electrical generation, the savings potential is greater both relatively and absolutely: over seventy percent of the year 2000 consumption is saved in the conservation scenario.

In Figure 1 the utility and buildings sector savings are represented separately. In addition, each "oil consumption bar" breaks down buildings sector consumption into the Btu content of oil used for residential and commercial space and water heating.

The utility oil savings were based on the Conservation Case long-range electric energy and demand forecast, which quantified the conservation scenario's impact on electric generation requirements. Figure 2 illustrates the impact of the conservation scenario on electric energy forecasts.

Figure 2
COMPARISON OF CONSERVATION AND BASE CASE FORECASTS OF ENERGY, NEW ENGLAND



In addition to the growing electric energy savings from conservation as shown in Figure 2, annual summer and winter peak demand is reduced considerably. Table 2 provides figures for peak demand (and for energy) under Base Case and Conservation Case conditions. By 1998, the regionwide peak is reduced by 24 percent from the Base Case forecast.

TABLE 2

COMPARISON OF ESRG BASE CASE AND CONSERVATION FORECASTS
OF ELECTRIC DEMAND
NEW ENGLAND AGGREGATE ENERGY AND PEAK

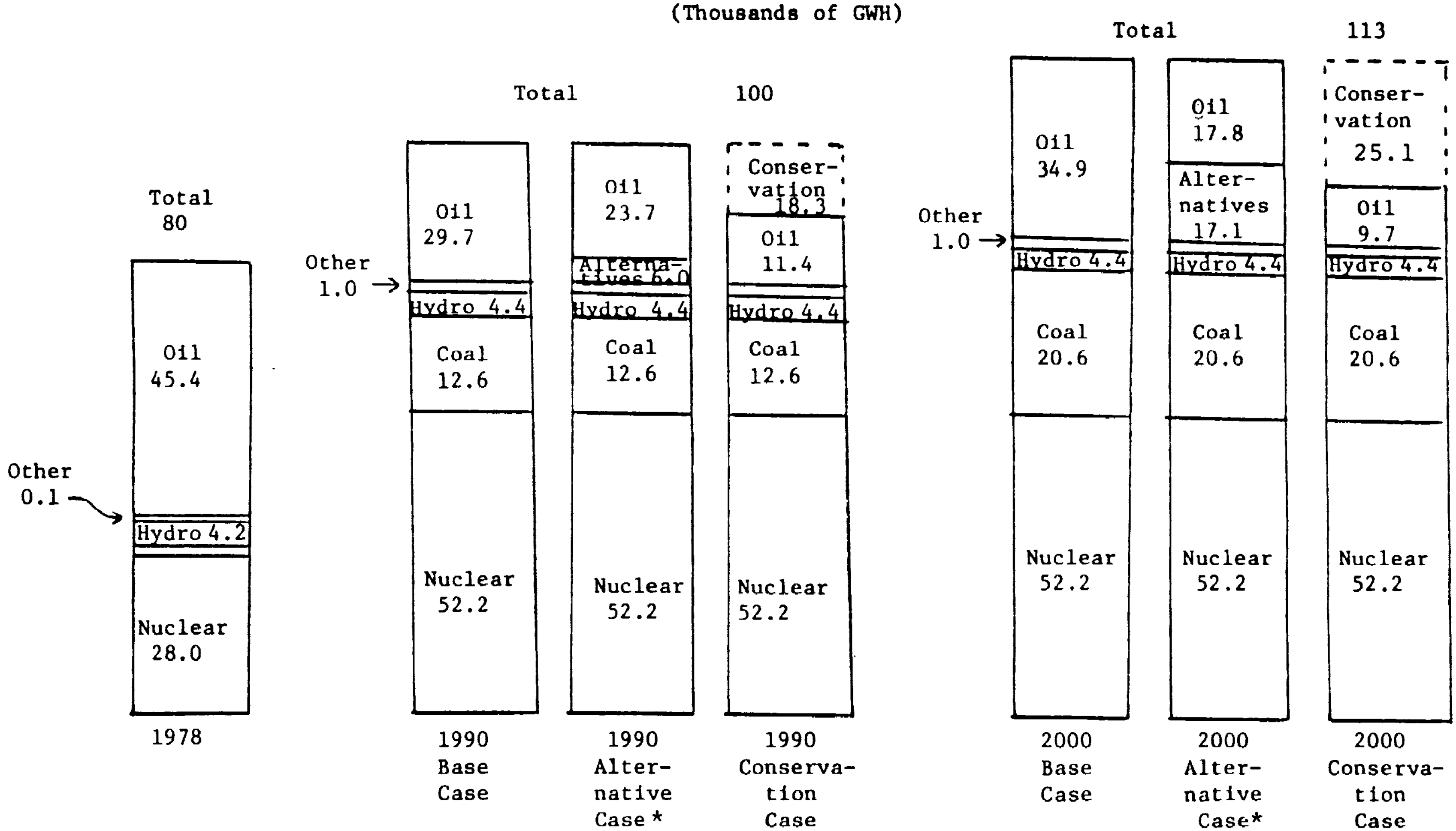
	Energy (GWH)		Summer Peak (MW)		Winter Peak (MW)	
	Base Case	Con-servation	Base Case	Con-servation	Base Case	Con-servation
1978	80,530	80,530	14,073	14,073	14,964	14,964
1983	88,730	86,160	15,330	15,240	16,780	16,400
1988	97,080	81,090	16,600	14,240	18,650	15,550
1993	104,750	83,680	17,740	14,640	20,210	15,940
1998	111,480	86,700	18,740	15,130	21,460	16,320

The ESRG Base Case forecast is lower than NEPOOL's forecast for New England. For the period 1980-1990, the annual rate of growth of system peak is 2.17 percent in the ESRG forecast and 2.51 percent in the NEPOOL forecast. The real divergence comes after 1990, when the ESRG peak growth rate drops to 1.26 percent per year while the NEPOOL growth rate increases to 3.2 percent per year. For 1990, the NEPOOL-forecasted peak is 20,650 MW. The ESRG-forecasted peak is six percent less. By 1995, the NEPOOL forecast is for a peak of 24,170 MW. The ESRG-forecasted 1995 peak is 14 percent less. The NEPOOL forecast implies a higher "Base Case" level of oil consumption than projected in this study.

To compute the implications for utility oil consumption of the considerable conservation reduction quantified above, we first assumed completion of a contemplated New England Power Pool (NEPOOL) construction program. We then assumed that the generation displaced by conservation would be oil-fired generation, an assumption based on oil's position as the marginal (most costly) utility fuel in the generation system and on the utilities' economic dispatch practices. The generation mix implications of conservation can be by comparing the "Conservation Case" and the "Base Case" bars for 1990 and 2000 in Figure 3.

FIGURE 3

ELECTRICAL GENERATION BY FUEL TYPE
(Thousands of GWH)



* "Alternative" sources include electricity from solid waste, hydropower, tidal power, windpower, and wood. (A small amount of generation from such sources is included within "Other" fuel types for 1978 and Base Case 1990 and 2000 forecasts.)

APPENDIX II

APPENDIX II

The 2000 Conservation Case bar in Figure 3 is particularly striking. Oil-fired generation is reduced to but 9 percent of the total generation mix, within striking distance of its possible practical lower limit of a few percent for cycling and peaking functions.

The quantification of buildings sector heating oil savings due to the conservation scenario was achieved through a series of computations based on adaptations of the long-range forecasting model's residential and commercial input and output data. Although the conservation scenario's ban on unassisted new resistance heating in the buildings sector increases the number of oil-heated units more rapidly than occurs under the "business-as-usual" conditions of the Base Case forecast, this effect is far outweighed by the utility oil savings from the ban and by the other energy-saving measures in the conservation scenario.

2.2 Impacts of the Supply Scenario

Realization of the most promising alternative supply options could significantly reduce the region's oil consumption for electrical generation. In Figure 3, the impact of those options on the generation mix was illustrated. The oil consumption implications of that change in generation mix are shown in Figure 4. Figure 4 gives oil consumption in terms of trillions of Btu (left-hand scale) or millions of barrels (right-hand scale) per year.

The estimate of the contribution of alternative energy to reduced oil usage was based analytically upon an extrapolation of the NEPOOL construction program to the year 2000. Present NEPOOL plans (retirements, reratings, and additions of authorized and planned units) would yield a total capability of 27,120 MW by the end of the latest planning period (1995/96). We therefore included utility-planned generating additions still under NEPOOL study. This produces a year 2000 capability of 28,700 MW, exclusive of the Montague plant that is no longer actively planned by Northeast Utilities System. The major additions that we assumed by the year 2000 are listed in Table 3 below. Plants of under 100 MW are not individually listed.

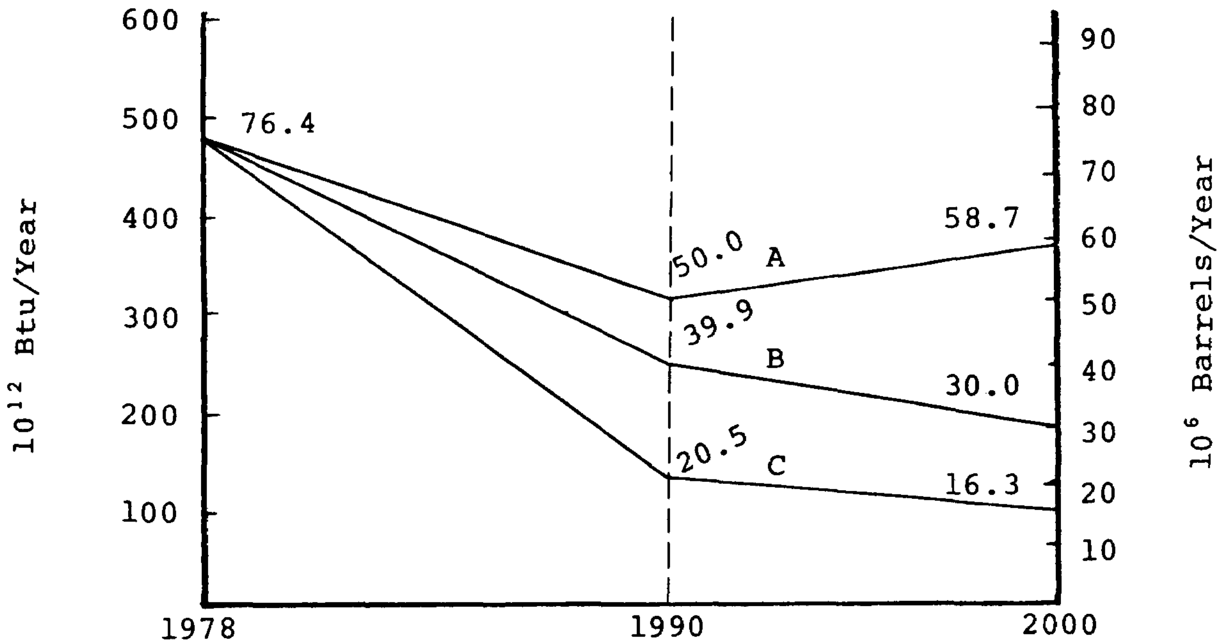
TABLE 3

NEW GENERATING CAPACITY ASSUMED ADDED IN NEW ENGLAND BY THE YEAR 2000

Plant	No. of Units	Fuel	Capacity (MW)
Stony Brook	2	Oil	510
Seabrook	2	Nuclear	2,300
Pilgrim	1	Nuclear	1,150
Millstone	1	Nuclear	1,150
Sears Island	1	Coal	570
Edgar	1	Coal	800
Canal	1	Coal	600
M.M.W.E.C.	2	Refuse	150

FIGURE 4

NEW ENGLAND OIL CONSUMPTION FOR ELECTRICAL GENERATION, 1978, 1990, AND 2000, UNDER BUSINESS AS USUAL, CONSERVATION, AND ALTERNATIVE SUPPLY SCENARIOS*



A Base Case Forecast

B Base Case Forecast and Implementation of Alternative Supply Potential

C Conservation Case Forecast

* All cases assume the NEPOOL construction program and the conversion of two generating stations from oil to coal.

The line labelled "B" represents the implementation of the alternative supply potential prioritized here relative to "A," the Base Case forecast. By 2000, oil consumption for generation would drop from 59 to 30 million barrels per year, a savings of nearly 50 percent relative to the Base Case forecast.

Note that in neither Figure 3 nor Figure 4 are the oil savings from conservation and alternative supply added together. If the conservation savings were fully realized and the full alternative supply potential identified here were also available by 2000, all oil-fired generation, save a minimum needed for peaking functions, would be eliminated. Approximately 25 to 50 percent of the generation from alternative sources would be substituting for oil. The balance would be substituting for other fuels, most likely coal. Since an oil-fired fuel cost estimate was the criterion for assessing the attractiveness of measures and options on both the conservation and the supply side, the analysis here cannot be held to confirm the direct economic desirability of full implementation of both the conservation and the alternative supply potentials.

Since the region has far to go in reducing oil dependence, however, it would clearly be rational to begin by aiming to tap the bulk of both the conservation and the alternative supply potential. Indeed, if there is reason to believe the NEPOOL construction program of new nuclear and coal capacity will not be completed, so that more oil will really be consumed than indicated in line "A" in Figure 4, then proceeding vigorously on both fronts would be completely consistent with the results of this study.

The alternative electric generation potential in New England, excluding units built, under construction, or definitely planned, is summarized below in Table 4. In the conservation scenario, we attempted to include measures which appeared to definitely require the stimulus of public action if their benefits were to be realized. Probably the bulk of the capacity listed in Table 4 also falls into this category, since for purposes of the supply scenario "Base Case" conditions are NEPOOL plans.

TABLE 4

ADDITIONAL* REGIONAL ELECTRIC GENERATION CAPACITY FROM ALTERNATIVE ENERGY SOURCES, POTENTIAL IN 1990 AND 2000 (MW)

	Wind	Solid Waste	Tidal Power	Hydroelectric Generation Large Scale	Hydroelectric Generation Small Scale	Wood
1990	500	480	13	195	510	30
2000	2900	850	750	580	510	80

*Increment over Base Case conditions

2.3 Overall Economic Implications of Conservation

The conservation and alternative supply scenarios were constructed on the basis of a direct economic comparison with the costs of oil-fired electricity generation. Thus, scenario components represent cost-effective energy options. Estimates of the total dollar costs and benefits of the conservation and supply scenarios have not been developed, except for the residential sector energy conservation scenario measures. For the residential sector, the energy savings from implementation of the conservation scenario between the base year and the end of the century amount to some 280 percent of the costs of the conservation investments, representing a clear economic advantage for conservation. Report V describes the derivation of these costs and benefits.

The direct economic trade-offs between conservation investments and energy production tell only part of the relevant story. The indirect economic consequences of alternative energy strategies--such as their environmental costs and their employment impacts--are of direct policymaking relevance.

In order to illustrate the relevance of the indirect economic trade-offs to evaluation of energy strategies, an input-output approach to modelling the regional economy was employed and the employment impacts of the residential measures in the conservation scenario were measured.

It was determined that after all job losses from reduced spending for energy due to the effects of conservation were accounted for, the investments in conservation that are implied in the conservation scenario would produce a net increase in employment. The increased employment was due to the direct and indirect labor and materials requirements for implementing the conservation scenario measures and to an increase in disposable consumer income from savings due to reductions in energy bills which was translated into increased spending for goods and services in the region.

The net result of the analysis was that in each state in each year between 1978 and 2000, total employment would increase as a result of the shift from the Base Case scenario to the residential conservation strategy. The relative gain would grow with time, and by the end of the century, well over 300,000 net additional jobs would have been created. This comparative benefit is modest considered against the scale of regional employment as a whole. But it is quite clearly a positive effect on balance, with the potentially positive effects of commercial and industrial conservation remaining to be explored.

3. ASSESSING THE POTENTIAL FOR CONSERVATION

3.1 The Conservation Scenario

The conservation scenario which was employed for analyzing the potential for electrical energy conservation was designed for use in conjunction with the ESRG long-range load forecasting model. The model is a detailed structure for quantifying present and future levels of electric energy consumption and peak demand. The mathematical structure and conceptual foundations of the model are specified in Technical Report I; also contained in that volume is a detailed presentation of the "Base Case" (or pre-conservation strategy) forecast produced by the model for this study. The Base Case forecast is a benchmark against which to quantify the potential for additional conservation of electric energy which would result from the policy-based conservation scenario in the region.

The forecasting model disaggregates energy use into various components within the major energy consuming sectors: residential, commercial, and industrial. Within the residential sector, detail is provided for several "end-uses," i.e., for 14 major sources of consumption, such as specific appliances, lighting, and heating. Within the commercial sector, four major end-uses are detailed in each of the five major types of buildings, such as hospitals and retail/wholesale establishments. Within the industrial sector, the consumption of electrical energy is detailed for each of twenty standard categories of manufacture. To produce a Base Case forecast, the computer sums the total yearly energy and peak demand from the many specific end-use submodels.

The Conservation Case forecast takes advantage of the detailed structure of the forecasting model. A conservation scenario is constructed by specifying changes that impact specific end-uses and groups of end-uses during the forecast period. Such demand-reducing measures as an increase in the amount of self-generation in industry, a reduction in the use of electric space heating in office buildings, and an increase in the insulation levels of single-family homes are quantified explicitly in the conservation scenario. Using these scenario inputs, the Conservation Case forecast interrupts Base Case computations to produce a second, slower growth year-by-year long-range forecast. When compared with the Base Case forecast, the Conservation Case forecast presents a quantitative estimate of the energy that can be saved (and the winter and summer peak reductions that can be attained) through a deliberate policy of implementing the measures in the conservation scenario.

As indicated in Report II, the Base Case forecast attempts to capture conservation that has occurred and is ongoing due to present trends and existing policies or policies whose implementation seems certain. The Conservation Case forecast attempts to capture additional conservation that would be attendant on more vigorous promotion of cost-effective demand reducing measures in the states. The criteria used to select additional conservation measures for inclusion in the scenario were:

- The conservation measures are technically feasible.
- The measures do not increase overall social costs for energy services.
- The measures appear to require the stimulus of additional public action for implementation.

Technical feasibility refers to the present or imminent availability of the hardware and know-how to promulgate the conservation measures. Measures in the scenario are generally based on available technology and practices. For example, increased levels of home insulation using existing building practices are included in the scenario; the use of radically new building practices, such as involved in the production of prototypical "zero energy" homes, are not. This is not to deny the possibility that it might be desirable for policymakers to strongly encourage or underwrite the development of new techniques for conserving energy.

The social cost criterion is that the benefits to society of implementing a measure exceed its cost. In this study we restrict consideration to direct cost tradeoffs; e.g., that the lifetime costs of a measure do not exceed the costs of producing the kilowatt-hours (kwh) saved by the measure during its lifetime. The avoided costs per kwh used to measure the cost attractiveness of a conservation measure are not necessarily those experienced by the individual consumer who will invest in the measure. Ideally they are the social costs of producing the incremental energy that would be required in the absence of conservation. These criteria are discussed more fully in the second Technical Report, which details the conservation scenario and the results of the Conservation Case forecast. The scenario is a cautious one, based on direct cost/benefit tradeoffs and available technologies. Indirect effects due to cost "externalities" (environmental benefits, scarce fuel preservation, capital conservation, etc.) have not been included nor have promising measures still in the development phase (industrial solar applications, total energy systems, etc.). Such scenario constraints are not meant to deny the possible value of a larger set of conservation activities and measures. Rather the scenario is designed to highlight for policymakers' consideration the most promising of those options for energy savings that otherwise may not be realized.

In the scenario, hypothetical new policy actions are linked to the specified conservation measures. In some cases a specific policy is posited -- e.g., a specific appliance efficiency regulation -- and in others a range of conceivable policies is set forth. The purpose of the analysis is not to develop a precise set of policy proposals, legislation, and regulations. It is rather to provide policymaking guidance by quantifying the conservation potential from feasible and socially cost-effective measures not likely to be implemented without additional public action, and thus to serve as a basis for recommendations on new policy areas that appear to deserve active consideration at this time.

The policy measures associated with the conservation scenario developed in Technical Report II include the following elements.

Residential Sector

Appliance Efficiency Standards
Lighting Efficiency Improvements
Building Envelope Standards
Plumbing Fixture Efficiency Standards
Electric Space Heat Regulation
Voltage Regulation

Commercial Sector

Building Envelope Standards
Passive Solar Energy Requirement in New Construction
HVA/C System Equipment Efficiency Regulations
HVA/C Operations Requirements
Internal Load Requirements (lighting levels and ventilation rates)
Electric Space Heat Regulation
Voltage Regulation

Industrial Sector

Cogeneration Regulation and Incentives (utility ownership option, utility surveys, back-up rate review, etc.)
Industrial Conservation Program (services, audits, outreach)
Building Envelope Standards

The degree of detail in the Conservation Case forecast is greater in the residential sector than in other sectors. This reflects the greater degree of end-use decomposition in the basic forecasting model, itself a reflection of the relative homogeneity of the sector and the greater degree of data availability. There is in general a more precise connection between the policy specification and the resulting savings in the residential sector than in other components of the Conservation Case forecast. The greater degree of detail available for the residential sector is fortunate because public policy initiatives are probably more important in realizing the conservation potential in this sector than in other sectors. Residential sector decision-makers are largely consumers while decision-makers in the other sectors are investors or agencies better able to "front-end" direct expenditures that are commercially or socially attractive on a life-cycle cost basis. (Nevertheless, further policy initiatives are needed to realize the existing conservation potential in the commercial and industrial sectors too.)

Measures that are of doubtful or unproven direct social cost attractiveness at this time, such as active residential solar systems and utility-initiated residential load control, were not included in the scenario. Such measures may have very real mid- or long-term social value; they simply are not among the most evidently attractive at this time.

Long-range forecasting is a science that necessarily involves uncertainty. The first volume of the Technical Report, in particular, addresses the issue of uncertainty. What the Conservation Case forecast gives us cannot be an advance proof that a precise amount of energy will be saved if a given policy is implemented. What we do get is a measure of the order of magnitude of savings that appear to be attainable through purposeful new initiatives.

The value of energy conservation measures as a social investment has been increasingly noted in the energy literature. What is distinctive about the Conservation Case forecast is its quantification of the specific effects for New England of a set of conservation actions and investments holding high technical and economic promise.

3.2 Results of the Conservation Forecast

The effect of the conservation package on forecasted electricity consumption in New England is dramatic. As the measures are phased in during the 1981 to 1988 period, total energy consumption actually begins to fall. Consumption increases again as underlying demographic trends and increasing saturations of some end-uses produce net growth. Nevertheless, the "energy gap" between the Base Case and the Conservation Case grows. During each year of the forecast period, more energy is conserved than during the previous year. The two forecasts were graphed in Sec. 2 above.

Since nuclear units have lower fuel costs than fossil-fired units, and since plans for converting to coal seem to be somewhat uncertain, the primary near-term supply benefit of a conservation strategy would be avoided purchases of largely imported and increasingly costly oil. Economic generation dispatch would dictate that oil plants be the first whose output would be reduced. These issues are more fully discussed in the supply summary below.

For consumers as a group, life-styles identical to those implied in the Base Case forecast are retained, yet less is spent on the mix of services than would have been without the conservation investments incorporated in the conservation scenario.

3.3 Observations Concerning Electricity Conservation Measures

The development of the conservation scenario, summarized and detailed in Technical Report II, was a process of pointing to conservation options that appear strongly promising at the present time. Given the dramatic energy savings resulting from the implementation of the measures in the aggregate, a general observation is that the order of magnitude of potential savings that remain above and beyond recent price and policy induced conservation is sufficiently large that even policies which do not cause full implementation of additional conservation can have an important effect.

The quantification of a regional electric energy conservation potential was not, of course, based on a political analysis of the process of institutional change. Rather, it assumed or hypothesized plausible policy changes in order to enter promising options for additional conservation into the forecasting model. Now, with the results in hand, it is appropriate to consider specific areas of opportunity.

Residential Sector

The residential conservation scenario included strong efficiency standards for several appliances. Minimum standards for new appliances have a legislative precedent at the state level. California has a comprehensive set of standards and some other states have selected standards. In addition, the U.S. Department of Energy is developing standards for a number of appliances under the National Energy Conservation Policy Act of 1978 (N.E.C.P.A.). N.E.C.P.A. also authorizes the Secretary of Energy to promulgate standards for appliances not specifically named in the legislation. The federal standards will supercede state standards unless a waiver is granted pursuant to application by the Secretary of Energy.

The conservation scenario employed more demanding standards than in effect in any state at present, resulting in the energy savings for new appliances indicated below. These are beyond Base Case improvements that assume new appliances will attain voluntary efficiency levels targeted to the Federal Energy Administration a few years ago.

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TABLE 5

INCREMENTAL ENERGY SAVINGS FOR PROTOTYPICAL NEW APPLIANCES (PERCENT VERSUS PRE-STANDARD LEVELS)

Appliance	1983 Standard	1988 Standard	Other
Refrigerator/Freezer	12	19	
Freezer	3	19	
Electric Range	2	2	
Electric Water Heater	5	2	
Room air conditioners*	12	2	
Central air conditioners			
Northern New England	-	6	
Southern New England	11	-	
Heat pump	-	13	
Plumbing fixtures	-	-	32**
Efficient lamps	-	-	48***

*Southern New England only

**Total effect by 1991 of standards effective in 1981

***Total effect by 1987 of promotion efforts begun in 1983

These appliance standards probably had a very strong effect on the Conservation Case forecast. A sensitivity run of the forecasts without the standards in a recent ESRG Connecticut study* produced a residential energy consumption that was almost 9 percent greater in 1988 and over 9 percent greater in 1998, than with the standards. Thus the appliance measures may account for nearly half of the conservation savings in the residential sector.

The conservation scenario employed a ban on additional unassisted resistance space heating after 1983. For a single measure, this has a strong effect on residential conservation, and its effect grows with time. In the Connecticut study, a sensitivity run without the e.s.h. ban showed Conservation Case residential energy consumption to be 3 percent higher by 1988 and 6 percent higher by 1998, than with the ban.

The conservation scenario included passive solar measures for new homes and weatherization for new and existing residential buildings, above and beyond the effects of the existing building code and Base Case weatherization retrofit trends. (A sensitivity run in the Connecticut study showed that the effects of the incremental conservation scenario weatherization grew slowly, reaching 2.4 percent of residential energy by 1998.) While there clearly is a conservation effect worth pursuing, we may have understated weatherization potential in two ways. First, we resolved all doubt in terms of the energy difference between 1978 actual weatherization on the one hand, and code-implied new-home weatherization on the other, in favor of a generous Base Case estimate of heating and cooling load reductions, in order not to overestimate conservation potential. Second, the emerging literature on residential thermal integrity suggests that practices which depart from conventional building practices (thus violating our conservation scenario "feasibility" criterion) may be highly cost-beneficial.

The conservation scenario includes a conservation voltage regulation (c.v.r.) Because it results in a direct energy savings of from 1.3 to 2.5 percent of total residential and commercial energy, depending on the state, at negligible cost to consumers, the c.v.r. is an obviously attractive measure to which too little attention has been paid. (A c.v.r. is a

*<u>The Potential Impact of Conservation and Alternate Supply Sources on Connecticut's Electric Energy Balance</u>, A Report to the Power Facility Evaluation Council of the State of Connecticut. Boston, Massachusetts: Energy Systems Research Group, Draft Report ESRG 80-09/R, June 2, 1980.

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regulation holding service voltage on distribution feeder circuits to the lower half of the voltage range, e.g., to 114 to 120 volts instead of 114 to 126 volts on a 120 volt circuit.)

Commercial Sector

Three of the residential sector measures also apply directly to the commercial sector. These are:

- Conservation voltage regulation.
- Resistance heating restriction.
- Heat pump improvement.

The discussion of conservation voltage reduction in the preceding section is applicable here. The effect of the e.s.h. ban (based on a commercial sector sensitivity run, in the Connecticut study referenced above), is smaller than in the residential sector. The ban may not decrease sectoral energy consumption by 1 percent until 15 years after the base year.

The conservation scenario is based on a set of measures for each building type and vintage in the model as discussed in Technical Report II. While the measures are cost-effective, the level of investment (and consequently of energy savings is estimated to be above that occurring in the commercial sector on the basis of market forces and current policies (compare table 8.20 and accompanying text of Technical Report I with table 4.1 in Report II). Depending upon building type, the additional conservation to be induced by policy would consist of such measures as increasing the R-value of all exterior surfaces, incorporating passive solar design elements providing additional waste heat reclamation; providing automated venting and bypass systems and combustion air preheat systems; increased use of task lighting and high-efficiency lamps; and providing integrated energy management systems for optimal operations and control settings.

When customers generate all or a portion of their own electricity, the supply they provide can be treated analytically as a reduction in demand. Self-generation simply reduces requirements for electricity from the utility system. Co-generation--combined production of electric and thermal energy--also increases the overall efficiency with which energy is consumed.

It should be noted that, because the major potential for self-generation or cogeneration of electricity is in the industrial sector, the conservation scenario did not incorporate an increase in commercial-sector cogeneration. This choice was not intended to imply that this area is undeserving of further investigation; it simply reflects the significant promise of the more thoroughly investigated conservation options summarized above. Another form of cogeneration, district heating, has not been addressed here.

Industrial Sector

Big industry in the United States is improving the productivity with which it utilizes energy. There is still some shifting from fossil fuels to electricity within several industrial categories, but there seems to be little question that conservation is going on.* While New England-specific conservation data for the recent period were not yet available at this writing, the conservation scenario assumed that state efforts would be directed at the small-business sector, comprising the bulk of manufacturing establishments, except in the area of cogeneration.

In the area of cogeneration, the conservation potential is noteworthy. In the recent report Cogeneration: Its Benefits to New England, the Massachusetts Governor's Commission on Cogeneration estimated a region-wide commercial and industrial potential of nearly 1,700 megawatts of new cogeneration capacity under "Base Case" conditions which included a rate framework similar to that which has been created by the Public Utility Regulatory Policies Act of 1978 (PURPA). The bulk of the site-specific analytical work in that study was in Massachusetts, with the results extrapolated to the region on the basis of patterns of industrial (and commercial) activity.

PURPA mandates development of utility purchase rates from cogenerators based on long-run avoided energy and capacity costs of the utility. It also mandates nondiscriminatory rates for back-up electric service to cogenerators. Development of these more favorable rates is assumed in the Base Case scenario. The conservation scenario assumes that rate development is embedded in a context in which other policy initiatives occur.

One possible initiative is a systematic survey of potential cogenerators to determine the technical and economic feasibility of increased cogeneration based on the new, more favorable rate framework of PURPA. Through the survey process, potential cogenerators can be made aware of tax incentives and financial assistance available to them and industry-utility discussions can be initiated.

Because the mere identification of potential that is attractive, even if followed by such initiatives as discussed in the preceding paragraph, may not be sufficient to overcome institutional inertia and the relatively high payback requirements that many industries place on energy capital investments, Technical Report II discusses the concept of utility ownership of cogeneration systems on customer sites.

Basically, the advantages of utility ownership are economic. Utility rate of return requirements are lower than those of industry when investment in generation capacity is involved. Investment in cogeneration equipment based on an agreement between a utility and the primary industrial steam/

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*See, for example, the Annual Report on the Industrial Energy Efficiency Program for July 1977 through December 1978, issued last December by the Department of Energy. Other citations on industrial energy conservation are contained within Technical Report II.

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electricity customer could permit a sharing of construction costs. In addition, utilities have appropriate skills in-house and experience with all aspects of the regulatory process. P.U.R.P.A. would probably have to be amended, as has been recommended by the Institute of Electrical and Electronics Engineers, to permit utility ownership of decentralized cogeneration systems.

Should government adopt a cogeneration policy orientation, the overall task is the development of an integrated framework for providing regulatory coherence, reviewing and establishing adequate utility/industry interface policy (particularly concerning backup charges), and creating adequate institutional mechanisms for initiating projects, raising capital, and implementing projects. State government can creatively work to develop a coherent regulatory framework for cogeneration addressing electric rates, fuels policy, and the application of environmental standards. It can develop a technical services capability to promote cogeneration by providing information and advice to would-be customers. In Report II, the conservation scenario assumed such initiatives. Production of new electricity through industrial cogeneration, based largely on historic patterns of self-generation, was estimated to attain a level twice that of the Base Case during the forecast period.

The conservation scenario also incorporated a ten percent additional gain in energy conservation for the industrial sector, attained in 1988 and maintained thereafter, due to additional industrial outreach efforts begun in 1983 and aimed primarily at medium and small businesses.

4. ASSESSING THE POTENTIAL FOR ALTERNATIVE SUPPLY

4.1 Criteria for Assessment of Electricity Supply Options

The purpose of the assessment of the potential for generation from alternative sources was to identify technologies that seem likely to be technically feasible and reasonably cost-effective over the 1978-2000 period. "Alternative sources" could encompasss a wide range of technologies other than conventional fossil fuel combustion and nuclear fission that are capable of providing electrical energy to the grid. We focussed upon technologies that utilize renewable resources (as opposed to technologies which utilize fossil fuels).

Technologies were judged likely to be technically feasible by 1990 if the underlying technology is proven and commercial-scale demonstration projects are now under way. For the purpose of judging cost-effectiveness, the cost per kwh of alternative supply options was compared to the cost of fuel for oil-fired generation. The sum of fixed and variable costs of alternative supply options were compared with only the variable fuel cost of conventional generation because the need for additional capacity in New Englnad is uncertain at this time. Of course, to the extent that alternative sources do provide additional capacity, they will be even more attractive if a need for such capacity develops. Technologies were considered likely to be cost-effective only if the best current estimates of their 1990 levelized busbar costs per kwh were in or below this range.

4.2 Technology Assessments

The technologies identified as more promising for New England were wind power, energy from municipal waste, small-site hydroelectricity ("small hydro"), large-scale hydro, tidal power, and wood. In this section, we begin by discussing these six technologies. Later we discuss other technologies that were considered but were judged to be too uncertain in their potential to receive priority at this time.

The potentials discussed below represent reasoned judgements based largely on the criteria of 1990 technical feasibility and cost-effectiveness. No systematic consideration has been given to institutional or environmental constraints that might limit the realization of the potentials. In the case of tidal power and conventional hydropower, where capacity additions have been proposed in the past and some measure of the intensity of institutional/environmental resistance has been gained, we have adjusted the potential downward from the level that would obtain on the basis of feasibility and economics alone. Such adjustments are fully described in Report IV, Sec. 2.3.

Wind Power. The extraction of energy from wind has a long history. Windmills were first used to generate electricity before 1900, and a 1.25 megawatt (mw) wind turbine was operated on Grandpa's Knob in Vermont in the 1940's. The widespread availability of cheap oil and gas, however, prevented substantial interest in wind generation until the mid-1970's.

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Several sub-megawatt wind units are in use by electric utilities under D.O.E. sponsorship. The U.S. Department of Energy (D.O.E.) in conjunction with the National Aeronautics and Space Administration (N.A.S.A.), has undertaken a wind program aimed at commercialization of megawatt-size wind energy conversion systems (WECS) by the mid-1980's. Initial commercial introduction could begin around the year 1983, with large-scale production under way by 1984. Wind generation is, therefore, considered feasible for the purpose of this study. One current concept for ultimate commercialization is a "wind farm" of about fifty 2-mw units, occupying about fifty acres. Such concentration would be aimed at efficient management of operations and maintenance requirements.

The cost-effectiveness of WEC systems is somewhat uncertain. First, the cost of the machines themselves that will ultimately be in commercial use must be projected from current prototypes using some assumed "learning curve" as well as factor input escalation. Second, the cost per kwh depends on both the cost of the WECS and the wind speed at the particular site.

Sites with higher average wind speeds will, in general, have lower costs per kwh. To achieve this lower cost, the WECS must be designed for the appropriate rated wind speed. Since the cost of the WECS (per kw) depends on the rated wind speed, comparisons of different machines can be misleading if their rated wind speeds differ. A more expensive machine may produce cheaper power if its rated wind speed is higher and it operates at a windier site. It appears, however, that the sensitivity of optimum design to site characteristics is not so great as to require custom design for each site. Mass production of a high, moderate and low wind model should be possible.

Given the uncertainties, no single figure for the cost of WECS power was developed. Estimates for levellized busbar costs per kwh range from 2.5 to 8¢/kwh for the 100th unit produced, as compared to oil-fired generation costs of at least 6-8¢/kwh (1990 costs in $ 1980). Despite the breadth of this range of estimates, it seems reasonable to conclude that wind will be cost-effective by 1990.

The magnitude of wind potential in New England is difficult to estimate. Identification of suitable sites is crucial to the economics of wind power. Twelve mph is thought to be the minimum viable average wind speed. Even average wind speeds are not adequate to characterize potential sites. The distribution of wind speeds is crucial, because WECS produce most efficiently at their rated wind speeds. The fraction of wind energy that is captured declines at speeds above or below this optimum, and the machine cuts out completely at certain upper and lower speed limits.

A detailed inventory of the wind resource is necessary before the potential for wind generation can be determined. It is likely that some of the highest wind speed sites are along the coast (where land is scarce and aesthetic objections to wind machines might be abundant). Nevertheless, some estimates of the regionwide potential indicate that the wind resource is worth considering seriously. The MITRE Corporation estimated that 35 100-mw windfarms could be developed in New England as a whole by the year 2000. The New England Energy Congress estimated a regional potential of 5,400 to 10,800 mw by the year 2000. If this maximum estimate were realized, windmills would be generating about 28 million megawatt-hours (mwh) of electricity yearly, saving as much as 50 million barrels of oil. Similarly, a recent generation planning study performed by the Electric Power Research Institute (EPRI) concluded that for oil-dependent utilities wind power penetration might economically exceed 10 percent of capacity. This implies at least 2000 mw regionwide.

The increasing cost of oil for utility consumption greatly enhances the attractivenss of wind machines. Though wind provides a somewhat intermittent source of power, electricity storage devices are not required to increase its economic attractiveness. As the EPRI report showed, the cost-effectiveness of storage depends on the overall nature of the utility system and its load. At the levels of wind penetrationconsidered here, the attractiveness of WECS is fairly insensitive to the level of storage.

These substantial estimates of the wind power potential contrast with the capacity figures mentioned by the New England Power Pool (NEPOOL). NEPOOL estimates that the maximum potential for wind power by 2000 is but 71.2 mw, even though NEPOOL's capital cost figures for wind machines of $856/kw to $1177/kw indicate that wind energy at a site with an average wind speed of 15 mph or greater would fall below 9.3¢/kwh, and thus meet our cost criterion.

Municipal Solid Waste (MSW). MSW can provide fuel for electric generation in one of three ways. A refuse-derived fuel (RDF) can be burned by the utility, usually along with existing fuels; a utility can contract to purchase steam for use in an existing station from a facility that burns raw or processed MSW; or, a facility specifically designed to generate electricity from waste combustion can be constructed. In any case, the maximum potential of the resource can be estimated on the basis of the available waste steam.

The economics of a MSW facility are described by an output price in ¢/kwh (or $/MMBtu) of steam and a "tipping fee" (in $/ton refuse) paid by the waste supplier. For a given technical configuration, the output price can be lowered by raising the tipping fee, and vice-versa. To be cost effective, a facility must produce energy at a cost competitive with oil, while charging a tipping fee that is competitive with disposal costs. As noted above, electricity from oil is expected to cost 6¢ to 8¢/kwh (1980 $) in 1990.

This is based on an oil cost of $5 to $6.75/MMBtu, so refuse derived fuels would have to be priced in that range to be competitive. An equivalent price, assuming 85 percent combustion efficiency, is $7 to $9 per MMBtu. The tipping fee that would be low enough to attract a steady MSW stream will be highly dependent on local disposal practices. Our review found that recovery of energy from MSW is cost-effective where sufficient waste exists, even with relatively low tipping fees.

In the U.S. at the present time, interest in MSW is focussed principally on large (>1000 tons/day) plants. Such plants are only feasible in metropolitan areas, since they require waste from about 500,000 people and transportation of MSW any great distance is not economical. Smaller plants (100-450 tons/day) are common in Europe, and could presumably be built here if they were economically justified. Construction began last fall on a 150 tpd plant in Auburn, Maine, designed to produce steam for local industry to be sold at a price indexed to the price of oil. The plant is expected to cost $3.2 million, with an initial tipping fee of $8.50/ton.

The best estimates of energy available from MSW in numerous specific New England cities and towns remain those developed in a Brookhaven National Laboratory study of 11 years ago. By analyzing that study in the context of the current situation and likely cost trends in the region as a whole, we developed a regionwide estimate of at least 1200 mw of potential electric generation capacity.

<u>Conventional Hydropower</u>. Technically feasible sites for new conventional hydro-electric generation capacity exist in New England. The U.S. Corps of Engineers has identified 17 major sites with a total potential for 975 mw and 2020 gwh/year. These totals do not include the controversial Dickey-Lincoln School project in Maine; that could add 760 mw and 1540 gwh/year. However, the Corps has established favorable benefit/cost ratios for less than half this capacity, with the remainder having ratios in the range of 0.8 to 1. While the 1979/1980 oil price increases since the U.S.A.C.E. report we consulted may have pushed all this capacity over the economic justification threshold, it is also quite likely that all these sites would be subject to severe environmental, land use, and water use conflicts.

<u>Small Scale Hydropower</u>. Much attention has been focussed on the potential for hydroelectric power at small dam sites in New England. In January, 1980, the New England River Basin Commission published a final Report based on its three-year investigation of this potential. Carried out in conjunction with the U.S.A.C.E., the study involved detailed engineering and economic analysis of the approximately 1,750 New England dams that do not now produce

power. This report showed that, while the maximum economic potential is much less than the technically feasible potential, there exists significant potential that is already economical.

The economic potential was detailed in Report IV. Depending on the required rate of return on the investment, approximately 500 mw of capacity in New England is cost-effective by our criterion, assuming the rate of return required for private investment. If the rate of return requirement were reduced through public ownership, the potential capacity would be some 700 mw.

Tidal Power. The technology for the generation of electricity from tidal action is similar to that used for hydroelectric generation, except that the direction of flow reverses with the tidal cycle, and the equipment must be designed to withstand the corrosive effects of salt water. Tidal variations on the order of 15 feet, which are generally considered necessary for tidal power generation, do occur along the upper Maine coast. Cost estimates for power produced from tidal projects in Maine range from about 7 to 8.5¢/kwh. If realized, these costs would be cost-effective by our criteria. The maximum potential for tidal power in New England is some 1200 mw. This potential consists of the Cobscook Bay area and other sites along Maine's upper coast. Development of these projects would require resolution of potential environmental conflicts.

Wood. The wood resources in New England could provide the basis for the development of the wood-electricity option in the region. Existing technology derives steam suitable for electrical generation from the combustion of green wood chips in a spreader-stoker boiler. A 17 mw wood-fired power plant is currently operated by the Burlington (Vermont) Electric Department, and planning is underway for a 50 mw facility expected to come into service November 1983. The planned facility will produce electricity at an estimated 9 to 11¢/kwh. A facility of this size requires a very large and steady supply of wood -- about 60 to 70 truckloads per day for the 50 mw plant. Since there are several competing uses for the region's forest and wood resources, it is not at this time certain that the development of a number of such facilities would entail an efficient use of these resources. Thus, the cost-benefit criterion for the development of this resource would ultimately require a more extended set of comparisons and analyses than a direct comparison with oil costs.

Other Supply Options

There are other technologies and primary energy sources that could be used to provide electricity in the New England region as part of an oil conserving strategy. Their exclusion from the foregoing discussion should not imply that they will not be viable energy supply options in the coming decades. Rather, it represents a judgement that the technologies discussed above have a sufficiently higher chance to achieve commercial status to merit priority attention. The second group of supply options are discussed briefly below.

Solar Generation. Electricity can be generated in two ways using solar radiation as the primary energy source. The direct heat of the sun can be used, with appropriate collecting and concentrating equipment, to produce steam to drive a conventional turbine generator. This is generally referred to as a solar thermal electric system because solar radiation can also produce electricity by striking arrays of photovoltaic cells fabricated from certain semiconductor materials. Because solar thermal electric systems have not yet been demonstrated commercially, it cannot be considered likely that they will be feasible until after 1990. The technical feasibility of photovoltaic electric generation has been established; the costs, though falling, remain very high.

Ocean Power. In addition to tidal power as discussed above, the possibility of generating electricity from wave action and ocean thermal gradients has received attention in the energy literature. Ocean thermal and wave energy are still at the early stage of development, and it is unlikely that the waters near New England would have sufficient temperature gradient or adequate wave energy characteristics for these sources to be suitable even if they do become technically feasible.

District Heating. District heating is a form of central-station cogeneration that reduces oil use per kwh of electricity generated due to the concurrent production of thermal energy for heating (or cooling) building complexes or neighborhoods. It does not fall within our criterion of an alternative technology, since it does not ordinarily utilize renewable resources. Nevertheless it is a promising method of increasing the efficiency of energy production. The economics of district heating are favorable due to the high cost of space heating in New England. Any city in New England that has conventional power plants situated in or around the city could probably be economically served by a district heating system at least for part of its heating requirement.

5. ASSESSING THE ECONOMIC AND EMPLOYMENT RAMIFICATIONS OF RESIDENTIAL ENERGY CONSERVATION

5.1 Approach

Regional input-output (I/O) analysis is one method of tracing the economic effects of a change in the level of activity in one industry upon the other industries with which it is associated in a regional economy. A given increase in the demand for storm windows, for example, increases in varying degrees the demand for materials and labor in all the industries involved in the chain of production leading to the fabrication of this final commodity. The spending of wages earned through this chain further spreads the effects of the change in demand through the economy.

In the current study, use of a regional I/O approach permits a complete analysis of the direct and indirect effects of specific increases in the demand for residential energy conservation goods and services.

In order to perform an I/O analysis, a regional input-output table or its equivalent is required. Regional Industrial Multipliers (RIMS) have been developed by the Bureau of Economic Analysis of the U.S. Department of Commerce. RIMS for the New England states were incorporated as one of the four major elements in the computerized employment model used for this analysis.

The employment impact analysis described in Report V is linked directly to the forecasting results described in Reports I and II. There, base and conservation case forecasts were developed for each of the New England states. Because the forecasts are end-use based, the implementation of conservation measures which impact residential consumption can be linked directly to changes in end-use consumption. For example, the conservation scenario embodies increases in the installation rate of storm windows relative to the Base Case. (In the forecast model, this is a factor in reducing the energy demand for space heating.) Comparing the base and conservation forecasts allows the identification of the annual number of added storm windows and the associated energy savings. Monetary savings which result will have a local employment impact through increased spending. Based upon this information, the model computes the economic consequences of additional demand for this number of storm windows. Analogous procedures for all conservation measures provides a stream of disaggregated conservation implementations. The I/O analysis is performed on a measure-by-measure basis, taking into account the number of yearly applications of each measure required to account for the differences between Base and Conservation Case forecasts.

To analyze the economic consequences of an individual conservation measure, such as the addition of a storm window, it is necessary to specify labor and material requirements. ESRG has developed a data base containing such information. In the course of the current project, this data has been expanded and adjusted to reflect New England conditions. This provides a key input to the ESRG model computations. Separate data exist on measures for new vs. existing and single vs. multifamily dwellings where appropriate. The employment model receives the input data on the labor and materials required for each measure, as well as the number of applications of each measure. Based on this input data, as well as the RIMS multipliers mentioned earlier, the model estimates the changes in regional economic activity necessary to meet the demands due to the yearly installation of the assumed number of conservation measures. There are a number of distinct effects upon the regional economy. These include:

- On-site employment required to install the measures.
- Demand for materials on regional sales activity.
- Spending of wages of on-site workers on regional sales.
- Decreased energy consumption on regional energy sales.
- Indirect effects of all of the above throughout the regional economy.

Aggregation of these effects yields a profile of the impact of incremental conservation investment by state and by type of employment impact.

In Figure 5, we trace the steps involved in computing the direct and indirect economic effects of investment in the additional conservation. The installation ("measure implemented") of a conservation measure triggers a series of economic responses. In addition to the labor involved in installation, there is maintenance for certain measures. Installation and maintenance activity together constitute the "on-site" employment due to the installation of the measure. The on-site employment leads to the first off-site effect: the spending of wages which are paid to workers engaged in the installation and maintenance of the measure. This is shown in the "off-site changes" column of the diagram. Two other off-site effects are also shown. The

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

JAN 16 1981

Mr. J. Dexter Peach
Director
Energy and Minerals Division
U.S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Peach:

We appreciate the opportunity to review the GAO draft report, "A More Effective Regional Effort in Conservation and Renewable Resource Development Can Help Alleviate New England's Oil Dependence," and submit the enclosed comments prepared by our staff.

Sincerely,

William G. McDonald
Executive Director

Enclosure

first is the purchase of locally produced materials. Here are also included any appropriate wholesale, retail, or transportation activity associated with goods produced outside the region.

Next is shown the increases due to non-energy spending. This is the most important effect of conservation. Many conservation measures pay for themselves quite rapidly and have a useful life far beyond the period needed to repay the cost of the installation. In our analysis, we assume that consumer expenditures measures are "repaid" out of savings due to decreased energy consumption. Energy savings eventually pay for the measure, as indicated in the diagram. Once the measure is paid for, the continued savings are shifted to general household expenditures, through which they increase non-energy spending within the economy. This "respending effect" provides the largest increase in local employment among the various direct and indirect effects.

In addition to the sources of increased employment, there is one major source of decreased employment. The decreased demand for energy caused by the conservation measures leads to decreased economic activity in the energy producing sectors. These include the electric and gas utilities and the petroleum industry. Decreased demand here is translated into overall employment reductions in a manner analogous to that discussed above. Associated indirect effects are taken into account here, as in the rest of our analysis.

5.2 Results

The residential sector shift from the Base Case to the Conservation Strategy scenario produces substantial overall regional employment gains. These are the product of an overall increase in regional economic activity as a result of conservation investment. There are two dimensions to this.

First, the regional commitment to conservation produces on-site employment (e.g., storm window installation). Second, there are indirect, "off-site" effects. Here, while reduced energy expenditure does reduce regional energy-related employment, measure implementation and the "respending" of associated savings increase conservation-related employment. The latter effect overshadows the former.

As explained above and shown in Figure 5, there are three different ways in which the effects of on-site conservation-related activity are linked to the local economy. The three are: (1) through the demand for materials purchased locally and through the spending wages to on-site workers, (2) through decreased consumption of local energy services, and (3) through shifts in household income and thereby spending, made possible by the re-allocation of savings from decreased energy expenditures. Table 6 presents the total employment impact by state disaggregated according to these different effects. Also presented are the total direct employment on-site as well as the overall total employment.

An examination of Table 6 shows that indirect employment (that is, employment off-site) gives the bulk of the impact in each of the states. Further, it is clear that this employment is a composite of competing effects. Purchase of materials and the spending of wages and the effect of shifts in disposable income tend to increase local employment, while decreased spending for energy tends to decrease employment. It is particularly interesting to compare the decrease in employment due to fuel savings with the increase due to the shift in funds associated with these savings. Despite the fact that the spending of energy savings only commences <u>after</u> the original capital investment in conservation is paid for, the results show that the net effect of this shift is to strongly increase regional employment.

TABLE 6

TOTAL EMPLOYMENT IMPACT DISAGGREGATED
BY ECONOMIC EFFECT OF CONSERVATION,
1978-2000

	ME	NH	VT	MA	RI	CT	NEW ENGLAND
On-Site	7,492	6,910	3,382	26,521	4,332	15,903	64,540
Indirect Employment Due To:							
Labor and Materials Purchases	14,490	15,171	6,248	69,356	9,266	33,718	148,249
Reduced Energy Expenditures	-39,468	-39,418	-16,613	-174,828	-24,500	-80,875	-375,702
Consumer Spending of Energy Savings	51,736	51,614	22,159	235,062	31,988	105,589	498,148
Sub-Total Indirect Employment	26,757	27,366	11,794	129,590	16,753	58,433	270,693
Total Employment	34,249	34,276	15,176	156,111	21,085	74,336	335,233

The yearly impacts of each of the basic employment factors for New England as a whole are given in Table 7. Here, as in Table 6, labor and materials impacts, together with on-site employment, are dominant in the early years. However, by the mid-point in the study period, they are overtaken by the effects of respending.

TABLE 7

TOTAL ANNUAL EMPLOYMENT IN NEW ENGLAND DISAGGREGATED BY ECONOMIC EFFECTS OF CONSERVATION

	1983	1988	1993	1998	TOTAL
On-Site	1,534	4,440	3,703	3,245	64,540
Indirect Employment Due To:					
Labor and Material Purchases	4,002	9,207	8,383	8,591	148,249
Reduced Energy Expenditures	-2,005	-12,667	-24,039	-35,471	-375,702
Consumer Spending of Energy Savings	1,721	14,836	31,353	50,888	498,148
Sub-Total Indirect Employment	3,718	11,376	15,697	24,008	270,693
Total Employment	5,251	15,815	19,402	27,252	335,233

The details of this pattern are related to the assumption that all savings are credited toward the cost of a conservation measure until that measure is paid off. Once the measure is "paid off," these savings are treated as additional disposable income, to be spent or saved following the general pattern of residential consumers.

From the standpoint of regional employment-creation, investment in conservation is very efficient. In Table 8, yearly employment per million dollars of total investment and per million dollars of local economic activity is given. The latter is a measure of the fraction of the expenditures on conservation which remain in the local economy. Thus, for example, if the measure under consideration were insulation, the local spending would include the portion of the total cost of the measure associated with local and some inter-regional transportation, wholesale and retail, together with any on-site labor costs involved in its installation. However, if the insulation were manufactured outside New England, no manufacturing costs would affect the local economy. The data in Table 8 shows that approximately 52 percent of the total investment in conservation leads to local economic activity and thus to local employment. Despite the fact that some investment "leaks" out of the region, comparison with other expenditures, such as power plant construction, shows that investment in conservation creates more employment per dollar invested than do most alternatives.

TABLE 8

EMPLOYMENT PER MILLION DOLLARS
OF CONSERVATION INVESTMENT BY STATE

	ME	NH	VT	MA	RI	CT	TOTAL N. E.
Total Employment	34,249	34,276	15,176	156,111	21,085	74,336	335,233
Total Investment, 10^6 $	680	659	335	2,558	413	1,630	6,275
Employment Per 10^6 $ Invested	50.4	52.0	45.3	61.0	51.1	45.6	53.4
Local Spending, 10^6 $	404	414	180	1,480	236	929	3,643
Employment Per 10^6 $ Spent Locally	84.8	82.8	84.3	105.5	89.3	80.0	92.0

The total cumulative costs of conservation investment, which reach some $6.3 billion by the end of the century, are far outstripped by the stream of energy savings. During the first few years, costs exceed savings. After 1985, cumulative savings already outstrip cumulative costs. The costs of implementing and maintaining conservation measures then remain relatively constant while savings continue to mount (see Table 9). After 25 years, total cumulative savings are some $17.7 billion. The "investment" figures do not include any finance charges, and the "savings" figures do not include the tax credits for which residents qualify under existing law.

APPENDIX II

TABLE 9

YEARLY CONSERVATION INVESTMENT AND
ENERGY SAVINGS IN NEW ENGLAND
(10^6 1980$)
1978 - 2000

	1978	1983	1988	1993	1998	TOTAL
Total Investment	0	161	379	366	368	6,276
Energy Savings	0	91	617	1,129	1,641	17,675

Of course, these data represent only the direct economic trade-offs. The primary purpose of the analysis described in this section has been to demonstrate the importance of also consideringthe indirect and employment impacts of alternative energy strategies.

APPENDIX III

Department of Energy
Washington, D.C. 20585

FEB 1981

Mr. J. Dexter Peach, Director
Energy and Minerals Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

The opportunity to review and comment on the GAO draft report entitled "A More Effective Regional Effort In Conservation and Renewable Development Can Help Alleviate New England's Oil Dependence" is appreciated.

The report's general conclusion "that conservation and alternative energy sources can play a significant role in reducing New England's dependence on oil" appears to be sound. There are two major problem areas and a number of lesser concerns which merit your attention. The problems are these: (1) The report should clarify, early on, the limitations on its scope, particularly its omission of any material concerning the transportation sector, which has a great influence upon petroleum consumption; 2) the report tends to downplay the potential of additional coal and nuclear power plants, as well as coal conversions of existing plants, to eliminate oil dependence. Without these additional considerations, the evaluation of New England's potential to backout imported petroleum is misleading and of limited help in planning to achieve national energy objectives.

The draft report relates only generally to the technical backup report by the Energy Systems Research Group, Inc., dated September 1980. The source and rationale of the draft report's recommendations are consequently difficult to understand. A comparison of DOE's EIA Base and Conservation Cases with corresponding GAO cases reflects the use of widely differing assumptions. Whereas the study's general conclusion appears to be reasonable, and it is expected that substantial conservation will take place in the future, the model upon which the assumptions are based is not valid.

The GAO report should clarify the assumptions that were used. The backup report assumes certain measures to be technically feasible and cost effective, but apparently ignores institutional and other barriers to utilization that affect expected energy savings. A similar approach for coal and nuclear energy may provide very different estimates for those energy sources. The study tends to be overly simplistic and, thus, overestimates oil savings from conservation and renewables.

It is suggested that a clearer definition of terms and the use of consistent measures be presented. The use of percentages to clarify the importance of particular measures or the consistent translation of these measures into "barrels-of-oil per day" would present a clearer picture of the measures' relative importance to the reader.

The following additional specific comments are presented for your consideration:

- The analysis of conservation opportunities would be enhanced if the data were presented in a supply-curve format, showing roughly how much conservation, measured in kilowatt hours or BTUs, is available from a particular option, and at what cost.

- Oil savings resulting from the proposed ban on electric resistance heating are dependent on the energy source which is used for generation of the electricity. The analysis upon which the suggested ban is based assumes that oil will be saved. However, once coal and nuclear have become the principal energy sources of the utilities, such a ban will not result in savings of oil.

- The report's major recommendations suggest a role for DOE's Region 1 office which appears to go beyond encouraging and fostering conservation and renewables development in New England. It calls for that office to play a direct role in planning and regulatory review which would expand the role of the Federal government substantially. A more modest approach should be pursued. The Regional office can play a useful role in working with Washington staff to provide technical assistance to utilities and State regulatory commissions regarding optimum (least-cost) investment strategies. Such assistance could address both planning and implementation of conservation and renewable efforts and would be consistent with current DOE activities. Expansion of the Regional office's current activities would have budget and personnel implications which must be considered.

- The major recommendation regarding the Region 1 office does not appear to be clearly related to the rest of the report. In addition, many of the points made in the Observations and Recommendations sections on the role of the Region 1 office are brief and would benefit substantially from further development and clarification.

In conclusion, the report tends to de-emphasize the role of price in producing energy conservation and renewables development. Actual prices and discussion of price assumptions are not presented in the GAO report - only in the backup study. The role of price increases in transitioning away from imported petroleum has been given inadequate attention as well as not presenting the economic burden of costs to New England of not backing out imported petroleum.

Comments of an editorial nature have been provided directly to members of your staff. The opportunity to comment on this draft report is appreciated and it is trusted that our comments will be considered in preparing the final report.

Sincerely,

P. Marshall Ryan
Controller

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

JAN 16 1981

Mr. J. Dexter Peach
Director
Energy and Minerals Division
U.S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Peach:

We appreciate the opportunity to review the GAO draft report, "A More Effective Regional Effort in Conservation and Renewable Resource Development Can Help Alleviate New England's Oil Dependence," and submit the enclosed comments prepared by our staff.

Sincerely,

William G. McDonald
Executive Director

Enclosure

Staff Comments on "A More Effective Regional Effort In Conservation and Renewable Resource Development Can Help Alleviate New England's Oil Dependence"

1. Page 5

What is the basis for assuming "that savings from conservation would first be applied to reducing oil consumption"? If this assumption is incorrect, are you not overstating the benefits for the conservation case?

2. Page 7

Your assertion that New England is especially vulnerable to oil supply disruptions would be strengthened if you could point to specific difficulties encountered by New England during the 1973-74 Arab oil embargo.

3. Page 8 - Paragraph 2

In citing the decline in home heating oil usage between 1972 and 1978, have you controlled for differences in weather between the two years?

4. Page 11

The meaning of the numerical values given in the table are unclear. For example, does "Level of Investment" refer to a life cycle or annual value? What is meant by the "ideal case"? If you give costs in dollars, then you should also estimate the benefits in dollars (i.e. the dollar value of the oil savings)? The Harvard Business School study cited in the footnote has over three hundred pages of text -- give a page reference.

[See GAO note, p. 102.]

APPENDIX IV

5. Page 15

"However, this would be switching from one fossil fuel to another which also could be scarce in New England." The meaning of this sentence is not very clear. Do you mean that natural gas will simply not be available or will only be available at a high price? If you mean the latter, it is inappropriate to use the word "scarce". It would be clearer to say that natural gas will no longer be cheap. The problem here seems to be one of semantics. For a discussion as to how to treat these concepts, you might want to read Chapter I of No Time To Confuse, a publication of the Institute for Contemporary Studies (1975).

6. Page 15 - Paragraph 5, next to the last line.

The sentence would be clearer if you said "available" rather than "realized".

7. Page 17

Why is your consultant's model better than the NEPOOL model? Models are ways of thinking about the world. They can be judged on the realism of their assumption or on the accuracy of their predictions. If you are going to use one model in place of another, then you have an obligation to your reader to explain why your model is better than the other model. It is not enough to simply list, as you do on Page 18, the differences between the models without further comments. If anything, the fact that the NEPOOL model is "more responsive to price changes" (Assumes price elasticities?) would appear to make it more realistic.

8. Page 18 - Footnote

Why isn't the MMWEC oil fired intermediate unit included on this list?

9. Page 27 - Paragraph five.

The sentence would be approved if it read "Energy costs have escalated and most of the money has flowed out of New England to other regions and other countries."

10. Page 29 - Paragraph 1, four lines from the bottom.

Change "results" to "result".

11. Page 40 - Paragraph 3, line 2.

Missing words -- "the most"?

12. Page 34

This page begs for further anaylsis. You indicate that most utilities have not been involved in financing conservation activities. You then go on to suggest that the inability to recover investment costs in conservation activities has been the principal stumbling block. The trade press reports, however, that the New England Electric System (NEES) has been very active in promoting conservation efforts by its customers. Why has NEES been more active than the other New England Utilities? Is it simply a difference of managerial philosophy or does NEES have access to regulatory benefits that are not available to other utilities? It would improve the report if you gave additional information on the regulatory and institutional framework.

13. Page 35

Last sentence in the first paragraph.

The wording of this sentence could be improved. We suggest that you change the second half of the sentence to: "then the utility should be given economic incentives to pursue socially cost-effective investments." As the sentence now reads, it appears that you are recommending that utilities should make investments that are socially beneficial but privately unremunerative.

14. Page 38

You recommend that New England state legislatures pass laws establishing energy efficiency standards. Are there any costs associated with such laws? If so, you don't mention them. Why won't New England energy consumers seek such efficiency in their own self-interest? On page 8, you indicate that New England consumers have already taken conservation actions in response to price increases? Why won't that continue to happen in the future? The report should include some discussion of the comments of the White House Regulatory Analysis Review Group on the need for Federally mandated efficiency standards (see the National Journal, 11/29/80). You might also review Irwin Stelzer's talk on "The Role of Utilities In Energy Conservation Programs" (Airlie House, September 22, 1980).

15. Page 39

Is it realistic to assume that the Federal government can engage in "supportive oversight." Federal oversight has a tendency to become bureaucratized and litigious. If tht turns out to be true, then you may simply have added one more layer of regulation with its accompaning potential for delay.

16. Page 33

Help the interested reader by giving full citations to these GAO reports.

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

PUBLIC UTILITIES COMMISSION
100 Orange Street
Providence, R. I. 02903

February 9, 1981

J. Dexter Peach, Director
Energy and Minerals Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

I hereby submit my comments as Chairman of the Rhode Island Public Utilities Commission, on the General Accounting Office's draft report entitled, "A More Effective Regional Effort in Conservation and Renewable Resource Development Can Help Alleviate New England's Oil Dependence."

I would like first to voice my positive reaction to the draft report as a whole. The observations, recommendations and suggestions for the consideration of the Congress show a good understanding of the peculiar set of problems faced by the New England region and indeed the entire Northeast, in alleviating our oil-dependence. However, I would make the following comments and additions to your report.

1. In the draft, in the matters for consideration of the Congress, the report says that DOE should provide a report to the Congress analyzing further the initiatives available to the federal government, including the possibility of a regional planning board or a regional power authority. I favor a regional planning board now. The only regions in the continental United States without some kind of Federal Power Marketing Authority are the Northeast and the upper Midwest. These areas also have the highest energy costs in the U.S. A regional Power Board would allow the region to deal more effectively (and more fairly for the member states) with energy producers.

2. Your draft's "Alternative Supply Case" which examines the potential for using renewable energy resources to generate electricity does not consider, nor does it even mention the possibility of purchasing hydropower from Canada. Quebec has excesses of power available from its enormous James Bay hydro development and some of this power is available for export. Newfoundland's Churchill

Falls projects also have export potential, as does Nova Scotia's proposed Bay of Fundy tidal project. The legislatures of three of the New England states, namely Rhode Island, Vermont and New Hampshire, have passed legislation allowing the Public Utilities Commissions of these states to act as agents of the states to purchase power from out of state energy producers. This bill was specifically passed in my state so that we would be empowered to deal with Quebec for hydro-electric energy. Furthermore, recognizing their common problem of dependency on imported oil, the six New England Governors and the five eastern Canadian Premiers have formed the Northeast International Committee on Energy. The Committee meets regularly to deal with matters assigned to it by the Governors and Premiers in the fields of alternative and renewable energy resources and conventional energy, and has become an effective forum for the exploration and discussion of energy matters of mutual concern to the states and provinces.

3. The draft neglects a particular area of interest to the Northeast International Committee on Energy in the conventional energy field; that area is Canadian natural gas. Two pipelines which are well along in planning will bring a combined total of 335 million cubic feet of natural gas per day from Canada to New England. The Boundary Gas Pipeline will bring in 185 million cubic feet per day and the Maritime Pipeline connecting with a new New England States Pipeline will bring 150 million cubic feet per day into the region. Consideration of this resource would alter the figures in the study appreciably.

4. I would recommend that the report suggest to the Congress that one of the most needed pieces of legislation from the New England point of view for alleviating New England's oil dependence is the oil back-out legislation (H1031) now before Congress. This legislation along with conservation and development of alternative sources of energy can help the citizens in our region pay energy bills that are more in line with those being paid by the rest of the citizens of our nation.

Thank you for this opportunity to comment.

Sincerely,

Edward F. Burke

Edward F. Burke, Chairman

STATE OF MAINE
OFFICE OF THE GOVERNOR
AUGUSTA, MAINE
04333

JOSEPH E. BRENNAN
GOVERNOR

January 16, 1981

Mr. J. Dexter Peach, Director
Energy and Minerals Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

This is in response to your recent letter requesting my comments on the draft report by the General Accounting Office entitled, "A More Effective Regional Effort in Conservation and Renewable Resource Development Can Help Alleviate New England's Oil Dependence."

As your report points out, the states will play a vital role in decreasing the region's dependence on oil through an aggressive program of conservation and alternative energy projects. I am concerned, however, with two of the recommendations contained in this draft report.

Firstly, you recommend that states consider adopting energy efficient standards for appliances. While I agree with the desirability of adopting such standards, I am doubtful that it would be wise for Maine to do so in the absence of similar action by a considerable number of other states or by the federal government. Otherwise, should Maine adopt such standards they would have little impact on the national market and Maine consumers would be deprived of a range of choices in selecting their appliances.

Secondly, you comment that DOE should report to Congress on the possibility of a regional power planning board or national power authority for New England if the New England States and utilities should be unable to reduce the region's dependence on imported oil. The question arises immediately as to who would determine that the States and utilities had been unable to reduce dependence to a desirable extent. Recent developments, related mainly to market conditions, have resulted in notable reductions in gasoline and home heating oil consumption and a slowing of the growth rate of electric consumption. We expect both Maine and New England will continue this trend as a result of the combinations of market forces and state and regional action.

APPENDIX VI

In preference to the recommendation for a DOE report, Federal action to assist the New England States in their efforts to improve energy exchanges with Canada would be more appropriate and germane. New England needs both the policy support of DOE and other federal agencies and some financial assistance to enable us to better consolidate our relationship with Canadian energy suppliers. I am certain that Maine and other New England States will make the appropriate institutional arrangements for cooperative or joint action, especially if they receive such support.

Thank you for the opportunity to comment.

Sincerely,

Joseph E. Brennan

JOSEPH E. BRENNAN
Governor

JEB/sc

CC: Chairman Gelder, Public Utilities Commission
Director Weil, Office of Energy Resources

NEW ENGLAND REGIONAL COMMISSION

141 Milk Street Boston, Massachusetts 02109 617/223-6380

January 9, 1981

Mr. J. Dexter Peach
Director
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

We appreciate the opportunity to comment on GAO's draft report, "A More Effective Regional Effort in Conservation and Renewable Resource Development Can Help Alleviate New England's Oil Dependence." It is encouraging to note the attention paid to this critical regional problem, a solution for which we have actively been seeking for several years.

The draft report makes a number of worthwhile recommendations which are largely in agreement with the numerous efforts of the states to reduce oil consumption. The principal thrust of the draft report--that oil use can be reduced by conservation and the use of renewable fuels--reflects ongoing projects throughout the region which have aimed to curtail oil consumption wherever possible, and a few of these projects are noted in GAO's Study. The primary focus on electrical generation is also a useful approach insofar as it recognizes the potential for gainfully altering New England's fuel mix and demand growth.

As a policy paper, however, we do not find the draft report to contribute in any significant way to our understanding of the region's energy challenges. Other organizations, notably the New England Energy Congress and our own energy staff, have made considerably more comprehensive analyses of regional energy needs.

A number of the specific suggestions (pp.37-40) are either too general to be of value or are calling for activities that are already underway. The most comprehensive recommendation--the pervasive involve ment of the Department of Energy Region One office as a "responsibility center"--is unnecessary given existing institutions in the Region and probably impractical given the staff limitations at DOE Region One.

Moreover, we find several of the findings published in the draft report puzzling, such as the elliptical reference to natural gas (p.15) and the somewhat brief and uneven treatment of non-electrical conservation in buildings (particulary in comparisons between "base case" and "conservation case", which are consistently confusing). Coal conversion, which probably represents the most immediate opportunity for reducing utility sector oil consumption, is given scant consideration. In part, many of these may be remedied by changes in the draft reports organization.

[See GAO note, p. 102.]

GAO Letter/2

In conclusion, it is important to reiterate the determination and sophistication with which the New England region has attacked its energy problems. We welcome useful and insightful studies of current and future demand and supply patterns, as well as specific policy recommendations. There is some material in the draft report that meets these ongoing requirements. Unfortunately, however, a large measure of the report is outdated, misdirected in emphasis, or, curiously, in error. It reflects a lack of understanding and knowledge of existing programs and institutions at the State and Regional level in New England.

If you desire further elaboration on any of these points, or would like further assistance, please contact Benjamin Kincannon who is Acting Director of the NERCOM Energy Program.

Thank you again for the opportunity to review the draft report.

Sincerely,

J. Joseph Grandmaison
Federal Cochairman

BFK:sat

GAO note: Page references in the appendixes refer to the final report and do not necessarily correspond to page numbers in the draft report.

CMP Central Maine Power Company
GENERAL OFFICE, EDISON DRIVE, AUGUSTA, MAINE 04336 (207) 623-3521
(TWIX NUMBER, CMP-AGUA 710-226-0195)

January 8, 1981

Mr. J. Dexter Peach
Director
Energy and Minerals Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

On December 17, 1980, Mr. James R. Smith of NEPOOL received your letter of December 11, 1980 and copies of a draft report entitled "A More Effective Regional Effort in Conservation and Renewable Resource Development Can Help Alleviate New England's Oil Dependence". You requested that NEPOOL comments on the draft report be submitted to you in writing within 30 days from your transmittal letter date so that they may be incorporated in your final report. In response to this request, we are enclosing our comments. We would point out, however, that insufficient review time has been allowed to provide a complete analysis of such an important document and efforts by our Planning Committee Chairman to extend the deadline for comments were not successful (Mr. J. Gurkin's communication with your Mr. T. McGrean of the GAO Boston office).

As our enclosed comments indicate, we commend GAO for its recognition of the importance in reducing New England's oil consumption. Indeed, it is also the goal of the New England electric utilities. However, as we indicate, the GAO and its consultant in this study have ignored many factors already influencing energy conservation and alternate energy resource development. The report's main recommendations involve additional legislation including the "possibility of a regional power planning board or a regional power authority". We disagree with this recommended means to reduce New England's oil dependency. Further, as our comments and the record indicates,

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Mr. J. Dexter Peach January 8, 1981

there is no justification for such recommendations. Any additional institutional/legal action would be best applied to reducing lead time requirements of existing base load nuclear and coal technologies, providing assistance for achieving adequate rate relief and providing aid in economically justifiable coal conversions. In summary, GAO's premise "that the Federal role should be one of supportive oversight" can be the basis for recommendations significantly different than those which GAO has included in this report draft.

Sincerely,

E. W. Thurlow

E. W. Thurlow, Chairman
Executive Committee
New England Power Pool

Enc.

NEPOOL COMMENTS

ON THE GAO DRAFT REPORT

"A MORE EFFECTIVE REGIONAL EFFORT IN

CONSERVATION AND RENEWABLE

RESOURCE DEVELOPMENT CAN HELP ALLEVIATE

NEW ENGLAND'S OIL DEPENDENCE

1/5/81
NEPLAN

General Comments

The goal of reducing New England's oil consumption as indicated in the GAO draft report is commendable. It is also the goal of the New England utilities. However, the GAO and its consultant (E.S.R.G.) have seemingly ignored many factors already influencing conservation and alternate energy resource installations when they suggest additional legislation is required. The apparently overlooked, or undervalued, factors at work are PURPA of 1978, backout legislation and the free market action influences of price, all of which will have a large effect and significantly reduce the additional potential cited in the report as being available from additional legislation.

The utilities do not need additional legislation which will add more monitoring by additional agencies and create further delays in the installation of known effective technologies which are dispatchable with proven capability to reduce oil consumption. Any additional institutional/legal action would be best applied to reducing the lead time requirements of existing base load nuclear and coal technologies, assisting the utilities in obtaining adequate rate relief to assure installation of the pool planned units without further delay and in obtaining adequate funding to assure coal conversions where they can be justified.

This point is emphasized by a quote from the final draft of Volume II, Chapter 2 of the "National Reliability Study" prepared by the Division of Power Supply and Reliability, Office of Utility Systems, Economic Regulatory Administration of the United States

Department of Energy. "The small, dispersed unconventional power generation technologies are found to be not very cost-effective. Their capital costs are too high for the energy provided. The additional benefits due to their being dispersable and ease of construction and licensing are not significant enough to offset their higher capital costs. The intermittency nature of the renewable sources results in low contribution to reliability improvement. Instead, their short-term power output variations may cause the power systems to acquire additional load following generating units and increase utility system's spinning-reserve requirements. Both of these effects will increase the penalty for intermittent generation".

If this type of capacity is not cost effective to make a reliable system, it will not be cost effective to supply only energy. This, coupled with the fact of inadequate manufacturing facilities, will not make wind generation, for example, a significant factor in the next ten years when great strides should be made in reducing oil consumption.

The utility industry in New England is already actively involved in implementing many of the measures proposed in this report. Many of the references cited in the report indicate areas of utility involvement.

In the area of conservation, electric utilities already are:

(a) Distributing informational and educational materials to all classes of customers. Conducting educational programs in conjunction with school systems;

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(b) Making home energy audits available to all residential customers;

(c) Counciling industrial and commercial customers to help improve efficiencies of their operations and identify cost effective conservation measures on an individual basis;

(d) Distribution of shower head flow controls to customers;

and many other programs. This is not an exhaustive list but an indication of the commitment on the part of electric utilities in New England to conservation.

In the area of utilization of alternate, renewable energy resources, New England electric utilities are:

(a) Currently building and developing small, low-head hydro projects;

(b) Currently using wood as a generating source with plans to build additional plants.

(c) Planning and building generation to utilize wastes and refuse.

(d) Supporting research and development of and demonstration projects of solar and wind power.

Again, this is not an exhaustive list.

In each of the last two years, New England companies have been named electric utilities of the year: New England Electric System in 1979 and Boston Edison Company in 1980. NEES was named specifically for its innovative plans for conservation, load management, alternate generation, and efficient (low-heat rate) generation. Boston Edison was also cited for its great improvements in generation efficiency. The most efficient generation in the world resides in New England.

Comments in the GAO staff summary (p. 35) relating to the extent to which New England utilities have considered and adjusted for energy conservation in their plans in balancing electricity demand and supply misrepresent what has actually occurred. In fact, the utilities have markedly reduced their projections of electricity supply needs since the high growth period prior to 1973. Much of this "conservation" has been a result of rational responses to market forces as prices increased rapidly.

This is the context in which one conclusion and recommendation of this report is made: if the utility industry in New England fails to cooperate in implementing conservation and alternate generation, a regional power authority should be established. Further, there is simply no way such a conclusion and recommendation can be made from the body of the report itself.

The entire thrust and goal of the report, analysis and scenarios seems to aim toward identifying the savings in imported oil that can be achieved. Utilities are fully aware of the need to save oil and

See GAO note on page 102.

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are taking steps to do so through coal conversions, installation of coal and nuclear generation, installation of alternate resources, load management, conservation, etc. The authors' analysis seems to be done in complete absence of utility input and current plans particularly regarding coal conversions. This places a great deal of suspicion on the method of analysis and results and conclusions of the report. In fact, the utilities through the oil backout legislation have been ordered to cut to 50% by 1990 the amount of oil used. Since the utilities are taking steps to comply, it would seem that these plans should be a part of the base case, conservation, and alternate generation scenarios. How does such input impact the results of this study?

In the conservation scenario, the electric energy by the year 2000 is reduced 20% compared to the base case. Yet there is no analysis of the electric revenues, revenue requirements, or electric rates on a per KWH basis in the report for the two cases. In both cases, the same generation expansion was assumed. Most notably, the four nuclear units and one coal unit currently planned by New England electric utilities before 1990 were installed in all three cases. With 20% less energy in the conservation case, presumably there must be a difference in the rates in order to provide financing for these units. Yet there is no recommendation to utility regulatory agencies regarding any rate policies under this condition. If only one of the nuclear units is deferred because of lack of sufficient revenues, most if not all of the oil savings resulting from all the conservation measures put together will be completely wiped out.

After reviewing this draft report we believe that, in its current form, one is unable to perform a comprehensive review and analysis of results presented. The major reason for this is that although "Technical Appendices" are included, insufficient detailed data is presented to support and/or analyze the authors' derived results. A prime example of this is a complete omission of detailed population and employment data for the forecast period. Sources are cited by ESRG, however, this data represents important growth parameters and should be explicitly shown. Also, since different sources were used by ESRG for various demographic/economic assumptions, without their inclusion in the report it is impossible to determine whether they constitute a reasonable set or scenario (i.e., unreasonable labor force participation rates or "negative" unemployment rates).

SPECIFIC COMMENTS ON TECHNICAL APPENDICES

The following sections deal with specific comments on certain subject matters contained within the five Technical Appendices. With the exception of Items 1, 14 and 15, the following comments are concerned primarily with Technical Appendices I - III. Following is a list of technical comments enclosed.

Transmittal Letter Request for Information on Utility Construction Plans 1995-2000

New England's extended forecast of April 1980 is published in the Northeast Power Coordinating Council ERA-411 Report of April 1, 1980. The forecasted peak load in that report for the winter of 1999/2000 is 28,060 MW. No specific construction plans have been developed for the period 1995/96 through 1999/2000. However, reliability runs, which install base load coal and nuclear generation to meet established New England generation mix guidelines, indicate 7000 MW of such capacity would be required resulting in installed reserves of about 20%. These additions, if made, together with anticipated coal conversions would result in a power year generation energy mix for the year 1999/2000 expressed in thousands of GWH of: nuclear 76.9, coal 44.8, hydro 4.4 and oil 21.9 based on the NEPOOL load forecast. These values indicate the oil consumption would be reduced to less than 15% of the total energy requirements.

Should the NEPOOL forecasted load actually develop the exact nature of how the energy requirements are met will depend on the amount of renewable resource capacity developed on a cost effective basis, the results of coal gasification studies, etc.

Of the 7000 MW of uncommitted base load dispatchable capacity indicated to meet the NEPOOL load forecast, 1600 MW has been included in the GAO report for all three cases consisting of coal units (1400 MW), wood (50 MW) and refuse fueled units (150 MW).

Lack of Free Market Impact on Energy Efficiency

The single most important factor underlying energy consumption is given only token representation in the ESRG Base Case forecast development and in their "conservation scenario"; namely, the impact of energy price on both the demand side and supply side of the energy market. Although ESRG repeatedly cites instances in the real world of the price effect (see, for example, Tech. App. I, pgs. 19, 78, 85, 101 and Tech. App. II, pg. 23) and identifies "energy conservation practices induced by electricity price increases" (Tech. App. I, pg. 13) as a factor which can impact average energy use, the explicit impact of energy price is notably absent in their actual forecast development process. Not only is this a critical weakness of the ESRG model structure, but is also a significant detrimental factor in the utilization of this model for policy determination, as it is being utilized in this current study for GAO. Specifically, not to attribute any increased energy efficiency expected in the future to price changes (both historical and future) but rather assign them to "mandated conservation measures" results in a misrepresentation of energy growth factors. Since the current study for GAO focuses precisely on conservation measures (as a growth factor), valid results obtained from assumptions about various degrees of "conservation measures" are indeterminate and could be misleading for policy determination.

Why are feasible and cost effective measures not likely to be implemented without additional public action? It is difficult to believe that additional bureaucratic regulations and mandates are needed to implement measures that are feasible (here and now) as well as cost effective. Certainly such is not the case in the electric utility industry when sufficient regulatory cooperation and required rates are provided to implement such measures. The authors indicate that measures to improve the efficiency of electric ranges are negligible and, in the case of self-cleaning ovens, such changes will in fact reduce unit costs. It is difficult to believe that in the extremely competitive appliance industry such cost-cutting improvements have not already been made. Certainly industry regulation and efficiency mandates are not required to accomplish this.

Relative to this subject, it is informative to note how other "reputable forecasting consultants" view the basic ESRG forecasting scheme. For example, testimony by National Economic Research Associates, Inc. on behalf of the Member Systems of the New York Power Pool, March, 1979 presented a critique of the ESRG Long Range Forecast for New York. Quoting NERA, "...ESRG fails to recognize the need for internal consistency in a forecast between price and growth projections for electricity. This relationship is important because a major factor in determining the trend in future electricity prices is the need for new construction to meet growth and demand." They further state that "the growth projections of ESRG do not support the real price increases for electricity which underlie, directly or indirectly, much of its analysis."

Also, it would appear that either GAO or ESRG should provide some reconciliation of market representation in this study with conclusions from a recent study by the Department of Energy. The survey study, entitled "Energy Programs/Energy Markets", by the Energy Information Administration, noted that many of the existing government programs "pull in the same direction that higher energy prices push", implying that the markets could have been used instead of the programs to accomplish the same results.

Methodology Used for Determination of Oil-Fired Generation Displacement

In Techn. App. II, a methodology is utilized whereby the costs of implementing specific "conservation measures" is compared with the cost of electricity that otherwise would be consumed. With respect to the displaced cost of electricity, E.S.R.G. notes that the appropriate cost for comparison should be "...the extra fuel costs of otherwise idle capacity" (Tech. App. II, p. 10), in a system where over capacity exists. Although E.S.R.G. repeatedly confirms the importance of this point as they present each of their conservation measures, they present no support for explicit or implied assumptions made concerning heat rates for displaced oil-fired generator units, load-following characteristics of the system, or of the daily/seasonal load profiles of the end use involved. Although E.S.R.G. on occasion alludes to the requirement of "detailed generation plant dispatch simulation runs" to confirm oil-fired generation reduction, they provide no such substantiation. Further, what may be an even more important "simplification assumption" made by E.S.R.G. involves their incorrect assumption that oil savings derived from the "conservation measures" are a simple addition of the effects of each measure. Since each end use affected has a unique daily/seasonal load profile, their order of introduction into a "conservation scenario" has a significant impact upon the load reduction by time of day/year and therefore, different types and costs of fuel displaced.

For example, the cost effectiveness of refrigerator efficiency improvements are based on the so-called cost of displaced oil. However, a refrigerator runs 24 hours a day year-round at a fairly constant load factor. Under the conservation case condition, after a 20% energy reduction, it is very likely that there will be many times that the load, including refrigerators, will be served totally by non-oil fuels.

The cost effectiveness analysis for air conditioning involves similar fallacious reasonings. E.S.R.G. claims through conservation that the 1990 summer peak can be reduced 2820 MW to 14300 MW. Under such conditions and with four new nuclear units and a coal unit, can it be said that air conditioners will be served by peaking oil steam and gas turbine units? Or will they be served by such units for the full 310 hours per year air conditioners are assumed to operate? Since the 1990 load level is less than the actual 1980 summer peak, it is doubtful. In this same analysis which shows that air conditioner efficiency improvements are marginally cost efficient, at best, an oil price of $6/MMBTU is assumed. In similar analysis in other sections of the report, a more accurate $3/MMBTU is assumed. In this same analysis, E.S.R.G. states that typical O & M costs are 1¢/KWH; ten times greater than actual typical O & M costs of 1 mill/KWH.

In a number of instances, the cost effectiveness of specific measures is analyzed using the cost of adding an additional KWH of electricity to the base case ("marginal cost"). However, as correctly formulated, P_O must be the cost of electricity (price/KWH) displaced by the conservation measure being assessed. (Tech. App. II, p.10).

In order to properly assess the cost effectiveness and oil savings of the proposed conservation measures and alternate generation sources, a detailed simulated generation dispatch must be performed. And to assess the impact of the energy differences between the cases, a detailed corporate financial model must be used. Only then can legitimate results and conclusions of the type presented in this report be addressed.

In order to analyze the cost effectiveness of each proposed conservation measure, they must be prioritized and applied additively. In each case, a generation dispatch must be performed to identify the cost of the energy and the fuel that would otherwise be used in the absence of that particular conservation measure. The same is true in analyzing alternate generation resources.

Conservation technologies that are likely to attain technical viability or economic attractiveness during the scenario period have been specifically excluded. Could some of these make the "here and now" options recommended uneconomic? For example, all measures are economically evaluated against the "marginal" cost of oil. Could coal conversions (or additional nuclear units) change the economic viability of some of the measures and the results of the study?

In this same regard, load management programs have not been included (beyond the base case which are not defined or data supplied). Could these programs not effect the results? Could load management programs be more effective in reducing oil usage and less costly?

Social Cost Criterion

The criterion utilized by ESRG for assessing the economic attractiveness of their proposed "conservation measures" is one of "relative social cost". As described in Tech. App. II, pg. 8, relative social cost is defined as "direct expenditures by society for energy conservation steps compared with expenditures for the additional electric energy displaced by those steps". A major assumption made by ESRG in the calculation of the relative social costs for each of their proposed conservation measures is that "escalation in the marginal electricity rate is roughly at the level of the discount rate" (Tech. App. II, pg. 10). ESRG makes this assumption to "simplify" the calculations and resultant cost comparisons; however, the range of discount rate levels by consumer (i.e., "society") reported in the literature is of such a magnitude as to warrant examination of alternative levels. Resultant "conclusions" as to the social cost benefit could prove interesting. Testimony given by Dr. S. Feld and by the Massachusetts Attorney General's Office in NRC Docket No. 50-471 contained discount rate assumptions of 10% (Feld's) to 20% (MAGO's). Given the importance of this factor in establishing "social economic gain", it would be prudent to examine the consequences of alternative discount levels for each of the proposed conservation measures considered in the "Conservation Case". It is especially important that such an analysis be performed given that nearly all of the conservation measures require expenditures of capital "up front" with the intention of avoiding costs "in the future".

The authors state that all direct costs have been included in analyzing the cost effectiveness of recommended appliance efficiency standards. At the same time, they recommend that these standards be mandated. However, no costs for instituting, regulating, policing and enforcing the standards have been included. If this bureaucracy is the recommended method of implementing these conservation measures, it would seem they should be a part of the direct "social" costs.

Initialization Year Data Problems

The initialization year of the forecast is defined by ESRG as 1978. Given that ESRG's forecasting scheme is one of forecast year factor multiplication times "initialization year" values, it is important that these initialization values be correct. It is important not only with regards to their "base case" forecast development but also for the "Conservation Case".

A cursory review of those initialization year values provided by ESRG has raised a number of questions concerning the validity of certain values. Following is a brief description of these problems.

a) The "high" and "low" cases developed by ESRG which supports their "base case" forecast is presented in Tech. App. I. For the 1978 base year, why is it that energy use for televisions and miscellaneous residential use is different (for each state) between the high and low while all other end use energies are identical?

b) Initialization year (1978) average KWH use per year for electric space heating is presented for each state in Tech. App. I, pg. 74. Why is it that KWH use/year is highest for the three southern N.E. states and lowest for the three northern states given that heating requirements (heating degree days) are substantially higher in the north? What is the source of this data? Further, for fossil heating auxiliaries, why are electrical usages the same for all states, given that different heating degree days exist for each state?

c) A question exists in our minds as to the accuracy of ESRG's initial 1978 disaggregation of New England oil consumption for water and space heating to commercial and residential categories. ESRG estimates that 64.3 million barrels of oil were used by commercial customers and 52.2 by residential customers in 1978. The procedures by which the breakdown was estimated is not documented. FEDS data for 1977 indicates that 53.5% of New England oil consumption for heating was used by residential customers and 46.5% by commercial customers. Thus, the basis for ESRG's 45% residential/55% commercial split in 1978 requires justification.

Residential Appliance Saturations

Residential appliance saturations are forecasted by E.S.R.G. whereby a "saturation logistics" curve is utilized. The most critical input to this curve is the fixed "terminal saturation" levels. E.S.R.G. indicates in Tech. App. I, p. 71 that "Guidance in estimating the terminal saturation levels was derived from econometric relationships between appliance saturation and price/ income variables." No basis is cited for the income and price input assumptions shown on page 71. Further, the very obvious ties between employment growth and income and between electric consumption/generation mix and electricity price is not addressed. With respect to the Conservation Case, electricity consumption/ generation mix is different from Base Case which would imply different electricity prices yet E.S.R.G. assumes the same levels of appliance saturation.

The electric space heating penetrations presented in Tech. App. I, p. 72 are based on nothing other than they are "values experienced during the 1970's" (p. 71). Obviously, this implies that the same determining factors of ESH penetration that existed in the past will exist in the future. It is difficult to conceive of this as a plausible assumption given decontrol of domestic oil and gas prices (note: oil-fired electric generators use virtually only imported residual oil), new nuclear capacity, and conversion of oil-fired generators to coal during the forecast period.

Electric Heat Pump Energy Utilization

The utilization of electric energy by heat pumps is presented in Tech. App. I and utilized for the Base Case forecast. Higher performance efficiencies are utilized for the Conservation Case for (Base Case) saturation levels as well as an alternative for the "electric resistance heat ban" conservation measure. In all of these cases, the levels of electricity utilization do not agree with estimates by at least one New England utility (Northeast Utilities special studies on space heating system life cycles, 1978). E.S.R.G. calculates COP's for each New England state (Tech. App. I, pp. 83-85) which they utilize in calculating heat pump energy use (EQ. 3.68, p. 32). The implied reduction in energy use of 50% (i.e., COP $\cong$ 2.0) is significantly higher than the 33% calculated by Northeast.* Perhaps E.S.R.G.'s failure to represent "heating season" heat pump energy use as a "seasonal performance factor" rather than an overall (total year) COP is the reason or perhaps it may be due to an error in their model equations (EQ. 8.3 on p. 84 does not agree with generic equation on p. 83 as E.S.R.G. says it should (p. 85)). Given the importance of this end use, this should be clarified and/or corrected and, in addition, weather data, population data and resultant calculations described on p. 85 should be presented in order that the reader may properly evaluate the conclusions.

*Northeast Utilities System 1980 Forecast of Loads and Resources Supporting Material, pp. 44-45, March 1, 1980.

Electric Space Heat Regulation

Several aspects concerning the proposed ban on new direct resistance heating as described in the Conservation Case should be noted. First, irrespective of relative cost considerations, it is important to note that such a policy makes more rigid the type of fuel that can be utilized for space heating. That is, the opportunity to supply end use heating needs by primary fuels other than oil/gas becomes more limited. ESRG argues that the primary fuel type that would be saved in New England would be oil, however, they have included only minimum (2 units) conversion of oil-fired generators to coal in their supply assumptions. Due consideration should be given to alternative assumptions of coal conversion levels as well as to synfuels and liquified coal use. Further, in this context, the banning of electric resistance heating is but one potential means for achieving reduced oil consumption and should be compared with other means such as coal conversion with a resultant assessment which includes an evaluation of the desired optimum mix of primary fuels that could be used for end use space heating.

The ESRG assumption that oil would be the primary fuel that would be saved as a result of banning additional resistance space heating is prefixed by the statement "though detailed generation plant dispatch simulation runs with and without additional resistance e.s.h. would be required to precisely confirm it." (Tech. App. II, pg. 31). Such a simulation should be performed to properly evaluate oil savings particularly at higher levels of oil generating unit coal conversion. The daily use profile of e.s.h. is an important component of such a simulation and cannot be generalized in any way due to its unique properties relative to other end uses of electricity (e.g. E.S.H.

energy as a % of total hourly system load is highest during weekday evening/early morning hours and weekend periods).

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Cogeneration Policy

The energy conservation measure of industrial cogeneration presented by ESRG as part of their "conservation case" is defined as double the amount of cogeneration in the base case by the year 2000 (except for Maine which is assumed at 35% higher - Tech. App. II, pg. 47). The resultant lower electricity consumption is translated to lower oil consumption, however in neither Tech. App. II nor III is it apparent that recognition is made of the increased quantities or types of fuels that will be used by industrial firms due to the increased level of cogeneration. This should be clarified and, if in fact this has not been recognized, it should be included in the analysis.

Regarding forecast accuracy of ESRG's models

Actual sales data for 1979 were compared with ESRG's projections. It is to be noted that the commercial model appears to predict the most poorly. For example, actual 1979 sales in Connecticut are not achieved in ESRG's "base" case until 1981 and are never achieved in their "low" case; in Massachusetts commercial sales increased by only 2.1% in 1979, yet ESRG does not forecast this to occur in their "base" case until 1984, and it never occurs in their "low" case; and, in Rhode Island, actual 1979 sales are not achieved in ESRG's "base" case until 1986 and, again, never are achieved in the "low" case. ESRG's residential energy forecast for 1979 is reasonably accurate while actual 1979 growth in the industrial sector is generally not achieved until 1980 in the "base" case.

Given that ESRG's models forecast recursively, future forecast accuracy is definitely impacted by these errors.

Regarding the commercial model

While conceptually appealing, ESRG's commercial model is misspecified and dysgenic. A number of specific points can be made.

(1) It simply assumed that commercial square footage per employee for 12 commercial categories is fixed at estimated 1975 levels. No documentation is cited for this assumption. On the contrary, available data indicates that the ratio is not fixed and that commercial floor space per employee has increased through time. This is a serious misspecification which strongly biases growth in commercial square footage downward.

ESRG's "base" case forecast calls for commercial floor space in New England to grow at about one percent per year, 1978-2000. By contrast, a current forecast by Jerry Jackson (perhaps the most respected and frequently cited authority on commercial end use modeling) expects commercial floor space in New England to grow at an annual rate of 2.4%, 1978-2000.

(2) Again, it is simply assumed that hostipal square footage per capita and school square footage per school age population are fixed at estimated 1975 levels. No evidence or documentation are cited for these assumptions. Further, it is curious that hostipal floor space is simply a function of total population growth rather than, for example, growth in the elderly population. The growth rate for the latter is roughly double that of the general population.

(3) The employment growth indices usedto drive future floor space are sorely lacking in a number of regards. In the "high" case commercial employment is projected to increase at a rate of about 1.3% per year, 1975-2000; in the "low" case, the growth rate is about 0.7%. By contrast, in NEPOOL's base case forecast (as of 4/1/80), commercial employment is forecasted to growth at an annual of 1.7% per year, 1975-1995. Thus, it is difficult to comprehend ESRG's "high" case as being high in an appropriate sense of the word.

With respect to the "low" employment growth indices (which were drawn from employment projections done by respective state planning agencies), apparently ESRG is unaware of the rather strong disclaimers included in the prefaces of them. For example, the document for Massachusetts cautions: "... the projections should be viewed essentially as a continuation of past trend (1958-1974) relationships between the nation and the state. It would, therefore, be more accurate to view the specific numbers as indicators of relative magnitude and central tendencies. In other words, the data should be used as indicators of probable direction and relationships rather than as forecasts." Employment Requirements for Massachusetts by Occupation, by Industry 1970-1974-1985, Occupation/Industry Research Department, July 1976,p.i)

Further, it should be noted that not all of the most recent state projections have been utilized. For example, Massachusetts issued a new set of projections in December 1979; therein 1985 employment is forecasted to be fully 10% greater than was projected in 1976.

(4) The reliance on the electric energy use intensities cited in Carhart (ESRG's Ref. 6 in Technical Appendix I) is puzzling since they are contradicted by Jackson's research (ESRG's Ref. 3 in Technical Appendix I). No mention of the different use intensities is acknowledged in the GAO report, yet the differences are enormous. Considering only the Retail & Wholesale Trade class, Carhart shows a 1975 use intensity for electric space heating to be 4.1 Kwh per square foot (for the Northeast) while Jackson estimates a national use intensity of 18.4 Kwh per square foot; for air conditioning, both are in basic agreement with Carhart showing 10.8 and Jackson 11.3 Kwh per square foot; for lighting and all other uses, Carhart shows an estimate of 24.6 Kwh per square foot which Jackson calculates a figure of 13.5. It should be noted that ESRG, for some unexplained and unacknowledged reason, choses a lower use intensity for air conditioning than Carhart shows -- for the Retail & Wholesale Trade class, an intensity of 5.2 Kwh per square foot is used. Thus, there is a very strong basis for questioning the initial use intensities selected; the magnitude of error is discussed below.

(5) Again, on the subject of the electric use coefficients used in the analysis, Table 8.19 of Technical Appendix I shows a curious relationship. For some reason it is specified that new commercial buildings with electric space heating will require more Kwh per square foot of floor space than existing commercial structures do -- between 40 and 60 percent more. Why is this assumed to be the case? Particularly when new structures heated with oil or gas are specified to consume 20-25 percent fewer Btu/square foot than existing structures do? This anomaly requires explanation.

(6) No mention is made in the GAO report of "level adjustments" made by the consultants to achieve actual 1978 consumption levels. For at least the commercial sector, the magnitude of the level adjustment required is so large as to indicate that perhaps the methodology employed by ESRG is seriously flawed. Consider only Massachusetts. If one multiplies the 1975 commercial floor space estimates given in Table 8.16 of Technical Appendix I by the appropriate energy use coefficients in Table 8.19, using the saturations cited on p.80 and make the appropriate weather adjustments indicated on p.79, one will obtain an estimate of 1975 commercial energy consumption for the state. The estimate is 14,184 gwh whereas actual sales in 1975 were 10,171 gwh. (cf., ESRG's Ref. 66). Thus, the magnitude of error for 1975 is nearly 40% entailing an extremely large level adjustment to match 1978 sales data. Why is the reader not told this? Is it the case that such a large level adjustment is reasonable and that the methodology is suitable? Or, is the magnitude of the adjustment sufficiency large as to lead one to question the appropriateness of the methodology employed?

(7) It is interesting to compare the discussion of post-1975 conservation practices on pp. 43-44 of Technical Appendix I with the source from which they are taken (i.e., Carhart, ESRG's Ref. 6). Level 1 conservation practices are described on page 43 of the GAO report as: "improvements which provide quick payback and require minimal engineering expertise (e.g., insulation, reduced lighting requirements, and other "housekeeping")"; on the next page of the report it is stated that "the model incorporates the cautious assumption that solar heating and air conditioning will have an insignificant impact on overall load during the forecast period." Reading Carhart one finds that Level 1 conservation practices include both solar heating and air conditioning and, further, that 21% of new commercial floor space constructed 1976-1990 is expected to have solar heating and 14% solar air conditioning (cf., Ref. 6, p.47). Thus, it appears that solar applications do have a significant impact during the forecast period and further that Level 1 conservation practices involve more than housekeeping activities.

(8) Regarding the conservation policy scenario for the commercial sector, it should be noted that the Level 3 conservation practices employed in the analysis (cf., p.40 of Technical Appendix II) are appropriate for the South not the Northeast. Carhart (in ESRG's Ref.28 pp. 76-80) specifies conservation levels for four regions of the U.S., and those utilized by ESRG are clearly for the South.

Other Consultant's Evaluations of ESRG Forecasts

National Economic Research Associates, Inc. (NERA) reported on their evaluation of three separate long range forecasts of electric energy and demand for New York state during March 1979 on behalf of the New York Power Pool member systems. These forecasts were developed by: (1) staff members of the New York Consumer Protection Board and the Department of Public Service; (2) Cornell University Group on behalf of the National Consumer Law Center; and (3) Energy Systems Research Group (ESRG) on behalf of the New York State Department of Environmental Conservation.

The report was entitled Critique on Behalf of the Member Systems of the New York Power Pool (NERA, New York, N.Y., March 16, 1979). Following are some of the more important points NERA made regarding ESRG's forecast and methodology.

(pp. vi-vii) ESRG's forecast relies extensively upon assumptions regarding both economic and engineering relationships. However, ESRG's assumptions regarding economic relationships are highly simplistic and inflexible. In addition, ESRG's approach to forecasting commercial energy requirements ... is flawed in it's logic and not supported by the very documentation relied upon by ESRG. ESRG's "most probable" forecast, a simple averaging of two cases which are labeled "high" and "low", is, as a result, unduly influenced by the set of extreme assumptions embodied in the "low" forecast.

(pp. 134-135)... the ESRG methodology represents a mixture of (1) use of engineering data on design standards and new technologies, (2) an extensive amount of judgmental guesses on quantitative relationships which cannot be verified in any meaningful way, (3) and some very naive economics.

(p. 135)... in its present form, the model is so simplistic and inflexible with regard to the multitude of economic relationships incorporated within it, particularly for the commercial and industrial sectors, that it cannot be recommended to utility forecasters as providing comprehensive, usable alternative information for their current efforts.

(pp. 140-141)... the methodology developed a "most probable" forecast based upon a simple average of a "high" and a "low" forecast scenario and results. There is no reason to believe, however, that ESRG's "high" and "low" forecasts are equally likely and, therefore, are symmetrical around a "most probable" forecast in any meaningful sense. Indeed, this approach invites biasing a "most probable" load forecast in one direction or another based upon extreme assumptions in either scenario. Because of simple averaging, at least half of any extreme assumption will be incorporated into the "most probable" forecast. In ESRG's case, the bias is clearly downward.

(p. 143) In summary, there is nothing inherently wrong with the methodology used by ESRG if it were used correctly. The major problems with this forecast relate instead to what appears to be a definite pattern of bias in applying the methodology: inflating the impact of conservation adjustments to sales and ignoring (setting at zero) changes in intensities of use by sector related to changes in economic factors such as prices and income. ...It is important to note, therefore, that, on balance, this approach relies heavily on an individual's judgment, which cannot be confirmed.

(p. 152) ... the ESRG commercial forecast ...is logically invalid and contains ad hoc design adjustments that apparently do not correspond with any supporting evidence.

(pp. 152-153) The ESRG analysis of the commercial class is based upon determining commercial floor space by type of building in each year and then applying fixed energy intensity factors to determine kilowatt-hours. These results are then adjusted to account for building design efficiencies and conservation. However, the description is somewhat misleading since ESRG assumes that employment is a fixed ratio of floor space and that kilowatt-hour consumption is also a fixed ratio of floor space.

(pp. 158-159) ...the assumption that both floor space per employee and electrical energy use per square foot are fixed parameters over the whole forecast ... is clearly contrary to fact. In the case of the employment per square foot ratio, changes in retailing practices and increasing use of capital equipment that is labor-saving have led to past declines. For example, ... retail-wholesale trade floor space grew at an average annual rate of 5.2 percent from 1965 to 1975. At the same time, employment in this category grew at an average annual rate of only 3 percent. Thus, the employment per floor space ratio is clearly not fixed; it decreases over time for some sectors, suggesting the ESRG has underestimated floor space on this basis.

But this downward bias pales in comparison with the effect of assuming that kilowatt-hour use per square foot of floor space is fixed. In fact, for the U.S. as a whole, over the period 1965 to 1975, commercial floor space grew at 3.4 percent, while commercial consumption of electricity grew at fully 7.6 percent ...

(pp. 163-164) ... ESRG's analysis is based largely upon the Brookhaven National Laboratory's BECOM Model as described in Carhart, et al., The Brookhaven Buildings Energy Conservation Optimization Model, BNL50828, January 1978. This document ... is surely one of the most frustrating reports one could ever deal with ...

No documentation of fuel prices, availabilities or other constraints

APPENDIX VIII

is discussed ... Selection of technologies is based upon a linear program which "minimizes cost" based upon a capital recovery factor determined by a "long-term discount rate" and equipment lifetime. Nowhere is it stated what the discount rate (or lifetime) is or how taxes are treated, if at all. There is no way, therefore, to evaluate potential penetration of new technologies indicated by the model... And, finally, the model is not described as having load forecasting applications, although it can be used to evaluate "implementation" of energy-conservation technologies (revealed, for example, through sales figures for insulation, heat pumps and so forth) and yearly totals for energy consumption in buildings.

Ernst & Whinney (E&W) reported on their evaluation of seven long range forecasts of electric energy and demand for the state of Wisconsin in July 1980 for the Wisconsin Public Service Commission. The report is entitled Review of the Forecasting Methodology of the Participants in the 1978 Advanced Plan Hearings, Exhibit (PHR-1), July 1980. Energy Systems Research Group, Inc.(ESRG) filed forecasts for both the eastern and western regions of the state. Following are some of the more important points made by E&W regarding the ESRG forecasts.

(pp. IV-29, IV-30) With respect to the statistical criteria, the model of industrial consumption is sorely lacking. Recall that regression analysis is required in order to derive a forecast of future electrical intensity. Therefore, all of the statistical criteria apply. However, no t-statistics nor F-statistics are reported. An R^2 measure is reported by SIC code .... As can be seen, fully fifteen out of nineteen regressions have R^2 values less than 0.5. In other words, there is no reason to suspect that knowledge of the independent variable will say anything about the future values of the dependent variable.

(p. II-30) It is incumbent upon any researcher involved in statistical analysis to report all of the relevant statistics so that an objective observer can decide the merit of the regressions employed. In this case, ESRG fails the documentation test. ESRG also fails the test of internal consistency by relying on poor regression equations without the usual caveats.

(p. II-33) Our review of the ESRG model indicates the possibility that the model may have some serious problems that would limit its value as a forecasting tool. With regard to statistical tests, three problems are apparent. First, since these tests were not performed, there is no indication that the models even handled historical data well. Second, and more important, when such tests indicated poor results, there was no mention made of this fact. This implies an omission of important information as it relates to the forecasting ability of the models. Third, proper documentation would require that all tests be run and results reported. This was not done.

(p. IV-34)... we do not believe that the required work has been performed that would merit acceptance of the forecasts.

APPENDIX VIII

Regarding long range energy growth

As the GAO report has not attempted to provide a perspective on future electric energy growth, beyond token reference to the NEPOOL forecast, a number of recent forecasts for New England are cited below:

	Annual Compound Growth Rate				
	Res.	Com.	Ind.	Total	Forecast Period
1. NEPOOL (4/1/80)	2.4	2.5	3.1	2.7	1980-1995
2. A.D. Little (2/79)	na	na	na	3.0	1978-1990
3. Oak Ridge (10/78)					
. High Prices	1.5	2.1	4.3	2.6	1974-1990
. Base Case	2.4	2.8	4.5	3.2	1974-1990
. Low Prices	3.3	3.4	4.7	3.8	1974-1990
4. Jerry Jackson (Summer 80)	na	2.9	na	na	1978-2000

Sources: (1) Load Forecasting Task Force, NEPOOL Forecast of New England Electric Energy and Peak Load 1980-1995, NEPLAN, West Springfield, MA, May 1980.

(2) Arthur D. Little, Inc., Implications of Lower Electric Power Growth Through 1990, Cambridge, MA, February 1980.

(3) W.S. Chern, R.E. Just, B.D. Holcomb, H.D. Nguyen, Regional Econometric Model for Forecasting Electricity Demand by Sector and State, ORNL/NUREG-49, Oak Ridge National Laboratory, Oak Ridge, TN, October 1978.

(4) Jerry Jackson, Peter Degenring, Robert Lann, "Regional Commercial Energy Forecasts," presented at Energy Demand Modeling Seminar, Georgia Institute of Technology, Atlanta, GA, July 8-9, 1980. While regional results were not yet available, Jackson et al. estimated that commercial electric energy growth for the U.S. 1978-2000 would decrease from 2.9% per year (base case) to 2.6% with the implimentation of strong conservation policies (e.g., BEPS, a $300 million federal grant program, a 10% tax credit on energy conservation investment).

Comment re. Table 5 of Technical Appendix III

This table showing commercial sector oil use consumption 1978-2000 is clearly wrong. The magnitude of the numbers shown are bizarre (e.g., that Connecticut consumes 75% more oil than Massachusetts). This should be corrected.

Technical Report IV - "An Alternative Supply Strategy Scenario"

If the GAO Report Base Case Load Forecast becomes a reality for the year 2000 the approved NEPOOL planned capacity (which does not include 1400 MW of coal, 50 MW of wood and 150 MW of refuse fired units) additions is all that would be required for reliability purposes. Since the GAO report recognized less than half the MW coal conversions anticipated by the pool, it is extremely doubtful that much of the alternate resource capacity indicated in the report could be justified, if commercially available. Undoubtedly some of the refuse fueled, small hydro and coal fired generation beyond the approved NEPOOL planned capacity would be justified.

Specific points worthy of citing are:

1. The GAO does not provide adequate cost information to justify or adequately evaluate the alternate resource capacity included.
2. A generation dispatch is required to determine how much oil-fired capacity can be displaced by the alternate energy resources included.
3. There is no indication that transmission costs for alternate energy sources have been included. This can be appreciable for the 2900 MW of wind and 710 MW of tidal capacity included.
4. Cost comparisons have been made which are not in common year dollars.
5. Much of the alternate resource capacity is not dispatchable and it is doubtful that the indicated

magnitude can be justified to replace oil generation. As indicated earlier, a generation dispatch is required to adequately assess this potential and insufficient detail and time has been provided to model the GAO load forecast and simulate the system for inclusion with these comments.

TECHNICAL REPORT V: THE EMPLOYMENT IMPACT OF ENERGY CONSERVATION

Technical Report V purports to assess the economic, specifically the employment, impacts of the conservation scenario described in Technical Reports II and III. Such an analysis is an obviously important component of the overall investigation undertaken by E.S.R.G. and naturally would be of great interest to regional planners and decision makers. The results obtained by E.S.R.G. show that slightly over 335,000 jobs would be added to the New England economy during the forecast period.

It is unfortunate that an earlier criticism must be reiterated with respect to the results displayed in Report V: without considerable time and effort devoted to computational sleuth work and bibliographic ferreting and without being informed of the magnitudes of several critical exogenous assumptions, it is very difficult to thoroughly evaluate and intelligentlv comment upon the procedures followed by E.S.R.G. or to concur in the reasonableness of their conclusions.

We would like to offer, however, some observations and to raise some questions concerning the discussions and findings within Report V.

In Section 1.2, the authors limit the characterization of energy/employment studies to a genre of policy analysis (the results of which, E.S.R.G. claims, generally indicate) that shifts away from capital intensive investments lead to increased employment. It is not clear which particular economic sectors are thus accurately described. Nor, is any mention made of the burgeoning body of economic literature in which the substitutability of labor and capital is a highly debated issue. (In any case, a comparison of the relative employment benefits of capital investments of varying intensities (e.g. new generation units vs. conservation materials) is not the Report's purpose. Rather, the authors intent is to show how capital investments in conservation measures increases total employment.)

It is emphasized in Section 1.3 that the study's results are conservative and, if anything, underestimate the employment benefits of the conservation scenario. The stated reasons for this low-side bias are that employment impacts will continue to occur beyond the year 2000 and that the industrial mix in New England is assumed to remain unaltered in the fact of heightened demand for "conservation" products and services. The former reason is patently fatuous and irrelevant given the discrete, finite nature of the analysis, while the latter reason implies structural changes and a reallocation of regional productive resources, the optimality of which is far from obvious. In any case, sensitivity runs examining the relative impacts of such factors receive no qualitative or quantitative treatment in the text.

The "shifted disposable income" (additional discretionary income) arising from total energy savings minus total conservation investment (Table 3) for each New England state is either overstated or calculated in a manner not deducible from the text. Estimates of costs and savings are presented by E.S.R.G. as "data" to demonstrate that the payback period for conservation investments is quite short, but too little attention is given the transcendent question, "Where will the investment funds come from?" According to E.S.R.G., the likely source of funds will be savings, reallocations of disposable income, or some form of credit. Given the volatility of interest rates, the recent low level of savings and the generally acknowledged and suffered tightness of household budgets, the availability of investment funds could easily become a far more serious obstacle than the report suggests.

In a discussion of the employment-creating "efficiency" of investment in conservation measures versus other investment alternatives, the report's authors rely upon their own assumptions and unsubstantiated estimates of regional material and labor availability factors as proof that most of the total conservation investment will be spent locally and that most of the labor required will be locally supplied and that, therefore, conservation investment is "efficient". Assumptions should be identified as such and not paraded as data (cf. Table 7, p. 14).

The labor and materials required for various conservation measures are specified in a data base engineered by E.S.R.G. Beyond noting that the input data was developed in previous studies, the authors offer no description or documentation.

A number of critical exogenous assumptions that affect final employment estimates are inadequately identified. For example, no magnitudes are provided for assumptions regarding the consumer savings rate (FWS), the fraction of "do it yourself" implementation (DOSELF), wages (W2G2), the percentage of labor which is available locally (FG2), the percentage of material inputs which are produced locally (C3G1), the employment to earnings ratio (EMPL) and the earnings to output ratio (EARN).

The pivotal component of E.S.R.G.'s employment model, the RIMS (regional industrial multiplier system) program, is essentially an input-output analysis developed by the Bureau of Economic Analysis. The procedure used in converting conservation expenditures and energy savings into employment impacts through RIMS is described briefly and opaquely. The basically static input-output approach utilized by E.S.R.G. is characterized by the assumption of fixed technology. That is, despite the significant changes likely to occur in the production functions of each industry as energy consumption is reduced, the report's results are based on a model of interindustrial flows and relationships which are fixed at a particular historic point. The employment impacts are made more uncertain by the assumption of fixed supply coefficients (distinguishing output produced for local use) which imply a rigid trade pattern among regions. This rather heroic assumption means that supply can adjust to demand instantaneously and that labor and transportation costs are constant. It is also assumed that there will be no capital availability impacts. No consideration is given to the effects of an increase of final demand on the derived demand for capital goods or to the dynamic nature of the necessary capital formation. These limitations seriously degrade the reliability of input-output projections. Even though the basic data may be fairly accurate (albeit outdated), input-output techniques are subject to large margins of errors and distortions.[1] According to E.S.R.G., input-output analyses have historically performed "at least as well or generally better than those using alternative methods". Numerous comparative studies, however, offer less sanguine conclusions regarding the bias of input-output projections.[2]

1 Oskar Morgenstern, On the Accuracy of Economic Observations, Princeton Univ. Press, 1963.

2 S. Arrow. Comparisons of Input-Output and Alternative Projections, Rand Corporation Paper P-239, 1951;
H.J. Barnett. "Specific Industry Output Projections", Long-Range Economic Projections, Princeton Univ. Press, 1954;
M. Hatanaka. Testing the Workability of Input-Output Analysis, Princeton, 1957.

ES&G- 79-29
Draft

REDUCING NEW ENGLAND'S OIL DEPENDENCE THROUGH CONSERVATION AND ALTERNATIVE ENERGY

A Report to the
General Accounting Office
of the
United States Congress

RESPONSE TO "NEPOOL COMMENTS ON THE GAO DRAFT REPORT 'A MORE EFFECTIVE REGIONAL EFFORT IN CONSERVATION AND RENEWABLE RESOURCE DEVELOPMENT CAN HELP ALLEVIATE NEW ENGLAND'S OIL DEPENDENCE,' 1/5/81"

Revised
April, 1981

ENERGY SYSTEMS RESEARCH GROUP, INC.
Boston, Massachusetts 02109

General Comments

Some of NEPOOL's comments regarding the GAO study concern its policy recommendations. While ESRG has done policy research, its contributions to this GAO report did not include policy recommendations. These were developed by GAO staff. Therefore, a response on our part to those NEPOOL comments which address policy or legislative suggestions contained in the GAO report would not be appropriate.

Others of NEPOOL's comments concern the effectiveness of efforts by electric utilities in New England to promote energy conservation. It was not the task of ESRG, as consultants to GAO, to evaluate utility conservation programs. It was rather our task to develop an estimate of the potential (a) of additional conservation efforts and (b) of additional development of renewable resource-based electric supply sources, for helping to alleviate the region's dependence upon oil. In order not to overstate the potential for additional conservation activity or renewable resource development, we explicitly incorporated as much of such activity as we felt it prudent to assume would occur under existing policies and trends as a basis of our analysis. These judgements are explained in detail in the technical appendices to this report, which are available under separate cover. As is implied by the forecasts of continued growth in energy consumption issued by NEPOOL and major utilities of New England, existing institutional efforts do not begin to exhaust the potential for cost-effective conservation.

Finally, NEPOOL comments address the analytical adequacy of our study. In general, NEPOOL concludes that it is impossible to perform a comprehensive review of our results, giving as an example a purported "omission of population and employment data" for the study period (page 111, NEPOOL "General Comments"). The reader interested in this example can turn to the first volume of the technical appendix and find the data employed given in considerable detail with full identification of the sources, which are readily available (e.g., U.S. Census Bureau publications). Indeed, some 300 pages are devoted to explaining the mathematical relationships contained in the models employed and the data and assumptions relied upon, in the Technical Reports incorporated in the second volume available upon request from the GAO and put at NEPOOL's disposal for review. Here, sources are referenced and every attempt is made to give the interested technical reader self-contained documentation sufficient to understand the analysis. Indeed, some may find the technical documentation somewhat excessive in the forecasting area in view of the fact that these models were employed only as accounting tools to track the impacts of a specified set of conservation measures as they are phased in over time and to provide a benchmark forecast for the alternative supply scenario.

Specific Comments

The failure of NEPOOL commentator(s) to carefully scrutinize our technical reports is disappointing. We trust that NEPOOL remains interested in the process of dispassionate scientific interchange on the potential for and uncertainties in achieving a creative policy response to the energy dilemmas of New England. If the difficulty with our basic data inputs alluded to in the preceding paragraph is any indication of the care with which NEPOOL scrutinized our work, it is not surprising that NEPOOL was unable to perform a comprehensive review of the research.

The bulk of NEPOOL's specific comments concern the methods and details of making long-range forecasts of future patterns of energy consumption. A key component in ESRG's analysis of the potential contribution of conservation and renewables to saving oil is a forecast of major elements of oil consumption under "Base Case" conditions, i.e., a forecast of what energy consumption patterns can be expected in the absence of major new institutional initiatives for change. In turn, the forecast of future electricity consumption is a major element of this "Base Case" energy forecast. Indeed, ESRG's forecasting model was originated as an electric load forecasting model.

The bulk of the NEPOOL comments are not relevant to the actual objectives and design of the ESRG study for GAO and its attendant reference scenario and conservation scenario forecasts. They raise technical points appropriate to electric utility systems planning and the interrelated modelling efforts in load forecasting, generation systems planning, and financial modelling which accompany such planning. Unlike the forecasts prepared for this study, many of the 60-odd energy forecasts prepared with the ESRG forecasting model have been electric load forecasts intended to inform the utility planning process. We have prepared such "Base Case" forecasts for governmental agencies (including utility regulatory commissions in several states) and non-governmental groups. While ESRG is currently assisting a utility in upgrading its own forecasting model, in general its "Base Case" planning forecasts have been prepared independently of the operating utilities in the relevant regions. Most of them have been entered in evidence in hearings before regulatory commissions, and subject to the public scrutiny characteristic of the adversarial fact-finding procedures of those commissions. ESRG has submitted several "Base Case" planning forecasts as alternatives to those prepared by utilities in New England, and in some of the hearings on these forecasts members of the ESRG research staff have offered expert scientific critiques of the relevant utility's forecasting methodology.*

However, the Base Case forecasts we have prepared for each New England state for the GAO study are different from most forecasts we have prepared or critiqued, for they were not designed as utility

*It may also be of interest in the present context to note that ESRG has prepared an assessment of NEPOOL's own load forecasting model for the New England Conference of Public Utility Commissioners (NECPUC). Our NEPOOL Model assessment, along with NEPOOL's response to it, was included in the 1979 NECPUC document Perspectives on the NEPOOL-Battelle Long-Range Electric Demand Forecasting Model. This report is an example of the dialogue among planning-oriented electric load forecasters that goes on in appropriate forums and which, in our view, is best restricted to such forums.

system planning tools. Rather, as is made explicit throughout the research, what we have prepared are statewide (not utility-system) forecasts of electricity and on-site buildings sector fossil fuel use in order to provide reasonable benchmark forecasts from which to compute the effects of conservation in region-specific detail. The six Base Case forecasts prepared for this study are but "reference forecasts" from which we can quantify the long range effects of a scenario of cost-effective, technically feasible conservation measures for the New England region through a second set of forecasts, the Conservation Case forecasts.

Forecast modeling is not the issue in this study. With appropriate adjustments NEPOOL's own model could have served as a tool for assessing conservation's potential impact, had it been available to us. Unfortunately, NEPOOL compounds the error of focussing on the wrong issue by offering observations which are sometimes unintelligible and in the main erroneous. Moreover, NEPOOL presents negative quotations from two consulting firms hired by electric utilities to critique ESRG forecasts in regulatory hearings. We have no choice but to rebut NEPOOL's technical points and unfortunate quotations, even though the effort will take us away from the purpose of this study and from its analytic core. (This detailed rebuttal commences below.)

In summary, then, the New England Power Pool has provided comments which appear to be oriented more to controversies of load forecasting and other utility systems modelling issues than to the related but still quite different issue at hand. In the detailed rebuttal which follows, we attempt to distinguish the few NEPOOL comments focussed on the actual aims of our research for GAO from the many whose ultimate context lies beyond the scope of this effort.

With the benefit of hindsight, it is possible to see that NEPOOL, despite its great responsibilities in the region, chose not to comment dispassionately upon the study at hand in the present instance. Our assessment of conservation and renewable resource potentials has been restrained, cautious, and limited in scope. Had comments on this study been solicited from one of the major environmental organizations that has devoted resources to articulating the need for and the possibility of a major re-orientation of our energy strategy, we believe that they would have offered a useful counterpoint to the NEPOOL commentator's perspective.

Page 113. "Transmittal Letter Request"

Here, NEPOOL offers preliminary speculation as to what supply mix might serve the load it anticipates in the 1995-2000 period. The demand and supply scenarios used by ESRG, on the other hand, are described in section 2 of our "Summary Brief of the Analysis and Results" incorporated in this volume. In NEPOOL's scenario, even if all coal conversions are completed (an unlikely event), some 21,900 GWH of oil-fired generation remains by 2000. This may be compared with our analysis suggesting that conservation implementation can displace some 25,100 GWH of such generation by 2000. It must be borne in mind that our demand and supply scenarios differ from those sketched here by NEPOOL, but it is evident that under <u>any</u> plausible scenarios, there is a vast amount of oil-fired generation that can potentially be displaced by conservation.

See GAO note on page 102.

Page 114. "Lack of Free Market Impact"

This section is partly an ideological diatribe and partly a dispute among modelers as to modelling approach. NEPOOL would place more reliance on price than does ESRG and would apparently ignore two major factors. First, electricity prices are deliberatively designed to achieve social objectives, one of which is conservation. Nothing in the ESRG analysis precludes price restructuring as one vehicle of promoting cost-beneficial conservation. Second, under either Base Case or Conservation Case conditions, other factors than price will influence conservation implementation. These include legislation and regulation; cultural values and social awareness; and technological changes in appliances and equipment, building practices, industrial processes, etc. Through a disaggregated end-use approach it is possible to avoid over-reliance on aggregate price elasticities as explanatory variables. The numerous factors that affect various aspects of electricity (and other fuel) consumption can be separately considered. Over-reliance on price will lead to forecasts in which minor errors in price forecasting or in elasticity estimates will have major effects on projected levels of use.

However, NEPOOL is in fundamental error in saying we attribute no effects to price changes. Price elasticities are used selectively throughout the end-use framework of the model. For example, in Report I of the Technical Appendix we give high case and low case estimates of changes in the prices of major fuel forms. These estimates are employed in developing our projections of terminal saturation levels for major appliances. Or, consider our commercial sector energy forecast, where we use a number of end-use-specific price elasticities, more in fact than are used in the less disaggregated commercial model employed by NEPOOL. It is possible to increase the direct application of price factors within the framework of our end-use forecasting (and in fact since the GAO runs we have increased our model's usage of price estimates in making specific end-use forecasts). In the GAO runs we attempted to incorporate the influence of price either directly or indirectly throughout the model, in combination with other factors which influence demand.

The principal reason why feasible and cost-effective conservation measures are not all implemented is that they cost money "up front" but return savings over time. Other (institutional and informational) barriers to conservation implementation have been noted widely in the literature and need no recapitulation here. The NEPOOL commentator's concentration on "free market impact" is admirable but can not help GAO in the concrete task of formulating policy recommendations, not even those that impact on pricing itself.

The NEPOOL commentator's quotation from NERA does more than merely recapitulate his preference for largely price-based forecasting; by innuendo it casts doubt on the reliability of

ESRG forecasts. The NERA quotation inappropriatelv introduces into a GAO study of New England energy alternatives a misleading snippet from a lengthy energy planning hearing in New York state. In its "Opinion and Order" of September 8, 1980, in Case 80003, the New York State Board on Electric Generation Siting and the Environment noted that "the NERA forecast was prepared at the request of the members of the New York Power Pool and it is substantially higher than any other forecast in the record" (page 17). While this quotation is a necessary counter to NEPOOL's inappropriate quotation from NERA, it does not advance the cause of the GAO study to introduce material from a state regulatory process that has stretched over several years. In order to understand the energy planning process in New York state and ESRG's positive role in that process, it is necessary to consider the record there in its entirety. One small part of that record is a nineteen page rebuttal of the NERA comments from which NEPOOL has quoted here. These debates are now only of historic interest. With the passage of time, the New York utilities in unison with their consultant, NERA) have annually adjusted their forecasts so that today there is no substantial deviation with the ESRG forecasts produced three and four years ago.

APPENDIX IX

Page 116. "Methodology Used"

Here the NEPOOL commentator questions the methodology for developing oil savings from displaced generation due to additional conservation of electric energy as quantified through the Conservation Case forecast detailed in Report II of the Technical Appendix volume. His confusion is understandable in that our assumptions are spelled out explicitly in Report III, not Report II.

The NEPOOL commentator echoes (here and repeatedly in subsequent pages) ESRG's observation that generation plant dispatch simulation runs would be useful to get a more detailed picture of the impact of conservation. ESRG wholeheartedly advocates additional, more detailed studies of conservation potential and implementation, studies which were properly outside the scope of this initial investigation. Indeed, a conclusion that can be drawn from our study is that, given the large potential for savings through the measures contained in our relatively cautious conservation scenario, additional "second-order" analyses would be warranted. In addition to the dispatch runs suggested by ESRG and NEPOOL, these could include investigation of conservation impacts on utility finances and optimal system planning, more thorough investigation of conservation costs and benefits and of concrete programmatic options, and so on. Indeed, ESRG has already begun this process of more detailed inquiry in studies under way at this writing for the Maine Public Utilities Commission.

Our conservation and alternative supply scenarios were not offered as blueprints for specific policy action over the twenty-year period covered in the analysis. Rather, they represented the choice of reasonable target achievement levels in order to orient and motivate the development of precise policy and program analysis. For this reason, our scenarios did not incorporate the full technological potential for the conservation and alternative supply options. In addition, we attempted to quantify the potentials which appear to be cost-effective according to fairly conservative criteria.

Given the purpose of our study, which was not to construct an alternative capacity expansion plan for the New England utilities or a detailed conservation plan for the New England utilities or other bodies in the region, it was of course necessary to make certain analytical decisions in order to conduct any kind of reasonable analysis. One decision that we made early in the study, for example, was to hold fixed a projected NEPOOL capacity expansion program in order to conduct the rest of our analysis in an efficient and useful fashion. Another decision we made was to conduct a benchmark base case forecast of electricity use and of certain kinds of oil use in New England for a twenty-year period, in order to be able to make systematic computations in the Conservation Case relative to some defined point of departure. Our purpose was not to introduce this forecast as a capacity planning tool for the New England utility system. Had it been, we would have spent more time in the process of electric load forecasting and less time in the process of analyzing the conservation and alternative supply potential relative to the forecast.

Page 117.

On page 117, The NEPOOL commentator questions our figures concerning the costs of meeting weather-sensitive peak period air conditioning load. In advocating the use of $3/MMBtu (fuel) and 0.1 ¢/kwh (operations and maintenance) as measures of the cost of generation to meet such load, the commentator is urging figures which are much too low. Regarding oil costs, according to the Cost and Quality of Fuels for Electric Utility Plants report for September 1980 issued by the Department of Energy, actual prices paid by New England utilities ranged from $3.42 to $6.91 (page 40). Costs for peakers were generally over $6/MMBtu. Real oil prices have been steadily rising, and long-run prices (not those prevailing at the moment) are the ones to consider in evaluating conservation measure cost-effectiveness. This matter is further discussed in Technical Report II.

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While it would be useful ultimately to perform a series of supply-side dispatch runs, it was not necessary to do so in order to get reliable first-order results such as presented in our reports to GAO for this study. Were the NEPOOL comments more balanced, they would point out that more detailed supply-demand analysis would permit a relaxation of the cautious parameters we used in designating our initial set of demand-side conservation measures.

It is clear that for the forseeable future under any scenario based on current policies and planning, there will be massive amounts of oil-fired generation to be displaced. More detailed modelling would permit evaluation of additional conservation measures and levels against the mix of fuel, maintenance, and capacity costs that they would displace.

Illustrative of the caution employed in constructing the present conservation scenario is the fact that load management, which refers to a set of techniques for managing the pattern of consumption so as to improve load factors, was not included in the scenario. Load management is more useful in controlling peak loads than in saving energy, as pointed out in Technical Report II.

Page 119. "Social Cost Criterion"

The section on the cost criterion used to assemble the set of measures incorporated in the ESRG conservation scenario was rewritten after NEPOOL received its copies of the draft report. The rewrite (in response to the ESRG-GAO review process) clarifies the role of the social cost criterion. See Technical Report II, Section 2. ESRG did not "recommend appliance efficiency standards;" we reported that energy-efficient applicances, such as could be required by appliance standards, were cost-justified and feasible conservation investments.

APPENDIX IX

Page 121. "Initialization Year Data Problems"

Here NEPOOL's commentator raises minor technical questions that are relevant to Base Case forecast details rather than the central focus of our effort, namely, careful calculation of the difference between Base Case consumption on the one hand and consumption under conservation scenario or alternative supply scenario conditions on the other. For the 1978 base year, the differing "high" and "low" case figures for two residential end-uses represented a deliberate effort to capture the range of uncertainty regarding the precise values of these inputs. (Other residential end uses, as well as total residential energy consumption, are identical for the "high" and "low" case base years.)

Kwh usage for residential space heating comes from utility sources as indicated in Technical Report I, and is lower in the Northern states due to superior insulation and extensive wood use. Heating auxiliary data could (ideally) be differentiated by states, but here again it is the reduction due to conservation from the base figure over the forecast period that is of interest, not the precise value of the base year usage. The data input were a reasonable regional average. For more energy-intensive end uses (space heating, heat pumps) and elsewhere as data permitted, state-specific figures were used.*

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*In considering these minor technical points raised in the NEPOOL comments, the reader should be aware that NEPOOL was asked to provide certain relevant historic data at the outset of the study, but declined to do so.

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The oil heating data question on page 122 is answered in some detail at the end of Technical Report III. In summary, if there are serious base year data problems, they are not those called to our attention by the NEPOOL commentator on pp 121-122.

Page 123. "Residential Appliance Saturations"

The first issue NEPOOL raises here is again a tangential technical forecasting point. The income and price assumptions input on page 71 of Technical Report I are consistent with ESRG's analysis of the range of estimates discussed in the literature on the subject. They represent our professional judgement at the time of the Base Case forecast one year ago. The reader may judge whether these explicitly identified assumptions were reasonable. We believe they were.

Regarding the second point raised here, the electric resistance heating penetration assumption sources are identified on page 72 of Technical Report I. Since the time of that analysis a year ago, we have determined that penetrations for Maine will probably be higher than indicated in Table 8.9 there. This means the potential for saving oil by restricting the spread of unassisted resistance heating in Maine is in fact greater than that computed in our Conservation Case forecast for GAO.

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Page 124. "Electric Heat Pump"

Persons interested in even greater detail on heat pump COPs than that already given on pages 83-85 of Report I in the Technical Appendix should consult the technical literature for that information. On review pursuant to these NEPOOL comments we find no errors or problems requiring rectification.

Page *125.* "Electric Space Heat Regulations"

We are in agreement that generation plant dispatch simulation model runs would be useful to track the effects of restricting unassisted space heating in precise detail. Absent such runs, the only reasonable assumption that can be made is that the primary fuel type to be saved is oil. The justification for this assumption is explicitly set out in Technical Reports II and III. We note that the NEPOOL commentator does not attempt to refute our showing that the economics of restricting electric heat are favorable.

Let us also repeat our disclaimer regarding policy measures. In the Conservation Case, we have modeled the residential and commercial sectors as if a ban on unassisted resistance heating in new buildings were in effect in order to illustrate the conservation potential from such a ban. But the same effects may be obtained by measures other than such a mandatory regulation. For example, if marginal cost based rates for resistance heating were put into place, they could also have the effect of virtually eliminating new space heating installations. It is up to the states, the utilities, the regulatory commissions, the Federal government, etc., to develop the policies to realize the conservation potential that we have identified from the measures incorporated in the scenario, in this case installation of heating systems that are more efficient and more cost-effective than unassisted resistance heating.

APPENDIX IX

Page 127. "Cogeneration Policy"

Since NEPOOL reviewed the ESRG Technical Report II, additional text has been added that addresses the fuel trade-offs in the industrial sector.

Page *128*. "Regarding Forecast Accuracy"

Here again, as generally throughout the "Detailed Comments," NEPOOL's real interest is electric load forecasting for planning purposes. To assess our forecasting model for these purposes, one would need (a) a forecast intended as a basis for electric utility systems planning, i.e., one different from that employed in this study, and (b) a comprehensive record of several years of observations for both energy and system peaks. The selected observations NEPOOL lists are not "errors" and have little bearing on the question of long-run forecast accuracy.

Page 128. "Regarding the Commercial Model"

Again, the issue raised concerns appropriate planning forecasts and is tangential to the study purpose. ESRG's comprehensive review of available data and models as of early 1980 led it to employ the assumptions incorporated in the commercial model. Documentation is provided in Report I of the Technical Appendix volume available from GAO on request. NEPOOL seems to feel our commercial sector forecast should be higher. If it were, our calculation of the impact of additional conservation would also be higher. In our study we have tried to be cautious in quantifying the potential for saving oil through either the conservation scenario or the alternative supply scenario.

Detailed analysis of this eight point commentary on the commercial Base Case forecast would take us too far afield even for these detailed responses. Our commercial forecast does not contain "errors" either for 1975 consumption or for regional conservation levels, and our procedures are explicitly described. When prepared it was at least as good as any available. In the year since the GAO runs, further refinement of the commercial model has occurred.

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Page 131. "Other Consultant's Evaluation"

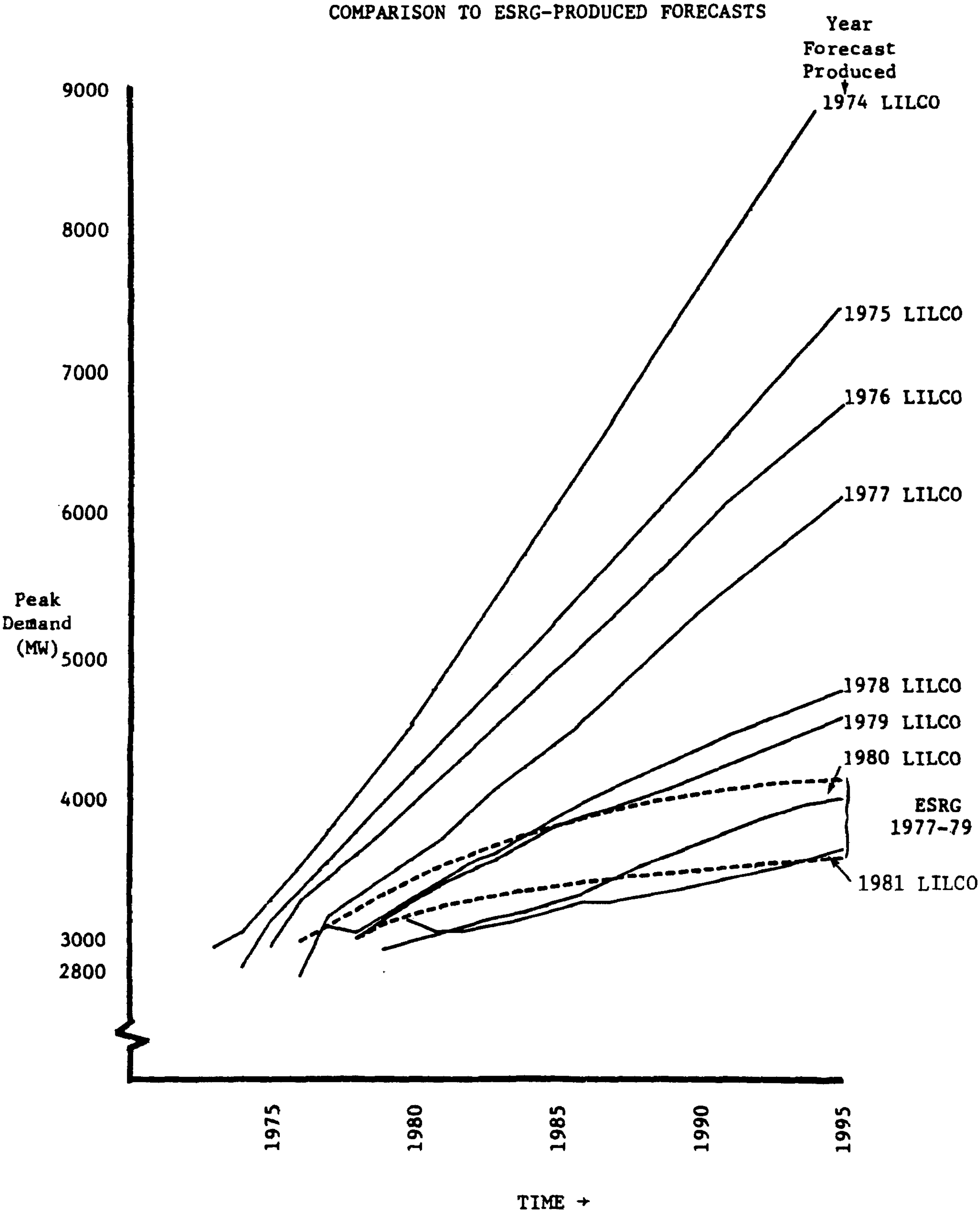
Even if ESRG had prepared a forecast for utility planning purposes, the device of selective quotation out of context would be an unprofessional way to address the question of planning forecast adequacy. In our response to pages 114 and 115 of the detailed NEPOOL comments we have already addressed the NERA role in New York state's electricity planning and siting hearings. NERA's interest was to show ESRG's forecasts too low for utility planning purposes. In introducing its detailed response to this NERA tract ESRG stated:

> It is straightforward to show on a point-by-point basis that NERA has not produced a single valid quantitative criticism in its Critique. The fundamental difference between ESRG and NERA, it will be seen, is that ESRG understands ESRG's forecast model but NERA does not. Informed critical feedback is fundamental to scholarly progress in any scientific discipline -- especially an emerging one such as utility system modelling. The major preconditions which the community of scientists generally insist upon of those who would engage in this dialogue is that criticism be as dispassionate as possible and be grounded in an adequate grasp of its subject matter. Unhappily, on these criteria NERA's critique of the ESRG forecast fails woefully. It is hoped that this response will neutralize the misconceptions which have now been inserted in the record.

ESRG's professional track record in New York is clear. ESRG forecasts have remained stable while those of the electric utilities have dropped precipitously, toward convergence with our earliest results. A flavor for this dramatic trend may be gleaned from the testimony of Dr. Paul D. Raskin of ESRG before the Public Service Commission of New York on February 12, 1981 (Case. No. 27811). There he compared changes in the load forecasts of the Long Island Lighting Company (LILCO) with the range of differences in ESRG Base Case forecasts made in 1977, 1978, and 1979. The figure making this comparison is reproduced below from Exhibit ___(PDR-1) of that testimony. All references are in the public record in that case. We have added the 1981 LILCO forecast (from the reference cited in the next paragraph) to the figure.

Currently, the utilities in New York foresee a 16-year increase in statewide peak load amounting to a growth rate of 1.2 percent per year. (Long Range Plan 1981, Volume 1 of Report of the Member Electric Systems of the New York Power Pool and the Empire State Electric Energy Research Corporation, April 1, 1981, page 54). This growth rate is less than half that the utilities were forecasting a few years ago when E.S.R.G. produced its first statewide forecast. On a 16 year basis from 1978, the earlier E.S.R.G.-forecasted peak load increases amounted to a growth rate of 1.2 percent per year. For energy, the new Power Pool forecast amounts to 1.5 percent per year (Long Range Plan p. 70), again less than half the growth rate that was being forecasted when E.S.R.G. produced its first statewide forecast with an energy growth rate of 1.1 percent per year.

CHANGES IN LILCO-PRODUCED FORECASTS 1974-80 AND
COMPARISON TO ESRG-PRODUCED FORECASTS



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The puzzlingly unprofessional tactic of the NEPOOL commentator is continued by selective quotation from Ernst & Whinney. Contrary to NEPOOL's statement, E & W worked for the utilities in Wisconsin. The E & W comments relate entirely to the particular data, statistics, and documentation provided by ESRG in a hearing specific to Wisconsin. ESRG's forecast and response are in that record, as is E & W's later acknowledgement that "we found ESRG to be extremely cooperative and timely in responding to our request for data." (page IX-11, Review of the Forecasting Methodologies of the Participants in the 1978 Advanced Plan Hearings, July 1980). Finally, in Wisconsin the state agency included the ESRG Base Case Forecast in its final planning decision based upon available forecasts.

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Page 135. "Regarding Long Range Energy"

Note that peak and energy forecasts are mixed in this list. Regarding line 1, the NEPOOL growth rate was already given in the Technical Appendix at the relevant points. Line 4 is irrelevant because it is national (not regional) and regional growth rates vary very widely. For further perspective, note that in a report prepared for the Maine Public Utilities Commission, ESRG has forecasted an annual New England electric energy growth rate of 1.3 percent per year for the 1979-1999 period (Long-Range Forecast of Central Maine Power Company and New England Electric Energy Requirements and Peak Demands, October 1980, page 9).

Page 135. "Comment re. Table 5"

These figures were reviewed and corrected in the process of ESRG/GAO review after NEPOOL received its copy of Report II.

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Page *136*. "Technical Report IV"

The commentator addresses the supply system that we use in order to illustrate the impact of our alternative supply scenario. Included were all the nuclear plants that we knew to be tentatively planned by NEPOOL, excluding the possible Montague plant which has since been cancelled. We included the only two coal-conversions we knew to be scheduled at the time. The difficulties which it appears are likely to accompany the effort to convert additional oil-fired plants to coal are evident. For example, in its January 1981 report to the Connecticut Department of Public Utility Control, entitled "Northeast Utilities Conservation Program for the 1980's and 1990's" NUS makes the following statement (page 67):

> It should be noted that, because of NU's financial condition and uncertainties about environmental approvals, no provision has been made in the System's six-year capital construction program for the cost of coal conversion. While progress has been made since the end of 1979 in developing a new mechanism for paying the cost of converting the Mt. Tom station in Holyoke, Massachusetts to coal in 1982 within accepted environmental parameters, the conversion of the other seven units does not yet have the necessary regulatory, financing and environmental clearances, and therefore, cannot yet be scheduled.

Even if we had considered additional coal-fired plants, it is likely that all of the fuel displaced by our scenario would have been oil. However, it was an initial and reasonable analytical decision to "go" with the structure of the plants that were used in this study as a basis for computing the oil savings. Transmission cost tradeoffs are outside the study scope. Cost information that underlies the alternative supply scenario is detailed in Technical Report IV and to the best of our current knowledge all cost comparisons are correctly made and explained there.

Page *138*. "Technical Report V"

Underlying these comments is an explicitly articulated rejection of the input-output method that economic analysts increasingly employ and upon which the employment analysis in the GAO study is based. ESRG's input-output analysis assesses the implication of the residential conservation measures only, not the entire conservation scenario. I/O analysis is widely recognized as one of the most useful tools now available for forecasting indirect economic ramifications of investment choices. As a by no means unique example of this recognition, consider the Abstract of Roger H. Bezdek's 1974 study Empirical Tests of Input-Output Forecasts; Review and Critique for the Department of Commerce's Bureau of Economic Analysis:

> Examines the procedures and results of sixteen major tests comparing input-output with alternative forecasting techniques conducted in the United States and in other nations in the past quarter century. Provides concise summary and analysis of these empirical tests of input-output forecasts. Finds that there are no simple alternative forecasting methods which are consistently as good as input-output.

The reader is encouraged to consult the explanation of methodology and results contained in Report V of the Technical Appendix.

The GAO analysis builds upon ESRG and other modelling efforts that are in the public domain; to burden the already extensive explication in Report V with the entire mechanics underlying the analysis would expand its size inordinately in a research area which, while important, is secondary to our primary focus on identifying direct economic savings, i.e., energy savings.

CMP **Central Maine Power Company**
GENERAL OFFICE, EDISON DRIVE, AUGUSTA, MAINE 04336 (207) 623-3521
(TWIX NUMBER, CMP-AGUA 710-226-0195)

January 8, 1981

Mr. J. Dexter Peach
Director
Energy and Minerals Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

On December 17, 1980, Mr. James R. Smith of NEPOOL received your letter of December 11, 1980 and copies of a draft report entitled "A More Effective Regional Effort in Conservation and Renewable Resource Development Can Help Alleviate New England's Oil Dependence". You requested that NEPOOL comments on the draft report be submitted to you in writing within 30 days from your transmittal letter date so that they may be incorporated in your final report. In response to this request, we are enclosing our comments. We would point out, however, that insufficient review time has been allowed to provide a complete analysis of such an important document and efforts by our Planning Committee Chairman to extend the deadline for comments were not successful (Mr. J. Gurkin's communication with your Mr. T. McGrean of the GAO Boston office).

As our enclosed comments indicate, we commend GAO for its recognition of the importance in reducing New England's oil consumption. Indeed, it is also the goal of the New England electric utilities. However, as we indicate, the GAO and its consultant in this study have ignored many factors already influencing energy conservation and alternate energy resource development. The report's main recommendations involve additional legislation including the "possibility of a regional power planning board or a regional power authority". We disagree with this recommended means to reduce New England's oil dependency. Further, as our comments and the record indicates, Mr. J. Dexter Peach -2- January 8, 1981

there is no justification for such recommendations. Any additional institutional/legal action would be best applied to reducing lead time requirements of existing base load nuclear and coal technologies, providing assistance for achieving adequate rate relief and providing aid in economically justifiable coal conversions. In summary, GAO's premise "that the Federal role should be one of supportive oversight" can be the basis for recommendations significantly different than those which GAO has included in this report draft.

Sincerely,

E. W. Thurlow

E. W. Thurlow, Chairman
Executive Committee
New England Power Pool

Enc.

(GAO response: Our main recommendations are directed toward increasing the New England's use of conservation and renewable resources within the current institutional framework. A "regional power planning board or regional power authority" is not one of the main recommendations of our report and is only mentioned as a long-range "possibility" if the region is unable to take the unified actions required to reduce their oil dependence.)

APPENDIX X

NEPOOL COMMENTS

ON THE GAO DRAFT REPORT

"A MORE EFFECTIVE REGIONAL EFFORT IN

CONSERVATION AND RENEWABLE

RESOURCE DEVELOPMENT CAN HELP ALLEVIATE

NEW ENGLAND'S OIL DEPENDENCE

1/5/81
NEPLAN

General Comments

The goal of reducing New England's oil consumption as indicated in the GAO draft report is commendable. It is also the goal of the New England utilities. However, the GAO and its consultant (E.S.R.G.) have seemingly ignored many factors already influencing conservation and alternate energy resource installations when they suggest additional legislation is required. The apparently overlooked, or undervalued, factors at work are PURPA of 1978, backout legislation and the free market action influences of price, all of which will have a large effect and significantly reduce the additional potential cited in the report as being available from additional legislation.

(GAO response: PURPA, oil backout legislation, and the correlation of price and energy consumption in the past are all mentioned in the text of our report. Also, our base case is intended to capture the effects of these and other existing policies and trends on future oil consumption. Therefore, these activites were not overlooked and we have attempted to place a prudent value on them.)

The utilities do not need additional legislation which will add more monitoring by additional agencies and create further delays in the installation of known effective technologies which are dispatchable with proven capability to reduce oil consumption. Any additional institutional/legal action would be best applied to reducing the lead time requirements of existing base load nuclear and coal technologies, assisting the utilities in obtaining adequate rate relief to assure installation of the pool planned units without further delay and in obtaining adequate funding to assure coal conversions where they can be justified.

(GAO response: The finding and recommendations in our report do not preclude the region's utilities and regulators from pursuing the installation of planned capacity and coal conversions. However, the report does point out the advantages to the region of pursuing cost-effective conservation and alternative energy sources and recommends that these two options be given the same consideration as additional conventional capacity.)

APPENDIX X

This point is emphasized by a quote from the final draft of Volume II, Chapter 2 of the "National Reliability Study" prepared by the Division of Power Supply and Reliability, Office of Utility Systems, Economic Regulatory Administration of the United States Department of Energy. "The small, dispersed unconventional power generation technologies are found to be not very cost-effective. Their capital costs are too high for the energy provided. The additional benefits due to their being dispersable and ease of construction and licensing are not significant enough to offset their higher capital costs. The intermittency nature of the renewable sources results in low contribution to reliability improvement. Instead, their short-term power output variations may cause the power systems to acquire additional load following generating units and increase utility system's spinning-reserve requirements. Both of these effects will increase the penalty for intermittent generation".

If this type of capacity is not cost effective to make a reliable system, it will not be cost effective to supply only energy. This, coupled with the fact of inadequate manufacturing facilities, will not make wind generation, for example, a significant factor in the next ten years when great strides should be made in reducing oil consumption.

(GAO response: As shown in Chapter 3 of our report, only about 35 percent of the electrical generating potential from our alternative supply case is expected to occur by 1980. Most of this potential will come from small hydropower dams and municipal solid wastes, two technologies for which cost effective sites are now being developed. Wind, tidal and conventional hydro become more of a generation factor in the 1990 to 2000 timeframe when their cost effectiveness is expected to improve and adequate manufacturing facilities will be available.)

The utility industry in New England is already actively involved in implementing many of the measures proposed in this report. Many of the references cited in the report indicate areas of utility involvement.

In the area of conservation, electric utilities already are:

(a) Distributing informational and educational materials to all classes of customers. Conducting educational programs in conjunction with school systems;

(b) Making home energy audits available to all residential customers;

(c) Counciling industrial and commercial customers to help improve efficiencies of their operations and identify cost effective conservation measures on an individual basis;

(d) Distribution of shower head flow controls to customers;

and many other programs. This is not an exhaustive list but an indication of the commitment on the part of electric utilities in New England to conservation.

In the area of utilization of alternate, renewable energy resources, New England electric utilities are:

(a) Currently building and developing small, low-head hydro projects;

(b) Currently using wood as a generating source with plans to build additional plants.

(c) Planning and building generation to utilize wastes and refuse.

(d) Supporting research and development of and demonstration projects of solar and wind power.

Again, this is not an exhaustive list.

APPENDIX X

(GAO response: Chapter 4 of our report briefly documents many of the conservation and renewable resource activities of New England utilities. Our intent is to recognize these utilities' efforts and to identify ways that the utilities could be encouraged to increase their involvement. Moreover, the effects of the utilities' efforts are captured in our base case.)

In each of the last two years, New England companies have been named electric utilities of the year: New England Electric System in 1979 and Boston Edison Company in 1980. NEES was named specifically for its innovative plans for conservation, load management, alternate generation, and efficient (low-heat rate) generation. Boston Edison was also cited for its great improvements in generation efficiency. The most efficient generation in the world resides in New England.

(GAO response: These comments are not relevant to any of our findings or conclusions.)

Comments in the GAO staff summary (p. 35) relating to the extent to which New England utilities have considered and adjusted for energy conservation in their plans in balancing electricity demand and supply misrepresent what has actually occurred. In fact, the utilities have markedly reduced their projections of electricity supply needs since the high growth period prior to 1973. Much of this "conservation" has been a result of rational responses to market forces as prices increased rapidly.

(GAO response: Our draft report has been changed to more accurately reflect the role that conservation and renewables have played in the utilities' plans.)

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This is the context in which one conclusion and recommendation of this report is made: if the utility industry in New England fails to cooperate in implementing conservation and alternate generation, a regional power authority should be established. Further, there is simply no way such a conclusion and recommendation can be made from the body of the report itself.

(<u>GAO responses:</u> We have addressed this comment earlier in our response to NEPOOL's cover letter.)

The entire thrust and goal of the report, analysis and scenarios seems to aim toward identifying the savings in imported oil that can be achieved. Utilities are fully aware of the need to save oil and are taking steps to do so through coal conversions, installation of coal and nuclear generation, installation of alternate resources, load management, conservation, etc. The authors' analysis seems to be done in complete absence of utility input and current plans particularly regarding coal conversions. This places a great deal of suspicion on the method of analysis and results and conclusions of the report. In fact, the utilities through the oil backout legislation have been ordered to cut to 50% by 1990 the amount of oil used. Since the utilities are taking steps to comply, it would seem that these plans should be a part of the base case, conservation, and alternate generation scenarios. How does such input impact the results of this study?

(<u>GAO response:</u> Our study includes the latest utility capacity expansion plans available at the time of our field work including 3 new coal plants totalling almost 2000 MW. We also discuss the possibility of additional coal conversions in the region, their potential for reducing oil consumption, and the importance of the proposed oil backout legislation to help the utilities to pay for these conversions.)

In the conservation scenario, the electric energy by the year 2000 is reduced 20% compared to the base case. Yet there is no analysis of the electric revenues, revenue requirements, or electric rates on a per KWH basis in the report for the two cases. In both cases, the same generation expansion was assumed. Most notably, the four nuclear units and one coal unit currently planned by New England electric utilities before 1990 were installed in all three cases. With 20% less energy in the conservation case, presumably there must be a difference in the rates in order to provide financing for these units. Yet there is no recommendation to utility regulatory agencies regarding any rate policies under this condition. If only one of the nuclear units is deferred because of lack of sufficient revenues, most if not all of the oil savings resulting from all the conservation measures put together will be completely wiped out.

(<u>GAO response</u>: Our recommendations include identifying the "regulatory and economic policies that influence utility policies and determine what changes may be needed" to assure that conservation and alternative supply options are considered. Without question, rate policies are among the vehicles available to regulators in influencing the region's utility plans.)

After reviewing this draft report we believe that, in its current form, one is unable to perform a comprehensive review and analysis of results presented. The major reason for this is that although "Technical Appendices" are included, insufficient detailed data is presented to support and/or analyze the authors' derived results. A prime example of this is a complete omission of detailed population and employment data for the forecast period. Sources are cited by ESRG, however, this data represents important growth parameters and should be explicitly shown. Also, since different sources were used by ESRG for various demographic/economic assumptions, without their inclusion in the report it is impossible to determine whether they constitute a reasonable set or scenario (i.e., unreasonable labor force participation rates or "negative" unemployment rates).

(Consultant response: NEPOOL comments address the analytical adequacy of our study. In general, NEPOOL concludes that it is impossible to perform a comprehensive review of our results, giving as an example a purported "omission of population and employment data" for the study period (page lll, NEPOOL "General Comments"). The reader interested in this example can turn to the first volume of the technical appendix and find the data employed given in considerable detail with full identification of the sources, which area readily available (e.g., U.S. Census Bureau publications). Indeed, some 300 pages are devoted to explaining the mathematical relationships contained in the models employed and the data and assumptions relied upon, in the Technical Reports incorporated in the second volume available upon request from the GAO and put at NEPOOL's disposal for review. Here, sources are referenced and every attempt is made to give the interested technical reader self-contained documentation sufficient to understand the analysis. Indeed, some may find the technical documentation somewhat excessive in the forecasting area in view of the fact that these models were employed only as accounting tools to track the impacts of a specified set of conservation measures as they are phased in over time and to provide a benchmark forecast for the alternative supply scenario.)

SPECIFIC COMMENTS ON TECHNICAL APPENDICES

The following sections deal with specific comments on certain subject matters contained within the five Technical Appendices. With the exception of Items 1, 14 and 15, the following comments are concerned primarily with Technical Appendices I - III. Following is a list of technical comments enclosed.

Transmittal Letter Request for Information on Utility Construction Plans 1995-2000

New England's extended forecast of April 1980 is published in the Northeast Power Coordinating Council ERA-411 Report of April 1, 1980. The forecasted peak load in that report for the winter of 1999/2000 is 28,060 MW. No specific construction plans have been developed for the period 1995/96 through 1999/2000. However, reliability runs, which install base load coal and nuclear generation to meet established New England generation mix guidelines, indicate 7000 MW of such capacity would be required resulting in installed reserves of about 20%. These additions, if made, together with anticipated coal conversions would result in a power year generation energy mix for the year 1999/2000 expressed in thousands of GWH of: nuclear 76.9, coal 44.8, hydro 4.4 and oil 21.9 based on the NEPOOL load forecast. These values indicate the oil consumption would be reduced to less than 15% of the total energy requirements.

Should the NEPOOL forecasted load actually develop the exact nature of how the energy requirements are met will depend on the amount of renewable resource capacity developed on a cost effective basis, the results of coal gasification studies, etc.

Of the 7000 MW of uncommitted base load dispatchable capacity indicated to meet the NEPOOL load forecast, 1600 MW has been included in the GAO report for all three cases consisting of coal units (1400 MW), wood (50 MW) and refuse fueled units (150 MW).

(Consultant response: Here, NEPOOL offers preliminary speculation as to what supply mix might serve the load it anticipates in the 1995-2000 period. The demand and supply scenarios used by ESRG, on the other hand, are described in section 2 of our "Summary Brief of the Analysis and Results" incorporated in this volume. In NEPOOL's scenario, even if all coal conversions are completed (an unlikely event), some 21,900 GWH of oil-fired generation remains by 2000. This may be compared with our analysis suggesting that conservation implementation can displace some 25,100 GWH of such generation by 2000. It must be borne in mind that our demand and supply scenarios differ from those sketched here by NEPOOL, but it is evident that under any plausible scenarios, there is a vast amount of oil-fired generation that can potentially be displaced by conservation.)

APPENDIX X

Lack of Free Market Impact on Energy Efficiency

The single most important factor underlying energy consumption is given only token representation in the ESRG Base Case forecast development and in their "conservation scenario"; namely, the impact of energy price on both the demand side and supply side of the energy market. Although ESRG repeatedly cites instances in the real world of the price effect (see, for example, Tech. App. I, pgs. 19, 78, 85, 101 and Tech. App. II, pg. 23) and identifies "energy conservation practices induced by electricity price increases" (Tech. App. I, pg. 13) as a factor which can impact average energy use, the explicit impact of energy price is notably absent in their actual forecast development process. Not only is this a critical weakness of the ESRG model structure, but is also a significant detrimental factor in the utilization of this model for policy determination, as it is being utilized in this current study for GAO. Specifically, not to attribute any increased energy efficiency expected in the future to price changes (both historical and future) but rather assign them to "mandated conservation measures" results in a misrepresentation of energy growth factors. Since the current study for GAO focuses precisely on conservation measures (as a growth factor), valid results obtained from assumptions about various degrees of "conservation measures" are indeterminate and could be misleading for policy determination.

Why are feasible and cost effective measures not likely to be implemented without additional public action? It is difficult to believe that additional bureaucratic regulations and mandates are needed to implement measures that are feasible (here and now) as well as cost effective. Certainly such is not the case in the electric utility industry when sufficient regulatory cooperation and required rates are provided to implement such measures. The authors indicate that measures to improve the efficiency of electric ranges are negligible and, in the case of self-cleaning ovens, such changes will in fact reduce unit costs. It is difficult to believe that in the extremely competitive appliance industry such cost-cutting improvements have not already been made. Certainly industry regulation and efficiency mandates are not required to accomplish this.

Relative to this subject, it is informative to note how other "reputable forecasting consultants" view the basic ESRG forecasting scheme. For example, testimony by National Economic Research Associates, Inc. on behalf of the Member Systems of the New York Power Pool, March, 1979 presented a critique of the ESRG Long Range Forecast for New York. Quoting NERA, "...ESRG fails to recognize the need for internal consistency in a forecast between price and growth projections for electricity. This relationship is important because a major factor in determining the trend in future electricity prices is the need for new construction to meet growth and demand." They further state that "the growth projections of ESRG do not support the real price increases for electricity which underlie, directly or indirectly, much of its analysis."

Also, it would appear that either GAO or ESRG should provide some reconciliation of market representation in this study with conclusions from a recent study by the Department of Energy. The survey study, entitled "Energy Programs/Energy Markets", by the Energy Information Administration, noted that many of the existing government programs "pull in the same direction that higher energy prices push", implying that the markets could have been used instead of the programs to accomplish the same results.

(Consultant response: This section is partly an ideological diatribe and partly a dispute among modelers as to modelling approach. NEPOOL would place more reliance on price than does ESRG and would apparently ignore two major factors. First, electricity prices are deliberatively designed to achieve social objectives, one of which is conservation. Nothing in the ESRG analysis precludes price restructuring as one vehicle of promoting cost-beneficial conservation. Second, under either Base Case or Conservation Case conditions, other factors than price will influence conservation implementation. These include legislation and regulation; cultural values and social awareness; and technological changes in appliances and equipment, building practices, industrial processes, etc. Through a disaggregated end-use approach it is possible to avoid over-reliance on aggregate price elasticities as explanatory variables. The numerous factors that affect various aspects of electricity (and other fuel) consumption can be separately considered. Over-reliance on price will lead to forecasts in which minor errors in price forecasting or in elasticity estimates will have major effects on projected levels of use.

However, NEPOOL is in fundamental error in saying we attribute no effects to price changes. Price elasticities are used selectively throughout the end-use framework of the model. For example, in Report I of the Technical Appendix we give high case and low case estimates of changes in the prices of major fuel forms. These estimates are employed in developing our projections of terminal saturation levels for major appliances. Or, consider our commercial sector energy forecast, where we use a number of end-use-specific price elasticities, more in fact than are used in the less disaggregated commercial model employed by NEPOOL. It is possible to increase the direct application of price factors within the framework of our end-use forecasting (and in fact since the GAO runs we have increased our model's usage of price estimates in making specific end-use forecasts). In the GAO runs we attempted to incorporate the influence of price either directly or indirectly throughout the model, in combination with other factors which influence demand.

The principal reason why feasible and cost-effective conservation measures are not all implemented is that they cost money "up front" but return savings over time. Other (institutional and information) barriers to conservation implementation have been noted widely in the literature and need no recapitulation here. The NEPOOL commentator's concentration on "free market impact" is admirable but can not help GAO in the concrete task of formulating policy recommendations, not even those that impact on pricing itself.

The NEPOOL commentator's quotation from NERA does more than merely recapitulate his preference for largely price-based forecasting; by innuendo it casts doubt on the reliability of ESRG forecasts. The NERA quotation inappropriately introduces into a GAO study of New England energy alternatives a misleading snippet from a lengthy energy planning hearing in New York state. In its "Opinion and Order" of September 8, 1980, in Case 80003, the New York State Board on Electric Generation Siting and the Environment noted that "the NERA forecast was prepared at the request of the members of the New York Power Pool and it is substantially higher than any other forecast in the record" (page 17). While this quotation is a necessary counter to NEPOOL's inappropriate quotation from NERA, it does not advance the cause of the GAO study to introduce material from a state regulatory process that has stretched over several years. In order to understand the energy planning process in New York state and ESRG's positive role in that process, it is necessary to consider the record there in its entirety. One small part of that record is a nineteen page rebuttal of the NERA comments from which NEPOOL has quoted here.

These debates are not only of historic interest. With the passage of time, the New York utilities (in unison with their consultant, NERA) have annually adjusted their forecasts so that today there is no substantial deviation with the ESRG forecasts produced three and four years ago.)

APPENDIX X

Methodology Used for Determination of Oil-Fired Generation Displacement

In Techn. App. II, a methodology is utilized whereby the costs of implementing specific "conservation measures" is compared with the cost of electricity that otherwise would be consumed. With respect to the displaced cost of electricity, E.S.R.G. notes that the appropriate cost for comparison should be "...the extra fuel costs of otherwise idle capacity" (Tech. App. II, p. 10), in a system where over capacity exists. Although E.S.R.G. repeatedly confirms the importance of this point as they present each of their conservation measures, they present no support for explicit or implied assumptions made concerning heat rates for displaced oil-fired generator units, load-following characteristics of the system, or of the daily/seasonal load profiles of the end use involved. Although E.S.R.G. on occasion alludes to the requirement of "detailed generation plant dispatch simulation runs" to confirm oil-fired generation reduction, they provide no such substantiation. Further, what may be an even more important "simplification assumption" made by E.S.R.G. involves their incorrect assumption that oil savings derived from the "conservation measures" are a simple addition of the effects of each measure. Since each end use affected has a unique daily/seasonal load profile, their order of introduction into a "conservation scenario" has a significant impact upon the load reduction by time of day/year and therefore, different types and costs of fuel displaced.

For example, the cost effectiveness of refrigerator efficiency improvements are based on the so-called cost of displaced oil. However, a refrigerator runs 24 hours a day year-round at a fairly constant load factor. Under the conservation case condition, after a 20% energy reduction, it is very likely that there will be many times that the load, including refrigerators, will be served totally by non-oil fuels.

(Consultant response: Here the NEPOOL commentator questions the methodology for developing oil savings from displaced generation due to additional conservation of electric energy as quantified through the Conservation Case forecast detailed in Report II of the Technical Appendix volume. His confusion is understandable in that our assumptions are spelled out explicitly in Report III, not Report II.

The NEPOOL commentator echoes (here and repeatedly in subsequent pages) ESRG's observation that generation plant dispatch simulation runs would be useful to get a more detailed picture of the impact of conservation. ESRG wholeheartedly advocates additional, more detailed studies of conservation potential and implementation, studies which were properly outside the scope of this initial investigation. Indeed, a conclusion that can be drawn from our study is that, given the large potential for savings through the measures contained in our relatively cautious conservation scenario, additional "second-order" analyses would be warranted. In addition to the dispatch runs suggested by ESRG and NEPOOL, these could include investigation of conservation impacts on utility finances and optimal system planning, more thorough investigation of conservation costs and benefits and of concrete programmatic options, and so on. Indeed, ESRG has already begun this process of more detailed inquiry in studies under way at this writing for the Maine Public Utilities Commission.

Our conservation and alternative supply scenarios were not offered as blueprints for specific policy action over the twenty-year period covered in the analysis. Rather, they represented the choice of reasonable target achievement levels in order to orient and motivate the development of precise policy and program analysis. For this reason, our scenarios did not incorporate the full technological potential for the conservation and alternative supply options. In addition, we attempted to quantify the potentials which appear to be cost-effective according to fairly conservative criteria.

Given the purpose of our study, which was not to construct an alternative capacity expansion plan for the New England utilities or a detailed conservation plan for the New England utilities or other bodies in the region, it was of course necessary to make certain analytical decisions in order to conduct any kind of reasonable analysis. One decision that we made early in the study, for example, was to hold fixed a projected NEPOOL capacity expansion program in order to conduct the rest of our analysis in an efficient and useful fashion. Another decision we made was to conduct a benchmark base case forecast of electricity use and of certain kinds of oil use in New England for a twenty-year period, in order to be able to make systematic computations in

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the Conservation Case relative to some defined point of departure. Our purpose was not to introduce this forecast as a capacity planning tool for the New England utility system. Had it been, we would have spent more time in the process of electric load forecasting and less time in the process of analyzing the conservation and alternative supply potential relative to the forecast.)

The cost effectiveness analysis for air conditioning involves similar fallacious reasonings. E.S.R.G. claims through conservation that the 1990 summer peak can be reduced 2820 MW to 14300 MW. Under such conditions and with four new nuclear units and a coal unit, can it be said that air conditioners will be served by peaking oil steam and gas turbine units? Or will they be served by such units for the full 310 hours per year air conditioners are assumed to operate? Since the 1990 load level is less than the actual 1980 summer peak, it is doubtful. In this same analysis which shows that air conditioner efficiency improvements are marginally cost efficient, at best, an oil price of $6/MMBTU is assumed. In similar analysis in other sections of the report, a more accurate $3/MMBTU is assumed. In this same analysis, E.S.R.G. states that typical O & M costs are 1¢/KWH; ten times greater than actual typical O & M costs of 1 mill/KWH.

(<u>Consultant response</u>: On page 117, the NEPOOL, commentator questions our figures concerning the costs of meeting weather-sensitive peak period air conditioning load. In advocating the use of $3/MMBtu (fuel) and 0.1/kwh (operations and maintenance) as measures of the cost of generation to meet such load, the commentator is urging figures which are much too low. Regarding oil costs, according to the <u>Cost and Quality of Fuels for Electric Utility Plants</u> report for September 1980 issued by the Department of Energy, actual prices paid by New England utilities ranged from $3.42 to $6.91 (page 40). Costs for peakers were generally over $6/MMBtu. Real oil prices have been steadily rising, and long-run prices (not those prevailing at the moment) are the ones to consider in evaluating conservation measure cost-effectiveness. This matter is further discussed in Technical Report II.)

In a number of instances, the cost effectiveness of specific measures is analyzed using the cost of adding an additional KWH of electricity to the base case ("marginal cost"). However, as correctly formulated, P_O must be the cost of electricity (price/KWH) displaced by the conservation measure being assessed. (Tech. App. II, p.10).

In order to properly assess the cost effectiveness and oil savings of the proposed conservation measures and alternate generation sources, a detailed simulated generation dispatch must be performed. And to assess the impact of the energy differences between the cases, a detailed corporate financial model must be used. Only then can legitimate results and conclusions of the type presented in this report be addressed.

In order to analyze the cost effectiveness of each proposed conservation measure, they must be prioritized and applied additively. In each case, a generation dispatch must be performed to identify the cost of the energy and the fuel that would otherwise be used in the absence of that particular conservation measure. The same is true in analyzing alternate generation resources.

Conservation technologies that are likely to attain technical viability or economic attractiveness during the scenario period have been specifically excluded. Could some of these make the "here and now" options recommended uneconomic? For example, all measures are economically evaluated against the "marginal" cost of oil. Could coal conversions (or additional nuclear units) change the economic viability of some of the measures and the results of the study?

(Consultant response: While it would be useful ultimately to perform a series of supply-side dispatch runs, it was not necessary to do so in order to get reliable first-order results such as presented in our reports to GAO for this study. Were the NEPOOL comments more balanced, they would point out that more detailed supply-demand analysis would permit a relaxation of the cautious parameters we used in designating our initial set of demand-side conservation measures.

It is clear that for the forseeable future under any scenario based on current policies and planning, there will be massive amounts of oil-fired generation to be displaced. More detailed modelling would permit evaluation of additional conservation measures and levels against the mix of fuel, maintenance, and capacity costs that they would displace.)

In this same regard, load management programs have not been included (beyond the base case which are not defined or data supplied). Could these programs not effect the results? Could load management programs be more effective in reducing oil usage and less costly?

(Consultant response: Illustrative of the caution employed in constructing the present conservation scenario is the fact that load management, which refers to a set of techniques for managing the pattern of consumption so as to improve load factors, was not included in the scenario. Load management is more useful in controlling peak loads in saving energy, as pointed out in Technical Report II.)

Social Cost Criterion

The criterion utilized by ESRG for assessing the economic attractiveness of their proposed "conservation measures" is one of "relative social cost". As described in Tech. App. II, pg. 8, relative social cost is defined as "direct expenditures by society for energy conservation steps compared with expenditures for the additional electric energy displaced by those steps". A major assumption made by ESRG in the calculation of the relative social costs for each of their proposed conservation measures is that "escalation in the marginal electricity rate is roughly at the level of the discount rate" (Tech. App. II, pg. 10). ESRG makes this assumption to "simplify" the calculations and resultant cost comparisons; however, the range of discount rate levels by consumer (i.e., "society") reported in the literature is of such a magnitude as to warrant examination of alternative levels. Resultant "conclusions" as to the social cost benefit could prove interesting. Testimony given by

Dr. S. Feld and by the Massachusetts Attorney General's Office in NRC Docket No. 50-471 contained discount rate assumptions of 10% (Feld's) to 20% (MAGO's). Given the importance of this factor in establishing "social economic gain", it would be prudent to examine the consequences of alternative discount levels for each of the proposed conservation measures considered in the "Conservation Case". It is especially important that such an analysis be performed given that nearly all of the conservation measures require expenditures of capital "up front" with the intention of avoiding costs "in the future".

The authors state that all direct costs have been included in analyzing the cost effectiveness of recommended appliance efficiency standards. At the same time, they recommend that these standards be mandated. However, no costs for instituting, regulating, policing and enforcing the standards have been included. If this bureaucracy is the recommended method of implementing these conservation measures, it would seem they should be a part of the direct "social" costs.

(Consultant response: The section on the cost criterion used to assemble the set of measures incorporated in the ESRG conservation scenario was rewritten after NEPOOL received its copies of the draft report. The rewrite (in response to the ESRG-GAO review process) clarifies the role of the social cost criterion. See Technical Report II, Section 2. ESRG did not "recommend appliance efficiency standards;" we reported that energy-efficient appliances, such as could be required by appliance standards, were cost-justified and feasible conservation investments.)

Initialization Year Data Problems

The initialization year of the forecast is defined by ESRG as 1978. Given that ESRG's forecasting scheme is one of forecast year factor multiplication times "initialization year" values, it is important that these initialization values be correct. It is important not only with regards to their "base case" forecast development but also for the "Conservation Case".

A cursory review of those initialization year values provided by ESRG has raised a number of questions concerning the validity of certain values. Following is a brief description of these problems.

a) The "high" and "low" cases developed by ESRG which supports their "base case" forecast is presented in Tech. App. I. For the 1978 base year, why is it that energy use for televisions and miscellaneous residential use is different (for each state) between the high and low while all other end use energies are identical?

b) Initialization year (1978) average KWH use per year for electric space heating is presented for each state in Tech. App. I, pg. 74. Why is it that KWH use/year is highest for the three southern N.E. states and lowest for the three northern states given that heating requirements (heating degree days) are substantially higher in the north? What is the source of this data? Further, for fossil heating auxiliaries, why are electrical usages the same for all states, given that different heating degree days exist for each state?

c) A question exists in our minds as to the accuracy of ESRG's initial 1978 disaggregation of New England oil consumption for water and space heating to commercial and residential categories. ESRG estimates that 64.3 million barrels of oil were used by commercial customers and 52.2 by residential customers in 1978. The procedures by which the breakdown was estimated is not documented. FEDS data for 1977 indicates that 53.5% of New England oil consumption for heating was used by residential customers and 46.5% by commercial customers. Thus, the basis for ESRG's 45% residential/55% commercial split in 1978 requires justification.

(Consultant response: Here NEPOOL's commentator raises minor technical questions that are relevant to Base Case forecast details rather than the central focus of our effort, namely, careful calculation of the difference between Base Case consumption on the one hand and consumption under conservation scenario or alternative supply scenario conditions on the other. For the 1978 base year, the differing "high" and "low" case figures for two residential end-uses represented a deliberate effort to caputre the range of uncertainty regarding the precise values of these inputs. (Otherresidential end uses, as well as total residential energy consumption, are identical for the "high" and "low" case base years.)

*Kwh useage for residential space heating comes from utility sources as indicated in Technical Report I, and is lower in the Northern states due to superior insulation and extensive wood use. Heating auxiliary data could (ideally) be differentiated by states, but here again it is the reduction due to conservation from the base figure over the forecast period that is of interest, not the precise value of the base year usage. The data input were a reasonable regional average. For more energy-intensive and end uses (space heating, heat pumps) and elsewhere as data permitted, state-specific figures were used**

The oil heating data question on page 122 is answered in some detail at the end of Technical Report III. In summary, if there are serious base year data problems, they are not those called to our attention by the NEPOOL commentator on pp. 121-122.

**In considering these minor technical points raised in the NEPOOL comments, the reader should be aware that NEPOOL was asked to provide certain relevant historic data at the outset of the study, but declined to do so.*

Residential Appliance Saturations

Residential appliance saturations are forecasted by E.S.R.G. whereby a "saturation logistics" curve is utilized. The most critical input to this curve is the fixed "terminal saturation" levels. E.S.R.G. indicates in Tech. App. I, p. 71 that "Guidance in estimating the terminal saturation levels was derived from econometric relationships between appliance saturation and price/ income variables." No basis is cited for the income and price input assumptions shown on page 71. Further, the very obvious ties between employment growth and income and between electric consumption/generation mix and electricity price is not addressed. With respect to the Conservation Case, electricity consumption/ generation mix is different from Base Case which would imply different electricity prices yet E.S.R.G. assumes the same levels of appliance saturation.

The electric space heating penetrations presented in Tech. App. I, p. 72 are based on nothing other than they are "values experienced during the 1970's" (p. 71). Obviously, this implies that the same determining factors of ESH penetration that existed in the past will exist in the future. It is difficult to conceive of this as a plausible assumption given decontrol of domestic oil and gas prices (note: oil-fired electric generators use virtually only imported residual oil), new nuclear capacity, and conversion of oil-fired generators to coal during the forecast period.

(Consultant response: The first issue NEPOOL raises here is again a tangential technical forecasting point. The income and price assumptions input on page 71 of Technical Report I are consistent with ESRG's analysis of the range of estimates discussed in the literature on the subject. They represent our professional judgement at the time of the Base Case forecast one year ago. The reader may judge whether these explicitly identified assumptions were reasonable. We believe they were.

Regarding the second point raised here, the electric resistance heating penetration assumption sources are identified on page 72 of Technical Report I. Since the time of that analysis a year ago, we have determined that penetrations for Maine will probably be higher than indicated in Table 8.9 there. This means the potential for saving oil by restricting the spread of unassisted resistance heating in Maine is in fact greater than that computed in our Conservation Case forecast for GAO.)

Electric Heat Pump Energy Utilization

The utilization of electric energy by heat pumps is presented in Tech. App. I and utilized for the Base Case forecast. Higher performance efficiencies are utilized for the Conservation Case for (Base Case) saturation levels as well as an alternative for the "electric resistance heat ban" conservation measure. In all of these cases, the levels of electricity utilization do not agree with estimates by at least one New England utility (Northeast Utilities special studies on space heating system life cycles, 1978). E.S.R.G. calculates COP's for each New England state (Tech. App. I, pp. 83-85) which they utilize in calculating heat pump energy use (EQ. 3.68, p. 32). The implied reduction in energy use of 50% (i.e., COP $\cong$ 2.0) is significantly higher than the 33% calculated by Northeast.* Perhaps E.S.R.G.'s failure to represent "heating season" heat pump energy use as a "seasonal performance factor" rather than an overall (total year) COP is the reason or perhaps it may be due to an error in their model equations (EQ. 8.3 on p. 84 does not agree with generic equation on p. 83 as E.S.R.G. says it should (p. 85)). Given the importance of this end use, this should be clarified and/or corrected and, in addition, weather data, population data and resultant calculations described on p. 85 should be presented in order that the reader may properly evaluate the conclusions.

*Northeast Utilities System 1980 Forecast of Loads and Resources Supporting Material, pp. 44-45, March 1, 1980.

(Consultant response: Persons interested in even greater detail on heat pump COPs than that already given on pages 83-85 of Report I in the Technical Appendix should consult the technical literature for that information. On review pursuant to these NEPOOL comments we find no errors or problems requiring rectification.)

Electric Space Heat Regulation

Several aspects concerning the proposed ban on new direct resistance heating as described in the Conservation Case should be noted. First, irrespective of relative cost considerations, it is important to note that such a policy makes more rigid the type of fuel that can be utilized for space heating. That is, the opportunity to supply end use heating needs by primary fuels other than oil/gas becomes more limited. ESRG argues that the primary fuel type that would be saved in New England would be oil, however, they have included only minimum (2 units) conversion of oil-fired generators to coal in their supply assumptions. Due consideration should be given to alternative assumptions of coal conversion levels as well as to synfuels and liquified coal use. Further, in this context, the banning of electric resistance heating is but one potential means for achieving reduced oil consumption and should be compared with other means such as coal conversion with a resultant assessment which includes an evaluation of the desired optimum mix of primary fuels that could be used for end use space heating.

The ESRG assumption that oil would be the primary fuel that would be saved as a result of banning additional resistance space heating is prefixed by the statement "though detailed generation plant dispatch simulation runs with and without additional resistance e.s.h. would be required to precisely confirm it." (Tech. App. II, pg. 31). Such a simulation should be performed to properly evaluate oil savings particularly at higher levels of oil generating unit coal conversion. The daily use profile of e.s.h. is an important component of such a simulation and cannot be generalized in any way due to its unique properties relative to other end uses of electricity (e.g. E.S.H.

energy as a % of total hourly system load is highest during weekday evening/early morning hours and weekend periods).

(Consultant response: *We are in agreement that generation plant dispatch simulation model runs would be useful to track the effects of restricting unassisted space heating in precise detail. Absent such runs, the only reasonable assumption that can be made is that the primary fuel type to be saved is oil. The justification for this assumption is explicitly set out in Technical Reports II and III. We note that the NEPOOL commentator does not attempt to refute our showing that the economics of restricting electric heat are favorable.*

Let us also repeat our disclaimer regarding policy measures. In the Conservation Case, we have modeled the residential and commercial sectors as if a ban on unassisted resistance heating in new buildings were in effect in order to illustrate the conservation potential from such a ban. But the same effects may be obtained by measures other than such a mandatory regulation. For example, if marginal cost based rates for resistance heating were put into place, they could also have the effect of virtually eliminating new space heating installations. It is up to the states, the utilities, the regulatory commissions, the Federal government, etc., to develop the policies to realize the conservation potential that we have identified from the measures incorporated in the scenario; in this case, installation of heating systems that are more efficient and more cost-effective than unassisted resistance heating.)

Cogeneration Policy

The energy conservation measure of industrial cogeneration presented by ESRG as part of their "conservation case" is defined as double the amount of cogeneration in the base case by the year 2000 (except for Maine which is assumed at 35% higher - Tech. App. II, pg. 47). The resultant lower electricity consumption is translated to lower oil consumption, however in neither Tech. App. II nor III is it apparent that recognition is made of the increased quantities or types of fuels that will be used by industrial firms due to the increased level of cogeneration. This should be clarified and, if in fact this has not been recognized, it should be included in the analysis.

(Consultant response: *Since NEPOOL reviewed the ESRG Technical Report II, additional text has been added that addresses the fuel trade-offs in the industrial sector.)*

Regarding forecast accuracy of ESRG's models

Actual sales data for 1979 were compared with ESRG's projections. It is to be noted that the commercial model appears to predict the most poorly. For example, actual 1979 sales in Connecticut are not achieved in ESRG's "base" case until 1981 and are never achieved in their "low" case; in Massachusetts commercial sales increased by only 2.1% in 1979, yet ESRG does not forecast this to occur in their "base" case until 1984, and it never occurs in their "low" case; and, in Rhode Island, actual 1979 sales are not achieved in ESRG's "base" case until 1986 and, again, never are achieved in the "low" case. ESRG's residential energy forecast for 1979 is reasonably accurate while actual 1979 growth in the industrial sector is generally not achieved until 1980 in the "base" case.

Given that ESRG's models forecast recursively, future forecast accuracy is definitely impacted by these errors.

(Consultant response: Here again, as generally throughout the "Detailed Comments," NEPOOL's real interest is electric load forecasting for planning purposes. To assess our forecasting model for these purposes, one would need (a) a forecast intended as a basis for electric utility systems planning, i.e., one different from that employed in this study, and (b) a comprehensive record of several years of observations for both energy and system peaks. The selected observations NEPOOL lists are not "errors" have little bearing on the question of long-run forecast accuracy.

Regarding the commercial model

While conceptually appealing, ESRG's commercial model is misspecified and dysgenic. A number of specific points can be made.

(1) It simply assumed that commercial square footage per employee for 12 commercial categories is fixed at estimated 1975 levels. No documentation is cited for this assumption. On the contrary, available data indicates that the ratio is not fixed and that commercial floor space per employee has increased through time. This is a serious misspecification which strongly biases growth in commercial square footage downward.

ESRG's "base" case forecast calls for commercial floor space in New England to grow at about one percent per year, 1978-2000. By contrast, a current forecast by Jerry Jackson (perhaps the most respected and frequently cited authority on commercial end use modeling) expects commercial floor space in New England to grow at an annual rate of 2.4%, 1978-2000.

(2) Again, it is simply assumed that hostipal square footage per capita and school square footage per school age population are fixed at estimated 1975 levels. No evidence or documentation are cited for these assumptions. Further, it is curious that hostipal floor space is simply a function of total population growth rather than, for example, growth in the elderly population. The growth rate for the latter is roughly double that of the general population.

(3) The employment growth indices usedto drive future floor space are sorely lacking in a number of regards. In the "high" case commercial employment is projected to increase at a rate of about 1.3% per year, 1975-2000; in the "low" case, the growth rate is about 0.7%. By contrast, in NEPOOL's base case forecast (as of 4/1/80), commercial employment is forecasted to growth at an annual of 1.7% per year, 1975-1995. Thus, it is difficult to comprehend ESRG's "high" case as being high in an appropriate sense of the word.

With respect to the "low" employment growth indices (which were drawn from employment projections done by respective state planning agencies), apparently ESRG is unaware of the rather strong disclaimers included in the prefaces of them. For example, the document for Massachusetts cautions: "... the projections should be viewed essentially as a continuation of past trend (1958-1974) relationships between the nation and the state. It would, therefore, be more accurate to view the specific numbers as indicators of relative magnitude and central tendencies. In other words, the data should be used as indicators of probable direction and relationships rather than as forecasts." Employment Requirements for Massachusetts by Occupation, by Industry 1970-1974-1985, Occupation/Industry Research Department, July 1976,p.i)

Further, it should be noted that not all of the most recent state projections have been utilized. For example, Massachusetts issued a new set of projections in December 1979; therein 1985 employment is forecasted to be fully 10% greater than was projected in 1976.

(4) The reliance on the electric energy use intensities cited in Carhart (ESRG's Ref. 6 in Technical Appendix I) is puzzling since they are contradicted by Jackson's research (ESRG's Ref. 3 in Technical Appendix I). No mention of the different use intensities is acknowledged in the GAO report, yet the differences are enormous. Considering only the Retail & Wholesale Trade class, Carhart shows a 1975 use intensity for electric space heating to be 4.1 Kwh per square foot (for the Northeast) while Jackson estimates a national use intensity of 18.4 Kwh per square foot; for air conditioning, both are in basic agreement with Carhart showing 10.8 and Jackson 11.3 Kwh per square foot; for lighting and all other uses, Carhart shows an estimate of 24.6 Kwh per square foot which Jackson calculates a figure of 13.5. It should be noted that ESRG, for some unexplained and unacknowledged reason, choses a lower use intensity for air conditioning than Carhart shows -- for the Retail & Wholesale Trade class, an intensity of 5.2 Kwh per square foot is used. Thus, there is a very strong basis for questioning the initial use intensities selected; the magnitude of error is discussed below.

(5) Again, on the subject of the electric use coefficients used in the analysis, Table 8.19 of Technical Appendix I shows a curious relationship. For some reason it is specified that new commercial buildings with electric space heating will require more Kwh per square foot of floor space than existing commercial structures do -- between 40 and 60 percent more. Why is this assumed to be the case? Particularly when new structures heated with oil or gas are specified to consume 20-25 percent fewer Btu/square foot than existing structures do? This anomaly requires explanation.

(6) No mention is made in the GAO report of "level adjustments" made by the consultants to achieve actual 1978 consumption levels. For at least the commercial sector, the magnitude of the level adjustment required is so large as to indicate that perhaps the methodology employed by ESRG is seriously flawed. Consider only Massachusetts. If one multiplies the 1975 commercial floor space estimates given in Table 8.16 of Technical Appendix I by the appropriate energy use coefficients in Table 8.19, using the saturations cited on p.80 and make the appropriate weather adjustments indicated on p.79, one will obtain an estimate of 1975 commercial energy consumption for the state. The estimate is 14,184 gwh whereas actual sales in 1975 were 10,171 gwh. (cf., ESRG's Ref. 66). Thus, the magnitude of error for 1975 is nearly 40% entailing an extremely large level adjustment to match 1978 sales data. Why is the reader not told this? Is it the case that such a large level adjustment is reasonable and that the methodology is suitable? Or, is the magnitude of the adjustment sufficiency large as to lead one to question the appropriateness of the methodology employed?

(7) It is interesting to compare the discussion of post-1975 conservation practices on pp. 43-44 of Technical Appendix I with the source from which they are taken (i.e., Carhart, ESRG's Ref. 6). Level 1 conservation practices are described on page 43 of the GAO report as: "improvements which provide quick payback and require minimal engineering expertise (e.g., insulation, reduced lighting requirements, and other "housekeeping")"; on the next page of the report it is stated that "the model incorporates the cautious assumption that solar heating and air conditioning will have an insignificant impact on overall load during the forecast period." Reading Carhart one finds that Level 1 conservation practices include both solar heating and air conditioning and, further, that 21% of new commercial floor space constructed 1976-1990 is expected to have solar heating and 14% solar air conditioning (cf., Ref. 6, p.47). Thus, it appears that solar applications do have a significant impact during the forecast period and further that Level 1 conservation practices involve more than housekeeping activities.

(8) Regarding the conservation policy scenario for the commercial sector, it should be noted that the Level 3 conservation practices employed in the analysis (cf., p.40 of Technical Appendix II) are appropriate for the South not the Northeast. Carhart (in ESRG's Ref.28 pp. 76-80) specifies conservation levels for four regions of the U.S., and those utilized by ESRG are clearly for the South.

(Consultant response: Again, the issue raised concerns appropriate planning forecasts and is tangential to the study purpose. ESRG's comprehensive review of available data and models as of early 1980 led it to employ the assumptions incorporated in the commercial model. Documentation is provided in Report I of the Technical Appendix volume available from GAO on request. NEPOOL seems to feel our commercial sector forecast should be higher. If it were, our calculation of the impact of additional conservation would also be higher. In our study we have tried to be cautious in quantifying the potential for saving oil through either the conservation scenario or the alternative supply scenario.

Detailed analysis of this eight point commentary on the commercial Base Case forecast would take us too far afield even for these detailed responses. Our commercial forecast does not contain "errors" either for 1975 consumption or for regional conservation levels, and our procedures are explicitly described. When prepared it was at least as good as any available. In the year since the GAO runs, further refinement of the commercial model has occurred.)

Other Consultant's Evaluations of ESRG Forecasts

National Economic Research Associates, Inc. (NERA) reported on their evaluation of three separate long range forecasts of electric energy and demand for New York state during March 1979 on behalf of the New York Power Pool member systems. These forecasts were developed by: (1) staff members of the New York Consumer Protection Board and the Department of Public Service; (2) Cornell University Group on behalf of the National Consumer Law Center; and (3) Energy Systems Research Group (ESRG) on behalf of the New York State Department of Environmental Conservation.

The report was entitled Critique on Behalf of the Member Systems of the New York Power Pool (NERA, New York, N.Y., March 16, 1979). Following are some of the more important points NERA made regarding ESRG's forecast and methodology.

(pp. vi-vii) ESRG's forecast relies extensively upon assumptions regarding both economic and engineering relationships. However, ESRG's assumptions regarding economic relationships are highly simplistic and inflexible. In addition, ESRG's approach to forecasting commercial energy requirements ... is flawed in it's logic and not supported by the very documentation relied upon by ESRG. ESRG's "most probable" forecast, a simple averaging of two cases which are labeled "high" and "low", is, as a result, unduly influenced by the set of extreme assumptions embodied in the "low" forecast.

(pp. 134-135)... the ESRG methodology represents a mixture of (1) use of engineering data on design standards and new technologies, (2) an extensive amount of judgmental guesses on quantitative relationships which cannot be verified in any meaningful way, (3) and some very naive economics.

(p. 135)... in its present form, the model is so simplistic and inflexible with regard to the multitude of economic relationships incorporated within it, particularly for the commercial and industrial sectors, that it cannot be recommended to utility forecasters as providing comprehensive, usable alternative information for their current efforts.

(pp. 140-141)... the methodology developed a "most probable" forecast based upon a simple average of a "high" and a "low" forecast scenario and results. There is no reason to believe, however, that ESRG's "high" and "low" forecasts are equally likely and, therefore, are symmetrical around a "most probable" forecast in any meaningful sense. Indeed, this approach invites biasing a "most probable" load forecast in one direction or another based upon extreme assumptions in either scenario. Because of simple averaging, at least half of any extreme assumption will be incorporated into the "most probable" forecast. In ESRG's case, the bias is clearly downward.

(p. 143) In summary, there is nothing inherently wrong with the methodology used by ESRG if it were used correctly. The major problems with this forecast relate instead to what appears to be a definite pattern of bias in applying the methodology: inflating the impact of conservation adjustments to sales and ignoring (setting at zero) changes in intensities of use by sector related to changes in economic factors such as prices and income. ...It is important to note, therefore, that, on balance, this approach relies heavily on an individual's judgment, which cannot be confirmed.

(p. 152) ... the ESRG commercial forecast ...is logically invalid and contains ad hoc design adjustments that apparently do not correspond with any supporting evidence.

(pp. 152-153) The ESRG analysis of the commercial class is based upon determining commercial floor space by type of building in each year and then applying fixed energy intensity factors to determine kilowatt-hours. These results are then adjusted to account for building design efficiencies and conservation. However, the description is somewhat misleading since ESRG assumes that employment is a fixed ratio of floor space and that kilowatt-hour consumption is also a fixed ratio of floor space.

(pp. 158-159) ...the assumption that both floor space per employee and electrical energy use per square foot are fixed parameters over the whole forecast ... is clearly contrary to fact. In the case of the employment per square foot ratio, changes in retailing practices and increasing use of capital equipment that is labor-saving have led to past declines. For example, ... retail-wholesale trade floor space grew at an average annual rate of 5.2 percent from 1965 to 1975. At the same time, employment in this category grew at an average annual rate of only 3 percent. Thus, the employment per floor space ratio is clearly not fixed; it decreases over time for some sectors, suggesting the ESRG has underestimated floor space on this basis.

But this downward bias pales in comparison with the effect of assuming that kilowatt-hour use per square foot of floor space is fixed. In fact, for the U.S. as a whole, over the period 1965 to 1975, commercial floor space grew at 3.4 percent, while commercial consumption of electricity grew at fully 7.6 percent ...

(pp. 163-164) ... ESRG's analysis is based largely upon the Brookhaven National Laboratory's BECOM Model as described in Carhart, et al., The Brookhaven Buildings Energy Conservation Optimization Model, BNL50828, January 1978. This document ... is surely one of the most frustrating reports one could ever deal with ...

> No documentation of fuel prices, availabilities or other constraints is discussed ... Selection of technologies is based upon a linear program which "minimizes cost" based upon a capital recovery factor determined by a "long-term discount rate" and equipment lifetime. Nowhere is it stated what the discount rate (or lifetime) is or how taxes are treated, if at all. There is no way, therefore, to evaluate potential penetration of new technologies indicated by the model... And, finally, the model is not described as having load forecasting applications, although it can be used to evaluate "implementation" of energy-conservation technologies (revealed, for example, through sales figures for insulation, heat pumps and so forth) and yearly totals for energy consumption in buildings.

(Consultant response: Even if ESRG had prepared a forecast for utility planning purposes, the device of selective quotation out of context would be an unprofessional way to address the question of planning forecast adequacy. In our response to pages 114 and 115 of the detailed NEPOOL comments we have already addressed the NERA role in New York state's electricity planning and siting hearings. NERA's interest was to show ESRG's forecasts too low for utility planning purposes. In introducing its detailed response to this NERA tract ESRG stated:

> *"It is straightforward to show on a point-by-point basis that NERA has not produced a single valid quantitative criticism in its Critique. The fundamental difference between ESRG and NERA, it will be seen, is that ESRG understands ESRG's forecast model but NERA does not. Informed critical feedback is fundamental to scholarly progress in any scientific discipline--espeically an emerging one such as utility system modelling. The major preconditions which the community of scientists generally insists upon of those who would engage in this dialogue is that criticism be as dispassionate as possible and be grounded in an adequate grasp of its subject matter. Unhappily, on these criteria NERA's critique of the ESRG forecast fails woefully. It is hoped that this response will neutralize the misconceptions which have now been inserted in the record."*

APPENDIX X

> *ESRG's professional track record in New York is clear. ESRG forecasts have remained stable while those of the electric utilities have dropped precipitously, toward convergence with our earliest results. A flavor for this dramatic trend may be gleaned from the testimony of Dr. Paul D. Raskin of ESRG before the Public Service Commission of New York on February 12, 1981 (Case No. 27811). There he compared changes in the load forecasts of the Long Island Lighting Company (LILCP) with the range of differences in ESRG Base Case forecasts made in 1977, 1978, and 1979. The figure making this comparison is reproduced below from Exhibit (PDR-1) of that testimony. All reference are in the public record in the case.) We have added the 1981 LILCO forecast (from the reference cited in the next paragraph) to the figure.*
>
> *Currently, the utilities in New York foresee a 16-year increase in statewide peak load amounting to a growth rate of 1.2 percent per year. (Long Range Plan 1981, Volume 1 of Report of the Member Electric Systems of the New York Power Pool and the Empire State Electric Energy Research Corporation, April 1, 1981, page 54). This growth rate is less than half that the utilities were forecasting a few years ago when E.S.R.G. produced its first statewide forecast. On a 16 year basis from 1978, the earlier E.S.R.G.-forecasted peak load increased amounted to a growth rate of 1.2 percent per year. For energy, the new Power Pool forecast amounts to 1.5 percent per year (Long Range Plan p. 70), again less than half the growth rate that was being forecasted when E.S.R.G. produced its first statewide forecast with an energy growth rate of 1.1 percent per year.*

Ernst & Whinney (E&W) reported on their evaluation of seven long range forecasts of electric energy and demand for the state of Wisconsin in July 1980 for the Wisconsin Public Service Commission. The report is entitled Review of the Forecasting Methodology of the Participants in the 1978 Advanced Plan Hearings, Exhibit (PHR-1), July 1980. Energy Systems Research Group, Inc.(ESRG) filed forecasts for both the eastern and western regions of the state. Following are some of the more important points made by E&W regarding the ESRG forecasts.

(pp. IV-29, IV-30) With respect to the statistical criteria, the model of industrial consumption is sorely lacking. Recall that regression analysis is required in order to derive a forecast of future electrical intensity. Therefore, all of the statistical criteria apply. However, no t-statistics nor F-statistics are reported. An R^2 measure is reported by SIC code .... As can be seen, fully fifteen out of nineteen regressions have R^2 values less than 0.5. In other words, there is no reason to suspect that knowledge of the independent variable will say anything about the future values of the dependent variable.

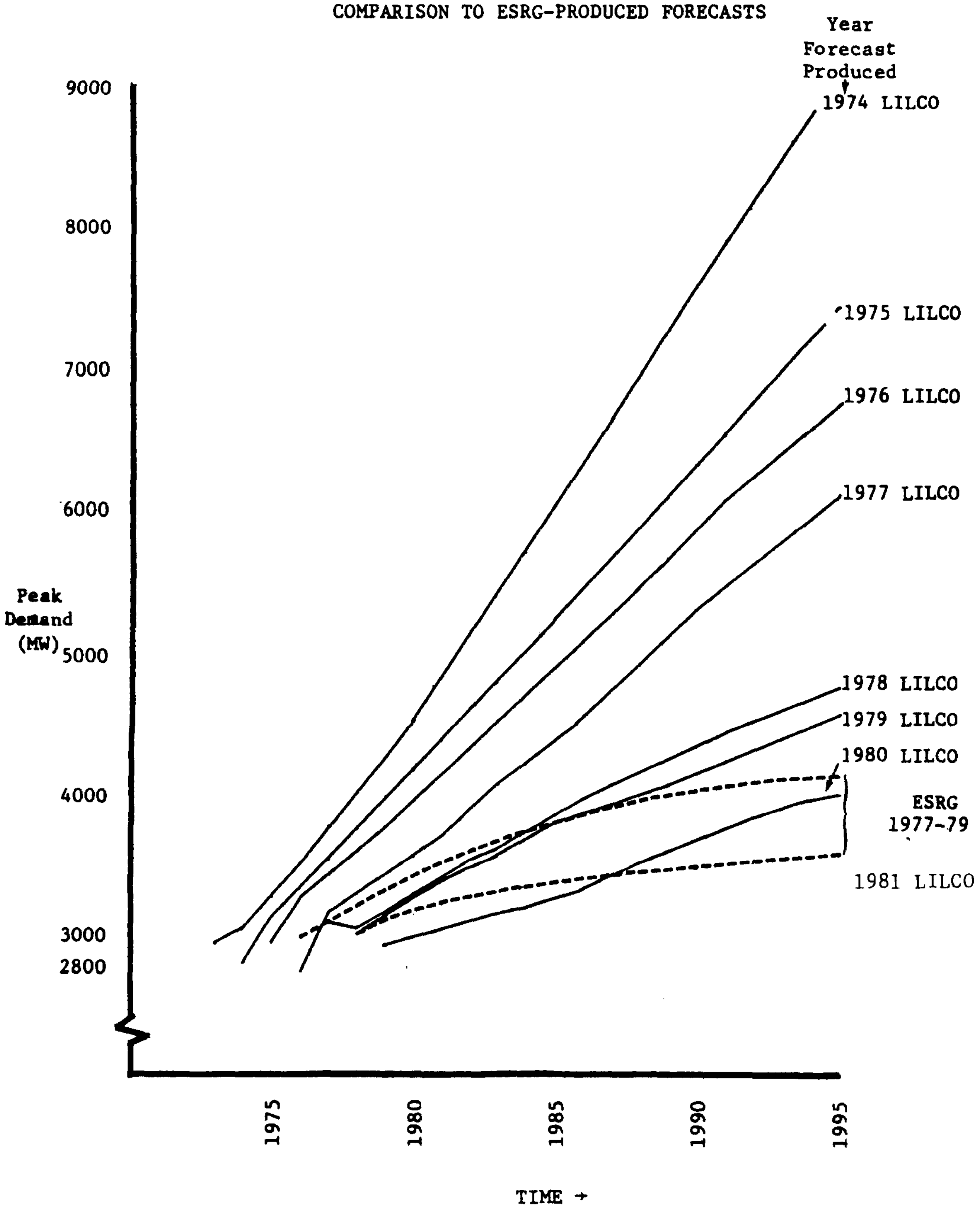
(p. II-30) It is incumbent upon any researcher involved in statistical analysis to report all of the relevant statistics so that an objective observer can decide the merit of the regressions employed. In this case, ESRG fails the documentation test. ESRG also fails the test of internal consistency by relying on poor regression equations without the usual caveats.

(p. II-33) Our review of the ESRG model indicates the possibility that the model may have some serious problems that would limit its value as a forecasting tool. With regard to statistical tests, three problems are apparent. First, since these tests were not performed, there is no indication that the models even handled historical data well. Second, and more important, when such tests indicated poor results, there was no mention made of this fact. This implies an omission of important information as it relates to the forecasting ability of the models. Third, proper documentation would require that all tests be run and results reported. This was not done.

(p. IV-34)... we do not believe that the required work has been performed that would merit acceptance of the forecasts.

APPENDIX X

CHANGES IN LILCO-PRODUCED FORECASTS 1974-80 AND COMPARISON TO ESRG-PRODUCED FORECASTS



(Consultant response: The puzzlingly unprofessional tactic of the NEPOOL commentator is continued by selective quotation from Ernst & Whinney. Contrary to NEPOOL's statement, E & W worked for the utilities in Wisconsin. The E & W comments relate entirely to the particular data, statistics, and documentation provided by ESRG in a hearing specific to Wisconsin. ESRG's forecast and response are in that record, as is E & W's later acknowledgement that "we found ESRG to be extremely cooperative and timely in responding to our request for data." (page IX-11, Review of the Forecasting Methodologies of the Participants in the 1978 Advanced Plan Hearings, July 1980). Finally, in Wisconsin the state agency included the ESRG Base Case Forecast in its final planning decision based upon available forecasts.)

Regarding long range energy growth

As the GAO report has not attempted to provide a perspective on future electric energy growth, beyond token reference to the NEPOOL forecast, a number of recent forecasts for New England are cited below:

	Annual Compound Growth Rate				
	Res.	Com.	Ind.	Total	Forecast Period
1. NEPOOL (4/1/80)	2.4	2.5	3.1	2.7	1980-1995
2. A.D. Little (2/79)	na	na	na	3.0	1978-1990
3. Oak Ridge (10/78)					
. High Prices	1.5	2.1	4.3	2.6	1974-1990
. Base Case	2.4	2.8	4.5	3.2	1974-1990
. Low Prices	3.3	3.4	4.7	3.8	1974-1990
4. Jerry Jackson (Summer 80)	na	2.9	na	na	1978-2000

Sources: (1) Load Forecasting Task Force, NEPOOL Forecast of New England Electric Energy and Peak Load 1980-1995, NEPLAN, West Springfield, MA, May 1980.

(2) Arthur D. Little, Inc., Implications of Lower Electric Power Growth Through 1990, Cambridge, MA, February 1980.

(3) W.S. Chern, R.E. Just, B.D. Holcomb, H.D. Nguyen, Regional Econometric Model for Forecasting Electricity Demand by Sector and State, ORNL/NUREG-49, Oak Ridge National Laboratory, Oak Ridge, TN, October 1978.

(4) Jerry Jackson, Peter Degenring, Robert Lann, "Regional Commercial Energy Forecasts," presented at Energy Demand Modeling Seminar, Georgia Institute of Technology, Atlanta, GA, July 8-9, 1980. While regional results were not yet available, Jackson et al. estimated that commercial electric energy growth for the U.S. 1978-2000 would decrease from 2.9% per year (base case) to 2.6% with the implimentation of strong conservation policies (e.g., BEPS, a $300 million federal grant program, a 10% tax credit on energy conservation investment).

(Consultant response: Note that peak and energy forecasts are mixed in this list. Regarding line 1, the NEPOOL growth rate was already given in the Technical Appendix at the relevant points. Line 4 is irrelevant because it is national (not regional) and regional grwoth rates vary very widely. For further perspective, note that in a report prepared for the Maine Public Utilities Commission, ESRG has forecasted an annual New England electric energy growth rate of 1.3 percent per year for the 1979-1999 period (Long-Range Forecast of Central Maine Power Company and New England Electric Energy Requirements and Peak Demands, October 1980, page 9).)

Comment re. Table 5 of Technical Appendix III

This table showing commercial sector oil use consumption 1978-2000 is clearly wrong. The magnitude of the numbers shown are bizarre (e.g., that Connecticut consumes 75% more oil than Massachusetts). This should be corrected.

(Consultant response: These figures were reviewed and corrected in the process of ESRG/GAO review after NEPOOL received its copy of Report II.)

Technical Report IV - "An Alternative Supply Strategy Scenario"

If the GAO Report Base Case Load Forecast becomes a reality for the year 2000 the approved NEPOOL planned capacity (which does not include 1400 MW of coal, 50 MW of wood and 150 MW of refuse fired units) additions is all that would be required for reliability purposes. Since the GAO report recognized less than half the MW coal conversions anticipated by the pool, it is extremely doubtful that much of the alternate resource capacity indicated in the report could be justified, if commercially available. Undoubtedly some of the refuse fueled, small hydro and coal fired generation beyond the approved NEPOOL planned capacity would be justified.

Specific points worthy of citing are:

1. The GAO does not provide adequate cost information to justify or adequately evaluate the alternate resource capacity included.

2. A generation dispatch is required to determine how much oil-fired capacity can be displaced by the alternate energy resources included.
3. There is no indication that transmission costs for alternate energy sources have been included. This can be appreciable for the 2900 MW of wind and 710 MW of tidal capacity included.
4. Cost comparisons have been made which are not in common year dollars.
5. Much of the alternate resource capacity is not dispatchable and it is doubtful that the indicated magnitude can be justified to replace oil generation. As indicated earlier, a generation dispatch is required to adequately assess this potential and insufficient detail and time has been provided to model the GAO load forecast and simulate the system for inclusion with these comments.

(<u>Consultant response:</u> The commentator addresses the supply system that we use in order to illustrate the impact of our alternative supply scenario. Included were all the nuclear plants that we knew to be tentatively planned by NEPOOL, excluding the possible Montague plant which has since been cancelled. We included the only two coal-conversions we knew to be scheduled at the time. The difficulties which it appears are likely to accompany the effort to convert additional oil-fired plants to coal, are evident. For example, in its January 1981 report to the Connecticut Department of Public Utility Control, entitled "Northeast Utilities Conservation Program for the 1980's and 1990's" NUS makes the following statement (page 67):

> *It should be noted that, because of NU's financial condition and uncertainties about environmental approvals, no provision has been made in the System's six-year capital construction program for the cost of coal conversion. While progress has been made since the end of 1979 in developing a new mechanism for paying the cost of converting the Mt. Tom station in Holyoke, Massachusetts to coal in 1982 within accepted environmental parameters, the conversion of the other seven units does not yet have the necessary regulatory, financing and environmental clearances, and therefore, cannot yet be scheduled.*

Even if we had considered additional coal-fired plants, it is likely that all of the fuel displaced by our scenario would have been oil. However, it was an initial and reasonably analytical decision to "go" with the structure of the plants that were used in this study as a basis for computing the oil savings. Transmission cost tradeoffs are outside the study scope. Cost information that underlies the alternative supply scenario is detailed in Technical Report IV and all cost comparisons are correctly made and explained there to the best of our knowledge.)

TECHNICAL REPORT V: THE EMPLOYMENT IMPACT OF ENERGY CONSERVATION

Technical Report V purports to assess the economic, specifically the employment, impacts of the conservation scenario described in Technical Reports II and III. Such an analysis is an obviously important component of the overall investigation undertaken by E.S.R.G. and naturally would be of great interest to regional planners and decision makers. The results obtained by E.S.R.G. show that slightly over 335,000 jobs would be added to the New England economy during the forecast period.

It is unfortunate that an earlier criticism must be reiterated with respect to the results displayed in Report V: without considerable time and effort devoted to computational sleuth work and bibliographic ferreting and without being informed of the magnitudes of several critical exogenous assumptions, it is very difficult to thoroughly evaluate and intelligently comment upon the procedures followed by E.S.R.G. or to concur in the reasonableness of their conclusions.

We would like to offer, however, some observations and to raise some questions concerning the discussions and findings within Report V.

In Section 1.2, the authors limit the characterization of energy/employment studies to a genre of policy analysis (the results of which, E.S.R.G. claims, generally indicate) that shifts away from capital intensive investments lead to increased employment. It is not clear which particular economic sectors are thus accurately described. Nor, is any mention made of the burgeoning body of economic literature in which the substitutability of labor and capital is a highly debated issue. (In any case, a comparison of the relative employment benefits of capital investments of varying intensities (e.g. new generation units vs. conservation materials) is not the Report's purpose. Rather, the authors intent is to show how capital investments in conservation measures increases total employment.)

It is emphasized in Section 1.3 that the study's results are conservative and, if anything, underestimate the employment benefits of the conservation scenario. The stated reasons for this low-side bias are that employment impacts will continue to occur beyond the year 2000 and that the industrial mix in New England is assumed to remain unaltered in the fact of heightened demand for "conservation" products and services. The former reason is patently fatuous and irrelevant given the discrete, finite nature of the analysis, while the latter reason implies structural changes and a reallocation of regional productive resources, the optimality of which is far from obvious. In any case, sensitivity runs examining the relative impacts of such factors receive no qualitative or quantitative treatment in the text.

The "shifted disposable income" (additional discretionary income) arising from total energy savings minus total conservation investment (Table 3) for each New England state is either overstated or calculated in a manner not deducible from the text. Estimates of costs and savings are presented by E.S.R.G. as "data" to demonstrate that the payback period for conservation investments is quite short, but too little attention is given the transcendent question, "Where will the investment funds come from?" According to E.S.R.G., the likely source of funds will be savings, reallocations of disposable income, or some form of credit. Given the volatility of interest rates, the recent low level of savings and the generally acknowledged and suffered tightness of household budgets, the availability of investment funds could easily become a far more serious obstacle than the report suggests.

In a discussion of the employment-creating "efficiency" of investment in conservation measures versus other investment alternatives, the report's authors rely upon their own assumptions and unsubstantiated estimates of regional material and labor availability factors as proof that most of the total conservation investment will be spent locally and that most of the labor required will be locally supplied and that, therefore, conservation investment is "efficient". Assumptions should be identified as such and not paraded as data (cf. Table 7, p. 14).

The labor and materials required for various conservation measures are specified in a data base engineered by E.S.R.G. Beyond noting that the input data was developed in previous studies, the authors offer no description or documentation.

A number of critical exogenous assumptions that affect final employment estimates are inadequately identified. For example, no magnitudes are provided for assumptions regarding the consumer savings rate (FWS), the fraction of "do it yourself" implementation (DOSELF), wages (W2G2), the percentage of labor which is available locally (FG2), the percentage of material inputs which are produced locally (C3G1), the employment to earnings ratio (EMPL) and the earnings to output ratio (EARN).

The pivotal component of E.S.R.G.'s employment model, the RIMS (regional industrial multiplier system) program, is essentially an input-output analysis developed by the Bureau of Economic Analysis. The procedure used in converting conservation expenditures and energy savings into employment impacts through RIMS is described briefly and opaquely. The basically static input-output approach utilized by E.S.R.G. is characterized by the assumption of fixed technology. That is, despite the significant changes likely to occur in the production functions of each industry as energy consumption is reduced, the report's results are based on a model of interindustrial flows and relationships which are fixed at a particular historic point. The employment impacts are made more uncertain by the assumption of fixed supply coefficients (distinguishing output produced for local use) which imply a rigid trade pattern among regions. This rather heroic assumption means that supply can adjust to demand instantaneously and that labor and transportation costs are constant. It is also assumed that there will be no capital availability impacts. No consideration is given to the effects of an increase of final demand on the derived demand for capital goods or to the dynamic nature of the necessary capital formation. These limitations seriously degrade the reliability of input-output projections. Even though the basic data may be fairly accurate (albeit outdated), input-output techniques are subject to large margins of errors and distortions.[1] According to E.S.R.G., input-output analyses have historically performed "at least as well or generally better than those using alternative methods". Numerous comparative studies, however, offer less sanguine conclusions regarding the bias of input-output projections.[2]

1 Oskar Morgenstern, On the Accuracy of Economic Observations, Princeton Univ. Press, 1963.

2 S. Arrow. Comparisons of Input-Output and Alternative Projections, Rand Corporation Paper P-239, 1951;
H.J. Barnett. "Specific Industry Output Projections", Long-Range Economic Projections, Princeton Univ. Press, 1954;
M. Hatanaka. Testing the Workability of Input-Output Analysis, Princeton, 1957.

(Consultant response: Underlying these comments is an explicitly articulated rejection of the input-output method that economic analysts increasingly employ and upon which the employment analysis in the GAO study is based. ESRG's input-output analysis assesses the implication of the residential conservation measures only, not the entire conservation scenario. I/O analysis is widely recognized as one of the most useful tools now available for forecasting indirect economic ramifications of investment choices. As a by no means unique example of this recognition, considered the Abstract of Roger H. Bezdek's 1974 study Empirical Tests of Input-Output Forecasts; Review and Critique for the Department of Commerce's Bureau of Economic Analysis:

> *Examines the procedures and results of sixteen major tests comparing input-output with alternative forecasting techniques conducted in the United States and in other nations in the past quarter century. Provides concise summary and analysis of these empirical tests of input-output forecasts. Finds that there are no simple alternative forecasting methods which are consistently as good as input-output.*

The reader is encouraged to consult the explanation of methodology and results contained in Report V of the Technical Appendix.

The GAO analysis builds upon ESRG and other modelling efforts that are in the public domain; to burden the already extensive explication in Report V with the entire mechanics underlying the analysis would expand its size inordinately in a research area which, while important, is secondary to our primary focus on identifying direct economic savings, i.e., energy savings.

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