PROPOSED

Comprehensive Energy Resources Plan

To be submitted

to the Governor and Legislature pursuant to 5 M.R.S.A. 5005

and published for Public Comment pursuant to 5 M.R.S.A. Chapter 375

by the Maine Office of Energy Resources

State of Maine
Executive Department
OFFICE OF ENERGY RESOURCES
State House Station 53
Augusta, Maine 04333
(207) 289-3811

Joseph E. Brennan
Governor

Gordon L. Weil
Director

December 10, 1980

To Maine People:

Pursuant to 5 M.R.S.A. 5005, I am submitting this proposed Comprehensive Energy Resources Plan for public review.

After receiving such input through public hearings and comment, this Plan will be revised and will be submitted on January 15, 1981 to the Governor and the 110th Legislature.

Because this report will not and cannot take final form until after public comment has been received, the contents of the Plan should be regarded as tentative and no projection should be regarded as final.

The purpose of public input is aimed, according to the legislation, at obtaining suggestions with regard to "a description and quantification of the availability of various energy resources for the State." However, the views of the public are requested on all aspects of the proposed Plan, including on the validity of assumptions underlying the projections.

Following the submission of the Comprehensive Energy Resources Plan to the Governor and Legislature, work will begin immediatey on the State Energy Policy with a view to the earliest possible completion of a proposed draft. There will be ample opportunity for wide public input in the preparation of the State Energy Policy, but should any wish to express their views on policy matters during the public phase of the preparation of the present Plan, their advice is most welcome.

Those wishing to participate in the public phase of this Plan may participate in hearings to be held as follows:

December 29 9:30 a.m. Bangor Hilton, Bangor

December 30 9:30 a.m. Downtown Holiday Inn, Portland

It would be appreciated if those planning to participate in the hearings would contact this office in advance. The Office of Energy Resources would be glad to receive oral or written comments prior to the hearings. The Office will also accept written comments through January 9. Please contact Jamie Firth at 289-3811 in all cases.

We firmly believe the success of this effort will be strengthened by broad public participation.

Gordon L. Weil

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I. INTRODUCTION

I. INTRODUCTION

The Maine Comprehensive Energy Resources Plan is a description of existing energy sources, existing and projected energy demands, and a characterization of existing and potential energy resources to meet our needs between now and the year 2000. This plan will allow the Governor, the Legislature, and the People of the State of Maine to work together to decide the directions of our energy future.

The energy future is crucial to our economic development. Plant expansions are delayed or cancelled and new industries are not located here, in part, because of high energy cost. In addition, our current reliance on imported oil leaves Maine's economy particularly vulnerable to periodic shocks over which we have no control. We must design energy policies to ensure a balanced growth in job opportunities and economic development. We will know more concerning the possible avenues to achieve this goal by carefully comparing the future energy demands and possible energy resource options set forth in this Plan.

Energy has a significant impact on the lives of Maine people. Energy costs are taking an increasing proportion of family incomes. Uncertain supplies, resulting from international events, can profoundly affect the ability of Maine people to provide home heating and vital transportation. Energy policies must have as a goal the stabilization of energy costs and the assurance of reliable supplies, as much as possible.

The purpose of this Plan is to provide the information needed to devise an energy strategy for Maine. In this sense, the report is descriptive, not prescriptive. There are no recommendations in this Plan to rely on particular energy resources to meet any particular amount of our energy demands. Before we decide where to go and which paths to follow, we must have a clear understanding of where we have been, where present trends could take us, and what options are available to the policy maker in correcting or affirming our course. After this Comprehensive Energy Resources Plan is reviewed by the public and submitted to the Governor and the Legislature, specific policy choices can begin to be made.

The Legislature deliberately chose this descriptive approach. During the First Regular Session of the 109th Legislature, the mandate of the Office of Energy Resources was clarified to require a two-stage process in the development of an energy plan for Maine. The first stage is a comprehensive energy <u>resources</u> plan to consist of two parts:

> 1) A description and quantification of the present supply, rates of use and energy needs of the State; a cost analysis of providing energy to meet the State's future needs; a description of the assumptions upon which the predictions and costs are based and the probability of error in the projections in the plan. These tasks shall be completed on an annual basis and submitted to the Governor and Legislature by January 15th of each year; and

> 2) A description and quantification of the availability of various energy resources for the State. This assessment shall utilize the most current available data and include all resources that can potentially help meet Maine's energy needs. This task shall be accomplished on a biennial basis and public input shall be sought through a public hearing process determined by the director in accordance with provisions of Title 5, chapter 375. After public hearings have been held, the final copy of the plan shall be submitted to the Governor and Legislature by January 15th to serve as a basis for legislative initiative;

A separate document containing the recommended Maine energy <u>policies</u> is also required:

> OER is directed to prepare a state energy policy to include the following: The direction or directions most feasible for Maine to pursue in the field of energy resource use and development, feasible alternatives to implement the state energy plan and long range as well as short range energy programs.

The policy plan, which will contain the recommended directions, for Maine's energy future, was deliberately left without a required deadline.

This two stage approach is not only required; it is preferable. It will allow a thorough public review and debate on the various alternatives described in the resources plan prior to the important decisions and recommendations which must be made in the policy plan.

Section II., "Sources and Uses of Energy In Maine: Trends, Current Status and Projections," responds, in particular, to the requirements of the first component of the Comprehensive Energy Resources Plan. In January 1980, the Office of Energy Resources submitted the first required report with regard to this component. This section projects energy use, supply and costs for a variety of sources, and uses, and dates according to two scenarios.

Section III covers conservation, which can be regarded as an energy resource.

Section IV deals with renewable energy resources. These resources are largely those available within the State of Maine.

Section V deals with more traditional energy resources on which we continue to be dependent.

These three sections respond to the requirement for a description and quantification of the availability of various energy resources.

Each energy source, other than the most traditional, is examined according to a common format, as follows:

Introduction

Current use

Resource availability

Limits and advantages

Current programs and policies

If we can agree on where we are and what our future options are, we can then proceed to the next step of deciding where we want to go and how we are going to get there. It is crucial that the widest possible public debate and input be sought prior to the adoption of future energy policies and implementing programs. To do anything other than continue our present course will require an extraordinary partnership of the private and public sectors, and call for trust and cooperation between government, businesses and private citizens.

While Maine cannot operate in a vacuum, indeed, in a time when federal and regional forces may severely limit our choices, this Plan clearly demonstrates that we can affirmatively act to affect our own destiny. The choices that will be made in designing our energy future will have a vast impact not only in the individual homeowner's method of home heating, but will determine our economic and future job opportunities as well. It is intended that this Comprehensive Energy Resources Plan will provide some of the raw materials with which these difficult choices can be made.

II. SOURCES AND USES OF ENERGY IN MAINE: TRENDS, CURRENT STATUS AND PROJECTIONS

II. SOURCES AND USES OF ENERGY IN MAINE: TRENDS, CURRENT STATUS, AND PROJECTIONS

Introduction

This section of the Plan has two purposes. The first part of the section describes historical energy supply and demand trends experienced in Maine. The second part of the section details energy demand scenarios for 1985, 1990 and 2000. The intent is to provide some basic information to help the reader understand Maine's energy use profile and to show how that profile might look in the future.

The historical data presented herein was taken from the State Energy Data Report compiled by the U.S. Department of Energy.

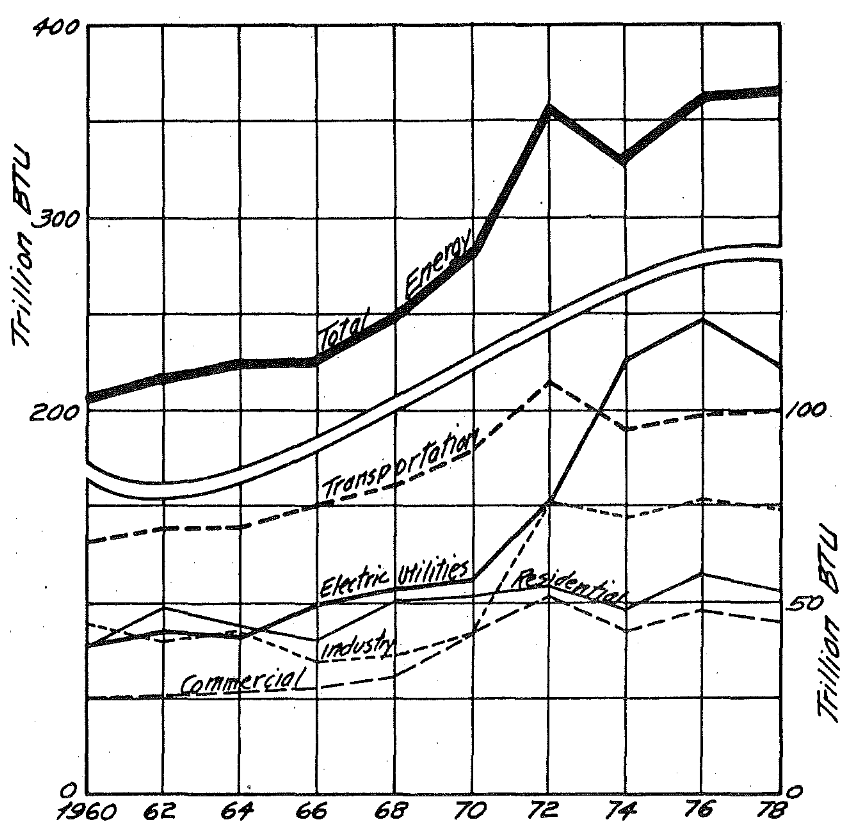
A. Trends

An examination of historical trends in energy consumption in Maine reveals a number of significant developments.

Figure 1 illustrates these trends in the various energy using sectors in Maine:

Figure 1

CONSUMPTION OF ENERGY IN MAINE BY END USE SECTOR
1960 - 1978



Source Figure 1: U.S. Department of Energy State Energy Data Report April 1980. It should be noted that the values indicated here differ substantially from the more detailed data derived from state sources and presented in Tables 1 and 2 and Figure 5 and 6, particularly in the electric utilities sector. Nevertheless, this graph does present a relatively accurate picture of the trends in energy use in Maine.

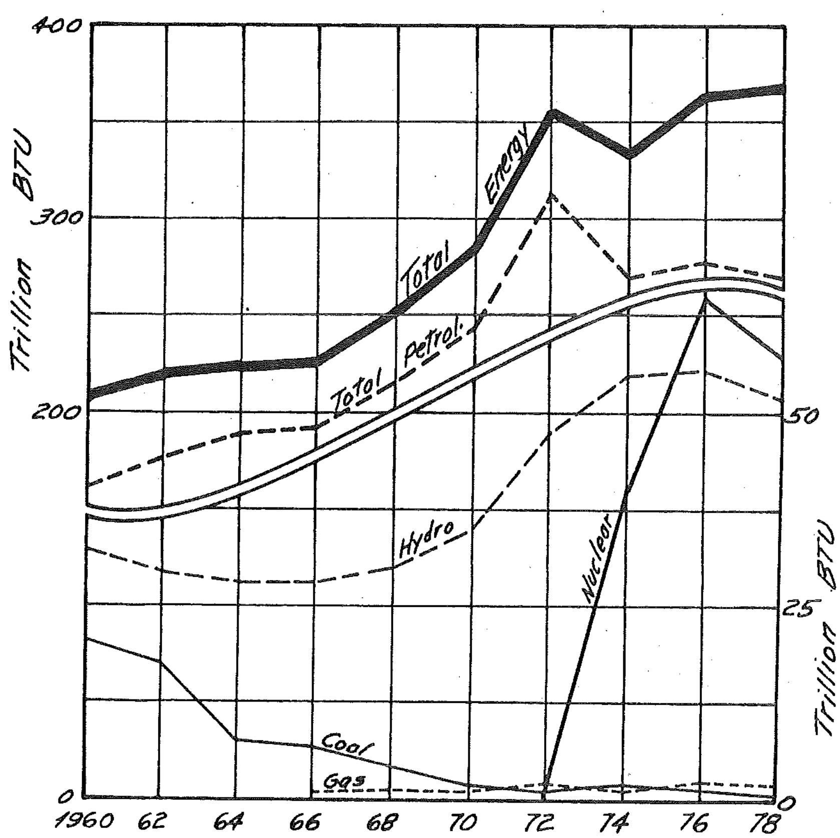
Apart from a brief aberration during the embargo period, total energy consumption between 1960 and 1978 increased at an average rate of just over 3% per year.

The most significant growth sectors were the industrial sector in the early 1970's and the electrical generation sector between 1970 and 1976. These trends reflect the major expansions made in many of the State's pulp and paper mills and the start up, in 1972, of the Maine Yankee nuclear powered electricity generation plant.

Residential, commercial, and transportation energy use in Maine has leveled off during this decade in Maine.

Figure 2 presents an historical picture of the various sources of energy between 1970 and 1978.

Figure 2
CONSUMPTION OF ENERGY IN MAINE BY FUEL TYPE
1960 - 1978



Source Figure 2: See note for Figure 1.

The decade of the 1960's saw significant growth in the utilization of petroleum and a simultaneous reduction in the use of coal during this period. Natural gas was also introduced into Maine in this period, but its contribution to the State's overall energy mix has not become significant.

Although the 1970's have seen a leveling off in the use of petroleum and the addition of nuclear power to the State's energy mix, Maine is still dangerously dependent upon petroleum for most energy needs.

The three consumption areas where Maine is most dependent upon petroleum, and where the greatest gains are to be made in any program to reduce that dependence, are in middle distillate fuels for residential space heating, gasoline and other petroleum products for transportation, and heavy residual fuel oil for industrial uses and electrical generation.

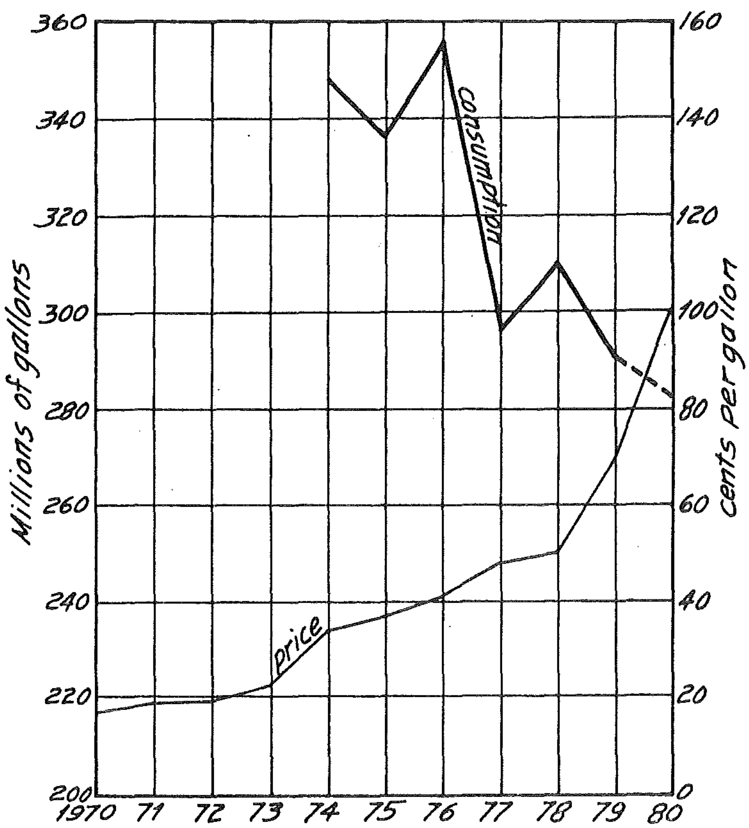
The State of Maine has already made major studies in the area of petroleum consumption.

Figures 3 and 4 analyze the most recent trends in heating oil and gasoline consumption.

Since 1976 Maine has experienced a 20% decline in the consumption of home heating oil while, during the same period, the price of heating oil has more than doubled (from 40¢/gallon to more than $1.00/gallon).

Figure 3

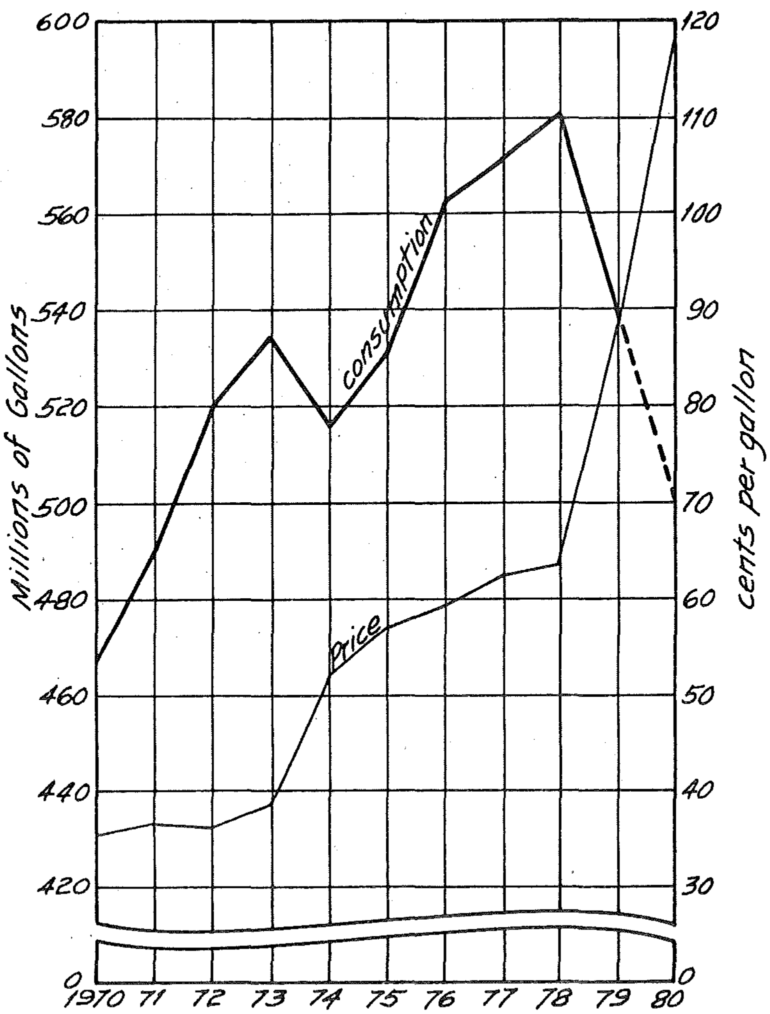
MAINE #2 HEATING OIL CONSUMPTION AND PRICE
1970 - 1980



Source: Maine Office of Energy Resources

Figure 4

MAINE GASOLINE CONSUMPTION AND PRICE
(State Tax Data)
1970 - 1980



Source: Maine Office of Energy Resources

The downturn in gasoline demand did not occur until 2 years after the turnaround in the demand for home heating oil. However, gasoline consumption has decreased by some 14% since 1978, while the price has increased by 90% during this period.

B. Current Status

Maine's energy supply and demand patterns can be put into perspective with the national pattern by comparing the pie charts in Figure 5. These charts show that the residential and commercial sectors consume relatively more energy in Maine than they do nationally, while the industrial sector consumes less energy in Maine than it does nationally. Overall, the pattern of consumption in Maine is quite similar to that of the United States.

On the supply side, Maine is much more dependent on oil and nuclear energy than is the country as a whole, and uses considerably less natural gas and coal. On the other hand, Maine has a much larger component of wood and hydro energy use than does the country as a whole.

Petroleum supplied 65.6% of the total energy consumed in Maine in 1978. However, because out-of-State utilities own a large fraction of the Maine Yankee Atomic Power Plant and smaller fractions of other electric generation facilities in Maine, the actual amount of energy supplied to the end use sectors in the state accounts for only 95.5% of the total energy consumption. Thus, consumers in Maine are actually dependent on petroleum products for 68.7% of the total energy they use.

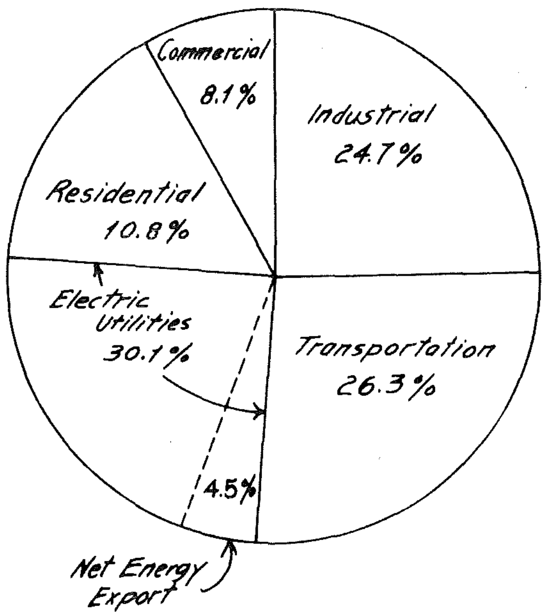
According to studies made of the oil supplied to New England, over 30% of the petroleum coming into the region is imported. Thus, Maine consumers are dependent on foreign oil for at least 55% of their total energy supply.

Table 1 illustrates the breakdown of the energy supply by fuel type. Table 2 shows energy supply by consuming sector. In both cases, the overwhelming dependence on petroleum in each sector is evident.

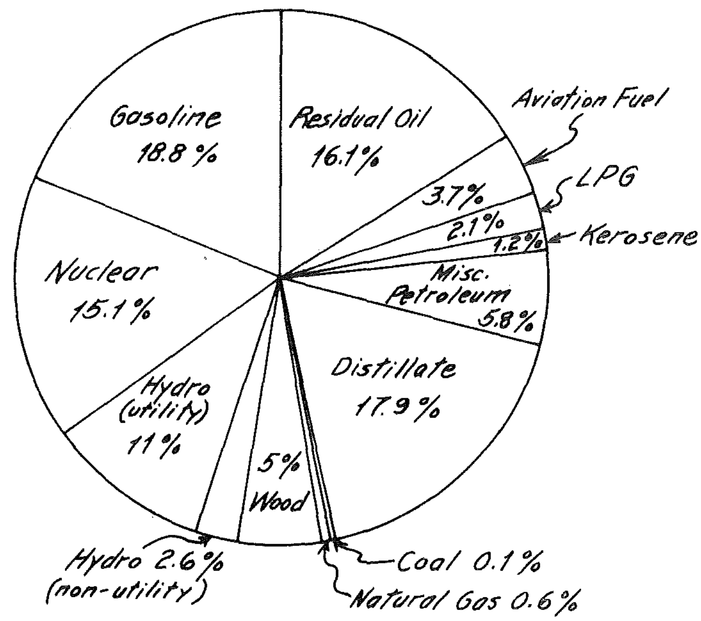
At a current average price of $30 per barrel, this level of dependence on foreign oil represents a drain on Maine's economy of more than $1 billion annually in the outflow of petroleum dollars, and contributes to the Federal balance-of-payments problem. As a result, current state policies are designed to: 1) reduce maine's dangerous overdependence on undependable and expensive foreign petroleum supplies and 2) mitigate the adverse effects on Miane's economy that are due to rapidly escalating petroleum prices.

FIGURE 5

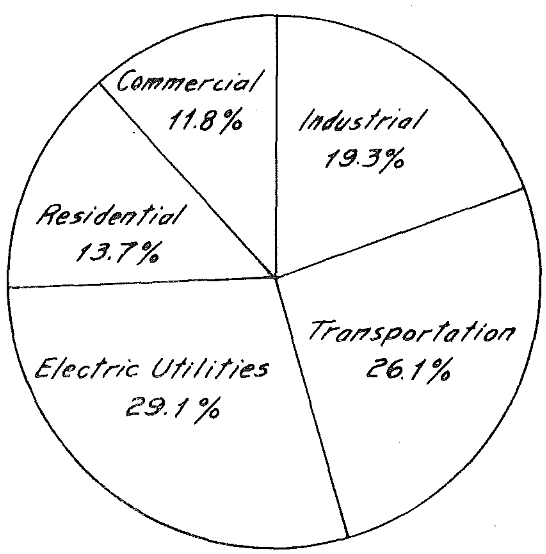
CONSUMPTION OF ENERGY BY SECTOR
MAINE 1978



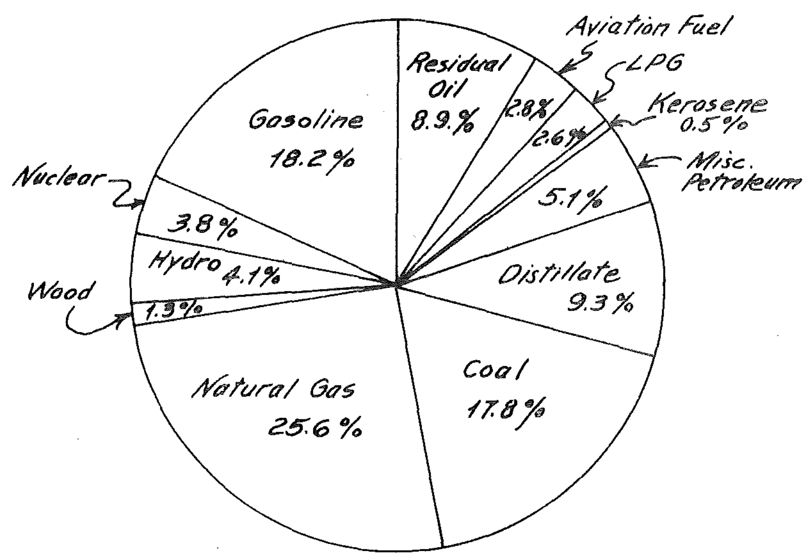
CONSUMPTION OF ENERGY BY FUEL TYPE
MAINE 1978



CONSUMPTION OF ENERGY BY SECTOR
US 1978



CONSUMPTION OF ENERGY BY FUEL TYPE
US 1978



DATA SOURCE: State Energy Data Report
U.S. Department of Energy

TABLE 1

Energy Supply by Fuel Type

	MAINE		NATIONAL	
	Trillion BTU	Percent	Trillion BTU	Percent
Gasoline	71.788	18.8	14210.988	18.2
Residual[1]	61.766	16.1	6936.026	8.9
Utility	(11.141)	(2.9)		
Non-Utility	(50.625)	(13.2)		
Distillate[1]	68.648	17.9	7296.139	9.3
Aviation Fuel	14.254	3.7	2230.039	2.8
LPG	8.111	2.1	2068.288	2.6
Kerosene	4.474	1.2	363.118	0.5
Misc. Petroleum	22.038	5.8	4860.697	5.1
Coal	0.498	0.1	13943.887	17.8
Natural Gas	2.149	0.6	19998.907	25.6
Wood[2]	19.25	5.0	1003.527[3]	1.3
Hydro	52.045	13.6	3173.000	4.1
Utility	(9.941)	(2.6)		
Non-Utility	(42.103)	(11.0)		
Nuclear	57.661	15.1	2976.585	3.8
TOTAL	382.727	100%	79259.294[3]	100%

[1]Residual and distaillate consumption figures have been adjusted for wood usage.

[2]Wood data was taken from Maine Fuelwood Survey and estimates of industrial fuelwood use made by Dartmouth College

[3]Includes approximately 1 quadrillion BTU's of wood used in industry nationally.

TABLE 2

Energy Demand by Consuming Sector

	MAINE		UNITED STATES	
	Trillion BTU	Percent	Trillion BTU	Percent
Rresidential	41.3	10.8	10858.1	13.7
Commercial	31.0	8.1	9352.2	11.8
Industrial	94.5	24.7	15296.5	19.3
Transportation	100.7	26.3	20685.9	26.1
Electric Utilities	115.2	30.1	23063.6	29.1
TOTAL	382.7	100.0	79256.3	100.0

The charts shown in Figure 6 give a graphical representation of the energy supply and demand picture in Maine in 1978. As shown in the figure, the overall consumption of energy in Maine was 382.7 trillion BTU's of which 373.1 trillion BTU's were consumed to provide energy for Maine's ultimate end-users.

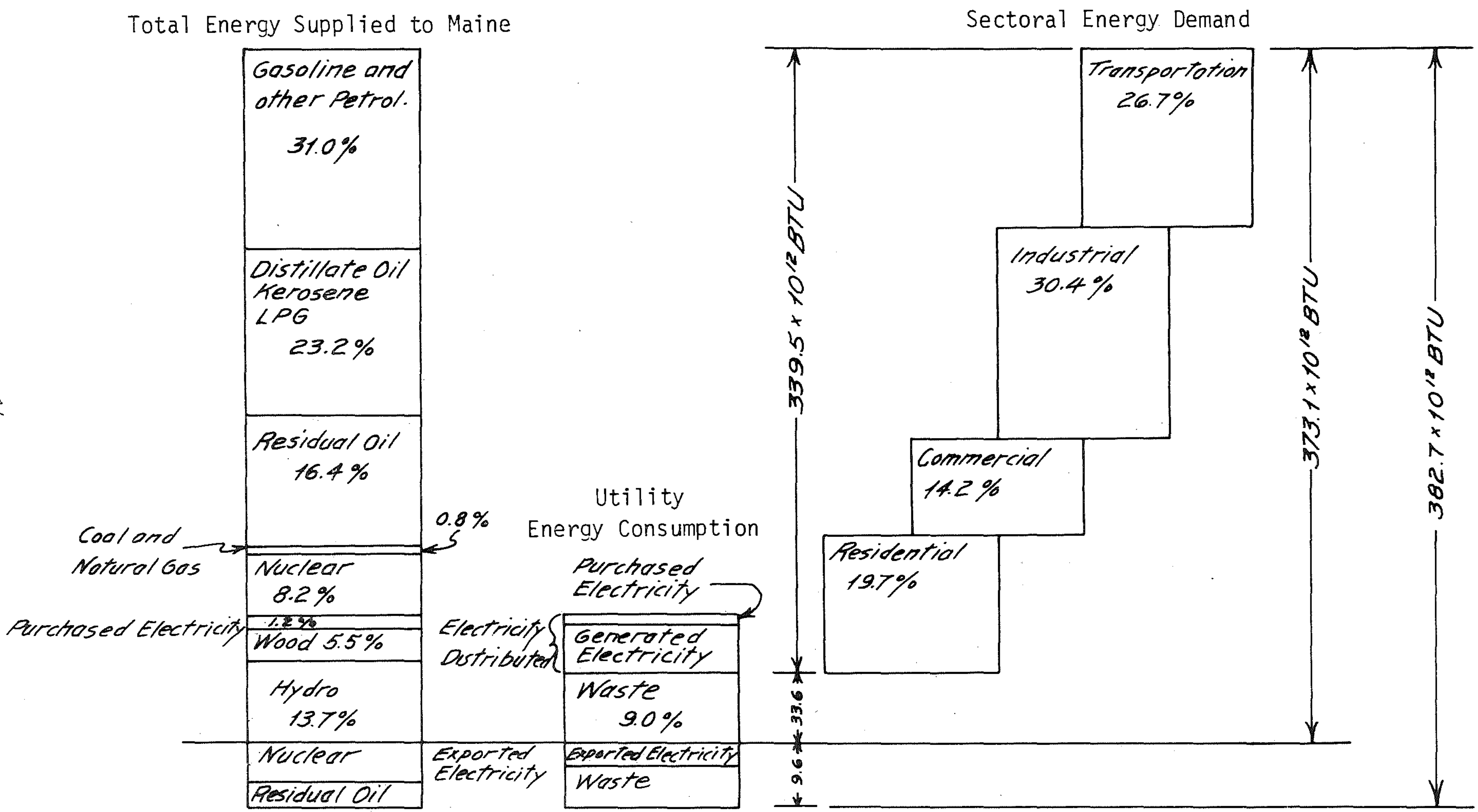
The left most bar-chart on the figure shows the sources of energy used in Maine. The portion of the chart above the base-line indicates the energy which was ultimately delivered to Maine consumers. That portion appearing below the line represents energy consumed in Maine to allow export of electricity from the State. All percentages shown on this chart are based on the energy delivered to Maine Consumers.

The center bar-chart represents electric conversion. Of the energy supplied to Maine's electric utilities, a portion is distributed to ultimate consumers and a portion is "wasted" to the environment. Again, the percentage shown in the "waste" segment is based on the total energy delivered to Maine consumers.

The final "stair-like" bar-chart represents the amount of energy consumed by each end-use sector. The percentage figures shown in this chart differs from those presented in Table 2 because the electrical energy supplied to each end-use sector has been allotted to that sector. Thus, the only actual energy use allocated to the utilities is the portion of energy input to those utilities which is lost through generation and transmission inefficiencies. This chart gives a more realistic picture of the actual distribution of energy in the State.

FIGURE 6

1978 ENERGY SCENARIO



NOTE: Percentages are based on total In-State Energy use not including exports.

C. Projections

The decisions that will determine Maine's energy future might well be divided into three types - individual decisions, policy decisions, and external decisions. Every day hundreds of Maine citizens make individual energy use decisions for their homes and businesses: whether or not to buy a new car which is more fuel efficient, whether or not to insulate their homes, whether or not to install more energy efficient equipment in their factories. These are the individual decisions. By and large they are made within an environment of fuel availability, price levels, personal incomes, and administrative regulations which are beyond their control. At the same time, although less frequently, the State's voters and government and the major energy producing businesses make energy use decisions with broad public consequences: whether or not to shut down Maine Yankee, whether or not to build the Sears Island plant, whether or not to subsidize home weatherization, whether or not to mandate energy efficiency standards for buildings. These are the policy decisions. They are, by and large, decisions that can be made at the State level. Since these decisions affect the context within which individual decisions are made, they will substantially alter Maine's ultimate energy future. Finally, there are decisions and events that are largely beyond the State's control. Whether or not oil flows from the Mideast are interrupted by war, whether or not major new gas or oil reserves are discovered, whether or not Congress decontrols energy prices. These are the external decisions. They clearly affect the context within which other energy use decisions are made and thus the ultimate character of Maine's energy future.

Given the uncertainty surrounding this hierarchy of energy use decisions and the interrelationships among them, an attempt to calculate a single forecast for energy demand is impossible. The purpose of projection is to improve decision making, to describe the alternate futures that are possible, to list the actions that will likely be required to realize each and to explain the implications of taking any particular course of action. This section attempts to do this by presenting high and low energy demand forecasts for each of the State's end use sectors and by explaining the events and actions that determine these alternate forecasts. The low demand projection is a "best case" projection from the viewpoint of energy consumption: it reflects a low level of economic activity and a high degree of conservation. The high demand projection is a "worst case" projection from the viewpoint of energy consumption: it reflects a high level of economic activity and a low degree of conservation. It is expected that actual demand would certainly fall within these limits. The ultimate purpose of this section is to create a context within which the resource use decision described in the following section can be made.

1. The Residential Sector

Energy consumption in the residential sector depends on the number of households, the thermal efficiency of the housing units in which the households reside, and the number and electrical efficiency of lights and appliances used in each household. Future energy demand in the residential sector thus depends on a wide variety of decisions that will affect these three basic items. To provide a range of values within which future residential energy demand is likely to occur, high and low forecasts were made.

The residential projections were made using the 1978 residential energy use and housing data as a point of departure. Baseline enrgy consumption for each household was computed by dividing the total energy use (73.5 trillion BTU's) by the number of households (370,000) to give an average consumption of 198.65 million BTU'sper residential unit.

Studies show that energy use in the residential sector breaks down as follows:

75% Space Conditioning
15% Water Heating
10% Lighting, cooking, appliance.

Applying these percentages to the overall residential consumption yeilds the following averages:

148.99 million BTU's for Space Conditioning
29.80 million BTU's for Water Heating
19.86 million BTU's for Lighting, etc.

It should be noted that many homeowners in Maine already have taken some steps to conserve energy. To compute the potential energy demand for 1985, 1990 and 2000, assumptions were made as to the present level of weatherization in existing residential units. These are shown below for 1978:

Level	Percentage	# of Households
0	37%	136,900
1	33%	122,100
2	20%	74,000
3	10%	37,000
		370,000

These figures were used to develop energy conservation estimates for various conservation measures with regard to space conditioning. These are summarized on the next page.

	Energy Saving	Consumption
0. No improvements	0%	171.25 million BTU's
1. Heating System maintenance, caulking and weatherstripping, storm windows and doors	13%	148.99 million BTU's
2. Level 1 plus ceiling insulation to R-38	23%	131. 86 million BTU's
3. Maximum conservation levels including Level 2 plus wall and floor and/or foundation perimeter	41%	101.04 million BTU's

In other words, we have assumed that the average household has achieved level 1. conservation.

The conservation levels for new housing would be somewhat different from those for existing housing, provided above. We assume that all new housing will meet the Maine Energy Conservation Building Standards which allow a maximum heat loss of 38,000 BTU per square foot of floor area. If, in addition to meeting the standard, these houses are properly designed and sited to take advantage of passive solar energy, the space heating energy consumption can be reduced even further. These two levels are represented as follows:

1. Meets building standards	52.80 million BTU's
2. Level 1 plus passive solar	42.30 million BTU's

Using these two base line facts, two alternative demand projections were calculated. A low demand forecast was calculated based on assumption of low household growth and extensive adoption of energy saving conservation methods. This scenario assumes that major public action is taken to induce residential conservation investments (e.g. low interest loans for weatherization, large scale publicly financed weatherization, major educational and educational efforts. The second demand forecast - the high growth scenario - is based on the assumption that population grows more rapidly and that population grows more rapidly and that conservation investments are made purely through private decisions - the marketplace with no major public intervention.

The results of these two scenarios are derived by assuming that a larger share of existing and new residential units are built or retrofitted to a lower energy demand level in the low growth scenario than in the high growth scenario. These alternate distributions are summarized below.

In sum, the high growth scenarios assumes rapid population growth and relatively slow adoption of residential energy conservation improvements. The low growth scenario assumes slower population growth and more rapid adoption of conservation improvements. Table 3 presents the results of these scenarios. Alternate assumptions can be made and the resultant energy demand easily calculated.

Residential Space Heat
Forecast Consumptions

A. Household Growth

	Low Growth	High Growth
1985	407,000	423,000
1990	436,000	461,000
2000	494,000	527,000

B. Distribution of Housing Units by Level of Conservation

		Low Growth		High Growth	
	Level	Existing	New	Existing	New
1985	0	15%	0%	20%	0%
	1	40%	90%	50%	90%
	2	40%	10%	30%	10%
	3	5%		0%	
1990	0	0	0	18%	0
	1	30%	90%	40%	90%
	2	60%	10%	35%	10%
	3	10%		7%	
2000	0	0	0	0	0
	1	0	85%	30%	75%
	2	75%	15%	60%	25%
	3	25%		10%	

Finally, alternate scenarios for the extent of use and energy efficiency of residential lights and appliances was taken from a study prepared for the Maine PUC*

*Energy Systems Research Group, Inc. Long Range Forecast of Central Maine Power Company and New England Electric Energy Requirements and Peak Demands, October 1980.

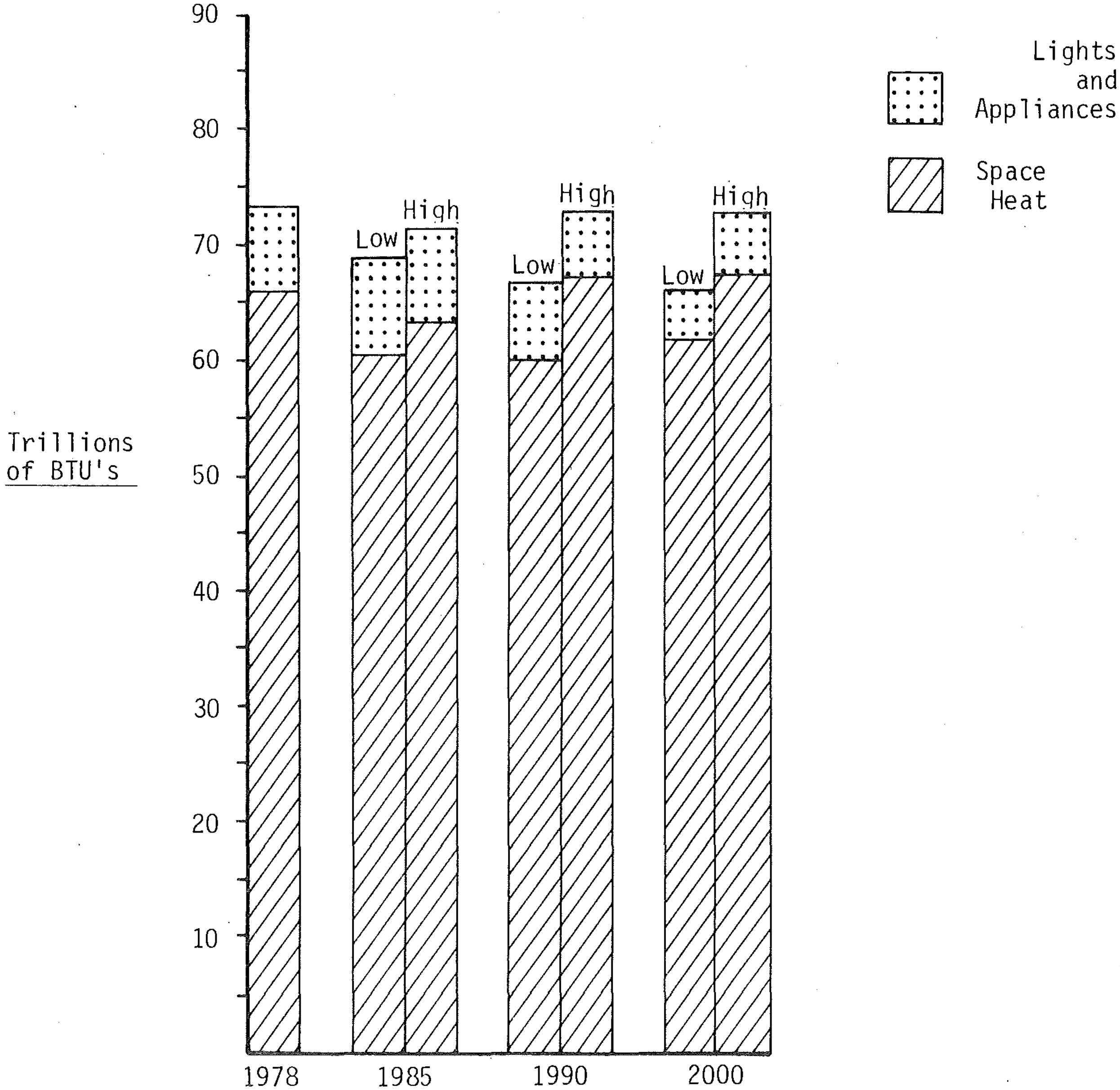
TABLE 3

RESIDENTIAL ENERGY CONSUMPTION TRILLION BTU'S

Actual 1978		
Space Heat	55.1	
Lights & Appliances	18.4	
Total	73.5	
Projected 1985	Low	High
Space Heat	54.8	57.6
Lights & Appliances	13.0	14.4
Total	67.8	72.0
1990		
Space Heat	53.0	57.9
Lights & Appliances	13.2	14.4
Total	66.2	72.3
2000		
Space Heat	52.3	57.4
Lights & Appliances	13.1	14.4
Total	65.4	71.8

FIGURE 7

Projections of Residential Energy Consumption 1978 - 2000



2. The Commercial Sector

Energy consumption in the commercial sector, as in the residential sector, serves primarily to provide space heat to run lighting and appliances. In addition, about 8% of the energy consumed in the commercial sector is diesel fuel used to power heavy equipment, mostly in the construction industry. Future energy demand in this sector will depend primarily on the growth of commercial activity in the State, on the thermal efficiency of commercial buildings, and on the electrical efficiency of the lights and appliances used in commercial establishments. Alternative energy demand forecasts, therefore, are built upon alternative forecasts of commercial employment growth and alternative estimates of the proportion of commercial establishments which adopt various energy saving technologies between now and the year 2000.

Again, the point of departure for the forecast was to take total commercial space heat use in 1978 (all petroleum except diesel fuel, all gas and wood plus 4% of electricity from Table 1) and divide by the total number of square feet of commercial buildings 9taken from the ESRG study). This calculation yielded an average annual space heating demand of 500,000 BTU's per commercial square foot.

This figure was used as the base from which the effects of various levels of conservation improvements could e calculated. These improvements and their likely effects were taken from research done by the Brookhaven National Laboratory as reported in the ESRG study. They are summarized below.

Energy Savings for Various Levels of Conservation

Conservation Level	Existing Buildings	Annual Space Heat Demand, thousand BTU's per Sq. Ft.	New Buildings	Annual Space Heat Demand, thousand BTU's per Sq. Ft.
0	0% Savings	500	0% Savings	500
1	10% Savings	450	30% Savings	350
2	17% Savings	415	35% Savings	325
3	20% Savings	400	50% Savings	250

Level one consists of building and appliance improvements which require minimal engineering expertise and provide quick paybacks (insulation, reduced lighting). level two improvements are level one improvements plus installation of existing technologies that require some building modification (temperature controls, heat saving devices). Level three improvements are level one and two improvements plus capital intensive modification that require considerable engineering expertise (building automation, waste heat reclamation).

Using this assumed baseline level of demand and savings potential, two alternate demand projections were calculated. The low demand forecast was based on an assumed employment growth in the commercial sector of 1.5% per year, a constant ratio of square footage per employee (300 sq. ft./employee) and a relatively high level of conservation investment (reflecting a policy of intense education, low interest, conservation loans and strong building efficiency standards). The high demand forecast was based on an assumed employment growth of 3.0% per year, the same 300 sq. ft. per commercial sector employee ratio and a much lower level of conservation investment (reflecting purely individual price induced actions). The high and low conservation investment and employment scenarios are derived from the ESRG study, from which the following data is also drawn.

Share of Commercial Square Footage at Each Conservation Level

	Low Growth				High Growth			
Year	Conservation Level				Conservation Level			
Levels	1	2	3	4	1	2	3	4
a. Existing Square Footage								
1985	60%	10%	20%	10%	80%	5%	10%	5%
1990	51%	12%	22%	15%	74%	7%	12%	7%
2000	35%	15%	25%	25%	60%	12%	16%	12%
b. New Square Footage								
1985	20%	20%	40%	20%	20%	20%	40%	20%
1990	14%	18%	38%	30%	14%	18%	38%	30%
2000	12%	15%	35%	40%	10%	15%	35%	40%

Table 4 presents the alternative energy demands derived from the baseline data and forecast assumptions presented above. By the year 2000, total energy demand inthe commercial sector could vary by as much as 20 trillion BTU's, an amount equivalent to about 3.3 billion barrels of oil, or to about one and one half times the entire amount of energy now generated from hydro power sources in Maine.

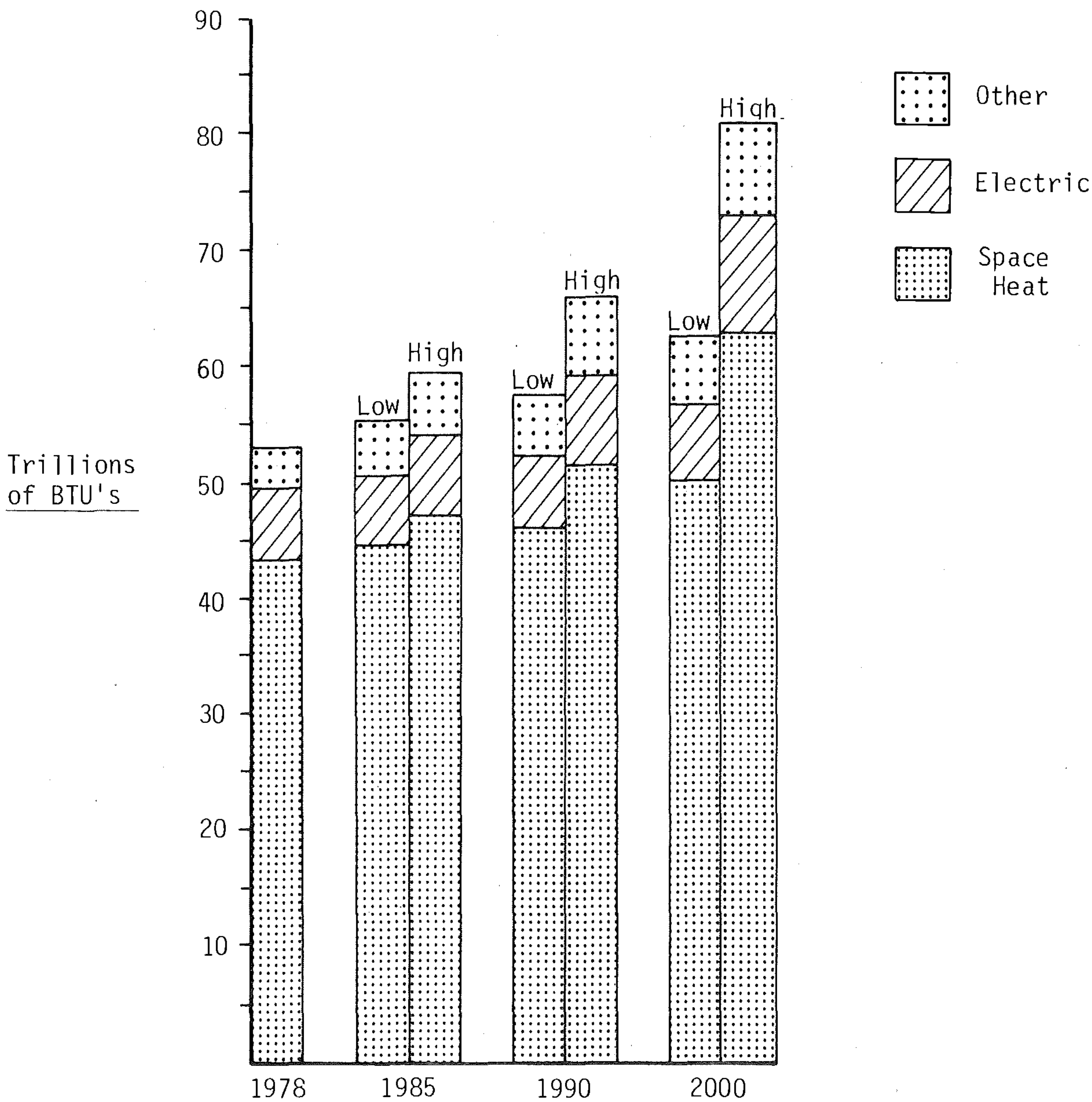
TABLE 4

Commercial Energy Use Trillions BTU's

1978 (Actual)			
Space Heat		43.1	
Light and Appliances		5.3	
Other (Mostly diesel)		4.4	
	Total	52.8	
1985 (Projected)		Low	High
Space Heat		44.3	48.2
Lights and Appliances		5.8	6.8
Other (Mostly diesel)		4.9	5.4
	Total	55.0	60.4
1990 (Projected)		Low	High
Space Heat		45.9	53.0
Lights and Appliances		5.9	7.8
Other (Mostly diesel)		5.3	6.3
	Total	57.1	67.1
2000 (Projected)		Low	High
Space heat		50.0	64.6
Lights and Appliances		6.3	10.3
Other (Mostly diesel)		6.0	8.1
	Total	62.3	83.0

FIGURE 8

Projections of
Commercial Energy Consumption
1978 - 2000



3. The Industrial Sector

Energy in the industrial sector is used to power machinery to provide space and process heat. Future industrial energy demand, therefore, depends on growth in industrial activity and increases in the energy efficiency of industrial processes. In addition, the industrial sector has the capacity to generate much of its own energy through utilization of hydropower, burning of waste materials, and reclamation of lost heat. High and low forecasts of industrial energy demand result from different assumptions about these basic determinants of demand.

As with the other sectors, the point of departure for the industrial sector is to divide total 1978 energy use by total 1978 employment. The resultant ratio - 800 million BTU's per employer - is used as the basis for both the low and high growth forecasts. The low growth forecast assumes industrial employment growth of 1.5% per year and improvements in energy efficiency per employee of 5% by 1985, 10% by 1990 and 20% by 2000. The high growth forecast assumes 3.0% per year employment growth and efficiency improvements of 0% by 1985, 5% by 1990 an 10% by 2000. The estimate of industrial employment growth are derived from the ESRG study for the MPUC. Energy efficiency per employee has been estimated by OER and the State Planning Office.

The low growth scenario also includes larger amounts of self-generated electricity on the assumption that self-generation is essentially a conservation action taken only because continued purchase of commercial electricity is more expensive. Table 5 summarizes the alternate industral scenarios.

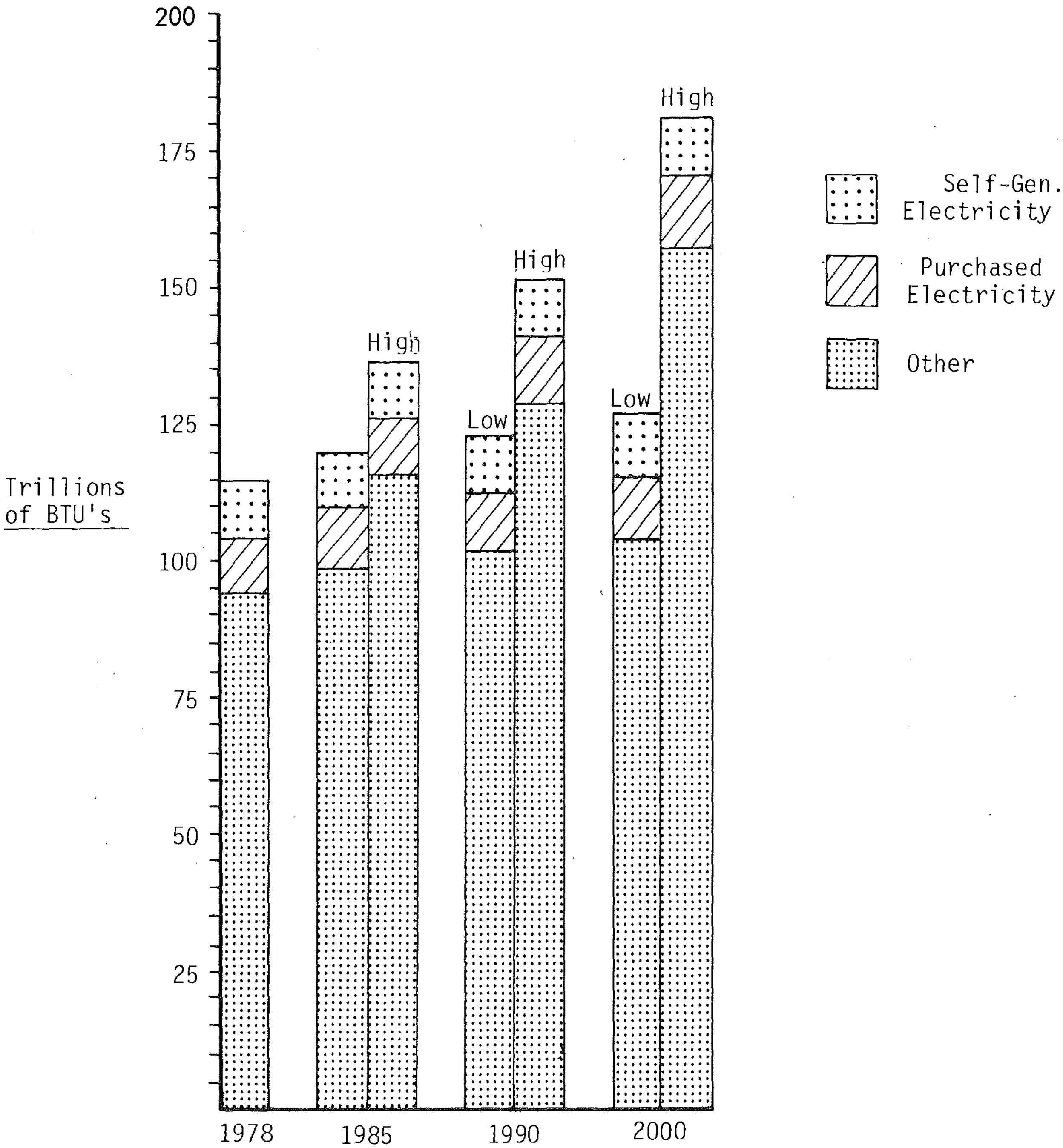
TABLE 5

Industrial Energy Use, Trillion BTU's

	Low	High
1978 (Actual)		
Electricity		
Self Generated	9.9	
Purchased	9.6	
Other	94.1	
Total	113.6	
1985 (Projected)	Low	High
Electricity		
Self Generated	10.9	10.4
Purchased	10.3	11.1
Other	99.2	115.5
Total	120.4	137.0
1990 (Projected)		
Electricity		
Self Generated	11.4	10.9
Purchased	10.6	12.2
Other	101.1	127.7
Total	123.1	150.8
2000 (Projected)		
Electricity		
Self Generated	12.0	11.4
Purchased	11.0	12.3
Other	103.8	157.3
Total	126.8	181.0

FIGURE 9

Projections of
Industrial Energy Consumption
1978 - 2000



4. The Transportation Sector

All energy used in the transportation sector in Maine is derived from petroleum, primarily gasoline and diesel fuels. These are used for all land-based transportation, including cars, trucks, buses, and trains. Some residual oil is used for shipping, and the aviation sector utilizes both kerosene jet fuel and aviation gasoline, particularly Bangor International Airport which serves overseas flights.

In this forecast, the major determinants of change in transportation demand are considered to be in land-based transportation. Four major factors are assumed to affect transportation demand:

1. The number of vehicles in the State.

2. The number of miles driven.

3. The fuel efficiency of the vehicles.

4. Transportation Conservation Programs.

Two scenarios for transportation demand are presented. The assumptions underlying these forecasts are as follows:

Common Assumptions to Both Forecasts

1. Linear projections based upon historical Maine data will be adequate to predict the number of registered vehicles, their average mileage per gallons, and fuel consumption.

2. Average mileage figures are based upon Maine vehicle registration data, fuel economy levels as measured by the Environmental Protection Agency, and statistics from the Regional Transportation Data book. Truck mileage per gallon is assumed to increase at the same rate as automobile mileage.

3. The number of vehicle miles travelled per vehicle will be constant (10,728).

4. Out-of-state tourists will use 10% of the state's gasoline consumption each year.

5. Diesel fuel demand will increase at a rate based upon historical consumption patterns.

6. Aviation fuel demand will be restrained by high prices and lack of availability and will level out at 40,000,000 gallons per year.

BASELINE FIGURES

Gasoline Consumption Without Conservation Programs

1985	Gallons	BTU's (in trillions)
Gasoline	531,194,640	66.399
Diesel	75,224,216	10.080
Aviation Fuel	40,000,000	5.000
Total	646,418,856	81.479

1990	Gallons	BTU's (in trillions)
Gasoline	502,730,290	62.841
Diesel	90,889,502	12.179
Aviation Fuel	40,000,000	5.000
Total	633,619,792	80.020

2000	Gallons	BTU's (in trillions)
Gasoline	404,861,070	50.608
Diesel	122,220,073	16.377
Aviation Fuel	40,000,000	5.000
Total	527,081,143	71.985

TABLE 6

HIGH SCENARIO

Assumption

1980 savings from carpools and vanpools will remain constant

Savings	Gallons	BTU's (in trillions)
1980	73,641	.0092

Consumption Figures

	Gallons	BTU's (in trillions)
1985	646,345,215	81.4702
1990	633,546,151	80.0113
2000	527,007,502	71.9759

LOW SCENARIO

1. Vanpools will increase at the rate of 200/year.
2. Carpools will increase at the rate of 1350/year.

Savings	Gallons	BTU's (in trillions)
1985	12,981,000	1.6226
1990	25,961,000	3.2451
2000	51,922,000	6.4903

Consumption figures

	Gallons	BTU's (in trillions)
1985	633,437,856	79.8568
1990	607,658,792	76.7754
2000	475,159,143	65.4948

AVERAGE MILES PER GALLON

Maine Vehicles

	Automobile	Truck
1975	13.61	11.83
1976	13.84	11.83
1977	14.44	11.83
1978	15.06	11.83
1979	15.85	11.83

PROJECTIONS

	Automobile	Truck
1980	16.34	13.97
1985	19.85	16.97
1990	24.11	20.61
2000	35.58	30.41

Based upon Maine vehicle registration data, industry fuel economy levels as measured by EPA, and the Regional Transportation Data Book.

VEHICLE REGISTRATION IN MAINE BY TYPE 1970 - 1979

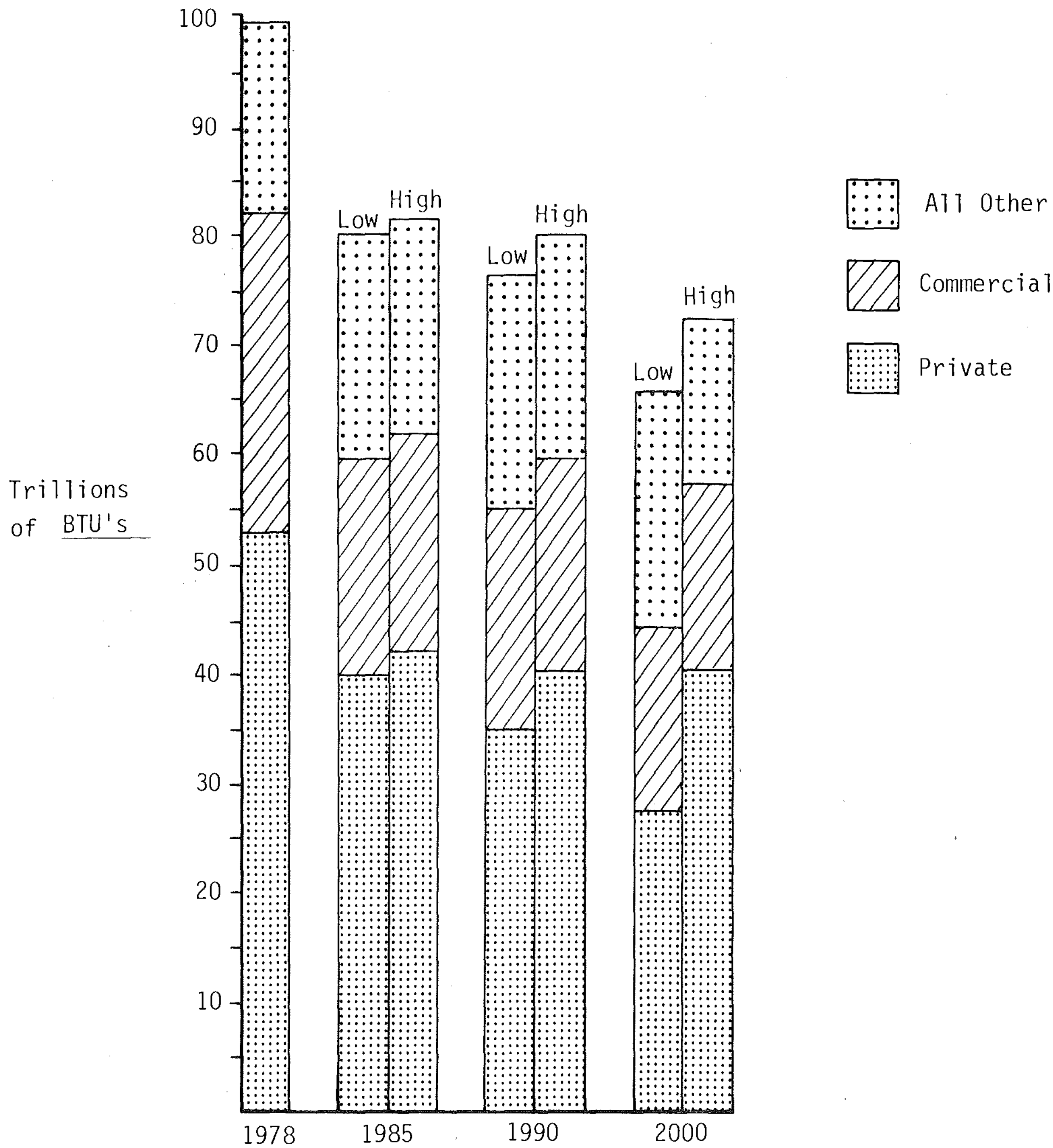
	Total Automobiles	Total Trucks	Higher Mileage Automobiles
1970	374,795	101,881	36,003
1971	388,612	109,811	42,307
1972	406,272	120,015	49,371
1973	421,400	131,719	57,196
1974	428,559	141,443	64,233
1975	440,826	149,895	71,836
1976	466,524	152,209	78,541
1977	492,594	164,866	89,861
1978	494,417	188,378	88,565
1979	496,374	192,831	96,404

PROJECTED VEHICLE REGISTRATION IN MAINE 1979 - 2000

	Total Automobiles	Total Trucks	Higher Mileage Automobiles
1980	522,044	203,082	109,316
1985	595,464	254,801	157,024
1990	668,699	306,389	212,579
2000	741,934	409,178	303,877

Projections of
Energy Consumption for Transportation
1978 - 2000

FIGURE 10



5. Total Energy Consumption Forecast

The base year in these forecasts, 1978, represents conservation measures taken over the five year period after the OPEC Oil Embargo and quadrupling of world oil prices in 1973. Thus, it reflects generally lower levels of demand than have historically occurred in Maine. Without additional conservation measures of the kinds outlined above, however, it is possible that by 1990 Maine will be consuming more energy than it did in its highest pre-embargo year of 1972 and, by 2000, we will be using almost 25% more energy than we do now (as shown in Table 12).

With conservation, however, it will probably be possible to do essentially the same level of work in 2000 as in 1978 but with either the same or less energy. Conservation will allow an increasing Maine population to enjoy the same jobs, mobility, convenience, and heating as in 1978 without significantly increasing energy consumption.

The importance of this conclusion is heightened when one considers that real average energy prices will probably at least double by 2000. Thus, even if we use the same amount of energy in 2000 as we do today, it will cost us twice as much to pay for it. To allow energy demand to rise significantly beyond current levels, will provoke a major loss of capital and income in Maine and will leave us a much poorer state in twenty years than we are now.

Finally, it should be emphasized that these forecasts are based on reasonable, but by no means, certain assumptions. A wide variety of changes can and will occur to alter these forecasts and it is not possible to use these numbers as absolutely accurate; however, the directions in energy use are clear. The effects of various changes in home insulation, automobile fuel efficienty, population growth, and other factors are visible no matter what numbers are used. Thus, although the precise nature of Maine's energy future is unknown, and largely unknowable, the general outlines of the future can be perceived and the choices facing the State illuminated.

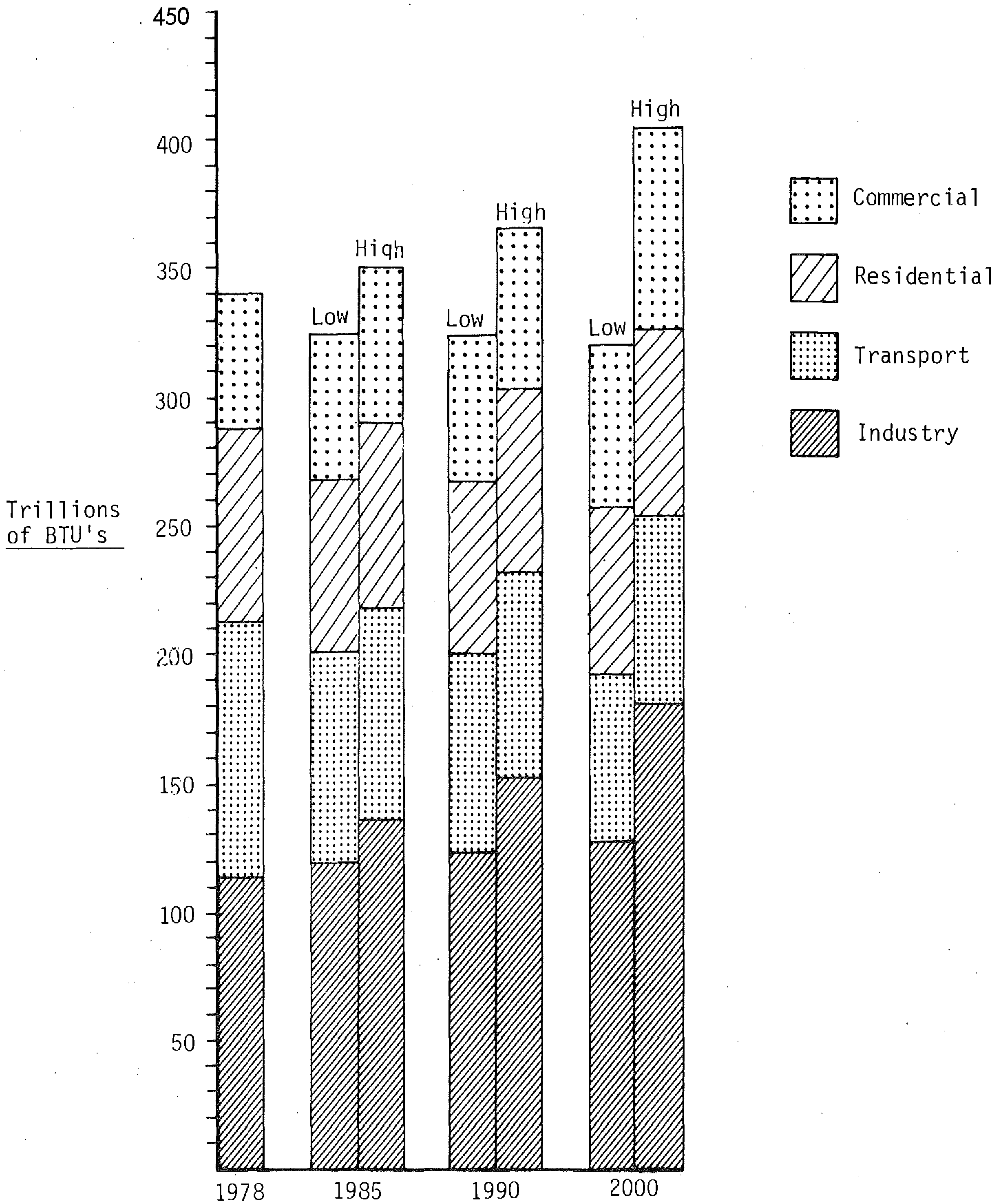
TABLE 7

TOTAL ENERGY USE FORECAST - TRILLION BTU'S

1978 (Actual)		
Industrial Use	113.6	
Transportation Use	99.6	
Residential Use	73.5	
Commercial Use	52.8	
Total	339.5	
	Low	High
1985 (Projected)		
Industrial Use	120.4	137.0
Transportation Use	79.9	81.5
Residential Use	68.6	72.0
Commercial Use	55.0	59.0
Total	323.9	349.5
1990 (Projected)		
Industrial Use	123.1	150.8
Transportation Use	76.8	80.0
Residential Use	66.2	72.3
Commercial Use	57.7	65.4
Total	323.8	368.5
2000 (Projected)		
Industrial Use	126.8	181.0
Transportation Use	65.5	72.0
Residential Use	65.4	71.8
Commercial Use	62.3	81.1
Total	320.0	405.9

FIGURE 11

Projections of
Total Energy Consumption
1978 - 2000



The preceding projections allow the development of overall supply and demand forecasts for 1985 and 1990.

Table 7 represents a compilation of information from earlier tables and shows use by sector in 1985 and 1990, using the low and high scenarios. Use is shown in trillion BTUs.

Table 8 shows how these BTUs might be distributed among various sources of energy supply. Supply, also according to the low and high scenarios, is in terms of percentage.

TABLE 8

SUPPLY SCENARIOS

1985

	Low Growth	High Growth
Gasoline and and other Petrol	26.4%	21.6%
Natural Gas	0.8%	0.7%
Distillate/Kerosene	19.6%	22.3%
Residential	6.7%	14.5%
Coal	8.5%	4.1%
Hydropower	13.7%	10.0%
Nuclear	15.3%	12.1%
Wood	21.0%	11.0%

1990

	Low	High
Gas & Petro	24.5%	23.6%
Natural Gas	0.8%	0.8%
Distillate/Kerosene	18.4%	22.9%
Residential	7.7%	14.6%
Coal	7.0%	5.6%
Hydropower	12.1%	9.4%
Nuclear	12.0%	11.4%
Wood	17.5%	11.8%

In order to project the potential cost of energy for Maine, standardized fuel costs in barrels of oil equivalent (BOE) were used. Because each consuming sector relies on a variety of fuels, this allowed for a general estimate of costs.

However, it should be noted that this method has one significant drawback. It assumes that the prices of all other fuels will increase at the same rate as the price of oil. This assumption may inflate energy costs, because the cost of alternatives to oil may be less. As a result, as the price of oil increases, Maine consumers would shift to other fuels bearing a lower cost.

A conservative method has been used to estimate oil price increases. It is assumed that residual oil will increase at 3% per year above a projected annual inflation rate of 7%. The result is a 10% increase in current dollars each year.

Table 9 shows the projected increased oil prices for 1985, 1990 and 2000.

Table 10 shows the projected cost of energy in Maine in those years.

TABLE 9

ENERGY PRICE FORECAST

BY FUEL UNITS

PETROLEUM (RESIDUAL OIL)*

	Price per barrel of Petroleum		Price per million BTU	
	Current$	Constant (1980)	Current $	Constant (1980)
1978 (Actual)	12.75	-----	2.03	----
1985	57.83	39.08	9.20	6.22
1990	93.33	44.60	14.84	7.10
2000	222.80	58.43	35.44	9.29

*Residual oil contains 6,287,000 BTU/barrel

Assumptions:

1. 10% per year increase in price of fuel (includes 3% per year increase in cost, 7% inflation)

TABLE 10

ENERGY PRICE FORECAST

	Low			High		
	Total Energy Consumed $ (Trillion BTU)	Current $ (Millions of $s)	Constant 1980 $'s	Total Energy (Trillion BTU)	Current Consumed (Millions of $s)	Constant 1980 $'s
1978 (Actual)	339.5	689	----	----	-----	----
1985	323.9	2,980	2,015	349.5	3,215	2,174
1990	323.8	4,805	2,299	368.5	5,469	2,616
2000	320.9	11,341	2,973	405.9	14,385	3,771

III. CONSERVATION

III. CONSERVATION

Introduction

The following section provides an overview of the current and future role of energy conservation. The conservation programs have been divided into six broad categories. These include the four basic energy-consuming sectors: residential, commercial/institutional, industrial, and transportation. These are followed by discussions of cogeneration and district heating potential in Maine. The latter two sections are included in the conservation scenario because they are technologies which can increase the efficiency of conventional fuel use.

One of the most critical factors in an assessment of Maine's energy needs and resources is conservation. Defined as "an improvement of energy efficiency", conservation has long been one of the top priorities in Maine energy policies and programs. More recently, the Federal government has realized the importance of conservation as a resource and has begun to focus more attention in this area. It is now being widely recognized that it is cheaper to save energy than it is to produce energy.

A review of our current conservation programs and policies and an assessment of the potential for future savings through conservation efforts follows for each of four broad categories: residential, commercial/institutional, industrial and transportation.

1. Residential

There are many federal, state and local programs focusing on residential energy conservation. Many have been in place for only a short period of time and others are just being implemented. It is important to remember, however, that these programs are only a part of what is happening in this area. More and more individuals are taking conservation measures on their own, without assistance from government.

The Federal government is involved in most state energy conservation programs, usually through provision of financial assistance and in some, through federal mandate that certain services be provided. These programs include the low-income weatherization program, the Residential Conservation Service, the Energy Extension Service and the Residential Energy Analysis Program. In addition, the federal government offers an income tax credit of 15% on the first $2,000 of expenditures for conservation measures.

Several state agencies are involved in residential energy conservation programs. A low income weatherization program conducted by the Maine Division of Community Services and financed by federal and state money has been ongoing since 1974. Through twelve community action agencies, the homes of over 18,000 low income and elderly families have been weatherized in this state. Community Services has established a goal of complete weatherization of all eligible homes in Maine by 1985. This will require weatherization of approximately 1,000 homes per month over the next five years at a cost of approximately $50 to $60 million.

The National Energy Conservation Policy Act of 1978, as amended by the Energy Security Act of 1980, requires major utilities to provide low cost, on site energy audits to their residential customers. OER was designated as the lead agency to prepare a plan for the implementation of the Residential Conservation Service by Maine utilities. The program is expected to begin in the spring of 1981 and OER will oversee the performance of audits and other services offered by the utilities.

The OER Energy Extension Service was initiated in the summer of 1980 to help small-scale energy users conserve energy. Five energy associates, located in offices throughout the state, provide general information and technical assistance to homeowners, small business owners, and commuters. Specific programs include wood burning safety education in coordination with the Maine Cooperative Extension Service, lighting workshops for small businesses coordinated with the Maine Merchants Association, "how-to" low/cost no/cost weatherization workshops coordinated with various local non-profit groups, promotion of the Residential Energy Analysis Program (REAP) coordinated with the Community Alternergy Corporation and promotion of ridesharing for commuters.

Since July, 1979, OER has offered a free, do-it-yourself energy audit to Maine homeowners. The Residential Energy Analysis Program (REAP) was publicized by virtually all Maine utilities and many members of the Maine Oil Dealer's Association. Over 5,000 Maine homeowners have participated in the REAP project. Along with an analysis of energy use in the home and recommendations for weatherization measures, the REAP packages received by participating homeowners include a series of fact sheets on energy conservation techniques, insulation and tax credits and financial incentives. REAP is now being actively promoted by the OER Energy Extension Service Program and it is expected that another 5,000 REAP audits will be completed during the present heating season.

Residential energy conservation programs initiated by state agencies, private and non-profit organizations include establishment of energy efficiency building standards, an energy conservation loan program, an oil burner efficiency program and the Neighbor-to-Neighbor Self-Help program.

The Maine Energy Efficiency Building Standard Act was passed in 1979 and the voluntary standards mandated by the law were developed and adopted by OER on July 1, 1980. The voluntary standard program establishes maximum heat loss levels for the building and performance standards for heating, ventilating and air conditioning equipment. OER has negotiated tentative agreements with the Maine State Housing Authority and the Farmers' Home Administration to adopt the OER standards for their construction projects. FMHA has also agreed to finance several passive solar single-family dwellings as demonstrations and to utilize wood or coal in two multi-family projects. OER is currently preparing a "manual of accepted practices" and conducting workshops and seminars in conjunction with the Homebuilders of Maine Association and lumber dealers throughout the state. A training program for local code enforcement officials will be developed by the University of Maine and presented in cooperation with the Maine Municipal Association.

The Maine State Housing Authority used its authority to support home improvement loans for energy conservation and renewable resource measures. During the summer and fall of 1980, $4 million of existing funds have been made available to consumers at an interest rate of 7%. Initial response to this program has been very favorable and it is anticipated that additional funds may be required to expand this program.

The OER and the Maine Oil Dealer's Association are conducting a joint project to promote conservation by improvement of oil heating equipment. The program trains service technicians in oil conservation techniques, servicing and installation of efficient burners, boilers and clock thermostats. Oil company marketing personnel have also been trained in effective marketing of these techniques and equipment. The program is scheduled to continue for two more years with the oil dealers gradually assuming complete programmatic and financial responsibility.

Finally, under the sponsorship of Governor Brennan, various human services agencies, local interest groups and private organizations have formed a coalition to assist low income and elderly citizens of Maine in coping with energy-related problems during the winter. This program has proven effective over the last two years in helping to coordinate public and private programs and provide maximum benefits to the poor and elderly.

Residential buildings offer a tremendous potential for energy savings. In 1978, 75% of all energy consumed in the residential sector was used for space heating. Bringing all existing residential buildings to a minimum level of energy efficiency and insuring that all new residential buildings are constructed to conform to existing state conservation standards are two major avenues for realizing this potential. Other measures that have been proposed and which might result in energy savings include the restructuring of electrical rates, use of time-of-day meters and adoption of minimum efficiency standards for appliances at the national level.

2. Commercial/Institutional

The programs described here to promote energy conservation in the commercial and institutional sectors are presently underway. The first two, energy conservation projects in schools, hospitals, local government buildings and public care institutions and the emergency building temperature regulations, require the direct involvement of the federal government. Other programs, including establishment of building performance standards and the initiation of a State government management task force, are largely State efforts.

Under Title III of the National Energy Conservation Policy Act, DOE is provided approximately $500,000 to conduct energy audits and $2.2 million to complete energy conservation projects on schools, hospitals, local government buildings and public care institutions. A total of $1.6 million is expected to be forthcoming for additional conservation projects. In the fall of 1978, Maine voters approved a $2.5 million bond issue for energy conservation improvements on local Government buildings. The money will be allocated on a 50%/50% matching basis using the results of energy audits completed by personnel of the Maine Municipal Association. Also, in November, 1980, Maine voters approved a $7 million dollar bond issue for energy conservation improvements to public schools and University of Maine buildings. These funds will augment $5 million already spent on conservation projects in schools from a bond issue authorized in 1977.

Since June 16, 1979, the Department of Energy has required virtually all non-residential buildings to be heated no warmer than 65 degrees in winter and mechanically cooled to no cooler than 78 degrees in summer. OER was designated as the lead agency in Maine to administer this program by the U.S. Department of Energy. In the winter of 1979/1980, 500 buildings were inspected by a private contractor hired by OER. Over 95% compliance was determined through these inspections. The inspectors also found numerous innovative approaches to energy conservation and alternate energy resource utilization.

As in the residential sector, the State of Maine Energy Efficiency Building Performance Standards also apply to commercial and industrial buildings. The standards contain lighting power standards for public buildings as well as maximum heat loss levels for the building and performance standards for heating, ventilating and air conditioning equipment.

Through the spring and summer of 1980, a State Government Management Task Force, appointed by Governor Brennan and headed by Commissioner Scribner of Finance & Administration, discussed various options for improving the efficiency of energy use in State Government. The Task Force report recommended continuing several ongoing State programs including the retrofit of State buildings, energy efficient procurement procedures, and the State vanpool program. The report also recommended the initiation of several additional efforts including the establishment of a uniform vehicle management system for State owned vehicles, the initiation of an energy consumption monitoring system and the creation of a permanent energy conservation assistance group within the Bureau of Public Improvements.

The commercial and institutional sector offers a substantial potential for saving energy. Approximately 75% of the energy consumed in this sector during 1978 was for space heating purposes. As a result, most of the conservation programs in the commercial and industrial areas will be aimed at bringing existing buildings up to minimum conservation standards; insuring that all new commercial and institutional buildings meet standards; reducing lighting in all commercial buildings to conform with voluntary State standards; instituting energy management programs in commercial establishments and achieving overall minimum energy consumption levels in government owned buildings.

Achieving a reduction in demand for energy in the commercial and institutional sector will mean facing many of the same constraints that exist in the residential area. Education, training, technical assistance and financial incentives are fundamental.

3. Industrial

Maine's industries consumed approximately 25% of all the energy consumed in the State in 1978. Paper and wood products, textiles, chemical, electric and electronic equipment industries and other important Maine industries all require substantial amounts of energy in their production processes. Several programs are directed towards energy conservation measures in the industrial sector.

Over the past three years, OER has sponsored several workshops for industrial energy users. These workshops have focused basically on operations and maintenance procedures for energy conservation improvements. Over 250 representatives of firms throughout the State have attended these workshops.

Other programs directed at industry include Maine's Energy Efficiency Building Performance Standards, the Emergency Building Temperature regulations and cogeneration. The first two programs have been outlined under the commercial/institutional energy conservation section. Cogeneration is fully discussed in detail in the next section.

New initiatives that may be undertaken to promote industrial energy conservation might include instituting effective energy management programs in Maine's industries; bringing new electrical generation capacity on line through industrial cogeneration and insuring that all new industrial buildings are built to at least minimum energy conservation standards. Some have proposed a restructuring of utility rates to provide conservation incentives.

The industrial sector is held back by the same constraints; the need for education, training, technical assistance and financial incentives, as mentioned in the preceding two sections. While industry offers a large potential for energy conservation the diversity of its processes and needs often may require a case-by-case approach in order to obtain substantial savings.

4. Transportation

Transportation accounted for 26% of all the energy consumed in the state in 1978. Maine is a rural state; substantial distances often separate people, goods and destinations. For these reasons, we have become more dependent on the private automobile and the trucking industry than most other states. Early efforts at energy conservation related to transportation were directed at lowering speed limits on all limited access highways and allowing "right-turn-on-red" at intersections. More effective methods are now being pursued in the form of public transportation, rideshare programs, and renewed rail service.

Since 1977, OER has supported four area-wide metropolitan transit districts by providing funds for marketing the use of public transit systems. OER has also encouraged these districts to address energy conservation in their ongoing planning and implementation programs. All of the public transit districts participating in this program have noted substantial increases in ridership.

Since the summer of 1979, the OER has worked with major employers throughout the State to promote carpools and vanpools. Numerous materials promoting ridesharing have been distributed and a matching service for employers to help them identify potential carpoolers among their employees has been made available at no charge. Through statewide workshops and on-site visits, nearly 100 employers learned of this service and agreed to participate. Thousands of potential carpools were identified and over 120 vanpools now operate throughout the State. Through contracts with the Portland and Bangor Chambers of Commerce, OER has initiated two areawide carpool matching services. The Portland service has been operational since September with the Bangor service scheduled to start in December. Promotion has been coordinated by the local Chamber members with OER supplying technical expertise and computer assistance. Area-wide task forces comprised of local business leaders have been established in order to promote these efforts. Over 1000 commuters have participated in the Portland program to date. The "match rate" for participants has been over 90%.

Since August 1979, the OER and the Department of Transportation (DOT) have jointly sponsored six state-owned vanpools for State workers. The program is currently operating between Augusta and the cities of Lewiston, Waterville, Winthrop, Readfield, Gardiner, Brunswick and Jefferson. During the day, two of the vans are used to provide a shuttle service between state agencies in the Augusta area.

The New England Regional Commission, in cooperation with the Maine Department of Transportation, has recently completed two studies of increased use of trains in Maine. The first made an assessment of the future of freight transportation by rail in New England. It indicated that Maine may have the most promising future in the region for increasing the use of trains for hauling freight. The second study addressed the feasibility of reestablishing passenger rail service between Boston and Portland. This study indicated that such a service is not economical at this time. Both studies point to a need to upgrade rail facilities, tracks, grade crossings, rolling stock and stations.

Future initiatives may include placing more of Maine's commuters in some sort of rideshare arrangement (carpools or vanpools); increased use of existing public transportation systems and development of newer systems where appropriate; and assistance to Maine's trucking, rails and barge industries in achieving maximum efficiency.

Other methods of increasing energy conservation in transportation may include developing package tours and group travel packages to destination resorts in Maine in cooperation with the Maine Publicity Bureau and the tourist industry. Such tourist services would allow travelers to travel in an energy saving manner and foster more complete use of the State's recreational facilities. Such initiatives might involve further examination of rail service, intercoastal ferry systems, vanpooling, seasonal bus and trolley services and others. Also, integration of energy considerations into state and local planning efforts relative to land use planning may result in energy conservation.

Due to a lack of availability of any other form of transportation in most areas of the state, heavy dependence on automobiles will continue in the foreseeable future. Similarly, the trucking industry of Maine will continue to transport the majority of goods to and from market. Taking into account the above situation, the need to examine carefully alternative and more efficient means of transporting people and goods becomes readily apparent. There are real social, financial and institutional barriers encountered by alternative transporation modes in rural states. Thus, transportation is probably the most difficult sector to deal with from an energy perspective.

5. Cogeneration

a. Introduction

Cogeneration is a method of increasing fuel efficiency. In the past, industries, utilities, institutions, and commercial establishments have secured their electricity and their process heat or steam separately, usually by burning fossil fuels or purchasing electricity (or mechanical energy) and process heat together in useable form. The result is a fuel savings which can range as high as 40 or 50 percent. Cogeneration systems have been used extensively in European countries, but their use has been limited in this country.

The term cogeneration applies to a number of different systems, all of which yield useable energy in more than one form. A cogeneration system can be fueled in many ways (oil, wood, coal, hydropower, waste, biomass, solar, geothermal, or wind). The generated energy can be in various forms (electricity, steam, heat, mechanical energy). The particulars of a cogeneration system depend upon the primary requirements of the cogeneration facility. For example, electricity may be the primary requirement for a utility company, with heat or steam cogenerated and used as a secondary product. Similarly, the primary requirement for a paper mill may be process steam, with electricity cogenerated secondarily. When cogeneration systems produce heat or electricity in excess of the needs of the particular facility, that excess is available to be sold to other users.

b. Current Use

The forest products industry is the largest industrial energy consumer in Maine. Energy needs are met in a variety of ways including hydro power, burning of wood and wood wastes, and purchases of fuel oil and electricity. Many individual forestry-related companies have used cogeneration systems for some time, and this industry group leads the state in cogeneration. A few large and small forest products enterprises generate electricity in excess of their needs and sell this additional power to utility companies. A number of Maine's larger sawmills now have cogeneration systems. Boilers which once provided only process steam to heat buildings and operate dry kilns are now powering steam turbines which generate electricity as well. These boilers are fired from wood residues which are either produced on the site or purchased from elsewhere. Cogeneration by other industry groups and utilities is not significant.

c. Resource Availability

The Maine Office of Energy Resources estimates that there is a potential for substantial increase in cogeneration in Maine.

Much of this potential is within the forest products industry, which is the largest industrial consumer of energy in Maine.

A study by Charles T. Main, Inc. for the Central Maine Power Company states that existing pulp and paper mills in Maine have already aggressively exploited cogeneration. The study concludes that there is relatively little potential for developing additional cogeneration systems at existing facilities--at most 20 MW. Most major forest-related industries in Maine are now considering coal or wood as a primary fuel source. Wood fuel can be in the form of chips, bark, or other residues. Cogeneration systems can be installed with both coal and wood-fueled systems (as well as with other fuel systems). The conversions which are now being contemplated provide good opportunities to install cogeneration systems. Major plant expansions and construction of new facilities also provide prime opportunities for installation of cogeneration systems. The Main study, however, notes that pulp and paper mills are moving toward facility designs and technologies which reduce the consumption of steam; this, in turn, would reduce the potential for cogeneration.

On the other hand, the Public Utilities Regulatory Policy Act of 1978 (PURPA) has made the installation of cogeneration systems somewhat more attractive. PURPA mandates that every electric utility is required to purchase electricity made available to it by a qualifying facility. The effect of PURPA will be that excess electricity which might be produced by a cogeneration system can be sold to a guaranteed market. The sales rates for this power have not yet been determined; the Maine Public Utilities Commission will make this determination during 1981.

In addition to PURPA, there are other incentives available to encourage the installation of cogeneration systems. An additional 10% tax credit from the Windfall Profits Tax is available for cogeneration equipment. And, as the cost of electricity increases the return on investment in cogeneration systems becomes more attractive.

A number of large forest-related industries are currently evaluating cogeneration systems. S.D. Warren's Westbrook mill is now buying some 6 MW of electricity from Central Maine Power Company. When S.D. Warren's new coal/biomass facility is completed, this picture will be reversed: CMP will buy S.D. Warren's excess electricity. The difference between what is now purchased from CMP and what is planned to be sold to CMP will be roughly 20 MW, a considerable source of base load power for that utility company.

Several other paper mills are conducting evaluations of similar changes. Boise Cascade has recently applied to the Board of Environmental Protection for an air quality license to construct a new coal-burning facility. Boise Cascade is considering a range of electrical cogeneration possibilities, from being self-sufficient in electrical power to being a net contributor to the power grid. Madison Paper Company, St. Regis, Keyes Fiber, Pejepscot, and others are all considering the fueling of their boilers with coal or wood. These considerations afford the opportunity to install cogeneration systems. Even if cogeneration systems do not provide enough electricity to sell to others, the additional generation of electricity displaces electricity which would have been purchased.

Cogeneration is by no means limited to the large paper and pulp mills. Woodtek, in North Anson, is considering a 5-7 1/2 MW power facility. Marine Colloids, a food processing facility in Rockland, and Hebron Academy are involved in plant facility changes which could produce electricity in amounts which exceed their needs and would be resold to others.

The Office of Energy Resources estimates that, in the next ten years, as much as 200 MW of new capacity could be realized by the combined development of new energy facilities in forest-related industries, agricultural and fish processing industries, and other commercial, institutional, and municipal facilities. The Charles T. Main, Inc. study, however, estimates the potential for industrial cogeneration to be only 45 MW.

d. Limits and Advantages

Installation of a cogeneration system is costly. Cogeneration systems require new equipment, increased manpower, and expensive distribution systems. Although the long-term economics of fuel savings can favor cogeneration, electricity from conventional utilities can undercut the price of cogenerated power. Assurances are needed that excess electricity or heat from a cogeneration system can be sold at competitive prices to other users on a long term basis.

There may be special siting problems involved in cogeneration systems, particularly when excess heat is to be sold to other users. In such cases, the facility must be located in very close proximity to the other users to avoid the loss of heat which results from a lengthy distribution system. Both economic and environmental problems must be overcome before siting a cogeneration facility in the midst of an urban area.

e. Current Programs and Policies

Recent changes in federal laws and regulations have been designed to encourage cogeneration. The Public Utility Regulatory Policies Act of 1978 (PURPA) removed three major obstacles which had discouraged both cogeneration and small power producers (less than 80 MW). The first obstacle was that utility companies were not required to buy at appropriate rates the electricity produced by cogeneration facilities or small power producers. The second obstacle was that some utilities charged discriminatorily high rates for back-up electrical service to cogenerators and small power producers. The third obstacle was that a cogenerator or small power producer ran the risk of being considered an electric utility and thus being subject to State and Federal regulation as an electric utility.

PURPA requires that electric utilities purchase available electric energy from cogeneration and small power production facilities which qualify under the law. The utility is required to pay rates which are just and reasonable to the ratepayers of the utility, are in the public interest, and do not discriminate against cogenerators or small power producers. Similarly, the law requires electric utilities to provide electric service to these facilities at reasonable rates. Finally, PURPA provides that qualifying cogeneration facilities and small power producers can be exempt from State regulation of utility rates and financing and from federal regulation as an electric utility.

To date, efforts to encourage cogeneration have been largely educational and informational. Some technical assistance has also been provided. These efforts include technology transfer, technical assistance regarding cogeneration for companies which are considering conversion to wood fuel, cogeneration workshops and seminars for business and industry, and assessment of the potential for industrial cogeneration in Maine.

6. District Heating

a. Introduction

District heating and cooling is achieved by using excess heat from a local industry or power plants and distributing it through a network of pipes to nearby buildings for space heating and cooling and also for domestic hot water heating.

Although this technology is not widely used in the U.S. today, district heating is not a new or untested concept. It works and works well. The central business district of Concord, New Hampshire is heated by a central plant and other examples abound. District heating is standard practice in many Scandinavian towns.

b. Current Use

Although no Maine communities have municipal district heating systems, a number of large building complexes in the State have steam heating systems which are essentially small scale applications of the district heating concept. The Brunswick Naval Air Station, Loring Air Force Base and the Augusta Mental Health Institute, for example, all have "district" heating systems.

The heat source for district heating can be either a heating plant built specifically to supply the system or an industrial or electrical generating plant that gives off "waste" heat that can be captured for the system. The fuel to feed these plants varies. At present, systems are fueled by oil, coal, wood and peat.

c. Resource Availability

It is difficult to determine with any accuracy the extent to which district heating and cooling could be introduced in an economically viable fashion in Maine, as no Maine applications have been studied in detail. The northern European experience, however, shows that such systems are feasible in communities with compact populations, down to a size as small as 1200 persons. Thus a considerable portion of Maine's population might possibly be served by district heating systems.

Given the unfamiliarity of engineers and planners with district heating systems and the complexity of the institutional arrangements that would be required to establish them, it seems likely that district heating has a much greater long term (10-25 years) potential for use in Maine than it does in the near-term future (10 years).

d. Limited Advantages

Use of district heating and cooling in Maine may present numerous benefits, but there are also many constraints.

Its advantages and benefits include:

- o Waste heat from existing power stations or large industrial boilers could be used in many cases for all or part of the heating required. Where this is possible, the current space heating fuel would be substantially displaced by the normal fuel used at such facilities.

- o Conversion of conventional residential space heating to more efficient, inexpensive, and less polluting fuel sources would occur more easily in district systems.

- o Winter heating crisis problems of the poor and elderly could be alleviated in areas served by district heating more easily than is currently the case with individual heating systems.

- o While district heating systems are not commonplace in the U.S., they are fully developed technologically in areas of Europe with a similar climate, geology and settlement patterns. Thus complete information on system design, costs, installation, and other important characteristics are readily available.

- o Major air quality improvements may be possible. Central, highly efficient and minimally polluting heat energy facilities would replace inefficient individual heating systems with the introduction of district heating.

Limits to introduction of district heating systems include:

- o New institutional arrangements would be necessary to establish and operate systems.

- o Close cooperation would be required between the public agencies or utilities that establish and operate district heating systems and the operators of power plants or industries that may be supplying heat energy to the system.

- o Installation of systems within communities requires extensive excavation that can be quite disruptive. Further, the pipes must be worked into the existing sub-surface infrastructure systems (sewer, water, power, telephone, gas).

- o Air quality problems may be encountered with the plants providing the required heat energy.

e. Existing Policy and Programs

Maine has no policies or programs that promote district heating and cooling. However, a new Federal Program - the National District Heating Program - is now available. The budget for FY 1981 is $25 million: $10 million for feasibility studies, plans, engineering, research and information dissemination; $15 million for construction grants.

The long range plan of the National District Heating Program calls for 300 to 450 communities undertaking district heating assessments and for the construction of 150 to 300 pilot district heating systems in the next 5 years.

7. Summary

There is an enormous untapped potential for energy conservation in Maine. Opportunities exist which are economically and technically feasible that can reduce overall energy consumption in Maine by 15% in the next ten years while maintaining our current standards of living. Most of our energy conservation opportunities are well known. They include:

- o Energy efficient weatherization of existing buildings;
- o Energy efficient construction of new buildings;
- o Energy efficient operation of commercial and industrial buildings and processes;
- o Installation of energy-efficient appliances in industrial equipment; and
- o Increased implementation of energy-efficient transportation methods including ridesharing and public transportation where appropriate.

Needless to say, conservation cannot elimate the need for using energy, nor can it meet future needs. However, one of the most important aspects of conservation is that it allows the extension of depletable, conventional energy resources now in use for a period long enough to bring renewable technologies and clean coal on line to meet our needs.

By reducing the use of energy, conservation may also help improve the quality of the environment, particularly through less use of oil and nuclear fuel. By improving efficiency of boilers and power plants, less of the energy burned will result in thermal pollution in the air and water.

Finally, conservation can stimulate economic growth by improving the efficiency of energy use and by keeping dollars from flowing out of state, thus making them available for local investment.

True conservation allows us to perform more work while using less energy. Too often, conservation is equated with cold homes, closed factories and restricted travel during vacation; in general, doing without something we want or need. However, by taking the proper steps, warm homes, economic growth, freedom of movement and lower energy use are all possible.

IV. RENEWABLE RESOURCES

IV. RENEWABLE RESOURCES

In combination with a strong conservation program and the exploration of cogeneration and district heating, the development of indigenous Maine resources offers opportunities to diversify Maine's energy mix. Renewable resources are not located in any one part of the State. They are dispersed throughout the entire State, thus creating economic development opportunities in many communities in Maine. For this reason, the development of our renewable resources can play a key role in revitalizing our rural economy.

Maine's alternative energy resources are currently in several different stages of development; some are ready for immediate use, some are in an evaluation stage, and some will be preserved for conservation and recreational reasons. Progress in the development of these resources will depend upon a series of policy choices which must balance economic and environmental concerns.

The scenarios outlined below describe the existing programs, potential capability, and constraints for the development of each of the following alternative energy resources: hydroelectricity, wood, solar power, solid waste, wind, the tide, biomass, and peat.

1. Hydroelectric

a. Introduction

Hydro power is the use of the mechanical energy of falling water to drive machinery. Usually a dam is built to raise the height of the water at a particular point. Other methods which can be used to provide the height of water or "head" necessary to drive machinery include tunneling through the ground or building a large diameter pipe or "penstock" downhill from the water source. In addition to taking advantage of precipitation to provide the water needed to power the facility, water can be pumped uphill for later release. This is called "pumped storage" and is used when there is excess low cost energy available at certain times. Energy captured at a hydro site can be used directly as mechanical energy or converted to electrical energy for use at the site or elsewhere.

Hydro power exerted a strong influence on the early development of the State. Before the early 1900's, methods of converting mechanical energy to electricity and then using the electricity had not been discovered and introduced, hence most industrial facilities were located at good hydro power sites. Many of Maine's major cities and towns thus grew up around these mill sites. In the 1920's and 1930's after electricity came into broader use and the capability to build large dams developed, Maine's hydro power sites came under increased pressure for development. Most large-scale facilities developed at that time as hydro power was an economical method of producing power. Pressure to develop Maine's hydro power potential during this period prompted some of the most spirited political debates of the time. The proposed development of Maine's hydro resources for use by out-of-state interests was particularly resented. This controversy culminated with the passage of the Fernald Law in 1909, which prevented the sale of Maine hydro power beyond the State's borders. It was not repealed until the early 1950's.

With the advent of cheap oil in the late 1940s, hydro power lost its economic advantages. There was little interest in additional development of Maine hydro power until the dramatic increase in oil prices made hydro power economically attractive again in the mid to late 1970s. At the same time, the use of Maine rivers for recreation has increased dramatically as has concern for protecting the environment.

Increased production of hydro power is seen as a desirable contribution to the national efforts to achieve energy self-sufficiency. Thus, the federal government has established conditions that have dramatically improved the economic viability of hydro power production. This recent shift in economic conditions has in turn resulted in considerable pressure to develop hydro power in Maine.

b. Current Use

Currently there are 85 hydro power facilities operating within the State of Maine. The total contribution of hydro power to Maine's energy needs has been relatively constant at 33 trillion btus (or 2.5-3 billion kw hours annually) since 1950.[1] Current developed capacity is more than 600 megawatts. This is approximately 10% of Maine's current total energy consumption, down from about 17% in 1950[1]. The current use of hydro power in Maine is lower than would be expected given the potential of the State's resources. This is in part because the Fernald Act mentioned above prevented development of Maine's hydro resources to meet out-of-state electrical needs during the last period when these facilities were an attractive investment. Development of this untapped potential was being actively pursued at over 50 existing dam sites in Maine during the last year.

c. Resource Availability

Two major studies of hydro power development potential in New England are currently being conducted by the U.S. Army Corps of

[1]Maine Comprehensive Energy Plan, 1976 Edition, Maine Office of Energy Resources.

Engineers[2] and the New England River Basins Commission[3]. While these studies have not fully addressed environmental and economic constraints to development, their preliminary findings are a good approximation of the amount of hydro power development potentially remaining in Maine. (See Figure H-1)

Table H-1
Development Potential in Maine

	Capacity (KW)	Energy (MWH)
New power from		
Existing Dams	417,000	1,394,190
New Dams	1,643,000	3,688,290
TOTAL	2,060,000	5,082,480

Source: National Hydropower Study: Corps of Engineers, 1980

While the above figures are calculated assuming development of both the Dickey-Lincoln School Project and the Cobscook Bay Tidal Project, they may be somewhat low. No studies to date have included estimates of hydro power development potential for a number of power-producing activities including

- o development of additional upper-basin water storage;
- o new, small hydro projects; and
- o changes in existing storage and power sites operation in developed basins.

The potential exists to approximately triple the amount of energy produced by hydro power in Maine. Conflicts with other beneficial water uses, environmental impacts, and economic constraints are such that only a portion (perhaps one-half) of the absolute development potential can reasonably be expected to be achieved.

If about one-half of the currently estimated hydro power potential were to be deveoped over the long-term (1030 MW of capacity; 2,500,000 MWH of annual energy), the contribution of hydro power to Maine's enery needs would about double and hydro power would then contribute about 20% of Maine's current annual total energy consumption, or 40-50% of total current annual electrical energy use.

[2]"National Hydroelectric Power Study, Northeast Power Coordinating Council Regional Report, Volume XV", U.S. Army Corps of Engineers, New England Division, Waltham, Massachusetts

[3]Ongoing Hydropower Expansion Study, New England River Basins Commission, 141 Milk Street, Boston, Massachusetts.

d. Limits and Advantages

Limits to the increased development of hydro power include the following:

- o Initial costs are high;
- o Many sites consume large acreages of land valuable for other purposes, as for example, timber production;
- o Conflicts between dam owners' needs to regulate water levels and shoreland owners' desires for stable water levels;
- o The development of many sites will eliminate areas for canoeing, kayaking and whitewater rafting;
- o The availability of power will be limited in drought years;
- o Development of some sites will destroy significant natural features, such as rare gorges and waterfalls.
- o Impacts of varying water discharges on the waste load assimilation capacity of river stretches resulting in possible failure of downstream discharge license holders to meet their legal requirements;
- o Conflicts with anadromous fish interests where dams may block runs and water releases may affect downstream habitat;
- o Conflicts with other fishery interests where dams may affect cold water fish habitat and flood nursery areas; and
- o Conflicts with wildlife interests where lake water level fluctuations may interfere with waterfowl and shorebird nesting, or flood deer wintering areas.

Its advantages include the following:

- o The source of power (water) is renewable;
- o There are no fuel costs;
- o Operation and maintenance costs are low;
- o Construction of these facilities keeps capital in Maine;
- o The generators can be turned on and off quickly making it suitable for peaking power;
- o No waste products are produced;
- o Some hydro power projects can reduce flood damages downstream and provide such other downstream benefits as augmenting flow for recreation, water supply, and waste load assimilation.

e. Current Programs and Policies

Maine law encourages development of hydro power while at the same time controls it to assure that unreasonable adverse impacts on the environment and other water uses do not occur.

- o The Mill Dam Act allows a shoreland owner to flood the land of others as the result of building a dam. Without this law, the building of dams would be very difficult in instances where the dam builder did not own all the land involved in the impoundment area.

- The Abandoned Dams Statute allows anyone to claim an abandoned dam, the owner of which cannot be determined. This act encourages the beneficial use of existing dams.

- Recently the State Legislature passed two laws intended to encourage the development of small hydro power facilities. The first simplifies regulatory procedures for installing power facilities at an existing dam. This law allows the developer to apply for one permit rather than for four which might otherwise be required. The second recent law defines the relationship between small power producers and utilities in a way that encourages small scale power production.

At the same time that Maine law encourages hydro development, it also controls it. Public utilities are required to get a certificate of public necessity and convenience for large hydro facilities intended to produce electricity. This serves to curb unnecessary development. To protect the environment, Maine law requires permits for a variety of activities associated with hydro development.

- Hydro power facilities developed in plantations or unorganized townships must receive a permit from the Maine Land Use Regulation Commission.

- The Site Location of Development Law requires permits for large-scale developments. The developer must show that his proposal will fit harmoniously with the natural environment in order to receive a permit.

- The Coastal Wetlands Act requires a permit for the alteration of tidal wetlands. To receive a permit the developer must show that his proposal will not damage habitats, interfere with navigation or the flow of water and will not lower water quality.

- The Great Ponds Act requires a permit for dredging or filling in or near a great pond (ponds 10 acres or more). To receive a permit the developer must show that his proposal will not damage habitats, lower water quality or interfere with water flow, recreation, navigation, or scenic or natural beauty.

- The Stream Alteration Law requires a permit for large scale dredging or filling in a stream or river or on its banks. Where a permit is required, the developer must show that his proposal will not unreasonably interfere with water flow, recreation and navigational uses, lower water quality or harm habitats.

- Other provisions of Maine law allow the Commissioners of the Department of Marine Resources and Inland Fisheries and Wildlife to require the construction of a fish ladder at any dam if they feel one is justified.

In addition to its laws, Maine has several programs that address hydro power development. The Office of Energy Resources offers information, technical assistance, and encouragement to hydro power developers, as well as providing for the public's interest in hydro power development in legislative and administrative procedings. The Office of Energy Resources has helped in the mediation of disputes over water levels between power producers and shoreland owners.

Under the Critical Areas Program, the State Planning Office is working to identify the scientific and natural values of Maine's water resources, for example, the most significant gorges in the State. This information will help to avoid conflicts and to reach informed decisions on which sites to develop.

Federal law also encourages and controls hydro power development. Some examples of how Federal law encourages hydropower development include:

- o Federal tax laws provide an eleven percent tax credit for investments in hydro power facilities, in addition to the regular 10% investment tax credit normally allowed for business investments.

- o The National Energy Act requires that utilities must buy power produced by small hydro power facilities when it is offered for sale. In Maine, the price the utility must pay is the cost of producing the same power from oil fired plants. As many hydro facilities can produce power for less than oil fired plants, this makes investment in hydro attractive.

- o Development of hydro power facilities is also encourged by the laws authorizing the Army Corps of Engineers to construct multiple purpose water development projects. For example, the Corps is authorized by Congress to work on the Dickey-Lincoln School Lakes project on the St. John River in Maine.

Some examples of how hydro development is controlled by Federal laws include:

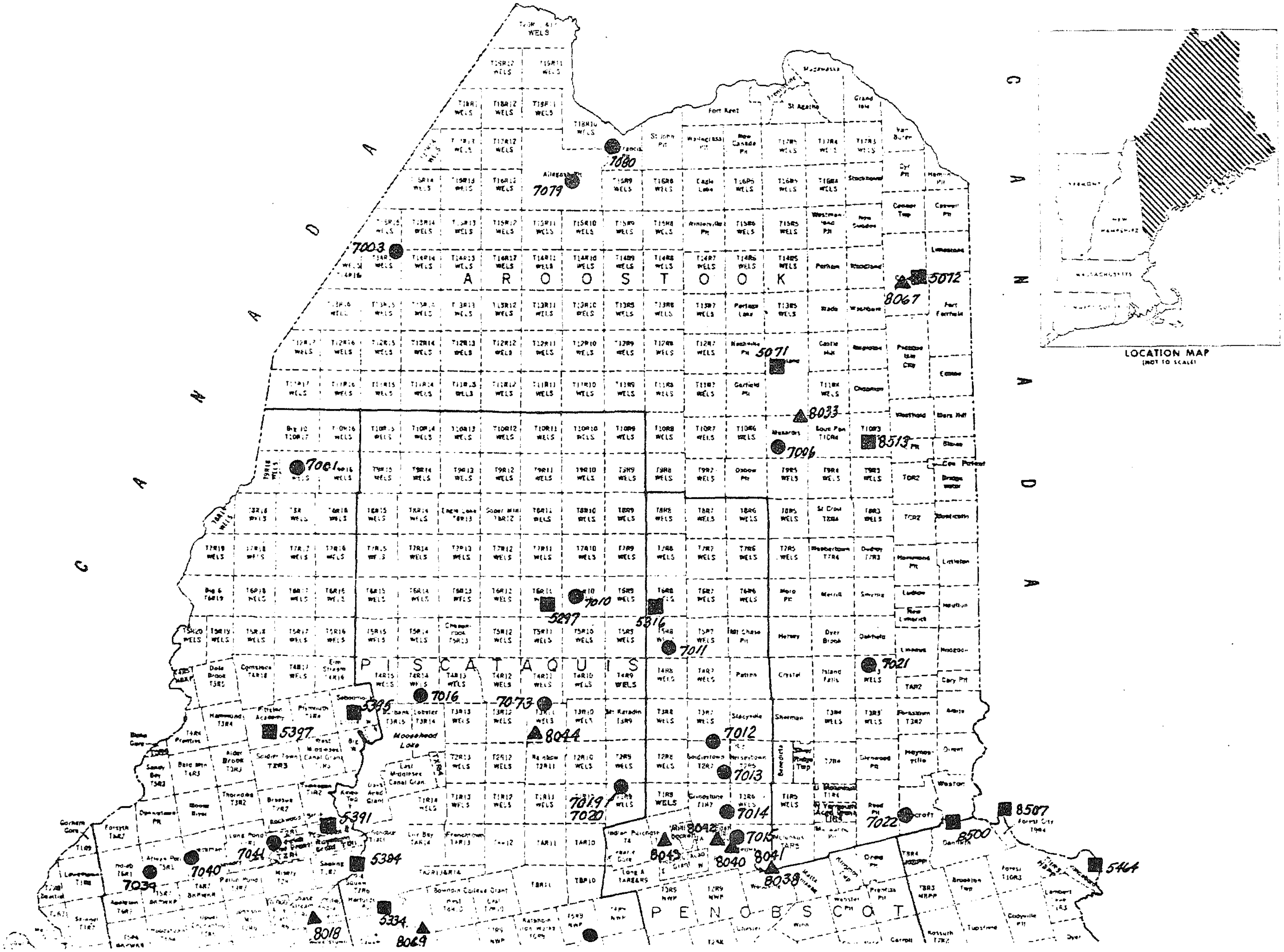
- o For proposed dams with greater than five megawatts of capacity, a license must be obtained from the Federal Energy Regulatory Commission (FERC). Projects at existing dams with less than five megawatts of capacity may be exempted from Federal licensing upon application from the owner.

- o The National Environmental Policy Act requires that an Environmental Impact Statement be prepared on all major federal decisions affecting the environment. The decision to build a dam such as the Dickey dam requires such a statement. The EIS must address environmental impacts of the proposal and alternatives to the proposed action.

- o Federal laws such as the Endangered Species Act, the Acts establishing the National Natural Landmarks Program and the National Wild and Scenic Rivers Program and the Historical Preservation Act make it difficult for federal agencies to fund or participate in projects that would threaten these values.

In addition to these and other laws, the federal government has several programs which address hydro power development.

- o The New England River Basins Commission and Corps of Engineers have conducted studies of hydro power development potential in Maine;
- o Technical assistance is available from the Department of Energy;
- o Low interest loans are available from the Farmers Home Administration;
- o Feasibility study loans are available from the Department of Energy;
- o The Federal Energy Regulatory Commission has simplified its license requirements for small scale hydro.


CANADA
AROOSTOOK
PISCATAQUIS
PENOBSCOT
Moosehead Lake
LOCATION MAP
(NOT TO SCALE)
7080
7079
7003
5072
8067
5071
8033
7006
8513
7001
5297
7010
5316
7011
7021
7016
7073
5395
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8018
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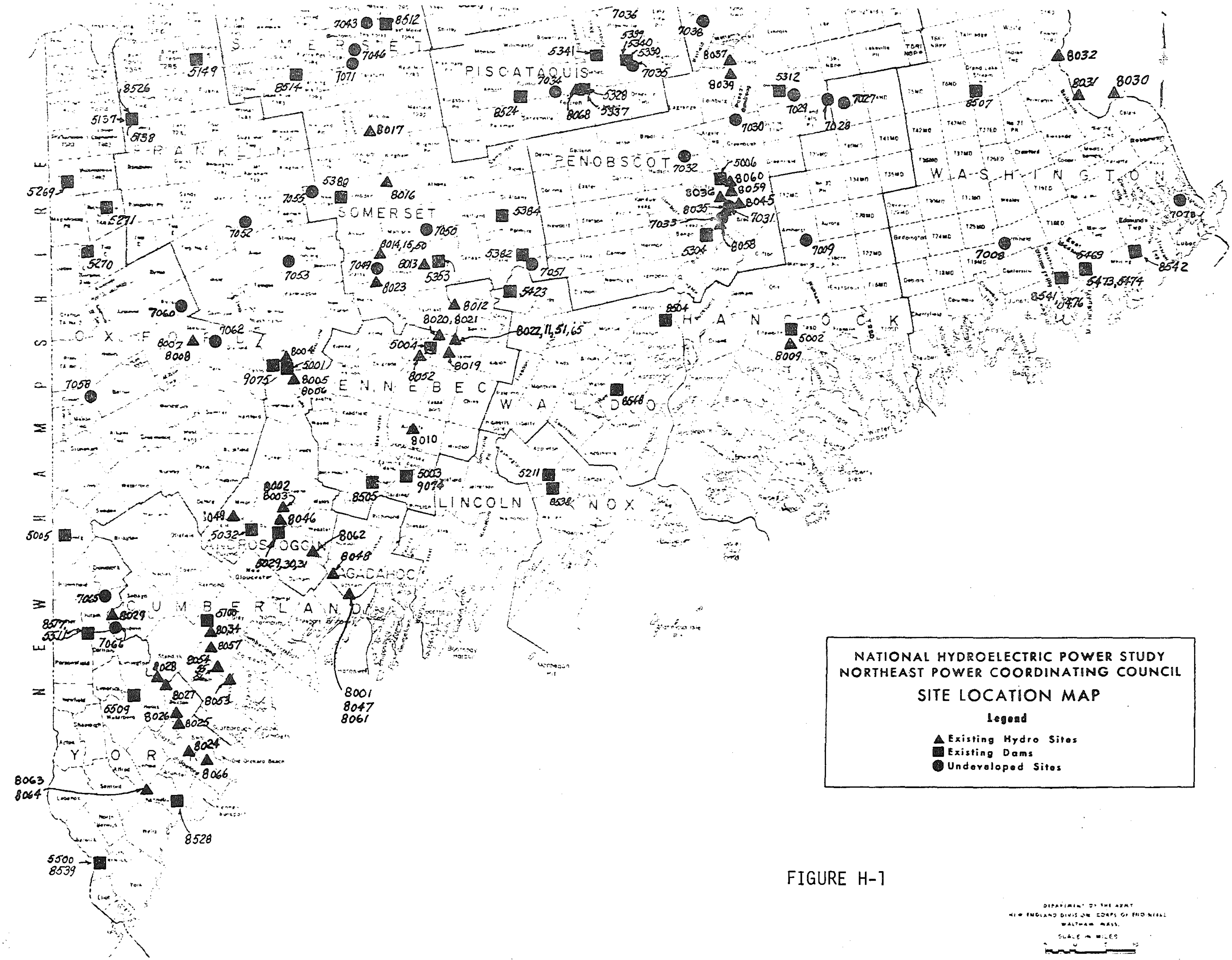
NATIONAL HYDROELECTRIC POWER STUDY
NORTHEAST POWER COORDINATING COUNCIL
SITE LOCATION MAP
Legend
Existing Hydro Sites
Existing Dams
Undeveloped Sites
SOMERSET
PISCATAQUIS
FRANKLIN
PENOBSCOT
WASHINGTON
SOMERSET
OXFORD
KENNEBEC
WALDO
HANCOCK
LINCOLN
KNOX
ANDROSCOGGIN
SAGADAHOC
CUMBERLAND
YORK
NEW HAMPSHIRE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
SCALE IN MILES

FIGURE H-1

2. Wood

a. Introduction

The most visible result in Maine of the past decade's rising oil prices has been a dramatic increase in the use of wood for residential space heating. In 1970, Maine households burned 324,000 cord of fuelwood. In the 1978-79 heating season, the figure was 575,000 cords.

All of Maine's pulp and paper companies burn at least some of their wood residues, other wood-using industries have also greatly increased use of their wood residues, i.e. sawdust, shavings and bark for process heat and electrical generation. These industries produced over 95 million cubic feet of residues in 1979. Probably 76 million cubic feet of residues were used by these industries.

b. Current Use

Residential: The New England Fuelwood Survey found that during the 1978-79 heating season 46% of all Maine households burned wood as a primary or supplementary source of heat. An OER Resurvey found that approximately 55% of Maine households burned wood during the 1979-80 heating season.

Wood is the only native rescurce directly available in Maine for home space heating at this time. After the 1973 oil embargo, as home heating oil prices rose and Maine people felt uncertain about oil supplies, many turned to cheaper and readily accessible wood. Rural Maine homes built before World War II were designed to be heated with wood. Most Maine homes, both urban and rural, have one or more chimneys to which wood stoves and furnaces may be connected.

Industrial: There are a few forest products firms in the State that have always burned wood. Currently, about 50 forest products firms, excluding the pulp and paper companies, are burning wood for their space and/or process heating needs. About 30 additional firms are examining the possibility of converting to wood.

Many of Maine's pulp and paper companies have utilized their wood residues for years. After the Arab oil embargo, most of Maine's pulp and paper companies either totally or partially converted to burning their wood residues. The total amount of oil displaced by the pulp and paper companies is not known, but Great Northern Paper Company's new bark fired boiler alone will displace over 400,000 barrels of oil per year.

c. Resource Availability

It is ironic to discuss the constraints on wood supply in the most heavily forested state in the country. However, whereas there are in the State millions of acres with unused hardwoods suitable for fuelwood, there are local supply problems in southern Maine where most of the State's population resides.

A cord of high quality hardwood that is processed in one of the mills can add hundreds of dollars of value to the State's economy. The same cord of high quality hardwood sold for fuelwood literally goes up in smoke.

The 1970 U.S. Timber Resources Survey found that for several hardwood species, high quality trees were already being overcut. It is very likely that overcutting has increased. The 1970 Survey also found that Maine's 100,000 small woodlots are not managed as well as larger tracts. Most of these woodlots are in the populated areas of the State where fuelwood markets are good.

d. Limits and Advantages

Limits to the use of wood include the following:

- Wood has the worst safety record of all home heating fuels. It is estimated that several thousand wood burning related fires occur every year. Preliminary studies by the EPA have found that woodstoves emit polycylichydrocarbons, a serious source of air pollution.

- Chuck wood for home heating is inconvenient. Automatically fed central heating systems have been developed for wood pellets and chips, but they are not widely used, because a supply system for wood pellets and chips does not exist.

The advantages of wood are:

- Readily available;
- Renewable; and
- Maine-based.

e. Current Programs and Policies

The State of Maine is encouraging wood burning in the state. Maine does allow part of the cost of wood fired central heating systems as a tax credit. Both the Maine Forest Service and the Office of Energy Resources have programs to promote wood as a residential and industrial energy source and the Maine Department of Environmental Protection is studying the air pollution impacts of wood-burning.

The switch from oil to wood as an energy source occurred without major government or other institutional intervention. In fact, federal programs have placed a higher priority on conservation and on other energy resources. The U.S. Department of Energy has funded feasibility studies on several large-scale wood-using electrical generation projects; however, little attention has been given to home space heating. It was not until this year that the Internal Revenue Service developed rules for allowing limited tax credits on the federal income tax for wood burning devices.

There are two good reasons for the lack of national attention. First, wood is not a suitable energy source for most of the country; Maine is one of the few states where there are large forested areas close to population. Second, wood is widely perceived as a transitional fuel to bridge the years between the age of petroleum and the widespread use of solar and other alternative fuels.

The Maine Forest Service administers a pilot U.S. Department of Agriculture fuelwood program which shares the costs of good forest management for small fuelwood harvesting operations between the landowners and the government. The U.S. Forest Service in cooperation with the Maine Forest Service is now conducting the decennial survey of Maine timber resources which will provide valuable data about the current availability of wood fiber for energy as well as for manufacturing and other uses.

One trend disclosed by recent surveys is that Maine households are becoming more sophisticated in their woodburning habits. Whereas three to four heating seasons ago, many people were burning wood in a fireplace or non-airtight stove, the trend is now toward airtight stoves and wood-fired central heating systems.

OER and the Forest Service predict that people will turn more to automatically fed solid fuel central heating systems. These systems may use wood chips, densified biomass such as wood pellets, or coal. OER believes that approximately 75% of all Maine households will be doing all or part of their space heating with solid fuel by 1990. By the year 2000, this percentage will probably remain at or near 75%.

While 35% of Maine households are apartments or mobile homes, the results of the New England Fuelwood Survey and preliminary results from the Resurvey seem to indicate that a large number of mobile home and apartment households are considering or have either partially or fully converted to wood. It also appears from these surveys that the turn to woodburning has not yet peaked, but is still continuing to increase. OER estimates that by 1985, approximately 70% of all Maine households will be burning some wood.

In contrast, the Maine Forest Service believes that home wood-burning may already have peaked. The seasonal shortage of fuelwood which occurred during the past three or four heating seasons has not occurred in the fall of 1980. There is some feeling that homes are now being converted to more convenient and comparably priced coal rather than to wood.

While use of wood in the residential sector and in the non-forest products industrial sector is more of a transitional source of fuel, the forest products industry will probably rely on wood energy for a longer period of time because of its availability and because if they don't use it, their residues will create a disposal problem. Potential wood use for energy in forest products industries is fully discussed in this report's section on cogeneration.

3. Solar

a. Introduction

Solar energy is widely recognized as a potential solution to many national and world energy problems. Underlying most energy scenarios is the assumption that the United States will heavily rely on solar power 25 to 35 years from now. The transition is underway, but how quickly the full potential of solar energy can be realized will depend upon world events, economics, advancing technology and changing attitudes.

Maine's Comprehensive Energy Plan of 1976 proposed the diversification of energy sources--including solar power--as a corner-stone policy. Maine's transition to solar use has accelerated since 1976 due to educational programs, tax incentives, loan programs and new legislation. Furthermore, during the past several years the solar industry in Maine has grown tremendously, largely because of the rapidly inflating cost of traditional energy resources.

b. Current Use

Solar energy technology is most commonly used in Maine for space heating and domestic hot water heating.

Passive solar "systems" that use the building orientation, configuration and materials to collect and store solar energy are perhaps the most common solar technologies with broad applicability. Basic passive solar features can often be incorporated into new construction at no additional cost.

Solar hot water collectors--devices usually installed on the roof of a building to supplement conventional domestic hot water heaters--are another widely available popular solar alternative. They can be installed on new or existing structures to supply up to 60% of the required heat and have a favorable "pay-back" period, or life cycle cost.

Retrofitting buildings with low cost solar devices which simply transfer heat into the adjacent interior space, without specific means of storage or distribution techniques, is also gaining in popularity. These systems will be widely used during the 1980's while more sophisticated solar technologies develop.

Space heating with active solar systems--collectors usually installed on a roof and associated with a remote heat storage device--is not a widely used technique because of the high initial cost compared with other solar technologies. Few building owners have the capital necessary to purchase such systems.

Solar photovoltaic cells that directly convert sunlight to electricity are commercially available but their use is presently limited to remote applications. Mass production and technological refinements that will make photovoltaics cost competitive are not expected until after 1985.

c. Resource Availability

Maine receives sufficient sunlight to produce low and medium temperature heat for building space and water heating. The State also has a relatively high percentage of winter sunlight, which coincides with seasonal heating demands. It is estimated that 32% of Maine's energy demand is for building space and hot water heating. It is also estimated that 60% of existing buildings have adequate solar access* and 90% of new buildings could be built with solar access if a commitment to solar power were made. Each of these buildings could incorporate solar energy at a reasonable cost. However, solar energy can only be used effectively in well-insulated buildings. Therefore, existing buildings should be weatherized to acceptable levels before any solar retrofit is considered and all new buildings should at least meet the State Energy Conservation Building Standards, prior to additional expenditures for solar energy.

The majority of existing solar installations provide between 20% and 30% of building space and water heating needs. This is supplemented by other forms of energy such as wood, oil or electricity. The solar technologies likely to be used in Maine buildings in the near future are the installation of appropriate windows and other similarly practical, durable and simple passive solar options. Even the idea of using common building components, such as windows, as effective solar collectors is a relatively new idea.

Simple passive solar technologies can make a significant contribution to the State's energy needs and Maine citizens can take advantage of these opportunities immediately. As solar energy development and commercialization continues, more sophisticated technologies will become available which can be integrated into existing solar buildings to reduce energy consumption further as well as to enhance the potential of non-solar buildings.

*For the purposes of this report, solar access is defined as the orientation of at least one major building facade within 30 degrees of true south, with minimal (less than 5%) shading on that surface between 9 AM and 3 PM.

d. Limits and Advantages

Limits to the use of solar energy include:

- Affordable capital is not presently available to owners of individual buildings for the purchase of solar equipment. Three of the four components needed to maximize the use of solar energy in Maine exist today, a market, a product, and an industry. Capital is the final component. The cost of financing is the primary capital related barrier. The majority of potential installations are retrofits and lack of availability of long-term, low-interest financing for existing homes is an important constraint. In a State with one of the nation's lowest average per capita income levels, even a minimal first cost is often too much;

- Lack of clear legal status of solar access rights associated with property ownership;

- Practical and aesthetic difficulties of retrofitting existing structures that were not designed or oriented for efficient use of solar energy;

- Attitudes of individual homeowners towards the major construction work and home modifications required for many solar retrofitting projects and towards the "unfamiliar" design of some new solar homes;

- Lack of public awareness of the technical and economic feasibility of using solar energy for water and space heating. The general public and most contractors and tradespeople still think in terms of traditional structures. Broader-based educational efforts are required to overcome this inertia and to acquaint Maine people with the potential of solar technologies; and

- The majority of existing homes are not insulated heavily enough to use solar space heating effectively. Their use of solar space heating is contingent upon that weatherization.

Advantages derived from use of solar energy include:

- No fuel cost;

- No waste products;

- Long-term lower cost for most space and water heating applications than the alternatives;

- Capital investment in solar energy facilities is investment kept within Maine;

- o Almost no conflict with other uses or environmental impacts;
- o Job creation and the utilization of native material resources in solar products produced and/or assembled in Maine.

e. Current Programs and Policies

Policies include:

- o To retrofit as many existing housing units and commercial buildings as possible with solar equipment.
- o To ensure new construction takes advantage of active and passive solar systems wherever feasible.
- o To educate Maine homeowners and businesses in the use of solar equipment.
- o To remove financial barriers for installation of solar energy systems.
- o To assist in the continued development of a healthy solar industry.
- o To remove remaining legal or institutional barriers to the use of solar energy.

A wide variety of activities are now underway which address the issue of increasing the demand for and supply of solar energy technologies. The following programs and projects are designed to meet these goals. An overview of each basic program area precedes the list of projects initiated during the past three years.

<u>Technology Transfer/Vocation Workshop Program</u>

Trades people and professionals need detailed, up-to-date information that is specific to their area of expertise. OER has held over thirty vocational workshops during the past three years to provide a wide variety of interest groups with needed information. To date we have focused primarily on builders and solar equipment installers. These trades have the capability to sell and install immediately simple, off-the-shelf equipment that does not need prior design work.

To assure the existence of quality solar technicians in private industry, who are already in contact with consumers, has been the first priority. Hence persons making an affirmative decision to buy solar can obtain the necessary services today. The continued education of technicians is critical. As the capability to perform basic construction and assembly develops, the effort to educate design and financing professionals and other groups will be intensified.

Related Projects

- Sponsored fifteen "hands on" Solar Greenhouse Workshops for the Financial Community
- Workshop for Planners, Building Officials and Inspectors and Surveyors
- 1979 Builders Workshop Series
- Sunbuilders Dinner Meetings and Workshops
- Workshops for Architects and Engineers

Publications

A variety of general information publications specific to Maine have been developed by the OER to answer typical questions asked by consumers. This is perhaps the most complete of all the OER programs. OER intends to develop additional materials as new generic technologies develop.

Related Projects

Developed fourteen Maine specific publications

- Passive Solar Energy: A guide to Sensible Energy Efficient Design
- Solar One
- Solar Two
- Solar Three
- Solar Four
- Maine Professional Solar Services Directory
- Maine Solar Site Evaluation
- 1980 Maine Solar Building competition
- Solar Energy Installers Certification: Program Summary
- A Guide to Financing Energy projects
- The Economics of Solar Water Heaters
- Low-Cost Solar Air Heaters You Can Build and Operate in Maine
- Maine Solar Architecture: A Building Inventory

Publish "Sunbeam" Bimonthly Newsletter
Develop Publications on New Technologies

General Education Program

The basic objective of the general education program is to create a forum for consumer information. This ranges from seminars and conferences on specific solar topics to a variety of public speaking engagements. Essentially this program addresses two audiences: the semi-informed individual trying to make a decision and the uninformed person who needs an introduction to solar technology. Personal contact is perhaps the most effective means of transferring solar information to consumers. The primary goal of the program is to develop and transfer a consistent information base to the public through all the appropriate channels, including government, educational institutions, community energy organizations and private industry.

Related Projects

- Annual Comprehensive Solar Conferences
- Statewide Solar Adult Education Network
- Maine Energy Extension Service

Capital Transfer Program

The objective of this program is to make the necessary capital for a solar purchase available to all Maine building owners at affordable rates. Primarily the activities undertaken to date have consisted of educating personnel of private, State and Federal financing institutions as to solar use possibilities and publicizing available borrowing opportunities to consumers. This effort will accelerate as financing from the Federal Solar and Conservation Bank becomes available in 1981. Also involved are the development and administration of various legislative financial incentives.

Related Projects

- Provide assistance to the Bureau of Taxation in administration of Solar Tax Credits and Exemptions by reviewing Solar Sales Tax Rebate applications
- Federal Solar and Conservation Bank
- Federal Income Tax Credits

Technology Development and Demonstration

Demonstrating to the industry and the public that solar energy works is a critical aspect of commercialization. Obviously the best demonstration is the 1,400 existing solar buildings in Maine. This programs objective is to transfer information on working solar projects and, in the case of emerging solar technologies to assist in their development, if necessary, and to provide information on their performance. A wide variety of projects are used to demonstrate Maine's solar potential including building and design competitions, grants for solar domestic hot water systems and appropriate technology projects, exhibits and audio visual materials.

Related Projects

- Exhibits
- Farmers' Home Administration, OER Solar Design/Build Competition
- Appropriate Technology Small Grants Program
- Audio Visual Lending Program
- Technical Assistance to Schools and Hospitals Energy Audit and Conservation Program
- Solar Hot Water Demonstration and Monitoring Program
- Two Maine Solar Building Competitons
- Workshops for Architects and Engineers

Solar Consumer Assurance

As part of a national effort, coordinated by the Federal Department of Energy to bolster consumer acceptance of solar related products, the Maine OER is one of thirty-five states participating in a National Consumer Assurance Program.

Maine's recommendations focus on the expansion of existing voluntary programs, such as installer certification, the development of educational programs for consumers and the solar trade, and the coordination of consumer protection and energy development efforts.

The Consumer Assurance Program, in conjunction with Federal and State tax incentives, will provide a healthy climate for the rapid expansion of solar utilization.

Related Projects

- Affirmative Disclosure in Advertising
- Consumer Protection Workshops
- Maine Consumer Manual
- Warranty Insurance Program
- Solar Consumer Assurance Liason

Removal of Barriers to Solar Utilization

This program has involved work on minimum warranties, solar access and planning legislation, solar licensing for installers and other areas where consumer confidence and decision-making, and industry capability could be hampered. The objective is to remove obstacles to solar development. As solar utilization increases additional barriers will be identified.

Related Programs

- o Solar Access
- o Community Planning
- o State Tax Incentive Programs

4. Solid Waste

a. Introduction

Urban waste-to-energy systems can provide an important supplement to Maine's energy supply and at the same time help to resolve material resource and solid waste disposal problems. Resource recovery offers cities alternatives to increasingly expensive and difficult-to-locate landfill sites as well as providing a local source of energy in times of reduced energy supply. Communities with fully utilized solid waste energy recovery facilities can stabilize or reduce their refuse disposal expenses while providing a reliable and financially attractive source of energy to a committed industry in their region.

b. Current Use

The city of Auburn has become the first community in Maine to build a solid waste resource recovery project. When this facility begins operation in January, 1981, it will generate steam for use by Pioneer Plastics, one of Auburn's largest industries. Auburn's experiences and methods of implementing the concept of solid waste resource recovery will be of value to other communities in Maine.

c. Resource Availability

Currently, there are approximately 300 solid waste disposal sites in Maine. Eight regional areas: Sanford, Biddeford-Saco; Greater Portland; Lewiston-Auburn; Norway-South Paris; Augusta; Waterville-Winslow; and Bangor/Brewer produce about 60% of the approximately 750,000 tons of solid waste generated in the State. For many communities, present methods of disposing of municipal refuse are outmoded, inefficient or prohibited by state and federal regulations.

In all, there are 12 specific areas in Maine where refuse to energy projects are considered feasible. Eight areas are actively investigating refuse to energy options and together with Auburn's project would displace the equivalent of 400,000 - 600,000 barrels of oil each year. A description of these projects is provided in Figure 4.1 and 4.2.

d. Limits and Advantages

Determining the feasibility of a regional resource recovery system is a difficult and complicated task. A broad range of understanding in many areas is required, including the quantity and characteristics of the waste stream, transportation constraints, the costs, available markets for recovered energy,

Figure 4.1

Area	Size	Estimated Cost	Type
Waterville/ Winslow	100 tons/day	$5 million	Incineration to Steam
Brunswick	Up to 300 tons/ day	$5-8 million	Incineration to Steam
Bangor/ Brewer	150 to 300 tons/ day	$5-15 million	Modular Incineration/ Steam Refuse Derived Fuel (RDF)
Augusta	100 tons/day	$5-6 million	Incineration to Steam
Biddeford/Saco	100 tons/day	$3-5 million	Modular Incineration/ Steam
Portland	250 to 400 tons/ day	$8-30 million	Incineration/Steam Recovery or RDF
Sanford	75 to 125 tons/ day	$3-5 million	Modular Incineration/ Steam
Norway/South Paris	50 tons/day	$2.5 million	Modular Incineration/ Steam

and various technological and financial options. Towns will need assistance in assessing these and other aspects of waste-to-energy systems. Many independent businesses and commercial facilities which presently use fuel oil as their primary energy source, as well as generate a significant amount of solid waste, will also require assistance in evaluating the feasibility of replacing a portion of their fuel oil with solid waste and other solid fuels.

Resource recovery systems, where practical, must address two difficult and seemingly unrelated problems: energy and solid waste disposal.

e. Current Programs and Policies

In general, consideration is being given to the construction of as many of the 12 identified urban waste-to-energy systems as are economically feasible.

Because of mutual concerns, the Office of Energy Resources and the Maine Department of Environmental Protection are cooperating in providing assistance to groups interested in resource recovery systems. The two agencies are able to provide specific assistance concerning regulatory, engineering, technical and financial aspects of solid waste energy facilities for Maine communities.

The U.S. Environmental Protection Agency is also able to provide support in the form of technical assistance although on a limited scale. Both DEP and OER are working with interested communities to obtain any available Federal assistance in this area.

Under Title II of the Energy Security Act of 1980, Congress authorized a two-year program of financial assistance with expenditures from the Energy Security Reserve of $850 million and Department of Agriculture expenditures of $600 million for biomass alcohol fuels and urban waste. $1500 million of the DOE allottment will be used for urban waste projects. Financial assistance may take the form of loans up to 80%, of loan guarantees up to 90% of construction costs, and of price supports or price-support loans for new and existing facilities.

An Office of Energy from Municipal Waste has been established in the Department of Energy. This office will administer a variety of programs to assist municipalities in evaluating resource recovery from solid waste.

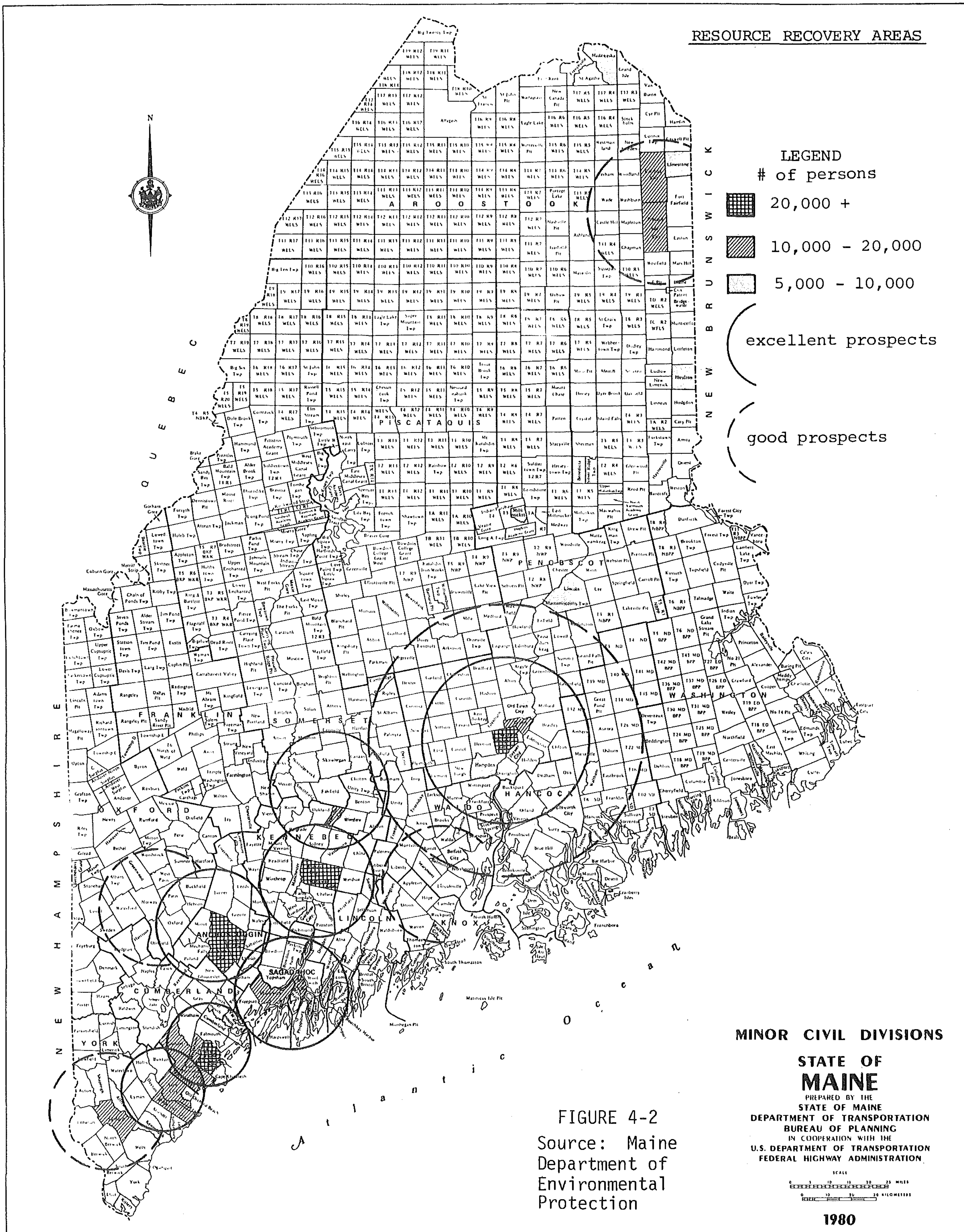

FIGURE 4-2
Source: Maine Department of Environmental Protection

5. Wind

a. Introduction

Energy from wind can provide a modest increment towards meeting Maine's needs in the coming decades, although the development of lower cost generating facilities will be necessary to make the fullest possible use of this ubiquitous resource.

b. Current Use

Currently in Maine there are a few windmills which pump water or perform other mechanical tasks, but the most significant and promising use for wind power is for electrical generation. About two dozen wind generators are currently operating in Maine, and several more will be operating soon. However, each of these operating units can generate only about 1 to 3 kilowatts of power. Under realistic operating conditions, these systems can probably generate no more than 3000 kilowatt hours of power per year. For comparison, Maine's total demand for electric power is approximately 9 billion kilowatt hours per year.

Despite the fact that wind is an abundant resource, major problems have prevented wind power from contributing more to Maine's electrical needs. First, the resource is dispersed, and it is not presently possible to concentrate power into a few large generators. Therefore, numerous relatively small but expensive generators are required to convert wind motion into useable power. The wind generators which have been produced thus far can also convert only a small portion of the wind energy which is available to them. Finally, although over long periods wind is a predictable and very secure energy source, it obviously does not blow constantly. During relatively calm periods, expensive wind generating machinery must stand idle or operate well below its capacity. Many of the wind systems in use today are the sole source of power for a remote home or commercial operation. In these cases, expensive storage systems are required to even out the supply of power. The storage problem is not so significant for wind systems which are part of a larger utility network. Because of the high capital cost per unit of output, wind-generated electricity is presently more expensive than power produced by hydro, nuclear fuel, coal or even oil. For example, wind-generated power currently costs 10¢ to 25¢ per kilowatt hour, while the hydroelectric generating facility being constructed on the Androscoggin River at Brunswick is expected to produce power at 4.5¢ per kilowatt hour. Oil fired generation costs between 3¢ and 6¢ per kilowatt hour for the fuel, plus additional fixed and variable costs of operation.

c. Resource Availability

No measure has been made of just how much energy potential is offered by the winds blowing across the State of Maine. The magnitude of the resource is undoubtedly very large, yet wind is currently used to produce only an insignificant fraction of Maine's energy. The inefficiency of current technology and the manufacturing costs of generation equipment currently restrict rapid expansion in the use of this resource. Wind energy can become an attractive source for electricity, however, if engineering research produces wind-generation devices which convert a higher proportion of available wind to electricity or which are less expensive to build than the systems now in use or if the relative economic feasibility of wind energy systems improves by some other means.

The U.S. Department of Energy manages a fairly extensive wind energy research and development program, the Maine application of which will be described in further detail below. This effort may greatly improve the efficiency of wind generation devices and it may result in lower equipment manufacturing costs.

Already, larger generators have been designed to achieve economies of scale. Recent technical advances also make it easier to link individual home or business generators to electric utility systems, enabling owners to sell their excess power to utilities during periods of high wind velocity. Legal obstacles once prevented such arrangements, but these problems have been largely resolved. Both Central Maine Power Company and Bangor Hydro-Electric Company will now purchase wind-generated power at 3 to 4¢ per kilowatt hour.

d. Limits and Advantages

Limits on increased use of wind energy include:

- o High initial costs for de-centralized, small-scale residential and commercial applications;
- o Current availability and cost of capital for wind energy installations;
- o Potential aesthetic problems that would be assocciated with large-scale wind energy systems in sensitive areas;
- o The unpredictable fluctuations in availability of wind to generate power at a site;
- o The diffuse nature of wind resources which discourages use of large, low cost central facilities.

Advantages:

- o No fuel costs;
- o No waste products;
- o Capital investment in wind energy systems is an investment that potentially could stay in Maine;

- The lack of environmental problems associated with small-sized wind energy systems has precluded the need for state and federal regulation of the installation of such systems.

e. Current Policies and Programs

At present, policies are directed at these goals:

- To encourage technological improvements to make wind energy more economically feasible through cooperation on federal and private experiments;

- Determine how much power can feasibly be produced by wind generators operating in Maine;

- Determine the cost of generating power in Maine with a wide range of wind-powered generators;

- Explain to the people and industries of Maine the current status of wind-power technology and the costs, efficiency, and reliability of specific equipment;

- Ensure that Maine people and companies who are interested in wind generators gather the information necessary to plan a successful system and that they get the right equipment for their needs; and

- Remove unnecessary legal and institutional barriers to economical wind power development.

To assist in accomplishing these objectives, Maine government, through OER, is actively pursuing the following programs:

1. Field Evaluation Program (FEP)

   Since November 1979, OER has been actively involved in this program managed by Rockwell International's Wind Systems Program for the U.S. Department of Energy and designed to accelerate the commercialization program for SWECS (Small Wind Energy Conversion System, less than 100 kw). The program goal is to provide near-term resolutions of existing technical and institutional constraints in order that wind energy can effect maximum impact on the nation's energy needs. The primary objectives of the FEP are:

   a) Data acquisition and cost-of-service evaluation;
   b) To assist and support state and local governments to reduce institutional barriers;
   c) To prepare consumer information regarding the performance and reliability of commercially available SWECS;
   d) To stimulate the SWECS industry; and
   e) To obtain typical operating experience data on SWECS.

To achieve these objectives, DOE is installing two SWECS in each of the 50 states and some U.S. territories. The machines assigned to Maine have been sited through the cooperative efforts of the Office of Energy Resources, the electric utility industry in Maine, and the Northern Maine Regional Planning Commission, with technical assistance and review by engineers from Rockwell International.

Machines being installed under this program are:

a) An Enertech 1800, a 1.8 kilowatt machine installed in October 1980 at the residence of James Buck in Trenton;
b) A Storm Master 18, an 18 kilowatt machine to be installed at radio station WDHP (FM)/WFST (AM) in Presque Isle.

2. <u>New England Wind Project (NEWP)</u>

In May 1980, the OER began participation in the second phase of the Field Evaluation Program, called the New England Wind Project. The objectives of this program are similar to those for the FEP, with the exception that the machines to be sited are prototypes (not yet commercially available). The systems to be evaluated under this program were designed and constructed in response to DOE solicitations and contract awards to meet specified criteria. The systems available under this program are:

a) 1-2 kilowatt DC output machines designed for "stand alone" applications, isolated from utility systems. Battery charging applications and remotely located navigation or communication systems are being sought for test installations.

b) 8-11 kilowatt AC output machines designed for parallel operation with utility systems. Two sites have been selected for installation of these machines, one a residence on North Haven and the other a residence and ski lodge at Rangeley.

c) 100 kilowatt AC output Darrius (vertical axis) machines designed for commercial or small industrial applications. Sites are being screened for installation of one of these machines.

3. <u>Information Dissemination</u>

More than 600 information packages have been distributed to Maine's citizens, upon request, to assist them in making a decision as to whether wind energy is a feasible alternative for them. Materials on site selection; unit sizing and load match; technical considerations; lists of available systems, manufacturers, dealers, and accessories; and descriptions of available tax credits and other incentives are all included in the information package.

4. Technical Assistance

Dozens of Maine citizens have been assisted by OER in more specific, detailed consideration of wind energy systems for their use. Several communities, such as Rangeley, Monhegan, Matinicus, and North Haven/Vinalhaven have been aided in assessing wind energy development potential on a community scale. Further, OER has worked in cooperation with Public Utilities Commission staff to apply wind energy systems to specialized communication and electrical generation needs - particularly on the Maine coastal islands whose remote locations and high cost electrical grid interconnections make them an ideal environment for SWECS applications.

5. Monitor Technological Developments

Considerable research, development, demonstration and commercialization work is occuring on a national scale on wind energy systems of all sizes, from less than 1 kilowatt to about 3,000 kilowatts. Several test installations have been or are being erected around the country for large machines of up to 3,000 kilowatts capacity, in addition to the SWECS programs in which OER is participating. While Rockwell International is the prime contractor to DOE for the SWECS program and operates the Wind Test Facility at Rocky Flats, Colorado for performance evaluation of SWECS, DOE and NASA are the cooperating agencies for administering the large Wind Energy Conversion Systems (WECS) test program. Machines on this scale are intended for larger industrial or electric utility applications.

In addition to the Federal (DOE) test program, some private wind energy evaluation programs are also underway. The Electric Power Research Institute (EPRI) is conducting one of these test programs on behalf of the country's investor-owned utilities, and at least one test machine has been installed, a 3,000 kilowatt unit manufactured by the Bendix Corporation for Southern California Edison. Recently, the government of Price Edward Island has established a wind test facility as part of an initiative co-ordinated with the six New England Governors-Eastern Canadian Premiers' joint energy program under the auspices of the Northeast International Committee on Energy (NICE). This facility will be dedicated to SWECS testing in the harsh coastal and marine environments and should yield technical data of special interest and use to Maine's coastal population.

The need for significant technological advances to make full use of the wind resource makes development of this source of energy more appropriately a federal responsibility.

However, the State can assist in this effort. Two specific steps we propose are the following:

1. Residential Conservation Service (RCS)

   OER will be responsible for administering the SWECS provisions of the RCS, in cooperation with the State's electric utilities and the Maine Pubic Utilities Commission. Standards are being developed for the RCS, and OER is now reviewing those standards.

2. Anemometer Loan Program

   The sensitivity of SWECS to wind velocity, and the site-specific nature of available wind energy, mandate that prospective wind energy users should document the wind regime at the intended installation site. Many states have undertaken an anemometer (a device for measuring wind velocity over time) loan program to facilitate such site-specific data acquisition, and such a program is proposed for Maine. This program would help to minimize the risks associated with making sizable investments in wind generating equipment, with the possibility of insufficient generation to justify that investment due to inadequate winds at the site.

6. Tidal

a. Introduction

Tidal power involves using the natural forces of daily tides to produce electricity. Ordinarily this is accomplished by placing a dam and turbine at the entrance to a bay or inlet. Twice a day, water is allowed to fill and empty from the bay passing through the turbine. Each time the water passes through the turbine electrical energy may be produced and subsequently distributed to a user.

Of particular importance in selecting a tidal power site is a wide tidal range between low and high tides. This range, or "head", determines the energy potential of the site. A very large "exchange volume" is also crucial to tidal power development, and the ideal site will have a large tidal range and a narrow, shallow strait opening into a larger tidal basin area.

b. Existing Use

The two largest tidal power facilities operating in the world are in France and the U.S.S.R. Canada will also be constructing a pilot project tidal facility in the Bay of Fundy and plans to build a large one if the pilot project goes well.

Currently there are no operating tidal power facilities in Maine. In the past small tidal facilities proliferated along the Maine coast providing power to grist and saw mills and stone cutting operations.

c. Resource Availability

It currently appears that the most favorable "large scale" sites for tidal power development are in Cobscook and Passamaquoddy Bays. These areas in eastern Maine are most favorable because of the fifteen to twenty foot tidal ranges commonly found east of Machias.

Two areas in particular have have received considerable study: Half-Moon Cove (in Cobscook Bay) and Cobscook Bay.

Half-Moon Cove:

Since 1976 the Pleasant Point Passamaquoddy Reservation in Perry has been examining the feasibility of constructing a tidal power facility at Half-Moon Cove. It is currently projected that it will produce 12 megawatts/year and will cost $34 to $35 million to construct. When completed it should be able to produce power for about 7 1/2¢/kw hour based on 1980 dollars and will displace 55,000 to 65,000 barrels of oil a year. The Reservation applied for and received a preliminary permit from the Federal Energy Regulatory Commission in 1980 which secures the site for three years. It is anticipated an application for a license to build and operate the facility will be requested during 1981 by the Reservation.

Cobscook Bay:

The Army Corps of Engineers has been examining this project since the 1930's. In their reports they identified approximately ninety tidal power alternatives. The size of the alternative projects ranged from 5 to 500 megawatts with possible annual power outputs of 16 to 790 million kilowatt hours per year. The construction costs of the projects range from $22,000,000 to $916,000,000.

A tidal power project involving the cooperation of the United States and Canada has also been proposed for the Passamaquoddy and Cobscook Bays. The first stage of development would result in 500 megawatts of capacity. By implementing the second stage the capacity could be increased to 1000 megawatts.

While the Cobscook/Passamaquoddy Bay area has the most favorable conditions for tidal hydro power development along the Maine coast, no assessment whatsoever has been made of the potential for tidal power development in other areas. While large sites with similar potential clearly do not exist, a large number of potential sites for small and medium-sized tidal power facilities probably do exist. Fifteen to twenty sites outside of Cobscook and Passamaquoddy Bays are now being actively investigated for development. As an example of the amount of power Maine could expect from tidal facilities in the future it was estimated in the Thayer School of Engineering's "Energy Atlas" (Dartmouth College) in 1978 that Cobscook and Passamaquoddy Bays combined could supply about 2.6 percent of Maine's total energy demand. Therefore, if all of the suitable sites on the Maine coast were developed, tidal power would provide a small but significant part of Maine's entire energy demand.

e. Limits and Advantages

Tidal power is a very attractive source of energy because once a tidal facility is built the cost of producing power will remain relatively stable for the life of the project (which should have a structural life in excess of 100 years). The potential availability of tidal power in Maine's future is essentially dictated by the number of sites suitable for development. There are several important constraints to developing tidal power on a large scale in Maine. A few of these are:

Economic - Depending on the type of economic analysis used to determine tidal power feasibility, cost/benefit vs. life cycle, it is either feasible or not. The type of analysis generally used on water projects do not favor tidal power proposals at this time.

Environmental-	The environmental effects of a tidal facility on a productive and functioning ecosystem would be significant but have yet to be fully quantified and compared to the energy benefits.
Funding -	Currently there are limited sources of capital available at reasonable interest rates.
Tidal - Characteristics	The tidal cycle and the availability of power often does not coincide with power system demands.
Access -	Boat access to and from the bay or inlet would be restricted unless a lock were built in the dam.

Advantages of developing tidal power include:

- o No fuel;
- o The possible development of a productive aquaculture site in the pool area;
- o No waste products; and
- o Stable and predictable costs of producing electricity.

e. Current Programs and Policies

Currently Maine has no policy relating to tidal power development other than to "encourage the use of this alternative energy source". Maine also has no state funding programs specifically available for tidal power development. There are, however, several federal funding programs where the state has the authority to act as a clearinghouse or can help to coordinate a developers plans with the federal agency program.

The most significant federal program, both in terms of dollars and man-hours invested, is the work prepared by the Army Corps of Engineers on Cobscook and Passamaquoddy Bays. For the past 40 to 45 years the Army Corps has been evaluating the tidal energy potential of these two bays. In the 1930's the Army Corps actually began construction on a tidal facility but later suspended operations due to changing economic conditions.

Another federal program which has assisted in the preparation of tidal power plans is the Coastal Energy Impact Program. Funded through the National Oceanic & Atmospheric Administration (NOAA).

Most state legislative policies cited in the section on riverine hydro power are applicable to tidal hydro power sites. In addition, tidal sites would require:

- a lease from the Bureau of Public Lands for use of the submerged lands at the dam site and beneath the power pool; and
- federal permits from the Army Corps (Section 10) and the Coast Guard for dredging and filling and creating obstructions to navigation.

7. Biomass

a. Introduction

Biomass is any plant or organic matter. It includes all agricultural crops and crop residues, animal wastes, plants grown for energy production and wood and wood residues. Biomass can be burned directly, it can be pelletized, it can be gasified and it can be made into alcohol.

b. Current Use

Ethanol and methanol are the two most prominent alcohol fuels presently being used to power internal combustion engines. Methanol, which can be made from biomass, has been used for years to power race cars. Ethanol, which is made from any biomass material containing sugars or carbohydrates, is enjoying an upsurge in popularity. While alcohol stills have produced "moonshine" by fermentation illegally for years, farmers and entrepreneurs are beginning to produce it legally. Both alcohols are used in a blend of 90% gasoline and 10% alcohol--so-called gasohol.

c. Resource Availability

Wood and wood residues are currently being burned directly, pelletized, and gasified in Maine. Some poultry farmers are gasifying chicken litter to produce methane gas to heat their poultry houses. The annual output of alcohol from available Maine potatoes could reach 4.7 million gallons annually, an amount equal to 1.6% of Maine's unleaded gasoline consumption. Oats could yield another 1.5 million gallons.

d. Limits and Advantages

Farm equipment or other vehicles that use an internal combustion engine can run on straight 160 proof or stronger alcohol by making minor adjustments to the engine carburetor. It is a well established fact that engines can run on blends of up to 20% alcohol and 80% unleaded gasoline with few resultant problems. However, because alcohol does have a tendency to separate from gasoline and to collect water it is generally felt that the 90% gasoline, 10% alcohol (200 proof) blend in gasohol is optimal because it is anhydrous or water free.

Alcohols have several detrimental characteristics They do not have as much energy output as gasoline, they burn with no visible flame, they are corrosive to engine parts, they often make starting in cold weather difficult, and they have a tendency to separate from gasoline. Alcohol plants are fairly capital intensive; this is particularly true of methanol plants. The environmental effects of large scale alcohol fuel production have not been addressed and the Environmental Protection Agency has not yet approved alcohol fuels as a gasoline additive.

Methanol production is not economical on a small scale, while ethanol production is a fact which makes production of the latter very attractive. Another desirable feature of ethanol production is the distillers grain by-product, which is extremely high in protein. This by-product can be fed to livestock, poultry or other animals. It is also being examined as an attractive high protein supplement for humans.

e. Programs and Policies

Many Federal agencies including the Department of Energy, the Department of Agriculture, the Small Business Administration, and Housing and Urban Development have been given additional funds to boost alternative fuel production. Other agencies have been instructed to redirect portions of their funding toward alternative fuels production.

Maine has an Alcohol Fuels Task Force comprised of 17 members representing both the public and private sectors of the economy. Their charge was to develop policies under the broad question of "Should the State of Maine support an alcohol fuels industry?" They looked at resource availability, various technologies, the economics of alcohol production, state and federal legislation and other aspects of alcohol fuels production. This task force is and has assisted the OER in efforts to encourage alcohol production in Maine. At the present time, the Task Force is studying the information that they have collected in preparation for making their recommendations. A final report will be issued by the Task Force in early February.

In addition, the Office of Energy Resources provides information and some technical assistance to persons interested in alcohol fuels production. OER is the state contact for the National Alcohol Fuels Commission, the Department of Energy's Fuels Office and the Solar Research Institute.

In addition to the Alcohol Fuels Task Force and technical assistance noted above, the influx of federal money has and will help to increase the production of alcohol fuels and will help decrease some of the capital costs of the construction of alcohol plants. These efforts will help allow alcohol fuel plants to come on line faster than they would without Federal assistance.

There are presently 3 moderate to large scale ethanol projects that are in various stages of planning or construction in Maine. Two of the plants would use potatoes, while one of the plants would use imported grains from the Midwest. In addition, two small alcohol fuel projects were recently awarded DOE Appropriate Technology Feasibility Grants. Tax credits and other Federal incentives have helped to make alcohol fuels production more attractive.

8. Peat

a. Introduction

For hundreds of years, peat has been utilized to generate energy. The importance of peat as a fuel generally depended upon the relative price and abundance of other types of fuel, particularly wood. Typically, interest in utilizing peat as an energy source in the home, and more recently in the commercial and industrial generation of power, is heightened during shortages or following substantial price increases for other fuels. Rising oil prices during the last decade have renewed interest in developing peat as a viable energy source in Maine.

b. Current Use

At the present time, peat is not used in Maine to supply the state's energy demands. Peat harvested in Maine is used solely for agricultural and horticultural purposes. Elsewhere in the world, primarily in northern latitudes, peat is important in the production of energy. Ireland, for instance, uses peat to generate nearly one third of the country's electricity. The U.S.S.R., which accounts for about 95 percent of the world's total peat extraction, has 76 peat-fired generating stations which produce about 3 percent of the country's total electrical output.

c. Resource Availability

The evaluation of Maine's peat resources indicates Maine has, as of September 1980, 78,094 acres of surveyed peat deposits with estimated resources of 117,493,500 short tons of air-dried peat. Peat may be processed for utilization as an energy source through gasification, briquetting, or pelletization. Of the three methods, briquetting and pelletization appear to have the best potential for providing peat for both domestic and industrial use in Maine.

d. Limits and Advantages

One of the major limits on the development of peat as an energy source is the environmental effects of mining peat. Peat deposits hold an important place in the hydrologic cycle, particularly as ground water recharge and retention areas. Harvesting and removal of peat may seriously alter surface water and ground water configurations and quality. These effects must be addressed prior to mining.

Many of Maine's peat deposits occur in wetlands that are important wildlife and botanical habitats. Conflicts may arise between those who want to develop a particular deposit and those who want to preserve it in its natural state. In addition, alteration of wetlands is regulated in Maine; restrictions and required permits vary for different areas within the state.

Development of many of Maine's more promising peat deposits may not occur for years because of their inaccessibility. Peat harvested from more remote deposits would not be economical as a fuel if it had to be transported great distances.

At the present time, all peat harvested in Maine is used for agricultural and horticultural purposes. Conflicts may arise about the most appropriate use for peat mined in the state, particularly given the marginal condition of Maine's farm land.

Although peat has a relatively low sulfur content if burned, its high nitrogen content may cause emissions to exceed U.S. Environmental Protection Agency standards.

e. Current Programs and Policies

The Maine Geological Survey and the Maine Office of Energy Resources are currently conducting a cooperative program to evaluate the fuel potential of Maine's peat resources. The project is funded by the U.S. Department of Energy, and was designed to supplement previous studies by the Maine and U.S. Geological Surveys. In the field study segment, peat deposits are mapped, their depth and aerial extent are determined, and the reserves for each deposit are calculated. Samples collected from the surveyed peat deposits are analyzed in U.S. Department of Energy laboratories. Data obtained for each sample includes proximate and ultimate analyses, heating value, pH, ash content, and water content. Additional geochemical analysis is conducted at the U.S. Geological Survey laboratories.

In view of the hydrogeologic importance of peat deposits, the Water Resources Division of the U.S. Geological Survey, in cooperation with the Maine Geological Survey and the Office of Energy Resources is investigating the hydrologic characteristics of selected peat deposits in the state. Surface water and ground water data and water quality information gathered in the field will be used to construct hydrologic models of the deposits' response to various stresses and changes.

The Institute of Quaternary Studies at the University of Maine at Orono is analyzing samples taken from deposits representative of the major physiographic forms for pollen and foraminifera content and radiometric dates. The Institute is also studying growth and regeneration rates for vegetation typical of peat deposits.

The Commissioner of the Maine Department of Agriculture has appointed a Task Force on Agriculture Uses of Peat in Maine. The Task Force has been asked to determine the potential value, quantity, and quality of peat utilized in agriculture, identify and support research or demonstration projects, and recommend policies regarding agricultural use of peat as a nonrenewable resource.

V. FOSSIL AND NUCLEAR SOURCES

V. FOSSIL AND NUCLEAR SOURCES

Introduction

As this Resources Plan is an attempt to describe Maine's various energy sources, a discussion of the current and potential future roles of fossil and nuclear fuels is essential. Fuel sources examined include petroleum, coal, nuclear and natural gas (natural gas is dealt with in the Canadian Energy section). In addition to these sources, analyses of the potential for energy exchanges with Canada and the nature of emergency contingency and economic assistance planning efforts are also included.

1. <u>Oil</u>

Oil, which in this case means the entire range of petroleum products including gasoline, heating oil, kerosene, diesel, aviation fuel, and residual oil, has been the dominant source of energy in Maine for the past thirty years. Petroleum's advantages over other fuels during the period from the end of World War II to the Arab oil embargo in 1973-1974 were substantial. Oil is easily transported by water, rail, and truck, making it an ideal fuel for a rural state like Maine. It is generally clean, easily burned, and for most of the period prior to 1973 its price in real terms was either declining or holding steady. Moreover, oil can be used to heat homes and offices, to run cars, trucks, and trains, and to generate electricity. It is little wonder that petroleum came to dominate completely the energy resource picture in Maine; as illustrated in Table A, oil accounted for 88% of all energy used in Maine in 1973.

Of course, Table A also shows what has happened to oil consumption over the years since 1973. The growth trend for oil consumption in Maine has reversed entirely, and is now (as of 1978) declining in all sectors from previous highs. The reasons for these declines are well known. The price of crude oil has gone up 800% on world markets since 1973, and the price of oil products that Maine people use have more than quadrupled (the differences in the rise in crude and product prices reflect in part the lower domestic crude oil prices which were price controlled.) In addition, the currently inextricable link between political stability in the Middle East and the supply and price of oil has led to two significant supply cutoffs in world markets during the past seven years. Each cutoff had serious consequences for Maine because of its dependence on petroleum products.

There can be little doubt that the use of petroleum in the energy resource mix of Maine will be the dominant energy problem for the remainder of the century. OPEC will continue to be able to exercise monopoly-like powers over both the supply and price of oil on world markets; there will continue to be a constant threat of political disruptions in the Middle East which might shut down shipments from that region entirely for unknown lengths of time; and there is no question whatsoever that the price of oil will be going up, making heating homes and driving cars an increasingly expensive proposition for Mainers. It is also certain that over the long run the world supply of petroleum will gradually decline; there is a finite supply of oil in the world, and though we have not yet reached the end of that supply, there is no doubt that it lies somewhere in the future.

A more detailed examination of petroleum's future supply and price gives even greater weight to the necessity of reducing overall levels of petroleum use, through conservation and the development of alternative fuels. For example, while it is not possible to predict with any certainty what the future price of oil will be (consider that the 800% price increases occurred primarily as a result of the Arab oil embargo in 1973-1974 and the Iranian Civil War in 1978-1979), a simple straight line projection of future oil prices, based on an assumed OPEC desire for an increase of 3-4%/year over and above the rate of inflation (assumed here to be 7%/year) would yield future prices for a barrel of residual oil as follows:

	1985	1990	2000
OPEC increases Price 3%/year over inflation			
Current $	57.83	93.33	222.80
Constant (1980)$	39.08	44.60	58.43
OPEC increases Prices 4%/year over inflation			
Current $	60.48	102.15	267.98
Constant (1980)$	40.87	48.84	70.27

Source: Data Resources, Inc.

Worldwide, the supply of oil is expected to be adequate to meet most world demand, at least through the mid-1990's. However, as the demand for oil increases with economic and population growth, not only in the United States but throughout the industrialized and non-industrialized world, the probability that oil supplies will become tighter and tighter sometime during the 1995-2000 period increases. Although the oil will not run out, it will become increasingly scarce, thus providing further impetus to price rises, over and above those pictured above.

Of course, the higher price for oil will provide economic incentive to explore for and produce more oil domestically. And these higher prices will be needed since almost all the known oil that remains in this country is in very high cost areas such as the Arctic, under the continental shelf off Alaska, and in the deep water under the Atlantic continental shelf. Because production from existing domestic wells will continue to decline throughout the next 20 years and demand will increase because of population and economic growth, new supplies of oil will have to be found just to keep us more or less even. The following table compares domestic and foreign oil production in current and future years.

U.S. Oil Supply (MM bbl./day)

	1980	1985	1990	2000
Domestic	8.23 (53%)	8.23 (53%)	9.72 (60%)	10.54 (59.7%)
Imported	7.29 (47%)	6.48 (47%)	6.48 (40%)	7.10 (40.3%)

Source: Data Resources, Inc.

It is obvious that conservation of oil use must be the focal point of any energy strategy for Maine. If we will still rely on oil for 68.7% of our energy in 1990 (as we did in 1978), and if that oil is double in price in real terms, and if we still must get 40% of our oil from OPEC, we will still be placing ourselves in substantial risk of economic catastrophe and will be a significantly poorer state.

Fortunately, it should be possible to save substantial amounts of oil between now and 1990. The programs outlined in the Section on conservation could save as much as 21% of our 1978 petroleum consumption. The biggest potential savings are in the commercial sector where almost 50% of 1978 consumption might be eliminated. Savings of 24% in the residential sector and 20% in the industrial sectors might also be possible. Because of Maine's total reliance on petroleum for transportation, the savings in that sector are estimated to be only 1.5%.

It now appears that Maine will continue to rely on petroleum for as much as half of all its energy needs by the year 2000, and for most of its needs in the critical transportation sector. Thus, in addition to the steps to be taken to increase conservation of oil, it will also be necessary to continue and expand energy emergency contingency planning, as outlined in Section F.

TABLE A
Trends in Oil Consumption in Maine by Sector, 1960-1978

Sector	1960	1970	1973*	1978
Residential Oil Consumption		1977*		
(Trillion BTUs)	36.3	50.5	57.9	51.7
Oil as % of Total Energy Consumption	72.5	70.7	62.3	58.9
Ave. Annual Change in Oil Consumption	-	3.8	2.1	-10.7
Commercial Oil Consumption			1972*	
(Trillion BTUs)	23.3	41.9	50.6	44.4
Oil as % of Total Energy Consumption	72.4	77.8	81.4	66.9
Ave. Annual Change in Oil Consumption	-	7.9	10.4	- 2.0
Industrial Oil Consumption			1977*	
(Trillion BTUs)	19.7	30.5	70.12	60.0
Oil as % of Total Energy Consumption	33.2	43.7	60.0	56.5
Ave. Annual Change in Oil Consumption	-	5.5	18.6	-10.1
Transportation Oil Consumption			1973*	
(Trillion BTUs)	66.3	88.0	110.3	99.8
Oil as % of Total Energy Consumption	99.9	99.9	99.9	99.9
Ave. Annual Change in Oil Consumption	-	3.3	8.5	- 1.9
Electric Generation			1972*	
(Trillion BTUs)	15.1	31.3	36.4	11.5
Oil as % of Total Energy Consumption	39.6	55.1	48.6	10.35
Ave. Annual Change in Oil Consumption	-	10.8	8.2	-11.4
Total State Oil Consumption				
(Trillion BTUs)	160.7	242.1	312.9	236.4
Oil as % of Total Energy Consumption	77.0	85.0	88.0	64.0
Ave. Annual Change in Oil Consumption	-	+.1	+ 9.7	- 4.9

*This year is the highest use year for petroleum in that sector.
Source: Department of Conservation, State Energy Data.

2. Coal

Two things are remarkable about the use of coal as an energy resource in Maine: the decrease of its use over the past 30 years and the promise it holds for supplying Maine in the future. From more than 21% of total energy supplied in 1950, coal dropped to virtually nothing in 1978 (See Table B). The reasons for coal's decline in usage were relatively simple: oil was both cheaper and more available during the period prior to the Arab oil embargo, and so the shift was made to oil and electricity by residential users for space heating as well as by industrial and commercial users for space and process heat. And the last of the steam locomotives were removed from service, to be replaced with diesels.

But the promise for a return to coal use in Maine over the next two decades is evident. Several recent events are indicative of what are likely to be the future trends: The Martin Marietta cement plant at Thomaston has converted to coal for its space and process heat uses. Central Maine Power is considering constructing a major coal fired-electric generating plant for Sears Island, and is also considering developing an innovative coal burning technology for electric power generation there. CMP has announced that it will convert 60% of its present generating capacity at the currently oil-fired Mason Station in Wiscasset to coal burning. And, while data are not yet available, there has been a substantial expansion of the home heating market for coal over the past two years. These events are undoubtedly signs of the upward direction of coal utilization in Maine. Coal-fired electric generation, as well as industrial and domestic use are expected to expand over the next decade.

Coal is by far America's most abundant fossil fuel resource, with proven resources sufficient for several hundred years at current consumption rates. However, there are several factors which will affect the extent to which coal becomes a major energy resource in Maine over the next ten-twenty years:

First, there are potential environmental problems which may accompany increased coal burning. Conventional coal burning, especially if high-sulfur eastern coal is utilized, creates substantial quantities of sulfur dioxide, a human health hazard and the underlying cause of acid rain. In addition, suspended particulates and nitrous oxides are produced by-products from conventional combustion technologies. These air quality effects may severely limit the applicability of large scale coal burning in Maine, especially in those areas of the State where there are severe air quality limitations.

New combustion technologies are available, however, which hold out a great deal of promise for alleviating these problems. CMP has already begun to investigate the feasibility of constructing a coal-fired Integrated-Gasifier Combined Cycle generating plant. This technology can convert high sulfur coal to a medium BTU gas, the gas will then be driven through a turbine which will generate electricity, and then the gas will be burned, driving additional turbines and generating more electricity. This process removes sulfur from the coal when it is converted to a gas, thus limited sulfur dioxide is created through combustion, with suspended particulates eliminated as well. Another promising technology is fluidized bed combustion which injects coal into a superheated bed of an inert material. The superheating allows for more complete combustion of the coal and reduced consumption. Fluidized bed combustion is widely used abroad, and several major installations have been constructed in various parts of this country.

The energy produced by these plants, or even from conventional coal burning plants, can be further increased by the use of coal in cogeneration stations where the heat produced in the electric generating process is used in addition to the electricity. The alternate combustion technologies, particularly fluidized bed are particularly suited to relatively small applications such as cogeneration stations.

Although proven in other areas, the application of these technologies to Maine will require examination of specific environmental problems which may occur. If a large number of coal plants are to be utilized the facility siting process in Maine must be able to handle these plants. The economics of power plant construction also may affect the utilization of these technologies.

Specific attention must be given to problems relating to the disposal of waste products, particularly coal ash and sludge, that result from coal combustion. Planning for suitable disposal sites, probably on a regional level, must occur and additional research conducted to determine the feasibility of coal ash reuse as a road bed aggregate.

Presently, Maine's rail and cargo port facilities are limited for transporting large quantities of coal into the state. To accomodate increased coal transhipments, renewed consideration must be given to the development of rail and port facilities.

Finally, there is the question of price. On a per BTU basis, coal most likely will continue to cost less than oil does, but it is likely that the price of coal will rise over the next twenty years at rates roughly comparable to the projected rise in oil prices. Thus, a projection of a 3% rise in the real price of coal above a 7% rate of inflation (or 10% annual price rise) would show coal prices as follows:

Maine Coal Prices (Eastern High Sulfur Bituminous-Steam Grade)

$/Ton

	1980	1985	1990	2000
Current $	49.99	87.47	137.27	306.07
Constant (1980)$	-----	59.10	65.60	80.26

Thus coal, although it will continue to be available and will be increasingly used in various applications in Maine, will not be cheap.

It is not possible at the moment to predict the precise extent of future coal use in Maine. The trend is obviously up. By 1990, based just on existing and planned projects it is probable that coal will account for between 6% and 8% of Maine's total projected energy needs. As conversions of existing industrial, commercial, and residential users continue and new coal-fired generating capacity comes on line this percentage will undoubtedly increase. In addition, in the decade of 1990-2000 it is likely that liquid fuels (synthetic fuels) derived from coal will begin to become available as substitutes for liquid petroleum fuels. The extent of these developments is unknown however.

TABLE A

Coal Use in Maine 1950-78

	1960	1970	1973*	1978
Statewide				
Trillion BTU's	36.413	20.178	1.663	0.488
% Total Consumption	21.6	9.7	0.6	0.0001
% Change		-44.6	-91.2	-99.9
Residential				
Trillion BTU's	2.62	1.914	0.189	0.032
% of Total Sector	5.3	3.8	0.2	0.03
% Change		-26.9	-90.1	83.0
Commercial				
Trillion BTU's	1.31	2.57	0.221	0.022
% of Total	10.03	7.9	0.4	0.03
% Change		96.2	-91.4	-90.0
Industrial				
Trillion BTU's	26.1	14.946	1.251	0.444
% of Total	40.11	25.52	1.8	0.3
% Change		-42.7	-91.63	-64.5
Transportation				
Trillion BTU's	2.82	0.253	0.002	0
% of Total	8.1	0.3	0.00002	0
Electricity & Gas				
Trillion BTU's	5.68	0.486		

3. Nuclear Energy

The 1973-74 oil embargo heightened interest in non-petroleum related energy sources, expecially the potential for producing power from nuclear energy. "Project Independence" called for nuclear energy to produce 30-40% of the nation's electrical needs by the end of the 1980's. Since then, concerns over health and safety issues related to nuclear power as well as practical problems of waste disposal and decommissioning have slowed the anticipated rate of new nuclear power plant construction. In 1979, President Carter reversed the priority given to atomic energy under the previous administration and, although he recommended a streamlining of nuclear power licensing procedures, he advocated an increase of nuclear power only as a last resort.

The Maine Yankee Atomic Plant is the only nuclear power plant operating within Maine. Maine Yankee has a rated capacity of 864 mwe and has on the average, produced 4.6 billion kwh of electricity per year since it came on line in 1972. It is licensed to remain in operation until 2008. Maine utilities own 50% of Maine Yankee's capacity. Thus, Maine Yankee produced 27% of the electricity sold in Maine in 1979, although it produced 60% of the total electricity generated in the state.

Maine utilities also own a combined total of 70 mwe of capacity in other nuclear power plants in New England. In 1979 these out-of-state plants contributed approximately 488 mwh or 6.2% of the electricity sold to Maine consumers. The utilities also plan to purchase 257 mwe of capacity from the Seabrook, New Hampshire and Pilgrim, Massachusetts power plants now under construction.

The future for nuclear power is uncertain both in Maine and in the rest of the country. The Atomic Industrial Forum said in May 1979, that nuclear power reactors coming on line by the year 2,000 will consume over their lifetime all of the uranimum now considered to be a practical planning resource. The Forum's suggestion is to have breeder reactors available by the turn of the century. Reprocessing would extend the contribution from today's light water reactors by up to a decade. Breeder reactors could sustain nuclear power indefinitely through their cycles.

Constraints unrelated to the availability of uranium make it very unlikely that any new nuclear power plants will be constructed in the State of Maine. First, legislation passed in 1977 prohibits the construction of any new nuclear power plants in Maine unless the Public Utilities Commission finds that a satisfactory solution exists to the problem of nuclear waste disposal. There is some question as to the effect of this law as it relates to the jurisdiction of the Nuclear Regulatory Commission. A similar law is being appealed to the U.S. Supreme Court from California. Second, although a referendum to close Maine Yankee failed this fall, it served as a further indication that Maine citizens are concerned about the use of nuclear power. Finally, while Governor Brennan supports maintaining Maine Yankee, he also opposes construction of all new nuclear power facilities until problems of nuclear waste disposal and decommissioning are resolved. For these reasons, we can expect all new nuclear power capacity for the State of Maine will be purchased from out-of-state sources.

There are several critical issues regarding Maine's existing nuclear power plant which are being addressed. These issues relate to safety and evacuation procedures, waste disposal and decommissioning.

Regulations issued by the Nuclear Regulatory Commission on August 19, 1980, describe the role of State and local emergency response plans for continued or new licenses to operate commercial nuclear power reactors. The regulations require two state plans, one for an emergency planning zone of about 10 miles radius and one for a planning zone of about 50 miles radius.

The State plan for the ten-mile zone has been completed by the Maine Office of Civil Emergency Preparedness in draft form and has received preliminary reviews from both the Nuclear Regulatory Commission and the Federal Emergency Management Agency. Full implementation of this plan will be completed by July 1, 1981. The zones for contaminated food and water with a 50 miles radius will be implemented in 1982.

Disposal of high-level radioactive waste has also become a very serious problem. Because of increased federal safety regulations which drove the price of reprocessed fuel exorbitantly high and President Carter's concern for nuclear weapons proliferation (plutonium is a product of nuclear fuel reprocessing) the President ordered a halt to all commercial nuclear fuel reprocessing in this country.

Maine Yankee's nuclear reactor cores functions with 217 bundles of 176 fuel rods per bundle. On the average, 70 of those bundles are removed per year to the spent fuel pool and replaced with new fuel. Maine Yankee was licensed to store 318 spent fuel bundles when it began operation. In 1975 it was allowed to reduce its rack spacing to allow for a total of 953 bundles. Now, in September of 1980, the company has filed for amendment of its license to allow for even closer rack spacing and individual rod storage to allow for a maximum of 2,400 bundles of storage. This will allow Maine Yankee to operate at a normal rate until the year 2,000 while storing all of its spent fuel on site. If the permission to allow more spent fuel storage on site is denied, the plant will have to ship it off site to another plant's pool, to Federal away-from-reactor (AFR) storage, or the plant will shut down. Presently, there are no designated federal AFR sites.

On a national scale there are presently no high level permanent storage or disposal sites available to place the waste reactor fuel for final internment. A special Interagency Review Group study done by the White House and completed in 1979 lists mined geological repositories, deep ocean sediments, and very deep drill holes as top choice options for high level nuclear waste disposal feasible by

1995. The Department of Energy is responsible for investigating these possibilities and recommending a disposal site. A study commissioned by the Department of Energy has indicated Maine as one of sixteen states with potential for further study of its large, crystalline granite formations as a site for high level waste storage. That process is presently continuing and federal agencies have appraised the state of their current activities.

Finally, planning should begin now for decommissioning Maine Yankee after the useful life of this facility has ended and the plant must be placed in a final shutdown position. At this time, no final decision as to whether Maine Yankee will upgrade certain of the plant's components to generate power beyond 2008 has been made. To date no nuclear power plants have been decommissioned; however, two plants are scheduled to close down in the 1980's and will provide some data for plant decommissioning of other nuclear power plants.

A 1978 study done by Pacific Northwest Laboratories for the Nuclear Regulatory Commission estimated decommissioning costs for a plant the size of Maine Yankee at $42 million in 1978 dollars. Other studies have predicted decommissioning costs of up to $100 million. The ratepayers of Maine will assume at least 50% of the decommissioning costs based on Maine utilities ownership in Maine Yankee.

4. Canadian Energy Exchange Potential

a. Introduction

The prospects for an exchange of energy between Canada and New England have recently drawn the attention of officials in both countries. Possible surpluses in hydropower and nuclear power from Quebec and New Brunswick and natural gas from Alberta and Eastern Canada has stirred the interest of the New England governors, public utility officials and the utilities themselves.

The New England Governors and the Eastern Canadian Premiers established the Northeast International Committee on Energy (N.I.C.E.) in June 1978, in order to oversee New England - Eastern Canadian joint energy initiatives and to initiate and maintain discussions of cooperative possibilities. An information exchange active program to exchange information is presently underway and N.I.C.E. has sponsored several innovative joint programs highlighting alternative energy, including a solar design competition, the establishment of a wind energy test facility on Prince Edward Island and the recently completed "International Conservation Days" competition involving towns from all six New England states and all five eastern Canadian provinces.

b. Current Use

Presently, Maine has six major interconnections (69 KV or above) with New Brunswick and several minor interconnections. The largest interconnection is the 600 megawatt MEPCO line from New Brunswick. Maine utility companies own a total of approximately 51 megawatts of capacity in the Coleson Cove coal-fired generating facility in New Brunswick. On November 1, 1985 this ownership will drop to one-half of that amount and on November 1, 1986 the contract expires completely. In 1979, Bangor Hydro Electric Company purchased 16 million kilowatt hours of electricity, CMP purchased 322 million KWH, Maine Public Service purchased 19 million kwh and Eastern Maine Electric Cooperative purchased 38 million kwh. This represents about 4.4% of the total electricity used in the state.

Canada offers an increased potential for imported electricity in the next five to ten years. Quebec has indicated its interest in exporting hydropower from the James Bay area and additional power may be available from the Churchill River area in Labrador. New Brunswick's new nuclear power plant, Point LePreau, is also predicted to have a surplus capacity. Central Maine Power Company is presently negotiating for 100 megawatts of capacity in that plant and Bangor Hydro is negotiating for 30 megawatts. If an agreement is reached, this power will be available between 1981 and 1989.

c. Limits

There are several barriers that exist to power exchanges with Canada. First, there is disagreement over the amount of power that will be available to New England. A NEPOOL preliminary report of potential New England/Quebec power interchanges indicates that a power interchange between Hydro-Quebec and New England before 1987 is not likely because adequate transmission lines cannot be completed in that time. The report also states that after 1987 Hydro-Quebec will have no surplus energy for sale. On the other hand, forecasts by Quebec planners of growth rates are quite high (6.5 to 7.5%) by comparison with recent New England forecasts of 2.0 to 3.5%. If the Quebec forecasts are high, by even 2 or 3%, there may be a very large amount of surplus capacity, between 2,000 to 5,000 megawatts, that could be exploited between 1985 and 1995.

Second, many utility companies are hesitant to purchase power in facilities not located in the United States. Third, Quebec seems to be more interested in dealing with a single large entity such as the New York Power Authority than with dealing with individual state and utilities. Presently, there is no organization that could represent the New England states in bargaining for power with Quebec. Fifth, transmission lines between Canada and the United States will need to be upgraded or new ones constructed. The MEPCO line could probably be upgraded to assume greater capacity sooner than new transmission lines can be constructed since environmental permits would not be necessary.

d. Natural Gas

Presently, the State of Maine does not receive any natural gas directly from Canada. There are, however, one immediate and two longer range sources for natural gas imports. Currently, a proposal to transfer a surplus of Alberta natural gas across an existing pipeline interconnection at Niagara Falls, New York, is pending before the U.S. and Canadian governments. While this flow would primarily benefit New York, New Jersey and southern New England, a small increment would enter Maine by way of the Bay State Gas-Northern Utilities pipeline. This line serves only the Portland and Lewiston-Auburn areas.

The potential for further gas exports from Canada is represented in the two stage extension of the trans-Canada pipeline, referred to as the Quebec and Maritime Pipeline Project. The first stage which extends the present pipeline to the Quebec area has been approved by the National Energy Board and will be under construction soon, pending resolution of some environmental and right-of-way questions. The second stage which extends the pipeline to the Maritimes has been announced as a policy goal of the Canadian government. This portion of the pipeline may involve an export segment called the New

England States Pipeline Project. This project is a joint venture between Algonquin Gas Transmission Company of Boston and Transcontinental Gas Pipeline Corporation of Houston. It involves the construction of a gas pipeline from the Canadian Border, through Maine, to Algonquin's pipeline in Rhode Island. It would bring 91.25 billion cubic feet per year of Canadian gas to New England and the New York area.

Maine is not assured of access to the gas in this pipeline since allocations must be approved by the Federal Energy Regulatory Commission. However, Maine has been assured by the companies involved in the pipeline that they would support distribution of gas from the pipeline in Maine. A report by E.J. Curtis Associates on behalf of the Massachusetts Office of Energy Resources, entitled "Prospects for Natural Gas Exchange between New England and Eastern Canada," states that the existence of the New England states pipeline would have implications that go beyond the immediate project: "Such a tie-in would constitute a "backdoor" interconnection with the entire U.S. gas pipeline system. To the extent that gas is delivered into the end of the U.S. gas pipeline, it creates some additional capacity in the system and, therefore, improves New England's access to supplies which may be developed to the south and west of the region. This is so because of the displacement principle. For example, if a Texas-based pipeline contracts to buy Canadian gas from the Sable Island Reserve, it could be delivered via New England to market all the way down the line to Texas. Since gas is already flowing into the northeast from Texas, however, the Canadian gas would not have to be physically transported to Texas. Instead New England would use Canadian gas. The net result is a decrease in the actual flow of gas into the New England area from the southwest, thereby increasing the capacity of the existing system to bring new gas into the region. This would clearly be desirable to the New England gas industry in that it would significantly expand supply options."

Future supplies that may augment the surplus of Alberta gas may come from the Canadian Outer Continental Shelf or the Canadian Arctic/U.S. Alaskan Reserve. Recent discoveries of natural gas on Sable Island and in Hybernia could be surplused to Canadian needs and, thus available to New England markets. These possibilities are in the future; however, if they do come to fruition, Maine may well become an energy corridor supporting a pipeline to southern New England to deliver this gas.

5. Emergency Planning and Economic Assistance Programs

a. OER Emergency Planning

The Maine Office of Energy Resources has, as one of its responsibilities, the development of emergency planning for fuel shortages. Both the oil embargo of 1973 - 1974 and the gasoline shortage of 1979 illustrate the need for such planning. Through its ongoing conservation and resource development programs, the office hopes to reduce overall petroleum consumption so that the State will be less vulnerable to supply disruptions. When a shortage does occur, the OER intends to call for voluntary compliance of specified conservation measures. In the event that voluntary compliance proves insufficient, OER is prepared to introduce mandatory measures to curtail consumption.

The OER maintains a data management function intended to monitor the supply of petroleum products in Maine. In addition, the office follows developments in the international oil market and watches national inventory levels. Each month the major suppliers of petroleum products to the State submit reports listing expected deliveries for the next month and current inventory levels. By comparing this data with historical consumption and stock levels, the OER can determine when a shortage may occur. In any month when the OER believes the supply of petroleum will not meet demand, the office will notify the Governor of the potential problem so that the appropriate steps may be taken.

Under the Civil Emergency Preparedness Act of 1974, the Governor has the power to adopt programs regulating the use and allocation of fuel. In response to a possible shortage, the Governor may call a meeting of appropriate industry and government representatives to discuss the situation. He may also inform the public as to the extent of the problem and call for voluntary compliance of certain conservation measures. If the people of Maine voluntarily curtail consumption, mandatory measures may be avoided.

Only if the crisis persists and a severe shortfall of fuel supplies occurs will mandatory measures be enacted. Such measures could include requiring a minimum purchase for gasoline, restricting gasoline sales under an odd-even program or enforcing building temperature standards. The OER has developed a list of priority users whose needs will be protected under the regulations. Emergency vehicles, agriculture, health care services and institutions, passenger transportation and commercial vehicles are examples of priority users. Every attempt will be made to allocate fuel supplies in an equitable manner and to protect vital services.

Another mechanism available to the state for coping with the fuel shortages is the state set-aside program. Each month the major suppliers "set-aside" 5% of the gasoline and 4% of the heating oil coming into Maine for the State to allocate to meet emergency or hardship needs. The Fuel Allocation Office, which administers the program, follows federal guidelines in the distribution of the product. First of all, the FAO acts to meet the needs of priority users, then attempts to prevent localized shortages, and also works to assure an adequate suppply for important economic or social activities such as tourism. The State set-aside program can be a very effective tool in mitigating the impact of fuel shortages on the State.

In November, 1979, Congress enacted the Emergency Energy Conservation Act (C.P.L. 96102) to provide a mechanism for dealing with national energy emergencies. The Act called for the development of a federal gasoline rationing plan, authorized the President to set both National and State conservation targets during a shortage and outlined a Standby Federal Conservation Plan. In the event of a severe supply disruption, the President will publish targets for each state. The states will then have 45 days to submit a plan detailing how they propose to meet the targets. If a state does not submit a plan, or if the federal government finds a state plan to be insufficient or ineffective, the government will then impose the Standby Federal Plan on that state. The OER has already developed a gasoline contingency plan and is in the process of completing an emergency plan which meets the requirements established in the Emergency Energy Conservation Acts.

The State of Maine has shown its vulnerability to supply disruptions of heating oil as well as of gasoline. In February of 1979 during a severe cold spell, one of the largest marketers of fuel oil in the State failed to receive an expected shipment of the product. Due to the upheaval resulting from the Iranian revolution the major supplier was unable to deliver the needed heating oil. When the marketer contacted the Office of Energy Resources, the company could meet demand for only a few more days before it ran out of product, and no other source of supply seemed available. The OER attempted to locate more heating oil, but received no help from the federal government or from the oil companies. Finally, the OER was able to negotiate a loan of 2,245,578 gallons of heating oil from the Defense Fuel Supply Point in Casco Bay. This product enabled the marketer to meet demand and averted a crisis. Three months later, the marketer paid back the amount of fuel which had been borrowed. This situation emphasized the necessity of being prepared for an emergency and the fact that the State of Maine cannot depend upon the federal government in a crisis but may have to solve its own problems.

The past two shortages and the experience of February, 1979 emphasize the need to be prepared for future crises. The OER will continue to monitor the supply situation in Maine and to update its emergency plans. And, by encouraging conservation and the development of native resources in the State, the OER will be working to lessen dependence upon imported oil and to decrease the State's vulnerability to supply disruptions.

b. Economic Assistance Programs

Vulnerability to crude oil supply disruptions and declining American reserves of petroleum have created the national energy crisis. But the rapidly escalating cost of energy has produced a different kind of crisis for consumers. Maine has approximately 70,000 low income households. These families, who are already suffering from the effects of inflation, find they must dedicate a larger and larger share of their dwindling income to home energy. Inability to meet energy costs creates serious economic hardship and threatens their health and well-being. It is, therefore, the policy of the State of Maine to continue to administer federally-funded programs designed to provide energy-related assistance to these households. The State of Maine administers two such programs: the Home Energy Assistance Program (HEAP) program which provides financial assistance for home energy costs, and the Weatherization Program which furnishes materials and labor to insulate homes. Priority for these programs is given to the elderly, the handicapped and those with the lowest incomes.

The 1980-1981 HEAP will distribute $23,833,718 to between 55,000 and 70,000 households with payments ranging from $176.00 to $400.00. Last year's program assisted 52,012 households with benefits of up to $350.00. Twenty-six community action agencies, municipalities and Native American tribes will administer the program as local program operators. Payments will be made to fuel vendors on behalf of applicants who purchase direct benefits. To be eligible for the program, applicants must have an income level at or below 125% of the CSA Poverty Guidelines. Benefits will vary according to income, location in the state and type of energy used.

Funding for the 1980-1981 Weatherization Assistance Program amounts to $6,606,982 and the Division of Community Services anticipates completing 5,752 homes by the end of 1980. To date over 17,800 homes in the state have been weatherized. The Community Action Agencies and three Indian Reservations operate the program. Eligibility guidelines have been established by the federal government, and households may receive up to $1,000 in benefits. In addition to insulating walls and attics, the program can provide glass replacement, door sweeps, weatherstrip kits, caulking, storm windows, doors and perimeter skirting.

In addition to these programs, Governor Brennan's office has coordinated several Neighbor-to-Neighbor Conferences as a means of preparation for winter. Held in the fall, these day long conferences focus on establishing community communication and neighbor assistance networks at the local level. The purpose is to ensure that no elderly, low-income, handicapped or other persons are in need of food, heat or other necessities during the winter months.